



## Description

**[0001]** The present invention relates to the field of heat exchangers and in particular to heat exchangers arranged on the front face of a motor vehicle.

**[0002]** Heat exchangers interact with a fluid circulation loop in order to generate heat exchange between the outside air of the motor vehicle directed to pass through these heat exchangers and the fluid. It may be a coolant fluid, a refrigerant fluid or a gaseous fluid such as an intake air flow for an internal combustion engine.

**[0003]** These heat exchangers may consist of radiators, condensers or supercharged air coolers. In these heat exchangers, several tubes are stacked on top of each other with heat dissipating elements arranged in-between. The fluid circulates inside the tubes and transfers or captures calories present in the outside air which passes through the dissipating elements of the heat exchanger.

**[0004]** These heat exchangers are conventionally arranged on the front face of motor vehicles in order to capture the outside air, ahead of the engine which is placed in the engine compartment of the motor vehicle.

**[0005]** The frontal position of these heat exchangers exposes the heat exchanger which is closest to the front face of the motor vehicle to the projection of debris or gravel which are in the road and which can damage or even pierce the tubes inside which the fluid circulates. More specifically, the tubes of the heat exchanger arranged closest to the front face of the motor vehicle are arranged transversally to the running direction of the motor vehicle in a flat and horizontal arrangement. As a result, the tubes of this heat exchanger located closest to the front face of the motor vehicle are exposed to the projections of debris or gravel at their edge facing the front face of the vehicle.

**[0006]** In order to protect these heat exchangers, it is known to place in front of them a protective grid capable of retaining the gravel or any other projectile and thus preventing shocks on the tubes of the heat exchangers. It is known for example to arrange a protective grid ahead of the heat exchanger(s) of the motor vehicle, by clipping this protective grid onto the heat exchanger.

**[0007]** If such an arrangement is an adequate protection of the heat exchangers, it should be noted, on one hand, that the presence of the protective grid generates a penalizing bulk in this zone where the available space is limited and, on the other hand, that the position of this protective grid with respect to the heat exchanger is determined by the need of clipping it to this heat exchanger.

**[0008]** Thus, one of the aims of the present invention is to offer an alternative to the known protective devices of heat exchangers, which makes it possible to effectively protect the heat exchanger equipped with its protective device against projectiles, such a combination being otherwise easy to produce, easily adaptable to various kinds of heat exchangers and less cumbersome than the protective devices currently in use.

**[0009]** An object of the present invention thus relates to a heat exchange device comprising at least one heat exchanger comprising a plurality of tubes configured for the circulation of a fluid, the tubes being spaced from one another in order to delimit a passage for an air flow, the heat exchanger being delimited by an inlet face through which the air flow is able to enter the heat exchanger, the heat exchange device comprising at least one protective grid arranged along the inlet face. According to the invention, the heat exchange device comprises at least one adhesive bond between the protective grid and the heat exchanger.

**[0010]** It will be understood that each passage for the circulation of the air flow is delimited by two successive tubes of the heat exchanger, the fluid circulating in the tubes being configured to exchange calories with the air flow circulating in the passages delimited by these tubes. In order to improve this exchange of calories, heat dissipating elements may be disposed in these passages. These heat dissipating elements may, for example, be made by fins or by spacers.

**[0011]** Advantageously, the protective grid protects the tubes of the heat exchanger and the heat dissipating elements interposed between these tubes against possible projections, for example projections of gravel present on the road.

**[0012]** The words "adhesive bond" are understood to mean that the protective grid is secured to the inlet face of the heat exchanger thanks to an adhesive material. This kind of fastening allows, in particular, a great freedom with regard to the arrangement of the protective grid on this inlet face of the heat exchanger. The adhesive material is interposed at least partially between the inlet face of the heat exchanger and the protective grid and can be disposed anywhere on this inlet face of the heat exchanger.

**[0013]** The adhesive bond thus created does not require additional fastening means on the protective grid or on the heat exchanger. As a result, the bulk of such heat exchange devices is reduced.

**[0014]** According to a feature of the present invention, the protective grid comprises a front face forming, at least partially, an entrance face of the air flow in the heat exchange device and a rear face, opposed to the front face, the adhesive bond being arranged at least partly between the rear face of the protective grid and the inlet face of the heat exchanger.

**[0015]** According to one aspect of the present invention, the rear face of the protective grid comprises at least one pellet bearing the adhesive bond.

**[0016]** Advantageously, the rear face of the protective grid may comprise five pellets, four of which are distributed at the four corners of the inlet face of the heat exchanger and one of which is disposed at the centre of this inlet face of the heat exchanger.

**[0017]** Advantageously, the adhesive bond placed in the centre of the protective grid is configured to limit the vibrations of this protective grid.

**[0018]** According to a feature of the present invention, at least the pellet and the protective grid are made of one-piece.

**[0019]** It will be understood that, according to this feature, the protective grid and the at least one pellet form a one-piece element, that is to say a single element which cannot be separated without causing damage to the protective grid or to the pellet.

**[0020]** Advantageously, each pellet forms a one-piece element with the protective grid.

**[0021]** According to the invention, at least one pellet comprises at least one hole passing through the pellet.

**[0022]** Advantageously, each pellet formed on the rear face of the protective grid comprises at least one hole. Even more advantageously, each pellet formed on the rear face of the protective grid comprises a plurality of holes.

**[0023]** According to a feature of the present invention, at least the pellet comprises a solid central surface and at least one ring arranged around this central surface, the central surface being connected to the ring by at least one arm.

**[0024]** For example, the central surface may be circular and the ring arranged around this central surface may be concentric to that central surface. According to an embodiment of the present invention, the pellet may comprise a first ring and a second ring, concentrically arranged around the central surface. According to this embodiment, the first ring and the second ring are connected together by at least one arm.

**[0025]** Advantageously the central surface can be connected to each ring by a plurality of arms and the first ring can be connected to the second ring by a plurality of arms.

**[0026]** It will be understood that these arms define, in pairs, the holes formed in each pellet. Thus, each hole formed in one of the pellets of the protective grid is delimited on one hand by two successive arms and on the other hand either by the central surface and the first ring or by the first ring and the second ring. In other words, a first series of holes is formed between the central surface and the first ring, each hole being then delimited by two successive arms connecting this central surface to the first ring, by the central surface and by the first ring, and a second series of holes is provided between the first ring and the second ring, each hole being then delimited by two successive arms connecting the first ring to the second ring, by this first ring and by this second ring.

