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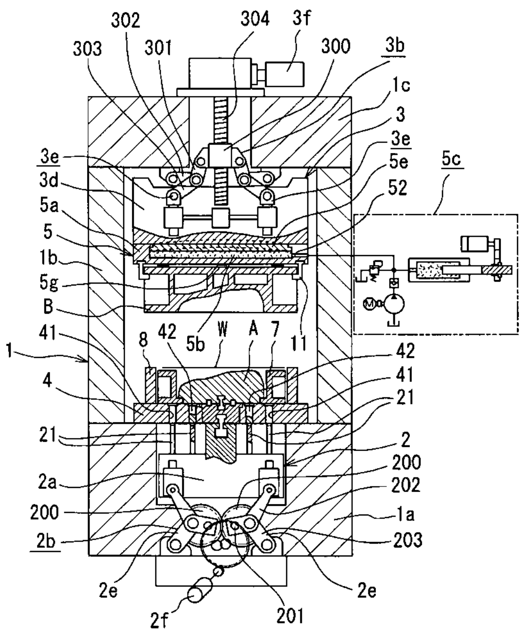
(54) UNDERDRIVE-TYPE PRESS

(57) [Object] An underdrive-type single action press capable of saving energy, saving space, and realizing high-precision formability in a well-balanced manner is provided. Particularly, a press capable of shortening a forming stroke, reducing overall height, exactly correcting the deflection of the slide or dies to improve adhesion of the dies to a workpiece, and realizing pressure equalization of a wrinkle holder is provided.

[Means for Resolution] An underdrive-type press includes a forming press unit including a lower die located inside an annular wrinkle holder fixedly disposed on a bed, and a drive mechanism disposed within the bed to raise or lower a slide supporting the lower die, a slide raised or lowered by a drive mechanism loaded on the side of a crown, a die-clamping press unit including an upper die having a clamping portion pinching a workpiece in cooperation with the wrinkle holder at its peripheral edge, and a device applying a pressing force to the upper die from its back after the last stage of the descent of the slide of the die-clamping press unit and the upper die for improvements in forming precision.

FIG. 3



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Description

TECHNICAL FIELD

[0001] The present invention relates to a press used for plastic forming of a metal material or nonmetal material, and particularly, to an underdrive-type high-precision forming press.

BACKGROUND ART

[0002] Presses are widely used as a means to perform plastic forming represented by drawing on metal and nonmetal materials. In a single-action type of such presses, generally, a frame structure in which a column is erected on a bed, and a crown is installed at the apex of the column is adopted. As shown in Fig. 1, a slide f on which an upper die (die in this example) e is loaded is adapted to be raised or lowered by a driving device (not shown) provided on the side of the crown. A lower die (punch in this example) g is fixed to the bed, and a wrinkle holding ring h is disposed around the lower die g. The wrinkle holding ring h is supported by a number of cushion pins m extending from a pad k which is raised or lowered by fluid pressure cylinders j.

In this press, as shown in Fig. 1, a forming stroke is performed by raising the pad k to lift the wrinkle holding ring h to the level of the lower die by the cushion pins m, lowering the slide to sandwich a peripheral edge of a workpiece W by the wrinkle holding ring h and a peripheral edge of the upper die e, further pressing and lowering the slide f in this state, and lowering the wrinkle holding ring h in an interlocking manner.

[0003] However, in the conventional press, the upper slide side becomes a forming press unit, and the slide is lowered by a whole stroke required for forming, by a drive mechanism. Thus, stroke length becomes large, and achievement of energy saving is difficult. Further, since the stroke length is large, the overall height of the press becomes high, and thereby, a large space is required within a building. In some case, a situation in which installation cannot be made also occurs.

[0004] Moreover, in a case where products to be press-formed are, for example, panels, such as vehicle bodies or doors of transportation means represented by automobiles, enlargement and complication of shapes, and development of materials progress, and accordingly, requirements for the processing precision of the press are becoming very high.

In order to cope with this, conventionally, the dies are processed with high precision, a frame structure whose rigidity has become high is adopted, or a CNC control method is adopted for operation of the press. However, any deflection by elastic deformation and occurrence of troubles resulting therefrom could not be avoided due to a large load during forming operation.

[0005] That is, deflection δ1 is caused in the slide as shown in Fig. 1 due to a large forming load. This impairs close contact between the slide and the upper die. Thus, it is difficult to uniformly transmit a forming force to the workpiece, and the uniform contact on a die cavity of the workpiece becomes is hardly performed. Therefore, forming precision deteriorates.

Further, in the conventional press, the wrinkle holding ring is supported by the die cushion pins with a pitch of 150 to 300 mm, and such cushion pins have dimensions such that they extend to pass through a bolster. For this reason, it is unavoidable that deflection δ2 is caused in a wrinkle holding ring between the cushion pins due to a compressive load by the slide. For this reason, nonuniformity of a wrinkle holding force occurs, and poor forming precision, such as a reduction in plate thickness or generation of a shocking line is easily caused.

[0006] In addition, in the conventional press, a hydraulic ram type drive mechanism or a crank type drive mechanism is adopted as a drive mechanism of the slide. Since the former cannot take a large number of strokes per unit time, realization of high throughput is difficult. Although the latter can make processing speed and the number of strokes high, there are problems in that processing force, processing speed, stroke position, etc., cannot be set arbitrarily, that the motion of the slide is limited, that slide speed cannot be adjusted according to various conditions, such as forming shapes or sizes of products, or materials, and that output according to the stroke length of the slide cannot be adjusted.

[0007] Thus, the present applicant has suggested a link motion press in Japanese Unexamined Patent Application Publication No. 2001-300778. In this link motion press, a slide is adapted to ascend and descend via a toggle link mechanism, and a servo motor and a screw nut are used as a driving means of the toggle link mechanism. This press has advantages in that the processing speed and the number of strokes can be made high, the processing speed, stroke, and output can also be set arbitrarily.

However, the above prior art is ineffective in improvements in the nonuniformity phenomenon of the wrinkle holding force resulting from the aforementioned deflection, and in the deflection phenomenon of the slide. Further, the slide is lowered by a whole stroke required for forming. Thus, stroke length becomes large, and achievement of energy saving is difficult. Further, the length of a screw shaft affects the height of the press, and the screw shaft becomes long as the stroke of the slide becomes long. Therefore, there is a problem in which the overall height of the press becomes high.

Patent Document 1: JP-A-2001-300778

DISCLOSURE OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0008] The invention has been made in order to solve the above problems. It is thus a first object of the invention to provide an underdrive-type single action press capable

of saving energy, saving space, and realizing high-precision formability in a well-balanced manner.
It is a second object of the invention to provide an underdrive-type single action press capable of realizing high throughput (high cycle time) in addition to the above object.

MEANS FOR SOLVING THE PROBLEM

[0009] In order to achiever the above first object, an underdrive-type press includes an annular wrinkle holder fixedly disposed on a bed; a forming press unit including a lower die located inside the wrinkle holder, a slide supporting a lower die within the bed, and a drive mechanism raising or lowering the slide; a drive mechanism loaded on the side of a crown, and a slide raised or lowered by the drive mechanism; a die-clamping press unit including an upper die having a clamping portion pinching a workpiece in cooperation with the wrinkle holder at its peripheral edge; and a device applying a pressing force to the upper die from its back after the last stage of the descent of the slide of the die-clamping press unit and the upper die for improvements in forming precision.

ADVANTAGE OF THE INVENTION

[0010] In the invention, the die-clamping press unit is disposed on the crown side, the forming press unit is disposed on the bed side, the die-clamping press unit is not lowered under pressure during descent, and a stroke length only for performing die-clamping is required. Thus, the overall height of the press can be made low. Further, forming is performed by raising a lower forming press to pressurize the lower die in a state where the die-clamping press unit operates and the upper die abuts on the wrinkle holder. Thus, a minimum stroke equal to the forming stroke will be sufficient for the stroke length of the forming press unit. As a result, energy saving can be realized.
[0011] Moreover, since the wrinkle holder does not ascend or descends while being supported by the cushion pins, but is fixed in position on the bed, deflection of the wrinkle holder between the pins does not occurs unlike the conventional press. In addition, a device for improvements in forming precision is provided on the side of the die-clamping press unit, and a pressing force is positively superimposed on the upper die from its back after the last stage of the descent of the die-clamping press unit. Thus, at least one of optimization of the wrinkle holding force by the upper die clamping portion and the wrinkle holder, and correction of deflection on the side of the slide can be achieved, and thereby, the forming precision of products can be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

[Fig. 1] Fig. 1 is a sectional view showing the outline and deflection generation situation of a conventional single-action-type press.
[Fig. 2] Fig. 2 is a partial cutaway front view showing a first embodiment of an underdrive-type press of the invention.
[Fig. 3] Fig. 3 is a longitudinal sectional front view showing the details of Fig. 2.
[Fig. 4] Fig. 4 is a partially enlarged view of Fig. 3.
[Fig. 5] Fig. 5 is a partially enlarged view showing an example of a pressurizing portion and a pressing member in a forming precision improving device.
[Fig. 6] Fig. 6 is a partially enlarged view showing another example of the pressurizing portion in the forming precision improving device.
[Fig. 7] Fig. 7 is an explanatory view showing an example of a pressure generating means in the forming precision improving device.
[Fig. 8] Fig. 8 is an explanatory view showing another example of the pressure generating means in the forming precision improving device.
[Fig. 9] Fig. 9 is a system diagram showing a pressure control means in the forming precision improving device.
[Fig. 10A] Fig. 10A is a sectional view showing the operation of the first embodiment in a stepwise fashion, and showing a last stage state before the start of forming.
[Fig. 10B] Fig. 10B is a sectional view showing the operation of the first embodiment in a stepwise fashion, and showing a state where a lower die and an upper die are matched together, and a wrinkle holding force is applied.
[Fig. 10C] Fig. 10C is a sectional view showing the operation of the first embodiment in a stepwise fashion, and showing a last stage state where the lower die has ascended to perform forming.
[Fig. 10D] Fig. 10D is a sectional view showing the operation of the first embodiment in a stepwise fashion, and showing a state where the forming is completed, and the upper die has ascended.
[Fig. 11A] Fig. 11A is a sectional view showing a state of the forming precision improving device when the upper die has touched a wrinkle holder.
[Fig. 11B] Fig. 11B is a sectional view showing a state of the forming precision improving device during forming.
[Fig. 12] Fig. 12 is an enlarged view of the state of Fig. 10B.
[Fig. 13] Fig. 13 is an enlarged view of the state of Fig. 10C.
[Fig. 14] Fig. 14 illustrates an example of a stroke and pressure diagram of a press to which the invention is applied.
[Fig. 15] Fig. 15 is a front view showing another example of a slide drive mechanism of a forming press unit.
[Fig. 16A] Fig. 16A is a sectional view showing the operation when the slide drive mechanism of Fig. 15

is used, in a stepwise fashion, and showing a state before the start of forming.

[Fig. 16B] Fig. 16B is a sectional view showing the operation when the slide drive mechanism of Fig. 15 is used, in a stepwise fashion, and showing a state where the lower die and the upper die are matched together, and the wrinkle holding force is applied.

[Fig. 16C] Fig. 16C is a sectional view showing the operation when the slide drive mechanism of Fig. 15 is used, in a stepwise fashion, and showing a last stage state where the lower die has ascended to perform forming.

[Fig. 16D] Fig. 16D is a sectional view showing the operation when the slide drive mechanism of Fig. 15 is used, in a stepwise fashion, and showing a state where the forming is completed, and the upper die has ascended.

[Fig. 17] Fig. 17 is a front view showing a second embodiment of the invention.

[Fig. 18] Fig. 18 is a partially enlarged view of Fig. 17.

[Fig. 19] Fig. 19 is a plan view of the device of Fig. 17.

[Fig. 20A] Fig. 20A is a sectional view showing another aspect of the pressurizing portion and the pressing member in the second embodiment.

[Fig. 20B] Fig. 20B is a plan view of Fig. 20A.

[Fig. 21] Fig. 21 is a front view showing an example in which the direction of the pressing member of the second embodiment is reversed.

[Fig. 22] Fig. 22 is a front view showing a third embodiment of the invention.

[Fig. 23] Fig. 23 is a sectional view taken along a X-X line of Fig. 22.

[Fig. 24A] Fig. 24A is a sectional view of a portion where adjustment pieces are used in the aspect of Fig. 22.

[Fig. 24B] Fig. 24B is a sectional view of a portion where the adjustment pieces are not used in the aspect of Fig. 22.

[Fig. 25] Fig. 25 is a front view showing an example in which the direction of the pressing member of the third embodiment is reversed.

[Fig. 26] Fig. 26 is a partially enlarged view of Fig. 25.

REFERENCE NUMERALS

[0013]

2: FORMING PRESS UNIT
2a: SLIDE
2b: DRIVE MECHANISM
2e: ECCENTRIC LINK
2f: DIGITAL SYSTEM MOTOR
3: DIE-CLAMPING PRESS UNIT
3b: DRIVE MECHANISM
3d: SLIDE
3e: TOGGLE LINK
3f: DIGITAL SYSTEM MOTOR
5: FORMING PRECISION IMPROVING DEVICE
5a: BASE
5b: PRESSURIZING PORTION
5b1: FIRST PRESSURIZING PORTION
5b2: SECOND PRESSURIZING PORTION
5c: PRESSURE GENERATING MEANS
5c1: FIRST PRESSURE GENERATING MEANS
5c2: SECOND PRESSURE GENERATING MEANS
5e: PRESSING MEMBER
5e1: FIRST PRESSING BODY
5e2: SECOND PRESSING BODY
A: LOWER DIE
B: UPPER DIE

PREFERRED EMBODIMENTS FOR CARRYING OUT THE INVENTION

[0014] Preferably, the device applying a pressing force to the upper die from its back for improvements in forming precision includes a disk-like base disposed between a lower surface of the slide and the upper die; a pressurizing portion built in the base; a pressing member having a pressing surface against the lower surface of the slide or the back surface of the upper die, and an opposite surface to the pressing surface facing the pressurizing portion; a pressure generating means disposed in a place outside the base to feed a pressurizing medium to the pressurizing portion; and a means disposed in a place outside the base to control the pressure of the pressurizing medium fed to the pressurizing portion from the pressure generating means.

