In a hot press molding method for press-molding a heated material and cooling the material while holding the material in a mold, during press molding of the material, shape changes including a portion that curves with respect to a longitudinal direction of the material are molded at longitudinal opposite end portions of the material and resistance to thermal contraction force of the material in the longitudinal direction during cooling is imparted. In one embodiment of the present invention, the shape changes molded on the material during the press molding are minute protrusions provided on surfaces of the longitudinal opposite end portions of the material. The invention makes it possible to suppress thermal contraction of the material during cooling in hot press molding to thereby prevent defects associated therewith.
HOT PRESS MOLDING METHOD, ARTICLE MOLDED BY HOT PRESS MOLDING, AND MOLD FOR HOT PRESSING

TECHNICAL FIELD

[0001] The present invention relates to a hot press molding technique.

BACKGROUND ART

[0002] Conventionally, hot press molding for cooling material heated to a quenching temperature while press-molding the material in a mold to thereby quench the material is widely used (see Patent Document 1, for example).

CITATION LIST

Patent Literature


SUMMARY OF INVENTION

Technical Problem

[0004] Metal material such as steel to be hot press-molded expands when heated and contracts when cooled. Because of the contraction of the material in the mold, defects such as biting of a molded article into the mold and dimensional errors of a shape of the molded article may be caused.

[0005] Therefore, the technique for avoiding the defects caused by the thermal contraction of the material when the material is cooled in a hot press machine is required.

Technical Solutions

[0006] In accordance with an aspect of the present invention, there is provided a hot press molding method for press-molding a heated material and cooling the material while holding the material in a mold, wherein, during press molding of the material, shape changes including a portion that curves with respect to a longitudinal direction of the material are molded at longitudinal opposite end portions of the material and resistance to thermal contraction force of the material in the longitudinal direction during cooling is imparted.

[0007] In accordance with another aspect of the invention, in the hot press molding method, the shape changes molded on the material during the press molding are preferably a plurality of minute protrusions provided on surfaces of the longitudinal opposite end portions of the material.

[0008] In accordance with another aspect of the invention, in the hot press molding method, the shape changes molded on the material during the press molding are preferably flanges molded on the longitudinal opposite ends of the material.

[0009] According to another aspect of the invention, there is provided a hot press molded article obtained by any one of the above-described hot press molding methods.

[0010] According to another aspect of the invention, there is provided a mold for hot pressing, the mold including an upper mold and a lower mold, for sandwiching a heated material between the upper mold and the lower mold to press-mold the material, and for holding the material in the mold to cool the material wherein a plurality of protruding portions protruding toward the upper mold or a plurality of recessed portions recessed from the upper mold toward the lower mold are provided at a portion of the lower mold corresponding to a longitudinal end portion of the material, a plurality of recessed portions or a plurality of protruding portions corresponding to the protruding portions or the recessed portions provided to the lower mold are provided to the upper mold, and a plurality of minute protrusions are molded on a surface of the longitudinal end portion of the material by the protruding portions or the recessed portions provided to the lower mold and the recessed portions or the protruding portions provided to the upper mold during press molding with the upper mold and the lower mold.

[0011] According to another aspect of the invention, there is provided a mold for hot pressing, the mold including an upper mold and a lower mold, for sandwiching a heated material between the upper mold and the lower mold to press-mold the material, and for holding the material in the mold to cool the material, wherein a flange bending from the upper mold toward the lower mold or from the lower mold toward the upper mold is molded at a longitudinal end of the material by the upper mold and the lower mold during the press molding.

Advantageous Effects of Invention

[0012] According to the invention, it is possible to suppress thermal contraction of a material during cooling in hot press molding to thereby avoid defects associated therewith.

BRIEF DESCRIPTION OF DRAWINGS

[0013] FIG. 1 is a schematic diagram of a hot press machine.

[0014] FIG. 2 is a perspective view of a hot press molded article.

[0015] FIG. 3 is a longitudinal sectional view of a mold for hot pressing.

[0016] FIG. 4 is a longitudinal sectional view of another embodiment of the mold for hot pressing.

[0017] FIGS. 5(a) and 5(b) are diagrams showing another embodiment of the hot press molded article.

DESCRIPTION OF EMBODIMENTS

[0018] As shown in FIG. 1, a hot press machine includes a mold 1 for hot pressing. The mold 1 for hot pressing has an upper mold 10 and a lower mold 20 and press-molds a material 2 by sandwiching the material 2 between the upper mold 10 and the lower mold 20. The upper mold 10 is supported on a moving device and movable in a vertical direction. The lower mold 20 is fixed immovably.

[0019] The material 2 is metal material such as steel which can be quenched. The material 2 is charged into the mold 1 for hot pressing after heated to a quenching or higher temperature by electric heating or the like. The material 2 is molded into a predetermined product shape (see FIG. 2) by press molding with the mold 1 for hot pressing and held for a predetermined time in the mold to thereby be cooled and quenched (hot press-molded).