**[0027]** As mentioned above, an adhesive material allows adhesive bonding between the protective grid and the inlet face of the heat exchanger. It will be understood that this adhesive material is firstly distributed over the central surface of the pellet of the protective grid and that in a second step the protective grid is brought into contact with the heat exchanger. During this second step, the adhesive material spreads and passes through the holes of the pellet of the protective grid. This adhesive material thus allows chemical bonding with the protective grid and

also forms a mechanical bonding by spreading through two holes of a same pellet into a well, this well facing the pellet.

**[0028]** It will also be understood that the adhesive material spreads in the passages delimited by the tubes of the heat exchanger, between the heat dissipating elements arranged near the pellet formed on the protective grid. Thus, this adhesive material enable the bounding between the protective grid and the heat exchanger.

**[0029]** According to an embodiment of the present invention, the protective grid comprises at least one well extending from the front face of the protective grid and to the rear face of this protective grid, the well comprising a bottom made by at least a portion of the pellet.

**[0030]** For example, the bottom of the well may be made by the central surface of a pellet. Advantageously, this well is configured to contain the adhesive material, in order to prevent this adhesive material from spreading in an uncontrolled manner.

**[0031]** Optionally, at least one pellet formed on the protective grid comprises at least one protrusion extending in one of the passages of the air flow.

**[0032]** In other words, this protrusion is received between two successive tubes, thus passing through some of the heat dissipating elements arranged in the passages of the air flow.

**[0033]** This projection makes it possible in particular to pre-position the protective grid on the heat exchanger in order to keep the protective grid in the desired position until the adhesive bond between this protective grid and the inlet face of the heat exchanger is sufficiently strong to support alone said protective grid.

**[0034]** This protrusion is also designed to reinforce the fastening of the protective grid on the inlet face of the heat exchanger.

**[0035]** According to the invention, the inlet face of the heat exchanger is delimited on one hand by a first collecting tank and by a second collecting tank and, on the other hand, by a first end cheek and a second end cheek.

According to one aspect of the present invention, the maximum area of the protective grid is less than or equal to the maximum area of the inlet face of the heat exchanger.

**[0036]** In other words, the protective grid extends between the first collecting tank and the second collecting tank on one hand and between the first end cheek and the second end cheek on the other hand. The terms "extend between" is understood to mean that this protective grid is included between the aforementioned elements, that is to say that in its maximum size, the protective grid is delimited by these elements.

**[0037]** According to a feature of the present invention, the protective grid is made of a synthetic material.

**[0038]** According to an embodiment of the present invention, the adhesive bond comprises glue.

**[0039]** This glue may for example be light-cured silicone glue.

**[0040]** The invention also relates to a motor vehicle

comprising at least one heat exchange device according to the present invention.

**[0041]** The invention as well relates to a method of assembly of a heat exchange device according to the present invention, comprising a step during which the adhesive bond is placed on the inlet face of the heat exchanger or on the protective grid, and a step of bringing the protective grid into contact with the inlet face of the heat exchanger.

**[0042]** This method may also comprise an additional step of drying the adhesive bond, this drying being realised, for example, by a light projection. More particularly, this drying step can be carried out by a projection of ultraviolet rays.

**[0043]** It is interesting to note that the protective grid can comprise a first part and a second part separated from each other and respectively secured to the inlet face of the heat exchanger so that a free zone is created between these two parts. It will be understood that this free zone is then deprived of a protective grid. Advantageously, such a free zone is configured to receive an additional heat exchanger intended to be placed over this free zone.

**[0044]** Advantageously, one and/or the other part of the protective grid comprises an adhesive bond with the inlet face of the heat exchanger.

**[0045]** For example, this first part and this second part may respectively be arranged at an upper end and at a lower end of the inlet face of the heat exchanger, the terms 'upper' and 'lower' referring to an arrangement of the heat exchange device in an engine compartment of a motor vehicle.

**[0046]** Other features, details and advantages will appear more clearly by reading the detailed description given hereafter, in relation with the various embodiments illustrated in the following figures:

- FIG. 1 is a perspective view of a heat exchange device according to the present invention;
- FIGS. 2 and 3 are respectively partial views of a rear face and a front face of a protective grid of the heat exchange device illustrated in FIG. 1 ;
- FIG. 4 is an enlargement of a well formed on the protective grid;
- FIG. 5 is a sectional view showing an adhesive bond between a heat exchanger and the protective grid of the heat exchange device according to a first embodiment of the present invention;
- FIG. 6 is a sectional view showing an adhesive bond between the heat exchanger and the protective grid of the heat exchange device according to a second embodiment of the present invention.

**[0047]** FIG. 1 shows a heat exchange device 1 according to the present invention placed in an orthonormal sys-

tem Oxyz and comprising at least one heat exchanger 2 and at least one protective grid 3. The heat exchanger 2 comprises a plurality of tubes 4 stacked along a stacking direction Z parallel to a direction Oz of the orthonormal system. The tubes are spaced apart from each other in order to delimit passages - notably shown on figure 5 - configured to be taken by an incoming air flow in a motor vehicle in which is arranged the heat exchange device 1 according to the present invention. In other words, two successive tubes 4 delimit a passage through which the air flow circulates.

**[0048]** Each of these tubes 4 extends mainly along a transverse direction Y, parallel to a direction Oy of the orthonormal system and through which flows a fluid intended to exchange calories with the air flow passing through the heat exchanger 2 via the passages delimited by the tubes 4. The fluid flowing through these tubes 4 may for example be a heat-carrying fluid such as glycol water when the heat exchanger 2 is a radiator, a refrigerant fluid when the heat exchanger 2 is a gas condenser or a gas cooler or an intake air flow when the heat exchanger 2 is a supercharged air cooler.

**[0049]** In the orthonormal system Oxyz, the direction Ox thus illustrates a direction along which an air flow can flow through the heat exchange device 1, while the direction Oy illustrates a direction perpendicular to the direction Ox and along which the fluid flows in the tubes 4 of the heat exchanger 2. Finally, the direction Oz is perpendicular to the two other directions mentioned above and illustrates a verticality of the heat exchange device 1. It should be noted that this term of verticality is understood here with reference to an orientation of the heat exchange device 1 in figure 1 and in an example of application in a given motor vehicle, but that this designation is not restrictive of the orientation the can be taken by the heat exchange device 1.

**[0050]** The heat exchanger 2 comprises an inlet face 5 and an outlet face 6, respectively arranged one after the other along the direction of movement of the air flow, that is to say along the direction Ox of the orthonormal system. It is thus understood that the inlet face 5 is a face of this heat exchanger 2 through which the air flow is able to enter the heat exchanger 2 and that the outlet face 6 is a face of this heat exchanger 2, opposed to its inlet face 5, and through which the air flow is able to leave the heat exchanger 2. In other words, the heat exchanger 2 is delimited, along the direction Ox, on one hand by this inlet face 5 and on the other hand by the outlet face 6.