[0015] If this construction is adopted, the pressing member protrudes to powerfully press the lower surface of the slide or the back surface of the upper die by feeding a pressurizing medium to the pressurizing portion from the pressure generating means, and then concave deflection of the slide is corrected. Thereby the slide and the upper die are brought close contact with each other, so that the forming force can be uniformly transmitted to a workpiece, and the pressure of the surfaces of the upper and lower dies which abut on the workpiece is equalized. For this reason, since a material flow state becomes uniform, the forming shape of a workpiece can be improved.

Further, since a means is provided to control the supply pressure of a pressurizing medium to the pressurizing portion by the pressure generating means, the force of the pressing member can be controlled according to a press stroke. Thereby, the wrinkle holding force to a workpiece can be controlled to an optimal magnitude, and the force of the pressing member is strengthened at a final forming stage, so that deflection of the slide can be corrected. Moreover, since the base including the pressing member and the pressurizing portion becomes a flat unit, structure is easy, and installation to the press is also easy.

[0016] In the invention, the pressurizing portion is composed of a chamber body and an elastic body built in the chamber body, or is composed of a chamber body and a fluid which fills the chamber body.

According to the former, since the elastic body is expanded by a pressurizing medium to move the pressing member, sealing is easy. Further, according to the latter, since the pressing member is directly pressurized, sensitivity becomes good, and pressure control is also easy.

[0017] Preferably, the pressure generating means has a servo motor as a driving source.

According to this, the pressure of the pressurizing portion which moves the pressing member can be freely controlled with precision, and optimal effects adapted to the degree of deflection, the material properties of workpieces, plate thickness, etc. can be obtained.

[0018] A sensor for adjusting the pressure to be fed to the pressurizing portion from the pressure generating means is interposed between the lower surface of the slide and the back surface of the upper die or between the base and the back surface of the upper die.

According to this, since control to an optimal pressure can be made in response to the state of deflection deformation, correction accuracy can be improved.

[0019] Depending on circumstances, the invention includes an aspect in which the pressing member and the pressurizing portion are composed of fluid pressure cylinders, and these cylinders are disposed within the base at predetermined intervals.

According to this, since a predetermined number of small piston cylinders may be arrayed within the base, the fabrication of the apparatus is easy. Further, if a plurality of rows of piston cylinders are disposed in the width direction of the chamber body, the deflection correction force and the wrinkle holding force can be adjusted more finely.

[0020] Other preferable aspects in the invention are as follows.

1) The pressing member has one disk shape with a size enough to cover a wrinkle holding region.

According to this, structure is easy, and fabrication is also easy.

2) The pressing member has a first body in its central region, and a second body in a position corresponding to the wrinkle holding region, the pressurizing portion is composed of a first pressurizing portion corresponding to the first body, and a second pressurizing portion corresponding to the second body, and the pressure generating means is composed of a first pressure generating means for the first pressurizing portion, and a second pressure generating means for the second pressurizing portion.

According to this, pressurization for the wrinkle holder, and pressurization for deflection correction can be controlled independently, and an optimal wrinkle holding force, and optimal deflection correction of the slide can be realized according to a press stroke.

[0021] Here, aspects of the above 2) includes a case where the first body has a disk shape, and the second has an annular flame shape in plan view, and a case where the first body has a disk shape, or the first body and the first pressurizing portion are composed of a plurality of fluid pressure cylinders which are connected with each other and are arranged at required intervals, and the second body and the second pressurizing portion are composed of a plurality of fluid pressure cylinders which are connected with each other and are arranged at required intervals.

According to these, control to an optimal wrinkle holding force adapted to properties and forming conditions of workpieces can be made. Particularly, in a case where the second body and the second pressurizing portion are composed of a plurality of fluid pressure cylinders which are connected with each other and disposed at required intervals, the magnitude of the wrinkle holding force can be adjusted locally and simply, and an optimal wrinkle holding force suited to the material, size, etc. of workpieces can be obtained.

[0022] Preferably, the drive mechanism of the die-clamping press unit includes a digital system motor and links, and the drive mechanism of the forming press unit includes a digital system motor and links.

According to this, since an ascent/descent position, a stroke, processing speed, and output can be set arbitrarily and can be controlled correctly, the number of strokes can be made significantly high. Particularly, in a case where eccentric links are used for the drive mechanism of the forming press unit, the drive mechanism is rotary, and does not have stop time. Thus, for example, high cycle time of about twice that of the servo press in the prior art can be obtained.

Although other features and advantages of the invention will be made clear from the following detailed description, it is apparent that the invention is not limited to the constructions shown in the embodiments as long as they include basic features of the invention, and various changes and modifications thereto can be made.

Embodiment 1

[0023] Hereinafter, embodiments of the invention will now be explained with reference to the accompanying drawings.

Figs. 2 and 3 show a first aspect of an underdrive-type digital driving press according to the invention. Reference numeral 1 represents a press frame which has a bed 1a, a plurality of columns 1b, and a crown 1c. The center of the bed 1a is equipped with a forming press unit 2, and the crown is equipped with a die-clamping press unit (upper press unit) 3. A bolster 4 is disposed on an upper surface of the bed.

[0024] The forming press unit (lower press unit) 2 includes a lower die A, a slide 2a disposed in a hole in the bed, and a drive mechanism 2b for raising or descending the slide. In the drive mechanism 2b, preferably, a digital system motor 2f, such as a servo motor or a CNC motor, and a pair of right and left eccentric links 2e which are driven by this motor are used.

In detail, the eccentric links 2e have first levers 201 ends of which are respectively supported in eccentric positions of a pair of right and left rotating disks 200 and 200, second levers 202 rear ends of which are linked to free ends of the first levers 201 and the other ends of which are linked to the slide 2a, and third levers 203 rear ends of which are linked to the free ends of the first levers 201 and the other ends of which are fixed to the bed. The rotating disks 200 and 200 have gears at their outer peripheries, respectively, and are adapted to be rotated in opposite directions by a large gear driven by a driving gear of the digital system motor 2f, a small gear in the center of this large gear, and a small gear meshing with this small gear.

[0025] The lower die (punch) A is located at an upper surface of the bolster 4, and the lower die A is linked with an upper portion of the slide 2a via a linking block which extends via an opening of the bolster 4.

An annular wrinkle holder 7 which places a plate-like workpiece W is fixed to the upper surface of the bolster 4, and a distance block 8 which once catches an upper die B during the descent of the upper die, thereby regulating a stroke, is installed on the bolster outside the wrinkle holder 7. The distance block 8 may be formed in the shape of a frame on the whole and may be a plurality of split single bodies (columns or walls). However, in any case, the height of the distance block is set to a dimension which is equal to or moderately higher than a level in a state where the workpiece W is disposed on the wrinkle holder 7 before start of forming.

[0026] In addition, in this embodiment, in order to attain the balanced ascent of the lower die A, guide pins 21 are implanted at predetermined intervals around the linking block of the slide 2a, and longitudinal holes 41 which allows insertion/removal of the guide pins 21 are disposed in the bolster 4. Also, in order to stabilize the ascent/descent movement of the lower die A, push-up pins 42 which are pressed by the guide pins 21 are inserted into the longitudinal holes 41 corresponding to a lower surface of the lower die A.

[0027] The die-clamping press unit 3 has a slide 3d and a drive mechanism 3b for raising or descending this slide. Although the drive mechanism 3b may be the same as the drive mechanism of the forming press unit 2, it is preferable that high-speed descent and a large die-clamping force are obtained. Thus, in this embodiment, a pair of right and left toggle links 3e and 3e, and a digital system motor (for example, an AC servo motor, etc.) 3f are used.

Each toggle link 3e has a first link 301 one end of which is linked to a nut 300 which is screwed to a screw shaft 304 rotated by the motor 3f, a second link 302 one end of which is linked to the crown, and a third link 303 one end of which is linked to the slide 3d, and the other ends of the links are collected and linked together by pivots.

[0028] Also, a means which exhibits a slide deflection correcting function or/and a wrinkle holding pressure-equalizing function for improvements in forming precision is provided in the die-clamping press unit 3 and its vicinity. Specifically, the slide 3d of the die-clamping press unit 3, and a device 5 which applies a pressing force to the upper die B from behind after the last stage of the descent of the upper die B are provided. This significantly differs from a normal press in which an upper die (die) B is only fixed to the lower surface of the slide 3d.

[0029] The device (hereinafter referred to as forming precision improving device) 5 has a main body interposed between the lower surface of the slide 3d, and the upper die B. The main body includes a disk-like relatively flat base 5a, a pressurizing portion 5b built in the base 5a, and a pressing member 5e an end surface of which faces the lower surface of the slide 3d in this embodiment, and which has a portion below the slide built in the pressurizing portion 5b so that it can ascend or descend. Outside the device, a pressure generating means 5c which supplies and discharges a pressurizing medium to and from the pressurizing portion 5b, and a control means 5f which controls the driving of the pressure generating means 5c are provided. The pressure generating means 5c is loaded on, for example, the column 1b.

[0030] Since the base 5a functions as a base, it is made of a thick plate, etc. so as to have high strength and rigidity. As shown in Fig. 4, the portion of the base outside the pressurizing portion 5b is suspended by a clamper 3g mounted on the slide 3d so that there may be a moderate gap S from the lower surface of the slide 3d in a normal state. The clamper 3g has an arm 31 with a hook which is engaged with and disengaged from a hanging portion provided at a side end of the base 5a.

Although the upper die B is suspended by an L-shaped suspension means 11 fixed to an edge of the base 5a, the upper die may be directly fixed to the base 5a. In a case where the suspension means 11 is used, a guide 110 as shown in Fig. 4 may be attached so that any deviation may not occur in the horizontal direction of the upper die B.

[0031] The pressurizing portion 5b is of a direct type in this embodiment. As shown in Fig. 5, the pressurizing portion is formed inside the base 5a as a relatively shallow flat chamber 5000, and is adapted such that a pressurizing medium is directly introduced or discharged through a channel 52 provided in a proper place of the base 5a. Although liquids, such as oil and water, are generally used as the pressurizing medium, gas is also used depending on circumstances.

To explain the pressurizing portion 5b in detail, the base 5a is integrated, for example, by fastening the main body 50 and a lid 51 with a fixing element. A recess 500 is formed in the main body 50, and a recess which faces the recess 500 is formed in the lid 51, thereby constituting a flat chamber. The lid 51 is formed with an opening 511 which communicates with the recess but has a smaller width than the recess. Since the pressurizing medium is directly introduced or discharged through the channel 52 as mentioned above, a sealing member 5100 which touches a peripheral wall portion of the pressing member 5e is attached along an inner wall surface of the opening

511.

The pressing member 5e is made of one disk-like body (plate) which has almost the same area as the area of the workpiece W in this embodiment. The portion of the pressing member below a pressing end surface 520 is fitted into the opening 511, and extends within the recess. A lower end lateral portion of the pressing member is provided with a flange 521 which can contact with the top wall of the recess. This flange and a ceiling wall are adapted to define a stroke ST to a range of, for example, 1 to 5 mm. Arrows of Fig. 5 indicate a state where a pressurizing medium is injected into the chamber 5000 through the channel 52, and thereby the pressing member 5e protrudes and the end surface 520 presses the slide 3d.

[0032] In addition, the pressurizing portion 5b is not limited to the direct type. Fig. 6 shows an example of an indirect type which is constituted by a chamber 5000 defined by a recess, and an elastic body 5001 built in the chamber.

The elastic body 5001 is made of contractable or expandable material, such as rubber. An upper surface of the elastic body 5001 may be joined to the pressing member 5e. In addition, in this embodiment, a flat bag is used as the elastic body 5001 a portion of which is connected to the channel 52 of the base 5a via a joint. However, the elastic body 5001 is not limited to a material as long as it is expanded by the pressure of the pressurizing medium to generate pressure, and liquid, pasty, or solid rubber may be used.

[0033] The pressure generating means 5c is a means which makes a pressurizing medium, and feeds and discharges the medium through the channel 52 to and from the pressurizing portion 5b. Preferably, a digital-controllable-type pressure generating means is used. Fig. 7 shows a cylinder-type pressure generating means as an example of the pressure generating means 5c. A branch pipe 540 connected to a pressurizing-side outlet of a cylinder 55 is connected to a pipe 54 connected to the channel 52 via a pump 53 and a check valve. A nut 56 is screwed to a screw 5501 of a piston rod 550 inserted into the cylinder 55. This nut 56 itself is connected with a rotational member (small pulley or pinion) 571 of an output part of a servo motor 57 by a transmission means, directly or via a rotational member (pulley or small gear) 560 for deceleration.

[0034] In this type, the output of the servo motor 57 is decelerated, and transmitted to the nut 56, the piston rod 550 is moved by the rotation of the nut 56, and thereby, the pressure of a system composed of the branch pipe 540 and the pipe 54, which are filled with a fluid from the pump 53 in advance, is controlled toward its increased side or reduced side. As such, as the movement direction and speed of the piston rod 550 change depending on the rotational direction, rotational frequency or torque of the servo motor 57, the pressure of the pressurizing portion 5b is changed and the projecting force and pressing force of the pressing member 5e changes.

[0035] The pressure generating means 5c is not limited to the cylinder type. Fig. 8 shows a pump-type pressure generating means. In this type, as the pump 53 is driven by the servo motor 57, the internal pressure in the pipe 54 which leads to the channel 52 is controlled to its increased side or reduced side. That is, the pressure generating means includes the pump 53 which is interposed in the pipe 54 to supply a pressurizing medium, for example, pressure oil, to the pressurizing portion 5b from a tank depending on the rotational direction, and on the contrary, returns the pressurizing medium to the tank from the pressurizing portion 5b, and the servo motor 57 which drives the pump normally or reversely, and controls the force created by the pressurizing portion 5b depending on the rotational direction, torque, and speed control.

[0036] In this type, the pressing member 5e ascends as the pressurizing medium within the tank is fed to the pressurizing portion 5b through the pipe 54 and the channel 52 from the pump 53 by the normal direction driving of the servo motor 57. Further, if the servo motor 57 is driven in the reverse direction, the pump 53 sucks the pressurizing medium of a pipe, and the oil in the pressurizing portion 5b and pipe 54 is returned to the tank. Thus, the pressing member 5e descends. Accordingly, the pressing force of the pressing member 5e can be arbitrarily controlled with precision by the control of the torque and speed of the servo motor 57.

