



## Description

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

**[0001]** The present invention relates to a clutch gear manufacturing apparatus and a clutch gear manufacturing method.

#### 2. Description of the Related Art

**[0002]** Conventionally, a clutch gear manufacturing apparatus has been suggested, which forms reverse tapers at spline teeth of a workpiece having straight spline teeth with chamfers.

**[0003]** In the apparatus, the position of the workpiece is aligned with a die to prevent an excessive force to act on the workpiece. Accordingly, the shapes of the reverse tapers can be accurately formed.

**[0004]** Meanwhile, a clutch gear used for a multi-cone synchronizer is necessary to have a cone hole which allows a claw portion of a middle cone to be engaged so as to synchronously rotate the middle cone, the middle cone being arranged between an inner cone and an outer cone. To secure the accuracy of the shapes of the reverse tapers, the cone hole is typically formed by machining after the reverse tapers are formed, or by forging or the like before the reverse tapers are formed (For example, see Japanese Examined Patent Application Publication No. 6-98451).

**[0005]** However, when the cone hole is formed by machining after the reverse tapers are formed, the number of manufacturing steps is increased, and hence, the manufacturing procedure may become troublesome. Also, when the cone hole is formed by forging or the like before the reverse tapers are formed, the cone hole may be deformed through the formation of the reverse tapers.

### SUMMARY OF THE INVENTION

**[0006]** Accordingly, it is an object of the present invention to provide a clutch gear manufacturing apparatus and a clutch gear manufacturing method capable of accurately manufacturing a clutch gear used for a multi-cone synchronizer while the number of manufacturing steps is reduced.

**[0007]** To attain the object, a clutch gear manufacturing apparatus and a clutch gear manufacturing method according to the present invention employ the following configurations.

**[0008]** A clutch gear manufacturing apparatus according to an aspect of the present invention manufactures a clutch gear used for a multi-cone synchronizer. The apparatus includes a die that allows a clutch gear primary product as an intermediate of the clutch gear, which has spline teeth with chamfers formed in an outer peripheral surface of the clutch gear primary product, to be disposed

in the die so that the chamfers face an upper side in a vertical direction, and includes a blade capable of forming reverse tapers at the spline teeth; a punch disposed in the die and being capable of pressing down the clutch gear primary product so that the spline teeth are pressed by the blade; a knockout sleeve that receives the clutch gear primary product which is pressed down by the punch; and a punch pin that forms a cone hole in a side surface of the clutch gear primary product while the spline teeth are pressed by the blade.

**[0009]** With the above-described reverse taper forming apparatus according to the aspect, the cone hole is formed when the clutch gear primary product is pressed down by the punch and the spline teeth are being pressed by the blade. Thus, the shapes of the reverse tapers can be prevented from being deformed through the formation of the cone hole. Accordingly, the step of forming the reverse tapers at the spline teeth and the step of forming the cone hole in the side surface of the clutch gear primary product can be performed by a single apparatus. As a result, the clutch gear used for the multi-cone synchronizer can be accurately manufactured while the number of manufacturing steps is reduced.

**[0010]** In the above-described clutch gear manufacturing apparatus, the punch may have a cylindrical shape with an outer diameter substantially equivalent to a tip diameter of the blade. Accordingly, positioning of the punch and the die can be directly performed. As a result, variation in dimensions can be reduced as compared with a case where positioning is performed in an additional step with a guide rod or the like. Thus, positioning can be further accurately performed.

**[0011]** Also in the above-described clutch gear manufacturing apparatus, the knockout sleeve may be configured to hold the clutch gear primary product between the knockout sleeve and the punch with a predetermined pressure when the knockout sleeve receives the clutch gear primary product. Accordingly, since the spline teeth can be reverse-tapered while the clutch gear primary product is held between the knockout sleeve and the punch, the clutch gear can be accurately manufactured. In addition, bulged portions or burr generated at the side surface of the clutch gear, for example, bulged portions generated near the roots of the spline teeth can be reliably crushed and eliminated.

**[0012]** Also in the above-described clutch gear manufacturing apparatus, the knockout sleeve may be configured to contact the clutch gear primary product and have a diameter substantially equivalent to the tip diameter of the reverse taper teeth of the die. Accordingly, the knockout sleeve can stably receive the clutch gear primary product, and hence, the clutch gear can be accurately manufactured. In addition, bulged portions or the like generated near the roots of the spline teeth can be reliably crushed and eliminated.

**[0013]** Also in the above-described clutch gear manufacturing apparatus, the knockout sleeve may be configured to receive the clutch gear primary product so that

the clutch gear primary product is pressed down while the clutch gear primary product is held between the knockout sleeve and the punch. Accordingly, the clutch gear primary product can be stably pressed down. As a result, the clutch gear can be accurately manufactured.

**[0014]** Also in the above-described clutch gear manufacturing apparatus, the knockout sleeve may have an insertion hole that allows the punch pin to be inserted. Accordingly, the cone hole can be formed by inserting the punch pin into the insertion hole. In addition, a waste after punching can be eliminated through the insertion hole.

**[0015]** Also in the above-described clutch gear manufacturing apparatus, the punch pin may be vertically movably arranged in the punch. Accordingly, the apparatus can become compact.

**[0016]** A clutch gear manufacturing method according to another aspect of the present invention manufactures a clutch gear used for a multi-cone synchronizer. The method includes the steps of (a) forming spline teeth with chamfers in an outer peripheral surface of a clutch gear primary product as an intermediate of the clutch gear; (b) disposing the clutch gear primary product in a die so that the chamfers face an upper side in a vertical direction, the die having a blade capable of forming reverse tapers at the spline teeth; (c) forming the reverse tapers by pressing the spline teeth by the blade while a punch pressed down the clutch gear primary product disposed in the die; and (d) forming a cone hole in a side surface of the clutch gear primary product by a punch pin while a knockout sleeve receives the clutch gear primary product in which the spline teeth are pressed by the blade.

**[0017]** With the above-described reverse taper forming method according to the aspect, the cone hole is formed by the punch pin when the clutch gear primary product is pressed down by the punch and the spline teeth are being pressed by the blade. Thus, the shapes of the reverse tapers can be prevented from being deformed through the formation of the cone hole. Accordingly, the step of forming the reverse tapers at the spline teeth and the step of forming the cone hole in the side surface of the clutch gear primary product can be performed by a single apparatus. As a result, the clutch gear used for the multi-cone synchronizer can be accurately manufactured while the number of manufacturing steps is reduced.

**[0018]** In the above-described clutch gear manufacturing method, the step (c) may be pressing down the clutch gear primary product by the punch which has a cylindrical shape with an outer diameter substantially equivalent to a tip diameter of the blade. Accordingly, positioning of the punch and the die can be directly performed. As a result, variation in dimensions can be reduced as compared with a case where positioning is performed in an additional step with a guide rod or the like. Thus, positioning can be further accurately performed.

**[0019]** Also in the above-described clutch gear manufacturing method, the step (c) may be pressing down the

clutch gear primary product while the clutch gear primary product is held between the knockout sleeve and the punch. Accordingly, the clutch gear primary product can be stably pressed down. As a result, the clutch gear can be accurately manufactured.

**[0020]** Also in the above-described clutch gear manufacturing method, the step (c) may be holding the clutch gear primary product between the knockout sleeve and the punch with a predetermined pressure when the knockout sleeve receives the clutch gear primary product. Accordingly, bulged portions or the like, which are generated near the roots of the spline teeth in the side surface of the clutch gear primary product though the formation of the spline teeth, can be crushed and eliminated.

**[0021]** Also in the above-described clutch gear manufacturing method, the step (d) may be receiving the clutch gear primary product by the knockout sleeve which has a diameter substantially equivalent to the tip diameter of the blade. Accordingly, the knockout sleeve can stably receive the clutch gear primary product. Also, bulged portions or the like, which are generated near the roots of the spline teeth can be reliably crushed and eliminated.

