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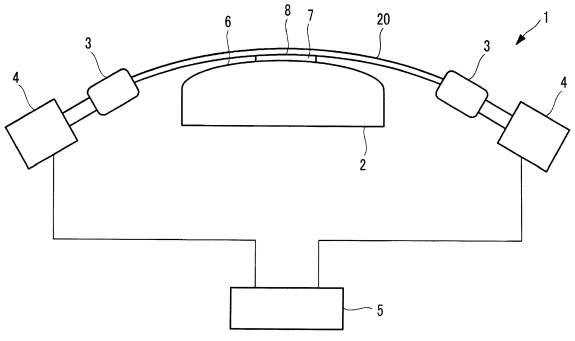
(54) STRETCH FORMING DEVICE AND STRETCH FORMING METHOD

(57) The objective of the present invention is to reduce unevenness in an amount of deformation of a central portion and an end portion of an elongate material being formed. A stretch forming device (1) is provided with a die (2) and gripping portions (3) which grip both end portions of an elongate material (20), wherein: the cross-sectional shape of the die (2) has a curved shape in which a central side of a forming surface (6) bulges; the length in a longitudinal direction of the elongate material (20) is less than that of the forming surface (6); a second die (7) having a second forming surface (8) along the forming surface (6) is installed removably on a central portion of the forming surface (6); and the stretch forming device (1) has a first mode in which, when the second die (7) has been installed on the forming surface (6), only the second die (7) is pressed against the elongate material (20) while a tensile force is applied to the elongate material (20) by the grip portions (3), and a second mode in which, when the second die (7) has been removed from the forming surface (6), the die (2) is pressed against the elongate material (20) while a tensile force is applied to the elongate material (20) by the gripping portions (3).

FIG. 1



EP 3 586 989 A1

Description

Technical Field

[0001] The present invention relates to a stretch forming device and a stretch forming method.

Background Art

[0002] An aircraft component such as a fuselage or a main wing of an aircraft is composed of structural members such as a plate-like skin, an elongated frame, and a stringer, for example. The fuselage, the main wing, and the like have a curved surface shape, and therefore, the frame and the stringer have a curved surface shape curved along a longitudinal direction.

[0003] In order to give a curved shape to an elongate material made of an aluminum alloy, in the related art, roll-forming is performed on an annealed (anneal) material (also referred to as an 0 material) by a roll-forming device, thereby giving an approximate shape to the 0 material. Thereafter, solution treatment is performed on the 0 material obtained by the roll-forming, thereby obtaining a W material.

[0004] In this case, stretch forming is performed in which a curved shape is further given to the W material by applying a die to an elongate material made of the W material while pulling both ends of the elongate material. In this way, a shape which is required as a product or a curvature close to it is given to the elongate material.

[0005] PTL 1 below discloses a forming device for performing stretch forming, in which a forming surface is formed by a plurality of blocks and the shape of the forming surface can be changed by individually moving the positions of the respective blocks in a forming direction, and good stretch forming is performed without performing relative movement with respect to a long material during forming.

Citation List

Patent Literature

[0006] [PTL 1] Japanese Unexamined Patent Application Publication No. 2006-231380

Summary of Invention

Technical Problem

[0007] If the stretch forming is performed, in the vicinity of both end portions of the elongate material that is a material to be formed, the elongate material is easily deformed and extended due to the action of a tensile force. On the other hand, in a central portion which comes into contact with a die, the elongate material is subjected to a reduced tensile force due to the influence of friction or the like, which acts between the elongate material and the die, and thus the amount of deformation is small and extension does not easily occur.

[0008] As a result of the stretch forming, the residual stress introduced in a process such as the roll-forming or the solution treatment before the stretch forming is reduced. However, the amount of deformation of the central portion is small, and therefore, in the central portion, the residual stress is not easily reduced compared to the end portion. Therefore, if etching or cutting work such as drilling is performed after the stretch forming, there is a problem in that a shape changes for each material and variation easily occurs.

[0009] The present invention has been made in view of such circumstances and has an object to provide a stretch forming device and a stretch forming method, in which it is possible to reduce variation in the amount of deformation between a central portion and an end portion of a material to be formed having an elongated shape.

Solution to Problem

[0010] In order to solve the above problem, a stretch forming device and a stretch forming method according to the present invention adopt the following means.

[0011] That is, according to a first aspect of the present invention, there is provided a stretch forming device including a die and gripping parts which grip both end portions of a material to be formed having an elongated shape, in which a cross-sectional shape of the die has a curved shape in which a center side of a forming surface of the die bulges, and the forming surface is formed so as to give a curved shape to the material to be formed, a second die having a second forming surface in which a length thereof along a longitudinal direction of the material to be formed is shorter than a length of the forming surface and which is along the forming surface is removably installed at a central portion of the forming surface, and the stretch forming device has a first mode in which, when the second die has been installed on the forming surface, only the second die presses the material to be formed while a tensile force is applied to the material to be formed by the gripping parts, and a second mode in which, when the second die has been removed from the forming surface, the die presses the material to be formed while a tensile force is applied to the material to be formed by the gripping parts.

[0012] According to a second aspect of the present invention, there is provided a stretch forming device including a die and gripping parts which grip both end portions of a material to be formed having an elongated shape, in which the die is divided into a plurality of pieces in a longitudinal direction of a material to be formed to have a plurality of divided dies which can be individually changed in position with respect to a side of the material to be formed, and the stretch forming device has a first mode in which, when the divided die installed at a central portion, among the plurality of divided dies, is disposed to protrude to the side of the material to be formed more

than the divided dies installed at end portions, only the divided die disposed at the central portion presses the material to be formed while a tensile force is applied to the material to be formed by the gripping parts, and a second mode in which, when the plurality of divided dies disposed at the central portion and the end portions are disposed so as to give a curved shape to the material to be formed, the plurality of divided dies disposed at the central portion and the end portions press the material to be formed while a tensile force is applied to the material to be formed by the gripping parts.

[0013] According to a third aspect of the present invention, there is provided a stretch forming device including a die and gripping parts which grip both end portions of a material to be formed having an elongated shape, in which a cross-sectional shape of the die has a curved shape in which a center side of a forming surface of the die bulges, and the forming surface is formed so as to give a curved shape to the material to be formed, and the stretch forming device has a first mode in which only a central portion of the forming surface of the die presses the material to be formed while a tensile force is applied to the material to be formed by the gripping parts, and a second mode in which an entire surface of the forming surface of the die presses the material to be formed while a tensile force is applied to the material to be formed by the gripping parts.

[0014] According to a fourth aspect of the present invention, there is provided a stretch forming method using a stretch forming device, the device including a die and gripping parts which grip both end portions of a material to be formed having an elongated shape, a cross-sectional shape of the die having a curved shape in which a center side of a forming surface of the die bulges, and the forming surface being formed so as to give a curved shape to the material to be formed, the method including: a step of installing a second die having a second forming surface in which a length thereof along a longitudinal direction of the material to be formed is shorter than a length of the forming surface and which is along the forming surface, at a central portion of the forming surface; a step of causing, when the second die has been installed on the forming surface, only the second die to press the material to be formed while a tensile force is applied to the material to be formed by the gripping parts; and a step of causing, when the second die has been removed from the forming surface, the die to press the material to be formed while a tensile force is applied to the material to be formed by the gripping parts.