[0037] The pressure control means 5f is disposed as a control panel, etc. in a proper place in the vicinity of the bed, the column, etc. in order to control the driving of the pressure generating means 5c. The pressure control means 5f, as shown in Fig. 9, is constituted as a computer including a controller like a CNC. Also, in order to detect the deformed state of the slide 3d or the upper die B, as shown in Figs. 3 to 6, a sensor 5g is attached to a central region between the lower surface of the base 5a and the upper die B, or a predetermined part, such as a lateral part, and is electrically connected to the controller. As the sensor 5g, displacement sensors represented by a distortion sensor, a pressure sensor, etc. which can detect compression and tension, are used. Furthermore, a position sensor may be used.

[0038] Further, a pressure sensor 5h is interposed in a system of the pressure generating means 5c. An output system of the pressure sensor 5h and of the displacement sensor 5g along with an output system of speed and torque of the servo motor 57 is connected to the controller. The kinds, properties, processing conditions, etc., of workpieces are input to and stored in a computer, and instructions on rotational direction, speed, and torque are issued from the controller in response to calculated suitable conditions.

Also, rotational frequency and torque are fed back to the controller from the output system of the servo motor 57. Further, the actual deflection state (compression and tension) of the slide 3d or the upper die B is detected by the sensor 5g, cushion pressure is detected by the pressure sensor 5h, and the deflection state and cushion pressure are fed back to the controller. Accordingly, the rotational direction, speed, and torque which are sequentially compared with proper values, and calculated, and which are corrected if there is any difference will be ordered to the servo motor 57.

[0039] Next, the operation and effects of the above embodiment will be explained.

Figs. 10A to 10D, and Fig. 11A, Fig. 11B, Fig. 12, and Fig. 13 show the operation of the press shown in Fig. 3 in a stepwise fashion, and Fig. 14 shows a stroke and pressure diagram. Fig. 10A shows a state before start of processing. The upper die B and the lower die A are at retreat limits. At this time, any deformation of the slide 3d or the upper die B is not caused. Thus, a distortion generation signal is not issued from the displacement sensor 5g in the forming precision improving device 5, but the pressure of the pressurizing portion 5b is set to zero to low pressure. A gap S exists between the upper surface of the base 5a of the forming precision improving device 5 and the lower surface of the slide 3d, as shown in Fig. 4. On the other hand, the workpiece W is mounted on the wrinkle holder 7, and the upper end surface of the distance block 8 is at almost the same level as the upper surface of the workpiece W.

[0040] Next, if the motor 3f is driven to operate the die-clamping press unit 3, the slide 3d and the upper die B are lowered, and as shown in Fig. 10B, the upper die B abuts on the wrinkle holder 7 and the distance block 8. Thereby, as shown in Fig. 11A, the suspended base 5a is pressed upward, and its upper surface touches the lower surface 320 of the slide 3d. If the sensor 5g detects this touch state, a signal is delivered from the control means 5f which has received the detection signal, and the pressure generating means 5c operates, and thereby, the pressurizing medium is fed to the pressurizing portion 5b via the pipe 54 and the channel 52.

Thereby, since the pressurizing portion 5b is boosted to the pressure P1, as shown in Fig. 11B, the pressing surface 520 of the pressing member 5e rises by a prescribed height, for example, 1 to 4 mm, from the level of the upper surface of the base. Thereby, a reaction force is applied to the upper die B. This state is shown in Fig. 10B and Fig. 12. Since a uniform wrinkle holding force acts on the whole surface of the wrinkle holder 7, the uniform wrinkle holding force is applied to the workpiece W between the upper die B and the wrinkle holder 7.

[0041] In this state, by operating the drive mechanism 2b of the forming press unit 2, and expanding the eccentric links 2e, the slide 2a is raised, and the lower die A is raised from the bolster 4.

That is, since a large gear is rotated by a drive gear by the driving of the digital system motor 2f and the one pair of rotating disks 200 and 200 are rotated by a small gear in the center of the large gear, the first lever 201 and 201 advance in the expansion direction, and the second lever 202 and the third lever 203 rise. Thereby, the slide 2a is pushed up within the bed, and the lower die A connected to the block in the center of the slide ascends. An ascent stroke at this time is low-speed → high speed as shown in Fig. 14.

In addition, during the ascent of the slide 2a, the guide pins 21 advances into the holes 42 of the bolster 4, and the pins 42 inserted into the holes 42 of the bolster 4 are pushed up, stable balanced ascent is guaranteed.

[0042] As such, if the slide 2a and the lower die A are raised, as shown in Fig. 10C, the lower die A advances into the upper die B, and desired processing, for example, drawing is performed. In this process, if the ascent of the lower die A proceeds, and the forming stroke approaches an end, the existence/nonexistence of distortion on the side of the slide is detected by the displacement sensor 5g. When it is detected that any convex distortion (compression deformation) has occurred on the upper side, the pressure generating means 5c is operated by a signal from the control means 5f, and the pressure P2 higher than that at the time of the above touch is introduced into the pressurizing portion 5b. Thereby, the output of the pressing member 5e becomes strong, and as exaggeratingly shown in Fig. 13, the pressure of the lower surface of the slide is intensified.

Thereby, since the upper die B is directed downward and a convex deformation force is given by a reaction force, distortion is corrected. For this reason, since the slide 3d and the upper die B adhere to each other, the forming force can be uniformly transmitted to a workpiece, and forming exactly suited to cavities of the dies A and B is performed, the forming shape of the workpiece becomes very good.

[0043] After the completion of forming, the slide 2a is lowered by the rotation of Servo motor 2f, and returns the lower die A to the position of the bolster. At this stage, a forming load is lost at this phase, and the deflection of the slide 3d and the upper die B disappear. Thus, the correction becomes unnecessary. Thus, the pressurizing portion 5b is decompressed by the pressure generating means 5c, and the pressing member 5e is made to return to its original position. Also, if the die-clamping press unit 3 is raised as shown in Fig. 10D and the slide 3e has stopped at a top dead center, a formed product w' is removed, and the processing process is completed.

[0044] As described above, as a first step, wrinkle holding pressure is controlled by applying pressure to the pressing member 5e via the pressurizing portion 5b at the time of the touch of dies. Thus, nonuniformity of the wrinkle holding force resulting from the deflection of the wrinkle holder can be canceled in cooperation with the fact that cushion pins are not used, and a uniform wrinkle holding state can be created. Further, as a second step, deflection correction on the side of the slide can be properly performed by applying a pressure higher than the first step at the stroke end to the pressing member 5e via the pressurizing portion 5b. Moreover, re-striking forming is performed by applying the deflection correction pressure of P2 at the stroke end. Accordingly, the precision of formed products can be significantly improved.

[0045] In addition, the pressure within the pressurizing portion 5b can be freely controlled in an arbitrary position of the press by a digital control system, the torque of a servo motor, and speed control. For example, if the rotational direction of the servo motor 57 is reversed by an instruction from a controller and the servo motor 57 is driven with the torque and rotational frequency according to processing conditions, in Fig. 7, the piston 550 retreats to increase the cylinder volume. In Fig. 8, the pump 53 makes reverse rotation to switch suction and discharge, and the pressure medium within the pipe 54 is returned to a tank according to torque and rotational frequency. Thereby, since the pressure of the pressurizing portion 5b becomes low, the pressing force of the pressing member 5e is also reduced, the wrinkle holding force is relieved, and the cushion effect suitable for drawing is exhibited to fluidize a material. Further, deepening on the detection of the displacement sensor 5g and the rotational direction, torque, and rotational frequency of the servo motor 57 corresponding thereto, the pressing force of the pressing member 5e according to the deflection state of the press is adjusted.

[0046] The wrinkle holding pressure and deflection correction pressure can be controlled in a stepless fashion by the torque and rotational frequency of the servo motor 57. That is, if the torque of the servo motor 57 is reduced, deceleration is made and if the torque is increased, acceleration is made. If the rotational frequency is small, the amount of the pressure medium returned to a cylinder or a tank decreases. Thus, the reduction in the pressure within the system of the pressurizing portion 5b is small. Accordingly, the die cushion pressure or deflection correction pressure become relatively higher than a case where the rotational frequency of the servo motor is large.

Accordingly, the servo motor 57 is driven with a suitable value in the course of the forming stroke according to this property. Thereby, deflection can be corrected, and control to a uniform pressing force can be made. Further, wrinkle holding pressure can be smoothly controlled with high precision, and highly precise forming matched with processing conditions can be realized.

[0047] As can be understood from the forming stroke, the overall height of the press can be reduced by processing stroke. Further, forming is performed by an underdrive method, using the lower forming press unit 2, and is performed with the same minimum stroke length as the forming stroke. Therefore, energy saving can be achieved.

Also, since the driving of the forming press unit 2 transmits a vertical motion to the slide 2a via the eccentric links 2e with the digital system motor 2f as a driving source, speed increase and large magnification ratio of a force can be obtained. Further, in this embodiment, the drive mechanism 2b is rotary, and does not have stop time. Thus, high cycle time of almost twice the SPM 15-18 of a conventional press is allowed.

[0048] In addition, the drive mechanism 2b for raising or lowering the slide 2a of the forming press unit 2 is not limited to the eccentric link method. Fig. 15 shows another example. In this example, a pair of right and left toggle links 20, and a digital system motor 21 are provided. The lower die A is located at the upper surface of the bolster 4, and the slide 2a is linked with the lower die A via the opening of the bolster 4. The toggle link 20 is composed of a pair of right and let links. Each toggle link has a first link 201 one end of which is linked to a nut 200 which is screwed to a screw shaft 205 rotated by the digital system motor 21, a second link 202 one end of which is linked to the bed, and a third link 203 one end of which is linked to the slide, and the other ends of the links are collected and linked together by pivots.

[0049] Figs. 16A to 16D show a forming process when a toggle link is used as the drive mechanism 2b in a stepwise fashion.

Since the operation and effects of the press are the same as those described with reference to Figs. 10A to 10D, the description thereof is omitted.

Embodiment 2

[0050] Figs. 10 to 21 show the embodiment using another aspect as the forming precision improving device 5. In this embodiment, the base 5a as a main body of the forming precision improving device 5, as shown in Fig. 18, is not different from that of the first embodiment in that the base is suspended by the clamper 3g such that a gap S can be formed with respect to the slide 3d.

In this embodiment, as shown in Figs. 17 and 18, the pressing member 5e is split into a first body 5e1 in its central region, and a second body 5e2 in a position corresponding to a wrinkle holding region. The pressurizing portion 5b is constituted by a first pressurizing portion 5b1 corresponding to the first body, and a second pressurizing portion 5b1 corresponding to the second body. The pressure generating means is constituted by a first pressure generating means 5cl for the first pressurizing portion, and a second pressure generating means 5c2 for the second pressurizing portion.

[0051] The first pressing body 5e1 has a disk shape, and any of the structures shown in Figs. 5 and 6 is adopted as the first pressurizing portion 5b1. As for the first pressure generating means 5c1 and the second pressure generating means 5c2, any of aspects in Figs. 7 and 8 is adopted. The first pressurizing portion 5b1 is connected with the first pressure generating means 5c1 by a channel 54.

The second pressing body 5e2 is composed of a plurality of fluid actuators which are disposed at intervals, in this embodiment. That is, a number of fluid pressure cylinders each including a cylinder tube serving as a unit pressurizing portion, and a piston serving as a unit pressing member are arrayed in chambers provided at required intervals inside the base 5a. The fluid pressure cylinders are individually provided, or are arrayed in a chamber which is widely formed as a recess. The pistons may be exposed to the upper surface of the base 5a, or a lid or cover with a hole is mounted on every cylinder. Each of the cylinder tubes of the fluid pressure cylinder group is connected by a communication channel (conduit) 542 and is connected to the pressure generating means 5c2 via a channel 54'.

[0052] Figs. 20A and Fig. 20B show another aspect of the second embodiment. Here, the second pressing body 5e2 is constructed as an annular frame as seen in plan view, and the second pressurizing portion 5b2 is constructed as a chamber formed in the shape of an annular groove inside the base 5a. The second pressurizing portion 5b2 may be of a direct type as shown in Fig. 5, or may be of an indirect type using an elastic body as shown in Fig. 6.

Since the other configurations are the same as those of the first embodiment, the explanation thereof will be shared with the first embodiment, and the same reference numerals will be given to the same parts.

[0053] The second embodiment also basically has the same effects as the first embodiment. However, in the first embodiment, the pressing member 5e and the pressurizing portion 5b are a single combination. Therefore, the wrinkle holding force and deflection correction force which are obtained as a uniform force is applied to the whole pressing member 5e will be created.

In contrast, in the second embodiment, a pressing member 2e is split into a first body 2e1 in its central portion or inner portion, and a second body 2e2 at its periphery (corresponding to each side of a product). Accordingly, a pressurizing portion 2b is also split into a first pressurizing portion 2b1 and a second pressurizing portion 2b2. Thereby, the pressure of each set is individually controlled by the first pressure generating means 5c1 and the second pressure generating means 5c2.

[0054] For this reason, pressure requirement can be made different by the first pressurizing portion 5b1 and the second pressurizing portion 5b2. Thus, in the first step (at the time of the touch) corresponding to Fig. 11A, the second pressing body 2e2 projects will project by a required stroke to press the peripheral edge of the upper edge if only the second pressurizing portion 5b2 is pressurized by the second pressure generating means 5c2. Thus, a suitable wrinkle holding force can be created and controlled. Then, in the second step (stroke end), the first pressure generating means 5c1 is driven to set the pressure of the first pressurizing portion 2b1 to the pressure of P2. Thereby, since the first body 2e1 strokes to generate a large force, any deflection of the slide 3d by the forming load can be properly corrected. Fig. 18 shows a state at this time. Referring to this drawing, a pressure medium is supplied to the first pressurizing portion 5b1 and the second pressurizing portion 5b2 simultaneously from the first pressure generating means 5c1 and the second pressure generating means 5c2, to simultaneously moving the first pressing body 5e1 and the second pressing body 5e2, and to generate a pressing force P1 + P2 of an equal or different magnitude, thereby creating the re-striking pressure. Improvements in forming precision, and energy saving can be achieved by such pressing.