## BRIEF DESCRIPTION OF THE DRAWINGS

### [0022]

Fig. 1 is a front configuration diagram showing a clutch gear used for a multi-cone synchronizer;

Fig. 2 is a cross-sectional configuration diagram showing a ring-like clutch gear material before the clutch gear is formed;

Fig. 3A is a cross-sectional configuration diagram showing a clutch gear primary product in which straight spline teeth are formed in an outer periphery of the clutch gear by a clutch gear tooth manufacturing apparatus;

Fig. 3B is an enlarged side view showing a primary portion of the clutch gear primary product in Fig. 3A;

Fig. 4A is a cross-sectional configuration diagram showing a clutch gear in Fig. 1;

Fig. 4B is an enlarged side view showing a primary portion of the clutch gear in Fig. 4A;

Fig. 5 is a configuration diagram schematically showing the clutch gear tooth manufacturing apparatus, in which the right side of a center line shows a state where the clutch gear material is set, and the left side of the center line shows a state where the straight spline teeth are being formed at the material;

Fig. 6 is a configuration diagram schematically showing a reverse taper forming apparatus, in which the right side of a center line shows a state where the clutch gear primary product is set, and the left side of the center line shows a state where reverse tapers are being formed at the spline teeth of the clutch gear, and cone holes are being formed;

Fig. 7 is an enlarged arrangement configuration di-

agram showing a primary portion of the reverse taper forming apparatus in Fig. 6, which is a phase diagram showing a state where the clutch gear primary product is set in a die;

Fig. 8 is a phase diagram showing a state where a knockout sleeve is moved upward from the state in Fig. 7 and receives the clutch gear primary product; Fig. 9 is a phase diagram showing a state where the clutch gear primary product is pressed to reverse taper teeth of the die while a punch is pressed down from the state in Fig. 8;

Fig. 10 is a phase diagram showing a state where the punch presses down the clutch gear primary product and the knockout sleeve to form the reverse tapers at the spline teeth;

Fig. 11 is a phase diagram showing a state where punch pins are pressed down from the state in Fig. 10 to form the cone holes; and

Fig. 12 is a phase diagram showing a state where the reverse tapers are formed at the spline teeth, the cone holes are formed, and the punch and the punch pins are moved upward.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0023]** A preferred mode for implementing the present invention is described below according to an embodiment.

**[0024]** First, a clutch gear as a product used for a multi-cone synchronizer is described.

**[0025]** Fig. 1 is a front view showing a clutch gear W which is manufactured by a clutch gear tooth manufacturing apparatus 5 and a reverse taper forming apparatus 15.

**[0026]** The clutch gear W has a plurality of spline teeth 1 formed in an outer periphery of the clutch gear W at intervals. Each of the spline teeth 1 has an angle chamfer 1a at an end portion thereof.

**[0027]** Also, the clutch gear W has a tapered portion 2, which is formed at a side surface of the clutch gear W at a position near an inner peripheral surface 3. Four cone holes 4 penetrate through the clutch gear W at even intervals in an area between the tapered portion 2 in the side surface of the clutch gear W and the spline teeth 1.

**[0028]** The cone holes 4 allows claw portions of a middle cone to be engaged therewith so that the middle cone is synchronously rotated with the clutch gear W. The middle cone is arranged between an inner cone and an outer cone of the multi-cone synchronizer.

**[0029]** The clutch gear W used for the multi-cone synchronizer in Fig. 1 is made of a clutch gear material Wa shown in a cross section in Fig. 2. The material Wa is processed into a shape shown in a cross section in Fig. 3A and an enlarged side view in Fig. 3B for a primary portion, by a clutch gear tooth manufacturing apparatus 5 shown in a schematic illustration in Fig. 5, and then, is processed into a shape with reverse tapers 1b shown in a cross section in Fig. 4A and an enlarged side view in

Fig. 4B for a primary portion, by a reverse taper forming apparatus 15 shown in Fig. 6. The details of the clutch gear tooth manufacturing apparatus 5 and the reverse taper forming apparatus 15 will be described later.

**[0030]** The clutch gear material Wa in Fig. 2 is made of a hot-forged material and has a ring-like shape, and has the inner peripheral surface 3 formed at the center thereof.

**[0031]** The clutch gear material Wa in Fig. 2 is formed into a shape shown in Figs. 3A and 3B by the clutch gear tooth manufacturing apparatus 5 in Fig. 5, to manufacture a clutch gear primary product Wb.

**[0032]** In particular, the clutch gear primary product Wb is formed by the clutch gear tooth manufacturing apparatus 5 such that the spline teeth 1 with the angle chamfers 1a, and tooth spaces M are alternately formed in the outer periphery of the primary product Wb, and also the tapered portion 2 is formed.

**[0033]** As described above, the spline teeth 1 are formed by the clutch gear tooth manufacturing apparatus 5. The spline teeth 1 have straight sides S.

**[0034]** Fig. 5 is a schematic illustration briefly showing the clutch gear tooth manufacturing apparatus 5 that manufactures the clutch gear primary product Wb shown in Figs. 3A and 3B. In Fig. 5, the right side of a center line shows a state where the clutch gear material Wa is set, and the left side of the center line shows a state where the straight spline teeth are being formed at the material Wa.

**[0035]** The clutch gear tooth manufacturing apparatus 5 includes a die 6 that forms the spline teeth 1 at the clutch gear material Wa in the state in Fig. 2, a vertically movable knockout sleeve 7 that receives the material Wa, and a cylindrical tooth punch 8 that presses down the material Wa from the upper side.

**[0036]** The die 6 is disposed on an upper back-up plate 12. The upper back-up plate 12 is disposed on a middle back-up plate 11. The middle back-up plate 11 is disposed on a lower back-up plate 10. The lower back-up plate 10 is disposed on a lower plate 9.

**[0037]** The knockout sleeve 7 is attached perpendicularly at an inner peripheral side of the die 6, in a vertically movable manner in the lower plate 9, the lower back-up plate 10, the middle back-up plate 11, and the upper back-up plate 12.

**[0038]** The tooth punch 8 is perpendicularly attached to a pressure plate 13 which is substantially horizontally arranged in an upper portion, with a punch holder 14 interposed therebetween.

**[0039]** When the tooth punch 8 is moved downward, thereby pressing down the clutch gear material Wa set in the die 6, and the tooth punch 8 presses down the material Wa, the die 6 forms a step to define the tapered portion 2 and the spline teeth 1, and the angle chamfers 1a and the straight sides S are formed at the spline teeth 1.

**[0040]** Then, the knockout sleeve 7 is moved upward, and the clutch gear primary product Wb, which is formed

in the state in Figs. 3A and 3B, is removed from the die 6.

**[0041]** The removal of the clutch gear primary product Wb from the die 6 is performed such that the knockout sleeve 7 presses up the primary product Wb. At this time, a friction is generated between the tooth spaces M and the die 6. Surfaces of the tooth spaces M are plastically deformed, and hence, bulged portions D are generated. Since the primary product Wb is formed while tip portions of the angle chamfers 1a are directed toward the lower plate 9, or downward in Fig. 5, as shown in Figs. 3A and 3B, the bulged portions D are formed on the side surface near the chamfers 1a of the primary product Wb, at positions corresponding to the tooth spaces M, or at positions between the spline teeth 1, in a bulged manner. The size of the bulged portions D ranges from about 0.1 to 0.2 mm.

**[0042]** Next, the reverse taper forming apparatus 15 is described.

**[0043]** The reverse taper forming apparatus 15 sets the clutch gear primary product Wb formed into the shape in Figs. 3A and 3B, and forms reverse tapers 1b at the spline teeth 1 of the primary product Wb as shown in Figs. 4A and 4B.

**[0044]** Also, the reverse taper forming apparatus 15 forms the reverse tapers 1 at the spline teeth 1, and also forms the cone holes 4 which allows the claw portions of the middle cone to be engaged.

**[0045]** Referring to Fig. 6, the reverse taper forming apparatus 15 includes a ring-like die 16 capable of forming the reverse tapers 1b, a cylindrical knockout sleeve 17 arranged so as to be vertically movable downward from the inner peripheral side of the die 16, and a punch 18 vertically movably arranged in an upper portion.

**[0046]** The die 16 is fitted into a tool 27. The tool 27 is disposed on an upper back-up plate 22. The upper back-up plate 22 is disposed on a middle back-up plate 21. The middle back-up plate 21 is disposed on a lower back-up plate 20. The lower back-up plate 20 is disposed on a lower plate 19. The lower plate 19 is disposed on a pedestal 24.

