(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 602 420 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 158(3) EPC

(43) Date of publication:
07.12.2005 Bulletin 2005/49

(21) Application number: **04705944.9**

(22) Date of filing: **28.01.2004**

(51) Int Cl.[7]: **B21D 43/28**, B21D 5/01

(86) International application number:
PCT/JP2004/000726

(87) International publication number:
WO 2004/067203 (12.08.2004 Gazette 2004/33)

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PT RO SE SI SK TR
Designated Extension States:
AL LT LV MK

(30) Priority: **30.01.2003 JP 2003021467**

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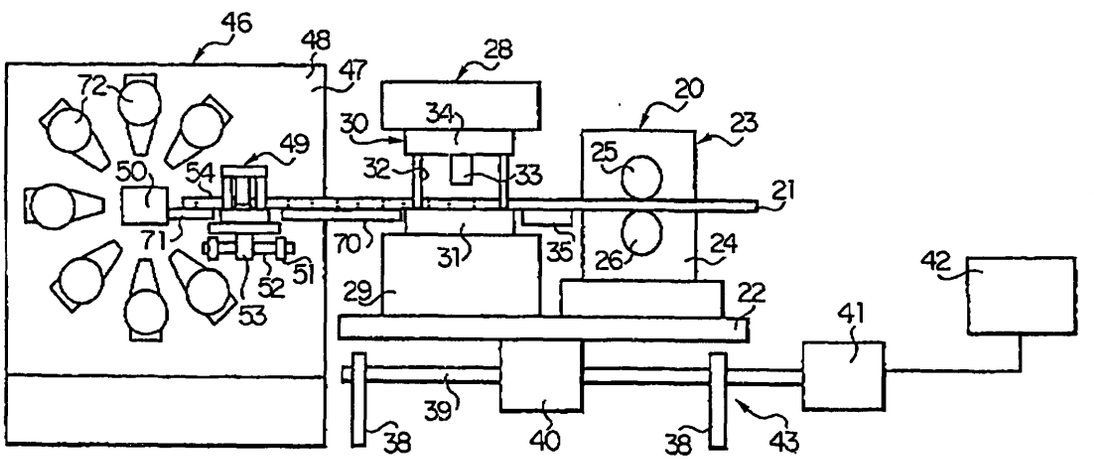
(54) SLENDER BODY MOLDING DEVICE

(57) A press machine 28 is fixed to a table 22 movable in the longitudinal direction of a strip material 21, and a moving unit 43 for moving the table 22 is provided. Even if the forced-back amount of the strip material 21 due to burrs varies according to changes of the kind of strip material 21, the table 22 and the press machine 28 can be integrally moved by the amount of variation by the moving unit 43 so that the distance between the position of processing (punching) of the strip material 21 by the press machine 28 and the position of cutting of the strip material 21 by the cutting machine 49 can be adjusted to a design value.

FIG. 1



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Description

<Technical Field>

[0001] This invention relates to a forming apparatus for strip materials which sequentially cuts a strip material into pieces while feeding the strip material in the longitudinal direction thereof and bends each of the pieces into a predetermined shape.

<Background Art>

[0002] A forming apparatus for strip materials, such as that described in JP-H01-109316U, has heretofore been known, and a related art such as that described in JP-H03-165941A has heretofore been known. The forming apparatus described in JP-H01-109316U is equipped with a feeder which intermittently feeds a strip material in the longitudinal direction thereof at a constant pitch, a partial processing machine (press machine) which is placed on a downstream side of the feeder and performs partial processing (punching of two holes) on the strip material, a cutting machine which is placed on a downstream side of the partial processing machine and cuts out pieces each having a length substantially equal to the constant pitch by cutting the strip material approximately in the longitudinal direction thereof, and a bending machine which is placed on a downstream side of the cutting machine and bends each of the pieces into a predetermined shape. The feeder, the partial processing machine, the cutting machine and the bending machine are individually fixed to the same frame in the state of being spaced apart from one another by a predetermined distance.

[0003] However, such a conventional forming apparatus for strip materials has the problem that a replacement process to be performed according to changes of the kind of strip material needs complicated and long-time work as will be described below.

