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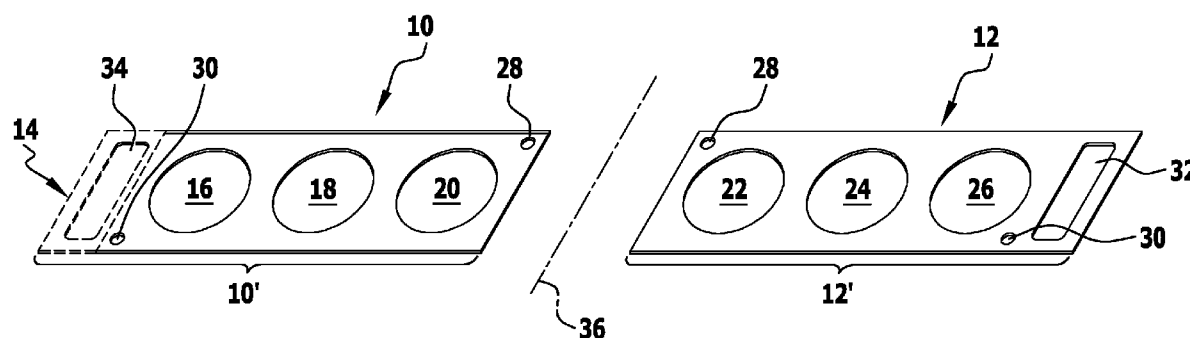


FIG.1

(57) Abstract: Elongate sheet-metal gasket layer, having several combustion chamber openings (16, 18, 20, 22, 24, 26), of a cylinder head gasket, and method for the production of such a gasket layer; the gasket layer comprises an entity made up of two gasket layer sections (10, 12) which contain all of the combustion chamber openings (16, 18, 20, 22, 24, 26) of the gasket layer and each of which comprises at least two elastomeric sealing elements spaced from each other and molded onto the gasket layer section (10, 12), the elastomeric sealing elements (i) of the two gasket layer sections forming, in each case, a pattern of sealing elements, and (ii) the patterns of the two gasket layer sections forming an overall pattern, and this overall pattern being of mirror-symmetrical configuration in relation to a transverse center line (36) extending between the gasket layer sections (10, 12) or the two patterns of the two gasket layer sections (10, 12) being of identical configuration.



**Method for the Production of a Sheet-Metal Gasket Layer
of a Cylinder Head Gasket and
Gasket Layer of a Cylinder Head Gasket**

The invention relates to a method for the production of an elongate sheet-metal gasket layer of a cylinder head gasket for a cylinder block which contains several cylinders arranged in a row and in which the cylinder head gasket is clampable between sealing surfaces of the cylinder block. In the assembled cylinder block, its sealing surfaces comprise, in each case, openings configured in accordance with an opening pattern, at least some of which are arranged one over the other and communicate with one another. The production method to which the invention applies relates, in particular, to cylinder head gaskets for commercial vehicle engines, i.e., for larger engines than passenger car engines. Hereinabove and hereinbelow, a cylinder block is to be understood as the unit consisting of cylinder head, cylinder head gasket and crankcase (the latter is often also referred to as engine block) of a multicylinder in-line engine or a corresponding cylinder block (often also referred to as cylinder bank) of a V-engine, in which each cylinder block has several cylinders. It should also be noted that the invention relates to a method for the production of a gasket layer of a cylinder head gasket, which may be single-layer or multilayer, i.e., may comprise only one gasket layer or several gasket layers arranged one on the other.

A cylinder head gasket to which the invention relates for a multicylinder in-line engine used in commercial vehicles with a so-called chain case or gear case over which the cylinder head gasket extends has a length of, in particular, more than 500 mm. In particular, the invention does, however, relate to a cylinder head gasket with a length of at least 850 mm, preferably at least 900 mm and, particularly preferred, at least 1000 mm, insofar as it also extends over a chain case or gear case. If the latter is not the case, the gasket length is at least 450 mm or 800 mm or 850 mm or 950 mm.

Cylinder head gaskets to which the invention relates for the cylinder banks of V-engines have lengths which, in particular, are approximately half the size of the aforementioned lengths.

In modern reciprocating piston internal combustion engines, more particularly, also in such engines for commercial vehicles, the inlet and outlet valves provided in the cylinder head are actuated by camshafts provided in the cylinder head, which are driven by the crankshaft of the engine by way of one or several chains or by way of a set of gears. For accommodating the chain, chains or gears, the engine has at its one front side a so-called chain case or gear case, which is divided between the crankcase or engine block and the cylinder head or the cylinder heads of a V-engine. The chain case or gear case may be formed in its entirety by an attachment of the engine or it is formed by a substantially dish-like attachment and a trough, in particular, provided at the one front side of the crankcase. The chain case or gear case must be sealed where it is divided. If this sealing is effected by a cylinder head gasket also extending over this case, it has a chain case opening or gear case opening in its one longitudinal end region.

In view of the costs involved in the production of a cylinder head gasket, cylinder head gaskets for relatively large engines, as are used in commercial vehicles, are not unproblematic, as these cylinder head gaskets inevitably have larger dimensions, above all, greater lengths than cylinder head gaskets for similar passenger car engines, unless the cylinder block of the in-line engine or V-engine produced for a commercial vehicle has for each cylinder a separate cylinder head and a separate cylinder head gasket (usually referred to as single gasket). The present invention does, however, relate exclusively to the production of a gasket layer of a cylinder head gasket, which extends over several cylinders.

A sheet-metal gasket layer of a single-layer or multilayer cylinder head gasket extending over several cylinders is known from the prior art, namely DE 10 2004 040 784 A1. This gasket layer comprises at least two layer parts

connectable or connected to each other, which will be referred to hereinbelow as gasket layer segments. The known gasket layer is thus divided into several gasket layer segments. In a multilayer cylinder head gasket in accordance with the construction principle underlying DE 10 2004 040 784 A1, only one of the gasket layers is divided into gasket layer segments, namely a so-called carrier layer of the cylinder head gasket, whereas all other gasket layers, in particular, one or several so-called functional layers are undivided, i.e., of continuous construction. A functional layer of a cylinder head gasket is understood by one skilled in the art as a gasket layer produced from a spring steel sheet, which is provided with one or several beads, whereas a carrier layer is understood as a gasket layer which, as the designation indicates, carries at least one gasket layer of a different kind, in particular, a functional layer - the sheet thickness of a functional layer is much smaller than that of a carrier layer and so the latter also serves to improve the form stability of the cylinder head gasket.

Figure 1 of DE 10 2004 040 784 A1 shows the gasket layer of a single-layer cylinder head gasket and indicates that this gasket layer is comprised of several gasket layer segments, more particularly, of a chain case sealing segment forming the one longitudinal end region of the gasket layer and several gasket layer segments containing combustion chamber openings, of which the gasket layer segment immediately adjacent to the chain case sealing segment and the gasket layer segment forming the other longitudinal end region of the gasket layer in comparison with each other, but also in comparison with the other gasket layer segments containing combustion chamber openings, are of different configuration with respect to their outer contours (even disregarding the fact that the gasket layer segment opposite the chain case sealing segment is comprised of two partial segments).

The same applies to the gasket layer shown in Figure 2 (however, only partially) which shows apart from a chain case sealing segment a gasket layer segment with two combustion chamber openings.

In accordance with claim 3 of DE 10 2004 040 784 A1, instead of a carrier layer divided into layer segments, a so-called thickness-forming layer or so-called distance layer can be used, i.e., a gasket layer which serves the purpose of increasing the material thickness of a multilayer cylinder head gasket, in order to achieve a greater so-called installation thickness of the cylinder head gasket (installation thickness is understood as the thickness of a cylinder head gasket in the installed state, i.e., when the gasket is clamped in the cylinder block with the aid of the cylinder head bolts).

In accordance with DE 10 2004 040 784 A1, elastomeric sealing elements can also be injection molded onto the gasket layer segments, in particular, for the sealing around through-openings of the gasket layer, such as through-openings for coolant and engine oil, but also a chain case opening or gear case opening.

The software used in the development of new engines for their design has recently been further improved, inter alia, with the aim, in order to reduce the production costs of the engine components cylinder head and engine block or crankcase, of designing these such that elements of the cylinder head and/or the engine block or crankcase can be produced more cost-effectively by being configured identically or mirror-symmetrically in relation to one another and, therefore, being able to be used several times in the respective component.

This development trend has been followed by the inventors of the present invention, who have set themselves the object of proposing a production method for a gasket layer of a single-layer or multilayer cylinder head gasket for commercial vehicle engines, for the performance of which devices, namely production tools, which are as low-priced as possible can be used. The production tools are to be understood as punching tools or other cutting tools for machining sheet metal, but, above all, the particularly high-priced tools for molding sealing elements onto the sheet metal of the gasket layer, in particular, for injection molding elastomeric sealing elements onto the sheet metal.

In this connection, it is pointed out that relatively small engines such as used in passenger cars and smaller commercial vehicles, such as so-called vans, are produced in much larger quantities than larger engines for commercial vehicles, construction machines and the like, but also for ships, and the same applies to larger stationary engines. Consequently, cylinder head gaskets for such larger engines are also only produced in relatively small quantities, and so in their production, the costs of the necessary production tools are of considerable importance, in particular, the costs of the particularly expensive tools for producing the elastomeric sealing elements.

A first solution to this object is based on a method for the production of an elongate sheet-metal gasket layer, provided with elastomeric sealing elements, of a cylinder head gasket, the gasket layer having two main surfaces, a first and a second longitudinal end, several combustion chamber openings arranged one behind the other in the longitudinal direction of the gasket layer as well as bolt through-openings for cylinder head bolts, first through-openings and elastomeric sealing elements associated with these as well as other openings, and comprising only two gasket layer segments lying in a gasket layer plane, and immediately adjacent to each other in the latter, and being provided, in each case, with at least one combustion chamber and with at least one such first through-opening including an elastomeric sealing element, the gasket layer segments containing all of the combustion chamber openings of the gasket layer, having, in each case, a longitudinal direction extending in the longitudinal direction of the gasket layer and a first and a second longitudinal end, and being, in the gasket layer plane, immediately adjacent to each other with their second longitudinal ends, and first gasket layer zones in which all of the elastomeric sealing elements of the two gasket layer segments are arranged being provided in the two gasket layer segments, each gasket layer zone being provided with at least one elastomeric sealing element, and at least one gasket layer zone comprising at least one of the first through-openings with at least one elastomeric sealing element associated with this first through-opening.

The aforementioned first through-openings are such through-openings of the gasket layer to which the following applies: Each of these first through-openings is individually sealed by an elastomeric sealing element which surrounds only this through-opening in a closed manner. Instead of a single sealing element, several elastomeric sealing elements may also be used, which all surround the associated through-opening in a closed manner (in each case, in a plan view of the gasket layer). Alternatively, although not preferred, only one elastomeric sealing element could be provided for a group of two or a few such first through-openings immediately adjacent to one another, which surrounds this group of first through-openings in a closed manner (again in a plan view of the gasket layer). In this case, too, instead of the one elastomeric sealing element, several elastomeric sealing elements could also be used, which all surround the entirety of this group of first through-openings in a closed manner. However, such a group of first through-openings is not to include all of the first through-openings of the layer segment or the gasket layer for which the gasket layer has elastomeric sealing elements.

In particular, through-openings of the gasket layer for coolant and engine oil, but also a chain case opening or gear case opening of the gasket layer belong to the aforementioned first through-openings.

The aforementioned first gasket layer zones are to be understood as regions of the gasket layer, in particular, of its sheet metal, each of which is provided with at least one elastomeric sealing element, which (in a plan view of the gasket layer) is at least substantially closed within itself and surrounds in most cases, i.e., in particular, one of the aforementioned first through-openings of the gasket layer - as will be clear from the following, the above definition of the gasket layer is, however, to also include the case that the gasket layer does not have any through-opening in such a gasket layer zone, i.e., that the elastomeric sealing element does not surround a through-opening.

The aforementioned other openings are to be understood, in particular, as such for engine oil, but also as so-called positioning holes of the gasket layer for the passage of positioning elements with which correct positioning of the cylinder head gasket in the assembled cylinder block is ensured.

Such a gasket layer can also be divided into several gasket layer segments such that gasket layer segments immediately adjacent to one another and adjoining one another in the gasket layer form of one or several bolt through-openings, in each case, only approximately half of the respective bolt through-openings, and, consequently, the two gasket layer segments together form complete bolt through-openings. Embodiments are, however, preferred, in which the bolt through-openings are undivided and, consequently, a bolt through-opening lies completely within one of the gasket layer segments.

In accordance with the invention, such a method is so configured that with it gasket layers are produced which, in each case, comprise only two of the aforementioned gasket layer segments, wherein for the production of the two gasket layer segments, in a first cutting operation two segment blanks are first cut out of sheet metal, each of the segments blanks having a first and a second main surface, a longitudinal direction and a first and a second longitudinal end, at least one blank combustion chamber opening and at least one first blank through-opening for one of the first through-openings of the gasket layer, and the elastomeric sealing elements for the first gasket layer zones of the gasket layer are then molded onto the segment blanks, the elastomeric sealing elements being so arranged and configured that with the two segment blanks, provided with the elastomeric sealing elements, arranged in a layer plane such that

- (a) the first main surface of the one segment blank and the second main surface of the other segment blank lie on the same side of the layer plane, and

- (b) the segment blanks are arranged in their longitudinal directions in alignment with each other one after the other and with their second longitudinal ends adjoining each other on either side of a center line extending in this layer plane and perpendicularly to the longitudinal directions of the segment blanks,

in a plan view of the aforementioned layer plane, the pattern formed by the elastomeric sealing elements of the two segments blanks is of mirror-symmetrical configuration in relation to this center line with respect to the number and positions and the sizes and shapes of the elastomeric sealing elements.

The number and the positions as well as the sizes and the shapes of the elastomeric sealing elements are, therefore, to be so selected that mirroring of the elastomeric sealing elements of the one segment blank at the said center line results in the elastomeric sealing elements of the other segment blank, more particularly, at least in a plan view of the segment blanks arranged in the aforementioned layer plane and on either side of the said center line. The mirror-symmetrical configuration of the pattern formed by the elastomeric sealing elements of the two segment blanks can also be so defined that when the two segment blanks are arranged in the above-described manner and the one segment blank is then pivoted about the said center line through 180° , so that the two segment blanks lie one on the other, the elastomeric sealing elements of the two segment blanks are arranged one over the other, and, in particular, in an exactly congruent manner (in a plan view of the segment blanks lying one over the other).

A blank combustion chamber opening is to be understood as an opening of a segment blank, which forms one of the combustion chamber openings of the gasket layer or which is formed by further machining into a combustion chamber opening of the gasket layer, and the same applies accordingly to a first blank through-opening of a segment blank with respect to one of the aforementioned first through-openings of the gasket layer.

If the two above-defined gasket layer segments contain all of the combustion chamber openings of the gasket layer, the two segment blanks also contain all of the blank combustion chamber openings for all of the combustion chamber openings of the gasket layer.

When it is stated hereinabove that the first main surface of the one and the second main surface of the other segment blank lie on the same side of the layer plane, this means that a plan view of the corresponding side of the layer plane also represents a plan view of these two main surfaces of the two segment blanks.

Finally, a mirror-symmetrical configuration of the pattern formed by the elastomeric sealing elements in relation to the aforementioned center line can also be understood as an axially symmetrical configuration in relation to this center line.

Since the two segment blanks are of mirror-symmetrical configuration in the above-described manner with respect to the pattern formed by the elastomeric sealing elements, the invention enables cost savings for the provision of the manufacturing equipment for the production of the gasket layer as the elastomeric sealing elements can be molded onto each of the two segment blanks with one and the same relatively small injection molding tool in which a segment blank is placed, in each case.

In conjunction with the solution, in accordance with the invention, to the set object, it should, finally, be noted that each cylinder head gasket is developed for a specific engine prescribed for the gasket design engineer, and so the design of the cylinder block sealing surfaces is prescribed for the gasket design engineer. The facts stated hereinabove do, however, also include the case that the design of the crankcase and/or of the cylinder head, in particular, of the sealing surfaces of these engine components that face one another, is developed and established in cooperation of the manufacturers of engine and

cylinder head gasket with one another, with the gasket design engineer endeavoring to ensure that a design of the sealing surfaces of crankcase and cylinder head, which is favourable for the construction and production of the cylinder head gasket, is obtained.

The above-defined solution, in accordance with the invention, to the set object leaves it open as to whether the two segment blanks obtained by the first cutting operation, for example, with respect to their outer contours and/or the number and positions and the sizes and shapes of those of its openings which correspond to the aforementioned first through-openings and/or the aforementioned other openings of the gasket layer segments to be produced, are of identical configuration and/or in this respect correspond to the configuration of the gasket layer segments to be produced. In this connection, the following is pointed out:

The sealing surfaces (often also referred to as cover surfaces) of the cylinder head and the crankcase or engine block of a cylinder block, between which the cylinder head gasket is clamped when assembling the cylinder block are often not of identical design: The outer contours of the two sealing surfaces may be of somewhat different design, the sealing surface of the crankcase or engine block and/or of the cylinder head may contain at least one opening having no opening of the cylinder head sealing surface or of the crankcase arranged opposite it, when the cylinder block is assembled, because one or several openings of the sealing surface of the crankcase or engine block and/or of the cylinder head is or are closed by the cylinder head gasket, and, in the assembled cylinder block, openings of the cylinder head sealing surface and of the crankcase sealing surface, which are of different design in shape and size, may be arranged opposite one another. This applies, in particular, to the openings of cylinder head gaskets for an engine oil or a coolant passage of the engine, above all, when the engine oil passage is not a pressure oil passage but an engine oil return-flow passage. In the case of coolant passages, there are often such passages in which the flow of coolant from the engine block into the cylinder head is throttled, more particularly, by the coolant passage

opening of the cylinder head gasket belonging to this coolant passage having a small cross-section corresponding to the desired throttle effect, which is significantly smaller than the cross-section of the opening in the sealing surface of the cylinder head and/or the engine block belonging to this coolant passage. In particular, in the aforementioned case that an opening of the sealing surface of the engine block and/or the cylinder head is closed by the cylinder head gasket because the associated liquid channel in the cylinder head or crankcase does not continue into the respective other engine component, a zone of the gasket layer of the cylinder head gasket is mostly provided with an elastomeric sealing element which seals around the mouth of the liquid channel in the component sealing surface associated therewith, but the gasket layer has no opening in this zone. Finally, for one or several of the aforementioned positioning elements, there is only in the sealing surface of the one engine component an opening for insertion of the positioning element fixed in the other engine component, which also results in the sealing surfaces of the engine block and the cylinder head not being of identical design. It should also be noted that the opening patterns of the sealing surfaces of the cylinder head and the crankcase of a cylinder block are often also not of mirror-symmetrical configuration with respect to a transverse center plane of the cylinder block because the cylinder block only has in its one longitudinal end region one or several cavities which are not present in the other longitudinal end region of the cylinder block, as is, for example, the case in an engine with a chain case or gear case, which results in the cylinder head gasket having a chain case opening or gear case opening only in one of its two longitudinal end regions and, consequently, for that reason alone not being able to be mirror-symmetrically configured with respect to the transverse center plane of the cylinder block.

The above-described cases do, however, not exclude that for such or other engines, by means of the aforementioned first cutting operation, two segment blanks are already produced, which have one, several or all of the following features:

- (a) each of the segment blanks forms sections of the longitudinal side edges of the gasket layer to be produced;
- (b) the two segment blanks are identical with respect to their outer contours;
- (c) the segment blanks are of identical design with respect to the number and positions and, in particular, also with respect to the shapes and sizes of at least their first blank through-openings and preferably all of their openings.

If the two segment blanks have the aforementioned features (b) and (c), in a series production of the gasket layer purely identical segment blanks can be cut out, in particular, stamped out by the aforementioned first cutting operation, for the placing of two such identical segment blanks congruently on each other and then the pivoting of the one segment blank about its second longitudinal end through 180° so that the two segment blanks lie in one plane and adjoin each other with their second longitudinal ends, result in an entity formed by the two segment blanks, which is of mirror-symmetrical configuration with respect to its outer contours and openings. This has the advantage that all of the segment blanks can be produced with one and the same punching tool, which in its size is adapted to that of a segment blank and, consequently, is only half the size of a punching tool for punching out a blank for the entire gasket layer to be produced.

The advantage that purely identical segment blanks can already be cut out by the first cutting operation and the elastomeric sealing elements can then be molded onto each of these segment blanks with one and the same tool, is, however, also achieved when the segment blanks obtained by the first cutting operation do not yet correspond to the corresponding gasket layer segments with respect to their outer and/or inner contours. For example, openings present in the gasket layer segments can also be cut out of the segment blanks with relatively low-priced cutting tools, for example, with small

punching tools and/or a laser, more particularly, also after the molding of the elastomeric sealing elements on the segment blanks.

In the case of substantially metallic single-layer and multilayer cylinder head gaskets, sealing around the combustion chamber openings of the gasket is usually effected by means of beads which were stamped into the gasket layer of a single-layer gasket or into gasket layers of a multilayer gasket, more particularly, preferably in the course of the punching-out of the gasket layer or gasket layers with a punching tool or a tool device in which punching is first carried out and the beads are then stamped in the punched-out gasket layer blank. When the above-discussed gasket layer in accordance with the invention has beads in the regions of the layer segments, in particular, around the combustion chamber openings, in view of the fact that, in accordance with the invention, identical segment blanks are first cut out in the described manner and these are used with different orientation of their main surfaces in the gasket layer, it is recommended that the production method in accordance with the invention be so configured that each of the segment blanks is punched out of the sheet metal and provided with at least one bead such that the bead of the one segment blank forms at its first main surface and the bead of the other segment blank at its second main surface, in each case, a projection. The different bead alignment in the two segment blanks can be readily taken into account by first segment blanks with the one bead alignment first being punched out and stamped and then segment blanks with the second bead alignment being punched out and stamped, more particularly, with a punching-stamping tool, which has at least one stamping tool part for the stamping of the bead or beads, with the one side of which the beads with the one bead alignment and with the opposite side of which the beads with the other bead alignment can be stamped, and which can be arranged in a different way in the tool such that either its one or its other side faces the respective segment blank to be stamped. Alternatively, two stamping tool parts, in particular, in the form of slide-in units, can be provided for the punching-stamping tool, which are so designed that with the one tool part beads with the one bead alignment and with the other tool part beads with the

other bead alignment can be stamped. Preferred embodiments of the method in accordance with the invention are, therefore, characterized in that each of the segment blanks is stamped out of a sheet metal and provided with at least one bead stamped in the sheet metal such that the bead of the one segment blank forms a projection at its first main surface and the bead of the other segment blank forms a projection at its second main surface.