**[0047]** A cylinder 25 is perpendicularly arranged at the inner peripheral side of the lower plate 19. The cylinder 25 allows the knockout sleeve 17 to be vertically moved.

**[0048]** Discharge chutes 26 are formed in the lower plate 19, the lower back-up plate 20, the middle back-up plate 21, and the upper back-up plate 22. The discharge chutes 26 are inclined downward from the knockout sleeve 17 toward the outer side.

**[0049]** Six gas cylinders 30 are provided in the upper portion perpendicularly from an upper base 29. Also, a pressure plate 23 vertically movably driven by the gas cylinders 30 is arranged. The punch 18 is attached on a lower surface of the pressure plate 23. When the pressure plate 23 is moved downward, the punch 18 presses down the clutch gear primary product Wb set in the die 16. The downward movement of the punch 18 is stopped when a stopper 28 contacts the tool 27.

**[0050]** In addition, four punch pins 31 are perpendic-

ularly arranged in the punch 18 in a vertically movable manner. The punch pins 31 form the four cone holes 4.

**[0051]** In Fig. 6, the right side of a center line shows a state where the punch 18 is moved upward, and the left side of the center line shows a state where the punch 18 and the punch pins 31 are moved downward. Fig. 7 shows a primary portion in an enlarged manner.

**[0052]** Referring to Fig. 7, the die 16 fitted in the tool 27 has a ring-like shape. A blade 16a for forming the reverse tapers 1b are provided at an inner periphery of the die 16.

**[0053]** The blade 16a is composed of protrusions 16b and inner peripheral grooves 16c. The protrusions 16b have trapezoidal shapes, each of which has a diameter increased from the upper side toward the lower side in Fig. 7. The inner peripheral grooves 16c have reverse-trapezoidal shapes, each of which defines a space between the adjacent protrusions 16b. The protrusions 16b and the inner peripheral grooves 16c are alternately entirely formed at an inner peripheral surface of the die 16.

**[0054]** Hence, to form the reverse tapers 1b at the spline teeth 1 of the clutch gear primary product Wb, the primary product Wb is set in the die 16 so that tip portions of the chamfers 1a face the upper side. A large diameter portion 16d is provided at an upper inner peripheral portion of the die 16. The large diameter portion 16d has a diameter increased toward the upper side so that the primary product Wb can be easily set in the die 16 for positioning.

**[0055]** The knockout sleeve 17 is vertically movably provided at a lower portion of the die 16. The knockout sleeve 17 can receive the clutch gear primary product Wb which is pressed down by the punch 18. The knockout sleeve 17 is driven by the cylinder 25 so that the primary product Wb can be held between the knockout sleeve 17 and the punch 18 with a predetermined pressure. Also, the knockout sleeve 17 has vertically formed insertion holes 17a which allow the punch pins 31 to be inserted. Inclined holes 17b are formed at lower ends of the insertion holes 17a. The insertion holes 17a communicate with the inclined holes 17b. The inclined holes 17b communicate with the discharge chutes 26.

**[0056]** The cylindrical punch 18 arranged at the upper portion has vertically formed pin holes 18a. Lower ends of the punch pins 31 are inserted to the pin holes 18a. The punch pins 31 are vertically movable in the punch 18.

**[0057]** An outer diameter a of the cylindrical punch 18, a tip diameter b of the blade 16a of the die 16, and an outer diameter c of the knockout sleeve 17 are substantially equivalent diameters.

**[0058]** Next, an operation of the reverse taper forming apparatus 15 is described.

**[0059]** Referring to Fig. 7, the clutch gear primary product Wb formed into the shape shown in Figs. 3A and 3B by the clutch gear tooth manufacturing apparatus 5 is set in the die 16 of the reverse taper forming apparatus 15 such that the chamfers 1a of the spline teeth 1 face the upper side. In particular, the straight spline teeth 1 of the

clutch gear primary product Wb are fitted to the inner peripheral grooves 16c formed at the inner periphery of the die 16, and thus, the primary product Wb is positioned and set in the die 16.

**[0060]** At this time, referring to Fig. 8, the knockout sleeve 17 is moved upward by the cylinder 25 to the position where the upper surface of the knockout sleeve 17 contacts the lower surface of the clutch gear primary product Wb. The primary product Wb is received by the knockout sleeve 17 before the primary product Wb is pressed down.

**[0061]** As described above, the clutch gear primary product Wb is pressed down by the punch 18 while the primary product Wb is received by the knockout sleeve 17. Accordingly, the primary product Wb can be stably pressed down. Also, since the tip diameter b of the blade 16a and the outer diameter c of the knockout sleeve 17 are the substantially equivalent diameters, the knockout sleeve 17 can stably receive and press down the primary product Wb can be stably received.

**[0062]** When the gas cylinders 30 are driven in this state, as shown in Fig. 9, the punch 18 is pressed down and thus contacts the upper surface of the clutch gear primary product Wb. Accordingly, the primary product Wb is held between the punch 18 and the knockout sleeve 17 with a predetermined pressure. In the reverse taper forming apparatus 15 of this embodiment, since the outer diameter a of the punch 18 and the tip diameter b of the blade 16a are the substantially equivalent diameters, positioning (centering) of the punch 18 and the die 16 can be directly performed when the punch 18 is pressed down. As a result, variation in dimensions can be reduced as compared with a case where positioning is performed in an additional step with a guide rod or the like. Thus, positioning can be accurately performed. In this embodiment, the predetermined pressure is equal to or larger than a value that causes the bulged portions D, burr, or the like, generated at the side surface of the primary product Wb to be crushed.

**[0063]** Then, referring to Fig. 10, the punch 18 is pressed down until the stopper 28 contacts the tool 27 while the above-described state is kept. The straight spline teeth 1 of the clutch gear primary product Wb are pressed by the blade 16a of the die 16, and hence, the reverse tapers 1b are formed at the spline teeth 1.

**[0064]** As described above, the clutch gear primary product Wb is held between the punch 18 and the knockout sleeve 17 by the predetermined pressure, and while this state is kept, the primary product Wb is pressed down. Accordingly, the bulged portions D formed in a bulged manner between the spline teeth 1 of the primary product Wb can be crushed and eliminated. Also, since the outer diameter a of the punch 18, the tip diameter b of the blade 16a, and the outer diameter c of the knockout sleeve 17 are the substantially equivalent diameters, the bulged portions D can be reliably crushed.

**[0065]** Then, referring to Fig. 11, while the spline teeth 1 of the clutch gear primary product Wb are pressed by

the blade 16a of the die 16, and while the primary product Wb is held between the punch 18 and the knockout sleeve 17 with the predetermined pressure, the punch pins 31 are pressed down, to form the cone holes 4 in the primary product Wb. As described above, since the cone holes 4 are formed by the punch pins 31 while the spline teeth 1 of the primary product Wb are pressed by the blade 16a of the die 16, and while the primary product Wb is held between the punch 18 and the knockout sleeve 17 with the predetermined pressure, the shapes of the reverse tapers 1b can be prevented from being deformed through the formation of the cone holes 4.

**[0066]** Wastes P, which are portions corresponding to the cone holes 4, fall in the insertion holes 17a of the knockout sleeve 17, and are discharged to the outside through the inclined holes 17b and the discharge chutes 26.

**[0067]** Then, referring to Fig. 12, the punch pins 31 and the punch 18 are moved upward, and the knockout sleeve 17 is moved upward, the clutch gear W as a product with the reverse tapers 1b and the cone holes 4 formed is removed from the die 16.

**[0068]** With the above-described reverse taper forming apparatus 15 according to the embodiment, the cone holes 4 can be formed by the punch pins 31 when the clutch gear primary product Wb is pressed down by the punch 18 and the spline teeth 1 are being pressed by the blade 16a of the die 16. Thus, the shapes of the reverse tapers 1b can be prevented from being deformed through the formation of the cone holes 4. Accordingly, the step of forming the reverse tapers 1b at the spline teeth 1 and the step of forming the cone holes 4 in the side surface of the clutch gear can be performed by a single apparatus. The clutch gear W used for the multi-cone synchronizer can be accurately manufactured while the number of manufacturing steps is reduced.

**[0069]** In addition, since the punch 18 has the cylindrical shape with the outer diameter a substantially equivalent to the tip diameter of the blade 16a, positioning of the punch 18 and the die 16 can be directly performed. Accordingly, variation in dimensions can be reduced as compared with a case where positioning is performed in an additional step with a guide rod or the like. Thus, positioning can be accurately performed.