[0004] The first reason for this is as follows. When a strip material is cut into pieces by a cutting machine, burrs are produced at the cutting position of each of the pieces, and the strip material is forced back toward a supply side due to accumulation of burrs produced at each of the pieces by their accumulating amount. The sizes of the burrs differ among the kinds of strip materials. Accordingly, even if a distance L1 between a rectangular processed hole 12 formed by a press machine and a cutting position 13 is adjusted to a design value in a previous kind of strip material 11 as shown in Fig. 9A, a distance L2 between the processed hole 12 and the cutting position 13 becomes a value different from the design value in the case of a different kind of strip material 11 as shown in Fig. 9B. In such a case, as shown in Fig. 10, a punching die set 15 of a press machine 14 is moved in the longitudinal direction of the strip material 11 by the rotation of adjustment screws 16 so that the distance L2 is adjusted to the design value, but it is technically extremely difficult to move the die set 15 by the amount of variation (L2-L1) between the previous process and the present process without deviating the die set 15 in the width direction of the strip material 11, so that the process becomes complicated and a long time is needed.

[0005] The second reason is as follows. In the case where a piece is bent into a predetermined shape by being pressed against a die by a bending tool of a bending slide unit, the die of a bending machine needs to be replaced with a die appropriate for a new strip material according to a change of the kind of strip material, but since the die is conventionally removably mounted on a front wall of a frame of the bending machine by a plurality of bolts, replacement of the die needs to be performed in such a way that after this plurality of bolts have been removed, the die is replaced, and after that, the bolts are fastened. In addition, at this time, the die must be set at a highly accurate position, so that the process becomes complicated and a long time is needed.

<Disclosure of the Invention>

[0006] An object of this invention is to provide a forming apparatus for strip materials which is capable of rapidly and easily executing a replacement process to be performed according to changes of the kind of strip material.

[0007] First, such object is achieved by providing a forming apparatus for strip materials which comprises a feeder for intermittently feeding a strip material in a longitudinal direction thereof at a constant pitch, a partial processing machine placed on a downstream side of the feeder and operative to perform partial processing on the strip material, a cutting machine placed on a downstream side of the partial processing machine and operative to cut out a piece having a length substantially equal to the constant pitch by cutting the strip material approximately in a width direction thereof, and a bending machine placed on a downstream side of the cutting machine and operative to bend the piece into a predetermined shape. In the forming apparatus, the partial processing machine is fixed to a table movable in the longitudinal direction of the strip material, and a moving unit is provided for moving the table.

[0008] Second, such object is achieved by providing a forming apparatus for strip materials which comprises a feeder for intermittently feeding a strip material in a longitudinal direction thereof at a constant pitch, a partial processing machine placed on a downstream side of the feeder and operative to perform partial processing on the strip material, a cutting machine placed on a downstream side of the partial processing machine and operative to cut out a piece having a length substantially equal to the constant pitch by cutting the strip material approximately in a width direction thereof, and a bending machine placed on a downstream side of the cutting machine and operative to bend the piece into a prede-

termined shape. The bending machine includes openable and closable paired grasping claws each having a front section projecting forwardly from a front wall of a frame of the bending machine, an opening and closing unit placed in the frame and operative to apply opening and closing driving forces to the grasping claws and operative to close the grasping claws and grasp and lock a die placed in abutment with the front wall of the frame, and a plurality of bending slide units supported on the frame so as to surround the die and operative to bend the piece by sequentially pressing their bending tools against the die via the piece.

[0009] First, in the invention, the partial processing machine is fixed to the table movable in the longitudinal direction of the strip material and the moving unit for moving the table is provided, so that even if the forced-back amount of the strip material varies according to changes of the kind of strip material, the distance between the position of processing of the strip material by the partial processing machine and the position of cutting of the strip material by the cutting machine can be adjusted to a design value only by moving the partial processing machine together with the table in the longitudinal direction of the strip material by the amount of variation of the forced-back amount by means of the moving unit. Accordingly, a replacement process can be rapidly and easily performed. In addition, the above-mentioned construction can easily cope with a case where the sizes of burrs vary with the lapse of time or the mounting position of a processing tool of the partial processing machine must be deviated.