[0015] According to a fifth aspect of the present invention, there is provided a stretch forming method using a stretch forming device, the device including a die and gripping parts which grip both end portions of a material to be formed having an elongated shape, the die being divided into a plurality of pieces in a longitudinal direction of a material to be formed to have a plurality of divided dies which can be individually changed in position with respect to a side of the material to be formed, the method including: a step of disposing the divided die installed at a central portion, among the plurality of divided dies, so as to protrude to the side of the material to be formed more than the divided dies installed at end portions; a step of causing only the divided die disposed at the central portion to press the material to be formed while a tensile force is applied to the material to be formed by the gripping parts; and a step of causing, when the plurality of divided dies disposed at the central portion and the end portions are disposed so as to give a curved shape to the material to be formed, the plurality of divided dies disposed at the central portion and the end portions to press the material to be formed while a tensile force is applied to the material to be formed by the gripping parts.

[0016] According to a sixth aspect of the present invention, there is provided a stretch forming method using a stretch forming device, the device including a die and gripping parts which grip both end portions of a material to be formed having an elongated shape, a cross-sectional shape of the die having a curved shape in which a center side of a forming surface of the die bulges, and the forming surface being formed so as to give a curved shape to the material to be formed, the method including: a step of causing only a central portion of the forming surface of the die to press the material to be formed while a tensile force is applied to the material to be formed by the gripping parts; and a step of causing an entire surface of the forming surface of the die to press the material to be formed while a tensile force is applied to the material to be formed by the gripping parts.

Advantageous Effects of Invention

[0017] According to the present invention, it is possible to reduce variation in the amount of deformation between the central portion and the end portion of the material to be formed having an elongated shape, and also in the vicinity of the central portion, similar to the end portion, the residual stress is reduced. As a result, when etching or cutting work such as drilling is performed after the stretch forming, it is possible to reduce a shape change occurring in the material or variation for each material.

Brief Description of Drawings

[0018]

Fig. 1 is a schematic configuration diagram showing a stretch forming device according to a first embodiment of the present invention.

Fig. 2 is a schematic configuration diagram showing the stretch forming device according to the first embodiment of the present invention.

Fig. 3 is a schematic configuration diagram showing a stretch forming device according to a second embodiment of the present invention.

Fig. 4 is a schematic configuration diagram showing

the stretch forming device according to the second embodiment of the present invention.

Fig. 5 is a schematic configuration diagram showing a modification example of the stretch forming device according to the second embodiment of the present invention.

Fig. 6 is a schematic configuration diagram showing a stretch forming device according to a third embodiment of the present invention.

Description of Embodiments

[0019] Hereinafter, embodiments of the present invention will be described with reference to the drawings.

[First Embodiment]

[0020] Hereinafter, a first embodiment of the present invention will be described using Figs. 1 and 2.

[0021] A stretch forming device 1 according to this embodiment is a device that performs stretch forming on an elongate material 20 that is a material to be formed, by using a die 2. The elongate material 20 is made of, for example, an aluminum alloy and is a material which is manufactured as a structural member such as a frame or a stringer which configures an aircraft component such as a fuselage or a main wing of an aircraft.

[0022] The elongate material 20 is a material (W material obtained by performing roll-forming on an annealed (anneal) material (0 material) and performing solution treatment on the 0 material obtained by the roll-forming. Alternatively, the elongate material 20 may be a material obtained by performing roll-forming on a W material obtained by performing solution treatment on an annealed material (O material).

[0023] In stretch forming, gripping parts 3 respectively grip both end portions of the elongate material 20, and the elongate material 20 is pressed against the die 2 (or the die 2 is pressed against the elongate material 20) while causing a tensile force to act on the elongate material 20. Then, in the stretch forming, plastic deformation is performed on the elongate material 20 formed into a curved shape by roll-forming, thereby further giving a curved shape to the elongate material 20.

[0024] The stretch forming device 1 includes the die 2, the gripping part 3, a moving unit 4, an operation unit 5, and the like.

[0025] The die 2 has a forming surface 6 which is long along a longitudinal direction of the elongate material 20 that is a material to be formed. The forming surface 6 of the die 2 is formed so as to give a curved shape to the elongate material 20 and has a curved surface. The cross-sectional shape of the die 2 is a curved shape in which the center side of the forming surface 6 bulges, and is a part of a circular arc or an ellipse, for example.

[0026] The gripping part 3 is configured to grip an end portion of the elongate material 20. The gripping parts 3 are respectively installed at both end portions of the elongate material 20. The gripping part 3 is connected to the moving unit 4 and can be moved by the moving unit 4.

[0027] A second die 7 is removably installed at the central portion of the forming surface 6 of the die 2 according to this embodiment. The second die 7 has a second forming surface 8 in which the length thereof along the longitudinal direction of the elongate material 20 is shorter than the length of the forming surface 6 and which is along the forming surface 6. The second forming surface 8 has, for example, a curved surface parallel to the forming surface 6 of the die 2. The length of the second die 7 is in a range of about 1/4 to 1/3 of the length of the die 2.

[0028] The moving units 4 move the gripping parts 3 to move the elongate material 20 gripped by the gripping parts 3 to the forming surface 6 side of the die 2, and in a case where the second die 7 is not installed, the moving units 4 move the gripping parts 3 to press the elongate material 20 against the forming surface 6 of the die 2, or in a case where the second die 7 is installed, the moving units 4 move the gripping parts 3 to press the elongate material 20 against for the second forming surface 8 of the second die 7. Further, the moving units 4 move the gripping parts 3 to the outside in the longitudinal direction of the elongate material 20 to apply a tensile force to the elongate material 20 pressed against the forming surface 6 of the die 2 or the second forming surface 8 of the second die 7.

[0029] The operation unit 5 receives an input operation from a worker and transmits an operation signal to the moving units 4.

[0030] In the above description, the moving units 4 move the gripping parts 3 to move the elongate material 20 gripped by the gripping parts 3 to the forming surface 6 side of the die 2. However, the present invention is not limited thereto and the die 2 may be moved to the elongate material 20 side by a moving unit (not shown) that moves the die 2.

[0031] In a stretch forming method using the stretch forming device 1 according to this embodiment, first, as shown in Fig. 1, the second die 7 is installed on the forming surface 6 of the die 2. Then, the elongate material 20 gripped by the gripping parts 3 is moved, so that the elongate material 20 is pressed against the second forming surface 8 of the second die 7. Further, the moving units 4 move the gripping parts 3 to the outside in the longitudinal direction of the elongate material 20, thereby applying a tensile force to the elongate material 20 pressed against the second forming surface 8 of the second die 7 (a first mode). At this time, the elongate material 20 is prevented from coming into contact with the forming surface 6 of the die 2.