**[0070]** In addition, when the knockout sleeve 17 receives the clutch gear primary product Wb, the knockout sleeve 17 holds the primary product Wb between the knockout sleeve 17 and the punch 18 with the predetermined pressure. Accordingly, the bulged portions D generated near the roots of the spline teeth 1 at the side surface of the primary product Wb can be reliably crushed and eliminated.

**[0071]** In addition, since the outer diameter c of the knockout sleeve 17 and the tip diameter b of the blade 16a of the die 16 are the substantially equivalent diameters, the knockout sleeve 17 can reliably receive the clutch gear primary product Wb. Also, the bulged portions D can be reliably crushed.

**[0072]** In addition, since the clutch gear primary product Wb is pressed down while being held between the punch 18 and the knockout sleeve 17, the primary product Wb can be stably pressed down. Accordingly, the clutch gear W can be accurately manufactured.

**[0073]** In addition, the punch pins 31 are inserted to the insertion holes 17a of the knockout sleeve 17, to form the cone holes 4. The wastes P after punching with the punch pins 31 can be properly discharged through the insertion holes 17a.

**[0074]** Further, in the reverse taper forming apparatus 15 of the embodiment, since the punch pins 31 are vertically movably arranged in the punch 18, the entire apparatus can become compact.

**[0075]** In the reverse taper forming apparatus 15 of the embodiment, although the clutch gear primary product Wb is pressed down by the punch 18 while being held between the punch 18 and the knockout sleeve 17 with the predetermined pressure, it is not limited thereto. When the punch 18 presses down the primary product Wb, the holding state with the predetermined pressure does not have to be kept. For example, the primary product Wb may be held between the punch 18 and the knockout sleeve 17 with a predetermined pressure only when the punch 18 contacts the upper surface of the primary product Wb, and thereafter, the punch 18 may freely press down the primary product Wb until the stopper 28 contacts the tool 27. Alternatively, the punch 18 may freely press down the primary product Wb from when the punch 18 contacts the upper surface of the primary product Wb to when the stopper 28 contacts the tool 27. Then, when the stopper 28 contacts the tool 27, the primary product Wb may be held between the punch 18 and the knockout sleeve 17 with a predetermined pressure.

**[0076]** In the reverse taper forming apparatus 15 of the embodiment, although the downward movement of the punch 18 is stopped when the stopper 28 provided on the lower surface of the pressure plate 23 contacts the tool 27, it is not limited thereto. The downward movement of the punch 18 may be stopped by the knockout sleeve 17. In this case, the downward movement of the punch 18 may be stopped when the knockout sleeve 17 reaches a bottom dead center. Alternatively, the downward movement of the punch 18 may be stopped by applying a pressure to the knockout sleeve 17 to balance with the punch 18.

**[0077]** While the present invention has been described with reference to the exemplary embodiment, the invention is not limited to the disclosed exemplary embodiment. It is to be understood that the present invention may be implemented with any modification within the scope of the present invention.

## Claims

1. A clutch gear manufacturing apparatus for manufacturing a clutch gear (W) used for a multi-cone syn-

chronizer, the apparatus comprising:

a die (16) that allows a clutch gear primary product (Wb) as an intermediate of the clutch gear (W), which has spline teeth (1) with chamfers (1a) formed in an outer peripheral surface of the clutch gear primary product (Wb), to be disposed in the die (16) so that the chamfers (1a) face an upper side in a vertical direction, and includes a blade (16a) capable of forming reverse tapers (1b) at the spline teeth (1);  
 a punch (18) disposed in the die (16) and being capable of pressing down the clutch gear primary product (Wb) so that the spline teeth (1) are pressed by the blade (16a);  
 a knockout sleeve (17) that receives the clutch gear primary product (Wb) which is pressed down by the punch (18); and  
 a punch pin (31) that forms a cone hole (4) in a side surface of the clutch gear primary product (Wb) while the spline teeth (1) are pressed by the blade(16a).

2. The clutch gear manufacturing apparatus according to Claim 1, wherein the punch (18) has a cylindrical shape with an outer diameter substantially equivalent to a tip diameter of the blade (16a).
3. The clutch gear manufacturing apparatus according to Claim 1 or 2, wherein the knockout sleeve (17) is configured to hold the clutch gear primary product (Wb) between the knockout sleeve (17) and the punch (18) with a predetermined pressure when the knockout sleeve (17) receives the clutch gear primary product (Wb).
4. The clutch gear manufacturing apparatus according to any of Claims 1 to 3, wherein the knockout sleeve (17) is configured to contact the clutch gear primary product (Wb) and has a diameter substantially equivalent to the tip diameter of the blade (16a).
5. The clutch gear manufacturing apparatus according to any of Claims 1 to 4, wherein the knockout sleeve (17) is configured to receive the clutch gear primary product (Wb) so that the clutch gear primary product (Wb) is pressed down while the clutch gear primary product (Wb) is held between the knockout sleeve (17) and the punch (18).
6. The clutch gear manufacturing apparatus according to any of Claims 1 to 5, wherein the knockout sleeve (17) has an insertion hole (17a) that allows the punch pin (31) to be inserted.
7. The clutch gear manufacturing apparatus according to any of Claims 1 to 6, wherein the punch pin (31) is vertically movably arranged in the punch (18).

8. A clutch gear manufacturing method for manufacturing a clutch gear (W) used for a multi-cone synchronizer, the method comprising the steps of:
- (a) forming spline teeth with chamfers (1a) in an outer peripheral surface of a clutch gear primary product (Wb) as an intermediate of the clutch gear (W); 5
  - (b) disposing the clutch gear primary product (Wb) in a die (16) so that the chamfers (1a) face an upper side in a vertical direction, the die (16) having a blade (16a) capable of forming reverse tapers (1b) at the spline teeth (1); 10
  - (c) forming the reverse tapers (1b) by pressing the spline teeth (1) by the blade (16a) while a punch (18) presses down the clutch gear primary product (Wb) disposed in the die (16); and 15
  - (d) forming a cone hole (4) in a side surface of the clutch gear primary product (Wb) by a punch pin (31) while a knockout sleeve (17) receives the clutch gear primary product (Wb) in which the spline teeth (1) are pressed by the blade (16a). 20
9. The clutch gear manufacturing method according to Claim 8, wherein the step (c) is pressing down the clutch gear primary product (Wb) by the punch (18) which has a cylindrical shape with an outer diameter substantially equivalent to a tip diameter of the blade (16a). 25 30
10. The clutch gear manufacturing method according to Claim 8 or 9, wherein the step (c) is pressing down the clutch gear primary product (Wb) while the clutch gear primary product (Wb) is held between the knockout sleeve (17) and the punch (18). 35
11. The clutch gear manufacturing method according to Claim 10, wherein the step (c) is holding the clutch gear primary product (Wb) between the knockout sleeve (17) and the punch (18) with a predetermined pressure when the knockout sleeve (17) receives the clutch gear primary product (Wb). 40
12. The clutch gear manufacturing method according to Claim 11, wherein the step (d) is receiving the clutch gear primary product (Wb) by the knockout sleeve (17) which has a diameter substantially equivalent to the tip diameter of the blade (16a). 45 50