It may be more advantageous not to already produce two segment blanks identical with respect to the number and positions and the shapes and sizes of all their openings by the aforementioned first cutting operation. This applies, in particular, to the case that the gasket layer to be produced has a, and, more particularly, only a single chain case opening or gear case opening. An alternative advantageous embodiment of the method in accordance with the invention is, consequently, characterized in that at least a second cutting operation is performed on at least one of the segment blanks provided with the elastomeric sealing elements such that the gasket layer formed with the thereby obtained layer segments has the final contours and openings of the gasket layer. Segment blanks can then be produced by the first cutting operation, which are all identical, in particular, with respect to the number and positions and the shapes and sizes of all of their openings, whereupon at least one second cutting operation is performed on at least one of the segment blanks provided with the elastomeric sealing elements, by means of which a region is severed from the one segment blank, which, for example, contains the second chain case opening or gear case opening that is not required or a predominant part of this opening. Other final contours of the gasket layer to be produced can, however, also be created by the at least one second cutting operation. In this connection, reference is made to the following explanations.

Since in preferred embodiments of the method in accordance with the invention the said second cutting operation is only performed after the molding of the elastomeric sealing elements on the segment blanks, it is advantageous if before performing the second cutting operation, on at least one of the said first blank through-openings the elastomeric sealing element is spaced from

the edge of this first blank through-opening such that the elastomeric sealing element and its adherence to the sheet metal are not impaired by the second cutting operation. This makes it possible, without impairing the elastomeric sealing element, to machine-finish the said first blank through-opening such that the corresponding first through-opening of the gasket layer segment corresponding to this segment blank results from it, more particularly, with the final size and shape of the gasket layer segment opening.

When hereinabove mention is made of the final contours and openings of the gasket layer, this is also to be understood as a gasket layer which has in its final form at least one so-called insert which is inserted into an opening of the gasket layer and is fixed therein and itself has an opening.

The following is to be added to the above statements relating to a second cutting operation:

If in each of the two segment blanks, the first longitudinal end is formed by a first longitudinal end region, and the second longitudinal end by a second longitudinal end region of the respective segment blank, a preferred embodiment of the method in accordance with the invention involving a second cutting operation is characterized in that the first longitudinal end region, which is a layer region that is not required in the finished gasket layer, is severed from a first one of the segment blanks provided with the elastomeric sealing elements by at least one second cutting operation - the finished gasket layer does, therefore, not include this severed first longitudinal end region. As is clear from the above explanations, the first longitudinal end region of each segment blank comprises, in particular, at least part of one of the said first blank through-openings, and this first blank through-opening is, in particular, an opening corresponding to a gear case opening or chain case opening of the layer segment obtained from the second segment blank.

As a precautionary measure, it is pointed out that the region severed by the second cutting operation from the one segment blank may contain apart from

the chain case opening or gear case opening or the at least one opening edge region of such an opening also at least one further element of this segment blank, which is not required in the final gasket layer, for example, a liquid through-opening and/or a positioning hole. Such an embodiment of the production method in accordance with the invention also allows the segment blanks to be provided with injection-molded elastomeric sealing elements in one and the same injection molding tool.

Embodiments of the method in accordance with the invention, in which, as described hereinabove, the first longitudinal end region is severed from a first segment blank by the second cutting operation, are preferably configured for the production of such a gasket layer in which the length of a first one of the two layer segments, which forms the first longitudinal end of the gasket layer and corresponds to the former first segment blank subjected to the second cutting operation, is smaller than the length of the second layer segment, more particularly, by a length L of the severed first longitudinal end region of the former first segment blank, wherein

- (a) the gasket layer, formed by the layer segments arranged in the gasket layer plane with their second longitudinal ends immediately adjacent to each other, without a longitudinal end region of the second layer segment forming the second longitudinal end of the gasket layer and having the length L , has a center line extending perpendicularly to the longitudinal direction of the gasket layer and lying in the gasket layer plane, and
- (b) the two layer segments without the longitudinal end region of the second layer segment having the length L are mirror-symmetrically configured in relation to this center line at least with respect to the number and positions and the sizes and shapes of the elastomeric sealing elements.

A gasket layer to be produced by the method in accordance with the invention will often have an even number of combustion chamber openings. For the

production of such a gasket layer, embodiments of the method in accordance with the invention are advantageous, in which segment blanks with an identical number of at least two blank combustion chamber openings are cut out.

Segment blanks, which are all in one piece and seamless, in particular, contain no welded or soldered seam, are cut out by preferred embodiments of the method in accordance with the invention. This is not to exclude the case that at least one of the gasket layer segments obtained from the segment blanks contains at least one so-called insert.

As is clear from the above explanations, embodiments of the method in accordance with the invention are preferred, in which the two segment blanks are each individually provided with the elastomeric sealing elements in an injection molding tool adapted to the size of a segment blank.

Finally, embodiments of the method in accordance with the invention are preferred, in which the two gasket layer segments immediately adjacent to each other are directly connected to each other by connecting elements which, when the cylinder head gasket is installed, lie outside of at least one of the sealing surfaces of a cylinder head and an engine block that are pressed against the cylinder head gasket, in any case, when the connecting elements are so designed that they result in a local thickening of the gasket layer.

As mentioned above, it is standard practice to define and fix the correct installation position of a cylinder head gasket by positioning elements such as positioning pins and/or positioning sleeves, which pass through positioning holes in the installed cylinder head gasket and are attached either to the cylinder head or to the engine block and engage in positioning holes of the respective other engine component. If a cylinder head gasket has only two positioning holes, which, in principle, is sufficient, if the two positioning holes are spaced to a sufficient extent from each other in the longitudinal direction of the gasket, the one positioning hole is usually circular and the other in the

form of an elongate hole in order that the cylinder head gasket will not be undesirably stressed during operation of the engine by thermal expansions of the engine components acting primarily in the longitudinal direction of the gasket. In a gasket layer produced in accordance with the invention with two gasket layer segments connected to each other, the one positioning hole can then be provided in the one and the other positioning hole in the other gasket layer segment.

Finally, it is pointed out that the gasket layer segments of a gasket layer produced in accordance with the invention may be spaced somewhat from one another in the longitudinal direction of the gasket. For this case, too, it is proposed that the gasket layer segments be directly connected to one another by connecting elements. Independently of whether the gasket layer segments adjoin one another or are spaced from one another, in the installed cylinder head gasket the gasket layer segments could, however, also be indirectly connected to one another, namely by way of at least one of the two engine components cylinder head and engine block, in particular, by means of positioning elements, as explained hereinabove.

The aforementioned second cutting operation has, at least in many cases, only to be performed on one of the two segment blanks, for example, in order to alter a circular positioning hole into an elongate hole and/or to remove a region of a segment blank not required in the finished gasket layer, which contains at least one element only present once in the finished gasket layer, such as, for example, a chain case opening or gear case opening.

The second cutting operation can also be performed with a comparatively simple punching tool, but preferably with a laser.

Regarding the elastomeric sealing elements mentioned hereinabove and also hereinbelow, it is pointed out that these project above the undeformed sheet metal of the gasket layer at at least one of the two main surfaces of the gasket layer and preferably at both of its main surfaces so that when the

cylinder head gasket is installed these elastomeric sealing elements are pressed sufficiently to be able to fulfill their sealing function. The regions of the elastomeric sealing elements projecting above the sheet-metal gasket layer usually form so-called sealing lips which, in a section through the gasket layer, are of approximately bulge-like or web-like configuration.

A variant, in accordance with the invention, of the solution to the object set forth hereinabove is based on a method for the production of an elongate sheet-metal gasket layer, provided with elastomeric sealing elements, of a cylinder head gasket, the gasket layer having two main surfaces, several combustion chamber openings arranged one behind the other in the longitudinal direction of the gasket layer as well as bolt through-openings for cylinder head bolts, first through-openings and elastomeric sealing elements associated with these as well as other openings, being in one piece and comprising only two such layer sections immediately adjacent to each other and arranged one behind the other in the longitudinal direction of the gasket layer and of substantially equal length in the longitudinal direction of the gasket layer that these two layer sections contain all of the combustion chamber openings and at least one group of the first through-openings of the gasket layer and each layer section is provided with at least one combustion chamber opening and with at least one of these first through-openings, and first gasket layer zones in which all of the elastomeric sealing elements of the two layer sections are arranged being provided in the two layer sections, each gasket layer zone being provided with at least one elastomeric sealing element, and at least one gasket layer zone comprising at least one of the first through-openings with at least one elastomeric sealing element associated with this first through-opening.

At least substantially the same is to apply to the above definition of this gasket layer as to the gasket layer on which the above-defined first solution, in accordance with the invention, to the set object is based.

In addition, regarding both gasket layers, it is pointed out, as a precautionary measure, that the elastomeric sealing elements of these gasket layers also include those elastomeric sealing elements which are associated with the first through-opening or through-openings of the gasket layer segments or gasket layer sections.

For this variant, such a production method is then so configured, in accordance with the invention, that a one-piece elongate gasket layer blank is first cut out of a sheet metal in a first cutting operation, the gasket layer blank having at least blank combustion chamber openings for all combustion chamber openings of the gasket layer and at least for each of the first through-openings of the aforementioned group of the first through-openings of the gasket layer a first blank through-opening, and comprising for the production of the two layer sections only two blank sections which are of at least substantially equal length in the longitudinal direction of the gasket layer blank and directly adjoin each other at least in areas at an axis of symmetry extending in the plane of the gasket layer blank and perpendicularly to its longitudinal direction, contain all of the blank combustion chamber openings and at least all of the first blank through-openings for the aforementioned group of first through-openings, and each of which is provided with at least one blank combustion chamber opening and at least one of these first blank through-openings for the aforementioned group of first through-openings, and the elastomeric sealing elements for the first gasket layer zones are then molded onto the gasket layer blank such that, in a plan view of the gasket layer, the pattern formed by the elastomeric sealing elements of the two blank sections is of mirror-symmetrical configuration in relation to this axis of symmetry with respect to the number and positions and the sizes and shapes of the elastomeric sealing elements.

Embodiments of this production method in accordance with the invention are preferred in which the opening pattern formed at least by the first blank through-openings for the aforementioned group of first through-openings of the gasket layer is also mirror-symmetrically configured in relation to the axis of symmetry.

When hereinabove mention is made of the fact that the gasket layer to be produced and the gasket layer blank are in one piece, this is to be understood as meaning that the gasket layer or the gasket layer blank is, in particular, seamless, for example, contains no welded or soldered seam. The feature that the gasket layer is in one piece must, however, not be interpreted as meaning that the finished gasket layer does not contain any elements connected to it, for example, so-called inserts inserted in the gasket layer.

In accordance with the above-defined variant, in accordance with the invention, of the solution to the object, the two layer sections of the gasket layer to be produced do not necessarily contain all of the first through-openings of the gasket layer (by which, in accordance with the definition, only such through-openings are to be understood as have elastomeric sealing elements associated with them) but at least a group, i.e., at least some of these first through-openings. This takes into consideration the case that in the finished gasket layer at least one layer region is only present once, for example, a layer region containing a chain case opening or gear case opening including an elastomeric sealing element. This must be taken into consideration in the interpretation of the above-mentioned feature of the mirror-symmetrical configuration of the opening pattern.

For the performance of the production method in accordance with the above-defined variant, in accordance with the invention, of the solution to the object a larger punching tool or punching-stamping tool than for the method in accordance with the first solution, in accordance with the invention, to the object, is required, but a single relatively small injection molding tool is sufficient for the above-defined variant of the solution to the object, for the injection molding of elastomeric sealing elements one after the other on each of the two blank sections or on each of the two halves of the gasket layer blank first produced.

Preferred embodiments in accordance with the above-defined variant of the solution to the object are characterized by at least one of the following features, with respect to which reference is made to the corresponding explanations of preferred embodiments of the production method in accordance with the invention, configured in accordance with the first solution to the object.

The gasket layer blank is provided with at least one bead stamped into the sheet metal before the injection molding of the elastomeric sealing elements.

In preferred embodiments of the second solution, in accordance with the invention, to the set object, the gasket layer blank already provided with the elastomeric sealing elements is formed, before a second cutting operation that may have to be performed, such that the pattern formed by all of the elastomeric sealing elements is of mirror-symmetrical configuration, more particularly, in relation to a center line lying in the plane of the gasket layer blank and extending perpendicularly to its longitudinal direction. This is also to apply to the case that the gasket layer blank provided with the elastomeric sealing elements comprises two layer sections forming its longitudinal ends with at least one elastomeric sealing element, in each case, and for the production of the final gasket layer, one of these layer sections is severed because the finished gasket layer does not have a layer region which corresponds to this severed layer section. In such a case, the finished gasket layer has only at one of its two longitudinal ends a layer section which, for example, contains a chain case opening around which an elastomeric sealing element is provided.

If the finished gasket layer has a longitudinal end region which is only present once in the gasket layer, the production method is configured as follows: The length, measured in the longitudinal direction of the gasket layer blank, of the gasket layer blank obtained by the first cutting operation is chosen greater by a length L than the length of the finished gasket layer, measured in the longitudinal direction of the gasket layer, and a first longitudinal end region of

the gasket layer blank forming a first longitudinal end of the gasket layer blank obtained by the first cutting operation is shortened by at least one second cutting operation by the length L, more particularly, by severing a first edge zone of this first longitudinal end region, which is a layer region that is not required in the finished gasket layer.

The gasket layer blank obtained by the first cutting operation comprises, in particular, a second longitudinal end region forming a second longitudinal end of the gasket layer blank and the second longitudinal end comprises a second edge zone corresponding to the first edge zone and not severed by the second cutting operation.

Furthermore, the first and the second longitudinal end regions of the gasket layer blank obtained by the first cutting operation preferably comprise, in each case, at least one of the first blank through-openings, and the first edge zone preferably contains at least part of the first blank through-opening of the first longitudinal end region.

Moreover, the first blank through-opening of the first longitudinal end region is, in particular, an opening corresponding to a gear case opening or chain case opening of the second longitudinal end region.

Finally, it is preferable to mold the elastomeric sealing elements for the first gasket layer zones onto the gasket layer blank before the second cutting operation, and to configure the production method, in particular, such that before performance of the second cutting operation, at least one of the elastomeric sealing elements is spaced from the edge of a first blank through-opening associated with this sealing element such that this sealing element and its adherence to the sheet metal are not impaired by the second cutting operation.

Furthermore, in a particularly preferred embodiment, the two blank sections are provided one after the other with the elastomeric sealing elements in an

injection molding tool adapted to the size of the blank sections, i.e., one of the blank sections.

Finally, a method feature is to be recommended, according to which the at least one second cutting operation is so performed that the gasket layer to be produced thereby obtains its final contours and openings.

The two above-described solutions, in accordance with the invention, to the set object have in common the basic principle of a mirror-image configuration of a pattern formed by elastomeric sealing elements, so that the gasket layer obtained by the invention does not as a whole have to be of mirror-symmetrical configuration in relation to a center line of the gasket layer extending transversely to the longitudinal direction of the gasket layer, but does, nevertheless, allow sections of the gasket layer, namely the two gasket layer segments or the two layer sections of the gasket layer to be provided with injection-molded elastomeric sealing elements with one and the same relatively small injection molding tool.

This also allows a third variant of the solution, in accordance with the invention, to the set object. This third variant of the solution relates to the production of a gasket layer of a single-layer or multilayer cylinder head gasket for such engines, in particular, commercial vehicle engines, whose crankcase and cylinder head comprise sealing surfaces to be pressed against the cylinder head gasket, which have openings around which sealing must be effected by elastomeric sealing elements of the cylinder head gasket in the assembled engine and which define opening patterns which allow the use of a cylinder head gasket with a gasket layer comprising several layer sections which are of identical configuration with respect to the number and positions and the shapes and sizes of their elastomeric sealing elements.

Consequently, the third solution variant of the present invention is based on a method for the production of an elongate sheet-metal gasket layer of a cylinder head gasket, which is provided with elastomeric sealing elements

injection molded onto the sheet metal of the gasket layer, the gasket layer comprising several combustion chamber openings arranged one behind the other in the longitudinal direction of the gasket layer and such first through-openings with which at least one of the elastomeric sealing elements is associated, in each case, as well as other through-openings, the gasket layer comprising several layer sections arranged one behind the other in its longitudinal direction and provided, in each case, with at least one elastomeric sealing element, the layer sections being of identical configuration at least with respect to the number and positions and the shapes and sizes of their elastomeric sealing elements and preferably being of equal length (at least substantially) in the longitudinal direction of the gasket layer.

In order to make such a production method cost-effective, it is proposed in accordance with the third solution variant, for the production of the gasket layer, to cut a one-piece gasket layer blank comprising blank sections corresponding to the aforementioned layer sections of the gasket layer out of a sheet metal and to provide these blank sections, in each case, individually with the elastomeric sealing elements in an injection molding tool adapted to the size of the blank sections.

The following is to be noted with regard to the above-defined production method:

The sheet-metal gasket layer does, of course, contain apart from the combustion chamber openings and the first through-openings, with which elastomeric sealing elements are associated, and which, in most cases, are through-openings for cooling water and engine oil, other through-openings and holes, in particular, through-openings for cylinder head bolts and possibly positioning holes for the passage of positioning elements therethrough.

Apart from the aforementioned layer sections provided with elastomeric sealing elements, which are of identical configuration with respect to the number, positions, shapes and sizes of their elastomeric sealing elements, the

gasket layer may have at least one further layer section which does not have the feature of identical configuration, and the aforementioned layer sections of identical configuration with respect to their elastomeric sealing elements do also not have to adjoin one another directly in the gasket layer, although such embodiments are to be preferred, which does, however, of course, require a corresponding design of the sealing surfaces of the crankcase and the cylinder head.

If the gasket layer to be produced contains a layer section which has a through-opening, with which an elastomeric sealing element is associated, but with respect to this elastomeric sealing element is not of identical configuration to the layer sections discussed above and relevant to the present invention, this layer section can be provided in a manner known per se with a so-called insert, which is inserted into the sheet metal of this layer section, is secured in the sheet metal and provided with an elastomeric sealing element, which surrounds a through-opening provided in this insert. Such a procedure is of importance, in particular, for a gasket layer which comprises a layer section containing a chain case opening or gear case opening. In this connection, it should be noted that such inserts are mostly parts which are formed by a sheet metal part which is provided with a through-opening and with an elastomeric sealing element surrounding the through-opening. For the manufacture of these relatively small inserts, a simple and correspondingly small injection molding tool is then sufficient for producing the elastomeric sealing element.

Furthermore, as a precautionary measure, it is pointed out that of the layer sections of identical configuration with respect to their elastomeric sealing elements, each layer section may comprise only a single through-opening, with which at least one elastomeric sealing element is associated.

Finally, it is pointed out that if the layer sections relevant to the present invention could be placed on one another, these need only be of identical, i.e., congruent configuration with respect to the number, positions, shapes and

sizes of their elastomeric sealing elements, but not with respect to other elements of these layer sections.

The above-defined third solution variant in accordance with the invention entails the following advantage:

Although the gasket layer blank first created for the production of the gasket layer is undivided, i.e., is in one piece, for the production of the gasket layer a large injection molding tool corresponding to the length of the gasket layer or the gasket layer blank is not required for providing the gasket layer blank with the elastomeric sealing elements. Instead, each of the blank sections relevant to the present invention can be separately provided with its at least one elastomeric sealing element in one and the same relatively small injection molding tool, i.e., the blank sections can be provided one after the other with their elastomeric sealing elements with the same injection molding tool. The possibility of using a single and relatively small injection molding tool is of particular importance for such cylinder head gaskets, which are produced in relatively small quantities for, in this case, the costs of the production of the cylinder head gaskets is influenced to a large extent by the tool costs, above all, by the costs of the injection molding tool, which increase sharply with its size.

As is already evident from the above explanations of the first and second solution variants, in the third solution variant, too, the elastomeric sealing elements could be injection molded onto the gasket layer blank before the through-openings, with which the elastomeric sealing elements are associated, are cut out of the gasket layer blank. It is, however, preferable to provide the gasket layer blank with the corresponding through-openings before the injection molding of the elastomeric sealing elements.

The production method configured in accordance with the third solution variant is preferably performed such that the blank sections relevant to the present invention are provided one after the other with the elastomeric sealing

elements in a single injection molding tool. The elastomeric sealing elements are, therefore, injection molded onto the blank sections sequentially, and the injection molding tool is then preferably configured such that the gasket layer blank can be pushed stepwise through the injection molding tool in order to provide one blank section after the other with at least one elastomeric sealing element after the respective blank section has previously been correctly positioned and fixed by known mechanisms in the injection molding tool. This procedure does, however, not necessarily require the blank sections relevant to the present invention to adjoin one another directly.

The following is also pointed out with regard to the three above-explained solutions, in accordance with the invention, to the set object:

To be able to injection mold elastomeric sealing elements onto the two segment blanks or the two blank sections or the several blank sections arranged one after the other in the gasket layer blank with one and the same relatively small injection molding tool, it may be advantageous or even necessary to injection mold on at least one segment blank or at least one blank section at least one elastomeric sealing element which has no function because the sealing surfaces of the crankcase and the cylinder head of the engine for which the cylinder head gasket was designed do not have any openings to be sealed in their areas opposite this elastomeric sealing element without any function, whereas the other segment blank or the other blank section or another blank section at the location corresponding to the location of the elastomeric sealing element without any function has an elastomeric sealing element which surrounds a first through-opening or a gasket layer region without an opening, which together with the elastomeric sealing element serves to seal an opening in the crankcase and/or cylinder head.

Finally, the present invention relates to elongate sheet-metal gasket layers of cylinder head gaskets, which can preferably be produced with a production method in accordance with one of the above-explained three variants of the solution to the set object and are defined by the appended claims 39 to 56. A

repetition of the features of these claims will, therefore, be dispensed with at this juncture.

Merely for the sake of completeness, mention will be made of the fact that one, several or all of the gasket layers produced in accordance with the invention may be provided completely or only partially with a coating or several coatings on one or both of their main surfaces, as is known from the prior art relating substantially to metallic cylinder head gaskets.