In addition, the bending machine includes the openable and closable paired grasping claws each having the front section projecting forwardly from the front wall of the frame of the bending machine, the opening and closing unit placed in the frame and operative to apply opening and closing driving forces to the grasping claws and operative to close the grasping claws and grasp and lock the die placed in abutment with the front wall of the frame, and the plurality of bending slide units supported on the frame so as to surround the die and operative to bend the piece by sequentially pressing their bending tools against the die via the piece. Accordingly, when the kind of strip material is changed, the opening and closing unit opens the grasping claws to release the die from the grasp of the grasping claws, and after that, a die appropriate for a new kind of strip material is brought into abutment with the front wall of the frame and the grasping claws are closed to grasp and lock the die, thereby completing replacement of the die. Accordingly, the replacement process can be rapidly and easily performed. In addition, at this time, only the front sections of the grasping claws project from the front wall of the frame, and the rear sections of the grasping claws and the opening and closing unit are arranged in the frame, so that the front surface of the front wall can be effectively utilized as an area in which to place the plurality of bending slide units.

[0010] Furthermore, since the cutting machine is arranged in the vicinity of the bending position of the bending machine, it is possible to decrease the forced-back amount due to the above-mentioned burrs. Particularly when one of the pieces is cut obliquely with respect to the width direction thereof, it is possible to effectively prevent the problem that the obliquely cut piece hides under or rides on an adjacent piece.

[0011] In addition, since the feeder is also fixed to the table, the strip material can be integrally moved by the feeder while the table is being moved, so that it is possible to prevent discard of a partially processed strip material located between the partial processing machine and the cutting machine, whereby it is possible to improve the yield of products.

[0012] In addition, in the present application, each of the bending slide units is made of a slider movable toward and away from a die, a bending tool mounted on a forward end section of the slider, and a transport unit which moves the slider toward and away from the die. An accommodating hole in which a lock member having at its forward end a locking engagement section having an L-like cross-sectional shape bent toward one side is movably accommodated is formed in the forward end section of the slider, while a bending engagement section having an L-like cross-sectional shape bent toward the other side and being capable of engaging with the locking engagement section is provided at the proximal end of the bending tool whose proximal end section is to be inserted into the accommodating hole. Furthermore, a window is formed in an internal surface of one side of the accommodating hole, and a groove is formed in the proximal end section of the bending tool on one side thereof. Accordingly, the bending tool may be mounted on the slider by inserting the proximal end section of the bending tool into the accommodating hole while the bottom of the groove is brought in sliding contact with the internal surface of the one side of the accommodating hole located on the forward end side relative to the window and while the projecting section is inserted in the window, then translating the bending tool toward the other side to engage the bending engagement section with the locking engagement section, and then moving the lock member toward a deep side of the accommodating hole by means of a moving mechanism until at least a part of the projecting section reaches a side deeper than the window.

[0013] According to the above-mentioned construction, during replacement of a die, it is possible to easily and rapidly perform replacement of the bending tools of the bending slide units.

<Brief Description of the Drawings>

[0014]

Fig. 1 is a schematic front view showing one embodiment of this invention;

Fig. 2 is a plan view of an opening and closing unit which grasps a die;
Fig. 3 is a perspective view of the opening and closing unit which grasps the die;
Fig. 4 is a cross-sectional plan view of the opening and closing unit;
Fig. 5 is a perspective view of a bending slide unit;
Fig. 6 is a partially broken plan view of a section where a slider and a bending tool are joined to each other;
Fig. 7 is a cross-sectional view taken along line VII-VII of Fig. 6;
Fig. 8 is a schematic front view similar to Fig. 1, showing another embodiment of this invention;
Figs. 9A and 9B are plan views of different strip materials in which processed holes are formed; and
Fig. 10 is a schematic front view of a conventional press machine.