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FIG. 1

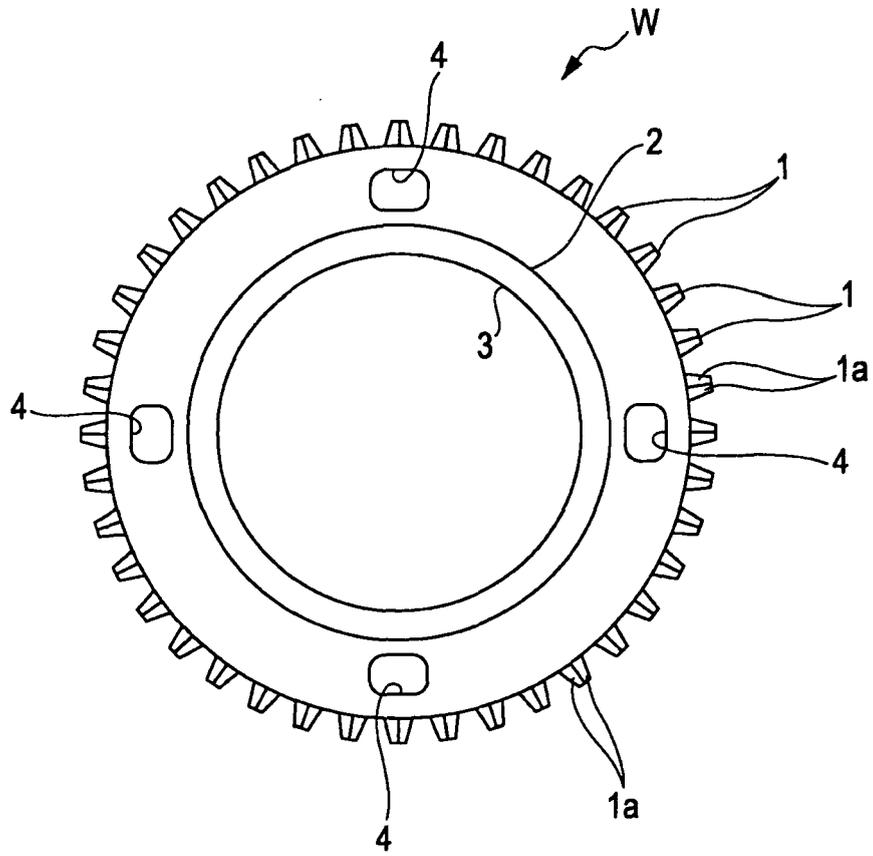


FIG. 2

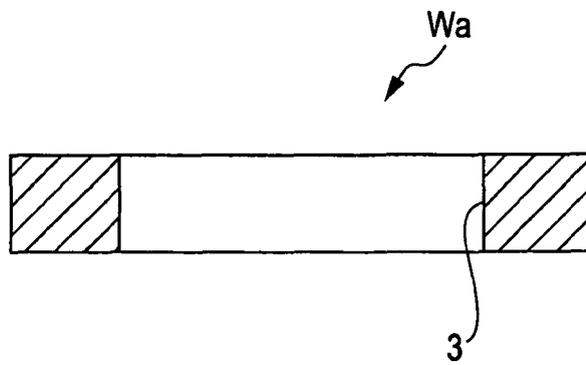


FIG. 3A

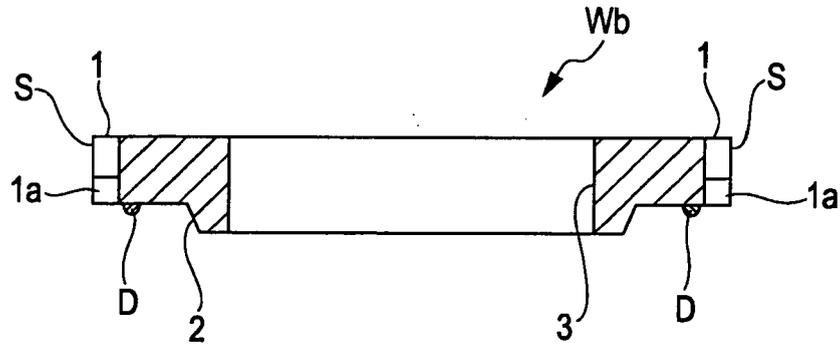


FIG. 3B

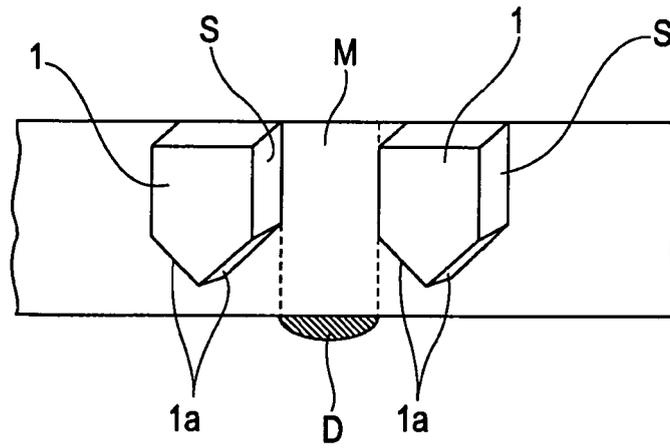