[0055] In addition, in Fig. 17, the pressing surfaces of the first pressing body 5e1 and the second pressing body 5e2 face the lower surface of the slide 3d. However, the invention is not limited thereto. The top and bottom of the apparatus may be reversed, and as shown in Fig. 21, the pressing surfaces of the first pressing body 5e1 and the second pressing body 5e2 may be made to face the back surface of the upper die B. In this case, the portion of the base outside the pressurizing portion 5b may be firmly fixed to the slide 3d and integrated with the slide 3d, by bolting, etc. In the case of Fig. 21, the first pressing body 5e1 and the second pressing body 5e2 are projected by the first pressurizing portion 2b1 and the second pressurizing portion 2b, whereby pressing forces directly act on the back surface of the upper die B, and addition of the wrinkle holding pressure and deflection correction are performed.

Embodiment 3

[Fig.] Figs. 22 to 26 show a third embodiment of the invention.

[0056] Even in this embodiment, similarly to the second embodiment, the pressing member 5e has a first body 5e1 in its central region, and a second body 5e2 in a position corresponding to a wrinkle holding region. The pressurizing portion 5b is split into a first pressurizing portion 5b1 corresponding to the first body, and a second pressurizing portion 5b1 corresponding to the second body. The pressure generating means is split into a first pressure generating means 5c1 for the first pressurizing portion, and a second pressure generating means 5c2 for the second pressurizing portion. Further, the second pressing body 5e2 is composed of a group of fluid-pressure cylinders disposed at intervals.

[0057] However, in this third embodiment, the first pressing body 5e1 which is the first pressing body 5e1 in the central region, and the first pressurizing portion 5b1 are also composed of a plurality of fluid pressure cylinders which are disposed at intervals.

That is, a number of fluid pressure cylinders each including a cylinder tube serving as a unit pressurizing portion, and a piston serving as a unit pressing member are arrayed in chambers provided at required intervals inside the base 5a. The fluid pressure cylinders are individually provided, or are arrayed in a chamber which is widely formed as a recess. Each of the cylinder tubes of the fluid pressure cylinder group is connected by a communication channel (conduit) 541 and is connected to the pressure generating means 5c1 via the channel 54.

[0058] In addition, in this embodiment, similarly to the aspect of Fig. 21, the first pressing body 5e1 and the second pressing body 5e2 are disposed such that their pressing surfaces face the upper die B. In Fig. 25, contrary to the above, the first pressing body 5e1 and the second pressing body 5e2 are disposed such that their pressing surfaces face the slide 3d. Fig. 26 shows Fig. 25 in partially enlarged manner. Since the other configurations and effects are the same as those of the second embodiment, the description thereof is omitted.

Even in this third embodiment, the first pressing body 5e1 and the second pressing body 5e2 are simultaneously moved at a stroke end, and a pressing force P1 + P2 of an equal or different magnitude is generated, thereby creating re-striking pressure. Thus, improvements in forming precision, and energy saving can be achieved by such press forming.

[0059] In addition, in a case where the pressing members and the pressurizing portions are individually constructed (point group), using a fluid pressure cylinder group like the second embodiment or third embodiment, fine control of a wrinkle holding force or a deflection correction force can be made. As a method of realizing this, the fluid pressure cylinder group may be split into some groups, these groups may be connected together by conduits, and a pressure generating means may be connected to every group.

However, more simply, as shown in Fig. 24A, pressure receiving pieces 9 are disposed on the upper surface of the upper die including the regions which require the pressing by the pressing members. The pressure receptacle pieces 9 are on the same axes as pistons, and receive the pressing by the stroke of the pistons. In the places where pressing is not required, as shown in Fig. 24B, the pressure receiving pieces are not arranged. Otherwise, the pressure receiving pieces which have different thicknesses according to the degree of necessity of a pressing force may be disposed.

By doing so, the wrinkle holding force can be controlled locally, using the fluid pressure cylinder group of the same specification and without increasing the number of pressure generating means. For example, in a case where a workpiece W is large, it is possible to simply realize a constructipn in which the pressing force of a straight line region can be made relatively high to obtain a strong wrinkle holding force, and the pressing force of a corner region can be made relatively and slightly low to weaken the wrinkle holding force slightly.

[0060] The illustrated presses are several examples of the invention, and the invention is not limited thereto. The same eccentric links as the forming press unit 2 may be used for the drive mechanism 3b of the die-clamping press unit 3. In this case, a rotary single-action-type under drive press is obtained. It is needless to say that the forming precision improving device 5 is interposed and fixed between the slide of the die-clamping press unit and the upper die.

[0061] Moreover, the forming precision improving device 5 itself can be used regardless of types of presses, can be applied to a general-purpose mechanical press, a hydraulic press, etc. as well as the link-type servo press shown as a prior art, and can be applied to a single-action-type press, or a double-action type press in the classification according to driving types.

Even if being applied to any of them, a pressure-equalizing effect is high, and a die-mating force and a wrinkle holding force become uniform regardless of deflection of presses and dies, product precision improves. Further, an energy saving effect is large, and if the pressure generating means is also constructed like the embodiments, a relief valve is not used. Thus, heat is not generated within a hydraulic circuit, and the surge pressure when the slide and a die cushion collide with each other is low. Moreover, durability and load bearing properties are high.

[0062] In addition, the invention includes the following contents.

1) A forming precision improving device including, between a die and a lower surface of a slide capable of ascending or descending, a disk-like base, a pressurizing portion built in the base and connected to external pressure generating means and supply-pressure control means, and a pressing member having a pressing surface against the lower surface of the slide or the upper surface of the die, and facing the pressurizing portion on the side opposite to the pressing surface.

2) A forming method using a press, including interposing between an upper die and a lower surface of a slide of a press, a device including a disk-like base, a pressurizing portion built in the base and connected to external pressure generating means, and a pressing member having a pressing surface against the lower surface of the slide or the upper surface of the die, and an opposite surface to the pressure surface facing the pressurizing portion, and setting the pressing force of the pressing member by the pressurizing portion in pressing a workpiece, i.e., a pressure P1 at a stage where the slide descends and the upper dies abuts on the workpiece, and a pressure P2 at a stage where the slide has arrived at a bottom dead center, to P2 > P1.

3) The aspect 2) includes an aspect in which the pressure P1 at a stage where the slide descends and the upper die has abutted on the workpiece is given to only the pressing member at its peripheral edge corresponding to the wrinkle holder, and the pressure P2 at a stage where the slide has arrived at the bottom dead center is given to the pressing member in its central portion.

Claims

1. An underdrive-type press comprising:

an annular wrinkle holder fixedly disposed on a bed;

a forming press unit including a lower die located inside the wrinkle holder, a slide supporting a lower die, and a drive mechanism disposed with-

in the bed to raise or lower the slide;
a drive mechanism loaded on the side of a crown, and a slide raised or lowered by the drive mechanism;
a die-clamping press unit including an upper die having a clamping portion pinching a workpiece in cooperation with the wrinkle holder at its peripheral edge; and
a device applying a pressing force to the upper die from its back after the last stage of the descent of the slide of the die-clamping press unit and the upper die for improvements in forming precision.

2. The underdrive-type press according to Claim 1, wherein the device applying a pressing force to the upper die from its back for improvements in forming precision includes:

a disk-like base disposed between a lower surface of the slide and the upper die;
a pressurizing portion built in the base;
a pressing member having a pressing surface against the lower surface of the slide, or the back surface of the upper die, and an opposite surface to the pressure surface facing the pressurizing portion;
a pressure generating means disposed in a place outside the base to feed a pressurizing medium to the pressurizing portion; and
a means disposed in a place outside the base to control the pressure of the pressurizing medium fed to the pressurizing portion from the pressure generating means.

3. The underdrive-type press according to Claim 2, wherein the pressing member includes a disk-like body with a size enough to cover a wrinkle holding region.

4. The underdrive-type press according to Claim 2, wherein the pressing member has a first body in its central region, and a second body in a position corresponding to the wrinkle holding region, the pressurizing portion has a first pressurizing portion corresponding to the first body, and a second pressurizing portion corresponding to the second body, and the pressure generating means is composed of a first pressure generating means for the first pressurizing portion, and a second pressure generating means for the second pressurizing portion.

5. The underdrive-type press according to Claim 4, wherein the first body has a disk shape, and the second body has an annular frame shape in plan view.

6. The underdrive-type press according to Claim 4, wherein the first body has a disk shape, or the first body and the first pressurizing portion are composed of any of a plurality of fluid pressure cylinders which are connected with each other and are disposed at required intervals, and the second body and the second pressurizing portion is composed of a plurality of fluid pressure cylinders which are connected with each other and are disposed at required intervals.

7. The underdrive-type press according to any one of Claims 2 to 5,
wherein the pressurizing portion is composed of a chamber body, and an elastic body built in the chamber body.

8. The underdrive-type press according to any one of Claims 2 to 5,
wherein the pressurizing portion is composed of a chamber body, and a fluid which fills the chamber body.

9. The underdrive-type press according to Claim 2, wherein a sensor for adjusting the pressure to be fed to the pressurizing portion from the pressure generating means is interposed between the lower surface of the slide and the back surface of the upper die or between the base and the back surface of the upper die.

10. The underdrive-type press according to Claim 2, wherein the pressure generating means has a servo motor as a driving source.

11. The underdrive-type press according to Claim 1, wherein the drive mechanism of the die-clamping press unit includes a digital system motor and links, and the drive mechanism of the forming press unit includes a digital system motor and links.