Further features, advantages and details of the invention will be apparent from the appended drawings and the following description thereof; in the drawings:

Figure 1 shows a schematic illustration of a gasket layer of a cylinder head gasket for a cylinder block or a cylinder bank with six cylinders, wherein the gasket layer was produced in accordance with a first embodiment of the method in accordance with the invention and is formed by two layer segments, which in Figure 1, however, were illustrated as still being at a longitudinal distance from each other;

Figures

2 and 3 show illustrations, corresponding to Figure 1, of a gasket layer for a cylinder block or a cylinder bank with three and five cylinders, respectively;

Figure 4 shows a schematic illustration of a gasket layer, produced in accordance with a second embodiment of the method in accordance with the invention, for a cylinder block or a cylinder bank with six cylinders;

Figure 5 shows an isometric illustration of a cylinder block which does, however, only show regions facing each other of a cylinder head and a crankcase or engine block with their sealing surfaces facing

each other and a cylinder head gasket to be clamped between the latter, which comprises the gasket layer shown in Figure 4;

Figures

6A and 6B show isometric illustrations of an injection molding tool together with a gasket layer blank, also recognizable in Figure 4, whose left half, in accordance with Figure 6B, is already provided with injection-molded elastomeric sealing elements;

Figure 7 shows a plan view of two segment blanks for a gasket layer comprised of two layer segments, more particularly, after the injection molding of elastomeric sealing elements onto the gasket layer blanks;

Figures

7A, 7B

and 7C show a left, middle and right part, respectively, of Figure 7 on a larger scale;

Figure 8 shows a plan view of the gasket layer produced using the segment blanks shown in Figure 7;

Figures

8A to 8D show sections along lines A-A, B-B, C-C and D-D in Figure 8;

Figure 9 shows a plan view of the segment blank, illustrated on the right in Figure 8, before the injection molding of the elastomeric sealing elements;

Figure 10 shows an isometric illustration, corresponding to Figure 6A or 6B, of a gasket layer blank and an injection molding tool of an embodiment in accordance with the third solution variant of the invention;

Figure 11 shows an isometric and highly simplified illustration of part of a punching-stamping tool for producing the segment blanks for the first production method in accordance with the invention, wherein two slide-in units, i.e., tool parts, are provided for this tool, only the one slide-in unit of which is illustrated in Figure 11;

Figures

12A and 12B

show sections through the two slide-in units in accordance with line 12-12 in Figure 11;

Figure 13 shows part of an injection molding tool for injection molding elastomeric sealing elements onto the segment blanks or a gasket layer blank for the first, second and third production method, respectively, in accordance with the invention, wherein the injection molding tool is shown highly simplified, partly in the manner of an isometric illustration and partly in section; and

Figure 14 shows a plan view of a region of a segment blank or a gasket layer blank to be provided with an injection-molded elastomeric sealing element, before the injection molding of the elastomeric sealing element.

A first embodiment of the first solution variant of the invention will be explained with reference to Figure 1, more particularly, on the basis of a gasket layer of a cylinder head gasket for an in-line six-cylinder engine. For this purpose, there are shown in solid lines in Figure 1 two layer segments 10 and 12 of a sheet-metal gasket layer of a cylinder head gasket for an in-line six-cylinder engine or for a cylinder bank of a V12 engine. Figure 1 is, however, also intended to illustrate how the segment blanks used in accordance with the invention for the production of the layer segments 10 and 12 may be configured. In this case, the contours of the layer segment 12 also

substantially constitute the contours of the segment blank for this layer segment, and on the left in Figure 1 there is indicated in dashed lines a longitudinal end region 14 by way of which the segment blank for the layer segment 10 primarily differs from the latter - consequently, the segment blanks for the layer segments 10 and 12 were also indicated by the reference numerals 10' and 12' in Figure 1.

The layer segment 10 or the segment blank 10' comprises three combustion chamber openings 16, 18 and 20 for the first three cylinders, and the layer segment 12 or the segment blank 12' three combustion chamber openings 22, 24 and 26 for the second three cylinders of the in-line engine or the cylinder bank of the V-engine. In addition, each of the layer segments or each of the segment blanks has a first positioning hole 28 and a second positioning hole 30, the layer segment 12 or the segment blank 12' is provided with a chain case opening 32 and the segment blank 10' with a chain case opening 34 (this could also be a gear case opening, and for simplification the term chain case opening will always be used for both hereinbelow).

Figure 1 shows the layer segments 10 and 12 at a distance from each other (in the longitudinal direction of the two layer segments or the gasket layer). They could, however, also adjoin each other directly and thus form a gasket layer which is continuous except for a dividing joint.

In any case, with respect to their outer contours and the positions, shapes and sizes of their openings, the two segment blanks 10' and 12' are of mirror-symmetrical configuration in relation to a center line 36 shown in Figure 1, which, in the illustration of Figure 1, is to lie in a plane in which the segment blanks 10' and 12' also lie. If one imagines that the segment blank 12' is pivoted in the counterclockwise direction about the center line 36 and through 180° so that it lies on the segment blank 10', Figure 1 shows that the two segment blanks are of identical configuration with respect to their outer contours and the positions, shapes and sizes of all of their openings.

Since the layer segments 10 and 12 and the associated segment blanks 10' and 12' were only illustrated in Figure 1 in a highly simplified and schematized way, Figure 1 does, of course, not show all of the elements of the layer segments or segment blanks, in particular, not bolt through-openings for cylinder head bolts and liquid through-openings for cooling water or engine oil, and also not any elastomeric sealing elements.

After the first cutting operation, which takes place in accordance with the present invention, for cutting out the segment blanks 10', 12', but, in particular, also after the injection molding of elastomeric sealing elements not shown in Figure 1, a second cutting operation takes place, in this case, in accordance with the invention, by which, above all, the longitudinal end region 14 of the segment blank 10', which is not required in the finished gasket layer, is severed - an engine usually has a single chain case or gear case for a cylinder block, and, consequently, the gasket layer comprised of the two layer segments 10 and 12 also only requires a single chain case opening or gear case opening and not the chain case opening or gear case opening 34 indicated on the left in Figure 1 as well.

In the course of this second cutting operation, in the embodiment shown in Figure 1, the initially circular positioning holes 28, 30 can then preferably also be partly machine-finished, more particularly, in one or both of the segment blanks 10', 12' one of the positioning holes is altered into an elongate hole, for example, the positioning holes 30 of the segment blank 10' and of the segment blank 12', in order to take into account unavoidable manufacturing tolerances and thermal expansions. However, in the course of the second cutting operation, other through-openings, not shown in Figure 1, of a segment blank or both segment blanks can also be machine-finished, for example, liquid through-openings of the segment blank 12'.

The production of alternative gasket layers will be explained hereinbelow with reference to Figures 2 and 3.

Figure 2 shows in solid lines two layer segments 10a and 12a of a gasket layer of a cylinder head gasket for an in-line three-cylinder engine or a cylinder head gasket for a cylinder bank of a V-engine with six cylinders. The layer segment 10a has only one combustion chamber opening 20a, whereas the layer segment 12a has two combustion chamber openings 22a and 24a. Furthermore, Figure 2 shows two positioning holes 28a and 30a of the layer segment 10a and two positioning holes 28a and 30a and a chain case opening 32a of the layer segment 12a.

For the production, in accordance with the invention, of the two layer segments, two segment blanks are first cut out. The segment blank 10a' for the layer segment 10a is illustrated on the left in Figure 2 partly in solid lines and partly in dashed lines, with the left boundary line, in accordance with Figure 2, of the layer segment 10a for illustration of the segment blank 10a' being omitted. The segment blank 10a' thus has two combustion chamber openings 18a' and 20a and one chain case opening 34a'. The contours of the segment blank 12a' shown on the right in Figure 2 are identical to the contours of the layer segment 12a.

In analogy with the illustration in Figure 1, the segment blanks 10a', 12a' shown in Figure 2 are to be of mirror-symmetrical configuration in relation to the center line 36, so that when the segment blank 12a' is pivoted through 180° about the center line 36', the two segment blanks 10a', 12a' lie congruently on each other.

In the second cutting operation to be performed in accordance with the invention, a left longitudinal end region 14a of the segment blank 10a', which is illustrated in dashed lines in Figure 2 and which contains the combustion chamber opening 18a' and the chain case opening 34a', is severed. A gasket layer comprised of the thus obtained layer segments 10a and 12a, therefore, only contains a single chain case opening, namely the chain case opening 32a.

Regarding the positioning holes 28a and 30a of the two segment blanks or the two layer segments, the same is to apply as to the positioning holes 28 and 30 of the embodiment shown in Figure 1.

It is also evident from Figure 2 that if instead of the left longitudinal end region 14a, illustrated in dashed lines in Figure 2, of the segment blank 10a' only a narrower left longitudinal end region is severed, which contains only the chain case opening 34a', but not the combustion chamber opening 18a', in accordance with the invention a gasket layer for a cylinder block or a cylinder bank with four cylinders can also be produced, i.e., a gasket layer with the combustion chamber openings 18a', 20a, 22a and 24a as well as a single chain case opening, namely the chain case opening 32a.

Figure 3 serves to explain a further embodiment which relates to the production, in accordance with the invention, of a gasket layer of a cylinder head gasket for an in-line five-cylinder engine or for a cylinder bank of a V-engine with ten cylinders. Since the illustration of Figure 3 is extremely similar to that of Figure 2, the letter **a** in the reference numerals used in Figure 2 was replaced by the letter **b** for Figure 3, and Figure 3 will only be described hereinbelow insofar as it differs from the illustration in Figure 2.

In the embodiment illustrated in Figure 3, each of the segment blanks 10b' and 12b' comprises three combustion chamber openings 18b', 18b and 20b and 22b, 24b and 26b, respectively, and a chain case opening 32b and 34b', the two segment blanks 10b' and 12b' are again of mirror-symmetrical configuration in relation to the center line 36, and when the segment blank 12b' is pivoted through 180° about the center line 36, the two segment blanks 10b' and 12b' lie congruently over each other.

In the second cutting operation to be performed in accordance with the invention, a left longitudinal end region 14b, in accordance with Figure 3, is severed from the segment blank 10b' and regarding further measures possible

in the course of the second cutting operation, reference is made to the above statements on Figures 1 and 2.

Accordingly, a gasket layer with five combustion chamber openings and a single chain case opening 32b can be produced with the layer segments 10b and 12b made in accordance with the invention.

An embodiment in accordance with the second solution variant of the present invention will be explained with reference to Figure 4.

Figure 4 shows in solid lines a gasket layer 40 of a cylinder head gasket for an in-line six-cylinder engine or for a cylinder bank of a V-engine with twelve cylinders, and, in addition, with a combination of solid and dashed lines a gasket layer blank 40', which serves for the production of the gasket layer 40, and for the illustration of which the left boundary line, in accordance with Figure 4, of the gasket layer 40 is omitted.

The gasket layer 40 and, therefore, also the gasket layer blank 40' has six combustion chamber openings 42, 44, 46, 48, 50 and 52, a chain case opening 54, two positioning holes 56 and 58, two engine oil through-openings 60 and 62 and six cooling water through-openings 64, 66, 68, 70, 72 and 74.

The gasket layer blank 40' is longer than the gasket layer 40 by a length L, more particularly, by the length of a left longitudinal end region 76', in accordance with Figure 4, which contains a chain case opening 78' corresponding to the chain case opening 54.

The gasket layer blank 40' is, in its entirety, to be of mirror-symmetrical configuration in relation to a center line 36 and so configured that, in this case, after a second cutting operation to be performed in accordance with the invention, in which the longitudinal end region 76' is severed, the gasket layer 40 is obtained - regarding further possible measures which can be taken in the

course of the second cutting operation on the gasket layer blank 40', reference is made to the above statements on Figures 1 to 3.

Before this second cutting operation, the gasket layer blank 40' is provided with elastomeric sealing elements for through-openings to be sealed in the finished gasket layer. In the case of such through-openings typical of the present invention, elastomeric sealing elements were indicated, in each case, by a thick dot-and-dash line and designated by E in Figure 4.

The following is to be noted in connection with Figure 4. This is also to apply to the case that Figure 4 is to be understood as illustration of two segment blanks:

Merely for the sake of completeness, gasket layer zones in which elastomeric sealing elements are arranged were also indicated in Figure 4. However, such gasket layer zones were only indicated in the regions of the chain case opening 54 and the engine oil through-opening 60, more particularly, by lines formed by dots, and these gasket layer zones were indicated by A. From the explanations given in the part of the specification preceding the description of the Figures, it is, however, clear, that such a gasket layer zone is always to contain at least one elastomeric sealing element, but is not provided in each case with a through-opening.

The left longitudinal end region 76' of the gasket layer blank 40' that is to be severed, could, however, contain instead of the chain case opening 78' not required in the finished gasket layer or in addition to the chain case opening 78' an element of the gasket layer blank, which is not required in the assembled finished gasket layer 40 because the engine containing the finished gasket layer 40 does not have a corresponding passage at the location of this element in its crankcase (engine block) and its cylinder head, for example, does not have a passage for engine oil or cooling water. The dimension L of the longitudinal end region 76' that is to be severed might than be somewhat larger than the dimension L indicated in Figure 4.

In Figure 4, too, further features of the gasket layer 40 and the gasket layer blank 40' where omitted for simplification of the illustration.

Figure 4 is, however, also to be understood as showing instead of the two halves of the gasket layer blank 40 two segment blanks of an embodiment in accordance with the first solution, in accordance with the invention, of the set object. In this case, the one segment blank lies, in accordance with Figure 4, to the left of the central line (or line of symmetry) 36 and the other segment blank to the right of the line 36, and the two segments blanks do not form a one-piece gasket layer blank, but two separate parts which adjoin each other at the line 36.

At this juncture, the following is pointed out:

In substantially metallic cylinder head gaskets, sealing beads are usually used for sealing around the combustion chamber openings. These are stamped into the gasket layer of a single-layer cylinder head gasket or into one or several gasket layers of a multilayer cylinder head gasket and surround the combustion chamber openings in a closed manner. In the embodiment in accordance with Figure 4, each of these sealing beads not illustrated in Figure 4 is to form a projection on the same main surface of the gasket layer 40 or the gasket layer blank 40'.

In this connection, the following is to be noted regarding the embodiments illustrated in Figures 1 to 3 and the above-mentioned case that Figure 4 shows two separate segment blanks.

If the segment blanks shown in Figures 1 to 4 and produced as separate parts are all produced in a punching-stamping tool adapted to the respective embodiment and are provided with stamped sealing beads for their combustion chamber openings, these sealing beads in respective first of the two segment blanks form a projection, in each case, at their one main

surfaces, whereas the sealing beads in respective second of the two segment blanks form a projection, in each case, at their other main surfaces and so in Figures 1 to 4 the sealing beads not shown there for reasons of simplicity will all project either upwards or downwards in accordance with these Figures of the drawings.

As explained hereinabove, the segment blanks of a gasket layer comprising only two layer segments can be punched out and provided with the sealing beads with one and the same tool device, the stamping of the differently oriented sealing beads only requiring that this tool device be provided with at least one exchangeable or reversible tool insert or slide-in unit, so as to be able to provide the one segment blank with sealing beads projecting in a first direction and the other segment blank with sealing beads projecting in a second, opposite direction. In this connection, reference is made to Figures 11 and 12 which will be explained hereinbelow.

As mentioned above, a gasket layer to be produced in accordance with the invention, comprises in the segment blanks of the embodiments shown in Figures 1 to 3 or in the gasket layer blank 40' one or several through-openings, for example, the engine oil and/or cooling water through-openings and/or the chain case openings illustrated in Figure 4, which are to be provided with elastomeric sealing elements injection molded onto the sheet metal, in particular, before performance of the second cutting operation. The injection molding of these elastomeric sealing elements onto the segment blanks or onto the two layer sections or halves of the gasket layer blank 40' lying on either side of the center line or axis 36 is then carried out with one and the same injection molding tool, which is adapted to the size and configuration of the two segment blanks of the embodiments in accordance with Figures 1 to 3 and to the configuration of one half of the gasket layer blank 40' of the embodiment in accordance with Figure 4, respectively. In this connection, reference is made to Figures 6a and 6b which will be explained hereinbelow and, in addition, it is recalled that in each of the embodiments in accordance with Figures 1 to 3 the two respective segment blanks and in the

embodiment in accordance with Figure 4 the two halves of the gasket layer blank 40' are, in particular, of identical configuration, except that in the embodiments in accordance with Figures 1 to 3 the sealing beads of the two respective segment blanks are differently oriented, as described hereinabove, but this is of no importance for the design of the injection molding tool.

Figure 5 shows an upper part of an engine block or crankcase 80, a lower part of a cylinder head 82 and a, in this case, single-layer, cylinder head gasket 84 of a cylinder block of an in-line six-cylinder engine or a cylinder bank, containing six cylinders, of a V-engine. For further details it is to be assumed that the gasket layer of the single-layer cylinder head gasket 84 is the gasket layer 40 shown in Figure 4, and, therefore, the same reference numerals were used for this gasket layer and its elements in Figure 5 as in Figure 4. To simplify the illustration, elastomeric sealing elements of the cylinder head gasket 84 injection molded onto the sheet metal of the gasket layer 40 were omitted in Figure 5.

Sealing surfaces of the engine block 80 and the cylinder head 82, between which the cylinder head gasket 84 is clamped in the assembled engine, were designated by 80A and 82A.

Figure 5 shows the engine block, the cylinder head gasket and the cylinder head, but in positions spaced from one another, so as to be able to show the opening patterns of the sealing surfaces 80A and 82A. Insofar as possible, the same reference numerals were used for the elements of the opening patterns of the sealing surfaces 80A and 82A as for the openings of the gasket layer 40, but supplemented by one prime in the sealing surface 80A and by two primes in the sealing surface 82A. Finally, six valve arrangements 86 for the six cylinders and bore holes 56'' for receiving two positioning pins 56' protruding from the sealing surface 80A and attached to the latter and a chain case opening 54'' are discernible in the sealing surface 82A of the cylinder head 82, and a corresponding chain case opening in the sealing surface 80A was designated by 54' - in this engine the chain case shaft which accommodates

the drive for the valves mounted in the cylinder head 82 is divided in the plane receiving the cylinder head gasket 84 in the assembled engine and is sealed there by the cylinder head gasket 84, and, therefore, the chain case openings 54, 54' and 54'' lie over one another in a fitting manner in the assembled engine.

In Figure 5 a plane of symmetry 36' is indicated, which extends perpendicularly to the drawing plane of Figure 5 and in relation to which (apart from the chain case openings 54, 54' and 54'' and the absence of positioning holes in the sealing surface 80A) the opening patterns of the sealing surfaces 80A and 82A and of the gasket layer 40 are preferably of mirror-symmetrical configuration. In this connection, however, the above explanations are to be noted, according to which these opening patterns may differ with respect to the number and/or the size and shape of their openings, and it is also pointed out that the openings provided for engine oil and cooling water in the sealing surfaces 80A and 82A are the orifices of cavities formed in the engine block 80 and in the cylinder head 82 for engine oil and cooling water, respectively, and the openings 42', 44', 46', 48', 50' and 52' discernible in the sealing surface 80A are the orifices of the cylinder bores of the engine block 80.

With reference to Figures 6A and 6B, the injection molding of elastomeric sealing elements onto the two halves of the gasket layer blank 40' of the embodiment in accordance with Figure 4 will be explained hereinbelow, and, therefore, the same reference numerals were used for the gasket layer blank and its elements in Figures 6A and 6B as in Figure 4, except that in Figure 6B elastomeric sealing elements were indicated, with which the left half of the gasket layer blank 40' in accordance with Figure 6B was already provided in a first step of the injection molding process. It is, however, to be noted again that Figures 6A and 6B may also be interpreted as showing instead of the two halves of the gasket layer blank 40' the two segment blanks 10' and 12' of the embodiment in accordance with Figure 1, the one segment blank of which is located in the injection molding tool and the other segment blank outside the

injection molding tool, but immediately adjacent to the segment blank located in the injection molding tool - in this case, Figure 6B shows on the left the one segment blank after it has already been provided with elastomeric sealing elements.

An injection molding tool 100 is shown schematically and highly simplified in Figures 6A and 6B. It has two tool halves, namely a lower tool half 100A and an upper tool half 100 B, so that it can be opened, for example, by lifting the tool half 100B in order to introduce or insert one half of the gasket layer blank 40' (or one of the segment blanks 10', 12' of the embodiment in accordance with Figure 1) into the injection molding tool 100. Such separable injection molding tools for injection molding elastomeric sealing elements onto the sheet metal of a gasket layer or a layer segment of a gasket layer of cylinder head gaskets are well known to one skilled in the art from the prior art, and, therefore, details of the injection molding tool, in particular, its channels for the guidance of the material to be injection molded and its mold surfaces for the configuration of the elastomeric sealing elements to be injection molded were not illustrated in Figures 6A and 6B, this not being required by one skilled in the art. In this connection, reference is, however, also made to Figures 13 and 14 which will be explained hereinbelow.

Figure 6A now shows the state in which the right half of the gasket layer blank 40' in accordance with Figure 4 is located in the closed injection molding tool 100, in order to injection mold, in each case, an elastomeric sealing element at the edge of the engine oil through-opening 62 and at the edge of each of the cooling water through-openings 70, 72 and 74 and finally at the edge of the chain case opening 54, the elastomeric sealing element projecting above the two main surfaces of the gasket layer blank 40'. After the injection molding of these elastomeric sealing elements, which were designated in Figure 6B by 102, 104, 106, 108 and 110, the injection molding tool 100 is opened, whereupon the gasket layer blank 40' in accordance with Figure 6A is pulled out of the injection molding tool 100 towards the left and in accordance with the arrow F_1 from Figure 6A is pivoted through 180° and thereby turned

in order to then insert the left half of the gasket layer blank 40' in accordance with Figures 4 and 6A into the injection molding tool 100 and close the injection molding tool 100 again - this state is shown in Figure 6B. Elastomeric sealing elements corresponding to the sealing elements 102, 104, 106, 108 and 110 shown in Figure 6B are then injection molded onto the second half of the gasket layer blank 40'.

Of course, each or the two halves of the gasket layer blank 40' must be correctly and exactly positioned in the injection molding tool 100 for injection molding the elastomeric sealing elements. Of the numerous mechanisms known and available to one skilled in the art therefor, in particular, the following are recommended: For example, the lower tool part 100A is provided with two positioning pins which, when the injection molding tool is closed, engage in two corresponding bores of the upper tool half 100B, and each of the two halves of the gasket layer blank 40' is provided with two positioning holes in which the two positioning pins fittingly engage when, with the injection molding tool 100 open, one half of the gasket layer blank 40' is correctly inserted into the injection molding tool and the injection molding tool is then closed, so as to ensure that the elastomeric sealing elements are precisely injection molded onto the associated openings of the gasket layer blank 40'.