FIG. 4A

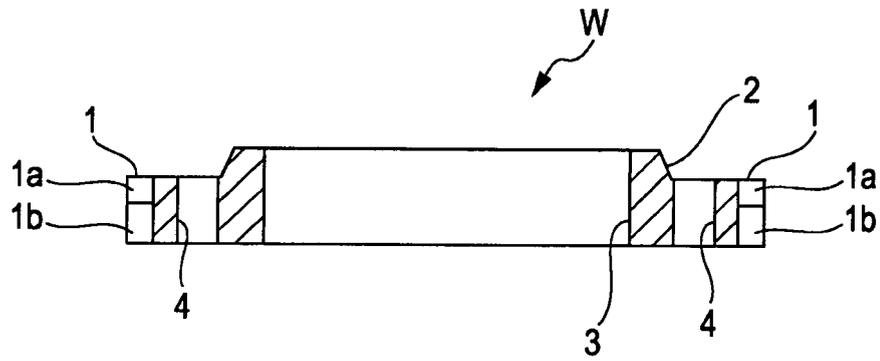


FIG. 4B

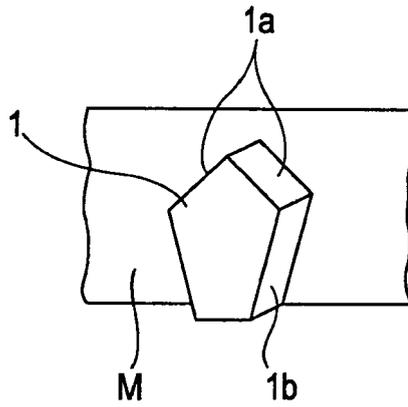


FIG. 5

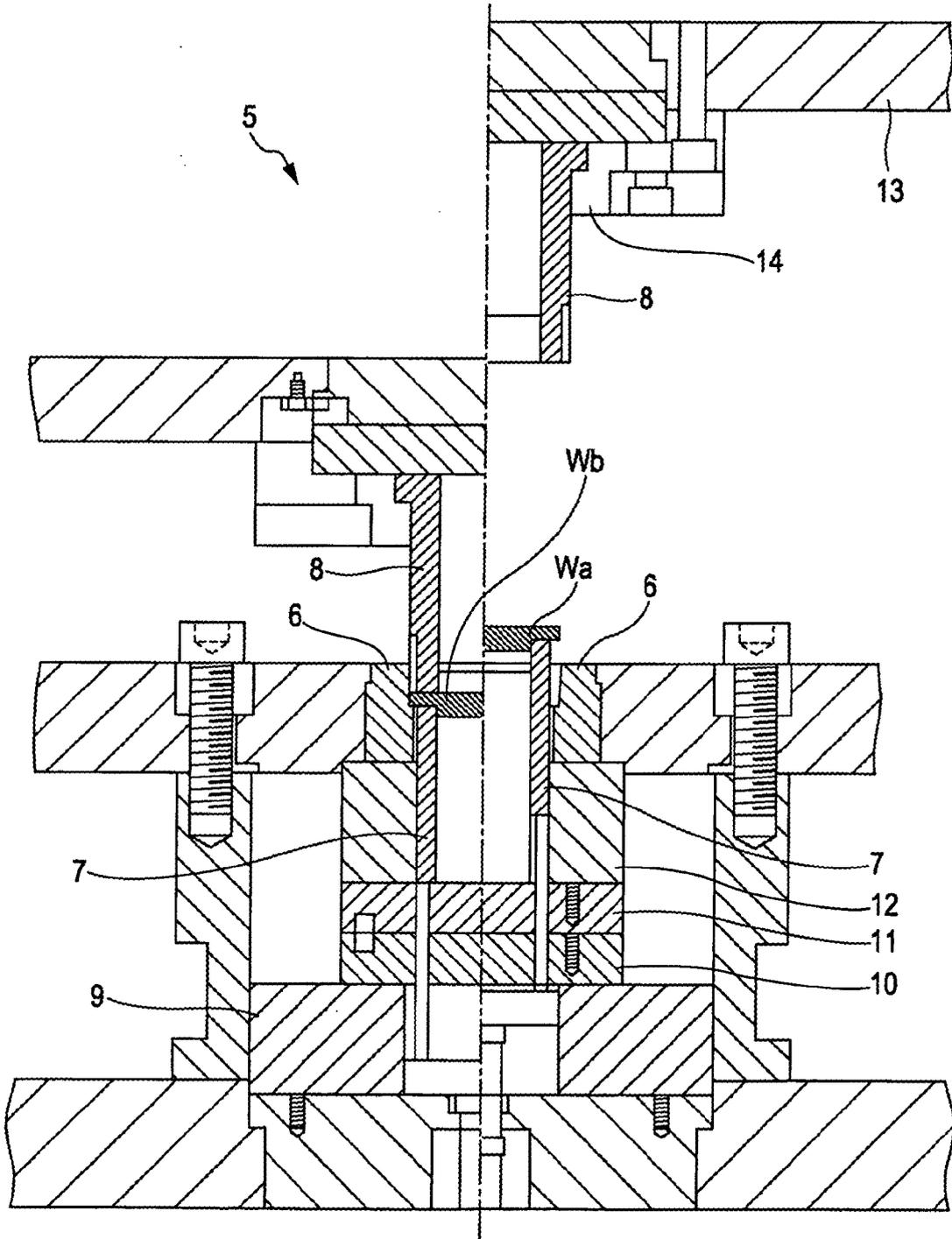


FIG. 6

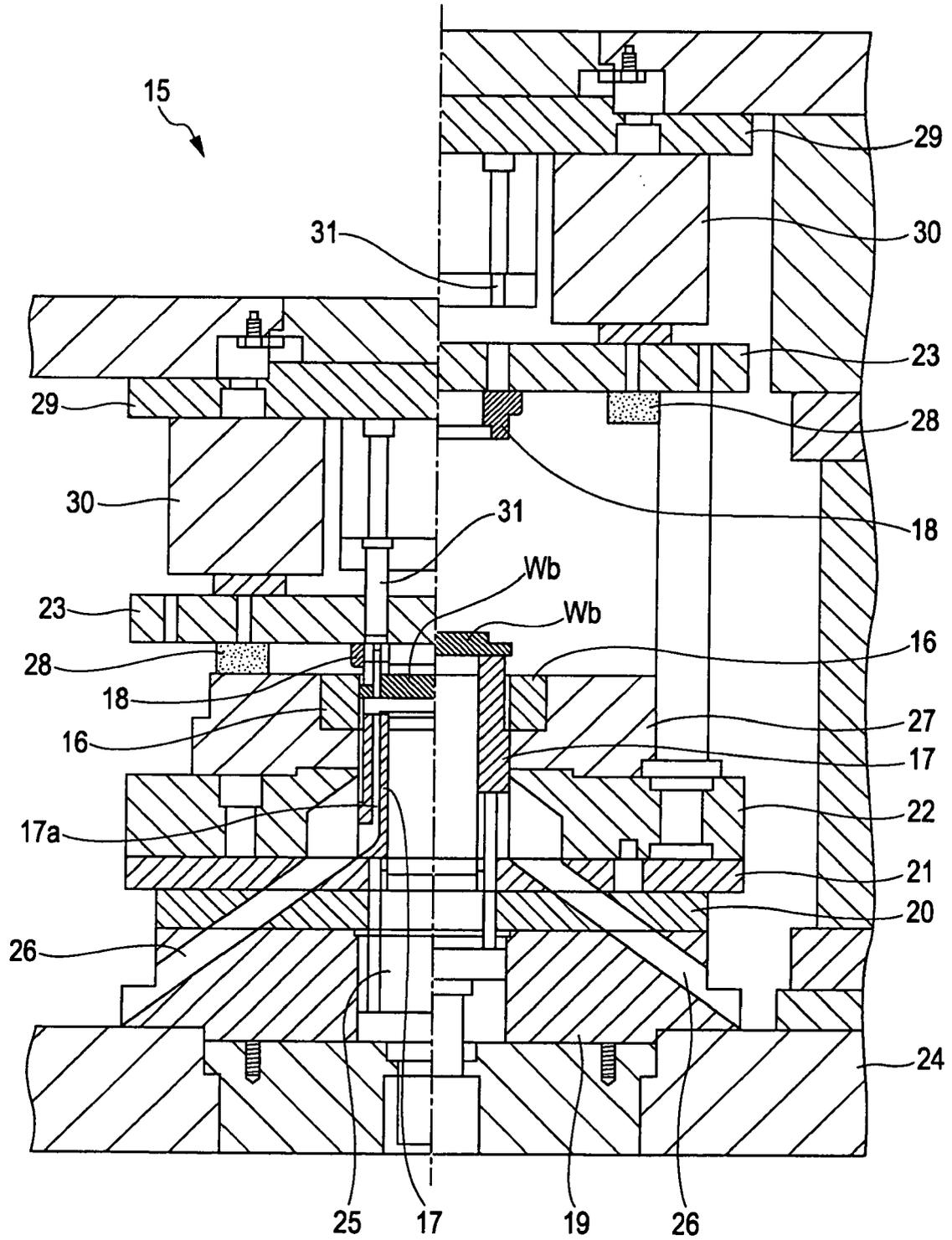


FIG. 7

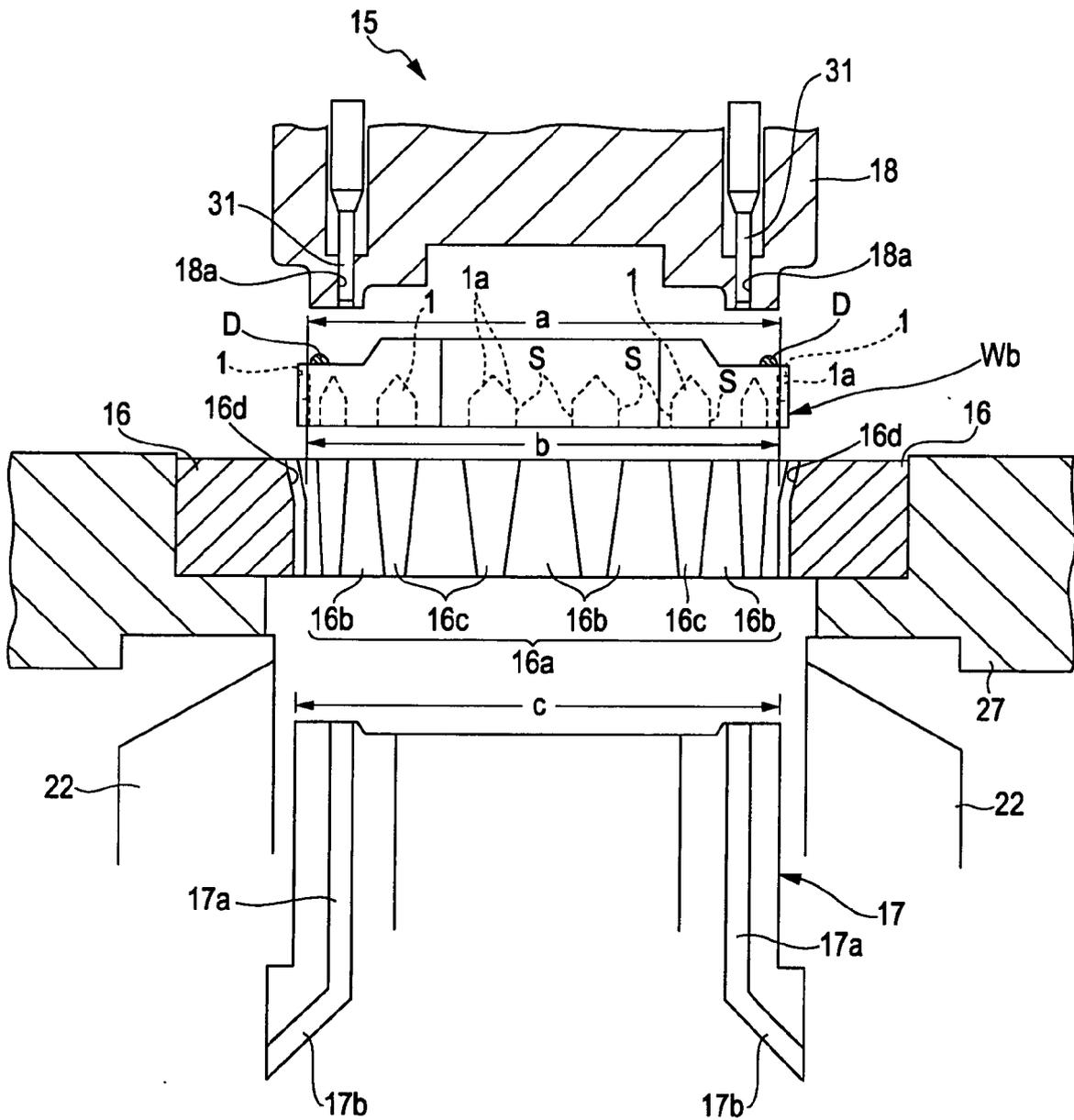


