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(72) Inventors:
• **SERIZAWA, Tsutomu**
Yokohama-shi
Kanagawa 222-0033 (JP)
• **OHBUCHI, Koji**
Yokohama-shi
Kanagawa 222-0033 (JP)
• **KIKAWA, Tamiya**
Yokohama-shi
Kanagawa 222-0033 (JP)

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(74) Representative: **Kilian Kilian & Partner**
Aidenbachstraße 54
81379 München (DE)

(71) Applicant: **Unipres Corporation**
Yokohama-shi
Kanagawa 222-8581 (JP)

(54) **HOT PRESS PROCESSING DEVICE AND HOT PRESS PROCESSING METHOD**

(57) The purpose is to eliminate burrs-occurring on a press-formed work even with a configuration in which a trimming process is to be performed on a high-temperature blank sheet material, thereby eliminating deburring process that is to be performed after the forming, reducing the processing man-hours and consequently achieving product cost reduction. During the press forming process of forming a blank sheet material 3 while clamping a die 1 on a punch 2, a trim portion 3a is clamped between a trim holding step 6 and a cut holder 8 in such a state that elastic force of a spring mechanism 9 is being applied on the trim portion 3a. As a press forming operation by the die 1 goes on, the trimming blade 7 is relatively moved along an outer margin 5b of a punch-side forming surface portion 5 while the cut holder 8 opposes elastic force of the spring mechanism 9 by receiving pressing force of the trim holding step 6 so that the trimming blade 7 shears and cuts off the trim portion 3a between the trimming blade 7 and the tip end corner 5c on the outer margin 5b of the punch-side forming surface portion 5.

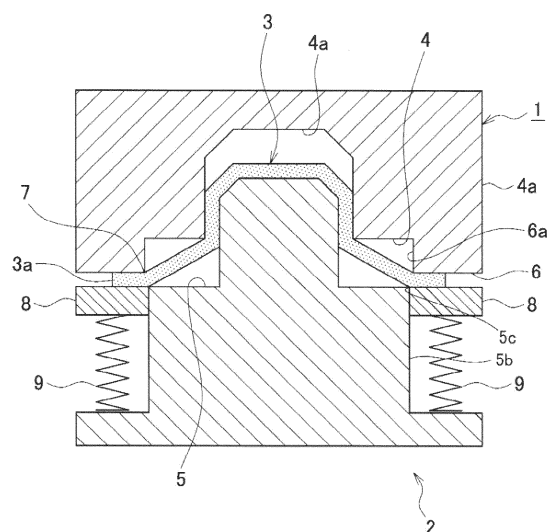


FIG. 3

Description

[0001] The contents of the following Japanese patent application(s) are incorporated herein by reference:

NO. 2016-214708 filed on November 1, 2016, and
NO. PCT/JP2017/004827 filed on February 9, 2017.

BACKGROUND

1. TECHNICAL FIELD

[0002] The present invention relates to a hot press forming apparatus that heats a blank sheet material made of a steel material to an austenizing temperature and forms and quenches the heated blank sheet material by using a low-temperature die to form the blank sheet material, and a hot press forming method using the hot press forming apparatus.

2. RELATED ART

[0003] In a hot press process, a to-be-formed blank sheet material is heated to an austenizing temperature (austenite temperature) from 750 °C to 1000 °C for quenching, and is supplied in the heated state into a die to form. Then, the heated blank sheet material is rapidly cooled and quenched by the low-temperature die at the end of clamping of the die, is transformed into a martensite structure and hardened. For that reason, according to the hot press process, an independent quenching process is not necessary and a press-formed work with high strength can be manufactured by low cost. Therefore, the hot press process is suitable for a vehicle body component manufactured by press forming, such as door impact beam or a center pillar of an automobile, and is widely applied for this reason.

[0004] Further, in the hot press process, performing a piercing process on a press formed work or a trimming process on a trim portion that is a margin of the press formed work is required if such a vehicle body component or the like is to be manufactured. Hardness of the material greatly increases by quenching. Therefore, there is a concern that if the piercing process or trimming process is applied after quenching the formed work, high residual stress is generated on a sheared section caused by the piercing process or trimming process performed on the formed work, and delayed fracture occurs in the press-formed work after the forming.

[0005] Here, the problem of the delayed fracture in the press-formed work after the forming can be solved by performing laser piercing process or laser trimming process on the formed work after the quenching.

[0006] However, the investment for dedicated laser equipment is necessary for the laser piercing process or laser trimming process that is performed on the formed work after the quenching. In addition, laser machining time is added on its cost. Therefore, this may also make

the press-formed work expensive.

SUMMARY

[0007] So, a plural devised hot press forming processing technologies by completing the piercing and trimming the blank sheet material in a heated state, that is, an unhardened state have been proposed conventionally to solve the delayed fracture by the laser machining and the cost-up by investment for dedicated equipment (for example, Patent Document 1 and Patent Document 2).

[0008] As a hot press forming apparatus that realizes the hot press forming processing technologies, a hot press forming apparatus that forms the material into a shape of the press-formed work having a hat cross section, for example, is exemplified. As shown in Fig. 5 to Fig. 8, this hot press forming apparatus is configured to have a die including a die a as a mobile type and a punch b as a stationary type. The die a has a recessed fitting portion d that is formed on a center of a die-side forming surface portion c. Also, the punch b has a raised portion f that is formed corresponding to the recessed fitting portion d on a center of a punch-side forming surface portion e. An outer edge portion h of the punch-side forming surface portion e cooperates with a trimming blade g that is formed on an outer edge portion of the die-side forming surface portion c to configure the trimming tool i.

[0009] According to a conventional hot press forming apparatus configured in this manner, first, as shown in Fig. 5, a blank sheet material j that is heated to an austenizing temperature is supplied between the die-side forming surface portion c and the punch-side forming surface portion e.

[0010] Next, the die a is moved toward the punch b, the recessed fitting portion d of the die-side forming surface portion c is fit in a raised portion f of the punch-side forming surface portion e to form the blank sheet material j.

[0011] To advance the process of forming the blank sheet material j, as the die a is further moved toward the punch b and clamping is performed, as shown in Fig. 6, a protruding portion k is gradually formed in a predetermined shape on the blank sheet material j, and the trimming blade g of the die-side forming surface portion c abuts on the blank sheet material j.

[0012] From the state that the trimming blade g of the die-side forming surface portion c abuts on the blank sheet material j in this manner, the die a is further moved toward the punch b side. Accordingly, as shown in Fig. 7, the forming of the protruding portion k on the blank sheet material j further goes on. In addition, after the blank sheet material j abuts on the outer edge portion h of the punch-side forming surface portion e, a trim portion m as a margin on a margin of the blank sheet material j is bent by a cooperation of the outer edge portion h and the trimming blade g, and accordingly, the trimming process starts.

[0013] Then, during a process in which the movement

of the die a to the punch b further goes on, the trim portion m is torn off (fractured) from the blank sheet material j by the cooperation of the trimming blade g and the outer edge portion h, and the trimming process ends (the state shown in Fig. 8).

[0014] After that, in such a state that the blank sheet material j is finally clamped between the die a and the punch b, the blank sheet material j is rapidly cooled by a cooling system not shown in the drawings, and undergoes the quench-hardening process. Accordingly, the blank sheet material j is formed so as to have a hat cross section having a protruding portion that has a predetermined shape, and a press-formed work is completed.

[0015] Therefore, the conventional hot press forming processing technology is still a technology of heating a blank sheet material to an austenizing temperature, forming the heated steel material by a die including the low-temperature die a and punch b, and quenching the steel material. In the conventional hot press forming processing technology, the trimming process by the trimming tool i is performed in such a state that the blank sheet material is unhardened yet during the press forming by the die.

[0016] As a result, because the trimming process performed during the hot press forming is performed on a blank sheet material that has not undergone the quench-hardening process in the still high-temperature state, the residual stress generated on the trimming portion to be cut off can be low, thereby making an effect of eliminating the occurrence of the delayed fracture.