After the gasket layer blank 40' has thus been provided with the elastomeric sealing elements or with all necessary elastomeric sealing elements, the longitudinal end region 76' illustrated on the left in Figure 4, which contains the chain case opening 78' and is not required in the assembled engine, is severed, and so the gasket layer 40 illustrated in Figure 4, which is provided with the elastomeric sealing elements E, is obtained.

From Figures 6A and 6B it is clearly evident that a single and relatively small injection molding tool is sufficient to provide each of the two layer sections or halves of the gasket layer blank 40' with injection-molded elastomeric sealing elements.

In view of a third solution variant, in accordance with the invention, to be discussed with reference to Figure 10, it should be noted that the injection molding tool 100 shown in Figures 6A and 6B can, of course, also be designed so that it does not have to be opened completely, but only to such an extent that the gasket layer blank 40' can be pushed into the injection molding tool and pushed through it with the injection-molded sealing elements, so that in accordance with Figures 6A and 6B the gasket layer blank 40' can be inserted both from the left to the right and from the right to the left into the injection molding tool, possibly after previous slight raising of, for example, the upper tool half 100B. Such a design of the injection molding tool belongs to the expertise of one skilled in the art with experience in the field of injection molding tools, and so in this respect neither a further description nor a more detailed graphic illustration of the injection molding tool is required.

In this connection, it should be noted that the necessity of a wide opening of the injection molding tool 100 can be avoided, for example, by the above-explained positioning pins provided in the injection molding tool being slideably guided in their longitudinal direction, for example, in the lower tool half 100A and being displaceable in this direction by some actuating mechanism or other so that they can be lowered into the lower tool half 100A and then raised again when the gasket layer blank 40' is located in a correct position for the injection molding of the elastomeric sealing elements and, consequently, the positioning pins can be pushed through the above-explained positioning holes of the gasket layer blank.

With reference to Figures 7, 7A to 7C, 8, 8A to 8D and 9, the production, in accordance with the invention, of a gasket layer of a cylinder head gasket for an in-line six-cylinder engine and this gasket layer itself will be explained hereinbelow. It should be noted in this connection that Figures 7, 7A to 7C, 8 and 9 do not illustrate some details of the gasket layer, the layer segments and the segment blanks, which are of no importance for the present invention, and such details are, therefore, also not described hereinbelow. This gasket

layer is the single gasket layer of a consequently single-layer cylinder head gasket, it could, however, also be a gasket layer of a multilayer cylinder head gasket. The gasket layer shown in the drawings consists of only two layer segments which, in accordance with the present invention, were produced from two segment blanks.

Figure 7 shows a plan view of the two segment blanks produced in accordance with the invention, which are arranged immediately adjacent to each other and adjoining each other. In order that details of the segment blanks can be illustrated better, the entity shown in Figure 7 made up of the two segment blanks was divided up into three sections in accordance with the lines X-X and Y-Y from Figure 7, and Figures 7A to 7C show the left section, the middle section and the right section, respectively, (in each case, in accordance with Figure 7) on a larger scale than in Figure 7.

In addition, it is pointed out that Figures 7 and 7A to 7C illustrate the segment blanks after injection molding of elastomeric sealing elements onto the sheet metal of the segment blanks, but before a second cutting operation to be performed in accordance with the invention.

Figure 7 shows on the left a first segment blank 200 and on the right a second segment blank 202, which abut against each other along a line Z-Z indicated in Figure 7 and (with one exception which has yet to be discussed) are of mirror-symmetrical configuration in relation to this line. If the segment blank 202 were pivoted about the line Z-Z through 180° to the left in accordance with Figure 7, the two segment blanks 200 and 202 would, consequently, lie congruently on each other (again apart from the exception which has still to be discussed), from which it is evident that the two segment blanks are of identical configuration (also apart from the exception which has still to be discussed) and, consequently, can be punched with one and the same punching tool out of a sheet metal and can be provided with elastomeric sealing elements using one and the same injection molding tool.

Owing to the mirror-symmetrical configuration of the two segments blanks 200 and 202 in relation to the line Z-Z, evident from Figure 7, only the segment blank 200 will be described in detail hereinbelow, and for details of the two segment blanks corresponding to one another, the same reference numerals were used in Figures 7, 7B and 7C for these details of the segment blank 202 as for the corresponding details of the segment blank 200.

The segment blank 200 has on the left (in accordance with Figures 7 and 7A) a chain case opening 204, to the right of this three combustion chamber openings 206, 208 and 210, around these combustion chamber openings a total of twelve bolt through-openings 212 for the passage of cylinder head bolts therethrough and at its right edge two half bolt through-openings 212', which are complemented by two corresponding half bolt through-openings 212' of the segment blank 202 to form complete bolt through-openings for the passage of further cylinder head bolts therethrough. To the right of the chain case opening 204, more particularly, beside its middle and beside its lower region, the segment blank 200 is provided, in each case, with a hole 204, so that the two segment blanks 200 and 202 together comprise four holes 214 through which engine oil under pressure can be conducted from the crankcase of the engine into its cylinder head. Depending on how many pressure oil channels the engine has interacting with these holes 214, however, one of the holes 214 or several of these holes may have no function in the assembled engine. For pressure-free return flow of the engine oil from the cylinder head into the crankcase, the segment blank 200 has a total four holes 216, which are of different configuration with respect to their shapes and sizes and one or several of which may have no function in the assembled engine, depending on how many oil return-flow channels the crankcase or the engine block has. All of the aforementioned holes with no function are nevertheless to be provided with elastomeric sealing elements.

For the passage of cooling water, the segment blank 200 is provided with cooling water through-openings 218. Five of the cooling water through-openings of the segment blank 202 were designated by 218' as these are to be

enlarged by the second cutting operation to be performed in accordance with the invention, more particularly, for the following reason: The engine for which this cylinder head gasket was designed requires in the regions of its cylinders 5 and 6 more cooling power than in the regions of its cylinders 1 to 4. Those combustion chamber openings of the segment blanks 200 and 202, which were designated from the left to the right by 206, 208, 210 and 210 in Figure 7 are to be allocated to the cylinders 1 to 4, whereas the combustion chamber openings 208 and 206 shown on the right in accordance with Figure 7 are to be allocated to the cylinder 5 and the cylinder 6, respectively. In order to improve the cooling of the engine in the regions of its cylinders 5 and 6, in the course of the second cutting operation to be carried out in accordance with the invention, the four cooling water through-openings 218' shown in Figure 7C are enlarged in order to enlarge in the engine the cooling water through-flow in the regions of the cylinders 5 and 6 of the engine (in comparison with the cooling water through-flow in the engine regions accommodating the cylinders 1 to 4).

The segment blank 200 is provided in its lower left corner region in accordance with Figures 7 and 7A with a positioning hole 220 for the passage of a positioning pin or another positioning element therethrough, which is first produced as circular hole, in order that two identical blanks for the two segment blanks 200 and 202 can be punched out using one and the same punching tool. In the second cutting operation to be performed in accordance with the invention, one of these positioning holes is extended to form an elongate hole, in the present case, the positioning hole 220 of the segment blank 200.

Each of the combustion chamber openings 206, 208 and 210 is enclosed by a combustion chamber sealing bead 222, which during the production of the segment blanks can be stamped into the sheet metal using a punching-stamping tool. In the two segment blanks 200 and 202 illustrated in Figure 7, the sealing beads 222 of the two segment blanks form projections which project in one and the same direction, i.e., lie either on the upper side or on

the underside of the entity formed by the two segment blanks 200 and 202. How this can be achieved with one and the same tool for producing both segment blanks has already been explained hereinabove.

If in the series production of the cylinder head gaskets a large number of segment blanks 200 and a large number of segment blanks 202 are first produced, these are then provided with injection-molded elastomeric sealing elements and, finally, undergo the second cutting operation to be performed in accordance with the invention, in order to thereby obtain the finished gasket layer segments, which differ in the orientation of their sealing beads 222, care must be taken to ensure during assembly of a gasket layer from two layer segments that, in each case, a layer segment obtained from a segment blank 200 is combined with a layer segment obtained from a segment blank 202, more particularly, in such a way that the sealing beads 222 of the two layer segments have the same orientation in the gasket layer. In order to ensure this in series production which is automated to the greatest possible extent, the segment blanks 200 and 202 shown in Figure 7 have, in each case, an auxiliary opening 226 and 226', respectively, which are of the same configuration, but are differently positioned. Although these auxiliary openings are already shown in Figure 7, they are only produced in the course of the second cutting operation to be performed in accordance with the invention. This also applies to the enlarging of the cooling water through-openings 218' and to the alteration of the positioning hole 220 of the segment blank 200 to an elongate hole.

Some openings of a gasket layer of a cylinder head gasket must be sealed. This applies, in particular, to engine oil through-openings and to at least some of the cooling water through-openings. In a gasket layer to be produced in accordance with the invention, this sealing is effected by elastomeric sealing elements which are injection molded onto the sheet metal of the segment blanks, in particular, onto the edges of the openings which are punched out or cut out in some other way or onto the edges of recesses which surround the openings and are spaced at a short distance from these. Figures 7, 7A to 7C, 8

and 8B to 8D show a large number of such elastomeric sealing elements with different shapes, some of which were designated by 230. Since the drive running through a chain case or wheel case for the valves arranged in the cylinder head is lubricated with engine oil, sealing around the chain case opening 204 still present after the second cutting operation must also be effected with an elastomeric sealing element, which was designated by 230'. As already mentioned several times, all of these elastomeric sealing elements are injection molded onto the sheet metal of the segment blanks before performance of the second cutting operation. The removal of the chain case opening 204 of the segment blank 200 in the course of the second cutting operation can be carried out such that - and this is preferred - part of the elastomeric sealing element 230' remains, as is clearly evident on the left in Figure 8.

Figure 8 shows a plan view of a gasket layer, designated in its entirety by 300, comprised of two layer segments 302 and 304, which were obtained from the segment blanks 200 and 202 by the second cutting operation to be performed in accordance with invention. Therefore, only the way in which the two layer segments 302, 304 were connected to each other in accordance with the invention for formation of the gasket layer 300 will be explained with reference to Figure 8.

The adjacent regions of the layer segments 302, 304 or the segment blanks 200 and 202 in the gasket layer 300 are provided, in each case, with two connection tongues 306 and two connection tongues 308, respectively, which can already be produced during the punching-out of the segment blanks 200 and 202. As is clearly evident from Figures 7 and 7B, which also show the connection tongues 306 and 308, the segment blank 202 provided with the connection tongues 308 is of the same configuration with respect to its contours obtained by the first cutting operation in accordance with the invention as the segment blank 200 provided with the connection tongues 306 (if the segment blank 202 shown on the right in Figure 7 is pivoted about the line Z-Z drawn in Figure 7 through 180° to the left, the two segment blanks

200 and 202 lie congruently on each other), i.e., two identical parts can be punched out of a sheet metal for the segment blanks 200 and 202. As is clearly evident from Figure 7, the entity consisting of the two segment blanks 200 and 202 is, consequently, of mirror-symmetrical configuration with respect to the line Z-Z except for the connection tongues 306 and 308. If the line Z-Z drawn in Figure 7 is regarded as pivot axis, the two segment blanks 200 and 202 including their connection tongues 306, 308 are, however, also of axially symmetrical configuration. After performance of the second cutting operation, the connection tongues are bent out slightly, in each case, from the plane defined by the two layer segments 302 and 304, so that, as is evident from Figures 7B and 8, the connection tongues 308 can overlap the connection tongues 306, whereupon the connection tongues 306, 308 are fixedly connected to each other with hollow rivets 310 (see Figure 8A).

If, as is meant to be the case here, in the assembled engine, the sealing surfaces of crankcase and cylinder head facing each other and clamping the cylinder head gasket between them are so configured that the connection tongues 306 and 308 lie in their entirety outside of at least one of these engine component sealing surfaces (seen in a plan view of the engine), the thickenings formed by these connection tongues and rivets do in no way impair the sealing capacity of the cylinder head gasket.

The sections shown in Figures 8B and 8D in accordance with lines B-B and D-D from Figure 8 show that all of the elastomeric sealing elements 230 and 230' were injection molded onto the punched edges of openings produced in the sheet metal of the segment blanks or of aforementioned recesses (see Figures 8D and 8B, respectively) - in Figures 8B and 8D the sheet metal of the layer segment 302 was designated by 302a and the sheet metal of the layer segment 304 by 304a.

Figure 9 shows a plan view of the segment blank 202 before the injection molding of elastomeric sealing elements and indicates that the elastomeric sealing elements for the cooling water through-openings 218 are not to be

injection molded onto the opening edges but onto the edges of recesses 250 produced in the sheet metal of the respective segment blank, which, in particular, were punched out of the sheet metal, each of these recesses being spaced from the edge of the associated cooling water through-opening 218 and, therefore, being interrupted by at least one connecting web 252 via which the region of the sheet metal adjoining the respective cooling water through-opening 218 is connected to the sheet-metal region lying radially outside of the respective recess 250.

Figure 8C also shows two such connecting webs 252, and Figure 8B was also given the reference numeral 250 for the respective recess.

Figure 10 serves to explain an embodiment in accordance with the third solution variant of the invention and shows in isometric illustration a one-piece gasket layer blank 400 punched out of a sheet metal and an injection molding tool 500 for injection molding elastomeric sealing elements on through-openings, which are to be sealed, of the gasket layer blank or the gasket layer produced therefrom.

The gasket layer blank 400 for the production of a gasket layer of a cylinder head gasket for an in-line six-cylinder engine consists of three blank sections 402, 404 and 406 following one another in the longitudinal direction of the gasket layer blank, which apart from combustion chamber openings and through-openings, not shown, for cylinder head bolts, comprise liquid through-openings for cooling water and engine oil, which are to be sealed, and, therefore, are to be provided with elastomeric sealing elements. With respect to the number and positions, but preferably also the shapes and, in particular, the sizes of these liquid through-openings, the blank sections 402, 404, 406 are of identical configuration – if the blank sections could be placed on one another, they would, therefore, be of congruent configuration in the above-indicated manner, in particular, also with respect to these liquid through-openings. This could, however, also apply to the through-openings, not shown in Figure 10, for the cylinder head bolts.

From Figure 10 it is evident that each blank section 402, 404, 406 comprises, for example, two combustion chamber openings 408, two cooling water through-openings 410, a so-called pressure oil hole, namely a through-opening 412 for the passage of engine oil, which is conducted from the crankcase into the cylinder head of the associated engine, and a through-opening 414 which is a so-called oil return-flow opening through which engine oil flows back without pressure from the cylinder head into the crankcase.

Finally, Figure 10 shows in the gasket layer blank 400 two so-called positioning holes 416 for the passage of positioning elements with which it is ensured that the gasket layer produced from the gasket layer blank 400 is mounted in the correct position between the crankcase and the cylinder head.

As already mentioned in connection with the two first solution variants, beads are normally used to seal around the combustion chamber openings. These were stamped into the sheet metal of the gasket layer and surround each of the combustion chamber openings in a closed manner. Such sealing beads, not shown in Figure 10, can in the course of the punching-out of the gasket layer blank 400 already be stamped into this, more particularly, such that all of these sealing beads are oriented in the same direction, i.e., form at one and the same main surface of the gasket layer blank, in each case, a projection.

Like the injection molding tool 100 shown in Figures 6A and 6B, the injection molding tool 500 also has a lower and an upper tool half 500A and 500B, respectively, and forms between these a slot-like or channel-like passage 502, only indicated in Figure 10, which is so configured that at least after slight raising of the upper tool half 500B, the blank section 402 can first be inserted into the injection molding tool 500 so as to adopt the position shown in Figure 10. After the subsequent lowering of the upper tool half 500B, the through-openings 410, 412 and 414 of the blank section 402 are provided with elastomeric sealing elements 420 and 422 and 424, respectively, indicated in Figure 10, by elastomeric sealing material being injection molded onto the

punched edges of these through-openings in the injection molding tool 500 and also stabilized with respect to form in the injection molding tool such that each of these elastomeric sealing elements forms a projection on each side of the gasket layer blank 400.

After, in particular, slight, raising of the upper tool half 500B again, the gasket layer blank 400 is then advanced to the right in accordance with Figure 10 to such an extent that the blank section 404 adopts the position shown in Figure 10 for the blank section 402, and so after lowering of the upper tool half 500B, the through-openings 410, 412, 414 of the blank section 404 can also be provided with elastomeric sealing elements 420, 422 and 424. The steps described hereinabove for the blank section 404 are then repeated for the blank section 406 in order to also injection mold elastomeric sealing elements on it.

Regarding correct positioning of the blank sections 402, 404 and 406 in the injection molding tool 500, reference is made to the statements made hereinabove in connection with Figures 6A and 6B regarding the exact positioning of the gasket layer blank 40' in the injection molding tool 100.

Although the gasket layer blank 400 and, therefore, the gasket layer produced using it are in one piece and are provided in all blank sections or layer sections of the gasket layer corresponding to these with the elastomeric sealing elements, the third solution variant of the present invention also allows, for the injection molding of the elastomeric sealing elements, use of a relatively small injection molding tool, the dimensions of which in the longitudinal direction of the gasket layer blank 400 need only be so large (at least this is to be understood by the aforementioned adaptation of the injection molding tool) that all of the elastomeric sealing elements of a blank section can be produced in a single step or cycle of the method in the injection molding tool.

Finally, some characteristics and features of preferred embodiments of the present invention will be mentioned, even if these are already evident from the appended drawings and/or the above description.

Even if, in accordance with the invention, two identical segment blanks are first cut out of a sheet metal for a group of two segment blanks, although the gasket layer segments produced from these segment blanks are not identical, this does not reduce the advantages achievable with the invention, as the initially identical segment blanks can be adapted without a lot of effort to the configuration of the two gasket layer segments to be produced by a second cutting operation. In this connection, reference is made, only by way of example, to the cutting-off of the left longitudinal end region of the segment blank 200 in accordance with Figure 7 and, therefore, of at least the major part of its chain case opening 204, but also to the subsequent production of the two auxiliary openings 226 and 226' shown in Figure 7 and to the subsequent enlargement of the cooling water through-openings 218' shown in the right part of Figure 7 and in Figure 7C.

The same applies accordingly to the case that, in accordance with the invention, a gasket layer blank is first cut out of a sheet metal, at least a region or the entirety of the gasket layer blank being of mirror-symmetrical configuration in relation to a center line extending perpendicularly to the longitudinal center axis of the gasket layer blank.

Openings of segment blanks or the gasket layer blank, for which no elastomeric sealing elements need be injection molded onto the sheet metal may be absent in a segment blank or the segment blanks or the gasket layer blank, as they are of no relevance to the design of the injection molding tool and may only be able to be produced in the course of a second cutting operation.

As is evident from the above description, but also from Figure 5, the opening patterns of the segment blanks and gasket layer segments or of the gasket

layer blank and the gasket layer produced from it do not have to correspond to the opening patterns of the sealing surfaces of the crankcase or engine block and the cylinder head to be pressed against the cylinder head gasket.

If a gasket layer is produced in accordance with the invention from at least one group of two segment blanks, this merely requires that in the regions of the sealing surfaces of the crankcase or engine block and the cylinder head corresponding to these two segment blanks, its opening patterns (at least insofar as these are to be sealed by elastomeric sealing elements) be of substantially mirror-symmetrical configuration in relation to a plane extending in the assembled engine perpendicularly to these sealing surfaces or to the plane defined by the cylinder head gasket and through a center line along which the two gasket layer segments produced from the two segment blanks lie against each other or from which these two gasket layer segments are equidistantly spaced. When hereinabove mention is made of the fact that regions of the sealing surfaces of the crankcase and the cylinder head are of substantially mirror-symmetrical configuration in relation to a certain plane, it must be borne in mind that these sealing surface regions do not include those sealing surface regions containing openings which are associated with passages present only once in the engine, as is, for example, the case with a chain case cavity or gear case cavity and/or may be the case with a pressure oil channel.

If a gasket layer is produced in accordance with the invention from a gasket layer blank, at least a region of which, at least insofar as this is provided with elastomeric sealing elements, is of substantially mirror-symmetrical configuration in relation to a plane of symmetry extending perpendicularly to the plane of the gasket layer blank and perpendicularly to its longitudinal center axis, this preferably only requires that in the assembled engine the opening patterns (at least insofar as these are to be sealed by elastomeric sealing elements) of the sealing surfaces of its crankcase or engine block and its cylinder head to be pressed against the cylinder head gasket be of substantially mirror-symmetrical configuration in relation to this plane of

symmetry. What was stated at the end of the preceding paragraph naturally also applies to this case, namely that a gasket layer is produced from a gasket layer blank, with respect to the mirror-symmetrical configuration of the opening patterns of the sealing surfaces of the crankcase and the cylinder head.

A stamping-punching tool 600 shown only partly and schematically in Figure 11 is a so-called follow-on tool with three stages and has a lower and an upper tool half 600A and 600B, respectively. The upper tool half 600B can be lifted up somewhat in the known manner from the lower tool half 600A – Figure 11 is, however, to show the tool in the closed state.

Furthermore, Figure 11 shows between the lower and the upper tool halves 600A and 600B, respectively, part of a steel strip 602, from which the segment blanks of the first embodiment of the production method in accordance with the invention are to be punched out and the segment blanks are to be provided with sealing beads, which surround the combustion chamber openings of the segment blanks in a closed manner. In Figure 11, two combustion chamber openings were designated by 604 and 606, respectively, and Figure 11 also shows on the right a sealing bead 608, stamped into the steel strip 602, for the combustion chamber opening 606.

The three stages of the tool 600 following one another in the direction of traverse of the steel strip 602 (from the left to the right in accordance with Figure 11) were designated by 600 I, 600 II and 600 III, respectively. In the first tool stage 600 I, a first part of the contours of the segment blanks is to be stamped out of the steel strip 602, in the present case, at least one combustion chamber opening, in each case, whereupon the steel strip 602 is advanced by one step in accordance with Figure 11 to the right, in order to stamp in the steel strip a sealing bead which encloses the previously stamped-out combustion chamber opening – this stamping procedure takes place in the second tool stage 600 II.

The steel strip 602 is then advanced by a further step in accordance with Figure 11 to the right, so that in the third tool stage 600 III at least the major part of all other contours of the segment blanks can be stamped out and, for example, the segment blanks severed from one another (this was, however, not shown in Figure 11).