[0032] In this way, the contact area between the elongate material 20 and the second die 7 becomes smaller than the contact area between the elongate material 20 and the die 2 when the second die 7 is not installed, and therefore, when a tensile force is applied to the elongate material 20, a frictional force which acts on the vicinity of the central portion of the elongate material 20 is reduced,

and thus the tensile force which is transmitted to the vicinity of the central portion increases. As a result, the amount of deformation which is generated in the vicinity of the central portion of the elongate material 20 increases.

[0033] Next, in a case where, based on the amount of movement in a tensile direction detected at the moving unit 4, it was confirmed that a predetermined amount of deformation was given, the movement of the moving unit 4 is stopped and the application of the tensile force to the elongate material 20 is stopped. Then, the elongate material 20 gripped by the gripping parts 3 is moved, so that the elongate material 20 is separated from the second forming surface 8, and the second die 7 is removed from the forming surface 6.

[0034] Thereafter, the elongate material 20 gripped by the gripping parts 3 is moved, so that the elongate material 20 is pressed against the forming surface 6 of the die 2, as shown in Fig. 2. Further, the moving units 4 move the gripping parts 3 to the outside in the longitudinal direction of the elongate material 20, thereby applying a tensile force to the elongate material 20 pressed against the forming surface 6 of the die 2 (a second mode). Next, in a case where, based on the amount of movement in the tensile direction detected at the moving unit 4, it was confirmed that a predetermined amount of deformation was given, the movement of the moving unit 4 is stopped and the application of the tensile force to the elongate material 20 is stopped. Then, the elongate material 20 gripped by the gripping parts 3 is moved, so that the elongate material 20 is separated from the forming surface 6.

[0035] In this way, the elongate material 20 is plastically deformed along the forming surface 6 of the die 2, so that a curved shape is given to the elongate material 20.

[0036] In the related art, from the time of the start of stretch forming, the elongate material 20 is pressed against the forming surface 6 of the die 2 to give a curved shape to the elongate material 20. However, in this embodiment, first, the elongate material 20 is pressed against the second forming surface 8 of the second die 7 having a small contact area to reduce a frictional force which acts on the vicinity of the central portion of the elongate material 20 and increase the tensile force which is transmitted to the vicinity of the central portion, thereby increasing the amount of deformation which is generated in the vicinity of the central portion of the elongate material 20. Then, the stretch forming is performed again on the elongate material 20 to which a large amount of deformation is given compared to the related art, by the die 2.

[0037] The stretch forming is carried out in two steps in this manner, whereby it is possible to reduce residual stress in the vicinity of the central portion of the elongate material 20. As a result, it is possible to reduce a shape change which occurs when etching or cutting work such as drilling is performed after the stretch forming, or variation for each material after cutting work. Further, since the existing die 2 can be utilized, it is not necessary to newly manufacture a die.

[Second Embodiment]

[0038] Next, a second embodiment of the present invention will be described using Figs. 3 and 4. With respect to the same configurations and operation as those in the first embodiment, a detailed description thereof will be omitted.

[0039] Unlike the first embodiment, the die 2 according to this embodiment has a plurality of divided dies 10. That is, the die 2 is divided into a plurality of pieces in the longitudinal direction of the elongate material 20 which is a material to be formed. Then, the plurality of divided dies 10 can be individually changed in position with respect to the elongate material 20.

[0040] The contact portion with the elongate material 20 in each of the divided dies 10 has a curved surface, as shown in Figs. 3 and 4.

[0041] In this embodiment, a moving unit 11 which moves the divided dies 10 is further provided. By changing the position of each of the divided dies 10 by the moving unit 11, it is also possible to dispose each divided die 10 (first mode), as shown in Fig. 3. That is, like a state where the second die 7 is installed on the forming surface 6 of the die 2 of the first embodiment, the divided dies 10 installed at the central portion, among the plurality of divided dies 10, can be disposed to protrude to the elongate material 20 side more than the divided dies 10 disposed at end portions. The length of the central portion in which the divided dies 10 protrude is in a range of about 1/4 to 1/3 of the entire length of the die 2.

[0042] Further, by changing the position of each of the divided dies 10 by the moving unit 11, it is possible to dispose the plurality of divided dies 10 in a curved shape in which the center side bulges (a second mode), as shown in Fig. 4. In this way, the plurality of divided dies 10 can give a curved shape to the elongate material 20, like the forming surface 6 of the die 2 of the first embodiment.

[0043] By adjusting the disposition position of each of the divided dies 10 by the moving unit 11, switching between the first mode and the second mode is possible. The switching between the first mode and the second mode may be performed manually by a worker, or may be performed by a control device so as to shift from the first mode to the second mode when, by detection of the amount of deformation of the elongate material 20, it was confirmed that a predetermined amount of deformation was given.

[0044] As shown in Figs. 3 and 4, the divided dies 10 may be divided into two or more divided dies at each of the central portion and the end portion to form a finely curved shape, or as shown in Fig. 5, the divided dies 10 may include a total of three divided dies, one at the central portion and one at each of the end portions. Further, a combination of both the aspects is also possible.

[0045] In a stretch forming method using the stretch forming device 1 according to this embodiment, first, as shown in Fig. 3, the divided dies 10 installed at the central portion, among the plurality of divided dies 10, are disposed to protrude to the elongate material 20 side more than the divided dies 10 disposed at the end portions. Then, the elongate material 20 gripped by the gripping parts 3 is moved, so that the elongate material 20 is pressed against the divided dies 10 disposed to protrude at the central portion. Further, the moving units 4 move the gripping parts 3 to the outside in the longitudinal direction of the elongate material 20, thereby applying a tensile force to the elongate material 20 pressed against the divided dies 10 (a first mode). At this time, the elongate material 20 is prevented from coming into contact with the divided dies 10 disposed at the end portions.

[0046] In this" way, the contact area between the elongate material 20 and the divided dies 10 becomes smaller than the contact area between the elongate material 20 and the die 2 when being pressed against all the divided dies 10, and therefore, when a tensile force is applied to the elongate material 20, a frictional force which acts on the vicinity of the central portion of the elongate material 20 is reduced, and thus the tensile force which is transmitted to the vicinity of the central portion increases. As a result, the amount of deformation which is generated in the vicinity of the central portion of the elongate material 20 is increased.

[0047] Next, in a case where, based on the amount of movement in the tensile direction detected at the moving unit 4, it was confirmed that a predetermined amount of deformation was given, the movement of the moving unit 4 is stopped and the application of the tensile force to the elongate material 20 is stopped. Then, each divided die 10 is moved, and thus the plurality of divided dies 10 are disposed in a curved shape in which the center side bulges, so as to be able to give a curved shape to the elongate material 20 (refer to Fig. 4).

[0048] Thereafter, the moving units 4 move the gripping parts 3 again to the outside in the longitudinal direction of the elongate material 20, thereby applying a tensile force to the elongate material 20 pressed against the divided dies 10 (a second mode). Next, in a case where, based on the amount of movement in the tensile direction detected at the moving unit 4, it was confirmed that a predetermined amount of deformation was given, the movement of the moving unit 4 is stopped and the application of the tensile force to the elongate material 20 is stopped. Then, the elongate material 20 gripped by the gripping parts 3 is moved, so that the elongate material 20 is separated from the divided dies 10.