FIG. 1

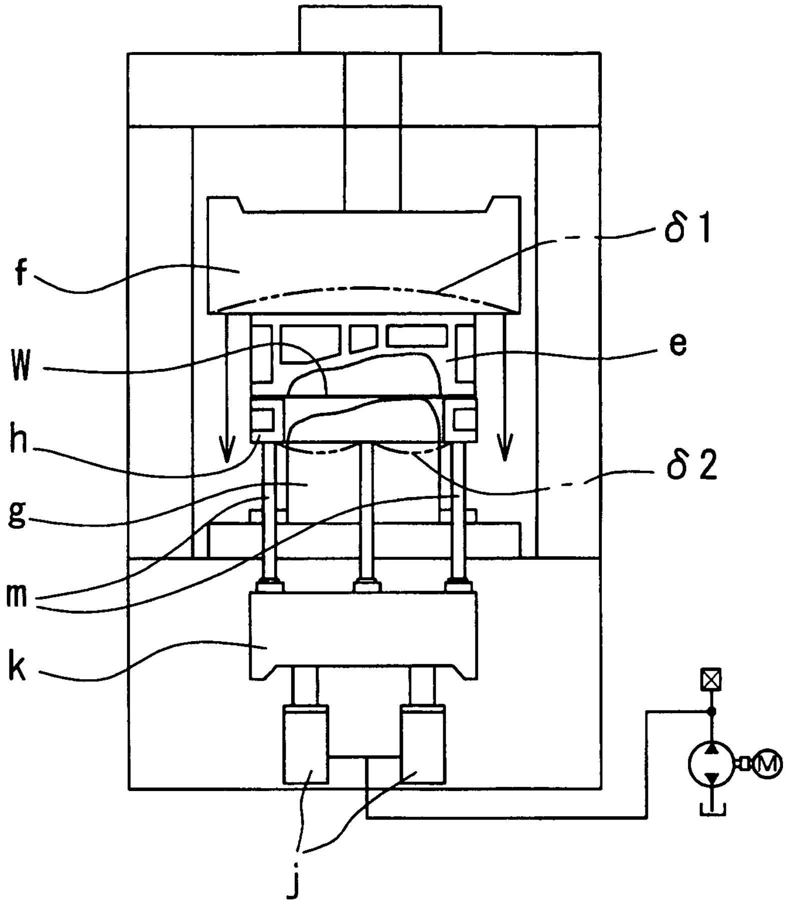


FIG. 2

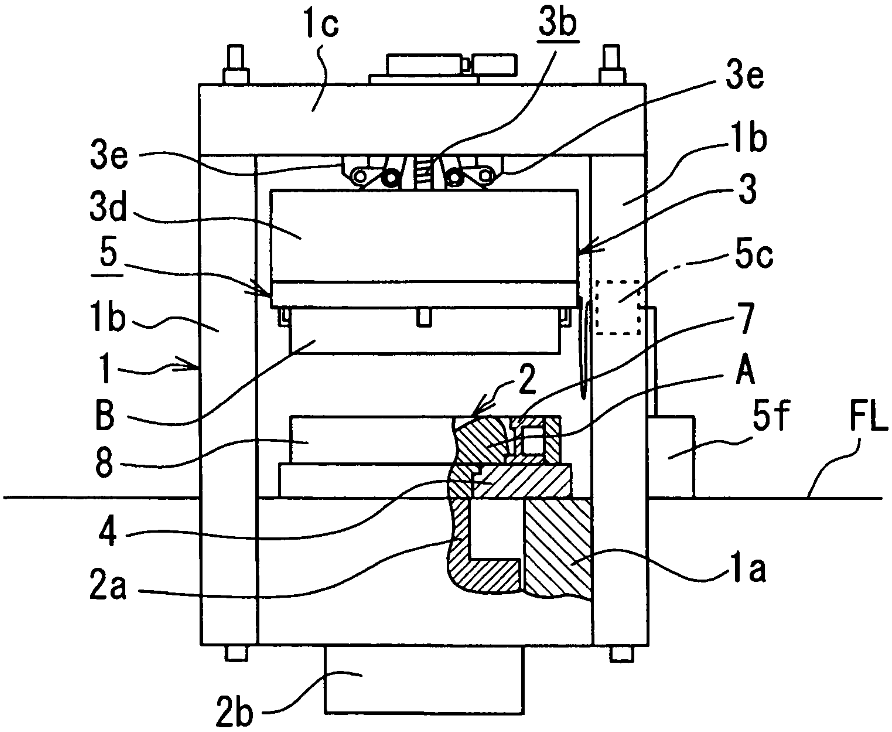
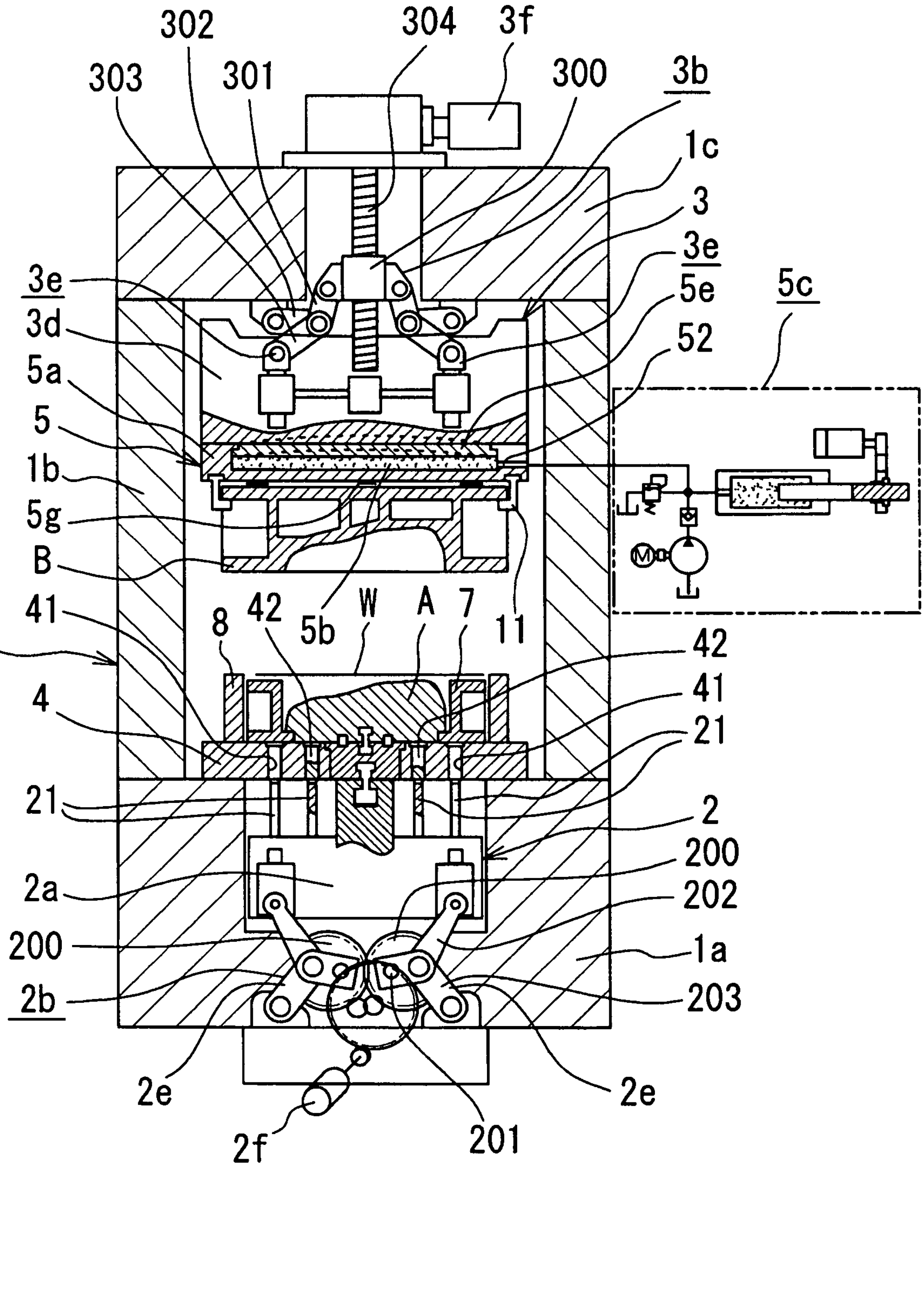


FIG. 3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5g
B
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42
5b
W
A
7
11
8
42
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FIG. 4

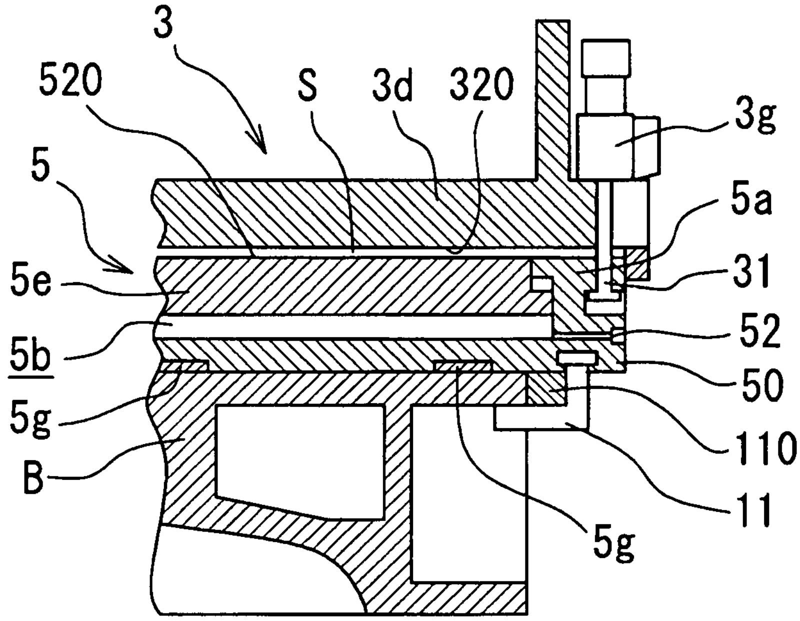
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FIG. 5

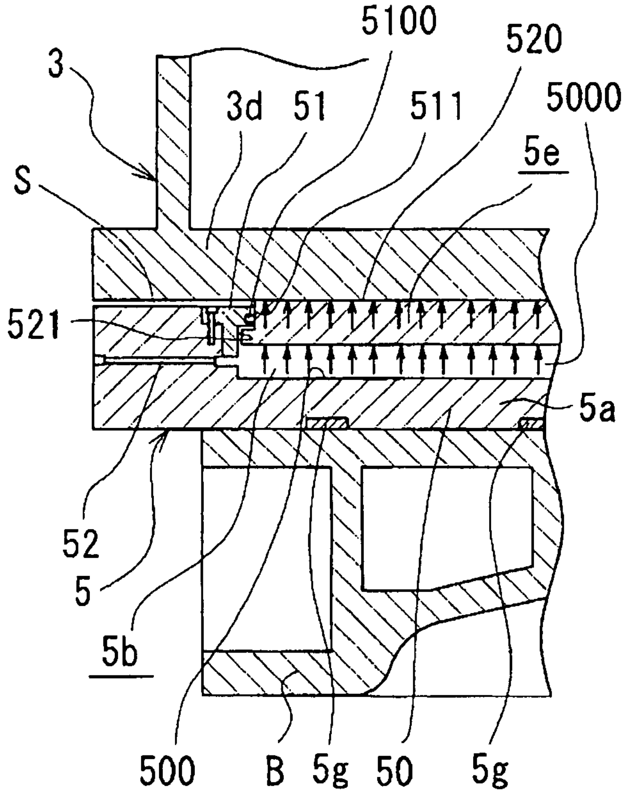
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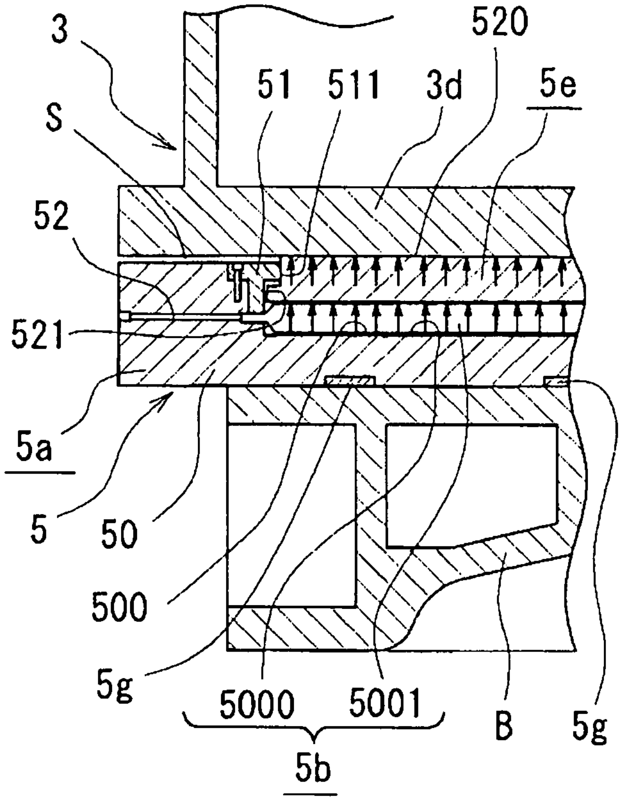
FIG. 6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50
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5g
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5b
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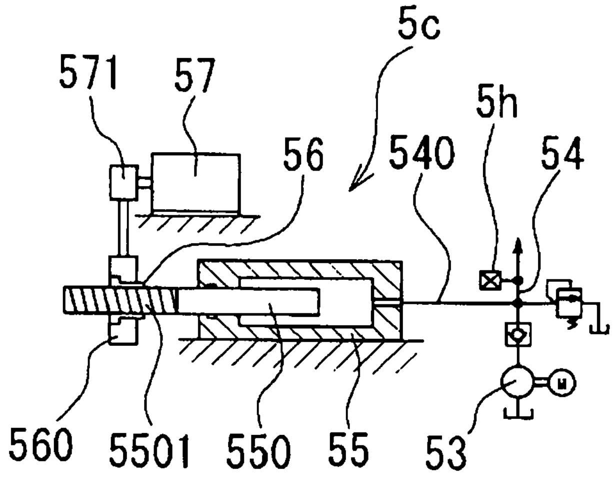
5g

FIG. 7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5h
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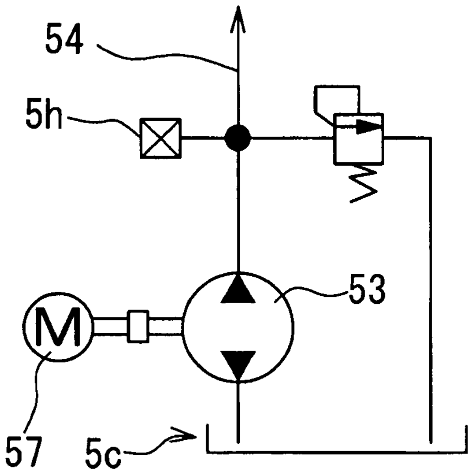
FIG. 8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5c