For stamping the sealing beads 608 at least one tool part to be inserted in the tool 600 is provided, for example, the slide-in unit 600C shown in Figure 11, which, as indicated by dot-and-dash lines, can be inserted into the second tool stage 600 II. The slide-in unit 600C has a slide-in unit lower part 600C₁ and a slide-in unit upper part 600C₂, which, after insertion of the slide-in unit 600C into the tool 600, are to be connected to its halves 600A and 600B such that when the upper tool half 600B is raised, the slide-in unit upper part 600C₂ is also lifted off the slide-in unit lower part 600C₁, and that, when the tool 600 is closed, its dividing plane extending between its two halves also extends between the lower part and the upper part of the slide-in unit 600C.

Finally, dashed lines at 600C₃ in Figure 11 indicate the contours of male mold and female mold of the slide-in unit 600C, which are required for stamping the sealing beads 608.

Merely for the sake of completeness, mention is also made of the fact that guide elements 600A₁ and 600 B₁ of the tool halves 600A and 600B which, when inserting the slide-in unit 600C, are to fittingly engage corresponding recesses, not shown in Figure 11, in the slide-in unit 600C were indicated in Figure 11.

Figures 12A and 12B now show sections along line 12-12 from Figure 11 through two different slide-in units 600C' and 600C'', of which the slide-in unit 600C' serves to provide the metal strip 602 for a combustion chamber opening, for example, the combustion chamber opening 604 or the combustion chamber opening 608, with a downwardly projecting sealing bead 608', whereas upwardly projecting sealing beads 608'' can be produced with the

slide-in unit 600C". In this way, segment blanks can be produced with the tool 600, in some of which the sealing beads form a projection at the first main surfaces of the segment blanks, whereas in the other ones of the segment blanks the sealing beads form a projection at the second main surfaces of the segment blanks.

Finally, with reference to Figures 13 and 14, it will now be explained how the segment blanks or gasket layer blanks produced in accordance with the invention can be provided with elastomeric sealing elements, in particular, in the way in which this was explained with reference to Figures 8C and 9.

In a way similar to how the punching-stamping tool 600 was illustrated in Figure 11, Figure 13 shows an injection molding tool 700 and a steel strip 702, along which the injection molding tool 700 is divided into a lower tool half 700A and an upper tool half 700B. Figure 13 shows the injection molding tool 700 in the closed state. However, for example, by raising the upper tool half 700B, the injection molding tool can be opened in order to be able to stepwise advance the metal strip 702, for example, from the left to the right or the right to the left (in accordance with Figure 13).

Figure 13 shows cavities 704 and 706 for accommodating sealing beads 708 for combustion chamber openings 710 and 712 of the gasket layer segments or gasket layer sections to be produced, these cavities being so designed that the sealing beads can project upwards or downwards in accordance with Figure 13.

Figure 13 shows on the left a first through-opening 714 punched out of the metal strip 702 and an elastomeric sealing element 716 associated with and surrounding the through-opening in a closed manner. For injection molding this sealing element onto the sheet metal of the metal strip 702 or a segment blank or a gasket layer section, there is formed in the upper tool half 700B an injection molding channel 720 for feeding the still liquid or pasty elastomeric sealing material 722 (a corresponding venting channel through which

excessive sealing material could also be conducted away could be formed in the lower tool half 700A). As already explained hereinabove, embodiments of the production method in accordance with the invention are, however, preferred, in accordance with which the first through-opening 714 shown in Figure 13 is only punched out of the metal strip 702 or a segment blank or a gasket layer section after the elastomeric sealing element 716 has been produced.

Figure 14 shows a plan view of a sheet steel region 726 provided for such a procedure before the punching-out of the through-opening 714. From this sheet metal region, two recesses 730 and 732 were punched out, each of which has an approximately circular arc-shaped recess region 730a and 732a, respectively, and the recess 730 comprises, in addition, an approximately circular disc-shaped recess region 730b, which is connected by a channel-like recess region 730c to the recess region 730a. Finally, the two recesses 730 and 732 are severed from each other by two sheet metal webs 726a - Figure 13 shows on the left one of these sheet metal webs 726a. After the injection molding of the elastomeric sealing element, the sheet metal webs 726a are embedded in the elastomeric sealing element 716, and the through-opening 714 is punched out, so that the latter is enclosed by the sealing element 716.

The recess region 730b is arranged and dimensioned such that the injection channel 720 shown in Figure 13 opens into the recess region 730b.

Apart from a gasket layer in accordance with the invention, which comprises several layer sections arranged one behind the other in its longitudinal direction, which with respect to the number, positions, shapes and sizes of their elastomeric sealing elements are identically configured, the basic concept of the present invention can also be defined as follows:

Gasket layer having several combustion chamber openings arranged one behind the other in the longitudinal direction of the gasket layer, the gasket layer comprising an entity made up of two gasket layer segments or gasket

layer sections lying one behind the other in the gasket layer plane and in the longitudinal direction of the gasket layer and immediately adjacent to each other in the longitudinal direction of the gasket layer, and being at least of substantially equal length in the longitudinal direction of the gasket layer, this entity containing all of the combustion chamber openings of the gasket layer, and each gasket layer segment or each gasket layer section comprising at least one combustion chamber opening, at least two elastomeric sealing elements arranged in spaced relation to each other in the gasket layer plane and at least one first through-opening with which one of these elastomeric sealing elements is associated, and in an plan view of the gasket layer plane, the pattern formed by the elastomeric sealing elements of this entity being of mirror-symmetrical configuration in relation to a center line of this entity, which extends in the gasket layer plane and perpendicularly to the longitudinal direction of the gasket layer between the two gasket layer segments or gasket layer sections.

If the two gasket layer segments or gasket layer sections are not of exactly the same length in the longitudinal direction of the gasket layer, the aforementioned center line is to be understood as an axis of symmetry or line of symmetry of the pattern formed by the elastomeric sealing elements of the aforementioned entity.

If the two gasket layer segments or gasket layer sections do not adjoin each other in the longitudinal direction of the gasket layer, although this is to be preferred, the two gasket layer segments or gasket layer sections have in the longitudinal direction of the gasket layer from the said center line or axis of symmetry, in each case, a small and at least substantially equally large spacing, the size of which is preferably at most one tenth and, in particular, at most 5% of the average length, measured in the longitudinal direction of the gasket layer, of the two gasket layer segments or gasket layer sections.

Such a gasket layer is preferably produced in accordance with one or several of the appended claims 1 to 30, and, in particular, such a gasket layer has the features of one or several of the appended claims 39 to 53.

In principle, the above-defined gasket layer can comprise instead of only one entity made up of two gasket layer segments or gasket layer sections, also several, in particular, two such entities, which are immediately adjacent to each other in the longitudinal direction of the gasket layer, or the gasket layer comprises a first such entity with gasket layer segments or gasket layer sections immediately adjacent to each other and at least one second entity made up of two such gasket layer segments or gasket layer sections, and, in this case, the gasket layer segments or gasket layer sections of the first entity are arranged between the two gasket layer segments or gasket layer sections of the second entity.

Regarding the aforementioned center line or axis of symmetry, it is also to be noted that this may, for example, be identical to the line 36 shown in Figure 4 or to the line Z-Z shown in Figure 7.

It is also evident from the part of the specification of the present application preceding the description of the Figures of the drawings that in the above definition of the invention on the basis of a gasket layer, the terms gasket layer segments and gasket layer sections can also be replaced by the terms segment blanks and blank sections.

Finally, reference is made to a further variant of the solution, in accordance with the invention, to the set object, which can be defined as follows:

Gasket layer with two longitudinal edges and several combustion chamber openings arranged one behind the other in the longitudinal direction of the gasket layer which, in each case, comprise an opening center which, in a plan view of the gasket layer, is arranged on a longitudinal center axis of the gasket layer common to all opening centers and extending in the longitudinal direction

of the gasket layer, the gasket layer comprising an entity made up of two gasket layer segments or gasket layer sections lying one behind the other in the gasket layer plane and in the longitudinal direction of the gasket layer and immediately adjacent to each other in the longitudinal direction of the gasket layer and being of at least substantially equal length in the longitudinal direction of the gasket layer, this entity containing all of the combustion chamber openings of the gasket layer, and each gasket layer segment or each gasket layer section comprising at least one combustion chamber opening, at least two elastomeric sealing elements arranged in spaced relation to each other in the gasket layer plane and at least one first through-opening with which one of these elastomeric sealing elements is associated, and patterns formed by the elastomeric sealing elements of the two gasket layer segments or gasket layer sections being at least substantially congruent when one of the two gasket layer segments or gasket layer sections is rotated through 180° about a pivot axis, which extends perpendicularly to the gasket layer plane and, in a plan view of the gasket layer, is arranged equidistantly between the two gasket layer segments or gasket layer sections and the two gasket layer longitudinal edges - the two gasket layer segments or gasket layer sections would then lie over each other.

As a precautionary measure, the following is pointed out in connection with the above definition of the invention:

The opening centers of the combustion chamber openings are, for example, the centers or center points of the combustion chamber openings 42, 44, 46, etc. and 206, 208, 210, 210, 208, 206, respectively, shown in Figures 4 and 7, and these opening centers all lie on a line extending in the longitudinal direction of the gasket layer and, in particular, forming a longitudinal center axis of the gasket layer.

The aforementioned pivot axis would in the illustration of Figure 4 and Figure 7, respectively, extend perpendicularly to the plane defined by the respective gasket layer and intersect the line 36 shown in Figure 4 and the line Z-Z

shown in Figure 7, respectively, at a point which lies on the connecting line of the centers of the respective combustion chamber openings.

Since the number and positions and the sizes and shapes of the elastomeric sealing elements are determined by the openings provided in the sealing surface of the engine block and/or in the sealing surface of the cylinder head, insofar as these are not elastomeric sealing elements without a function, which were only made so as to be able to produce with one and the same small injection molding tool, the above definition of the invention presupposes such a design of the sealing surfaces of engine block and cylinder head that rotation of the one gasket layer segment or gasket layer section through 180° about the said pivot axis will also result in the patterns formed by the elastomeric sealing elements of the gasket layer segments or gasket layer sections then arranged on one another being arranged at least substantially congruently over one another.

Claims

1. Method for the production of an elongate sheet-metal gasket layer, provided with elastomeric sealing elements, of a cylinder head gasket, the gasket layer having two main surfaces, a first and a second longitudinal end, several combustion chamber openings arranged one behind the other in the longitudinal direction of the gasket layer as well as bolt through-openings for cylinder head bolts, first through-openings and elastomeric sealing elements associated with these as well as other openings, and comprising only two gasket layer segments lying in a gasket layer plane, and immediately adjacent to each other in the latter, and being provided, in each case, with at least one combustion chamber opening and with at least one such first through-opening including an elastomeric sealing element, the gasket layer segments containing all of the combustion chamber openings of the gasket layer, having, in each case, a longitudinal direction extending in the longitudinal direction of the gasket layer and a first and a second longitudinal end, and being, in the gasket layer plane, immediately adjacent to each other with their second longitudinal ends, and first gasket layer zones in which all of the elastomeric sealing elements of the two gasket layer segments are arranged being provided in the two gasket layer segments, each gasket layer zone being provided with at least one elastomeric sealing element, and at least one gasket layer zone comprising at least one of the first through-openings with at least one elastomeric sealing element associated with this first through-opening, wherein for the production of the two gasket layer segments, in a first cutting operation two segment blanks are first cut out of sheet metal, each of the segment blanks having a first and a second main surface, a longitudinal direction and a first and a second longitudinal end, at least one blank combustion chamber opening and at least one first blank through-opening for one of the first through-openings of the gasket layer, and the elastomeric sealing elements for the first gasket layer zones are then molded onto

the segment blanks, the elastomeric sealing elements being so arranged and configured that with the two segment blanks, provided with the elastomeric sealing elements, arranged in a layer plane such that

the segment blanks are arranged in their longitudinal directions in alignment with each other one after the other and with their second longitudinal ends adjoining each other on either side of a center line extending in this layer plane and perpendicularly to the longitudinal directions of the segment blanks,

in a plan view of the aforementioned layer plane, the pattern formed by the elastomeric sealing elements of the two segment blanks is of mirror-symmetrical configuration in relation to this center line with respect to the number and positions and the sizes and shapes of the elastomeric sealing elements.

2. Method in accordance with claim 1, wherein each of the gasket layer segments comprises at least parts of bolt through-openings.
3. Method in accordance with claim 2, wherein each of the segment blanks comprises at least parts of bolt through-openings.
4. Method in accordance with any one of the preceding claims, wherein the gasket layer comprises two longitudinal side edges, and each of the segment blanks forms sections of the gasket layer longitudinal side edges.

5. Method in accordance with any one of the preceding claims, wherein two segment blanks identical with respect to their outer contours are produced by the first cutting operation.
6. Method in accordance with any one of the preceding claims, wherein two segment blanks which are of identical configuration with respect to the number and positions and, in particular, also with respect to the shapes and sizes of at least their first blank through-openings and preferably all of their openings are produced by the first cutting operation.
7. Method in accordance with any one of the preceding claims, wherein each of the segment blanks is punched out of a sheet metal and provided with at least one bead stamped into the sheet metal such that the bead of the one segment blank forms a projection at its first main surface, and the bead of the other segment blank forms a projection at its second main surface.
8. Method in accordance with any one of the preceding claims, wherein at least one second cutting operation is performed on at least one of the segment blanks provided with the elastomeric sealing elements such that the gasket layer formed with the layer segments thereby obtained has the final contours and openings of the gasket layer.
9. Method in accordance with claim 8, wherein before performance of the second cutting operation, on at least one first blank through-opening the elastomeric sealing element is spaced from the edge of this first blank through-opening such that the elastomeric sealing element and its adherence to the sheet metal are not impaired by the second cutting operation.

10. Method in accordance with any one of the preceding claims, wherein in each of the two segment blanks, the first longitudinal end is formed by a first longitudinal end region, and the second longitudinal end by a second longitudinal end region of the respective segment blank, and wherein from a first one of the segment blanks provided with the elastomeric sealing elements, the first longitudinal end region, which is a layer region that is not required in the gasket layer, is severed by at least one second cutting operation.
11. Method in accordance with claim 10, wherein the first longitudinal end region of each segment blank comprises at least part of a first blank through-opening.
12. Method in accordance with claim 11, wherein this first blank through-opening is an opening corresponding to a gear case opening or chain case opening of the layer segment obtained from the second segment blank.
13. Method in accordance with any one of claims 10 to 12, wherein

the length of a first one of the two layer segments, which forms the first longitudinal end of the gasket layer and corresponds to the former first segment blank subjected to the second cutting operation, is smaller than the length of the second layer segment, more particularly, by a length L of the severed first longitudinal end region of the former first segment blank, and wherein

- (a) the gasket layer, formed by the layer segments arranged in the gasket layer plane with their second longitudinal ends immediately adjacent to each other, without a longitudinal end region of the second layer segment forming the second longitudinal end of the gasket layer and having the length L, has a center line extending perpendicularly to the longitudinal direction of the gasket layer and lying in the gasket layer plane, and
 - (b) the two layer segments without the longitudinal end region of the second layer segment having the length L are mirror-symmetrically configured in relation to this center line at least with respect to the number and positions and the sizes and shapes of the elastomeric sealing elements.
14. Method in accordance with any one of the preceding claims, wherein segment blanks with an identical number of at least two blank combustion chamber openings are cut out.
15. Method in accordance with any one of the preceding claims, wherein each of the segment blanks is in one piece and seamless.
16. Method in accordance with any one of the preceding claims, wherein the two segment blanks are, in each case, individually provided with the elastomeric sealing elements in an injection molding tool adapted to the size of the segment blanks.
17. Method in accordance with any one of the preceding claims, wherein the two gasket layer segments are directly connected to each other by connecting elements which, when the cylinder head gasket is installed,

lie outside of at least one of the sealing surfaces of a cylinder head and an engine block that are pressed against the cylinder head gasket.

18. Method for the production of an elongate sheet-metal gasket layer, provided with elastomeric sealing elements, of a cylinder head gasket, the gasket layer having two main surfaces, several combustion chamber openings arranged one behind the other in the longitudinal direction of the gasket layer as well as bolt through-openings for cylinder head bolts, first through-openings with elastomeric sealing elements associated with these as well as other openings, being in one piece and comprising only two such layer sections directly adjoining each other and arranged one behind the other in the longitudinal direction of the gasket layer and of at least substantially equal length in the longitudinal direction of the gasket layer that these two layer sections contain all of the combustion chamber openings and at least one group of the first through-openings of the gasket layer and each layer section is provided with at least one combustion chamber opening and with at least one of these first through-openings, and first gasket layer zones in which all of the elastomeric sealing elements of the two layer sections are arranged being provided in the two layer sections, each gasket layer zone being provided with at least one elastomeric sealing element, and at least one gasket layer zone comprising at least one of the first through-openings with at least one elastomeric sealing element associated with this first through-opening,

wherein for the production of the gasket layer, a one-piece elongate gasket layer blank is first cut out of sheet metal in a first cutting operation, the gasket layer blank having at least blank combustion chamber openings for all combustion chamber openings of the gasket layer and at least for each of the first through-openings of the aforementioned group a first blank through-opening, and comprising for the production of the two layer sections only two blank sections which

are of at least substantially equal length in the longitudinal direction of the gasket layer blank and directly adjoin each other at least in areas at an axis of symmetry extending in the plane of the gasket layer blank and perpendicularly to its longitudinal direction, contain all of the blank combustion chamber openings and at least all of the first blank through-openings for the aforementioned group of first through-openings, and each of which is provided with at least one blank combustion chamber opening and at least one of these first blank through-openings for the aforementioned group of first through-openings,

and wherein the elastomeric sealing elements for the first gasket layer zones are then molded onto the gasket layer blank such that, in a plan view of the gasket layer, the pattern formed by the elastomeric sealing elements of the two blank sections is of mirror-symmetrical configuration in relation to this axis of symmetry with respect to the number and positions and the sizes and shapes of the elastomeric sealing elements.

19. Method in accordance with claim 18, wherein the opening pattern formed at least by the first blank through-openings for the aforementioned group of first through-openings of the gasket layer is mirror-symmetrically configured in relation to the axis of symmetry.
20. Method in accordance with claim 18 or 19, wherein the gasket layer blank is provided with at least one bead stamped in the sheet metal before the molding of the elastomeric sealing elements.
21. Method in accordance with any one of claims 18 to 20, wherein the length, measured in the longitudinal direction of the gasket layer blank, of the gasket layer blank obtained by the first cutting operation is greater by a length L than the length of the gasket layer, measured in the

longitudinal direction of the gasket layer, and wherein a first longitudinal end region of the gasket layer blank forming a first longitudinal end of the gasket layer blank obtained by the first cutting operation is shortened by at least one second cutting operation by the length L, more particularly, by severing a first edge zone of this first longitudinal end region, which is a layer region that is not required in the gasket layer.

22. Method in accordance with claim 21, wherein the gasket layer blank obtained by the first cutting operation comprises a second longitudinal end region forming a second longitudinal end of the gasket layer blank and comprising a second edge zone corresponding to the first edge zone and not severed by the second cutting operation.
23. Method in accordance with claim 22, wherein the first and the second longitudinal end regions of the gasket layer blank obtained by the first cutting operation comprise, in each case, at least one of the first blank through-openings, and the first edge zone contains at least part of the first blank through-opening of the first longitudinal end region.
24. Method in accordance with claim 23, wherein the first blank through-opening of the first longitudinal end region is an opening corresponding to a gear case opening or chain case opening of the second longitudinal end region.
25. Method in accordance with any one of claims 21 to 24, wherein the elastomeric sealing elements for the first gasket layer zones are molded onto the gasket layer blank before the second cutting operation.

26. Method in accordance with the claim 25, wherein before performance of the second cutting operation, at least one of the elastomeric sealing elements is spaced from the edge of a first blank through-opening associated with this sealing element such that this sealing element and its adherence to the sheet metal are not impaired by the second cutting operation.
27. Method in accordance with any one of claims 18 to 26, wherein a gasket layer blank is cut out with an even number of at least four blank combustion chamber openings.
28. Method in accordance with any one of claims 18 to 27, wherein the two blank sections are provided one after the other with the elastomeric sealing elements in an injection molding tool adapted to the size of a blank section.
29. Method in accordance with any one of claims 21 to 28, wherein the at least one second cutting operation is performed such that the gasket layer comprises its final contours and openings.
30. Method in accordance with any one of claims 1 to 29 for the production of a gasket layer in which the combustion chamber openings are arranged at equal spacings from one another.
31. Method for the production of an elongate sheet-metal gasket layer of a cylinder head gasket, which is provided with elastomeric sealing elements injection molded onto the sheet metal of the gasket layer, the gasket layer comprising several combustion chamber openings arranged

one behind the other in the longitudinal direction of the gasket layer and such first through-openings with which at least one of the elastomeric sealing elements is associated, in each case, as well as other through-openings, the gasket layer comprising several layer sections arranged one behind the other in its longitudinal direction and provided, in each case, with at least one elastomeric sealing element, the layer sections being of identical configuration at least with respect to the number and positions and the shapes and sizes of their elastomeric sealing elements, characterized in that to produce the gasket layer, a one-piece gasket layer blank comprising blank sections corresponding to the aforementioned layer sections is first cut out of a sheet metal, and in that the blank sections are, in each case, individually provided with elastomeric sealing elements in an injection molding tool adapted to the size of a blank section.

32. Method in accordance with claim 31, wherein the gasket layer blank is provided with a first blank through-opening for each first through-opening before the injection molding of the elastomeric sealing elements.
33. Method in accordance with claim 32, wherein the first blank through-openings are made when cutting out the gasket layer blank.
34. Method in accordance with any one of claims 31 to 33, wherein the blank sections are provided one after the other with the elastomeric sealing elements in the injection molding tool.
35. Method in accordance with any one of claims 31 to 34, wherein the blank sections directly adjoin one another.