**[0051]** Along the direction Oy, the heat exchanger 2 is delimited by a first collecting tank 7 and by a second collecting tank 8. The tubes 4 thus extend mainly between this first collecting tank 7 and this second collecting tank 8. As illustrated in figure 1, the first collecting tank 7 comprises a first sleeve 9 and a second sleeve 10 through which the fluid circulating in the tubes 4 can enter or leave the heat exchanger 2.

**[0052]** Finally, the heat exchanger 2 is delimited, along the direction Oz, by a first end cheek 12 and by a second

end cheek 13, this first and second end cheeks 12, 13 facing each other along the vertical direction Oz. Each of these end cheeks 12, 13 extends mainly along a direction parallel to the axis Oy of the orthonormal system between the first collecting tank 7 and the second collecting tank 8.

**[0053]** As mentioned above, the fluid which circulates in the tubes 4 of the heat exchanger 2 exchanges calories with the air flow which passes through the heat exchanger 2 along the Ox direction.

**[0054]** In order to improve this exchange of calories, heat dissipating elements are disposed in the passages taken by the air flow. The tubes 4, the passages delimited by these tubes 4 and the heat dissipating elements will be more fully described hereinafter, in particular with reference to FIG. 5.

**[0055]** As previously mentioned, the heat exchange device 1 according to the invention comprises the heat exchanger 2 and also a protective grid 3 arranged against the inlet face 5 of the heat exchanger 2 through which the air flow is able to enter this heat exchanger 2. In other words, this protective grid 3 is arranged ahead of the heat exchanger 2, the word "ahead" having to be understood with respect to the direction of the air flow passing through the heat exchanger 2.

**[0056]** The protective grid 3 comprises a front face 14 forming an entrance face of the air flow in the heat exchange device 1 and a rear face, opposed to this front face 14 and facing the inlet face 5 of the heat exchanger 2.

**[0057]** According to one embodiment of the present invention illustrated in FIG. 1, the protective grid 3 comprises a first part 30 and a second part 31, separated from each other. As a result, a free zone 16 can be provided between the first part 30 and the second part 31 of this protective grid 3.

**[0058]** This free zone 16 may, for example, receive an additional heat exchanger.

**[0059]** According to the present invention, the protective grid 3 and the heat exchanger 2 are secured to each other by at least one adhesive bond 17. It will be understood that this adhesive bond 17 is arranged between the rear face of the protective grid 3 and the inlet face 5 of the heat exchanger 2.

**[0060]** This adhesive bond 17 advantageously allows to position this protective grid 3 at any point on the inlet face 5 of the heat exchanger 2. Thus, for example, a dimension of the free zone 16 can be adapted depending on the kind of additional heat exchanger to be added. According to the embodiment illustrated in FIG. 1, each part 30, 31 of the protective grid 3 is secured to the inlet face 5 of the heat exchanger 2 by five adhesive bonds 17. As it can be seen, four of these adhesive bonds 17 are distributed at the four corners of each part 30, 31 of the protective grid 3 and an adhesive bond 17 is arranged at the centre of each of these parts 30, 31.

**[0061]** These five adhesive bonds 17 have a function of mechanical bonding of the protective grid 3 on the inlet face 5 of the heat exchanger 2. Advantageously, the ad-

hesive bond 17 disposed at the centre of the protective grid 3 can also limit the vibrations of this protective grid 3.

**[0062]** It will therefore be understood that firstly an adhesive material, for example glue, is distributed on the rear face of the protective grid 3 or on the tubes 4 of the heat exchanger 2 and that, in a second step, the protective grid 3 and the heat exchanger 2 are brought into contact in order to create the adhesive bonds 7. Following this contact, the adhesive material spreads, especially in the passages delimited by the tubes 4 of the heat exchanger 2. After drying, the adhesive material distributed on both the protective grid 3 and around the dissipating elements disposed in the air flow passages enable the fastening of this protective grid 3 with the heat exchanger 2. The mechanical strength of the heat exchange device 1 is thus ensured. The drying step of the adhesive material may for example be carried out by light projection, and more particularly by a projection of ultraviolet rays.

**[0063]** For example, glue may be light-cured silicone glue.

**[0064]** According to the invention, the protective grid 3 has a transverse dimension, that is to say measured along a straight line parallel to the axis Oy, less than or equal to a transverse dimension, also measured along a straight line parallel to the axis Oy, of the inlet face 5 of the heat exchanger 2. In other words, this protective grid 3 strictly extends between the first collecting tank 7 and the second collecting tank 8. It will be understood that the main function of this protective grid 3 is to protect the tubes 4 of the heat exchanger 2, it would therefore be useless for this protective grid 3 to extend beyond these heat exchangers tubes 4.

**[0065]** According to another embodiment of the invention not shown here, the protective grid can extend over a whole vertical dimension of the inlet face 5 of the heat exchanger 2, that is to say between the first end cheek 12 and the second end cheek 13, along the direction Oz.

**[0066]** The protective grid 3 of the heat exchange device 1 will now be described in greater detail with reference to FIGS. 2 to 4, FIG. 2 illustrating the rear face 15 of the protective grid 3, FIG. 3 illustrating the front face 14 of this protective grid 3 and FIG. 4 illustrating an enlargement of a well formed in the protective grid 3.

**[0067]** This protective grid 3 comprises at least one series of protective transverse elements 18, only some of which are referenced in FIGS. 2 and 3, in order to avoid overloading these figures. As it can be seen in FIGS. 2 and 3, two successive transverse elements 18 are interconnected by a plurality of vertical elements 19, that is to say parallel to the axis Oz of the orthonormal system, whose function is to bring a mechanical resistance to the plurality of protective transverse elements 18.

**[0068]** The mechanical strength of the protective grid 3 is also reinforced by the presence of mounts 34 which are configured to connect the protective transverse elements 18 and which extend over a whole vertical dimension of the protective grid 3, that is to say over an entire dimension of this protective grid 3 measured along a di-

rection parallel to the axis Oz of the orthonormal system.

**[0069]** These mounts 34 therefore make it possible to maintain the transverse elements 18 by determining a space 35 between each of these transverse elements 18, these spaces 35 corresponding in particular to a distance measured parallel to the direction Oz which separates two successive tubes from the heat exchanger. In other words, these spaces have a dimension substantially equivalent to a dimension of the passages of the heat exchanger in which the air flow circulates.