[0015] In the drawings, 20 ··· forming unit, 21 ··· slander material, 22 ··· table, 23 ··· feeder, 28 ··· partial processing machine, 43 ··· moving means, 46 ··· bending machine, 47 ··· frame, 48 ··· front wall, 49 ··· cutting machine, 54 ··· piece, 56 ··· opening and closing means, 67 ··· grasping claw, 72 ··· bending slide unit, 84 ··· slider, 85 ··· accommodating hole, 86 ··· lock member, 87 ··· locking engagement section, 92 ··· bending tool, 93 ··· transport means, 94 ··· bending engagement section, 97 ··· window, 98 ··· groove, 99 ··· projecting section, and 110 ··· moving mechanism.

<Best Mode for Carrying Out the Invention>

[0016] One embodiment of the invention will be described below with reference to the accompanying drawings.

[0017] In Fig. 1, reference numeral 21 denotes a metallic strip material which is made of a band-shaped plate material or a wire-shaped material and is a work to be processed. The strip material 21 extends horizontally from one side toward the other side, and after the strip material 21 has been cut into pieces of the same length by a forming machine 20, each of the pieces is formed into a product by bending. Reference numeral 22 denotes a horizontal rectangular plate-shaped table placed immediately below the strip material 21, and a feeder 23 which intermittently feeds the strip material 21 at a constant pitch in the longitudinal direction thereof; in this embodiment, from one side toward the other side, is fixed to the top surface of one side of the table 22. The feeder 23 has a body 24, a top roller 25 supported by the body 24 and located above the strip material 21, and a bottom roller 26 supported by the body 24 and located below the strip material 21, and at least one of the top and bottom rollers 25 and 26 is rotationally driven as needed, by a rotating unit which is not shown. As the top and bottom rollers 25 and 26 are intermittently rotated by a predetermined amount by the rotating unit while the top and bottom rollers 25 and 26 are clamping the strip material 21 from above and below, the strip material 21 is intermittently fed at a constant pitch from one side toward the other side by the top and bottom rollers 25 and 26.

[0018] A press machine 28, which serves as a partial processing machine which performs partial processing on the strip material 21; in this embodiment, forms rectangular processed holes 12 as shown in Figs. 9A and 9B by way of example, is placed on a downstream side, i.e., the other side, of the feeder 23. The press machine 28 is fixed to the top surface of the table 22 on the other side thereof. Typical examples of the partial processing are, in addition to piercing using punching as in this embodiment, trimming which removes unnecessary areas by cutting, and stamping which forms an uneven pattern on a part of the surface of the strip material 21. The press machine 28 is made of a body 29 and a die set 30 removably mounted on the body 29. The die set 30 is made of a die holder 31 on which a die is mounted, a plurality of guide posts 32 uprightly provided on the die holder 31, and a punch holder 34 which can move up and down by slidably engaging with the guide posts 32 immediately above the die holder 31 and has a punch 33 mounted on its bottom surface.

[0019] When the punch holder 34 is moved down by a lifting unit contained in the body 29 and the punch 33 is inserted into the die, the processed holes 12 each having the same shape as the cross-sectional shape of the punch 33 are formed in the strip material 21. Conversely, a die holder on which a die is mounted may be placed above the strip material 21 and a punch holder on which a punch is mounted may be placed below the strip material 21 so that the processed holes 12 can be formed in the strip material 21 by moving up the punch holder. Reference numeral 35 denotes a guide plate which is placed between the feeder 23 and the press machine 28 so as to guide the strip material 21 between the feeder 23 and the press machine 28 while supporting the strip material 21 from below.

[0020] A screw shaft 39 made of a ball thread rotatably supported at both ends by bearings 38 and arranged to extend in parallel with the strip material 21 is placed immediately below the table 22. The screw shaft 39 is screwed through a screw block 40 fixed to the bottom surface of the table 22. Reference numeral 41 denotes a driving section joined to one end of the screw shaft 39. The driving section 41 gives rotational driving force to the screw shaft 39 on the basis of control signals from a control section 42, thereby causing the table 22, the feeder 23 and the press machine 28 to move integrally in the longitudinal direction of the strip material 21. The driving section 41 may use, for example, a servo motor or a stepping motor. In addition, the screw shaft 39, the screw block 40, the driving section 41 and the control section 42 as a whole constitute a moving unit 43 which causes the table 22 movable in the longitudinal direction of the strip material 21 to move together with the feeder

23 and the press machine 28. The moving unit 43 may use a servo cylinder and the like.