[Patent Document 1] Japanese Patent Application Publication No. 2005-248253

[Patent Document 2] Japanese Patent Application Publication No. 2011-92946

[0017] However, in any of these conventional hot press processing technologies, when the trimming process is to be performed, the trimming process is performed on the trim portion m that remains in such a state that the trim portion m is not supported or held by the punch b, that is, remains in a so-called aerial cutting state.

[0018] The trimming process of cutting off the trim portion m by the aerial cutting is performed on the trim portion m that remains in the not-held state. As a result, during the process of cutting off the trim portion m by tearing off the trim portion m while the trimming tool i is bending the trim portion m, "burrs" are formed on a cut surface present on a component of the press-formed work of the blank sheet material j.

[0019] Because the pressed product in which the "burrs" are formed in this manner cannot be supplied for actual use, an operator needs to perform a deburring process as a subsequent process that is performed after the press forming and that is not included in the press forming process, to remove the burrs.

[0020] As a result, for the completed press-formed work, the working man hour increases caused by the addition of the manual process, which has been a reason

causing high cost. Because the burrs are also quenched and hardened together with the press-formed work, the deburring process is even more difficult. This also increases the cost of the press-formed products.

5 **[0021]** Here, the present invention provides a hot press forming apparatus and a hot press forming method that can eliminate the burrs-occurring on the press-formed work by the trimming process during the hot press forming process even with a configuration in which the trimming process is performed on a high-temperature blank sheet material, which eliminates the hand-work process for deburring performed after forming and enables the reduction of the processing man-hours and consequently, cost-down of the products.

10 **[0022]** The hot press forming apparatus according to one aspect of the present invention may have a press forming apparatus configured to form a pre-heated blank sheet material into a shape of a press-formed work by clamping a die having a forming surface portion on a punch having a forming surface portion. The hot press forming apparatus may have a trim portion cut-off apparatus configured to trim a trim portion as a margin being a portion of the blank sheet material that is not included in the press-formed work. The hot press forming apparatus may have a quench-hardening apparatus configured to quench and harden the heated blank sheet material by rapidly cooling while being clamped between the punch and the die. The trim portion cut-off apparatus may have a trim holding step formed forward so as to protrude toward the punch at the outer margin of the die-side forming surface portion. The trim portion cut-off apparatus may have a trimming tool that includes a trimming blade formed on a tip end corner on an inner margin of the trim holding step, and a tip end corner formed on the outer margin of the punch-side forming surface portion. The trim portion cut-off apparatus may have a cut holder surrounded the outer margin of the punch-side forming surface portion so as to face the trim holding step. The trim portion cut-off apparatus may have a spring mechanism that is provided on the punch and that supports the cut holder in such a state that the cut holder is elastically energized toward the trim holding step, the cut holder being movable closer to/away from the trim holding step. During a press forming process of forming the blank sheet material while the blank sheet material is clamped between the die and the punch by the press forming apparatus, the trim portion may be clamped between the trim holding step and the cut holder in such a state that elastic force of the spring mechanism is being applied. As the press forming operation by the die goes on, the trimming blade may be relatively moved along the outer margin of the punch-side forming surface portion while the cut holder opposes elastic force of the spring mechanism by receiving pressing force of the trim holding step so that the trimming blade may shear and cut off the trim portion between the trimming blade and the tip end corner on the outer margin of the punch-side forming surface portion. After the cutting off process of the trim portion by

the trim portion cut-off apparatus ends, the quench-hardening apparatus may quench the blank sheet material by clamping the blank sheet material between the punch and the die finally.

[0023] Also, the hot press forming method according to one aspect of the present invention is a hot press forming method using the hot press forming apparatus. The hot press forming apparatus may have a press forming apparatus configured to form a pre-heated blank sheet material into a shape of a press-formed work by clamping the blank sheet material between a die having a forming surface portion and a punch having a forming surface portion. The hot press forming apparatus may have a trim portion cut-off apparatus configured to trim a trim portion as a margin being a portion of the blank sheet material that is not included in the press-formed work. The hot press forming apparatus may have a quench-hardening apparatus configured to quench and harden the heated blank sheet material by rapidly cooling while the heated blank sheet is clamped between the punch and the die. The trim portion cut-off apparatus may have a trim holding step formed forward so as to protrude toward the punch at the outer margin of the die-side forming surface portion. The trim portion cut-off apparatus may have a trimming tool that includes a trimming blade formed on a tip end corner on an inner margin of the trim holding step, and a tip end corner formed on the outer margin of the punch-side forming surface portion. The trim portion cut-off apparatus may have a cut holder surrounded the outer margin of the punch-side forming surface portion so as to face the trim holding step. The trim portion cut-off apparatus may have a spring mechanism that is provided on the punch and that supports the cut holder in such a state that the cut holder is elastically energized toward the trim holding step, the cut holder being movable closer to/away from the trim holding step. The hot press forming method may include: during a press forming process of forming the blank sheet material while the press forming apparatus is clamping the blank sheet material between the die and the punch, clamping the trim portion between the trim holding step and the cut holder in such a state that elastic force of the spring mechanism is being applied. The hot press forming method may include: as a press forming operation by the die goes on, shearing and cutting off, by the trimming blade, the trim portion between the trimming blade and the tip end corner on the outer margin of the punch-side forming surface portion by causing the trimming blade to relatively move along the outer margin of the punch-side forming surface portion while causing the cut holder to oppose elastic force of the spring mechanism by receiving pressing force of the trim holding step. The hot press forming method may include: after the cutting off process of the trim portion by the trim portion cut-off apparatus ends, quenching, by the quench-hardening apparatus, the blank sheet material by clamping the blank sheet material between the punch and the die finally.

[0024] According to one aspect of the present inven-

tion, the cut holder is configured to cooperate with the trim holding step to clamp the trim portion, and the spring mechanism is configured to support the spring mechanism. Accordingly, as the forming of the blank sheet material goes on, accompanied by the progress of the press forming operation by the die, the trim holding step presses and moves the cut holder while causing the cut holder to oppose elastic force of the spring mechanism. As the process of pressing and moving goes on, the spring mechanism is contracted, and accordingly, the clamping force to the trim portion between the cut holder and the trim holding step is gradually increased while the cut holder increases the reaction force.

[0025] According to the above, before the trimming process on the trim portion before the final clamping of the die on the punch, because the degree of contraction of the spring mechanism is still low and the reaction force on the cut holder by the spring mechanism is small, the clamping force on the trim portion between the cut holder and the trim holding step is extremely slight. Therefore, the blank sheet material can be drawn to two forming surfaces of each of the die and the punch with approximately no resistance, and the blank sheet material feed to the two forming surface portions is not impeded. As a result, the blank sheet material can be formed into a desired thickness or a desired shape by the punch and the die, thereby obtaining a desired press-formed work.

[0026] Also, as described above, according to one aspect of the present invention, the clamping force between the cut holder and the trim holding step before the trim portion is cut off is small because the degree of expansion/contraction of the spring mechanism is extremely slight, and the temperature fall by heat dissipation of the pre-heated blank sheet material is suppressed by clamping the trim portion between the cut holder and the trim holding step. Accordingly, by the early hardening of the blank sheet material, that the material cannot be fed to the forming die including the die and the punch can be prevented. Therefore, occurrence of the worst phenomenon such as material crack of the blank sheet material can be prevented. Also, a press-formed work having desired strength can be formed when the subsequent cooling and quenching is to be performed on the blank sheet material after finally clamping the blank sheet material between the punch and the die.

[0027] According to one aspect of the present invention, at the time of final clamping of the die on the punch, the trim holding step causes the spring mechanism to be largely contracted according to the clamping operation by the die, and accordingly, the degree of contraction of the spring mechanism that supports the cut holder becomes high. In response to this, a large reaction force is generated on the cut holder on the trim holding step, and the clamping force on the trim portion between the cut holder and the trim holding step extremely increases. As a result, the blank sheet material before the quench-hardening right before the final forming step is firmly clamped by the cut holder and the trim holding step. Accordingly,

the occurrence of wrinkles or overlapping of the press-formed works caused by excessive feed of the blank sheet material to the forming surface portions of each of the punch and the die is suppressed. Also, a shearing process enabling neat finish with no burr by cutting off the trim portion can be performed on the press-formed work.