**[0070]** The transverse elements 18 are parallel, or substantially parallel, to one another and extend parallel to the direction of extension Y of the tubes of the heat exchanger. Depending on the arrangement of the heat exchanger 2 on the motor vehicle, the transverse elements 18 may be aligned horizontally or vertically. Whatever the orientation of the heat exchanger 2 is, this series of protective transverse elements 18 extend in a plane parallel to a plane in which the inlet face of the heat exchanger is inscribed.

**[0071]** These transverse elements 18 form zones capable of absorbing at least partially the shocks sustained by the heat exchange device, for example an impact of a gravel, and prevent this gravel from piercing the tube protected by one of these transverse elements 18. In this way, the transverse elements 18 are protective transverse elements 18 of the tubes of the heat exchanger.

**[0072]** Each transverse element 18 extends parallel to the direction of extension Y of the tube which it protects. The transverse element 18 thus forms an elongated element for protecting the tube. This or these transverse elements 18 have a band or cord shape. The section of the transverse element 18 is for example circular, ovoid, rectangular or square.

**[0073]** As previously mentioned, the protective grid 3 is secured to the inlet face of the heat exchanger thanks to adhesive bonds. More particularly, these adhesive bonds are created between the rear face 15 of this protective grid 3 and the inlet face of the heat exchanger 2. Thus, as illustrated in FIG. 2, the rear face 15 of this protective grid 3 comprises pellets 20 bearing these adhesive bonds. As previously described, the protective grid 3 and the heat exchanger 2 are secured by five adhesive bonds. In order to facilitate the reading of FIGS. 2 and 3, the protective grid 3 is only partially represented, comprising only three pellets 20.

**[0074]** According to an embodiment of the present invention illustrated in FIGS. 2 and 3, the pellets bearing the adhesive bonds are circular. Each of these pellets 20 comprises a central surface 21 around which are arranged a first ring 22 and a second ring 220, the first ring 22 being the ring closest to the central surface 21. Arms 23 are also formed to connect these rings 22, 220 to the central surface 21 and also the first ring 22 to the second ring 220. According to the embodiment illustrated in these FIGS. 2 and 3, these rings 22, 220 are concentric around the central surface 21. Each pellet 20 also comprises a plurality of holes 24 delimited by the rings 22, 220, the

central surface 21 and the arms 23 connecting this central surface 21 to the rings 22, 220 and also connecting the first ring 22 to the second ring 220. These holes will be more fully described below, with reference to FIG. 4 on which the rings 22, 220 and the central surface 21 are also more visible.

**[0075]** These holes 24 make it possible in particular to channel the adhesive material interposed between the rear face 15 of the protective grid 3 and the inlet face of the heat exchanger. Indeed, it is understood that when this adhesive material is placed on the protective grid 3 or on the inlet face of the heat exchanger, and then when these two elements are brought into contact, the adhesive material spreads between said holes 24. This adhesive material passes through the holes 24 provided on each pellet 20 and is then contained in a well 25 provided between the front face 14 and the rear face 15 of the protective grid 3, one well 25 being provided for each pellet 20. These wells 25 are for example illustrated in FIG. 3 and an enlargement of one of them is shown in FIG. 4.

**[0076]** It will therefore be understood that the adhesive material overflows through the holes 24 of each pellet 20 in the well 25 facing the concerned pellet 20. It is also understood that the adhesive material overflows each pellet by passing through the holes 24 formed around the well 25. Thanks to this organization, a chemical bond is ensured between the protective grid 3 and the adhesive material and mechanical bond is also ensured by the contact of the adhesive material overflowing through a first hole 24 and the adhesive material overflowing through a second hole 24, for example radially opposite to the first hole 24. This mechanical bond is illustrated, for example, in FIG. 5.

**[0077]** The protective grid 3 according to the invention is made of a synthetic material. Since this protective grid 3 can for example be obtained by injection, injection holes 11 are also visible on the protective grid 3.

**[0078]** FIG. 4 illustrates one of these wells 25 formed in the protective grid 3 and which are configured to contain the adhesive material. Each of these wells 25 extends between the front face 14 of the protective grid 3 and the rear face of this protective grid 3. Each well 25 is delimited by the first ring 22 of the pellet 20 facing the concerned well 25. The well 25 is open on the front face 14 of the protective grid 3 and partially closed on the rear face of this protective grid 3, for example by the central surface 21 of the pellet 20.

**[0079]** As shown in FIG. 4, the first ring 22 is lengthened to the front face 14 of the protective grid 3 by a keg 35 defining the well 25 radially. This keg 35 comprises a front edge 26 by which the well 25 opens onto the front face 14 of the protective grid 3 and a rear edge 27, formed by the first ring 22, by which the well 25 opens onto the rear face of this protective grid 3.

**[0080]** Each well 25 also comprises a bottom 28 made by the central surface 21 of the pellet 20 facing concerned well 25. As it can be seen in particular in FIG. 4, the

central surface 21 is solid, that is to say that this central surface 21 partially closes the well 25 on the side of the rear face of the protective grid 3.

**[0081]** According to an embodiment illustrated in FIG. 4, each pellet 20 comprises a plurality of holes 24 arranged in an arc of a circle around the central surface 21. A first series of holes 24 is provided between the central surface 21 and the first ring 22 and one second series of holes 24 is provided between the first ring 22 and the second ring 220. As previously mentioned, the central surface 21 is connected to the first ring 22 by several arms 23, and this first ring 22 is also connected to the second ring 220 thanks to several arms 23.

**[0082]** Each hole 24 of the first series of holes is thus delimited by the central surface 21, the first ring 22 and two successive arms 23 connecting the central surface 21 to the first ring 22.

**[0083]** Each hole 24 of the second series of holes is delimited by the first ring 22, by the second ring 220 and by two successive arms 23 connecting the first ring to the second ring 220.

**[0084]** In order to facilitate the reading of the figure, only a portion of the holes 24 and of the arms 23 are referenced.

**[0085]** From the foregoing, it will therefore be understood that the bottom 28 of each well 25 comprises the central surface 21 of the pellet concerned and in which is formed the first series of holes 24 delimited by the arms 23 connecting this central surface 21 to the first ring 22 of this pellet, this first ring 22 forming at least the rear edge 27 of the well 25.

**[0086]** FIG. 4 also shows the second ring 220 of each pellet 20 arranged on the rear face of the protective grid, around both the first ring 22 and the central surface 21.

**[0087]** FIG. 5 is a sectional view realised along a vertical plane parallel to the Oxz plane of orthonormal system, showing one of the adhesive bonds 17 between the protective grid 3 and the heat exchanger 2 of the heat exchange device according to a first embodiment of the present invention. FIG. 5 illustrates a situation in which the adhesive bond 17 has dried, the adhesive material 170 being illustrated schematically.