FIG. 8

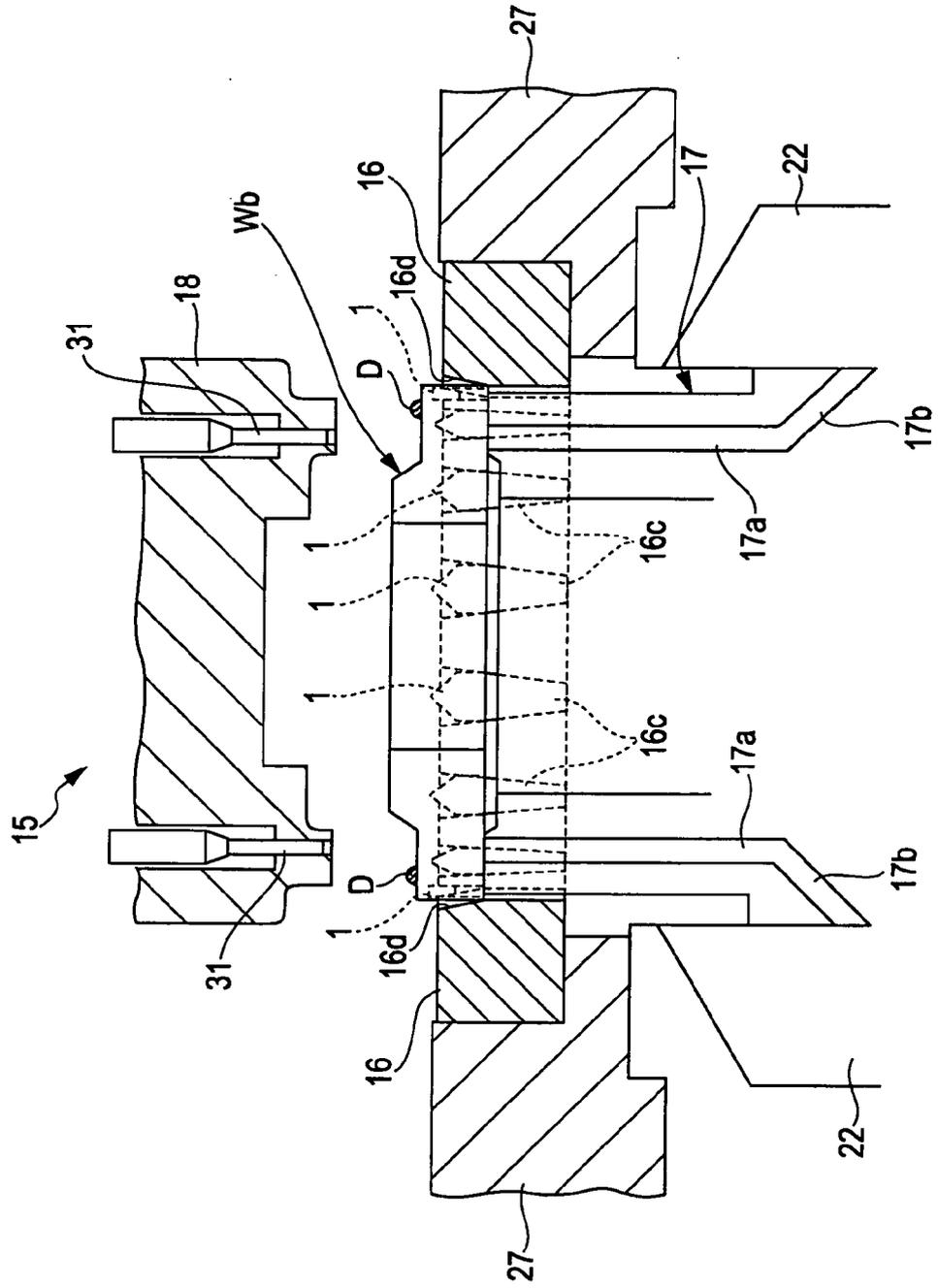


FIG. 9

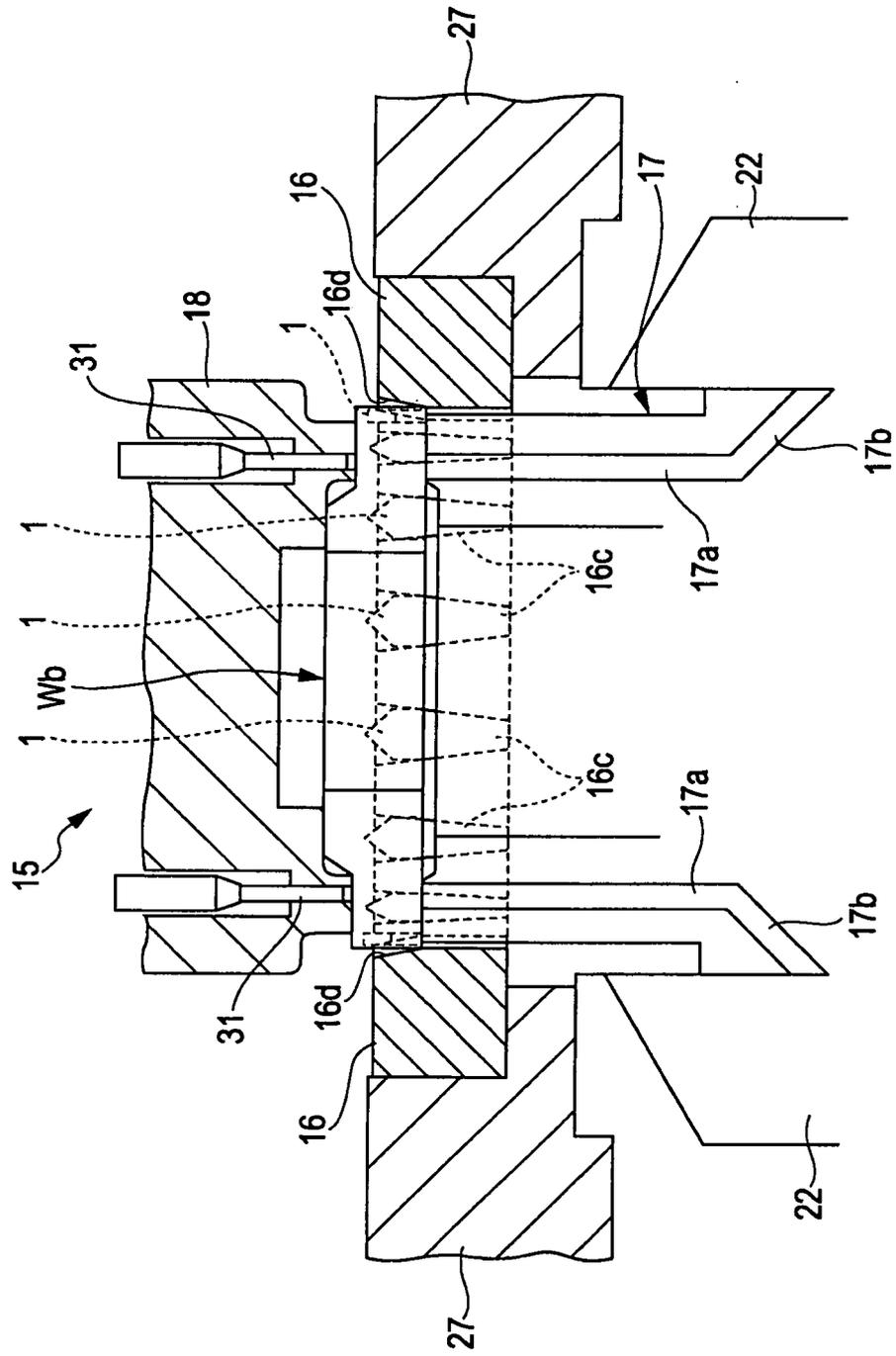


FIG. 10

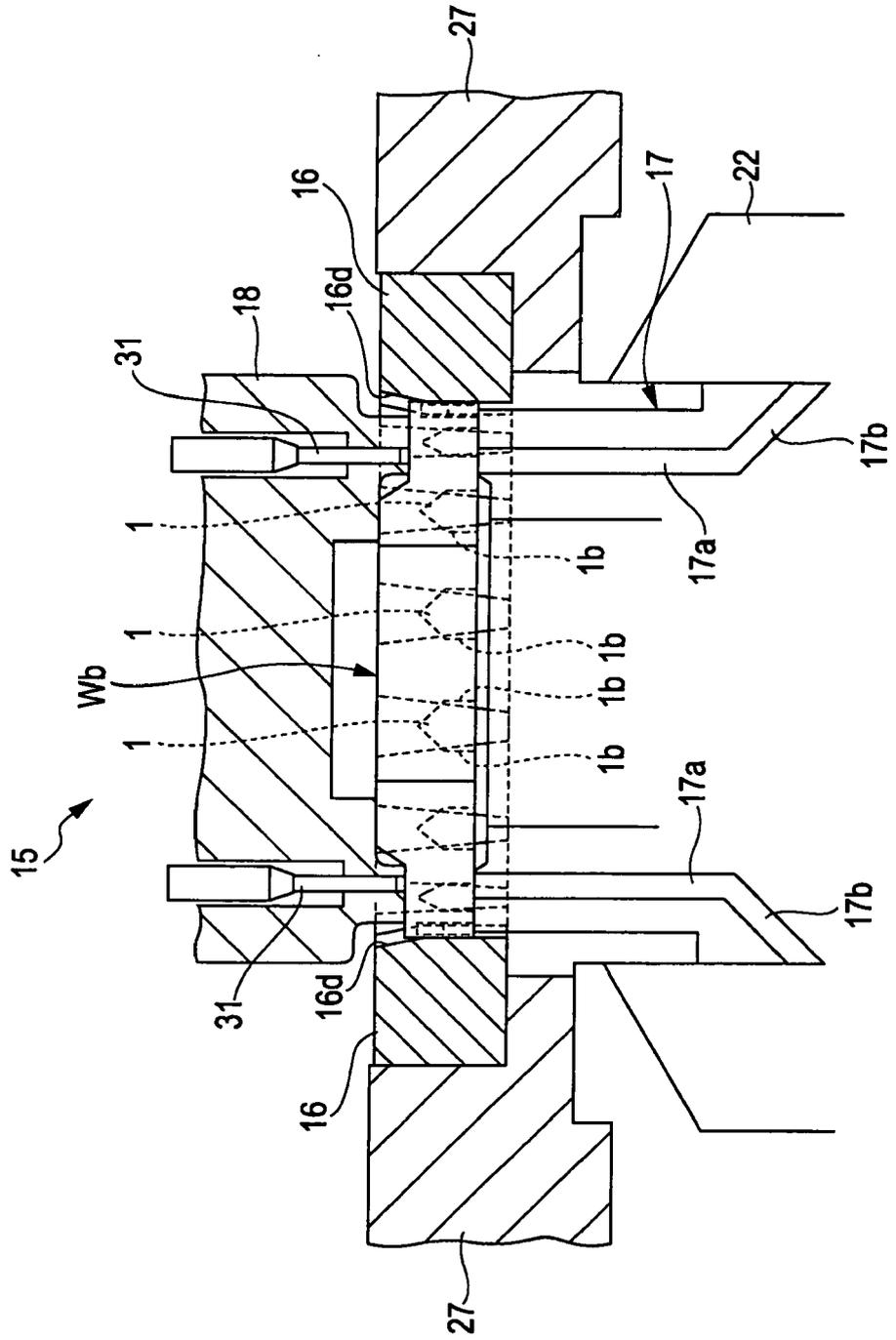
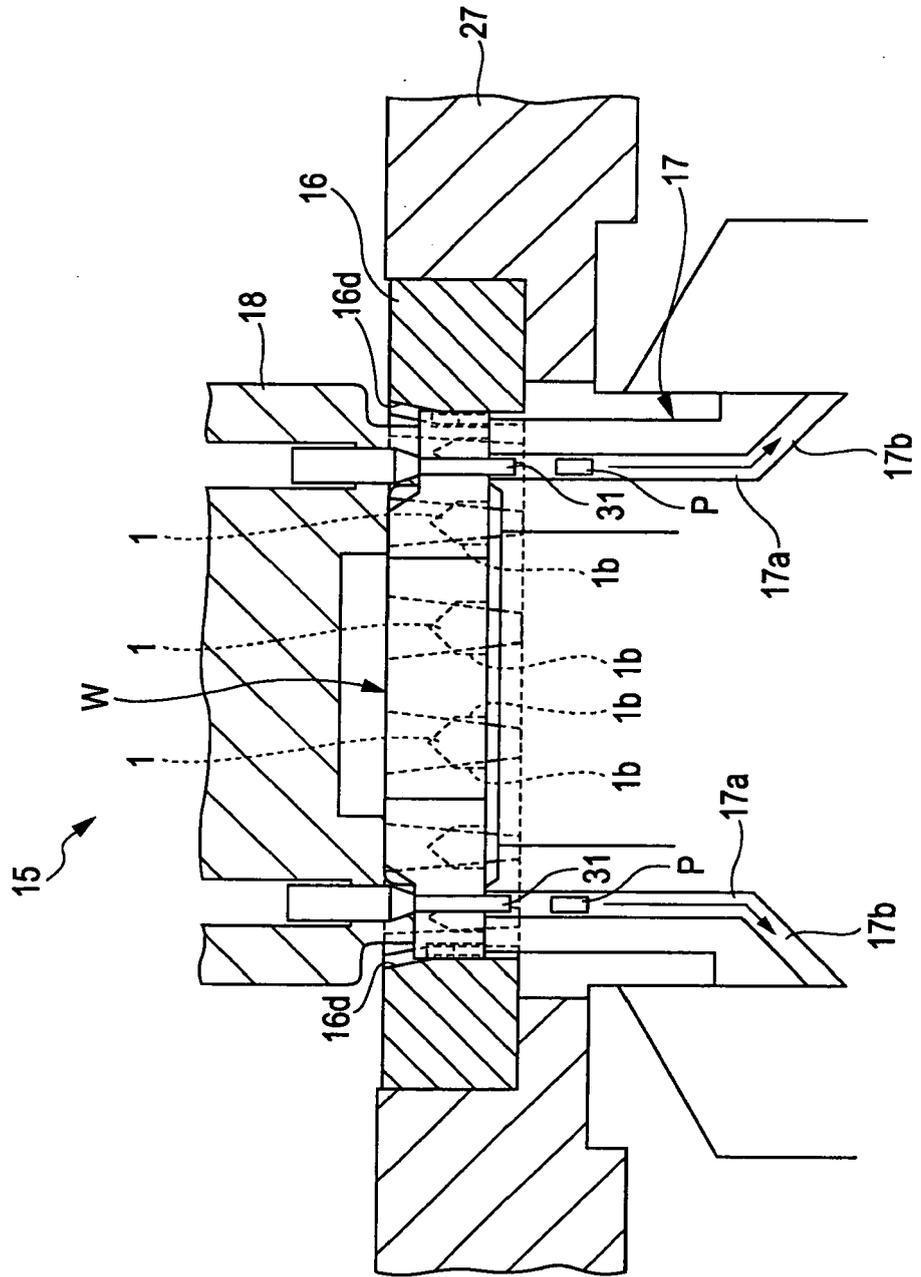


FIG. 11







EUROPEAN SEARCH REPORT

Application Number  
EP 08 01 4089

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			TECHNICAL FIELDS SEARCHED (IPC)
			B21K B21D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 3 December 2008	Examiner Augé, Marc
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