A method of producing a heat shield includes the step of producing a plate-shaped material provided by developing a funnel shape having a plurality of face sections \((20, 21, 22)\) which are adjacent to each other and one \((20)\) of which is a mounting surface and the bending step of bending the plate-shaped material such that the face sections \((21, 22)\) other than the face section \((20)\) corresponding to the mounting surface are orthogonal to the mounting surface section.
METHOD OF PRODUCING HEAT SHIELD

TECHNICAL FIELD

[0001] The present invention relates to a method of producing a heat shield that three-dimensionally surrounds an object to be shielded from heat.

BACKGROUND ART

[0002] In the opening-adjusting system of a turbocharger vane and an EGR system which are accessoryly provided on an engine of an automobile or the like, a motor is used for a vehicle-mounted actuator for driving the above systems. The vehicle-mounted actuator is disposed in an environment to which heat from the engine is conducted. For this reason, in order to protect particularly a motor unit having a motor main body, a circuit main body therefor, and so on from the heat of the engine, a structure in which the motor unit is covered with a heat shield has been adopted.

[0003] The motor unit as an object to be shielded from heat has a three-dimensional shape such as a cylinder, and the heat shield is arranged to have, at its corner area, a funnel shape composed of a plurality of face sections adjacent to each other and cover the motor unit with the plurality of face sections. The heat shield having the funnel-shaped corner area is constructed, e.g., by combining three rectangular plates constituting the face sections so as to form a pyramid shape where the plates are adjacent to each other, and when the heat shield is horizontally disposed with one of those three plates as a bottom face sections, the other two face sections constitute two side face sections vertically extending, which can cover the motor unit with the two sides to shield the section from heat.

[0004] Usually such a heat shield is produced by a sheet metal process; however, at that time, when the motor unit has a height of 20 mm or more, for example, the heat shield covering the motor unit should also have a height of 20 mm or more in the side face section. A heat shield of such a dimension, having a funnel-shaped corner, is usually produced by a drawing process.

[0005] A progressive press system or scheme with a high production efficiency is excellent in the automatization for a sheet metal working. However, when the drawing depth is about 20 mm or more, the drawing becomes “deep drawing”; thus, the working by the progressive press system becomes difficult, and a single press system or scheme has to be employed. However, the production efficiency of the single press system is low, resulting in increasing the production cost.

[0006] Here, conventional technologies for forming a plate-shaped material into a bending shape include a technology by which a slide supporting unit of a lower die, opposed to a forming cam, is partially cut away on the side of a guide cam, the cut-away portion is replaced with a member extended from the lower portion of the guide cam, and upon forming of shiftingly bending or cam flange, a slide member of the forming cam on the shiftingly bending side is arranged to be slid on the top of the extended member of the guide cam (see, e.g., Patent Document 1). However, since the publicly known technology is related to the single press system, the above-mentioned advantage in the progressive press system cannot be obtained.


[0008] The present invention has been made to solve the above-mentioned problems, and an object of the present invention is to provide a method of producing a heat shield that can be manufactured in the progressive press system.

DISCLOSURE OF THE INVENTION

[0009] The present invention is arranged to include the step of producing a plate-shaped material provided by developing a funnel shape having a plurality of face sections which are adjacent to each other and one of which is a mounting surface, and the bending step of bending the plate-shaped material such that the face section corresponding to the mounting surface is orthogonal to the other corresponding face sections on the material.

[0010] According to the present invention, the manufacturing thereof in a progressive press system becomes possible, productivity thereof can be enhanced, and the cost reduction thereof can be achieved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. 1 is a sectional view of a vehicle-mounted actuator which is an object to be shielded from heat.

[0012] FIG. 2 is an perspective view of a heat shield.

[0013] FIG. 3 is a plan view of the heat shield shown in a developed state.

[0014] FIG. 4 is an perspective view showing the state where a portion of a plate-shaped material is bent in the course of the manufacture of the heat shield.