**[0088]** FIG. 5 makes particularly visible the tubes 4 of the heat exchanger 2 and the passages 29 delimited by these tubes 4 and through which the air flow is able to circulate. As illustrated, each tube 4 comprises two large walls 40, 41 facing each other and connected together by two small walls, these two small walls forming a front edge 42 of the tube 4 and a rear edge 43 of this tube 4. Thus, the inlet face 5 of the heat exchanger 2 is formed by a plane P1 in which the front edges 42 of the tubes 4 of this heat exchanger 2 are inscribed. The front edge 42 of each tube 4 is the edge of this tube 4 closest to the protective grid 3. Likewise, it will be understood that the rear edges 43 of these tubes 4 are inscribed in a plane P2 forming the outlet face 6 of the heat exchanger 2.

**[0089]** As previously mentioned, heat dissipating elements 32 may be disposed in the passages 29 delimited

by the tubes 4 in order to improve the exchange of calories between the air flow circulating in these passages 29 and the fluid circulating in the tubes 4 of the heat exchanger 2.

**[0090]** These dissipating elements 32 are, for example, fins or spacers, for example provided with louvers, each fin or spacer being disposed between two tubes 4 immediately adjacent to each other.

**[0091]** FIG. 5 shows the protective grid 3 which comprises the protective transverse elements 18 of the tubes 4. As previously described, each transverse element 18 is arranged so as to cover a front edge 42 of one of the tubes 4 in order to protect said tube 4. The front edge 42 of each tube 4 is thus protected by one of the transverse elements 18.

**[0092]** As previously mentioned, the adhesive material 170 is interposed between the inlet face 5 of the heat exchanger 2 and each pellet arranged on the rear face 15 of the protective grid 3, this adhesive material 170 extending partially in the well 25 formed between the front face 14 and the rear face 15 of the protective grid 3 via the holes 24 described above and partially in the passages 29 delimited by the tubes 4. It will be understood that in this cross-sectional view, the adhesive material 170 hides the arms which delimit the holes 24 through which it has spread into the well 25. As it can be seen, the pellet bearing the adhesive bond 17 has a convex cross-section. As a result, the central surface 21 of this pellet is not in contact with the inlet face 5 of the heat exchanger 2 and the adhesive material 170 also spreads between this central surface 21 and the front edge 42 of the corresponding tube 4.

**[0093]** FIG. 5 also illustrates the mechanical bond operated by the adhesive material 170 which overflows into the well 25 through its various holes 24, as described above. It can be seen that a portion of the adhesive material 170 overflows through a first hole 24a, that another portion of this adhesive material 170 overflows through another hole 24b and that these two portions meet in the corresponding well 25, thus creating said mechanical bond.

**[0094]** As previously described, this adhesive material 170 is configured to spread in the passages 29 comprising the dissipating elements 32 and delimited by the tubes 4 of the heat exchanger 2. More precisely, the adhesive material 170 enters into these dissipating elements 32, for example between each fin, thus forming a mechanical bond between the protective grid 3 and the dissipating elements 32.

**[0095]** Finally, FIG. 6 illustrates a second embodiment of the present invention, seen in a section taken along the vertical plane parallel to the Oxz plane of the orthonormal system. FIG. 6 illustrates a situation in which the adhesive bond 17 has dried, the adhesive material 170 being illustrated schematically.

**[0096]** According to this second embodiment of the present invention, a protrusion 33 is formed from at least one of the pellets 20 disposed on the rear face 15 of the

protective grid 3.

**[0097]** As shown in FIG. 6, this protrusion 33 emerges from the central surface 21 of one of the pellets 20 provided on the protective grid 3 and extends in one of the passages 29 formed between two successive tubes 4, passing partly through the dissipating elements 32 disposed in this passage 29. It will be understood that only a small portion of these dissipating elements 32 is crossed by this protrusion 33 and that this protrusion 33 is not such as to alter the effective operation of the heat exchanger 2 of the heat exchange device 1 of the present invention.

**[0098]** Advantageously, a protrusion 33 emerges from each pellet formed on the rear face 15 of the protective grid 3, these protrusions 33 making it possible in particular to pre-position the protective grid 3 on the heat exchanger 2.

**[0099]** Indeed, as mentioned above, the method of assembly of the protective grid 3 on the inlet face 5 of the heat exchanger 2 comprises a drying step allowing cross-linking of the adhesive material 170 used. During this step, it is important to keep the protective grid 3 in position on the inlet face 5 of the heat exchanger 2, this holding in position being thus facilitated by these protrusions 33.

**[0100]** These protrusion 33 also reinforce the fastening of the protective grid 3 on the heat exchanger 2.

**[0101]** It will be understood from the foregoing that the present invention provides a simple, easily adaptable and space-saving means to protect a heat exchanger arranged on the front face of a motor vehicle and therefore subjected to shocks and projections of objects present on the road.

**[0102]** However, the invention cannot be limited to the means and configurations described and illustrated herein, and it also extends to any equivalent means or configurations and to any technically operative combination of such means. In particular, the shape and arrangement of the pellets and of the wells formed on the protective grid can be modified insofar as they fulfil the functionalities described in the present document.

## Claims

1. A heat exchange device (1) comprising at least one heat exchanger (2) comprising a plurality of tubes (4) configured for the circulation of a fluid, the tubes (4) being spaced from one another in order to delimit a passage (29) for an air flow, the heat exchanger (2) being delimited by an inlet face (5) through which the air flow is able to enter the heat exchanger (2), the heat exchange device (1) comprising at least one protective grid (3) arranged along the inlet face (5), **characterized in that** the heat exchange device (1) comprises at least one adhesive bond (17) between the protective grid (3) and the heat exchanger (2).
2. The heat exchange device (1) according to claim 1,

wherein the protective grid (3) comprises a front face (14) forming, at least partially, an entrance face of the air flow in the heat exchange device (1) and a rear face (15), opposed to the front face (14), the adhesive bond (17) being arranged at least partly between the rear face (15) of the protective grid (3) and the inlet face (5) of the heat exchanger (2).