[0028] As a result, according to one aspect of the present invention, in the trimming process that is performed by the trimming blade by cooperating with the tip end corner of the punch-side forming surface portion, the so-called aerial cutting, by which the trim portion is torn off while being bent as the prior art, does not occur. Consequently, no burr is formed on the completed press-formed work. Therefore, the deburring process performed after the pressed product is completed can be eliminated, thereby achieving the reduction of the processing man-hours and consequently, the product cost reduction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029]

Fig. 1 is a schematic longitudinal cross-sectional view illustrating one example of a state that a blank sheet material is set at the time of die-opening of a die on a punch of a hot press forming apparatus according to one embodiment.

Fig. 2 is a schematic longitudinal cross-sectional view illustrating one example of a process in the middle of press forming of the blank sheet material in such a state that the blank sheet material is formed by clamping the blank sheet material between the die and the punch from the die-opening state in Fig. 1 and the trim portion is clamped between the cut holder of the punch and the trim holding step of the die.

Fig. 3 is a schematic longitudinal cross-sectional view illustrating one example of a state that the cutting off of the trim portion starts between the trimming blade of the die and a tip end corner formed on the outer margin of the punch-side forming surface portion when the clamping of the die on the punch goes on from the state of the process in the middle of press forming the blank sheet material in Fig. 2.

Fig. 4 is a schematic longitudinal cross-sectional view illustrating one example of a state that the clamping of the die on the punch further goes on from the state that the shearing and cutting off of the trim portion starts in Fig. 3, and after the trim portion is sheared and cut off by the trimming blade of the die and the tip end corner formed on the outer margin of the punch-side forming surface portion, the quenching of the blank sheet material by clamping the blank sheet material between the die and the punch finally is to be performed.

Fig. 5 is a schematic longitudinal cross-sectional

view illustrating a state that a blank sheet material is set at the time of die-opening of a punch on a die of a conventional hot press forming apparatus.

Fig. 6 is a schematic longitudinal cross-sectional view illustrating a process in the middle of press forming of the blank sheet material by clamping the die on the punch from the die-opening state in Fig. 5.

Fig. 7 is a schematic longitudinal cross-sectional view illustrating a state that the clamping of the die on the punch goes on from the state of the process in the middle of press forming of the blank sheet material in Fig. 6 and the cutting off of the trim portion starts.

Fig. 8 is a schematic longitudinal cross-sectional view illustrating a state that the clamping of the die on the punch further goes on from the state that the cutting off of the trim portion starts in Fig. 7, after the trim portion is cut off, the quenching of the blank sheet material by clamping the blank sheet material between the die and the punch finally is performed.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0030] According to the hot press forming apparatus and the hot press forming method using the apparatus according to an embodiment of the present invention, the burrs-occurring on the press-formed work by the trimming process in the hot press forming process is eliminated, thereby eliminating the deburring process performed after the forming and achieving the reduction of the processing man-hours and consequently, the product cost reduction.

[0031] Next, the hot press forming apparatus according to an embodiment of the present invention is described using Fig. 1 to Fig. 4.

[0032] The hot press forming apparatus according to an embodiment of the present invention has a die including a die 1 as a mobile type and a punch 2 as a stationary type, similar to the prior art. Then, each of the die 1 and the punch 2 has forming surface portions 4, 5 made to form a blank sheet material 3 to be a press-formed work (not shown in the drawings) presenting a predetermined shape, for example, a hat cross section.

[0033] Here, among the forming surface portions 4, 5, a recessed fitting portion 4a is formed on a center of the die-side forming surface portion 4. On a center of the punch-side forming surface portion 5, a raised portion 5a is formed facing the recessed fitting portion 4a. The recessed fitting portion 4a and the raised portion 5a cooperate with each other to form the blank sheet material 3 into the press-formed-work shape being the hat cross section.

[0034] Therefore, the die 1 having the die-side forming surface portion 4 on which the recessed fitting portion 4a is formed and the punch 2 having the punch-side forming surface portion 5 on which the raised portion 5a is formed configure a press forming apparatus to form the press-formed work having the hat cross section.

[0035] Also, the trim holding step 6 that protrudes toward the punch 2 is formed forward at the outer margin 4b of the die-side forming surface portion 4. The trimming blade 7 is formed on the tip end corner in an inner margin 6a of the trim holding step 6. The trimming blade 7 and a tip end corner 5c formed on an outer margin 5b of the punch-side forming surface portion 5 configure a trimming tool.

[0036] Further, the cut holder 8 is arranged facing the trim holding step 6 and being adjacent to the outer margin 5b of the punch-side forming surface portion 5. The cut holder 8 is configured to be movable along the outer margin 5b of the punch-side forming surface portion 5 by being pressed on the trim holding step 6 accompanied by the forming operation by the die 1 in such a state that the cut holder 8 is elastically energized toward the trim holding step 6 by a spring mechanism 9 provided on the punch 2. Note that the spring mechanism 9 can be configured by using a coil spring or a pneumatic or hydraulic cylinder.

[0037] As a result, during the press forming process, by the press forming apparatus, of forming the blank sheet material 3 while moving the die 1 toward the punch 2 and clamping the die 1, the trim holding step 6 and the cut holder 8 clamp the trim portion 3a being the margin of the blank sheet material 3 in such a state that the elastic force of the spring mechanism 9 is being applied.

[0038] Also, while the trim portion 3a is kept being clamped by the trim holding step 6 and the cut holder 8, in response to the press forming operation by the die 1 advancing, the trim portion cut-off apparatus causes the cut holder 8 to relatively move along the outer margin 5b of the punch-side forming surface portion 5 while causing the cut holder 8 to oppose the elastic force of the spring mechanism 9 and applying the pressing force of the trim holding step 6 to the trimming blade 7. Accordingly, the trim portion cut-off apparatus is configured to shear and cut off the trim portion 3a between the trimming blade 7 and a tip end corner 5c on the outer margin 5b of the punch-side forming surface portion 5.

[0039] The quench-hardening apparatus is configured to: after the trim portion cutting-off process by the trim portion cut-off apparatus ends, quench the blank sheet material 3 by clamping the blank sheet material 3 between the die 1 and the punch 2 finally and rapidly cooling them by using a cooling system or the like which is not shown in the drawings.

[0040] By using the hot press forming apparatus according to the above-described embodiment of the present invention, the blank sheet material 3 is formed by the below processes to obtain the press-formed work. First, as shown in Fig. 1, the blank sheet material 3 heated to an austenizing temperature is supplied and set between the die-side forming surface portion 4 of the die 1 that is opened relative to the punch 2 and the punch-side forming surface portion 5 of the punch 2.

[0041] Next, the die 1 is moved toward the punch 2 and the punch-side forming surface portion 5 is fit in the

recessed fitting portion 4a of the die-side forming surface portion 4 to form the blank sheet material 3.

[0042] As the die 1 is further moved toward the punch 2 and the clamping is performed to advance the forming of the blank sheet material 3, a protruding portion is formed on the blank sheet material 3 by an effect of the recessed fitting portion 4a and the raised portion 5a, as shown in Fig. 2. In addition, because the cut holder 8 is flush with the punch-side forming surface portion 5 or protrudes to the trim holding step 6 by the elastic force of the spring mechanism 9, the cut holder 8 and the trim holding step 6 receive the elastic force of the spring mechanism 9 to clamp the trim portion 3a being the margin of the blank sheet material 3.

[0043] In this manner, as the forming operation on the blank sheet material 3 by the die 1 goes on while the trim portion 3a is kept being clamped by the cut holder 8 and the trim holding step 6, the cut holder 8 receives the pressing force of the trim holding step 6, and is relatively moved along the outer margin 5b of the punch-side forming surface portion 5 while opposing the elastic force of the spring mechanism 9.

[0044] In this manner, the relative movement of the cut holder 8 along the outer margin 5b of the punch-side forming surface portion 5 goes on and as the cut holder 8 is moved below the tip end corner 5c of the punch-side forming surface portion 5 as shown in Fig. 3, the trimming blade 7 starts shearing the trim portion 3a of the blank sheet material 3 between the punch-side forming surface portion 5 and the tip end corner 5c accompanied by this movement.