[0049] In this way, the elongate material 20 is plastically deformed along the plurality of divided dies 10 of the die 2, so that a curved shape is given to the elongate material 20.

[0050] In the related art, from the time of the start of stretch forming, the elongate material 20 is pressed against all the plurality of divided dies 10 to give a curved shape to the elongate material 20. However, in this embodiment, first, the elongate material 20 is pressed against only the divided dies 10 of the central portion such that a contact area is reduced, and thus a frictional force which acts on the vicinity of the central portion of the elongate material 20 is reduced, and thus the tensile force which is transmitted to the vicinity of the central portion increases, whereby the amount of deformation which is generated in the vicinity of the central portion of the elongate material 20 is increased. Then, the stretch forming is performed again on the elongate material 20 to which a large amount of deformation is given, compared to the related art, by the die 2.

[0051] The stretch forming is performed in two steps in this manner, whereby it is possible to reduce residual stress in the vicinity of the central portion of the elongate material 20. As a result, it is possible to reduce a shape change which occurs when etching or cutting work such as drilling is performed after the stretch forming, or variation for each material after cutting work. Further, unlike the first embodiment, a time which is taken to remove the second die 7 is not required, and a change of a die shape can be automatically carried out by a machine, not a manual operation.

[Third Embodiment]

[0052] Next, a third embodiment of the present invention will be described using Fig. 6. With respect to the same configurations and operation as those in the first embodiment, a detailed description thereof will be omitted.

[0053] In this embodiment, unlike the first embodiment, the stretch forming is carried out in two steps using only the die 2 without installing the second die 7 on the forming surface 6 of the die 2. That is, the stretch forming is performed on the elongate material 20 in two steps, similar to the first and second embodiments, by adjusting a moving direction of the gripping part 3 by the moving unit 4 to press the elongate material 20 against only the central portion of the forming surface 6, as shown by a solid line portion of the elongate material 20 in Fig. 6, or to press the elongate material 20 over the entire surface in the longitudinal direction of the forming surface 6, as shown by a two-dot chain line portion of the elongate material 20 in Fig. 6.

[0054] The moving units 4 move the gripping parts 3 to move the elongate material 20 gripped by the gripping parts 3 to the forming surface 6 side of the die 2 and press the elongate material 20 against the forming surface 6 of the die 2. Further, the moving units 4 move the gripping parts 3 to the outside in the longitudinal direction of the elongate material 20 to apply a tensile force to the elongate material 20 pressed against the forming surface 6 of the die 2.

[0055] In a first mode, the moving units 4 move the gripping parts 3 such that only the central portion of the forming surface 6 of the die 2 presses the elongate ma-

terial 20 while applying a tensile force to the elongate material 20 by moving the gripping parts 3. In a second mode, the moving units 4 move the gripping parts 3 such that the entire surface of the forming surface 6 of the die 2 presses the elongate material 20 while applying a tensile force to the elongate material 20 by the gripping parts 3. In the first mode, the length of the central portion of the forming surface 6, with which the elongate material 20 is brought into contact, is in a range of about 1/4 to 1/3 of the entire length of the forming surface 6.

[0056] By adjusting the moving direction of the gripping part 3 by the moving unit 4, switching between the first mode and the second mode is possible. The switching between the first mode and the second mode may be performed manually by a worker, or may be performed by a control device to shift from the first mode to the second mode when, by detection of the amount of deformation of the elongate material 20, it was confirmed that a predetermined amount of deformation was given.

[0057] In a stretch forming method using the stretch forming device 1 according to this embodiment, first, as shown by the solid line portion of the elongate material 20 in Fig. 6, the elongate material 20 gripped by the gripping parts 3 is moved such that only the central portion of the forming surface 6 of the die 2 presses the elongate material 20, and thus the elongate material 20 is pressed against the central portion of the forming surface 6 of the die 2. Further, the moving units 4 move the gripping parts 3 to the outside in the longitudinal direction of the elongate material 20, thereby applying a tensile force to the elongate material 20 pressed against the central portion of the forming surface 6 of the die 2 (the first mode). At this time, the elongate material 20 is prevented from coming into contact with the end portions other than the central portion of the forming surface 6 of the die 2.

[0058] In this way, the contact area between the elongate material 20 and the die 2 becomes smaller than the contact area when the elongate material 20 and the entire surface of the die 2 come into contact with each other, and therefore, when a tensile force is applied to the elongate material 20, a frictional force which acts on the vicinity of the central portion of the elongate material 20 is reduced, and thus the tensile force which is transmitted to the vicinity of the central portion increases. As a result, the amount of deformation which is generated in the vicinity of the central portion of the elongate material 20 increases.

[0059] Next, in a case where, based on the amount of movement in the tensile direction detected at the moving unit 4, it was confirmed that a predetermined amount of deformation was given, the movement of the moving unit 4 is stopped and the application of the tensile force to the elongate material 20 is stopped.

[0060] Thereafter, the moving units 4 are moved while the gripping parts 3 grip the elongate material 20, and thus the elongate material 20 is pressed against the entire surface of the forming surface 6 of the die 2, as shown by the two-dot chain line portion of the elongate material 20 in Fig. 6. Further, the moving units 4 move the gripping parts 3 to the outside in the longitudinal direction of the elongate material 20, thereby applying a tensile force to the elongate material 20 pressed against the entire surface of the forming surface 6 of the die 2 (the second mode). Next, in a case where, based on the amount of movement in the tensile direction detected at the moving unit 4, it was confirmed that a predetermined amount of deformation was given, the movement of the moving unit 4 is stopped and the application of the tensile force to the elongate material 20 is stopped. Then, the elongate material 20 gripped by the gripping parts 3 is moved, so that the elongate material 20 is separated from the forming surface 6.

[0061] In this way, the elongate material 20 is plastically deformed along the entire surface of the forming surface 6 of the die 2, so that a curved shape is given to the elongate material 20.

[0062] In the related art, from the time of the start of stretch forming, the elongate material 20 is pressed against the entire surface of the forming surface 6 of the die 2 to give a curved shape to the elongate material 20. However, in this embodiment, first, the elongate material 20 is pressed against only the central portion of the forming surface 6 of the die 2 having a small contact area, whereby a frictional force which acts on the vicinity of the central portion of the elongate material 20 is reduced, and thus the tensile force which is transmitted to the vicinity of the central portion is increased, thereby increasing the amount of deformation which is generated in the vicinity of the central portion of the elongate material 20. Then, the stretch forming is performed again on the elongate material 20 to which a large amount of deformation is given compared to the related art, by the entire surface of the forming surface 6 of the die 2.

[0063] The stretch forming is performed in two steps in this manner, whereby it is possible to reduce residual stress in the vicinity of the central portion of the elongate material 20. As a result, it is possible to reduce a shape change which occurs when etching or cutting work such as drilling is performed after the stretch forming, or variation for each material after cutting work. Further, since the existing die 2 can be utilized, it is not necessary to newly manufacture a die.