3. The heat exchange device (1) according to claim 2, wherein the rear face (15) of the protective grid (3) comprises at least one pellet (20) bearing the adhesive bond (17).
4. The heat exchange device (1) according to claim 3, wherein at least the pellet (20) and the protective grid (3) are made of one-piece.
5. The heat exchange device (1) according to any of the claims 3 or 4, wherein at least the pellet (20) comprises at least one hole (24, 24a, 24b) passing through the pellet (20).
6. The heat exchange device (1) according to any of the claims 3 to 5, wherein at least the pellet (20) comprises a solid central surface (21) and at least one ring (22, 220) arranged around this central surface (21), the central surface (21) being connected to the ring (22, 220) by at least one arm (23).
7. The heat exchange device (1) according to any of the claims 3 to 6, wherein the protective grid (3) comprises at least one well (25) extending from the front face (14) of the protective grid (3) and to the rear face (15) of this protective grid (3), the well (25) comprising a bottom (28) made by at least a portion of the pellet (20).
8. The heat exchange device (1) according to any of the claims 3 to 7, wherein at least the pellet (20) formed on the protective grid (3) comprises at least one protrusion (33) extending in one of the passages (29) of the air flow.
9. The heat exchange device (1) according to any of the preceding claims, wherein the inlet face (5) of the heat exchanger (2) is delimited on one hand by a first collecting tank (7) and by a second collecting tank (8) and, on the other hand, by a first end cheek (12) and a second end cheek (13), and wherein the maximum area of the protective grid (3) is less than or equal to the maximum area of the inlet face (5) of the heat exchanger (2).
10. The heat exchange device (1) according to any of the preceding claims, wherein the adhesive bond (17) comprises glue.
11. A method of assembly of a heat exchange device

(1) according to any of the preceding claims, comprising a step during which the adhesive bond (17) is placed on the inlet face (5) of the heat exchanger (2) or on the protective grid (3), and a step of bringing the protective grid (3) into contact with the inlet face (5) of the heat exchanger (2).

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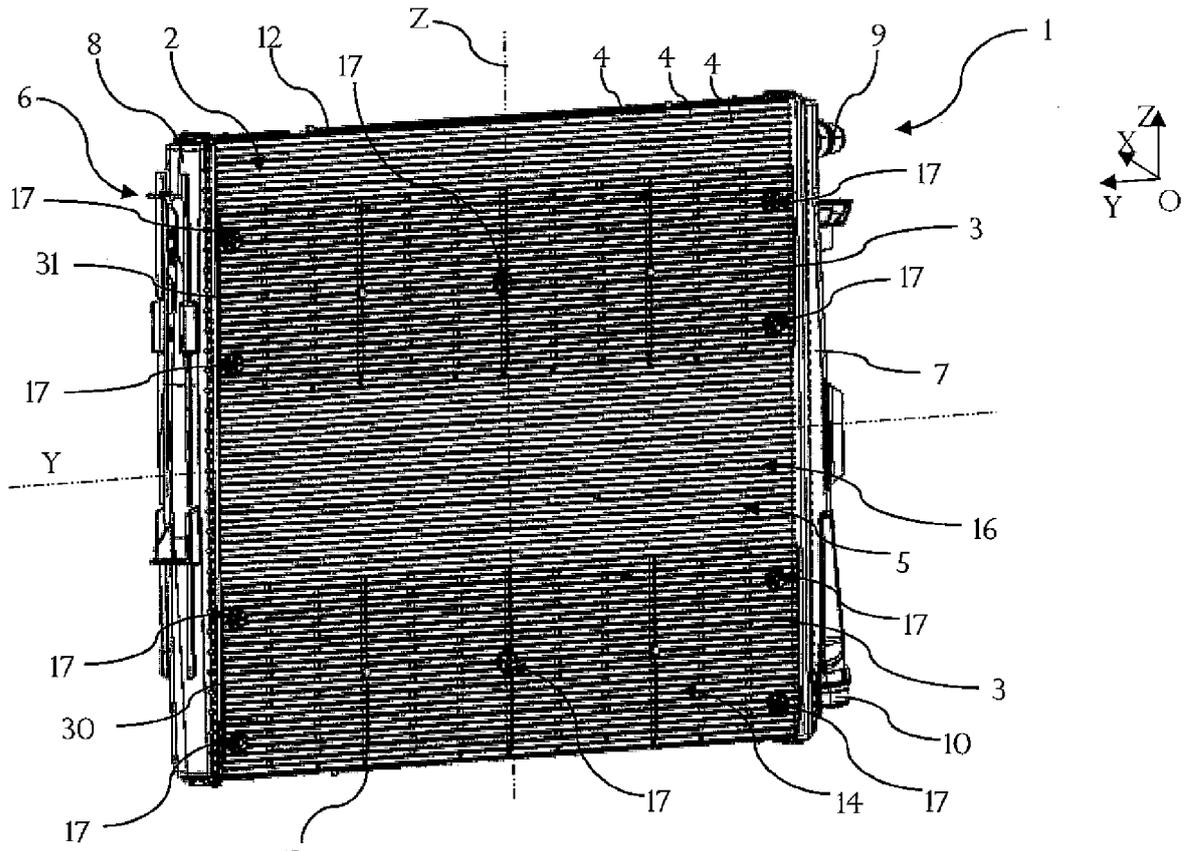