[0045] As the cut holder 8 is moved along the outer margin 5b of the punch-side forming surface portion 5 while opposing the elastic force of the spring mechanism 9 from the state, the shearing of the trim portion 3a that is kept being clamped between the cut holder 8 and the trim holding step 6 goes on. Finally, as shown in Fig. 4, the trim portion 3a is sheared and cut off from the main body portion constituting the press-formed work of the blank sheet material 3.

[0046] Then, when the cutting off process of the trim portion 3a ends in this manner, the die 1 and the punch 2 are finally clamped and are rapidly cooled by the cooling system, and the quenching process of performing quenching on the blank sheet material 3 is performed. Accordingly, the press-formed work is completed.

[0047] As described above, in the above-described embodiment of the present invention, the cut holder 8 that cooperates with the trim holding step 6 to clamp the trim portion 3a is supported by the spring mechanism 9.

[0048] As the forming of the blank sheet material 3 goes on, the trim holding step 6 causes the cut holder 8 to be moved while pressing the cut holder 8 opposing the elastic force of the spring mechanism 9 accompanied by the progress of the press forming operation by the die 1. As the movement along with the pressing goes on, the spring mechanism 9 is contracted and the cut holder 8 generates the reaction force to gradually increase the

clamping force on the trim portion 3a between the cut holder 8 and the trim holding step 6.

[0049] According to the above, before the trimming process on the trim portion 3a before the time of the final clamping of the die 1 on the punch 2, the degree of contraction of the spring mechanism 9 is still low and the reaction force on the cut holder 8 by the spring mechanism 9 is small. Accordingly, the clamping force on the trim portion 3a between the cut holder 8 and the trim holding step 6 is extremely slight. The blank sheet material 3 can be drawn to the forming surface portions 4, 5 of each of the die 1 and the punch 2 with approximately no resistance and the blank sheet material 3 feed to the forming surface portions 4, 5 is not impeded. By forming the blank sheet material 3 by such punch 2 and die 1, a press-formed work having a desired thickness or a desired shape can be obtained.

[0050] Also, as described above, according to the embodiment of the present invention, because the degree of expansion/contraction of the spring mechanism 9 before the trim portion 3a is cut off is extremely slight, the clamping force between the cut holder 8 and the trim holding step 6 is small. Therefore, the pre-heated blank sheet material 3 dissipates the heat by clamping the trim portion 3a by the cut holder 8 and the trim holding step 6, and the temperature fall can be suppressed from occurring. That the material cannot be fed to the forming die configured with the die 1 and the punch 2 due to the early hardening of the blank sheet material 3 and the occurrence of the worst phenomenon such as the material crack of the blank sheet material 3 can be prevented. Furthermore, the press-formed work having desired strength can be formed when the subsequent cooling and quenching is to be performed on the blank sheet material 3 after the final clamping is performed on the punch 2 and the die 1.

[0051] According to the embodiment of the present invention, at the time of final clamping of the die 1 on the punch 2, the spring mechanism 9 is largely contracted according to the clamping operation by the die 1 on the trim holding step 6, and accordingly, the degree of contraction of the spring mechanism 9 that supports the cut holder 8 becomes high. In response to this, large reaction force on the trim holding step 6 is generated on the cut holder 8, and the clamping force on the trim portion 3a between the cut holder 8 and the trim holding step 6 extremely increases. As a result, the blank sheet material 3 before quench-hardening right before the final forming step is firmly clamped by the cut holder 8 and the trim holding step 6. Accordingly, the occurrence of the wrinkles or overlapping of the press-formed works caused by the excessive feed of the blank sheet material 3 to the forming surface portions 4, 5 of each of the punch 2 and the die 1 is suppressed. In addition, a shearing process enabling neat finish with no burr by cutting off the trim portion 3a can be performed on the press-formed work.

[0052] As a result, according to one aspect of the present invention, in the trimming process that is per-

formed by the trimming blade 7 by cooperating with the tip end corner 5c of the punch-side forming surface portion 5, the so-called aerial cutting by which the trim portion is torn off while being bent as the prior art does not occur.

Accordingly, the burrs are not occurred in the completed press-formed work. Therefore, the deburring process performed after the pressed product is completed is eliminated, thereby achieving the reduction of the processing man-hours, and consequently the product cost reduction.

INDUSTRIAL APPLICABILITY

[0053] According to the above-described one aspect of the present invention, the burrs-occurring on the press-formed work by the trimming process during the hot press forming process can be eliminated even with a configuration in which the trimming process is performed on a high-temperature blank sheet material. Accordingly, the deburring process performed after forming is eliminated, thereby achieving the reduction of the processing man-hours, and consequently, the product cost reduction. Therefore, for a vehicle body component manufactured by the press forming, for example, a door impact beam or a center pillar of an automobile, the hot press forming apparatus of forming by heating a blank sheet material made of a steel material to an austenizing temperature and forming and quenching the heated steel material by using a low-temperature die, and the hot press forming method using the hot press forming apparatus are suitable.

EXPLANATION OF REFERENCES

[0054] 1 ... die; 2 ... punch; 3 ... blank sheet material; 3a ... trim portion; 4 ... die-side forming surface portion; 4a ... recessed fitting portion; 4b ... outer margin; 5 ... punch-side forming surface portion; 5a ... raised portion; 5b ... outer margin; 5c ... tip end corner; 6 ... trim holding step; 6a ... inner margin; 7 ... trimming blade; 8 ... cut holder; 9 ... spring mechanism

Claims

1. A hot press forming apparatus comprising:

a press forming apparatus configured to form a pre-heated blank sheet material into a shape of a press-formed work by clamping a die having a forming surface portion on a punch having a forming surface portion;

a trim portion cut-off apparatus configured to trim a trim portion as a margin being a portion of the blank sheet material that is not included in the press-formed work; and

a quench-hardening apparatus configured to quench and harden the heated blank sheet material by rapidly cooling while being clamped be-

tween the punch and the die, wherein the trim portion cut-off apparatus has:

a trim holding step that is formed forward as to protrude toward the punch at an outer margin of the forming surface portion of the die; 5

a trimming tool that includes a trimming blade formed on a tip end corner on an inner margin of the trim holding step, and a tip end corner formed on an outer margin of the forming surface portion of the punch; 10

a cut holder that is arranged adjacent to the outer margin of the forming surface portion of the punch so as to face the trim holding step; and 15

a spring mechanism that is provided on the punch and that supports the cut holder in such a state that the cut holder is elastically energized toward the trim holding step, the cut holder being movable closer to/away from the trim holding step, wherein 20

during a press forming process of forming the blank sheet material while the press forming apparatus is clamping the die on the punch, the trim portion is clamped between the trim holding step and the cut holder in such a state that elastic force of the spring mechanism is being applied, 25

as a press forming operation by the die goes on, the trimming blade is relatively moved along the outer margin of the forming surface portion of the punch while the cut holder opposes elastic force of the spring mechanism by receiving pressing force of the trim holding step so that the trimming blade shears and cuts off the trim portion between the trimming blade and the tip end corner on the outer margin of the forming surface portion of the punch, and 30

after the cutting off process of the trim portion by the trim portion cut-off apparatus ends, the quench-hardening apparatus quenches the blank sheet material by clamping the blank sheet material between the punch and the die finally. 35 40 45

2. A hot press forming method using a hot press forming apparatus, wherein the hot press forming apparatus has: 50

a press forming apparatus configured to form a pre-heated blank sheet material into a shape of a press-formed work by clamping a die having a forming surface portion on a punch having a forming surface portion; 55

a trim portion cut-off apparatus configured to trim a trim portion as a margin being a portion of the

blank sheet material that is not included in the press-formed work; and

a quench-hardening apparatus configured to quench and harden the heated blank sheet material by rapidly cooling while being clamped between the punch and the die, wherein the trim portion cut-off apparatus has:

a trim holding step that is formed forward so as to protrude toward the punch at an outer margin of the forming surface portion of the die;

a trimming tool that includes a trimming blade formed on a tip end corner on an inner margin of the trim holding step, and a tip end corner formed on an outer margin of the forming surface portion of the punch;

a cut holder that is arranged adjacent to the outer margin of the forming surface portion of the punch so as to face the trim holding step; and

a spring mechanism that is provided on the punch and that supports the cut holder in such a state that the cut holder is elastically energized toward the trim holding step, the cut holder being movable closer to/away from the trim holding step, and

the hot press forming method comprises:

during a press forming process of forming the blank sheet material while clamping the die on the punch by the press forming apparatus, clamping the trim portion between the trim holding step and the cut holder in such a state that elastic force of the spring mechanism is being applied;

as a press forming operation by the die goes on, shearing and cutting off, by the trimming blade, the trim portion between the trimming blade and the tip end corner on the outer margin of the forming surface portion of the punch by causing the trimming blade to relatively move along the outer margin of the forming surface portion of the punch while causing the cut holder to oppose elastic force of the spring mechanism by receiving pressing force of the trim holding step; and

after the cutting off process of the trim portion by the trim portion cut-off apparatus ends, quenching, by the quench-hardening apparatus, the blank sheet material by clamping the blank sheet material the punch and the die finally.