[0015] FIG. 5 is a perspective view showing the state immediately preceding the final bending stage in the course of the manufacture of the heat shield.

[0016] FIG. 6 is an exploded perspective view of a structure where a vehicle-mounted actuator is secured to a bracket together with the heat shield.

[0017] FIG. 7 is an assembly view of a structure where the vehicle-mounted actuator is secured to the bracket together with the heat shield.

[0018] FIG. 8 is a plan view of a structure where the vehicle-mounted actuator is secured to the bracket together with the heat shield.

[0019] FIG. 9 is a front view of a structure where the vehicle-mounted actuator is secured to the bracket together with the heat shield.

BEST MODE FOR CARRYING OUT THE INVENTION

[0020] Embodiments of the present invention will now be described with reference to the accompanying drawings in order to explain the present invention in more detail.

First Embodiment

[0021] In advance of explaining the method of producing a heat shield, an explanation will be given by reference to FIG. 1 of the schematic structure of a vehicle-mounted actuator including a motor unit that is the object to be shielded from heat from an engine using the heat shield according to the embodiment. A vehicle-mounted actuator 1 is basically composed of an actuator unit 2 and a motor unit 3 for driving the actuator unit 2, and further, the motor unit 3 consists of a motor main body 4 and a circuit main body 5 for driving the motor.

[0022] The circuit main body 5 has an external input-and-output connector 6, a terminal 7, a board 18 connected with
the terminal 7, and other components. The motor main body 4 includes a stator 8 polarized into a plurality of poles, a coil 9 wound on the stator 8, a rotor 10, a magnet 11 rotating integrally with the rotor 10, bearings 12, 13 supporting the rotor 10, a base 25, a cylindrical supporting unit 26 slidably supporting an output shaft 14 integrally with the base 25, and other components. The base 25 is provided with mounting holes 27. The base 25 has a bottom face section 20 of a heat shield 19 sandwiched between the base and a bracket 38 (described later in FIG. 6 to FIG. 9) to secure the vehicle-mounted actuator 1 together with the heat shield 19 to the bracket 38.

[0023] The actuator unit 2 is a part for driving the output shaft 14, and in the actuator unit, a male screw 14a formed at the base end of the output shaft 14 is screwed into a female screw 10a axially formed in the rotor 10. The end portion of the output shaft 14 has secured thereon a joint 15 for connection with a nut 16, in order to drive a valve that is an object to be driven.

[0024] The operation of the actuator is as follows: the application of voltage to the terminal 7 feeds a current through the coil 9, thus magnetizing the stator 8. Thus, the magnet 11 magnetized with an N-pole and an S-pole rotates with the rotor 10. As the rotor 10 rotates forward or backward, the output shaft 14 is restrained from rotating by a rotation-restraining means (not shown) which makes reciprocating and straight movements as shown by arrow 17 according to the predetermined amount of the rotation thereof by a so-called threading relation between a nut and a screw, thus operating the object to be driven.

[0025] In the aforementioned structure of the vehicle-mounted actuator 1, the motor main body 4 and the circuit main body 5 constituting the motor unit 3 include components having to be prevented from being over heated, such as the board 18, the coil 9, the magnet 11, and other components, and thus a heat shield has to be provided in a disposing relation with the engine.

[0026] In the following, a method of producing a heat shield to be adapted for heat-shielding predetermined places in the motor unit 3 (portions exposed to a high temperature in the motor main body 4; portions equipped with components susceptible to temperature such as a board and the like in the circuit main body 5; and so on) is described:

[0027] FIG. 2 shows a heat shield 19 in a finished form. The heat shield 19 has the shape of a funnel having three face sections, a bottom face section 20, a side face section 21, and a side face section 22 which are adjacent to each other and obtained by bending a plate-shaped material, the heat shield of the example being shaped to have a corner area 23. Each of the face sections is shown as having a generally rectangular shape by way of example; however, the shape thereof is decided according to the shape of an object to be shielded from heat, and thus the shape of the face section is not limited to the shown one.