[0020] As shown in FIG. 2, the material 2 is molded into a rectangular shape having one direction in a longitudinal direction into a molded article 3 having a hat-shaped section continuous along the longitudinal direction by the hot press molding. In other words, by bending molding of the material 2 along a short-side direction with the mold 1 for hot pressing, the material 2 is molded into the molded article 3 having the hat-shaped section.
As the molded article 3 formed by using the mold 1 for hot pressing according to the embodiment, there are a rocker outer and the like besides a pillar outer shown in FIG. 2.

As shown in FIG. 2, protrusions 30, 30, . . . are molded on a top face at longitudinal opposite end portions of the molded article 3. The protrusions 30 are molded by curving molding of portions of the material 2. In other words, the protrusions 30 are shape changes including the curved portion inclined with respect to the longitudinal direction of the material 2. The plurality of protrusions 30 are molded as minute protrusions protruding upward (or downward) into hemispherical shapes from a flat face of the material 2.

The protrusions 30, 30, . . . are molded on the top face of the molded article 3 and sprinkled at predetermined intervals in the longitudinal direction and the short-side direction. Size, shape, and the number of protrusions 30, 30, . . . are set so as not to hinder mounting operation, assembly operation, and the like in later steps, for example, i.e., not to impair the function of the molded article 3 as a product.

As described above, the minute protrusions 30 are protrusions having three-dimensional shapes such as hemispheres, oval hemispheres, cubes, rectangular parallelepipeds, and frustums formed in such size as not to impair the function of the molded article 3 as the product and protruding to a front face side or a back face side from the flat face portion (especially, the flat face extending in the longitudinal direction) of the molded article 3. The number of protrusions 30 to be provided is set so as to be able to impart sufficient resistance to thermal contraction force in the longitudinal direction of the material 2 in view of the shape and the size.

For example, protruding lengths of the protrusions 30 from the surface are preferably equal to or shorter than thickness of the material 2. If the thickness of the material 2 is 1.4 mm, diameters of the protrusions 30 formed into the hemispherical shapes are preferably 3 mm or smaller.

As shown in FIG. 3, recessed portions 11, 11, . . . recessed upward are formed on the upper mold 10 and protruding portions 21, 21, . . . protruding upward are formed on the lower mold 20. These recessed portions 11, 11, . . . and the protruding portions 21, 21, . . . are provided to mold the protrusions 30, 30, . . . on the material 2 and have shapes corresponding to the protrusions 30, 30, . . . . The respective protrusions 30 are molded by sandwiching portions of longitudinal opposite end portions of the material 2 between the respective recessed portions 11 and the respective protruding portions 21 in the press molding.

By sandwiching the material 2 between the upper mold 10 and the lower mold 20 to mold the protrusions 30, 30, . . . in this manner and then holding the material 2 in the mold for a predetermined time to thereby cool the material 2, the hot press molded article 3 is obtained.

As described above, in the embodiment, the protrusions 30, 30, . . . are formed by sandwiching the material 2 between the recessed portions 11, 11, . . . of the upper mold 10 and the protruding portions 21, 21, . . . of the lower mold 20 during the press molding with the mold 1 for hot pressing, i.e., before cooling in the mold proceeds and the material 2 is hot press-molded into the molded article 3.

Here, when the heated metal material is cooled, the material contracts from the longitudinal opposite end portions toward a central portion and an amount of contraction in the longitudinal direction is greater than that in the short-side direction, in general. To cope with this, if the protrusions 30, 30, . . . are formed on the longitudinal opposite end portions and shapes of the opposite end portions are changed to be inclined with respect to a direction of the flat face of the material 2, it is possible to impart resistance to contraction force to contraction starting points. Therefore, it is possible to satisfactorily prevent the contraction in the longitudinal direction during cooling to thereby prevent deformation and biting into the mold.

Since the protrusions 30, 30, . . . are formed as the minute protrusions, they do not affect the product strength, deformation mode, and the like. In other words, the protrusions 30, 30, . . . do not greatly increase cross-sectional moment of the shape of the product and do not serve as points where bending starts. In this manner, the protrusions 30, 30, . . . do not impose a large limitation on the shape of the product and it is easy to design the molded article 3 including the protrusions 30, 30, . . .

From a viewpoint of prevention of the contraction, the protrusions 30, 30, . . . are preferably close to the longitudinal ends as far as the protrusions 30, 30, . . . are formed in positions as not to impair functions of the molded article 3. Here, “the positions as not to impair functions of the molded article 3” are positions where the molded article 3 does not affect the product strength and the deformation mode of the molded article 3.

If the product shape of the molded article 3 includes a hole, a notch, or the like on the top face or a side wall portion, the protrusions 30, 30, . . . are formed in positions closer to the end portions than positions where the hole or the notch is provided.