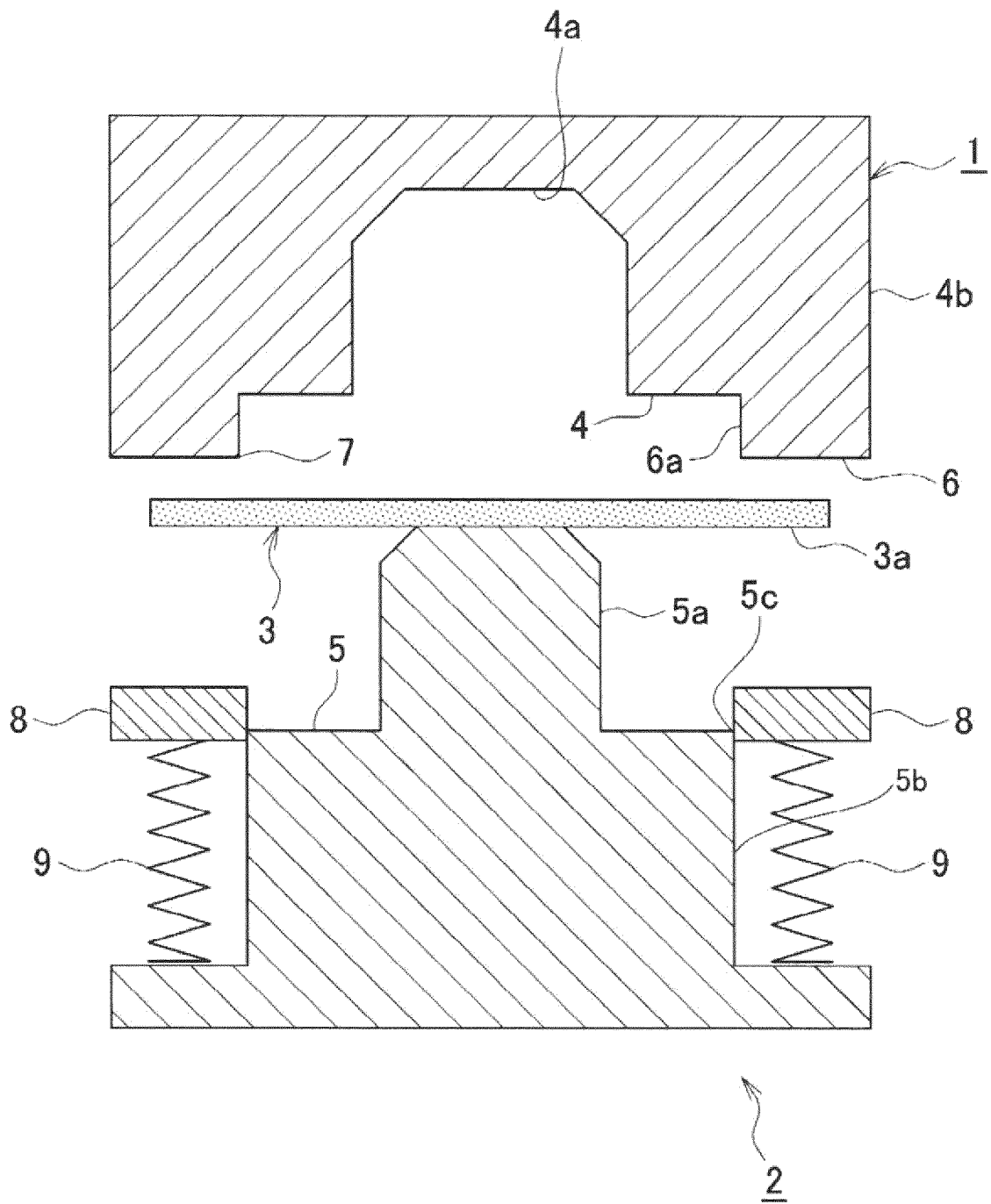


FIG. 1

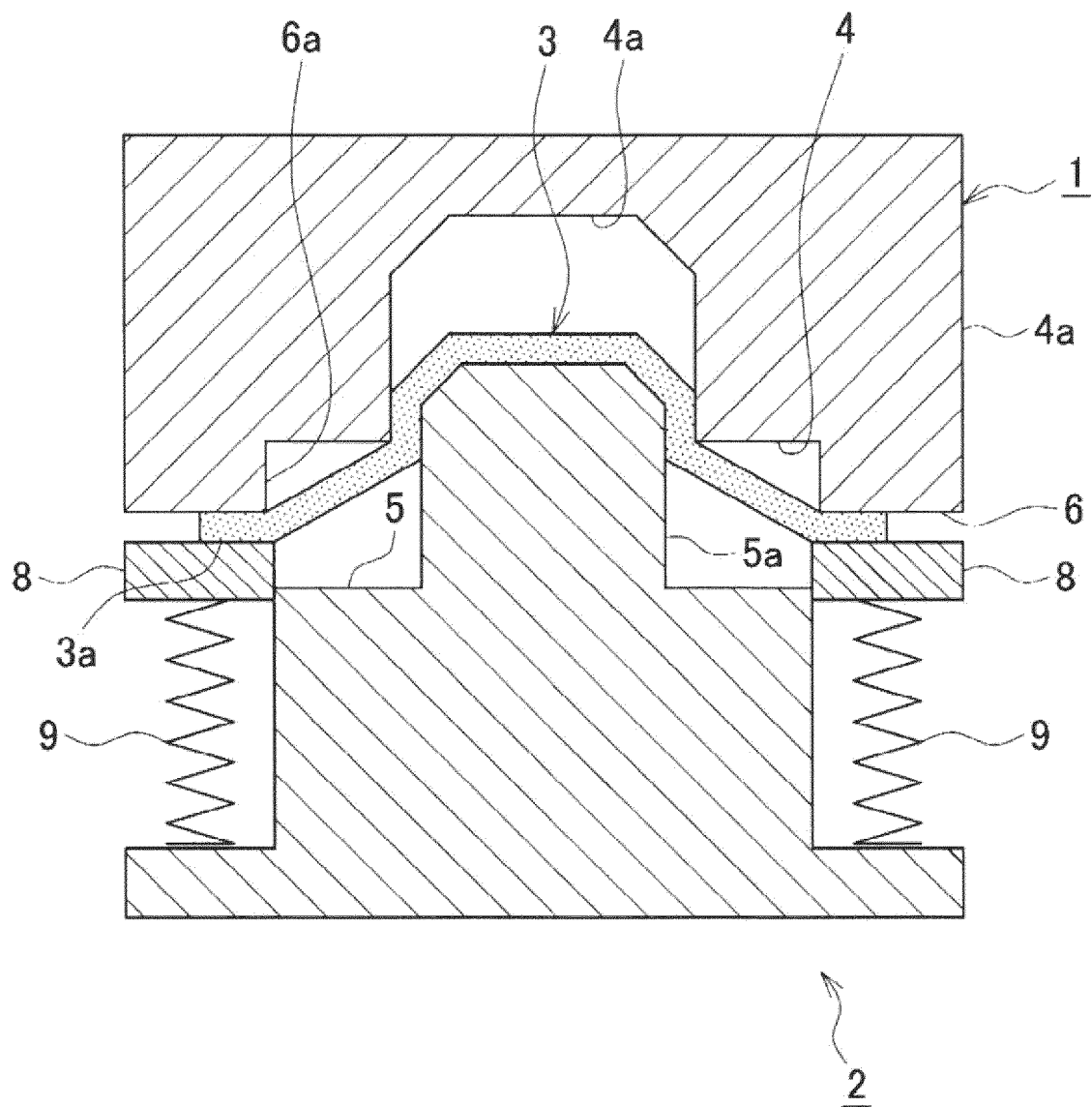


FIG. 2

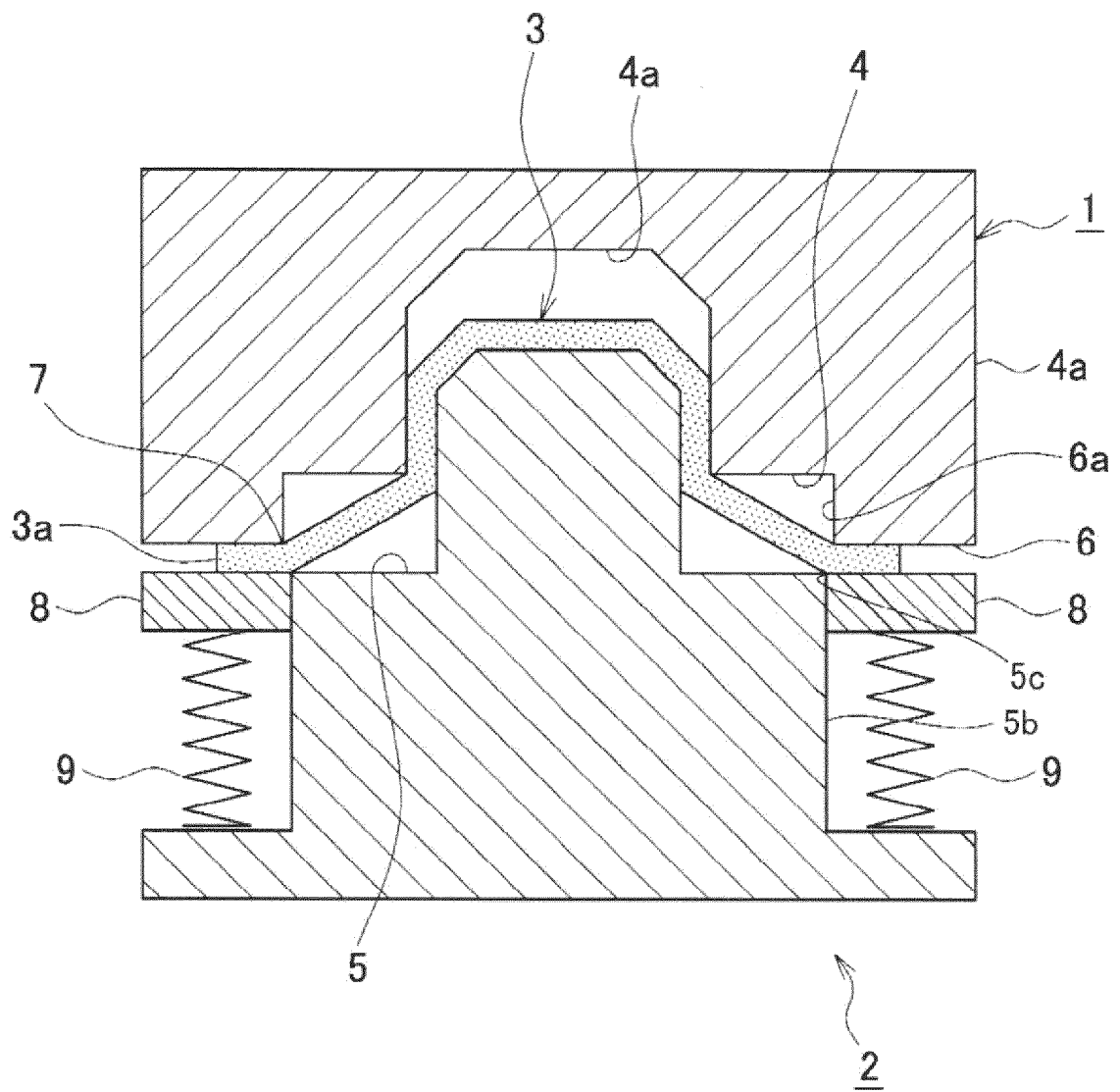


FIG. 3

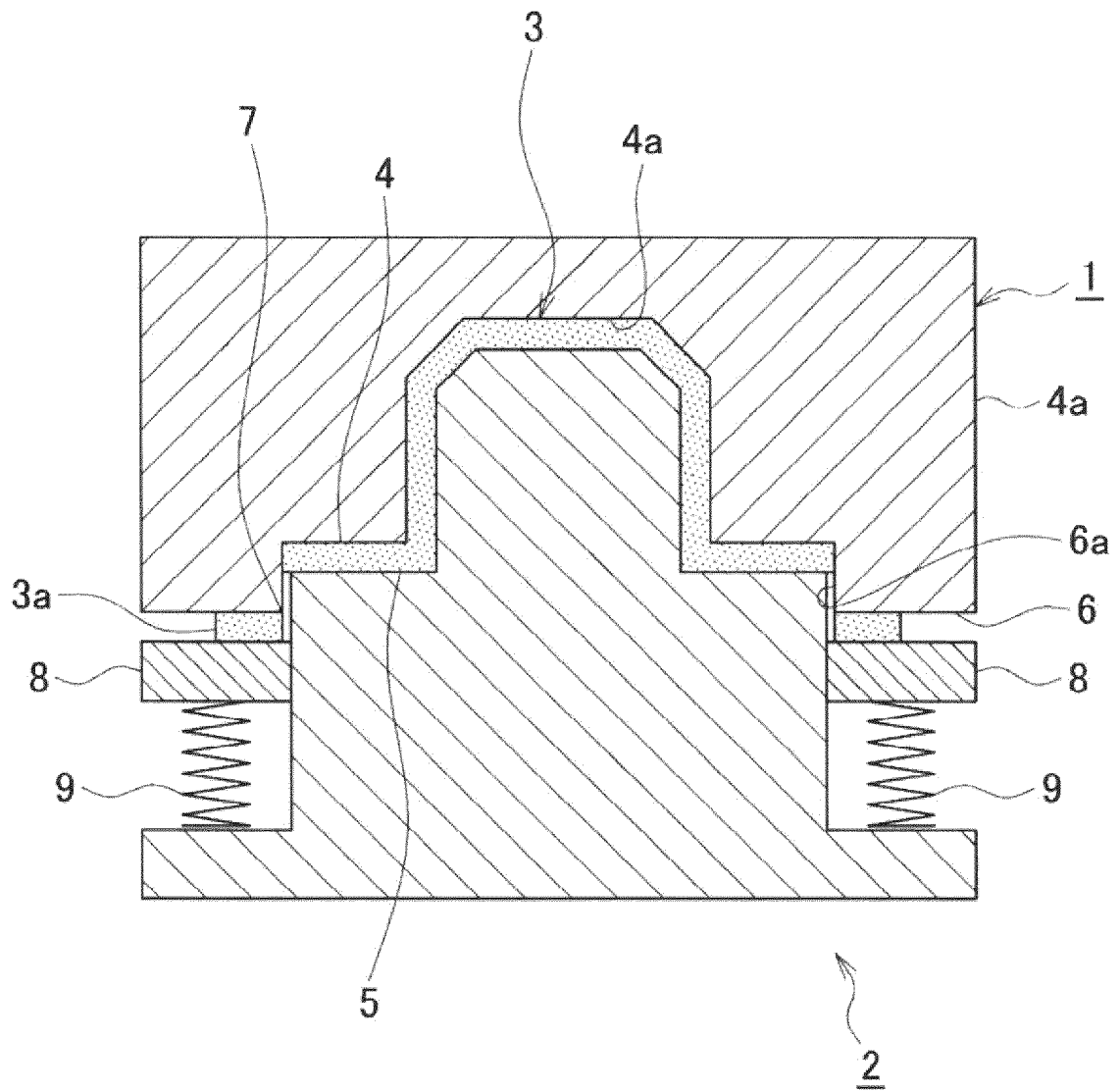


FIG. 4

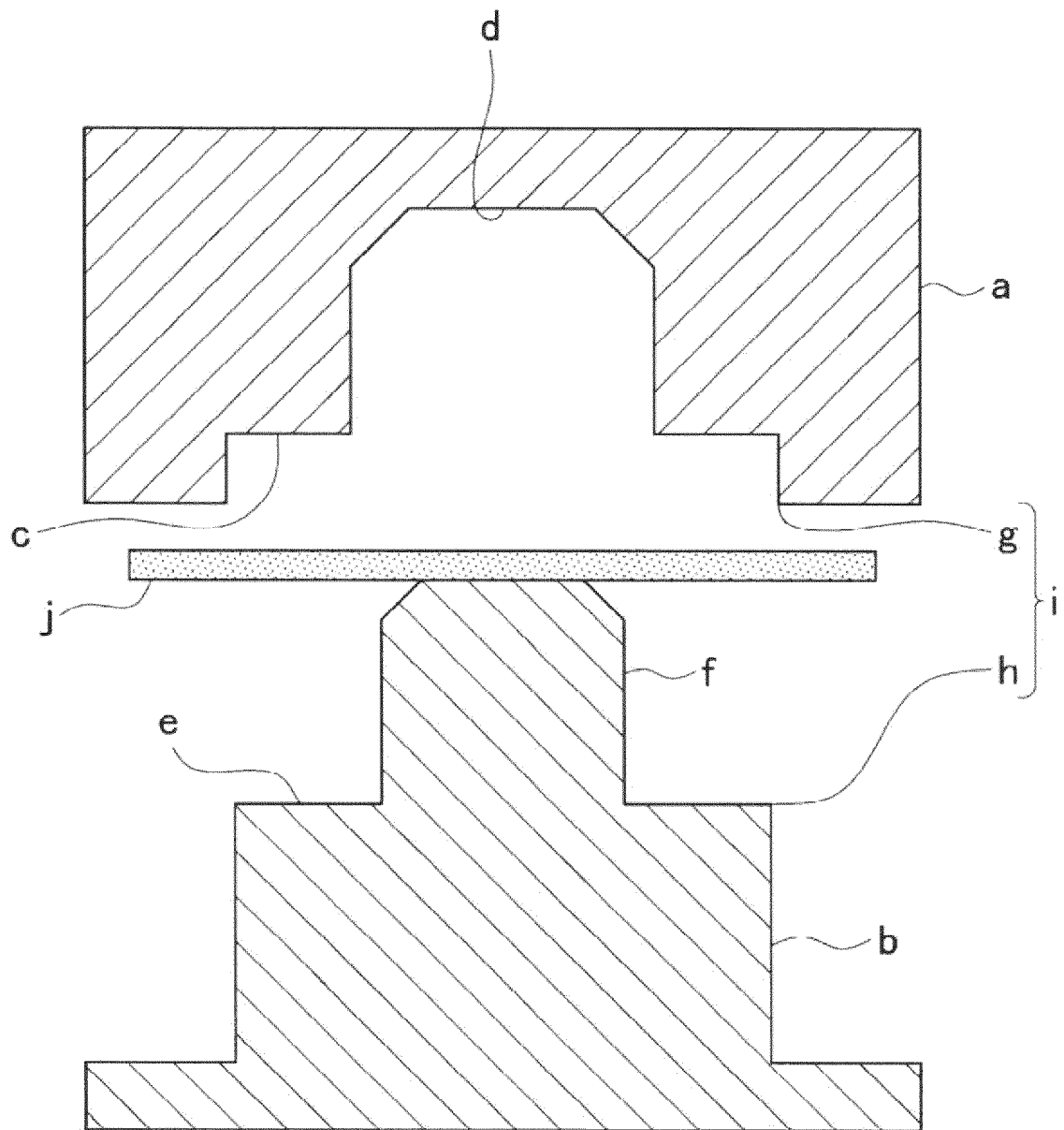


FIG. 5

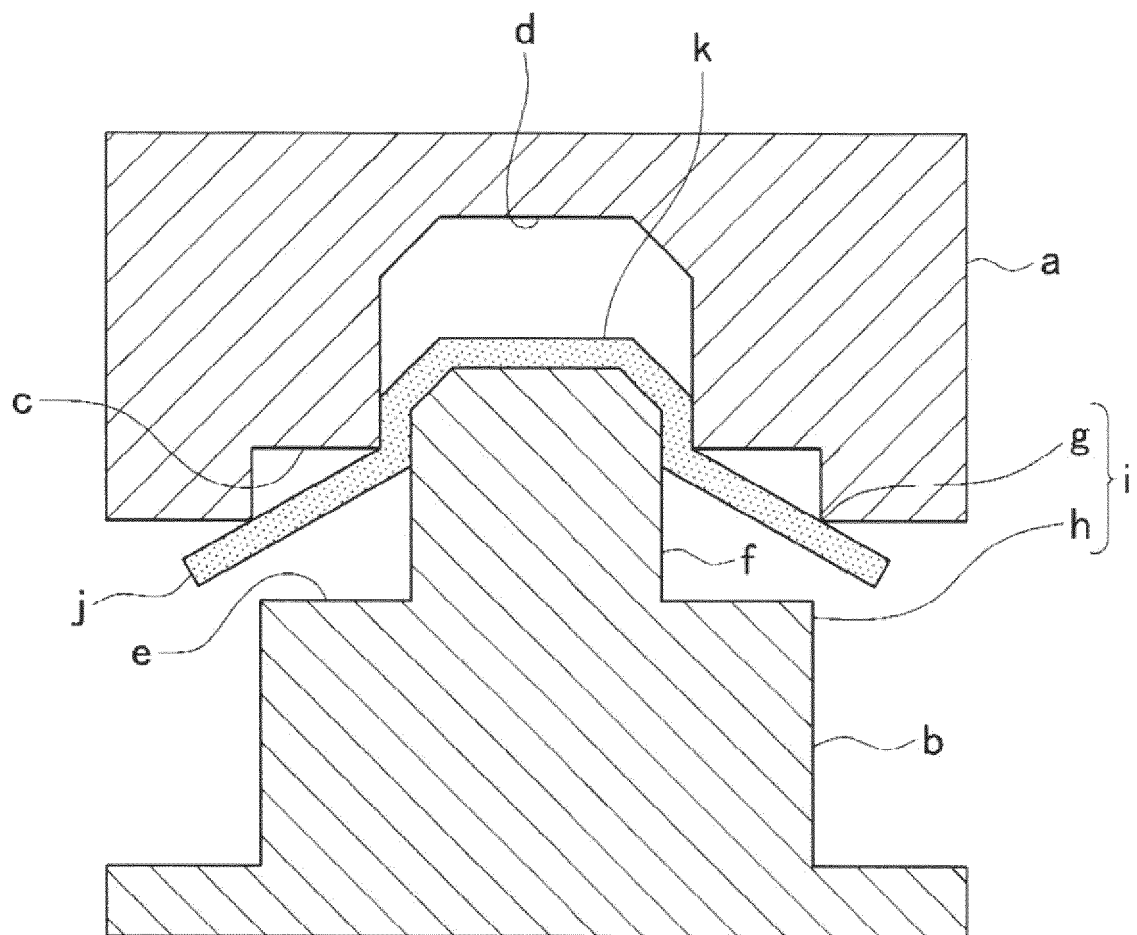


FIG. 6

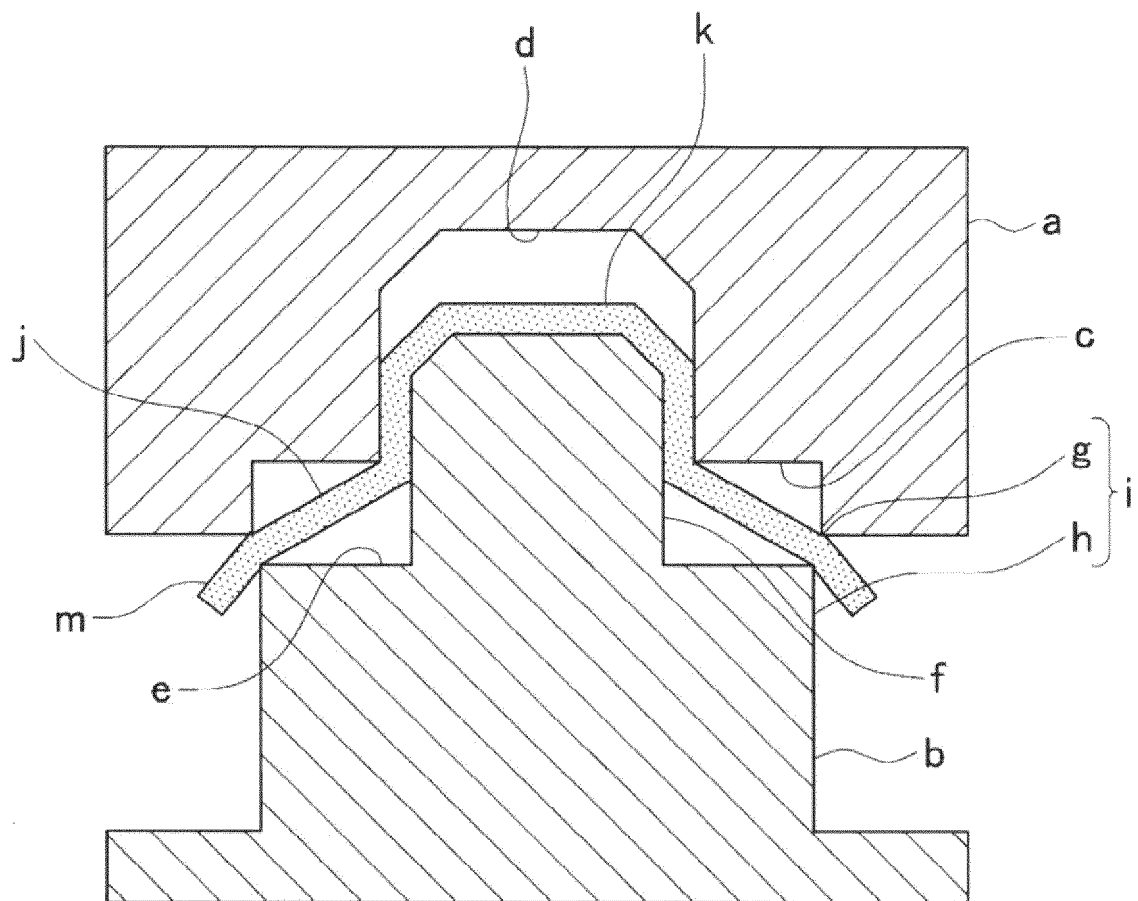


FIG. 7

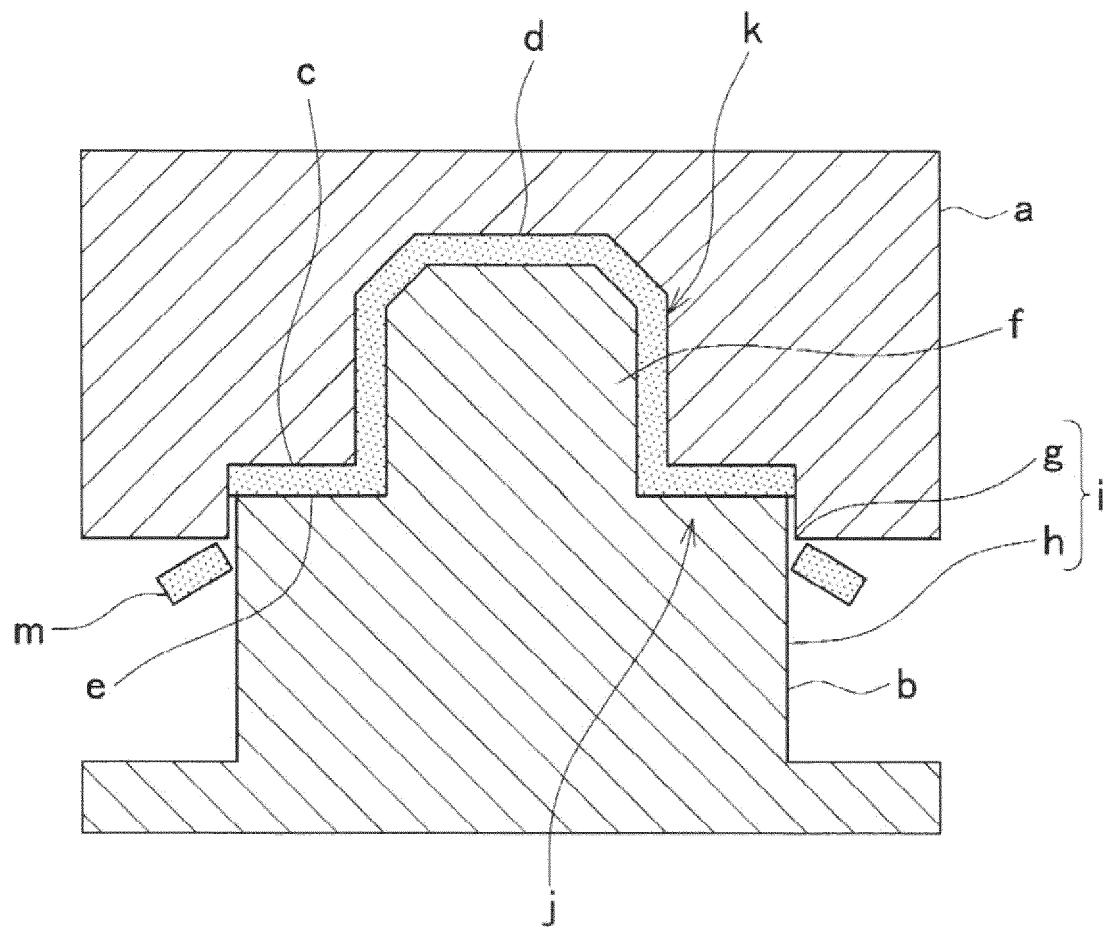


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/004827

A. CLASSIFICATION OF SUBJECT MATTER

B21D22/20(2006.01)i, B21D24/00(2006.01)i, B21D28/00(2006.01)i