FIG. 1

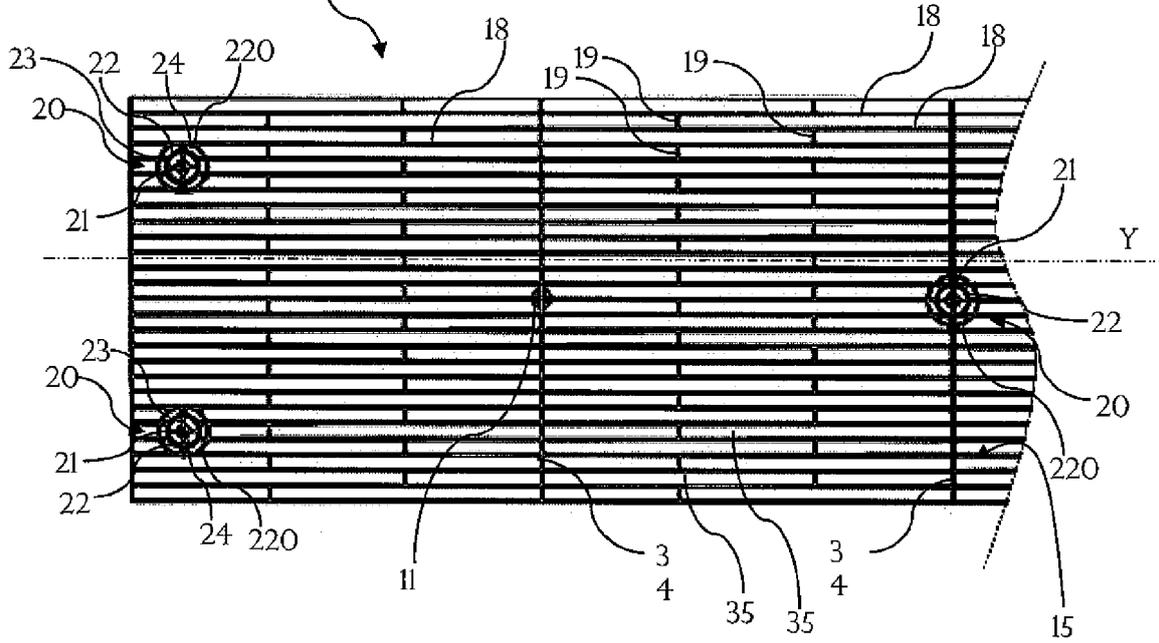


FIG. 2

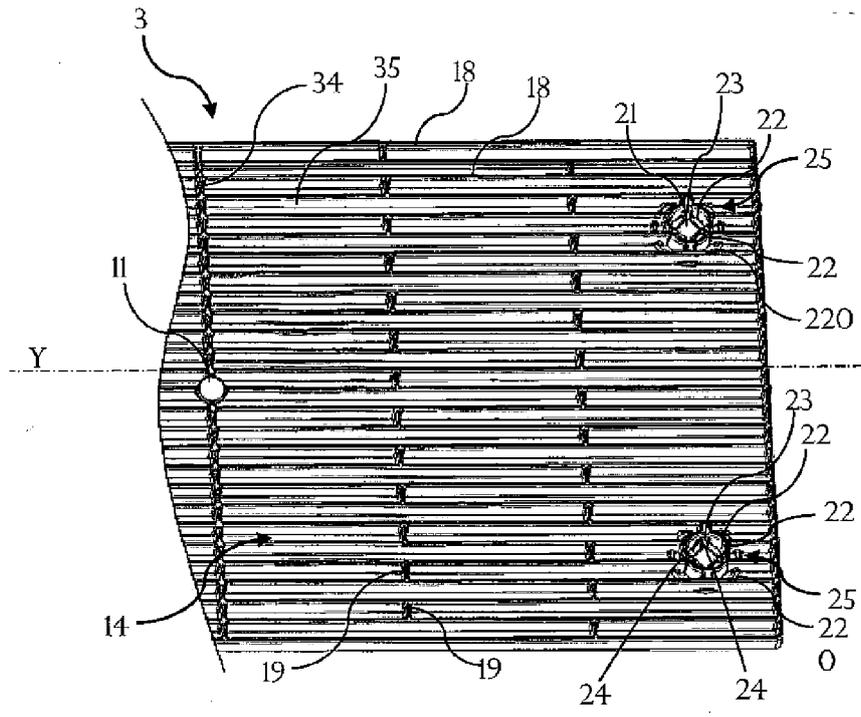


FIG. 3

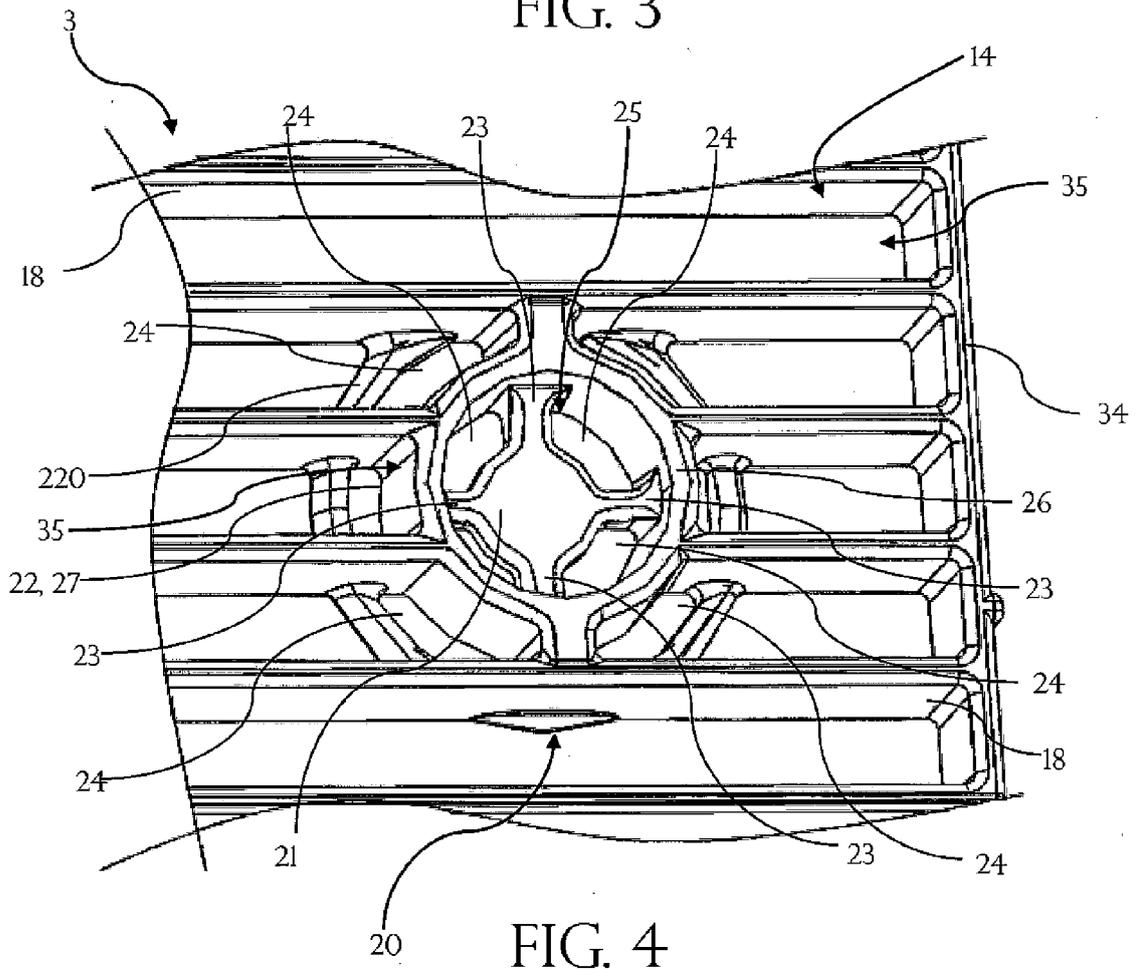
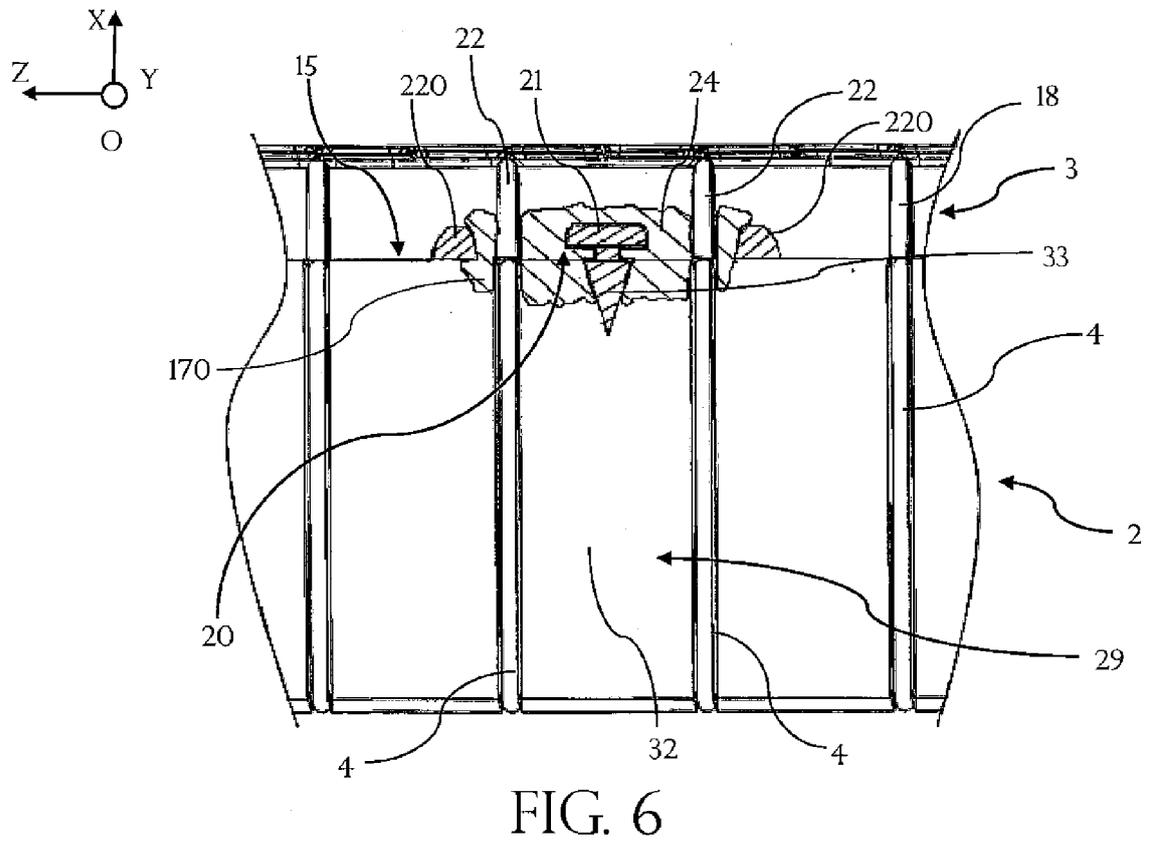
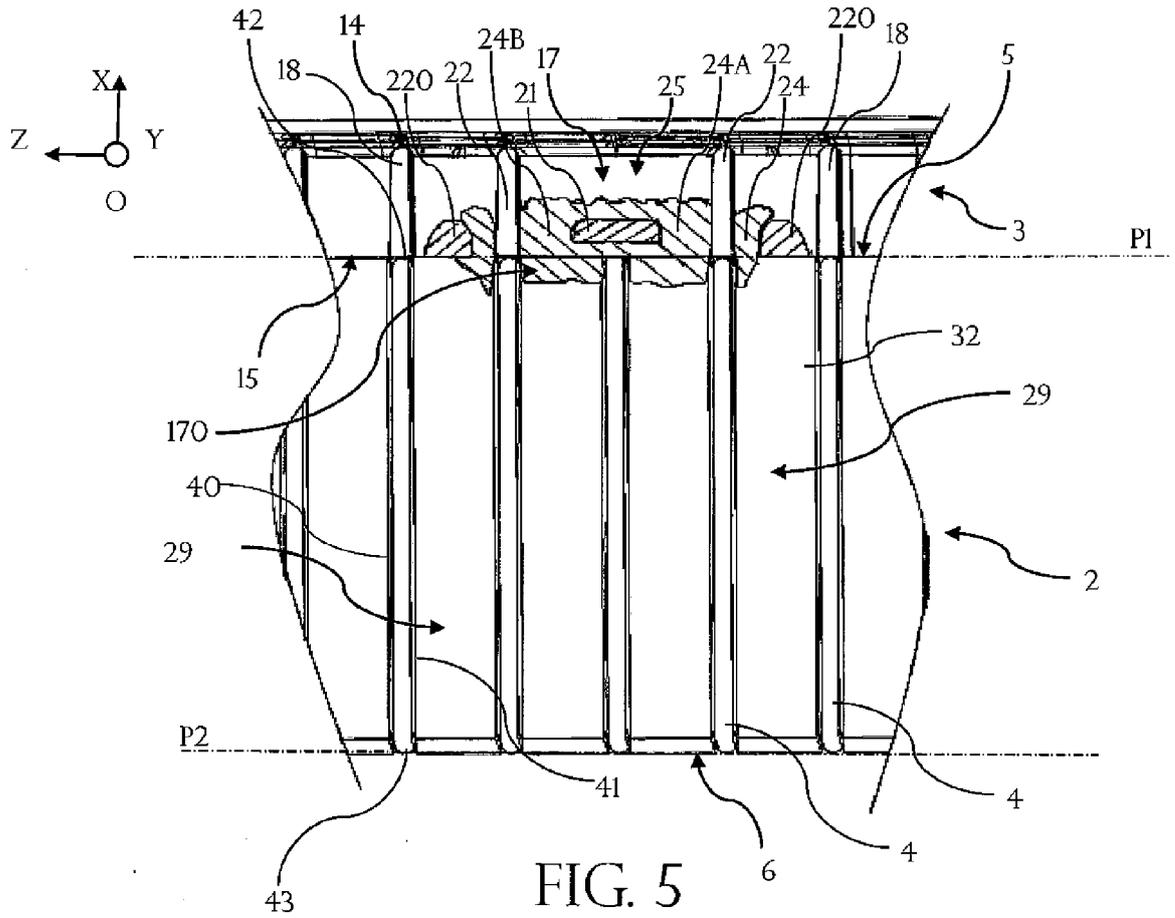


FIG. 4





EUROPEAN SEARCH REPORT

Application Number  
EP 17 46 1574

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			F28F
The present search report has been drawn up for all claims			
Place of search <b>Munich</b>		Date of completion of the search <b>6 December 2017</b>	Examiner <b>Axters, Michael</b>
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ..... & : member of the same patent family, corresponding document	

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
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