[0028] Such a heat shield 19 is produced by performing a step of producing a plate-shaped material as obtained by developing a funnel shape having a plurality of face sections which are adjacent to each other and one of which is a mounting surface, and a bending step of bending the plate-shaped material such that the face section corresponding to the mounting surface is orthogonal to the other face sections.

[0029] Of the three face sections, the bottom face section 20 may consist of a continuous plate; however, the bottom face section of the example is not formed of a continuous plane of a plate-shaped material, but formed by arranging the opposing plate ends of a partial bottom face section 20a and a partial bottom face section 20b in a butting relation. By opposing close the ends of the plate to each other along a division line 24 within the bottom face section 20, the other face sections such as the side face sections 21, 22 acting as a heat shield are arranged to have no division line therein. The division line 24 diametrically passes across a circular hole 28 of a size such that the supporting unit 26 (see FIG. 1) will pass therethrough.

[0030] The bottom face section 20 is a mounting surface section for securing the heat shield 19 thereto by being sandwiched between fixing members, and the bottom face section is arranged to include an abutting section formed by a butt-bending step. By performing the step of producing the plate-shaped material and the bending step, it becomes possible to produce a three-dimensional product having a funnel shape by only a bending process without a drawing process, which also enables the manufacture in a progressive press system.

[0031] Further, in the butt-bending step of forming the bottom face section by arranging the ends of the plate-shaped material (abutting sections) in an abutting relation, the abutting section is formed along the division line 24 within the bottom face section 20 serving as the mounting surface. In this way, no division line is formed in other sections. Thus, the obtained heat shield is improved in earthquake resistance and heat-resisting property.

[0032] The ends of the plate opposed to each other along the division line 24 may be arranged to be only opposed to each other; however, in order to precisely hold the shape of a completed heat shield, it is effective to provide a fit means at each of the ends of the plate to be arranged in a butting relation and mechanically connect those ends by fitting the ends with each other. The so-called “dowel and dowel hole” can be used for a fit means. Also in the example, a structure where the ends thereof are connected to each other with the fit means is employed.

[0033] The surrounding area of the circular hole 28 is provided with four small bores 29 for securing the heat shield thereto. The top of the corner area 23 is cut away for forming a cut-away section 30 for increasing the workability of the area in the bending process.

[0034] A step section 31 formed on the side face section 22 is used for engaging the circuit main body 5 thereon.

[0035] In FIG. 2, the boundary between the partial bottom face section 20a and the side face section 21 has been bent at 90 degrees with a fold line 32 as an axis. The boundary between the side face section 21 and the side face section 22 has been bent at 90 degrees with a fold line 33 as an axis. The boundary between the side face section 31 and the partial bottom face section 20b is bent at 90 degrees with a fold line 34 as an axis.

[0036] In FIG. 2, of the ends constituting the division line 24 of the partial bottom section 20b, an end 37 is disposed inwardly shifted from the fold line 34. If the division line 24 is arranged to be located along the fold line 34, the discontinuity therebetween is located in the bend, and thus it becomes difficult to hold a bendable shape therein. Moreover, the bottom face section and the side face section are separated, thus reducing the earthquake-resistance thereof. As is provided in the example, the division line 24 is located inside the bottom face section 20, and thus a holding allowance for being sandwiched between the base 25 and the bracket 38 is formed to increase the fixing area, and a state where the bottom face
section and the side face section are connected to each other is obtained, thus increasing the earthquake resistance thereof.

0037] The figure obtained by developing the completed heat shield 19 as shown in FIG. 2 is shown in FIG. 3, to be more specific, by partially separating the heat shield along the division line 24 and straightening into a flat plate the bending sections (forming the ridges thereof) forming the boundaries between the face sections to form the heat shield.