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)

B21D22/20, B21D24/00, B21D28/00

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2017
 Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2010-501358 A (Magna Automotive Services GmbH), 21 January 2010 (21.01.2010), paragraphs [0058] to [0067]; fig. 1 & US 2010/0126640 A1 paragraphs [0065] to [0076]; fig. 1 & US 2014/0033785 A1 & WO 2008/025387 A1 & EP 2059355 A1 & DE 102006040224 A & BR PI0715202 A	1-2

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

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"&" document member of the same patent family

 Date of the actual completion of the international search
 20 April 2017 (20.04.17)

 Date of mailing of the international search report
 09 May 2017 (09.05.17)

 Name and mailing address of the ISA/
 Japan Patent Office
 3-4-3, Kasumigaseki, Chiyoda-ku,
 Tokyo 100-8915, Japan

Authorized officer

Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/004827

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2014-76483 A (Hyundai Motor Co.), 01 May 2014 (01.05.2014), paragraphs [0032] to [0054], [0084] to [0112]; fig. 5 to 8 & US 2014/0096583 A1 fig. 5 to 8 & DE 102012224418 A & KR 10-2014-0044676 A & CN 103707066 A	1-2
X	US 2010/0018277 A1 (HIELSCHER Christian), 28 January 2010 (28.01.2010), paragraphs [0025] to [0027]; fig. 4 to 6 & DE 102008034996 A & FR 2934280 A	1-2

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REFERENCES CITED IN THE DESCRIPTION

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- JP 2011092946 A [0016]