36. Method in accordance with any one of the preceding claims, wherein the first through-openings are liquid through-openings.
37. Method for the production of a cylinder head gasket comprising several sheet-metal gasket layers arranged one over the other and extending at least substantially over the entire cylinder head gasket, characterized in that at least one gasket layer is produced in accordance with any one of claims 1 to 36.
38. Gasket layer of a cylinder head gasket, produced with a method in accordance with any one of claims 1 to 36.
39. Elongate sheet-metal gasket layer, provided with elastomeric sealing elements, of a cylinder head gasket, the gasket layer having a first and a second longitudinal end, several combustion chamber openings arranged one behind the other in the longitudinal direction of the gasket layer as well as bolt through-openings for cylinder head bolts, first through-openings and elastomeric sealing elements associated with these as well as other openings, and comprising only two gasket layer segments lying in a gasket layer plane, and immediately adjacent to each other in the latter, and being provided, in each case, with at least one combustion chamber opening and with at least one such first through-opening including an elastomeric sealing element, the gasket layer segments containing all of the combustion chamber openings of the gasket layer, having, in each case, a longitudinal direction extending in the longitudinal direction of the gasket layer and a first and a second longitudinal end, and being, in the gasket layer plane, immediately adjacent to each other with their second longitudinal ends, and first gasket layer zones in which all of the elastomeric sealing elements of the two gasket layer segments

are arranged being provided in the two gasket layer segments, each gasket layer zone being provided with at least one elastomeric sealing element, and at least one gasket layer zone comprising at least one of the first through-openings with at least one elastomeric sealing element associated with this first through-opening, and the elastomeric sealing elements of the two gasket layer segments being so arranged and configured that when the two layer segments are arranged in a layer plane with their longitudinal directions in alignment with each other one behind the other and with their second longitudinal ends adjoining each other on either side of a center line extending in this layer plane and perpendicularly to the segment blank longitudinal directions, in a plan view of the aforementioned layer plane, the pattern formed by the elastomeric sealing elements of the two layer segments is of mirror-symmetrical configuration in relation to this center line with respect to the number and positions and the sizes and shapes of the elastomeric sealing elements.

40. Gasket layer in accordance with claim 39, wherein the two layer segments are of identical configuration at least with respect to the number and positions of at least their first through-openings.
41. Gasket layer in accordance with claim 39 or 40, wherein each of the gasket layer segments comprises at least parts of bolt through-openings.
42. Gasket layer in accordance with any one of claims 39 to 41, wherein the length of a first one of the two layer segments, which forms the first longitudinal end of the gasket layer, is smaller than the length of the second layer segment by a length L , and wherein

- (a) the gasket layer, formed by the layer segments arranged in the gasket layer plane with their second longitudinal ends immediately adjacent to each other, without a longitudinal end region of the second layer segment forming the second longitudinal end of the gasket layer and having the length L, has a center line extending perpendicularly to the longitudinal direction of the gasket layer and lying in the gasket layer plane, and
 - (b) the two layer segments without the longitudinal end region of the second layer segment having the length L are of mirror-symmetrical configuration in relation to this center line at least with respect to the number and positions and the sizes and shapes of the elastomeric sealing elements.
43. Gasket layer in accordance with any one of claims 39 to 42, wherein the two layer segments have an identical number of at least two combustion chamber openings.
44. Gasket layer in accordance with any one of claims 39 to 43, wherein each of the layer segments is in one piece and seamless.
45. Gasket layer in accordance with any one of claims 39 to 44, wherein the two gasket layer segments are directly connected to each other by connecting elements which, when the cylinder head gasket is installed, lie outside of at least one of the sealing surfaces of a cylinder head and an engine block that are pressed against the cylinder head gasket.
46. Elongate sheet-metal gasket layer, provided with elastomeric sealing elements, of a cylinder head gasket, the gasket layer having several

combustion chamber openings arranged one behind the other in the longitudinal direction of the gasket layer as well as bolt through-openings for cylinder head bolts, first through-openings with elastomeric sealing elements associated with these as well as other openings, being in one piece and comprising only two such layer sections directly adjoining each other and arranged one behind the other in the longitudinal direction of the gasket layer that these two layer sections contain all of the combustion chamber openings and at least one group of the first through-openings of the gasket layer and each layer section is provided with at least one combustion chamber opening and at least one of these first through-openings, the two layer sections being of at least substantially equal length in the longitudinal direction of the gasket layer, directly adjoining each other at least in areas at an axis of symmetry extending in the plane of the gasket layer and perpendicularly to its longitudinal direction, and containing at least all of the first through-openings of the aforementioned group of first through-openings, first gasket layer zones, in which all of the elastomeric sealing elements of the two layer sections are arranged, being provided in the two layer sections, each gasket layer zone being provided with at least one elastomeric sealing element, and at least one gasket layer zone comprising at least one of the first through-openings with at least one elastomeric sealing element associated with this first through-opening, and, in a plan view of the gasket layer, the pattern formed by the elastomeric sealing elements of the two layer sections being of mirror-symmetrical configuration in relation to this axis of symmetry with respect to the number and positions and the sizes and shapes of the elastomeric sealing elements.

47. Gasket layer in accordance with claim 46, wherein the opening pattern formed at least by the first through-openings of the aforementioned group of first through-openings is of mirror-symmetrical configuration in relation to the axis of symmetry.

48. Gasket layer in accordance with claim 46 or 47, wherein the gasket layer comprises a first longitudinal end region which is arranged in the longitudinal direction of the gasket layer beside the two layer sections and adjoins a first one of these layer sections.
49. Gasket layer in accordance with claim 48, wherein the first longitudinal end region is provided with at least one opening.
50. Gasket layer in accordance with claim 49, wherein an elastomeric sealing element is associated with this opening.
51. Gasket layer in accordance with one of claims 49 and 50, wherein this opening is a chain case opening or gear case opening.
52. Gasket layer in accordance with any one of claims 48 to 51, wherein a second one of the two layer sections forms a second longitudinal end region of the gasket layer.
53. Gasket layer in accordance with any one of claims 46 to 52, wherein the gasket layer has an even number of at least four combustion chamber openings.
54. Elongate sheet-metal gasket layer of a cylinder head gasket, which is provided with elastomeric sealing elements injection molded onto the sheet metal of the gasket layer,

the gasket layer comprising several combustion chamber openings arranged one behind the other in the longitudinal direction of the gasket layer and such first through-openings with which at least one of the elastomeric sealing elements is associated, in each case, as well as other through-openings, and the gasket layer comprising several layer sections arranged one behind the other in its longitudinal direction and provided, in each case, with at least one elastomeric sealing element, the layer sections being of identical configuration at least with respect to the number and positions and the shapes and sizes of their elastomeric sealing elements,

produced in accordance with any one of claims 31 to 36.

55. Gasket layer in accordance with claim 54, wherein the layer sections directly adjoin one another.
56. Gasket layer in accordance with claim 54 or 55, wherein the first through-openings are liquid through-openings.

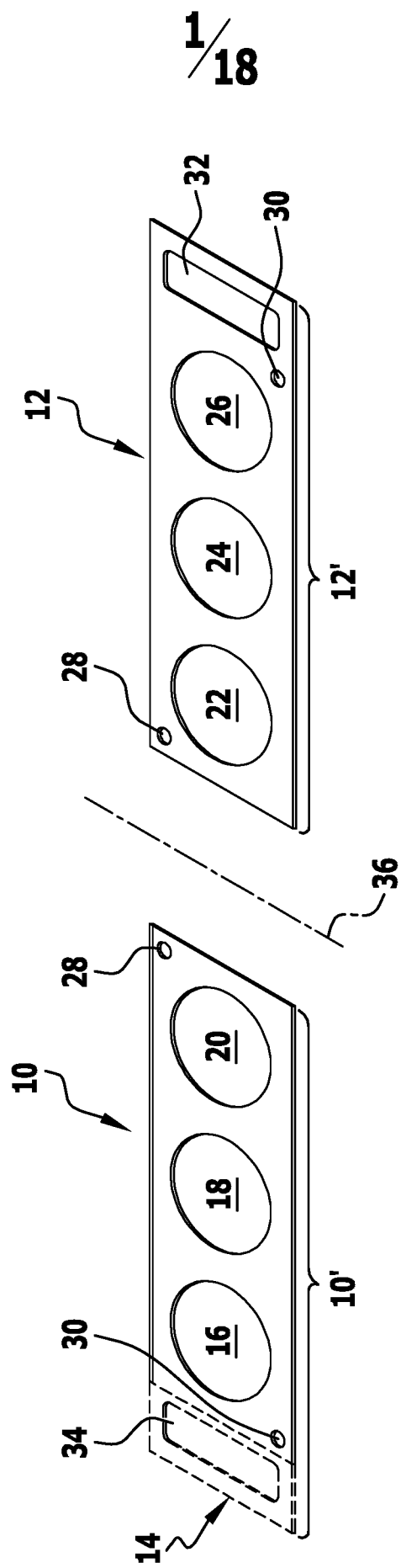


FIG.1

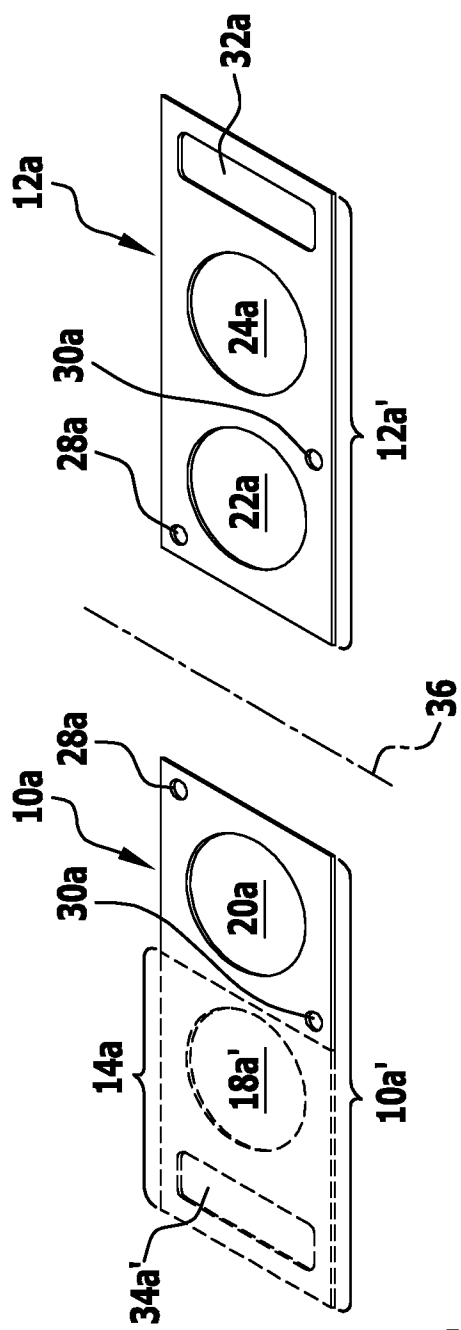


FIG. 2

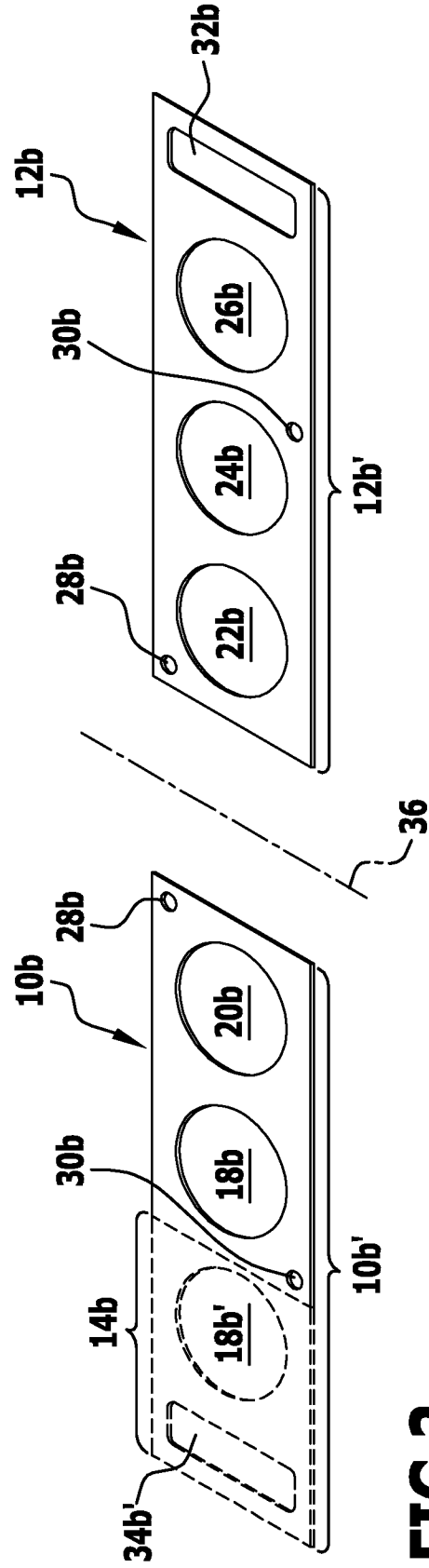


FIG. 3

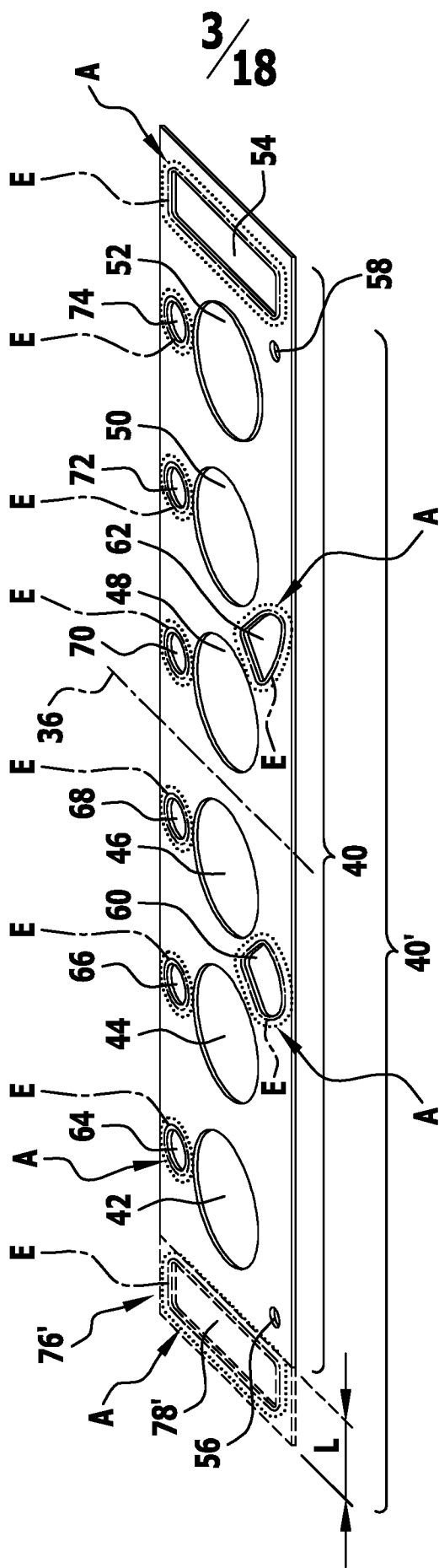


FIG.4

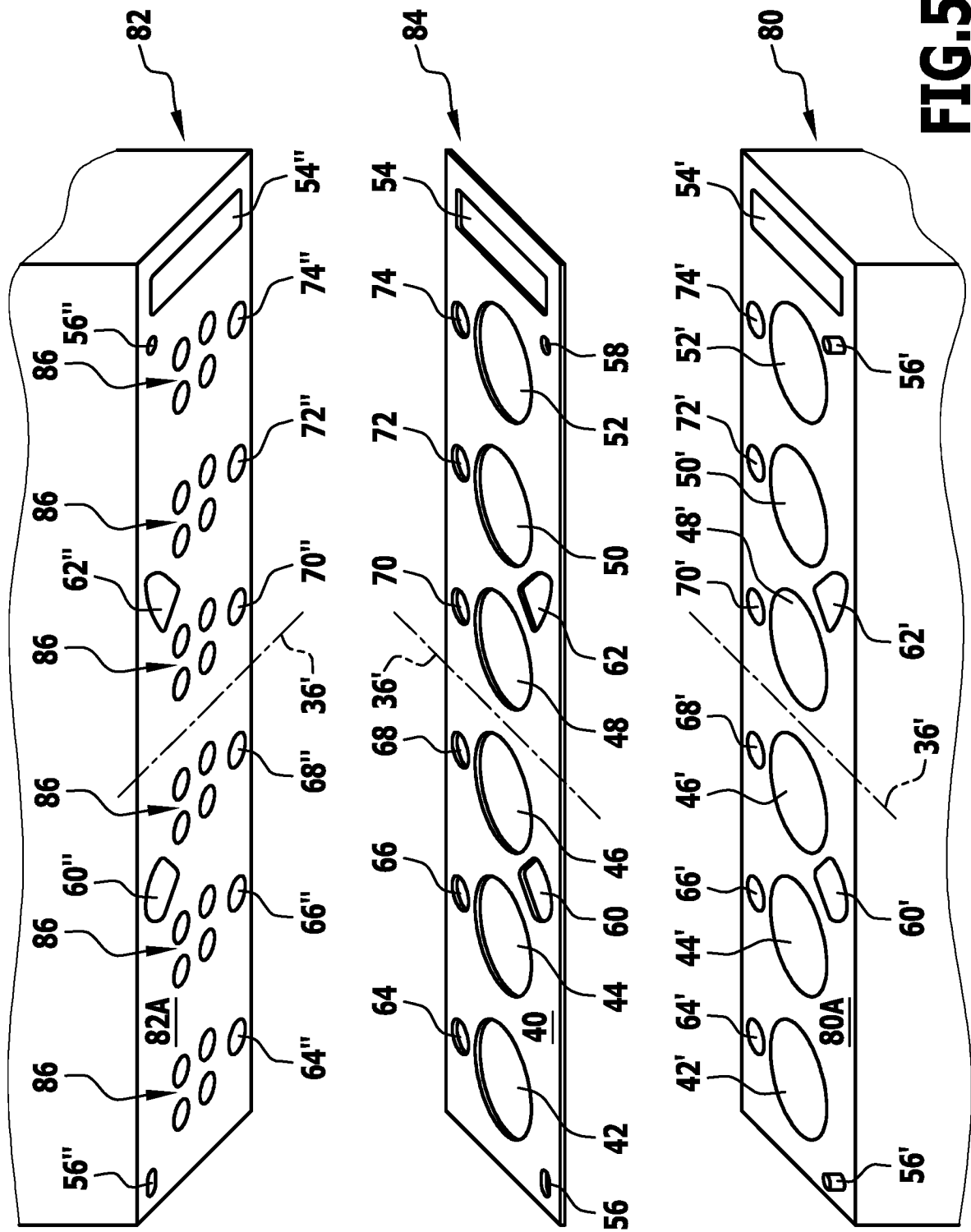
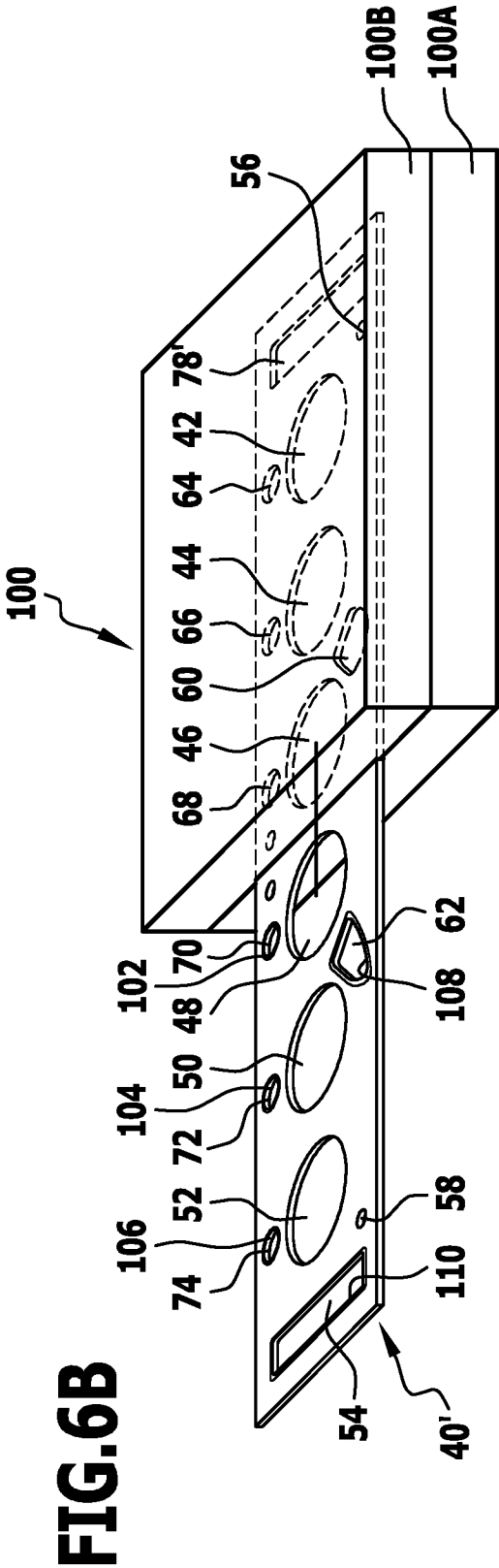
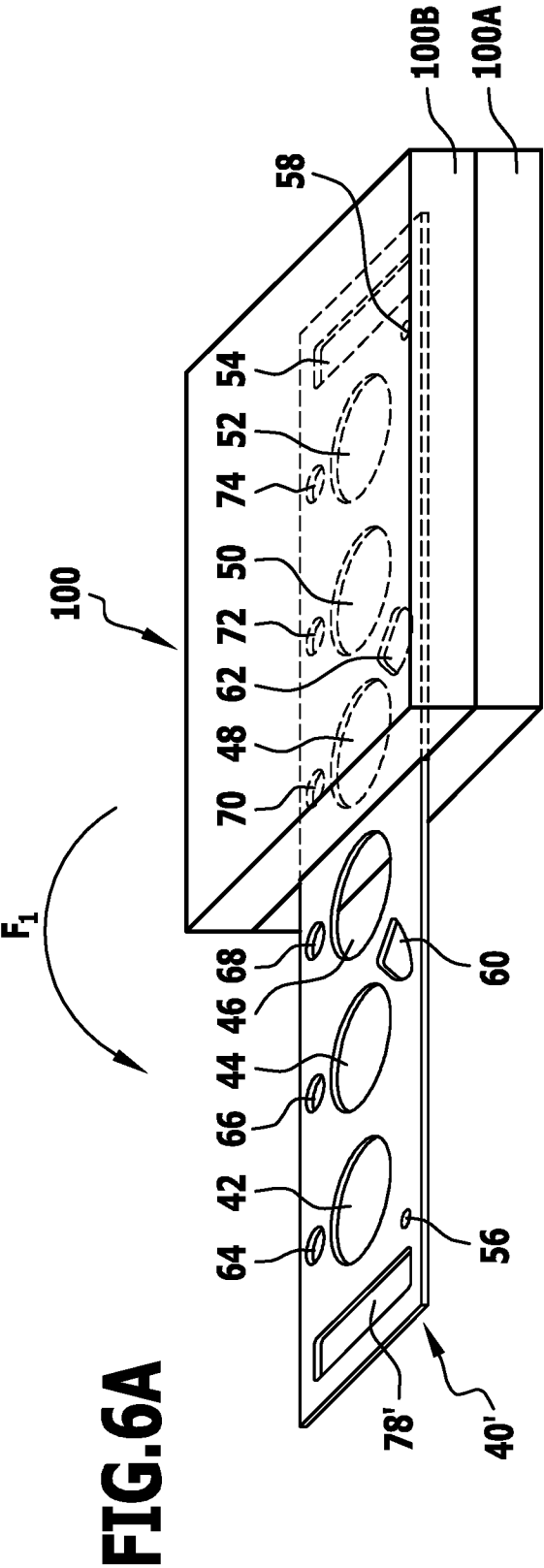