0038] In FIG. 3, the portions corresponding to those shown in FIG. 2 are designated by similar numerals.

0039] Referring to FIG. 3, the fold line 32 and the fold line 34 are in line with each other and they are orthogonal to the fold line 33. The intersection point of those fold lines lies at the center of the arc of the cut-away section 30. A semi-circular concavity 28a formed in the partial bottom face section 20a and a semi-circular concavity 28b formed in the partial bottom face section 20b constitute the circular hole 28 in the heat shield shown in FIG. 2.

0040] In FIG. 3, each of the ends located on the open side of the concavity 28a is provided with a dowel hole 35 having a keyhole shape, functioning as a fit means. Each of the ends located on the open side of the concavity 28b is provided with a dowel 36 functioning as a fit means. The dowel 36 and the dowel hole 35 function as a retainer in engagement with each other, and thus the partial bottom face section 20a and the partial bottom face section 20b are substantially integral with each other.

0041] Four small boxes 29 are positioned with respect to the mounting holes 27 with great accuracy.

0042] The process of manufacturing the heat shield 19 in a progressive press system is as follows:

0043] First step (the step of producing a plate-shaped material):

0044] From a strip of base material from which a lot of heat shield plates can be cut out, a plate-shaped material having a flat shape shown in FIG. 3 is cut out, to be concrete, the cut-out material having a shape provided by developing a funnel shape having a plurality of face sections which are adjacent to each other and one of which is a mounting surface. However, in order to smoothly carry out the subsequent operation, the plate-shaped material is not completely separated from the base material, and a portion of the plate-shaped material shown in FIG. 3, e.g., a portion of the side face section 21 is connected with the base material through a small bridge (not shown) which can be easily separated therefrom.

0045] Second step:

0046] Referring to FIG. 2, the cut-out plate-shaped material is bent in the direction where the partial bottom face section 20a is caused to rise through 90 degrees with respect to the side face section 21 with the fold line 32 as the axis. The resultant shape thereof is shown in FIG. 4.

0047] Third step:

0048] In FIG. 4, the work is bent in the direction where the side face section 22 is caused to rise through 90 degrees with respect to the side face section 21 with the fold line 33 as the axis. The partial bottom face section 20b is shifted integrally with the side face section 22. The obtained shape thereof is shown in FIG. 5.

0049] Fourth step:

0050] The step is the butt-bending step according to the present invention; in FIG. 5, the work is further bent in the direction where the partial bottom face section 20b is caused to rise through 90 degrees with respect to the side face section 22 with the fold line 34 as the axis. In the bending step, the end of the partial bottom face section 20b and the end of the partial bottom face section 20a are arranged in a butting state by a rotation movement of the partial bottom face section 20b with the fold line 34 as the axis, and further the dowel 36 smoothly fits in the dowel hole 35. As a result, the heat shield 19 as shown in FIG. 2 is produced.

0051] Fifth step:

0052] A connection having a small-bridge shape described above, which connects the side face section 21 to the base material, is separated. Thus, the heat shield 19 comes to a state of independence from the base material.

0053] The bending sequence thereof is explained with the above steps by way of example; however, the process for manufacturing the heat shield 19 is not limited to the above-mentioned one. However, the butt-bending step is performed at the end of the bending operations. The dimensional accuracy of the heat shield can be enhanced by making the dowel 36 and the dowel hole 35 fit each other at the end of the bending sequence.

0054] Further, in the structure having the dowel 36 and the dowel hole 35, when the butt-bending step with the fold line 32 or the fold line 34 as the axis is performed at the end of the bending sequence, the dowel 36 and the dowel hole 35 engage with each other in a manner to bring the dowel into engagement with the dowel hole from front to rear or from rear to front, and thus the engagement between the dowel 36 and the dowel hole 35 can be obtained, which is smoother than that obtained when the bending step is carried out with the fold line 32 or 34 as the axis and then the final butt-bending step is performed with the fold line 33 as the axis.