[0021] Reference numeral 46 denotes a bending machine which is generally called a multi-forming machine and is placed on a downstream side of the press machine 28; in this embodiment, on the other side of the same. A frame 47 of the bending machine 46 has a vertically extending, front wall 48 at its front end, and a cutting machine 49 is mounted on the front surface of the front wall 48. The cutting machine 49 is arranged in the vicinity of a die 50 on an upstream side (one side) of the bending position of the bending machine 46, i.e., a position where the die 50 is placed, so that the bending machine 46 is placed on a downstream side (the other side) of the cutting machine 49. The cutting machine 49 cuts the strip material 21 approximately in the width direction thereof each time the feed of the strip material 21 by the feeder 23 comes to a stop, and successively cuts out pieces 54 each having a length substantially equal to the feed pitch (constant pitch) of the strip material 21. A screw shaft 52 arranged to extend in parallel with the strip material 21 is rotatably supported via bearings 51 on the front wall 48 immediately below the cutting machine 49, and is screwed through a screw block 53 fixed to the bottom end of the cutting machine 49. Accordingly, a cutting position for the strip material 21 can be simply and easily adjusted by rotating the screw block 53 to move the cutting machine 49 in the longitudinal direction of the strip material 21.

[0022] An opening and closing unit 56 which is placed in the frame 47 in such a manner that its front end is mounted on the rear surface of the front wall 48 will be described below with reference to Figs. 1, 2, 3 and 4. The opening and closing unit 56 is made of a pair of opening and closing mechanisms 57 which are separated from each other in the longitudinal direction of the strip material 21. Each of the opening and closing mechanisms 57 is made of a body block 58, a transmission rod 59 supported in the body block 58 for forward and rearward movement therein and arranged to extend in the forward and rearward directions thereof, a swing arm 61 joined to a rear end section of the transmission rod 59 at its internal end section, swingably supported in the body block 58 by a pin 60 at its central section, and arranged to extend approximately in parallel with the strip material 21, a driving mechanism (not shown) which swings the swing arm 61 by giving driving force to the external end section of the swing arm 61, and a swing link 63 arranged to extend approximately in parallel with the transmission rod 59 at the outside thereof and swingably joined to the body block 58 by a pin 62 at its rear end section.

[0023] Reference numerals 67 denote a pair of openable and closable grasping claws (although in this embodiment a pair of grasping claws are used, a plurality of pairs of grasping claws may also be used). The front end section of the transmission rod 59 is pivotably joined to an internal end section of each of the grasping claws 67 at the rear end section thereof by a pin 68, while the front end section of the swing link 63 is pivotably joined to an external end section of the same by a pin 69. only the front section of the grasping claw 67 projects forwardly from the front wall 48 of the bending machine 46, and the rear section of the grasping claw 67 is located in the frame 47. It can be considered that a plurality of fixing units for positioning and fixing the die 50 to the front wall 48 are placed on the front surface of the front wall 48, but in this case, the front surface of the front wall 48 is occupied by the fixing units to a certain degree, so that an area in which to place bending slide units which will be described later becomes narrow and complicated bending becomes difficult. Conversely, in the case where only the front section of the grasping claw 67 is projected forwardly from the front wall 48 and the rear section of the grasping claw 67 and the opening and closing unit 56 for opening and closing the grasping claw 67 are accommodated in the frame 47 as in this embodiment, the front surface of the front wall 48 can be effectively utilized as an area in which to place a plurality of bending slide units, so that complicated bending becomes possible.