Reference Signs List

[0064]

1: stretch forming device
2: die
3: gripping part
4: moving unit
5: operation unit
6: forming surface
7: second die
8: second forming surface
10: divided die

11: moving unit
20: elongate material

Claims

1. A stretch forming device comprising:

a die; and
gripping parts which grip both end portions of a material to be formed having an elongated shape,
wherein a cross-sectional shape of the die has a curved shape in which a center side of a forming surface of the die bulges, and the forming surface is formed so as to give a curved shape to the material to be formed,
a second die having a second forming surface in which a length thereof along a longitudinal direction of the material to be formed is shorter than a length of the forming surface and which is along the forming surface is removably installed at a central portion of the forming surface, and
the stretch forming device has
a first mode in which, when the second die has been installed on the forming surface, only the second die presses the material to be formed while a tensile force is applied to the material to be formed by the gripping parts, and
a second mode in which, when the second die has been removed from the forming surface, the die presses the material to be formed while a tensile force is applied to the material to be formed by the gripping parts.

2. A stretch forming device comprising:

a die; and
gripping parts which grip both end portions of a material to be formed having an elongated shape,
wherein the die is divided into a plurality of pieces in a longitudinal direction of a material to be formed to have a plurality of divided dies which can be individually changed in position with respect to a side of the material to be formed, and
the stretch forming device has
a first mode in which, when the divided die installed at a central portion, among the plurality of divided dies, is disposed to protrude to the side of the material to be formed more than the divided dies installed at end portions, only the divided die disposed at the central portion presses the material to be formed while a tensile force is applied to the material to be formed by the gripping parts, and
a second mode in which, when the plurality of divided dies disposed at the central portion and the end portions are disposed so as to give a curved shape to the material to be formed, the plurality of divided dies disposed at the central portion and the end portions press the material to be formed while a tensile force is applied to the material to be formed by the gripping parts.

3. A stretch forming device comprising:

a die; and
gripping parts which grip both end portions of a material to be formed having an elongated shape,
wherein a cross-sectional shape of the die has a curved shape in which a center side of a forming surface of the die bulges, and the forming surface is formed so as to give a curved shape to the material to be formed, and
the stretch forming device has
a first mode in which only a central portion of the forming surface of the die presses the material to be formed while a tensile force is applied to the material to be formed by the gripping parts, and
a second mode in which an entire surface of the forming surface of the die presses the material to be formed while a tensile force is applied to the material to be formed by the gripping parts.

4. A stretch forming method using a stretch forming device,
the device including
a die, and
gripping parts which grip both end portions of a material to be formed having an elongated shape,
a cross-sectional shape of the die having a curved shape in which a center side of a forming surface of the die bulges, and the forming surface being formed so as to give a curved shape to the material to be formed,
the method comprising:

a step of installing a second die having a second forming surface in which a length thereof along a longitudinal direction of the material to be formed is shorter than a length of the forming surface and which is along the forming surface, at a central portion of the forming surface;
a step of causing, when the second die has been installed on the forming surface, only the second die to press the material to be formed while a tensile force is applied to the material to be formed by the gripping parts; and
a step of causing, when the second die has been removed from the forming surface, the die to press the material to be formed while a tensile force is applied to the material to be formed by

the gripping parts.

5. A stretch forming method using a stretch forming device,
the device including
a die, and
gripping parts which grip both end portions of a material to be formed having an elongated shape,
the die being divided into a plurality of pieces in a longitudinal direction of a material to be formed to have a plurality of divided dies which can be individually changed in position with respect to a side of the material to be formed,
the method comprising:

a step of disposing the divided die installed at a central portion, among the plurality of divided dies, so as to protrude to the side of the material to be formed more than the divided dies installed at end portions;
a step of causing only the divided die disposed at the central portion to press the material to be formed while a tensile force is applied to the material to be formed by the gripping parts; and
a step of causing, when the plurality of divided dies disposed at the central portion and the end portions are disposed so as to give a curved shape to the material to be formed, the plurality of divided dies disposed at the central portion and the end portions to press the material to be formed while a tensile force is applied to the material to be formed by the gripping parts.

6. A stretch forming method using a stretch forming device,
the device including
a die, and
gripping parts which grip both end portions of a material to be formed having an elongated shape,
a cross-sectional shape of the die having a curved shape in which a center side of a forming surface of the die bulges, and the forming surface being formed so as to give a curved shape to the material to be formed,
the method comprising:

a step of causing only a central portion of the forming surface of the die to press the material to be formed while a tensile force is applied to the material to be formed by the gripping parts; and
a step of causing an entire surface of the forming surface of the die to press the material to be formed while a tensile force is applied to the material to be formed by the gripping parts.