0055] This is because when the bending operation with the fold line 33 as the axis is performed as the final butt-bending step, the dowel 36 and the dowel hole 35 is caused to fit with each other vertically along an arcuate locus with the fulcrum axis (fold line 33) as center. Thus, the fit thereof is placed in a complicated situation.

0056] As described above, according to the embodiment, it is possible to manufacture even a heat shield having a height of 20 mm or more only by performing a punching step and a bending step by a sheet metal method using a progressive press system without drawing operation. This can increase productivity for manufacturing the heat shield and reduce the production cost thereof.

0057] In such a way, the completed heat shield 19 is secured to the bracket 38 together with the vehicle-mounted actuator 1 as shown in FIG. 6 to FIG. 9. To be specific, the supporting unit 26 is threaded through a through hole 40 provided through a mounting base 38a forming the upper portion of the bracket 38 and the circular hole 28 thereof, the bottom face section 20 thereof is placed between the base 25 and the upper mounting base 38a of the bracket 38, and then the vehicle-mounted actuator 1 and the heat shield 19 are secured to the bracket 38 by threading each of screws 39 through the mounting hole 27 and the small bore 29 in this order from the top and screwing down the screw into a tapped hole 40a formed in the mounting base 38a. The bracket 38 is fixed on a portion of the supercharger of an engine room.

0058] The heat shield 19 covers the motor unit 3 with the side face section 21 and the side face section 22 thereof and shields it from heat in the two directions. The circuit main body 5 engages the step section 31 formed on the side face section 22, and thereby the main body 5 is covered by the side face section 21 to be shielded from heat.
[0059] The bottom face section 20 including the abutting section formed by the butt-bending step is sandwiched therewith, and thereby the heat shield 19 has ensured its strength and has ensured its earthquake resistance. In the structure having, in the divisional face section, a shape such as the small bore 29, requiring position accuracy as a product after performing the butt-bending step, the position accuracy of the small bore 29 can be secured by providing a fit means (the dowel hole 35 and the dowel 36) in the divisional face section and fitting the fit means when the work is bent at the end of the bending process by a progressive press system.

[0060] When a heat shield is manufactured by drawing, the heat shield is deformed in the drawing step if the shield has a hole or the like; however, when the heat shield is produced by bending as shown in the embodiment, such deformation can be reduced. Further, the position of the small bore 29 can be adjusted with the clearance of the fit in the fit means by disposing the small bores in each of the divided partial bottom face section 20a and partial bottom face section 20b.

INDUSTRIAL APPLICABILITY

[0061] As mentioned above, the method of producing a heat shield according to the present invention is suitable, e.g., for producing a heat shield for covering the motor unit of a vehicle-mounted actuator because the method is arranged to produce a heat shield by performing the step of producing a plate-shaped material having a plurality of face sections, one of which is a mounting surface and the step of bending the plate-shaped material such that face sections other than a mounting surface section of the material, corresponding to the mounting surface, are orthogonal to the mounting surface section, and thereby, productivity for manufacturing the heat shield by a sheet metal method using a progressive press system is enhanced.

1-4. (canceled)

5. A method of producing a heat shield comprising: the step of producing a plate-shaped material provided by developing a funnel shape having a plurality of walls which are adjacent to each other and one of which is a mounting wall; the bending step of bending the plate-shaped material such that the face section corresponding to the mounting surface is orthogonal to the other corresponding face sections; and the butt-bending step of forming the mounting face section corresponding to the mounting surface by butting the ends of the plate-shaped material against each other.

6. The method of producing a heat shield according to claim 5, wherein in the step preceding the butt-bending step, a fit means is provided at each of the ends thereof to be arranged in an abutting relation and then those fit means are fit with each other by the butt-bending step.

7. The method of producing a heat shield according to claim 5, wherein the fit means includes a dowel and a dowel hole.

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