[0024] When driving forces from the driving mechanisms are respectively transmitted to the transmission rods 59 via the swing arms 61 to move the transmission rods 59 forwardly, the respective grasping claws 67 swing outwardly about the pins 69, so that the grasping claws 67 open and release the grasp of the die 50 pressed against the front wall 48. Conversely, when the transmission rods 59 are respectively moved rearwardly by driving forces from the driving mechanisms, the respective grasping claws 67 swing inwardly about the pins 69, so that the grasping claws 67 close and grasp the die 50 on both sides thereof while pressing the die 50 against the front wall 48, thereby highly accurately positioning and fixing the die 50 at a predetermined bending position. In this manner, when opening and closing driving force from the opening and closing unit 56 is applied to the paired grasping claws 67 to close the grasping claws 67, the die 50 which abuts on the front wall 48 of the frame 47 is grasped and locked by the grasping claws 67. Reference numerals 70 and 71 denote guide plates which are respectively placed between the press machine 28 and the cutting machine 49 and between the cutting machine 49 and the die 50 of the bending machine 46, and the guide plates 70 and 71 respectively guide the strip material 21 between the press machine 28 and the cutting machine 49 and between the cutting machine 49 and the die 50 of the bending machine 46 while supporting the strip material 21 from below.

[0025] A plurality of bending slide units 72 which are arranged to surround the die 50 will be described below with reference to Figs. 1, 5, 6 and 7. Each of the bending slide units 72 is fixed to the front surface of the front wall 48 by a slide block 73. A slide plate 74 is slidably supported by the slide block 73. The slide plate 74 extends

approximately in the radial direction centered on the die 50. Reference numeral 75 denotes a cam shaft which extends through an external end section of the slide plate 74 in the forward and rearward directions, and the rear end section of the cam shaft 75 is rotatably supported by the front wall 48 and is joined to a servo motor which is not shown. A push cam 76 and a return cam 77 are fixed to the front end section of the cam shaft 75, and a cam follower 79 which is rotatably supported on the slide plate 74 by a support block 78 is in rolling contact with the peripheries of the push cam 76 and the return cam 77. Accordingly, as the cam shaft 75, the push cam 76 and the return cam 77 are integrally rotated by the activation of the servo motor, the slide plate 74 moves toward the die 50 by being pushed by the push cam 76. On the other hand, when the slide plate 74 is pushed by the return cam 77, the slide plate 74 moves away from the die 50.

[0026] A quadrangular prism-shaped mounting case 82 having a hollow section 81 opened on the front side and on the forward end side is fixed to the front surface of the forward end section of the slide plate 74 which is in the vicinity of the die 50, and a rectangular plate-shaped cap 83 which closes the front-side opening of the hollow section 81 is mounted on the front side of the mounting case 82. The slide plate 74, the mounting case 82 and the adjustment mechanism 83 as a whole constitute a slider 84 which is movable toward and away from the die 50 of the bending machine 46, and an accommodating hole 85 opened on the forward end side is formed in the forward end section of the slider 84 by the front-side opening of the hollow section 81 being closed by the cap 83. An approximately quadrangular prism-shaped lock member 86 is accommodated in the deepest section (proximal section) of the accommodating hole 85 for movement in the longitudinal direction of the slider 84, and the lock member 86 has at its forward end a locking engagement section 87 having an L-like cross-sectional shape bent toward one side (in this embodiment, toward the front side).

[0027] Reference numeral 90 denotes a punch holder, and a punch 91 which applies bending to the pieces 54 in cooperation with the die 50 is fixed to the forward end section of the punch holder 90. The punch holder 90 and the punch 91 as a whole constitute a bending tool 92 removably mounted on the forward end section of the slider 84, and the cam shaft 75, the push cam 76, the return cam 77, the support block 78, the cam follower 79 and the servo motor as a whole constitute a transport unit 93 which moves the slider 84 toward and away from the 50. When the bending tool 92 is mounted on the slider 84, the proximal end section of the bending tool 92; in this embodiment, the proximal end section of the punch holder 90, is inserted in the accommodating hole 85 of the slider 84. A bending engagement section 94 having an L-like cross-sectional shape bent toward the other side (rear side) is provided at the proximal end of the bending tool 92, specifically, at the proximal end of the punch holder 90, and the bending engagement section 94 can be brought into engagement with the locking engagement section 87 of the lock member 86. The slider 84, the bending tool 92 and the transport unit 93 as a whole constitute the bending slide units 72 which bends the pieces 54 into a predetermined shape by sequentially pressing the bending tool 92 against the die 50 via the pieces 54.