FIG. 5



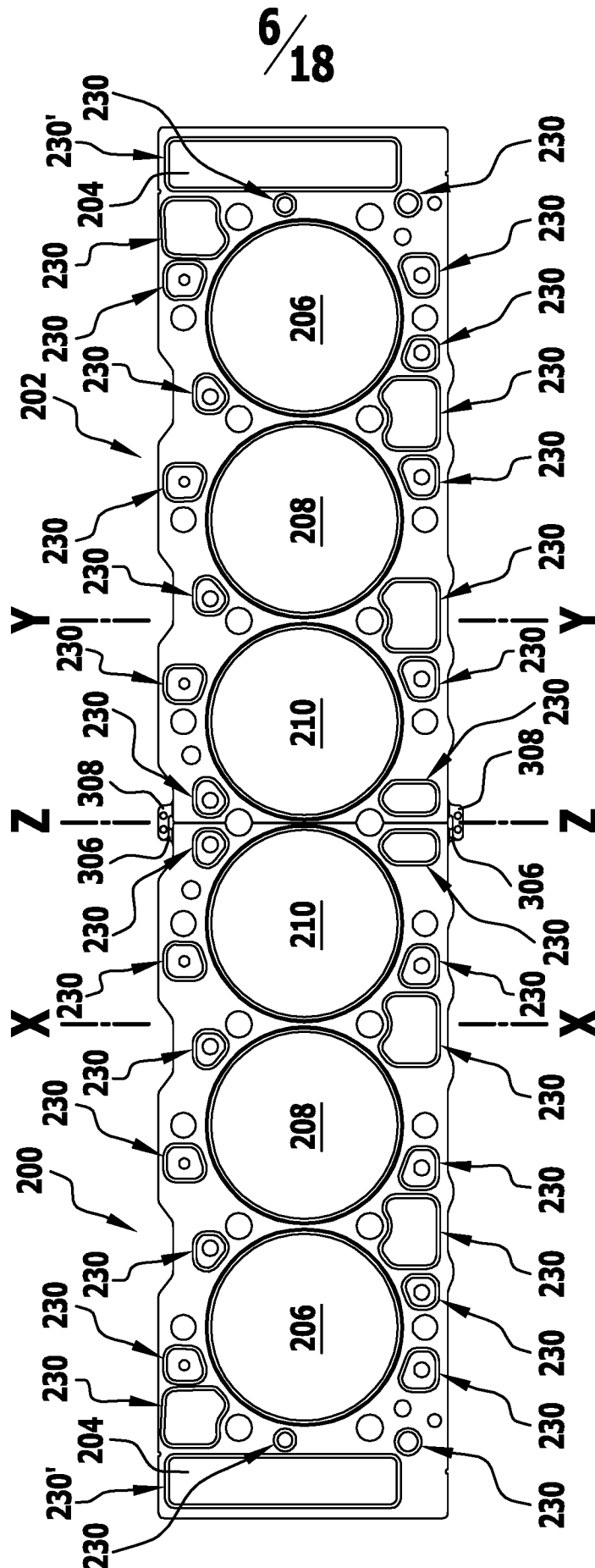


FIG. 7

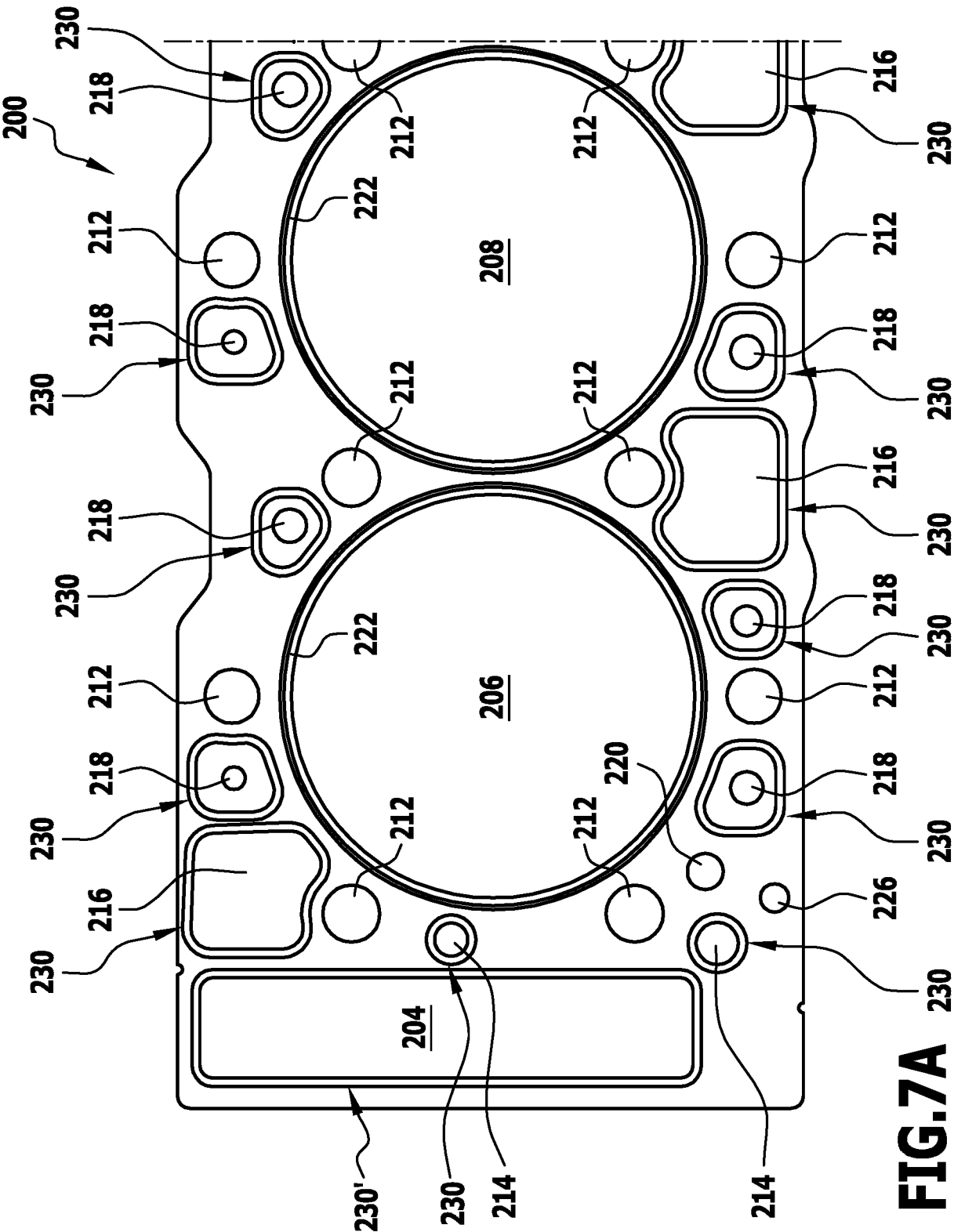
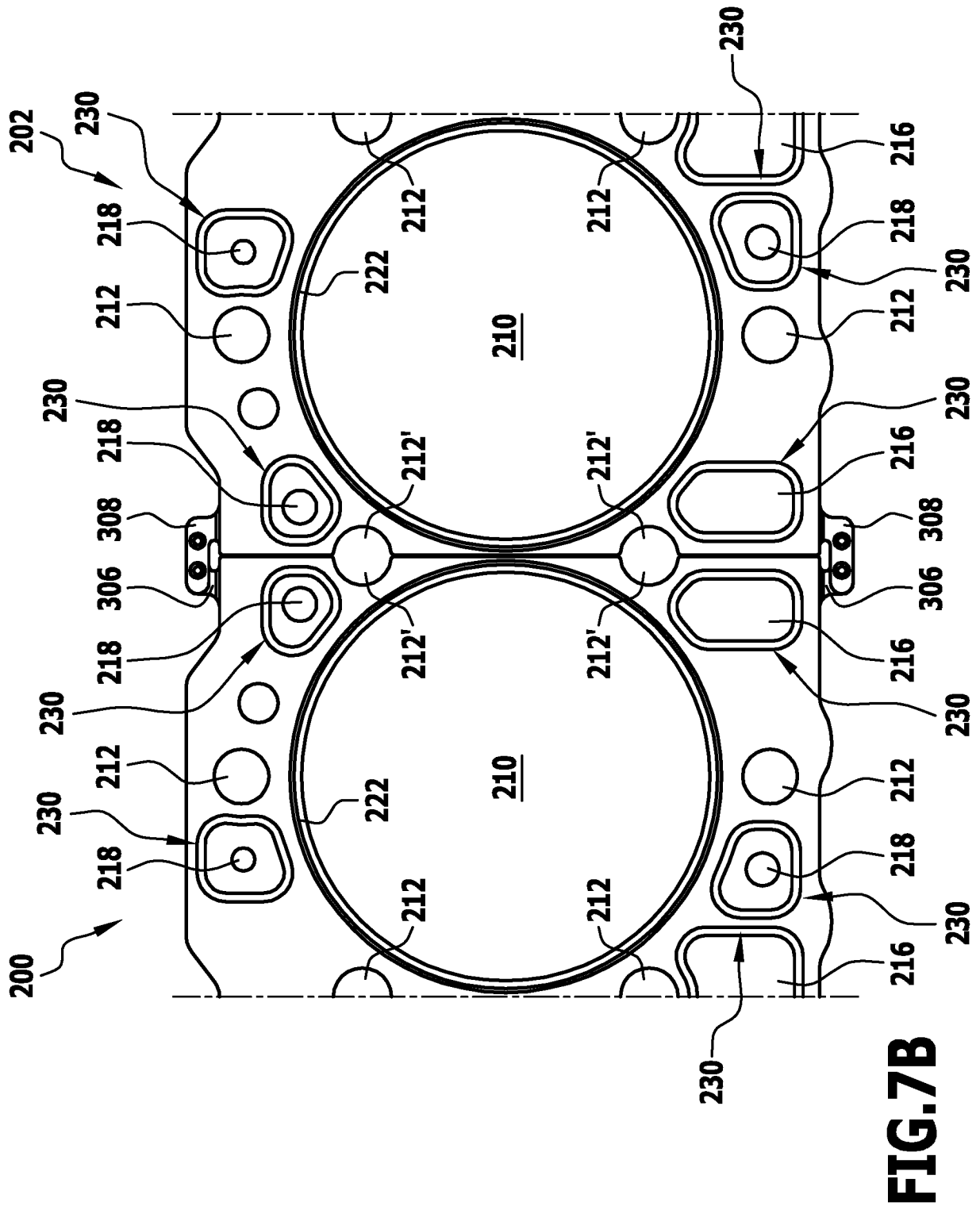
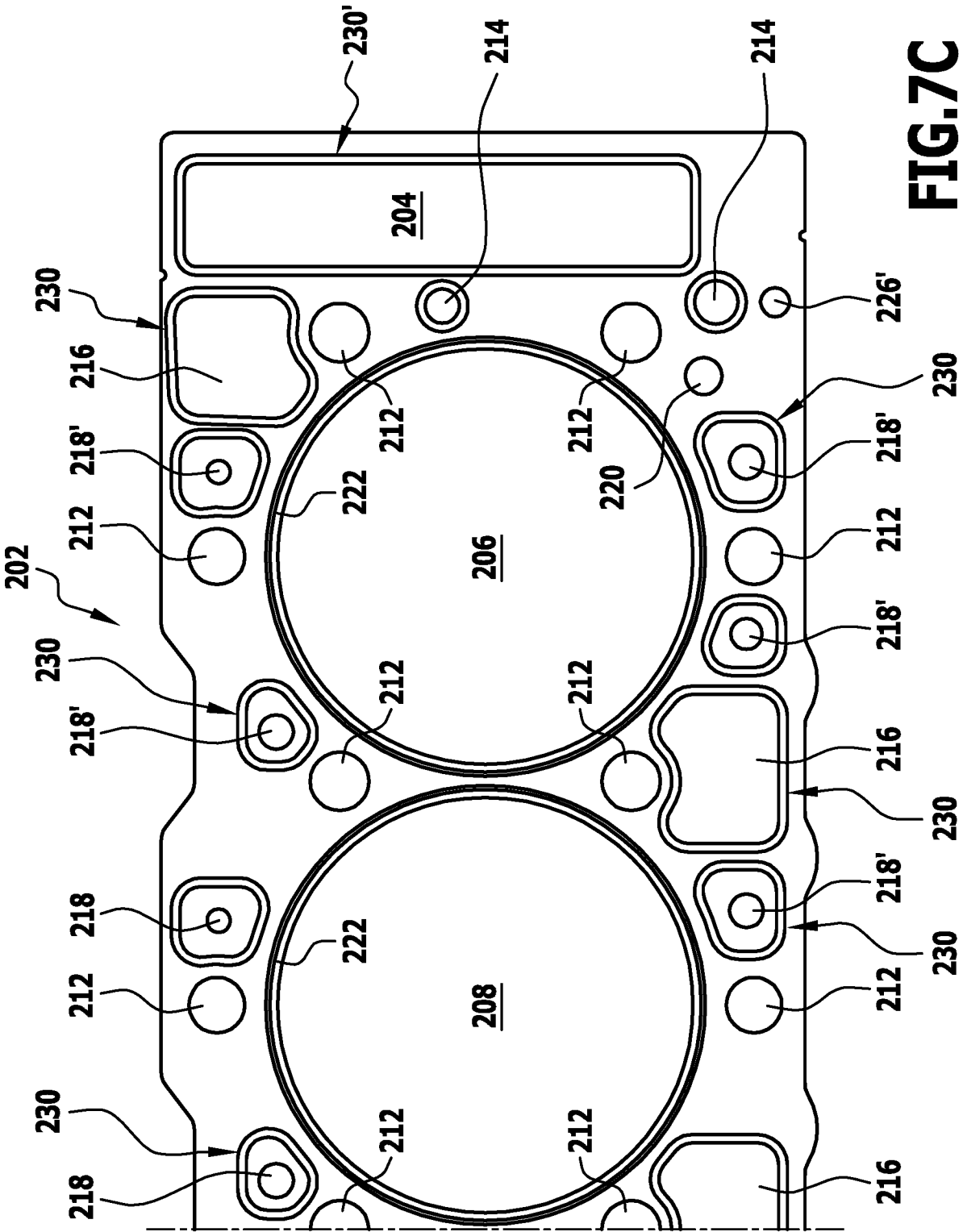