In general, when the above-mentioned hole or notch is provided to the molded article 3, it is often formed simultaneously in the hot press molding and a processing blade such as a trim punch for this purpose is provided in the mold in many cases. By providing the protrusions 30, 30, . . . on the outer sides (on the end portion sides when seen from the central portion) of the shape change as in the embodiment, it is possible to prevent thermal contraction in an area on an inner side of the protrusions 30, 30, . . . . Therefore, the protrusions 30, 30, . . . do not affect positions or dimensions of the hole and the notch and it is possible to improve processing quality.

In the case where the product shape of the molded article 3 is the rocker outer, if protrusions 30, 30, . . . are molded based on the same technical idea, it is possible to satisfactorily prevent the contraction in the longitudinal direction during cooling to thereby prevent deformation and biting into the mold.

Although the protrusions 30, 30, . . . have been explained as being protruding from the lower mold 20 toward the upper mold 10 (upward) in the above embodiment, they may protrude from the upper mold 10 toward the lower mold 20 (downward) and their protruding directions are not restricted.

The protruding directions of the respective protrusions 30 may be selected according to the function of the molded article 3. In other words, the upward and downward protruding directions of the protrusions 30 may be mixed.

As shown in FIG. 4, in place of the protrusions 30, 30, . . ., flanges 40, 40 may be provided to longitudinal opposite ends of the molded article 3. In the embodiment, in the same manner as in the embodiment in which the protrusions 30, 30, . . . are molded, portions bent with respect to a longitudinal direction (flat face direction) of a material 2 are
molded at longitudinal end portions of the material 2 in press molding and resistance to contraction force in the longitudinal direction is imparted.

[0038] The flanges 40, 40 are molded by bending the longitudinal opposite ends of the material 2 downward (or upward). The respective flanges 40 are provided to opposite ends of the molded article 3 as inclined faces having angles which are larger than 45° and which are such angles that the flanges 40 can be molded by press molding with respect to the flat face direction of the material 2. The flanges 40 are preferably molded as the inclined faces having the angles from 60° to 80°.

[0039] The flanges 40, 40 may be bent from the upper mold 10 toward the lower mold 20 as shown in FIG. 4 or in an opposite direction from the lower mold 20 toward the upper mold 10.

[0040] By bending and molding the longitudinal opposite ends of the material 2 in this manner, a longitudinal length of the molded article 3 is kept as a length between the flanges 40, 40 and resistance to contraction force in the longitudinal direction can be imparted. Therefore, it is possible to prevent the contraction in the longitudinal direction during cooling to thereby prevent deformation and biting into the mold.

[0041] The longitudinal opposite ends on which the flanges 40, 40 are molded are trimmed in a later step to be used as an end product or parts of the product shape.

[0042] As a product shape of the molded article 3, shapes with open longitudinal end faces may be employed as well. For example, as shown in FIGS. 5(a) and 5(b), a shape having a simple hat-shaped section continuous in a longitudinal direction (FIG. 5(a)) and a shape having a substantially hat-shaped section, with a wall face molded as an inclined face, continuous in a longitudinal direction (FIG. 5(b)) may be employed.

DESCRIPTION OF NUMERALS


1. A hot press molding method for press-molding a heated material and cooling the material while holding the material in a mold,

wherein, during press molding of the material, shape changes including a portion that curves with respect to a longitudinal direction of the material are molded at longitudinal opposite end portions of the material and resistance to thermal contraction force of the material in the longitudinal direction during cooling is imparted.

2. The hot press molding method according to claim 1, wherein the shape changes molded on the material during the press molding are a plurality of minute protrusions provided on surfaces of the longitudinal opposite end portions of the material.

3. The hot press molding method according to claim 1, wherein the shape changes molded on the material during the press molding are flanges molded on the longitudinal opposite ends of the material.

4. A hot press molded article obtained by the hot press molding method according to claim 1.

5. A mold for hot pressing, the mold including an upper mold and a lower mold, for sandwiching a heated material between the upper mold and the lower mold to press-mold the material, and for holding the material in the mold to cool the material,

wherein a plurality of protruding portions protruding toward the upper mold or a plurality of recessed portions recessed from the upper mold toward the lower mold are provided at a portion of the lower mold corresponding to a longitudinal end portion of the material,

a plurality of recessed portions or a plurality of protruding portions corresponding to the protruding portions or the recessed portions provided to the lower mold are provided to the upper mold, and

a plurality of minute protrusions are molded on a surface of the longitudinal end portion of the material by the protruding portions or the recessed portions provided to the lower mold and the recessed portions or the protruding portions provided to the upper mold during press molding with the upper mold and the lower mold.

6. A mold for hot pressing, the mold including an upper mold and a lower mold, for sandwiching a heated material between the upper mold and the lower mold to press-mold the material, and for holding the material in the mold to cool the material,

wherein a flange bending from the upper mold toward the lower mold or from the lower mold toward the upper mold is molded at a longitudinal end of the material by the upper mold and the lower mold during the press molding.

7. A hot press molded article obtained by the hot press molding method according to claim 2.

8. A hot press molded article obtained by the hot press molding method according to claim 3.