[0028] Reference numeral 97 denotes a rectangular window which is formed in an internal surface of the accommodating hole 85 on one side (front side) thereof and extends through the cap 83, and the window 97 is located on a forward end side relative to the lock member 86. A rectangular groove 98 which extends in the longitudinal direction of the bending tool 92 and has a uniform depth is formed in the bending tool 92, specifically, in the proximal end section of the punch holder 90 on one side (front side) thereof, while a projecting section 99 which projects toward one side (front side) is formed at the proximal end of the bending tool 92, specifically, the punch holder 90. Reference numeral 100 denotes a press cam accommodated in the accommodating hole 85, and a spring 101 which urges the press cam 100 toward the forward end is inserted between the press cam 100 and the bottom of the accommodating hole 85. When the proximal end section of the bending tool 92 is inserted into the accommodating hole 85 and mounted onto the slider 84, the press cam 100 presses the proximal end section of the bending tool 92, specifically, the punch holder 90 against the internal side surface of the accommodating hole 85 by means of an inclined surface 102, thereby effecting positioning of the bending tool 92 with respect to the slider 84 in the width direction thereof and preventing deviations in the width direction.

[0029] Reference numeral 105 denotes a rotating shaft having a central section extending through the side wall of the accommodating hole 85 and an intern end section inserted in the lock member 86, and a circular cam 106 is eccentrically fixed to the internal end of the rotating shaft 105. The cam 106 is accommodated in a rectangular parallelepiped-shaped cam chamber 107 formed in the lock member 86, and the proximal end of a lever 108 is fixed to the external end of the rotating shaft 105. As shown in Figs. 5 and 6, when the lever 108 is made to swing toward the proximal end of the punch holder 90, the lock member 86 moves toward the deepest part of the accommodating hole 85 by being pressed by the cam 106. On the other hand, when the lever 108 is made to swing toward the forward end of the punch holder 90, the lock member 86 moves toward the forward opening of the accommodating hole 85 by being pressed by the cam 106. The rotating shaft 105, the cam 106 and the lever 108 as a whole constitute a moving mechanism 110 which moves the lock member 86 in the accommodating hole 85 toward the forward end or the deepest part. In the case where the bending engagement section 94 of the bending tool 92 is en-

gaged with the locking engagement section 87 of the lock member 86, when the lock member 86 moves toward the inner part as described above, the bending tool 92 is also moved into the accommodating hole 85, but at this time, when at least a part of the projecting section 99 reaches a side deeper than the window 97, the forward and rearward movement of the bending tool 92 is restricted by the mounting case 82 and the cap 83, so that the bending tool 92 is prevented from coming off the slider 84. Then, when the bending tool 92 is moved into the accommodating hole 85 by the swing of the lever 108 toward the proximal end until a step 109 of the punch holder 90 comes into abutment with the forward end surface of the mounting case 82, the bending tool 92 is firmly mounted on the slider 84.

[0030] The operation of the embodiment of the invention will be described below.

[0031] It is assumed here than the servo motor of each of the bending slide units 72 is operating to sequentially move a respective one of the bending tools 92 toward the die 50 and sequentially press each of the pieces 54 against the die 50 and bend it into a predetermined shape by means of the punch 91 . During this bending process, in the forming machine 20, the top and bottom rollers 25 and 26 of the feeder 23 stop rotations in the state of grasping the strip material 21 from above and below. In the press machine 28, the punch holder 34 is moved up after having been moved down by the lifting unit, so that the punch 33 and a die (not shown) of the die holder 31 cooperate to form the processed holes 12 in the strip material 21. In addition, the cutting machine 49 operates to cut the strip material 21 approximately in the width direction thereof at a cutting position 13, thereby cutting out the pieces 54 having a length substantially equal to the feed pitch of the strip material 21. In addition, at this time, a plurality of cut pieces 54 are placed on the guide plate 71 in the state of abutting on one another.