FIG. 9

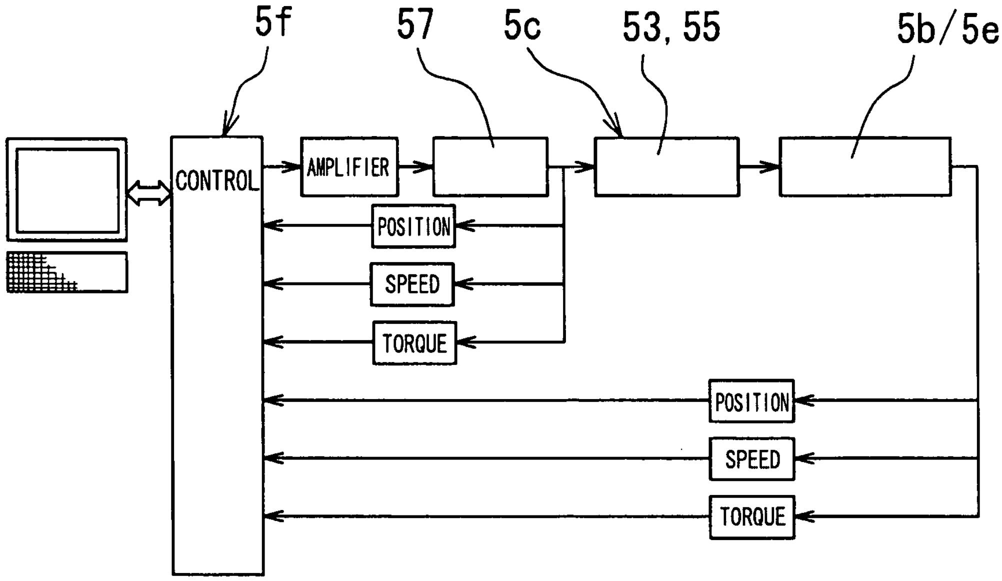

5f
57
5c
53, 55
5b/5e
CONTROL
AMPLIFIER
POSITION
SPEED
TORQUE
POSITION
SPEED
TORQUE

FIG. 10-A

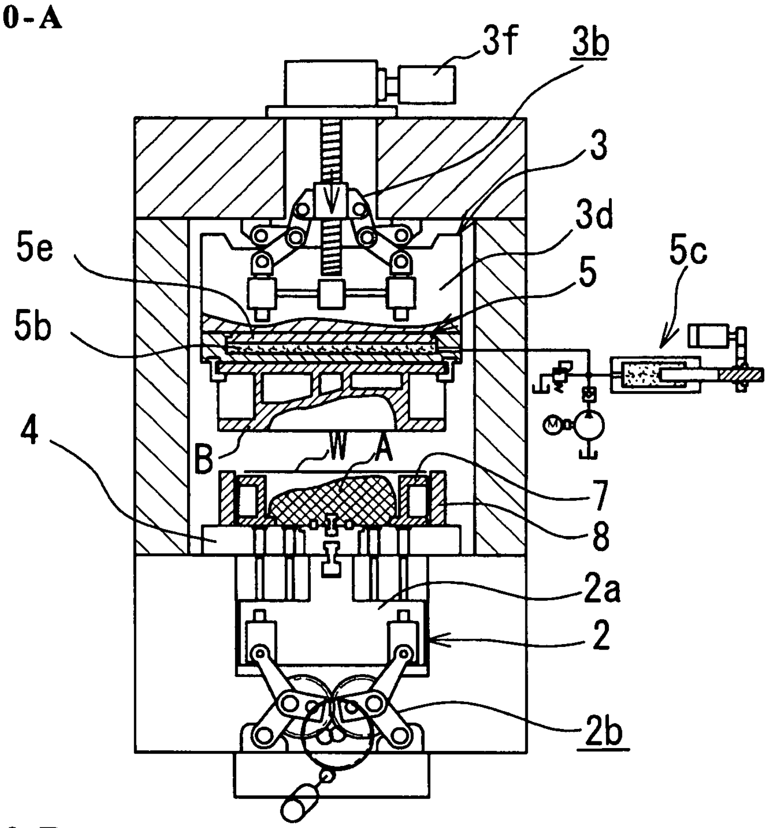


FIG. 10-B

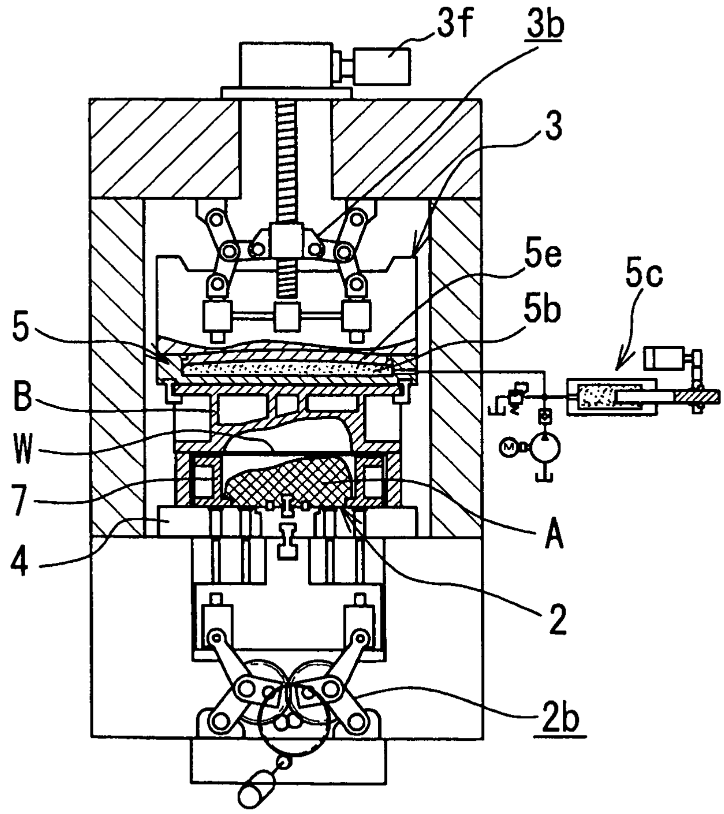


FIG. 10-C

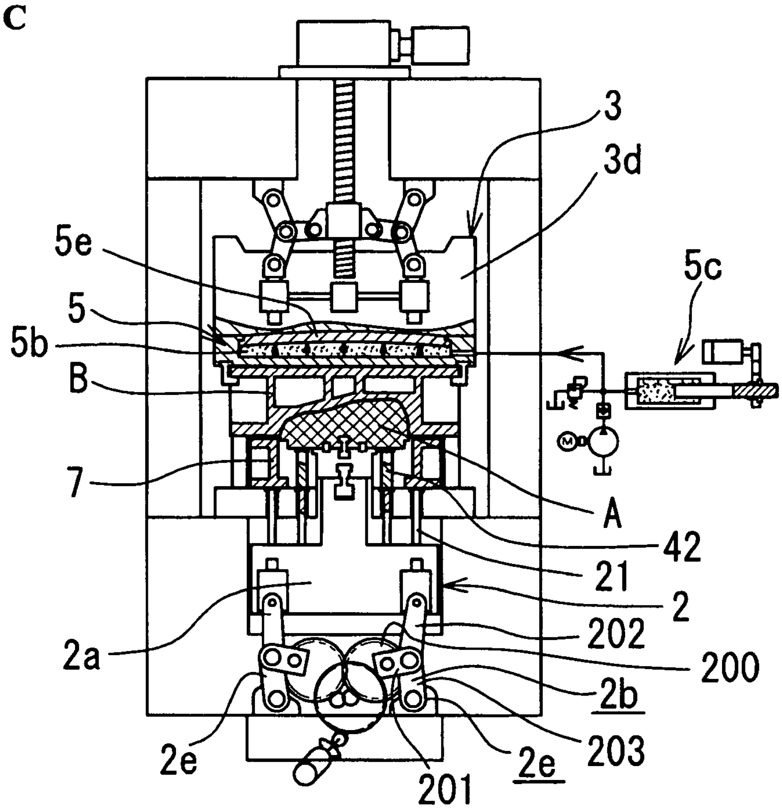


FIG. 10-D

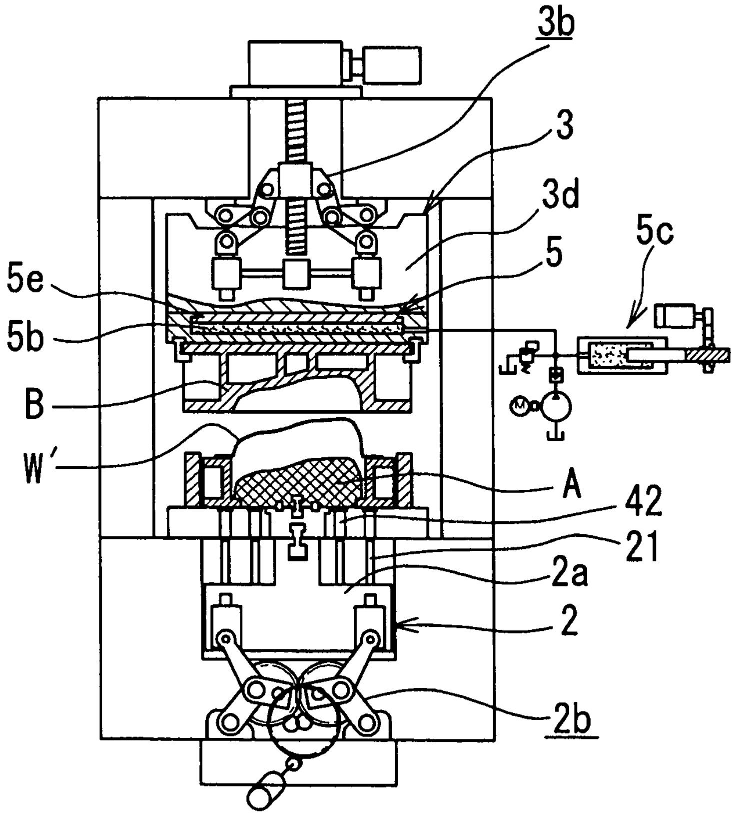


FIG. 11-A

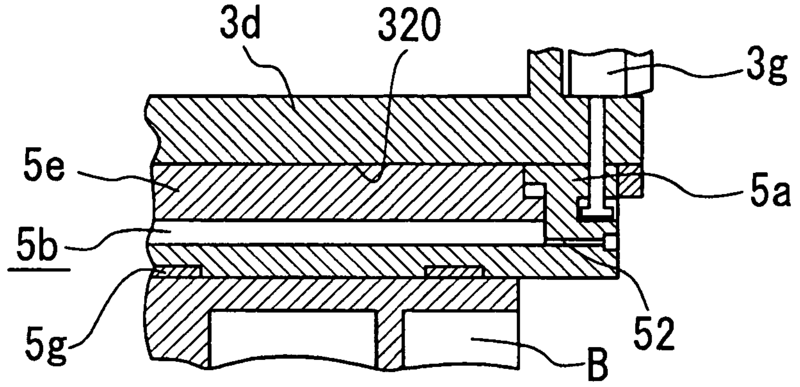


FIG. 11-B

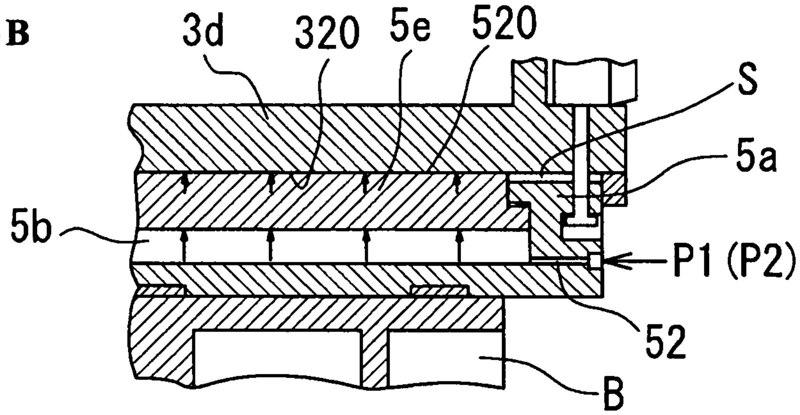


FIG. 12

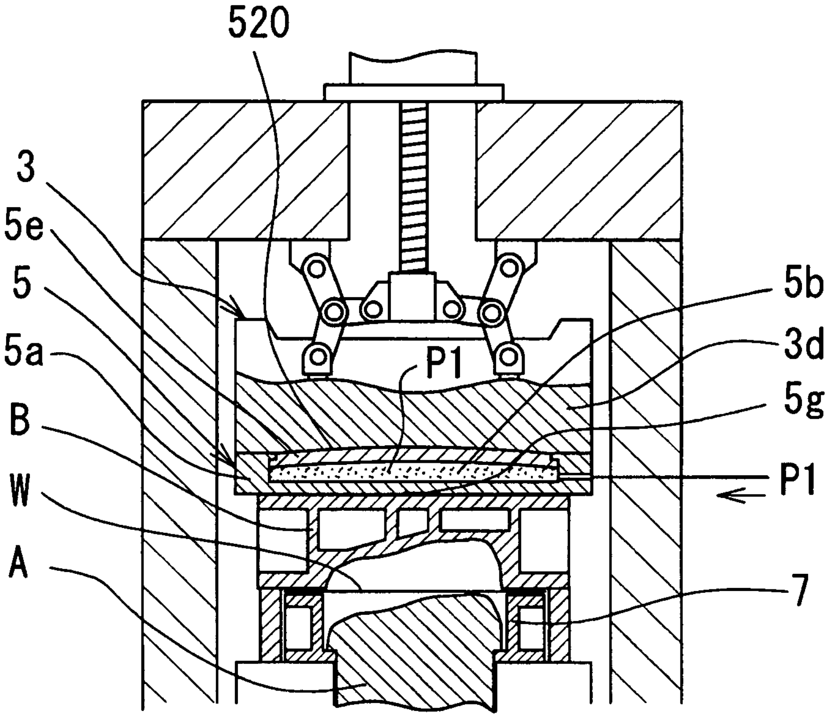


FIG. 13

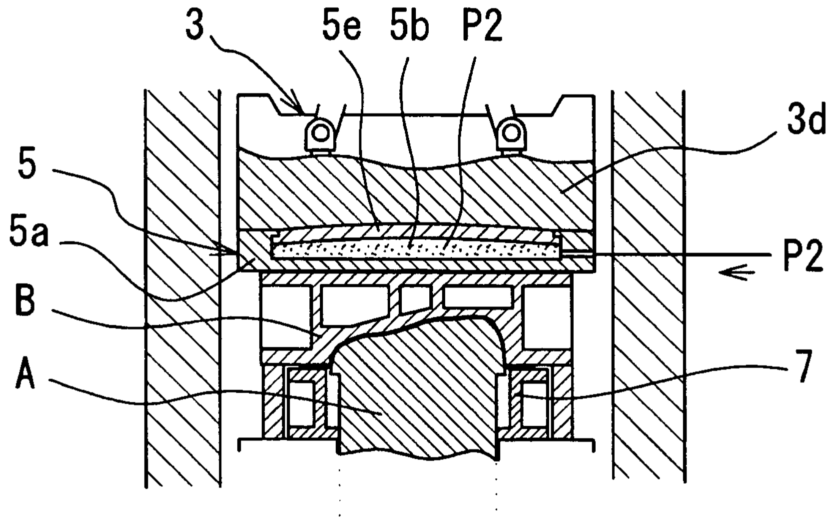


FIG. 14

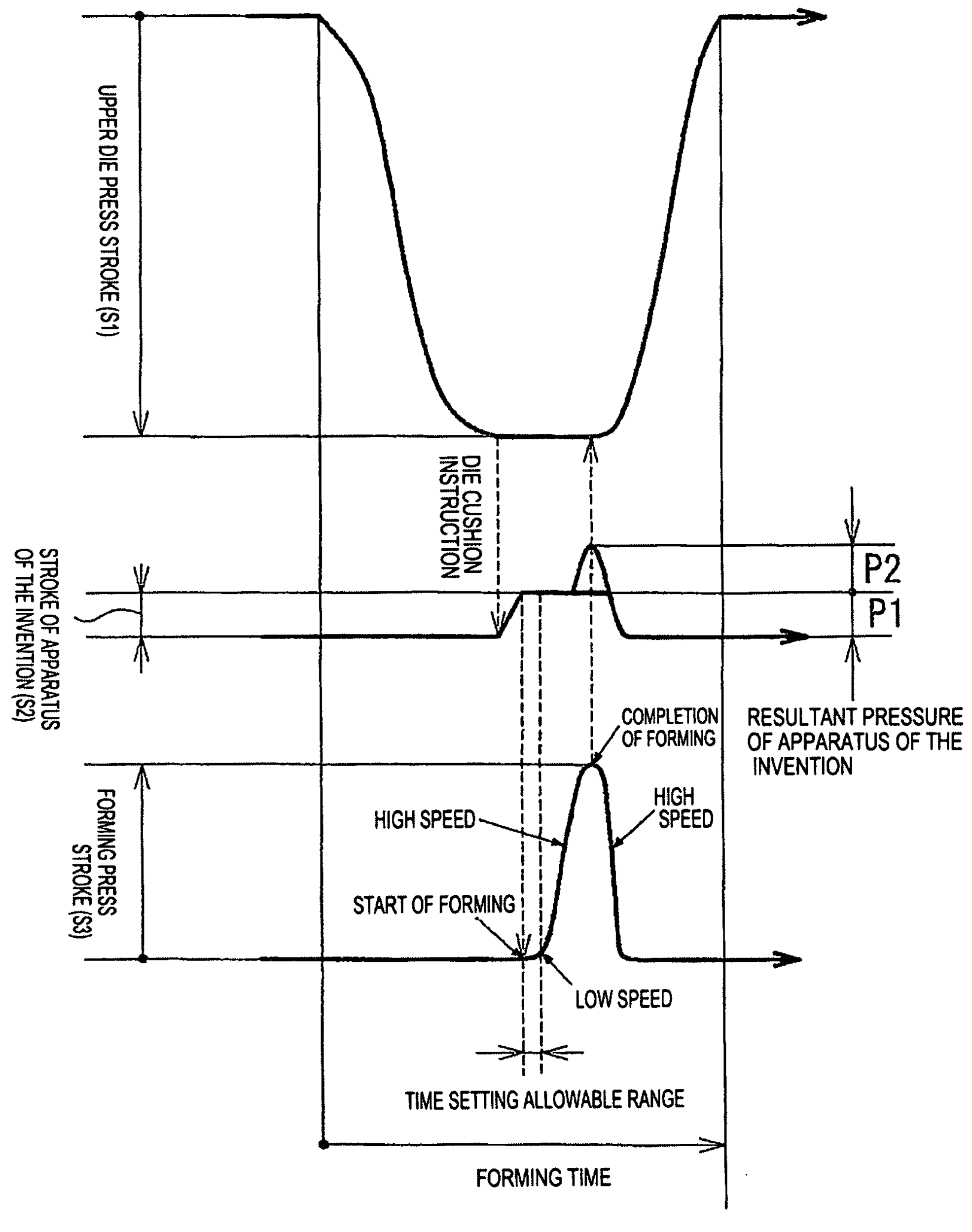

UPPER DIE PRESS STROKE (S1)
DIE CUSHION INSTRUCTION
STROKE OF APPARATUS OF THE INVENTION (S2)
P2
P1
RESULTANT PRESSURE OF APPARATUS OF THE INVENTION
COMPLETION OF FORMING
HIGH SPEED
HIGH SPEED
FORMING PRESS STROKE (S3)
START OF FORMING
LOW SPEED
TIME SETTING ALLOWABLE RANGE
FORMING TIME