FIG. 7A





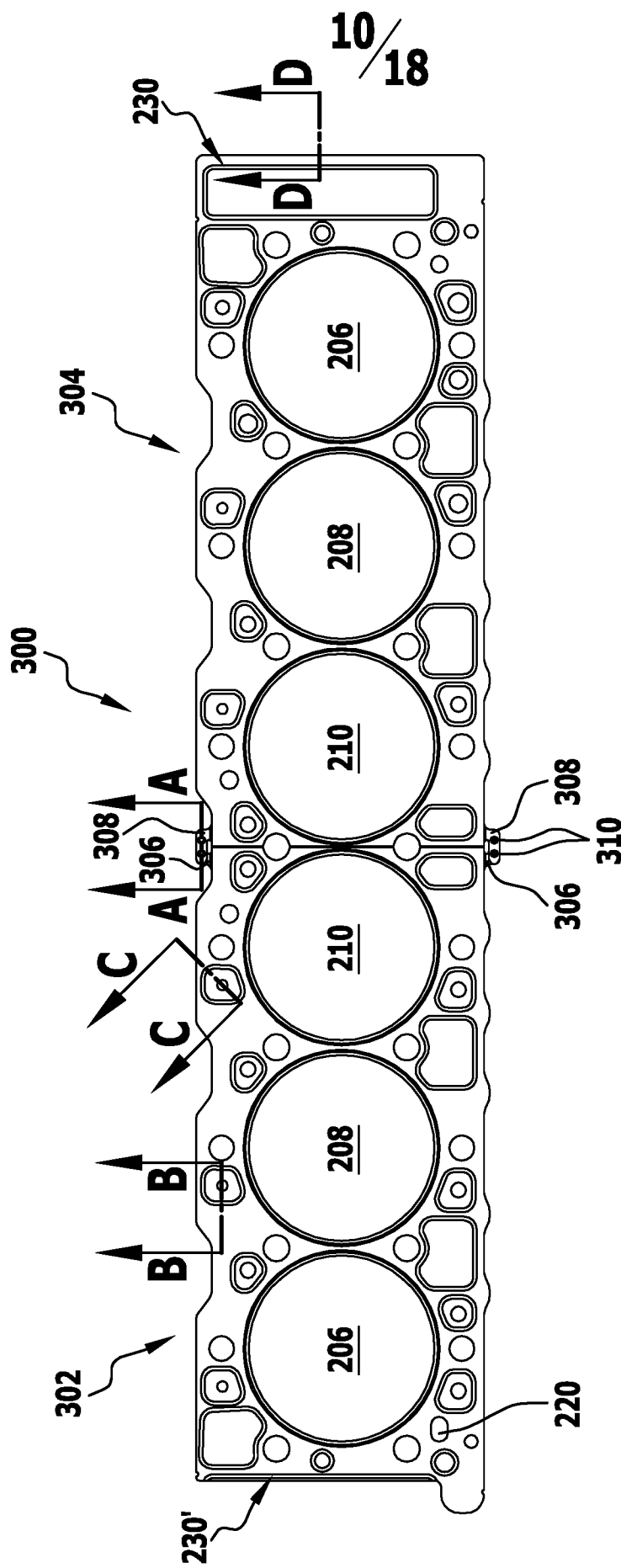


FIG. 8

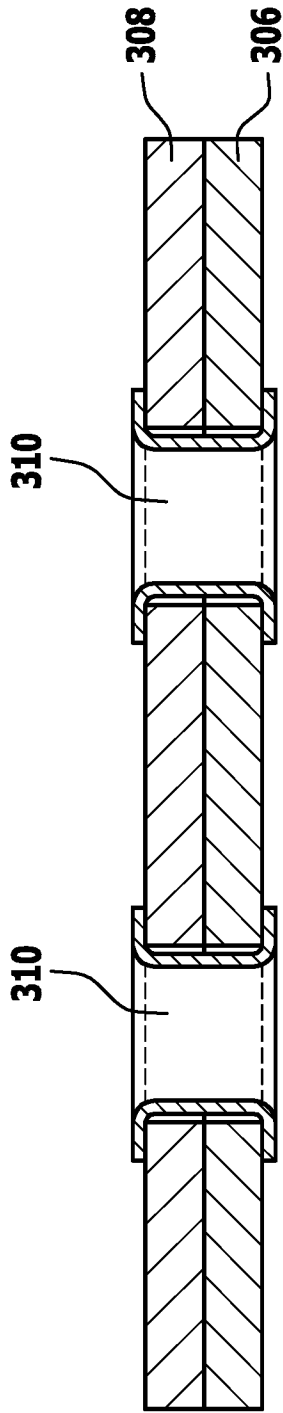


FIG. 8A

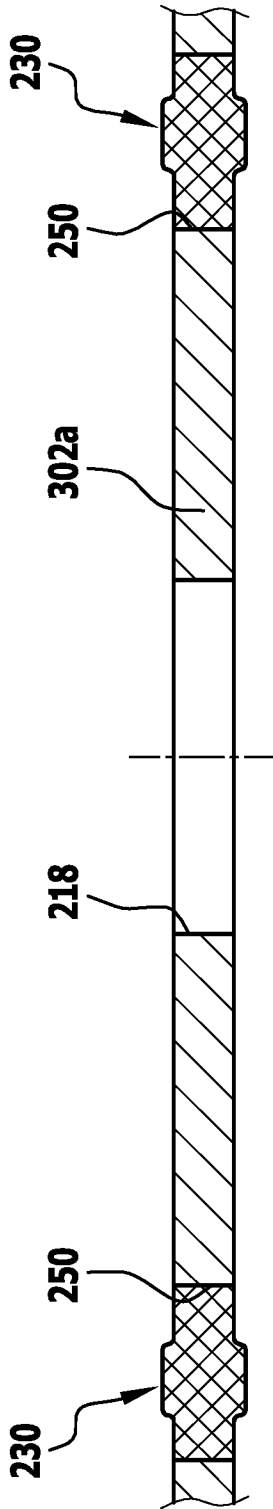


FIG. 8B

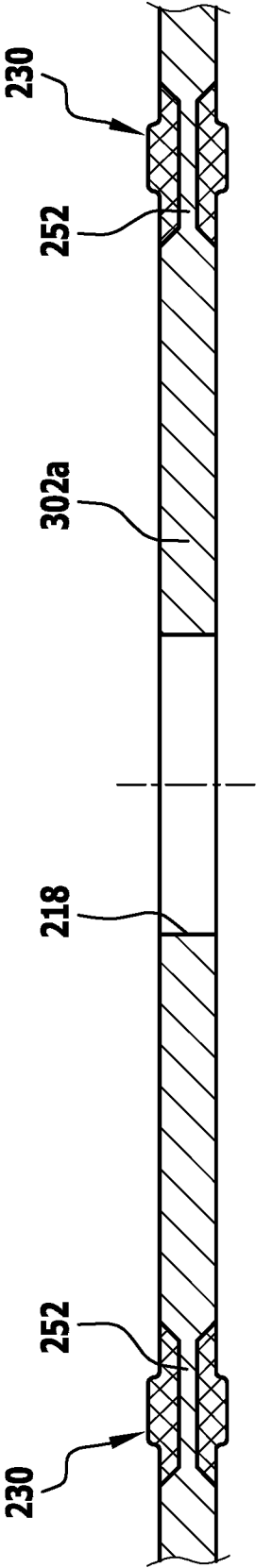


FIG. 8C

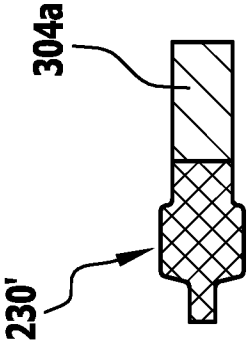


FIG. 8D

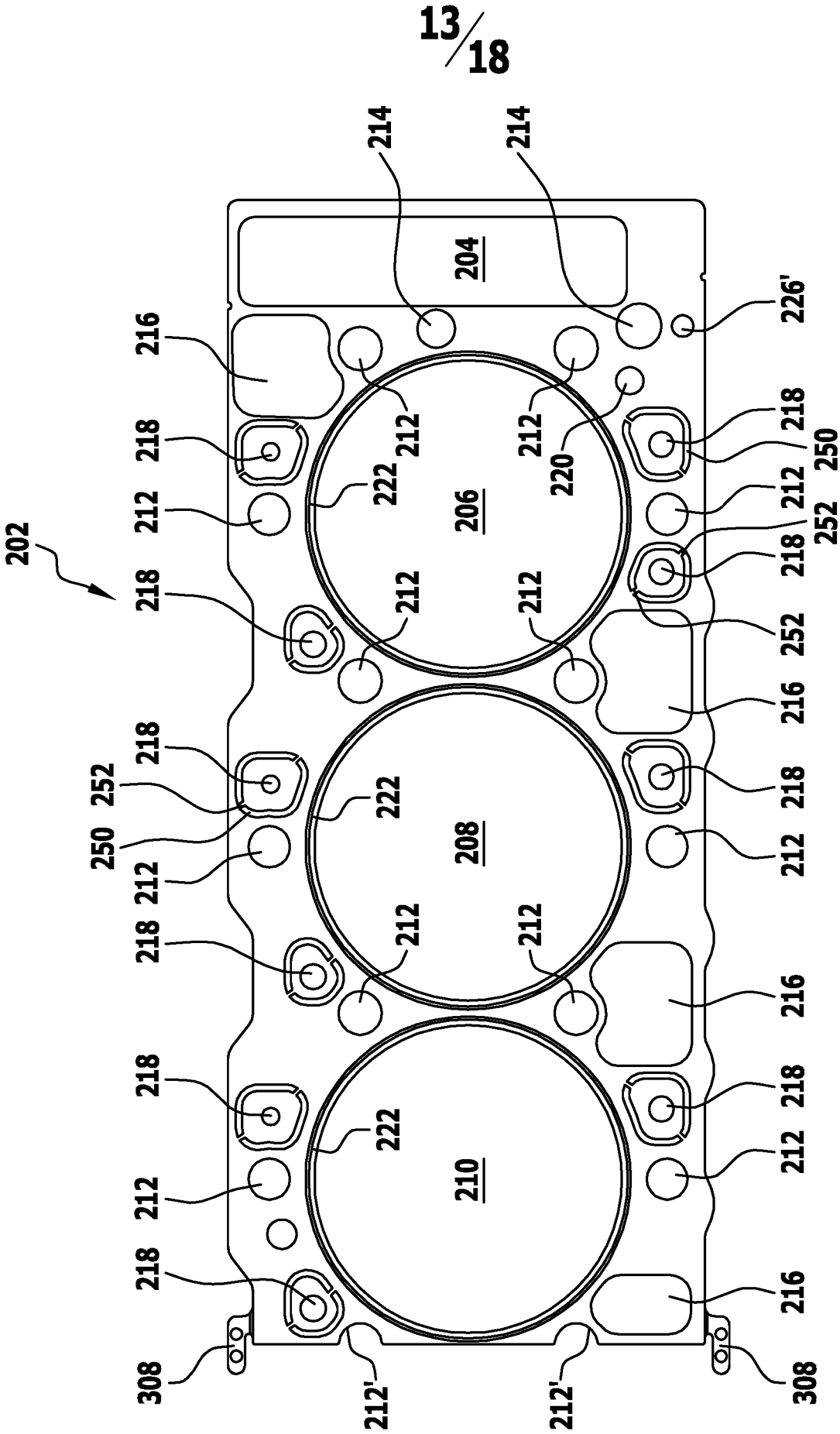


FIG. 9

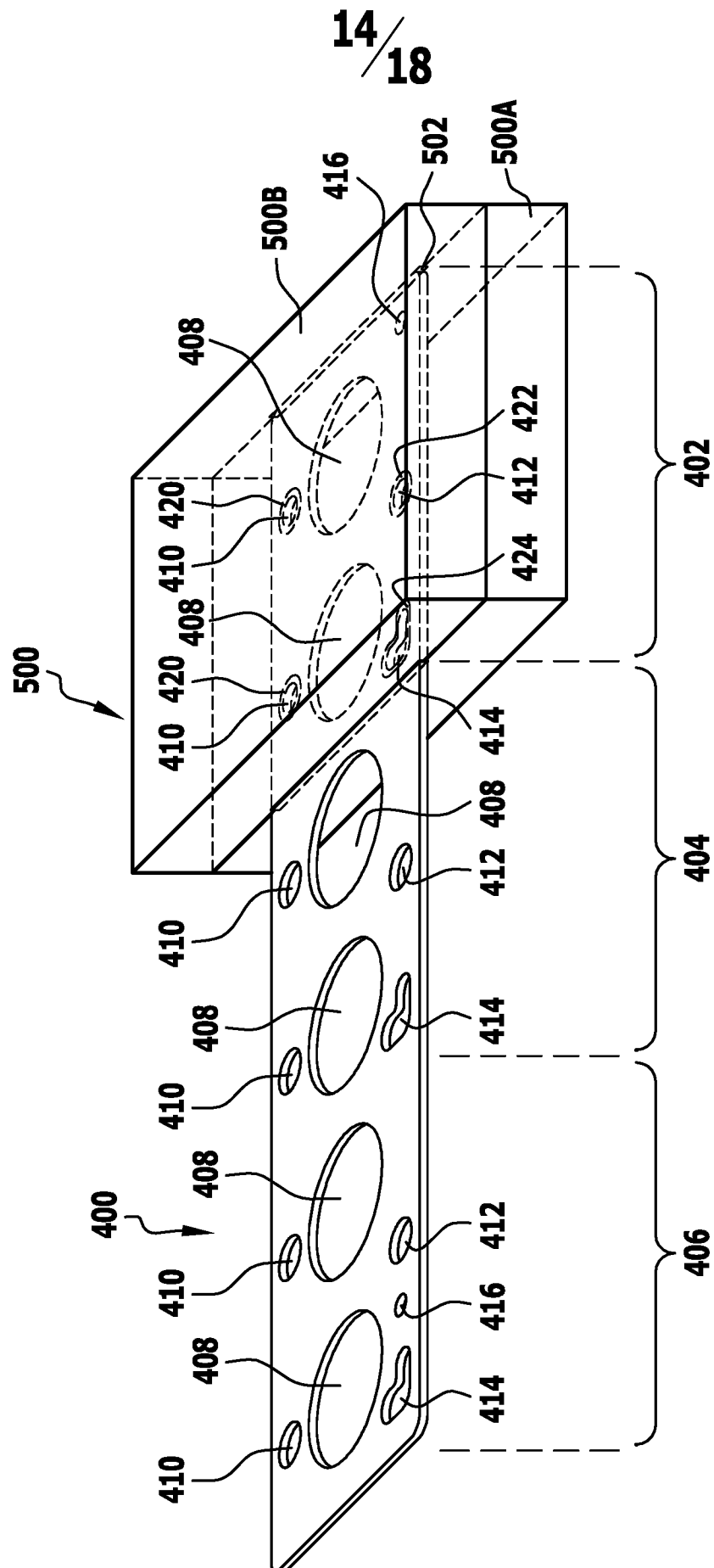
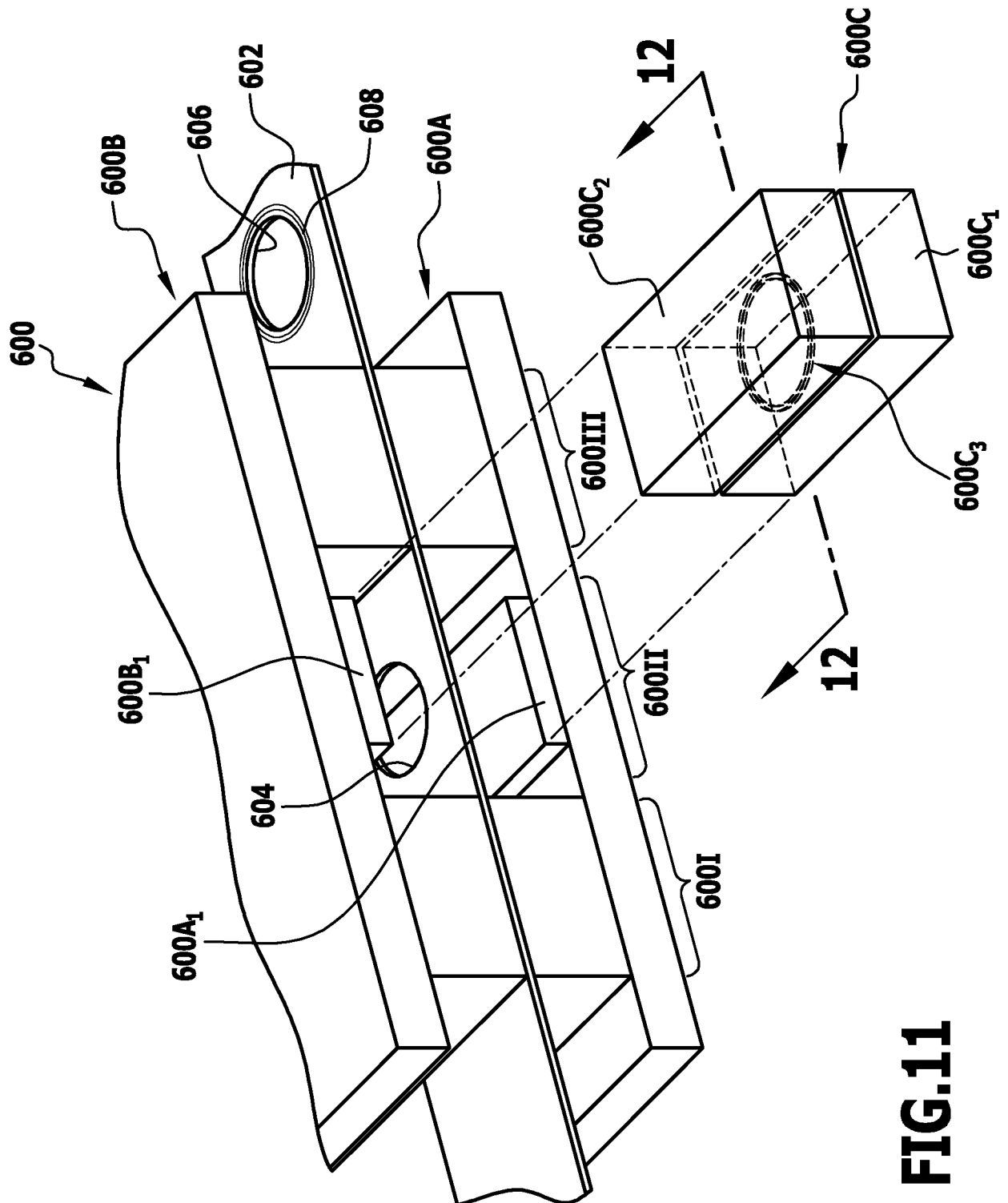


FIG.10



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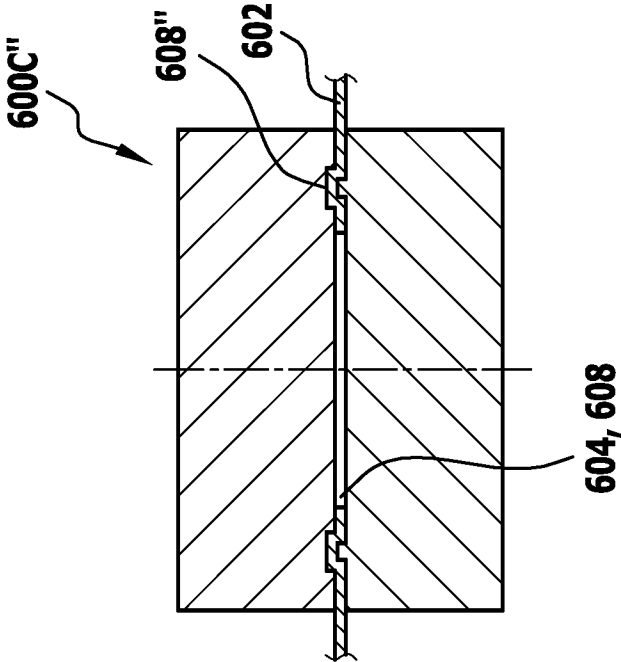


FIG.12B

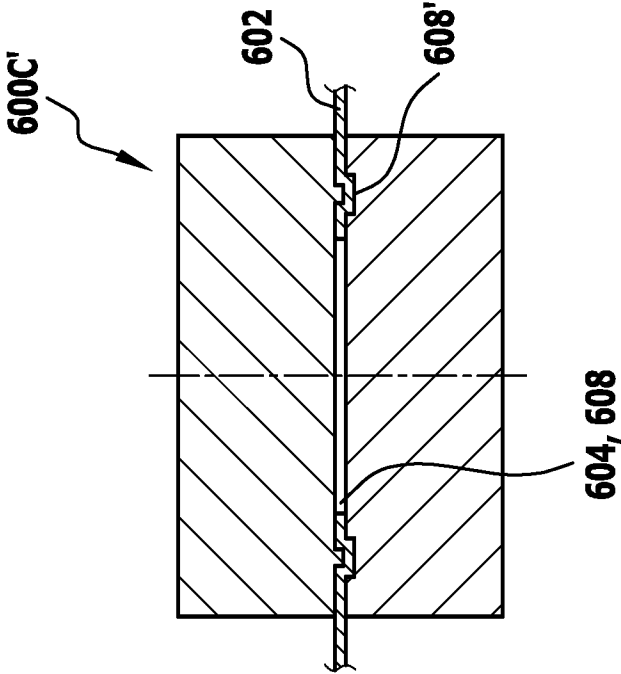
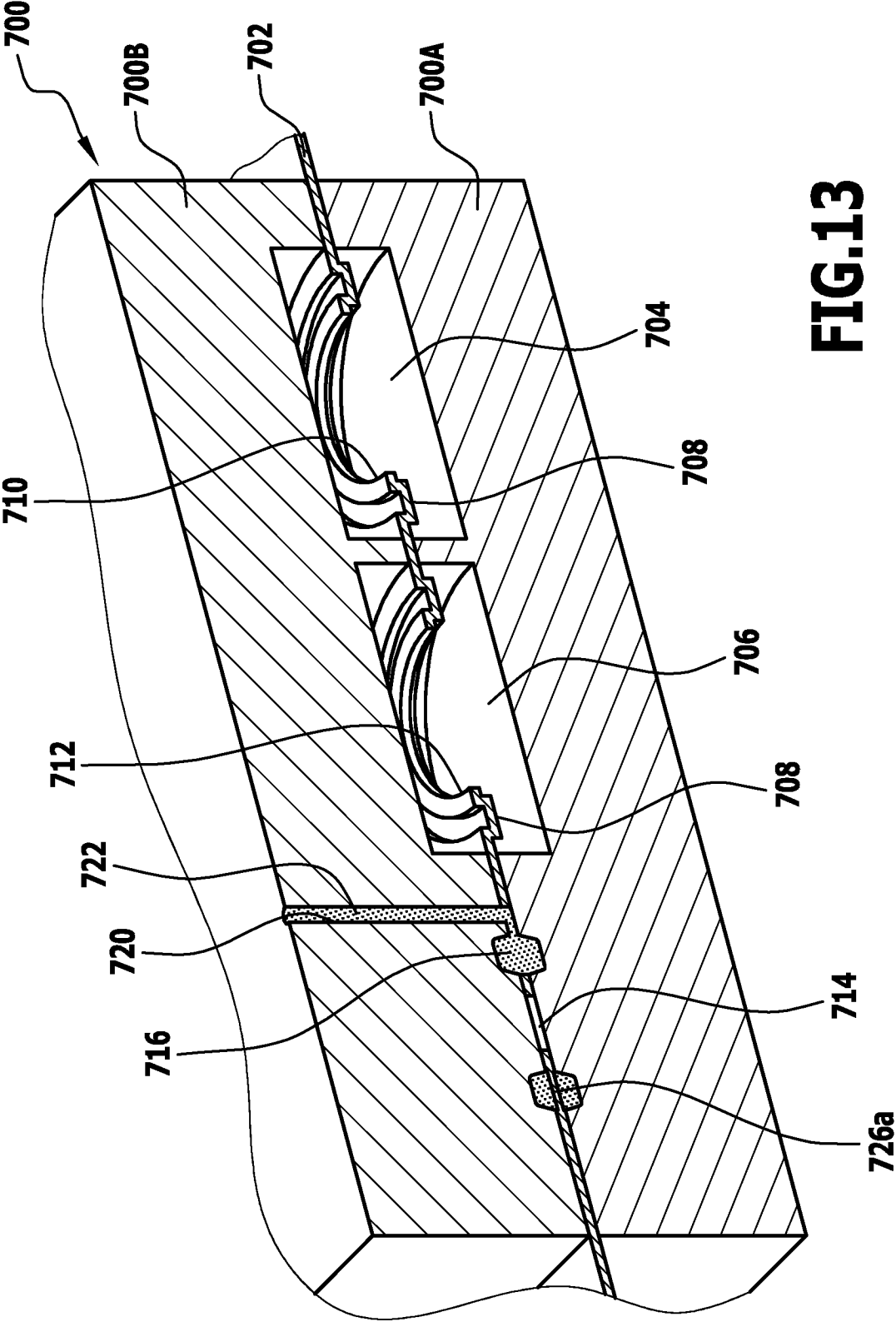


FIG.12A

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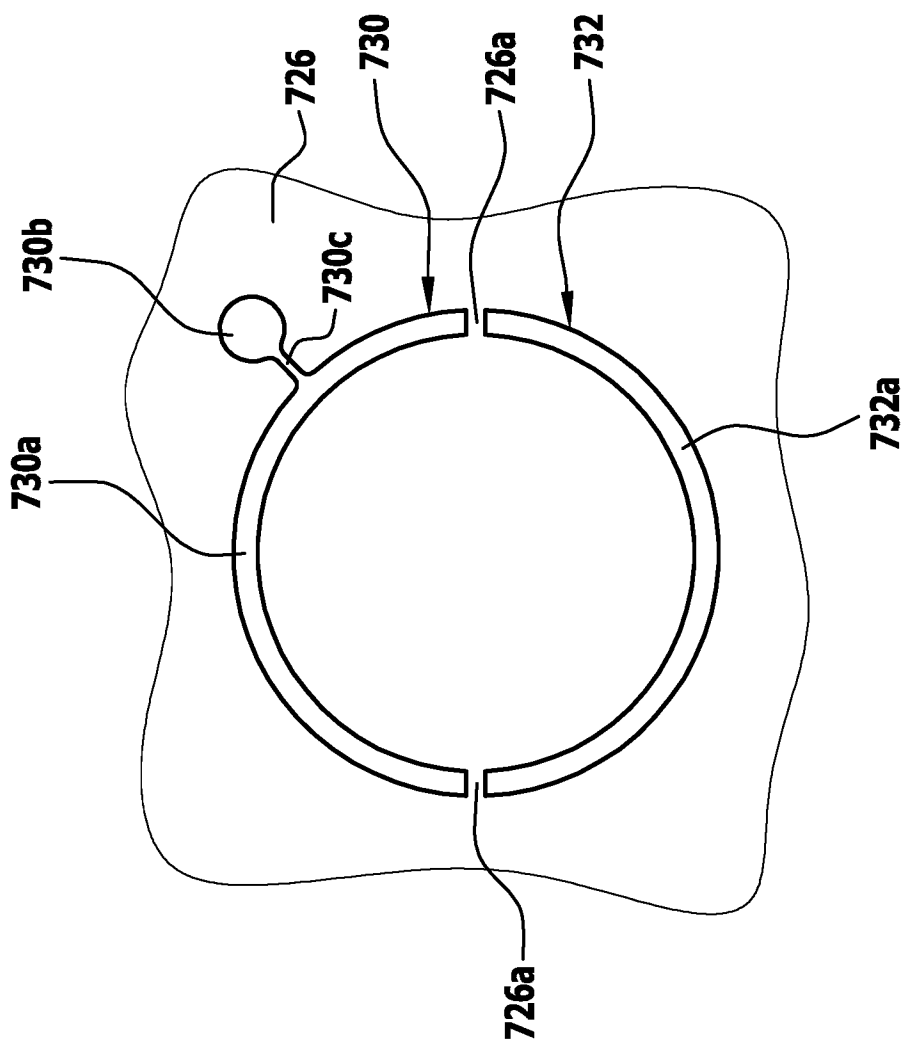


FIG.14

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2017/071174

A. CLASSIFICATION OF SUBJECT MATTER

INV. F16J15/06 F16J15/08
ADD.

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)
F16J

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 practicable, 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	US 5 890 719 A (BETTENCOURT ALAN C [US]) 6 April 1999 (1999-04-06) column 1, lines 8-12 column 7, lines 28-44 column 8, lines 44-57 column 9, lines 11-35 figures 1-7	1-7, 14-20, 27-30, 38-50, 52,53
Y	US 2005/194749 A1 (UDAGAWA TSUNEKAZU [JP]) 8 September 2005 (2005-09-08) paragraphs [0026] - [0027], [0033] figures 1-8 ----- -/-	31-38, 54-56



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

24 November 2017

Date of mailing of the international search report

04/12/2017

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Van Wel, Oscar

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2017/071174

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	EP 1 840 363 A1 (ELRINGKLINGER AG [DE]) 3 October 2007 (2007-10-03) paragraphs [0006], [0014], [0020] figures 1-6 -----	31-38, 54-56

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2017/071174

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EP 1840363	A1	03-10-2007	AT 433048 T 15-06-2009
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