FIG. 1

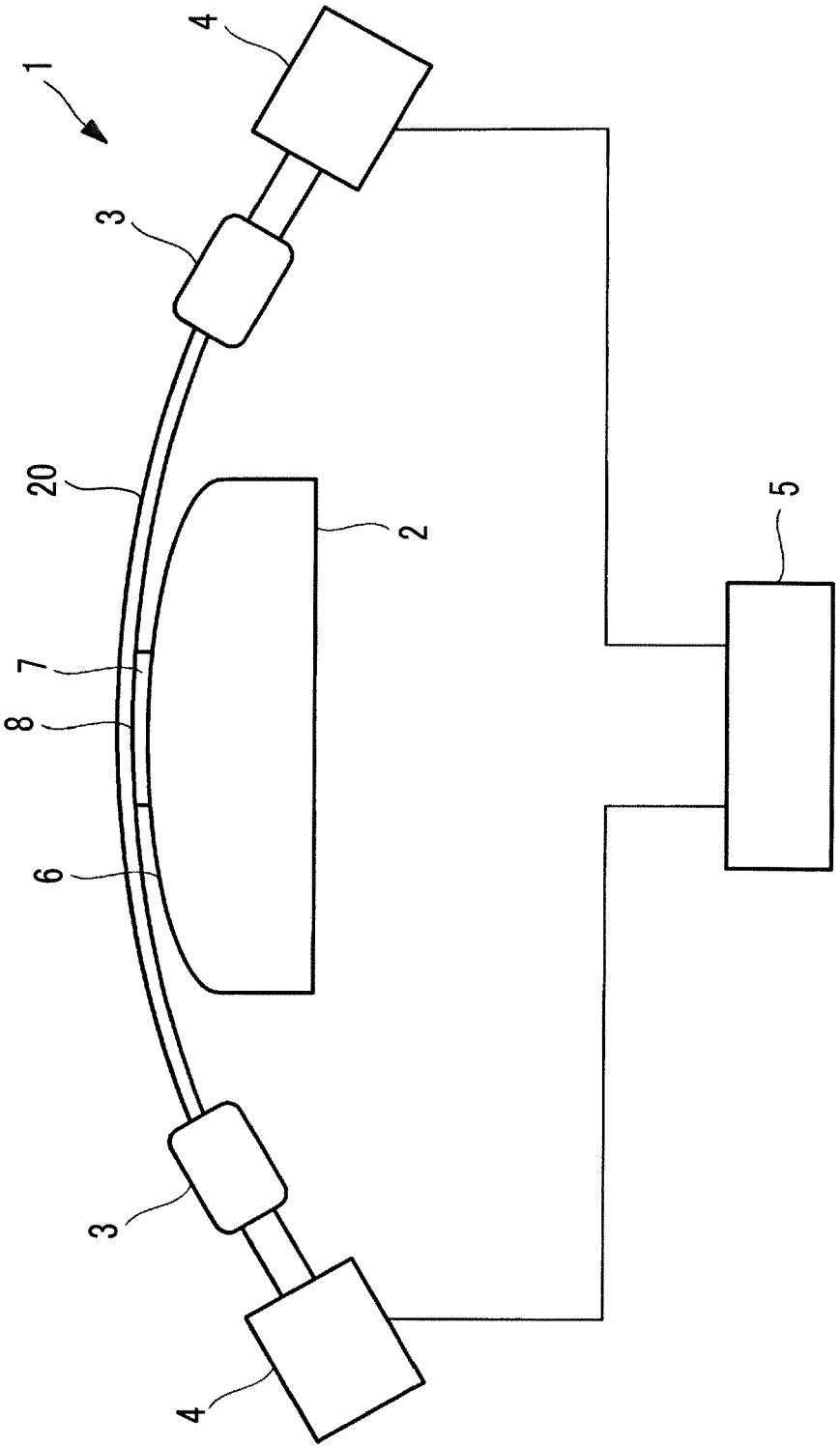


FIG. 2

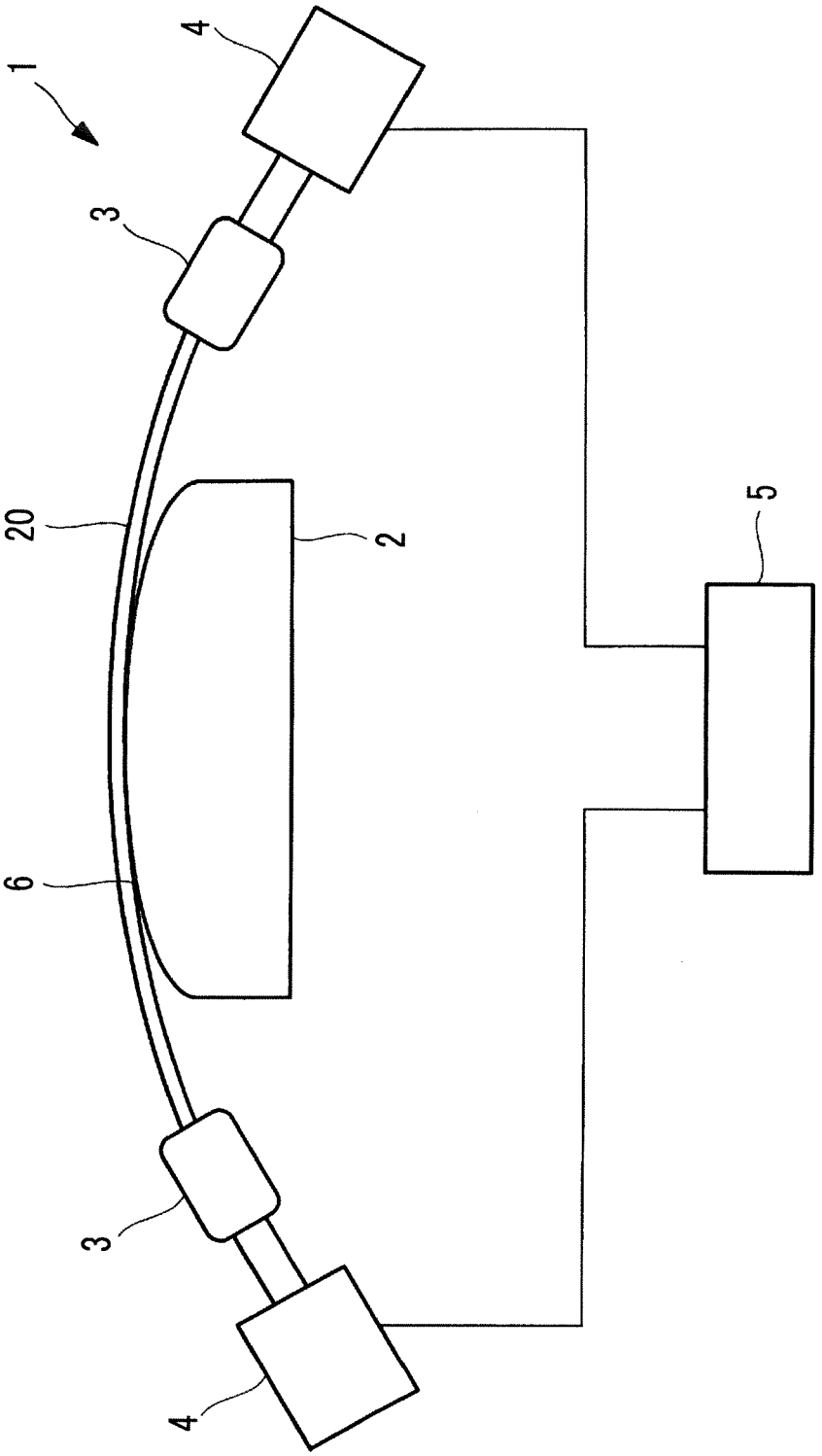


FIG. 3

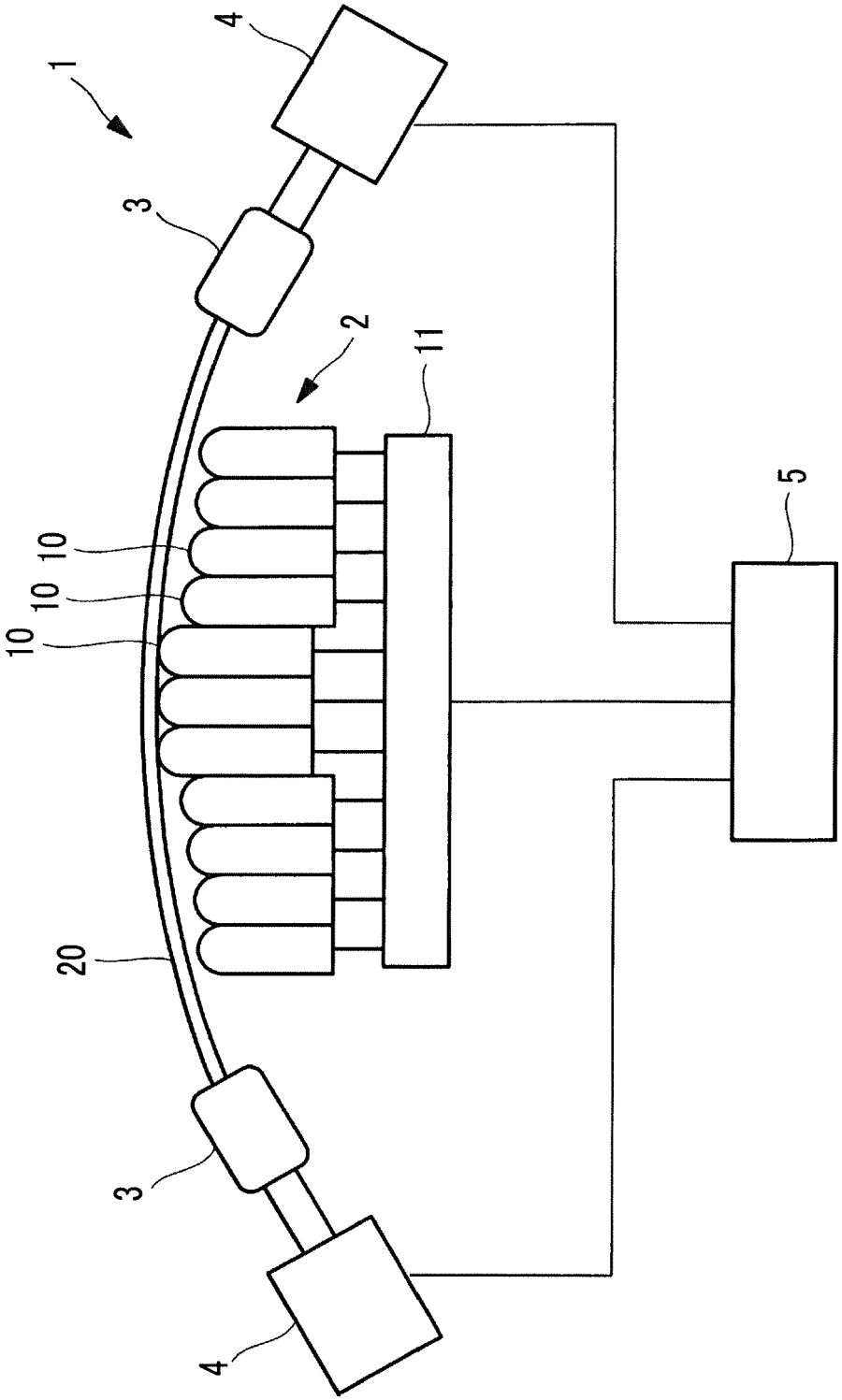


FIG. 4

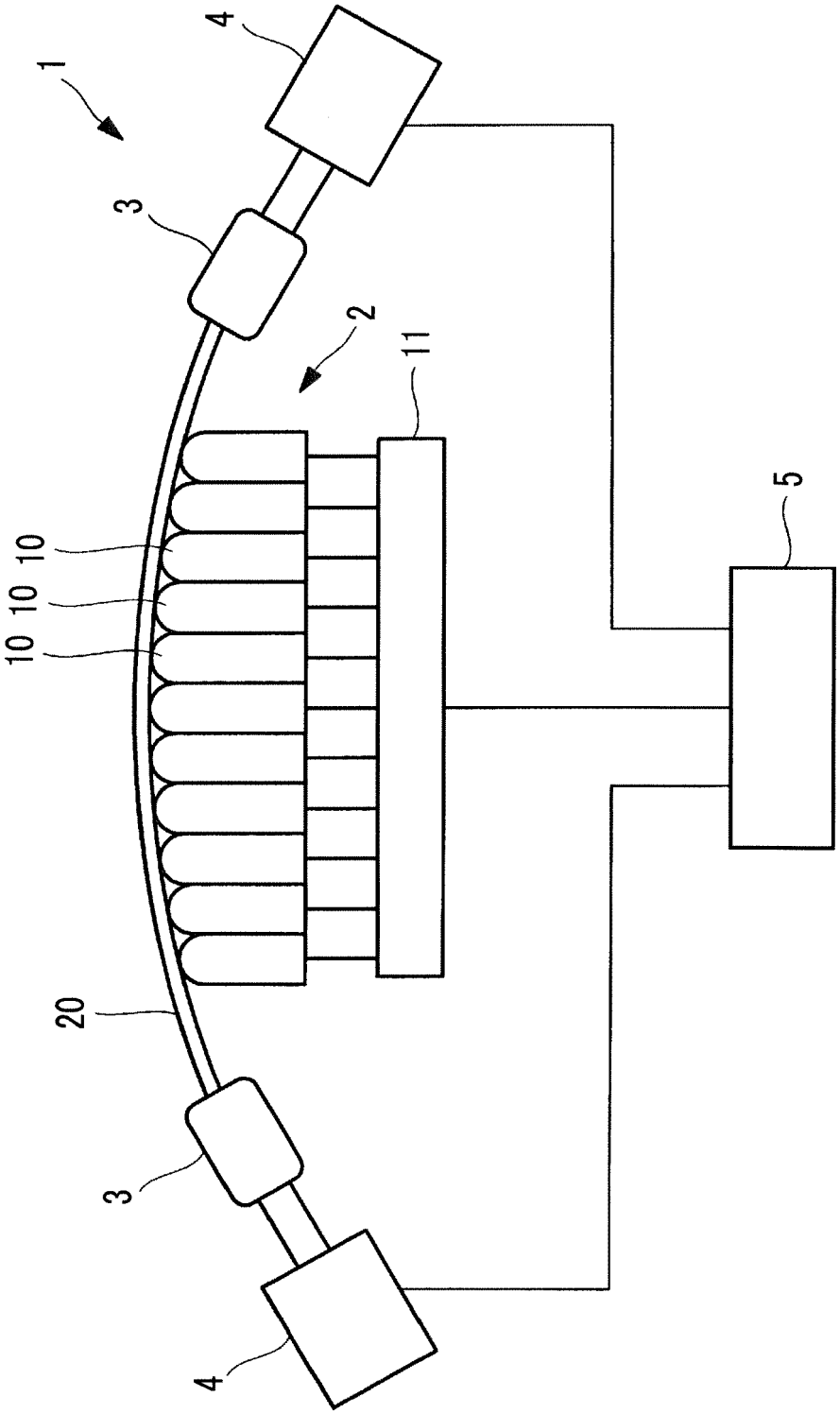


FIG. 5

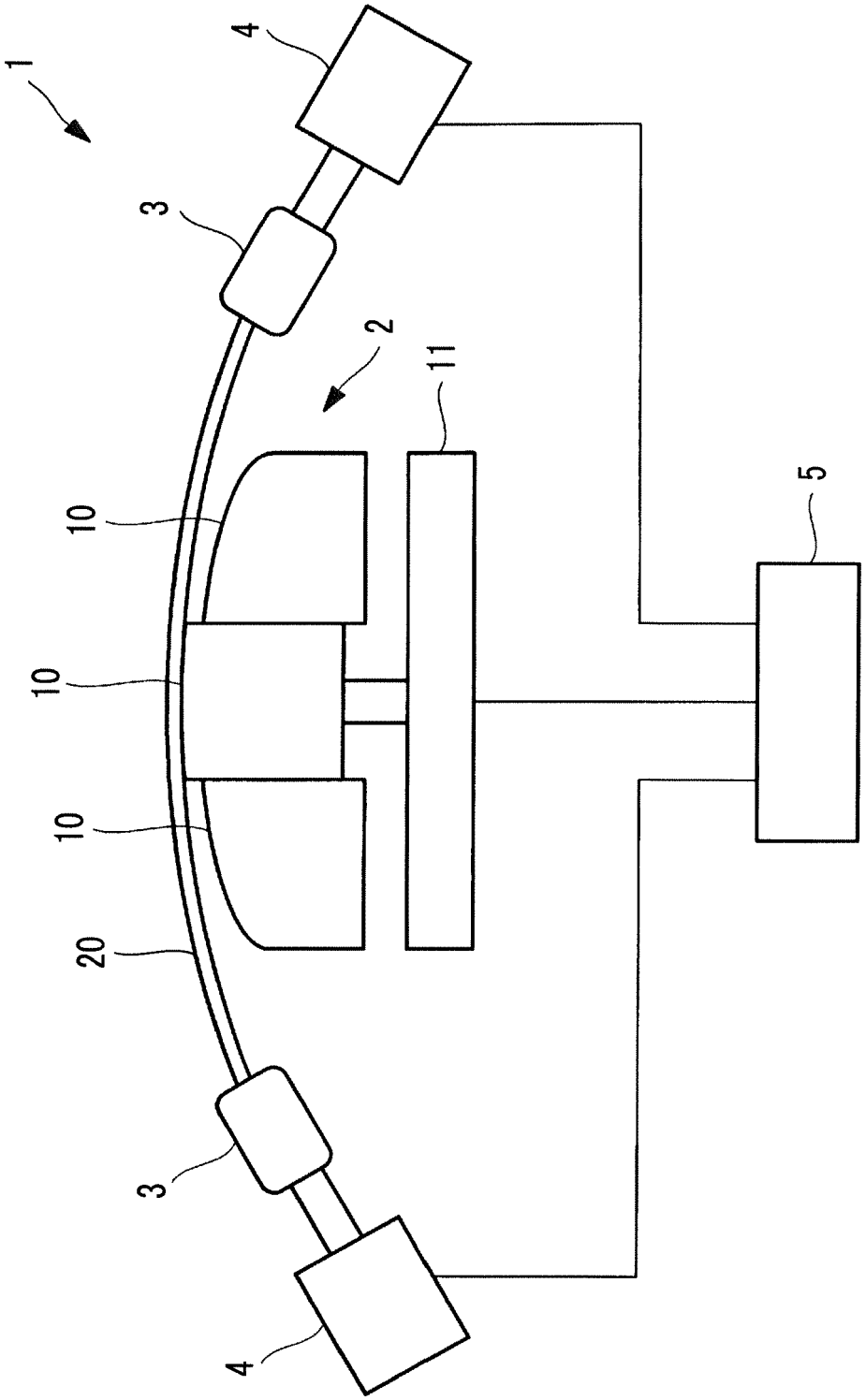
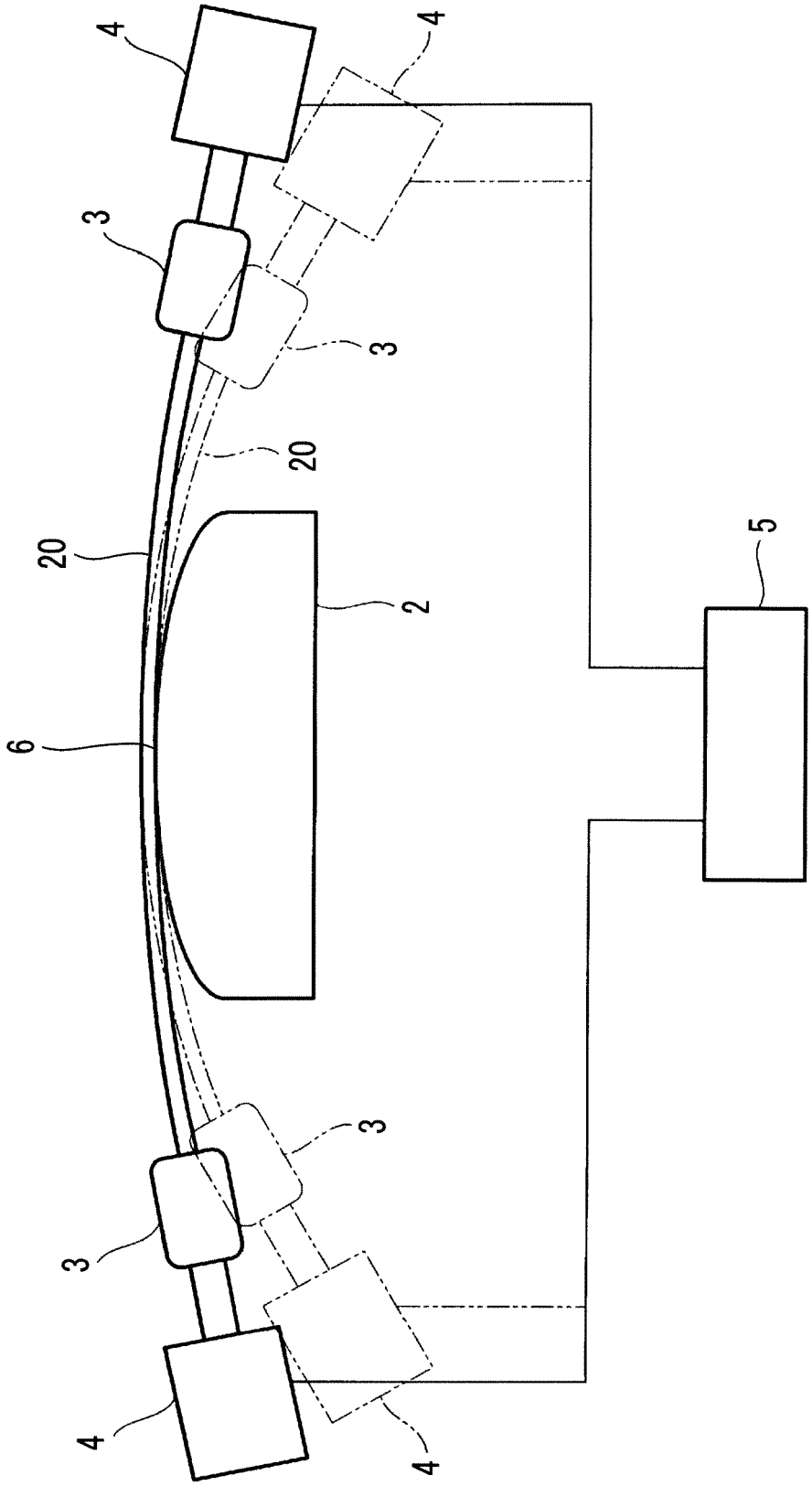


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/035357

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. B21D7/06(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)
Int. Cl. B21D7/06

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2017
Registered utility model specifications of Japan	1996-2017
Published registered utility model applications of Japan	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 Y	JP 2006-231380 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 07 September 2006, paragraphs [0019]-[0046], fig. 1-7 (Family: none)	2-3, 5-6 1, 4
Y A	JP 01-154821 A (MARU KIKAI KOGYO) 16 June 1989, page 2, upper left column, line 13 to page 4, lower right column, line 1, fig. 1-9 (Family: none)	1, 4 2-3, 5-6

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
14.11.2017	28.11.2017
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

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Patent documents cited in the description

- JP 2006231380 A **[0006]**