FIG. 15

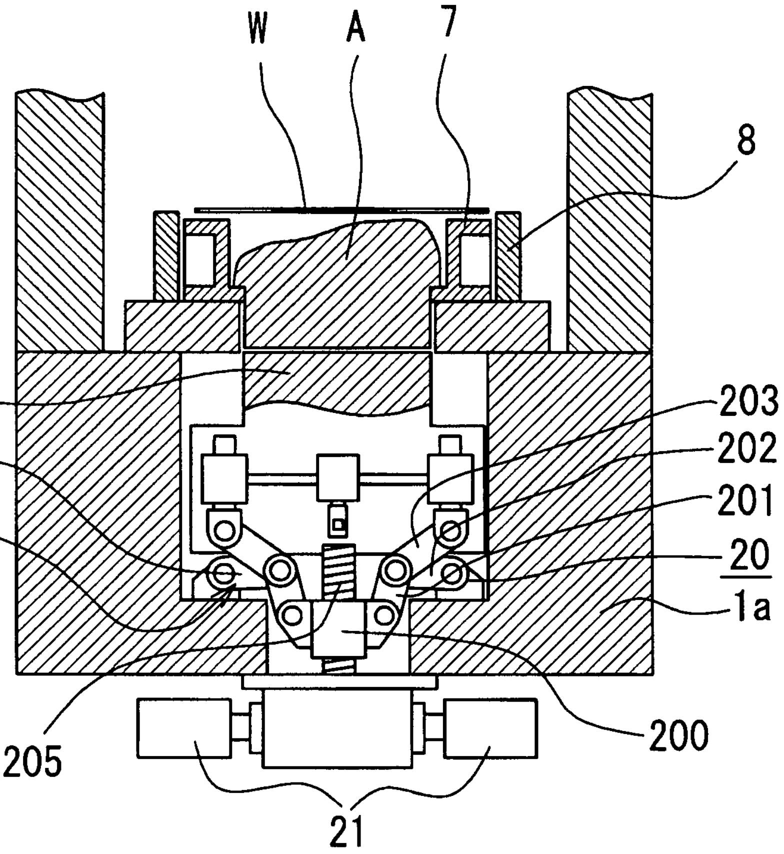


FIG. 16-A

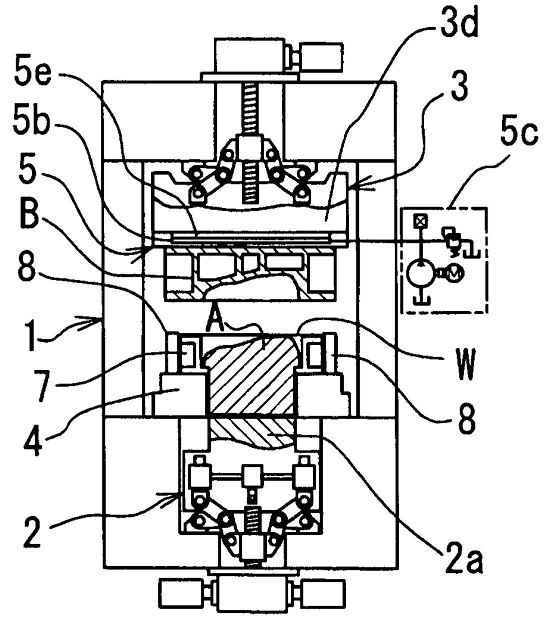


FIG. 16-B

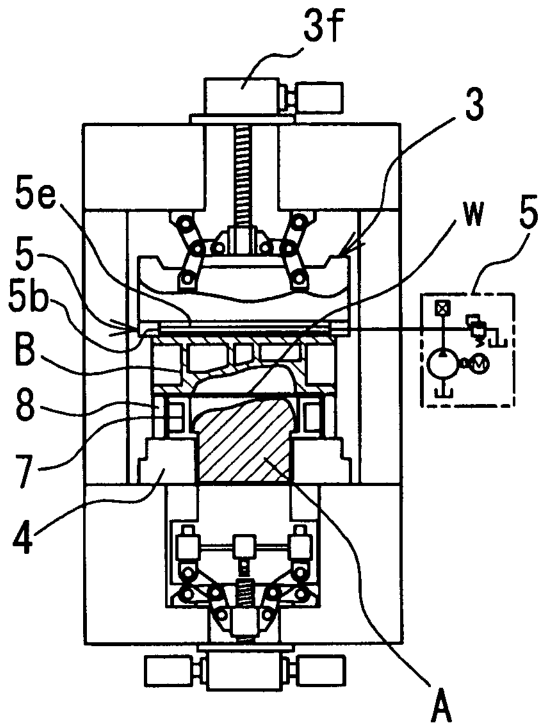


FIG. 16-C

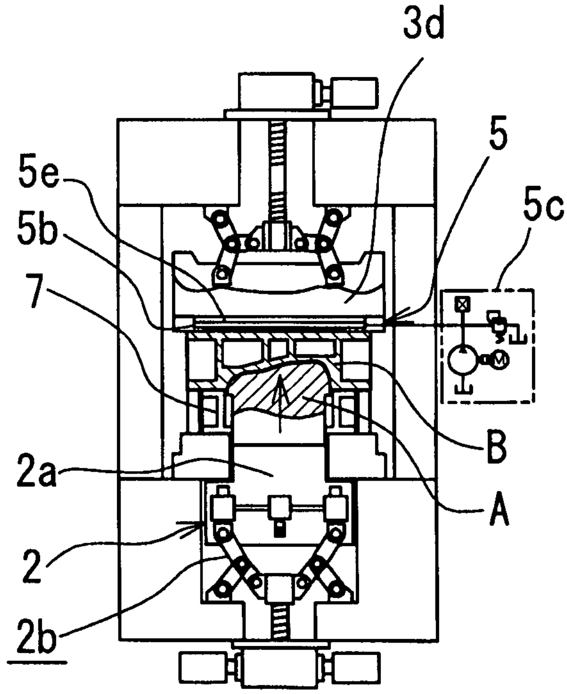


FIG. 16-D

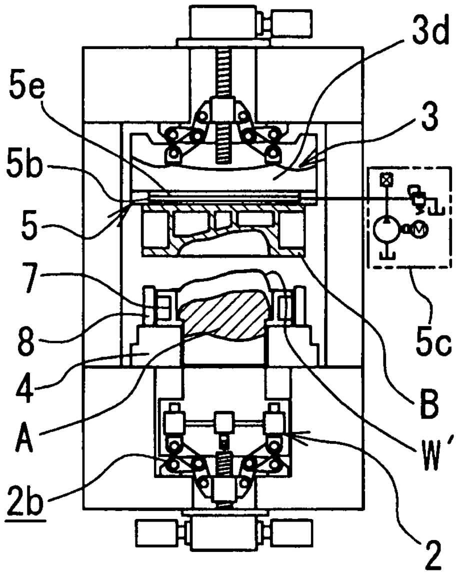


FIG. 17

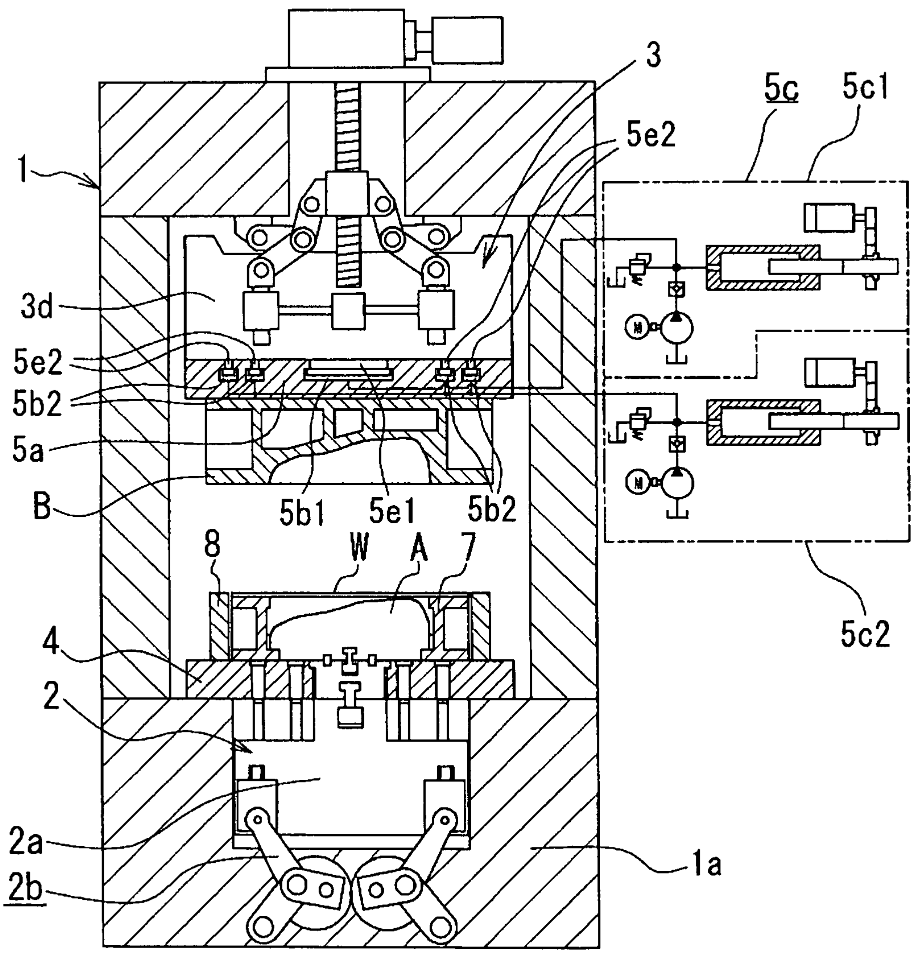


FIG. 18

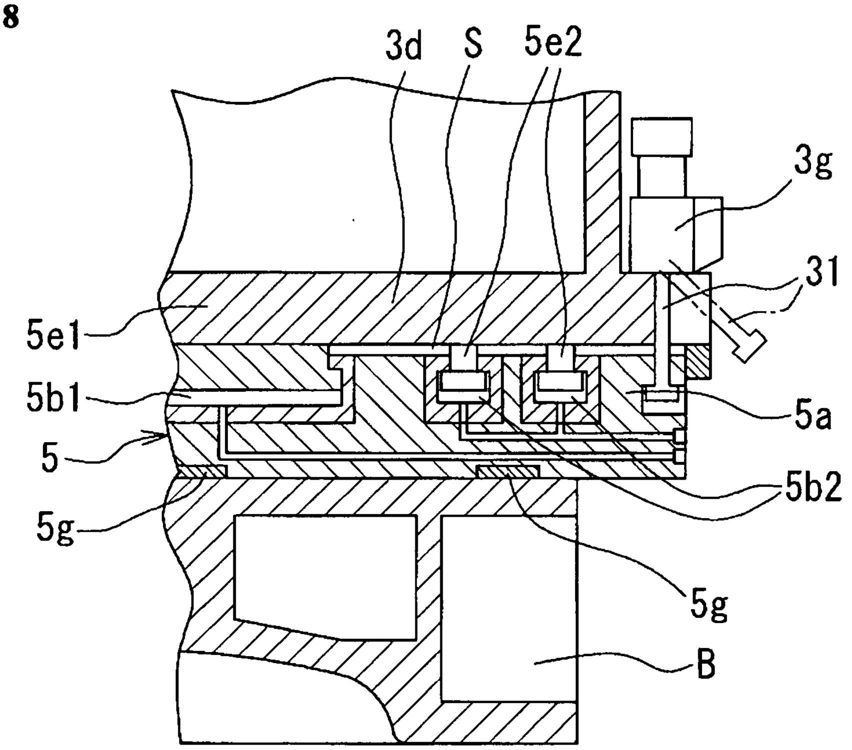


FIG. 19

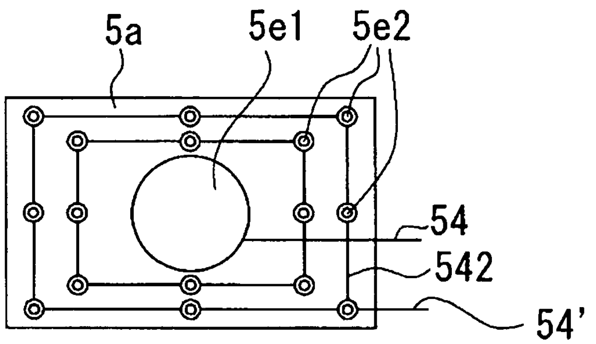


FIG. 20-A

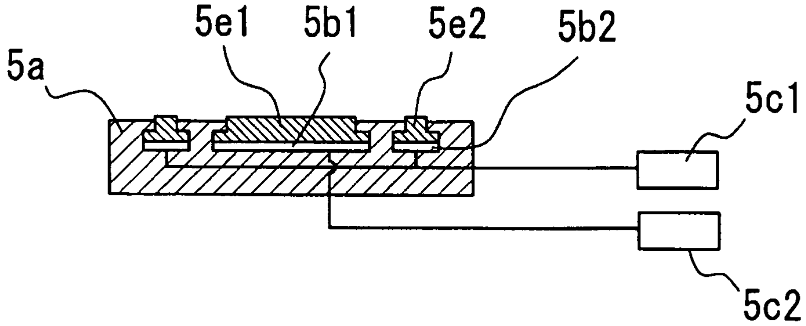


FIG. 20-B

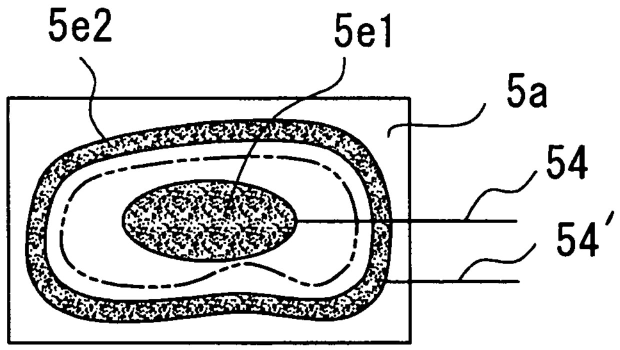


FIG. 21

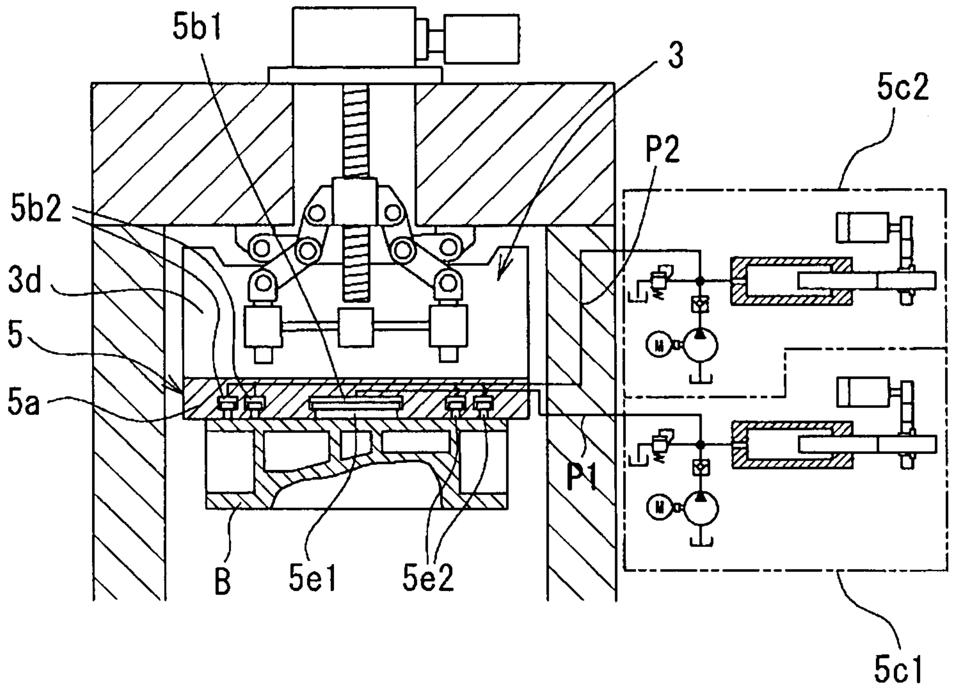


FIG. 22

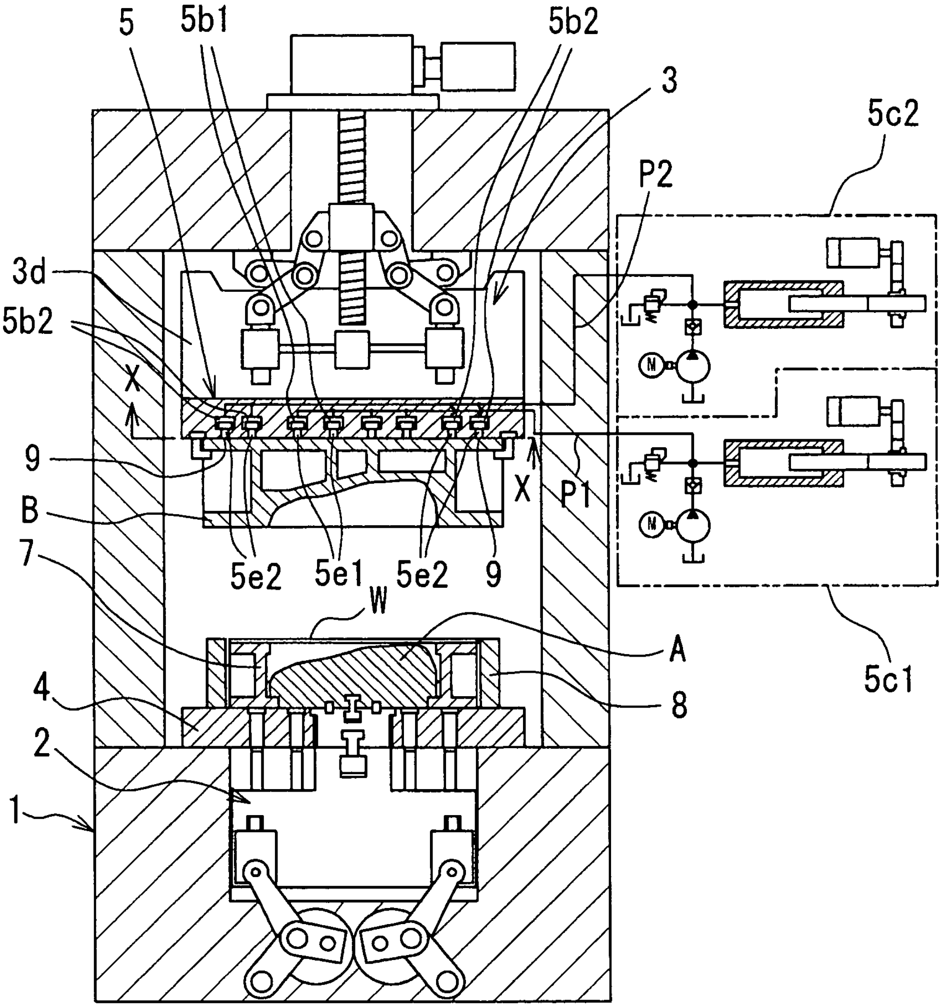

5
5b1
5b2
3
5c2
P2
3d
5b2
X
9
X
P1
B
7
5e2
5e1
5e2
9
W
A
5c1
4
8
2
1

FIG. 23

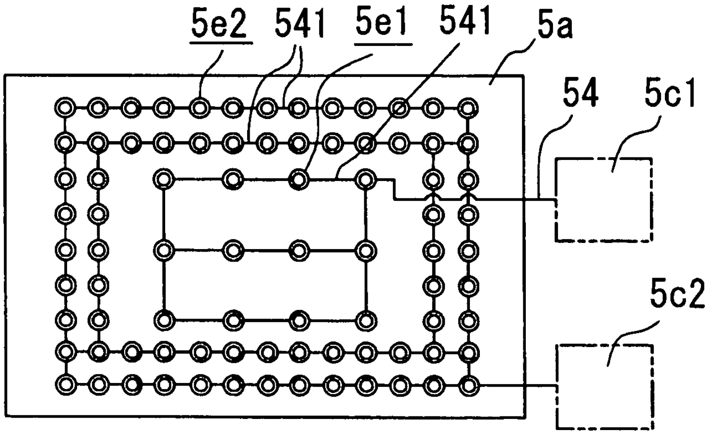

5e2
541
5e1
541
5a
54
5c1
5c2

FIG. 24-A

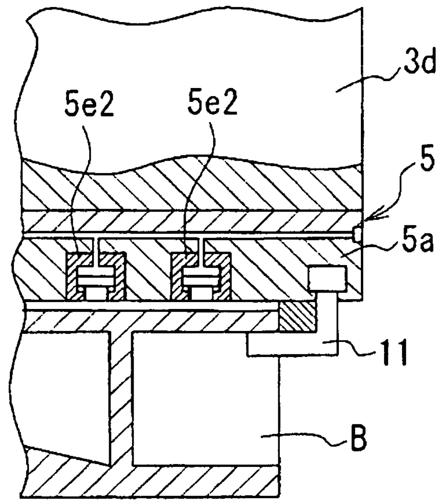


FIG. 24-B

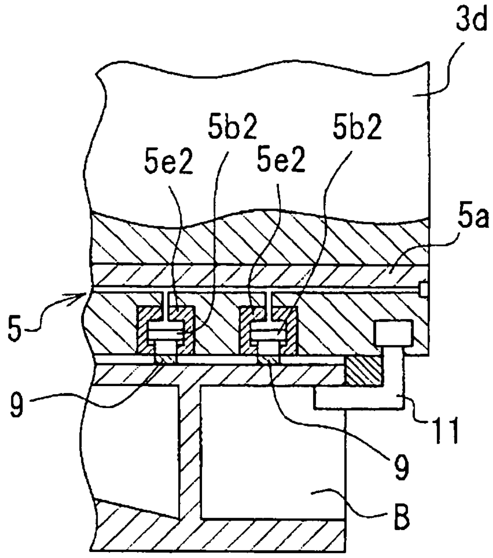


FIG. 25

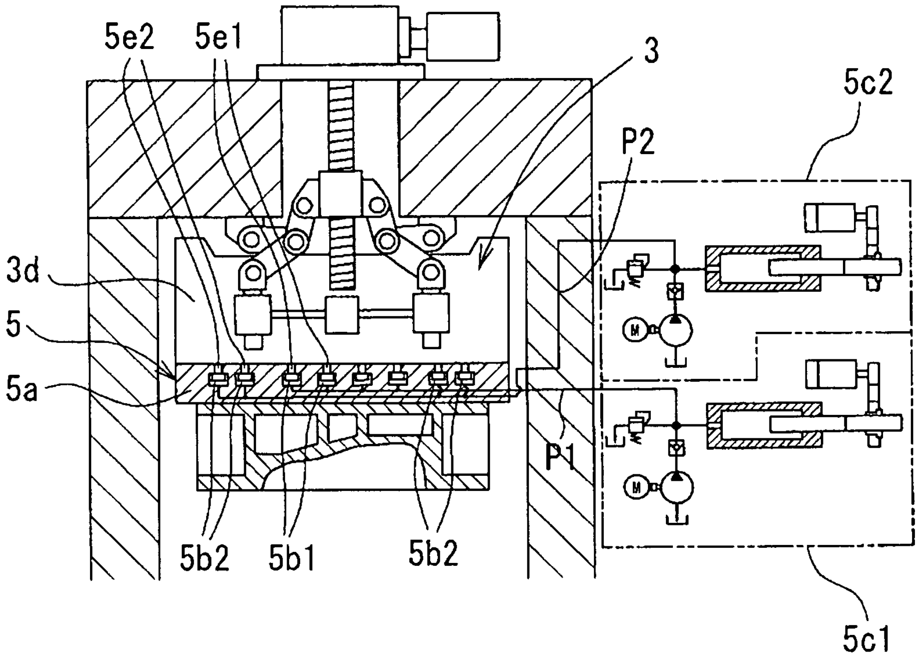
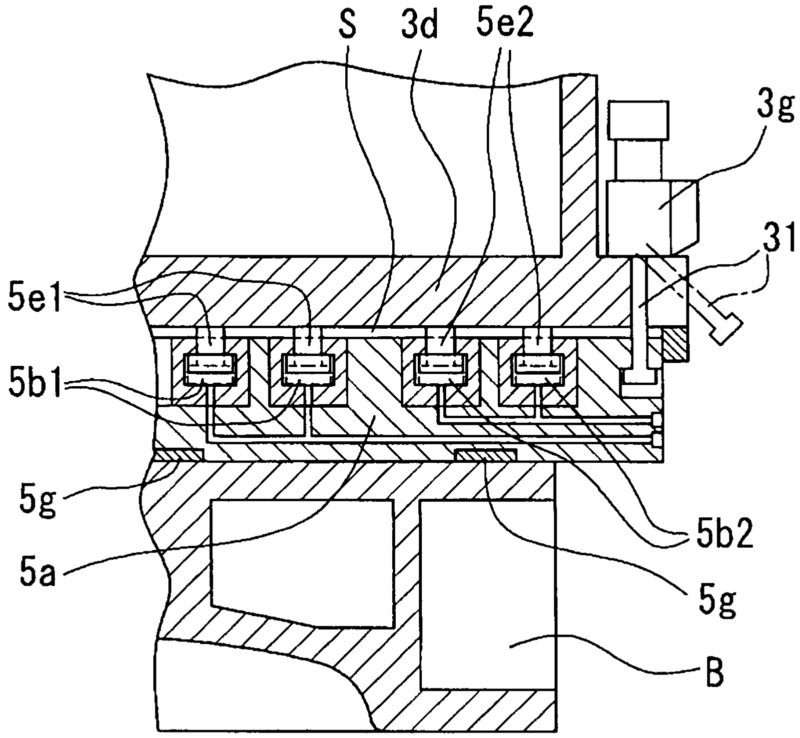

5e2
5e1
3
5c2
P2
3d
5
5a
P1
5b2
5b1
5b2
5c1

FIG. 26


S
3d
5e2
3g
31
5e1
5b1
5g
5b2
5a
5g
B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/059500

A. CLASSIFICATION OF SUBJECT MATTER
B30B15/02(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)
B30B15/02

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	1996-2007
Kokai Jitsuyo Shinan Koho	1971-2007	Toroku Jitsuyo Shinan Koho	1994-2007

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.
A	JP 2004-114079 A (Honda Motor Co., Ltd.), 15 April, 2004 (15.04.04), Full text; all drawings (Family: none)	1-11
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 49827/1987(Laid-open No. 157428/1988) (Fuji Heavy Industries Ltd.), 14 October, 1988 (14.10.88), Full text; all drawings (Family: none)	1-11

☐ 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	Date of mailing of the international search report
05 September, 2007 (05.09.07)	18 September, 2007 (18.09.07)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (April 2005)

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Patent documents cited in the description

- JP 2001300778 A **[0007] [0007]**