[0032] Then, when each of the pieces 54 has been bent into a predetermined shape as described above, the piece 54 bent in this manner is ejected from the bending machine 46. Then, when the top and bottom rollers 25 and 26 of the feeder 23 are rotated by a predetermined amount by the rotating unit, the strip material 21 is intermittently fed at a constant pitch from one side toward the other side by the top and bottom rollers 25 and 26, so that the piece 54 located at the downstream end is fed to the bending position of the bending machine 46, i.e., the die 50. After that, the piece 54 is bent into a predetermined shape in a manner similar to the above-mentioned one.

[0033] When bending is to be performed on a different kind (width, thickness, material or the like) of strip material 21 after the completion of the bending of the above-mentioned kind of strip material 21, the die set 30, the die 50 and the bending tool 92 are replaced with those appropriate for the new kind of strip material 21 in the press machine 28 and the bending machine 46. In this case, first, after the previous kind of strip material 21 has been removed from the forming machine 20, the die set 30 is removed from the body 29, and then the die set 30 appropriate for the new kind of strip material 21 is mounted on the body 29. In the bending machine 46, driving forces from the driving mechanisms are applied to the swing arms 61 of the opening and closing unit 56, thereby moving the transmission rods 59 of the respective opening and closing mechanisms 57 forwardly. In this manner, the respective grasping claws 67 swing outwardly about the pins 69, so that the paired grasping claws 67 are opened and release the grasp of the die 50 pressed against the front wall 48.

[0034] After the die 50 released from the grasping claws 67 has been unloaded from the bending machine 46 in this manner, the die 50 appropriate for the new kind of strip material 21 is loaded into the bending machine 46 and is pressed against the front wall 48 at the bending position. In this state, the transmission rods 59 of the respective opening and closing mechanisms 57 are moved rearwardly by the driving mechanisms, so that the paired grasping claws 67 are made to swing inwardly and are closed. In this manner, the die 50 is grasped on both sides by the grasping claws 67, and is positioned and fixed to the frame 47 of the bending machine 46. Accordingly, when the kind of strip material 21 is to be changed, replacement of the die 50 can be performed only by opening the grasping claws 67 by means of the opening and closing unit 56 to release the grasp of the die 50 and then closing the grasping claws 67 to grasp and clock the die 50 appropriate for the new kind of strip material 21 while holding the die 50 in abutment with the front wall 48 of the frame 47. Accordingly, replacement processing can be rapidly and easily performed.

[0035] In addition, in each of the bending slide units 72, as the lever 108 is swung toward the forward end to cause the cam 106 to perform approximately a half rotation, the lock member 86 and the bending tool 92 are moved by the cam 106 to a position where the projecting section 99 overlaps the window 97 on the forward opening side of the accommodating hole 85. After that, the bending tool 92 is translated to one side (front side) until the projecting section 99 is inserted into the window 97 and the bottom of the groove 98 comes into abutment with the internal surface of one side (front side) of the accommodating hole 85 which is located on the forward end side relative to the window 97. In this manner, the bending engagement section 94 of the bending tool 92 is disengaged from the locking engagement section 87 of the lock member 86. Then, the bending tool 92 is moved toward the forward end while the bottom of the groove 98 is brought in sliding contact with the internal surface of the one side (front side) of the accommodating hole 85 located on the forward end side relative to the window 97 and while the projecting section 99 is inserted in the window 97. After that, the bending tool 92 is translated toward the other side (rear side) and is

again moved toward the forward end. In this manner, the bending tool 92 for the previous kind of the die 50 is extracted from the slider 84.

[0036] Then, the proximal end section of the bending tool 92 appropriate for the new kind of die 50 is inserted until the bending engagement section 94 comes into abutment with the locking engagement section 87 in the accommodating hole 85. Then, the bending tool 92 is translated toward one side (front side) until the projecting section 99 is inserted into the window 97 and the bottom of the groove 98 comes into abutment with the internal surface of one side (front side) of the accommodating hole 85 located on the forward end side relative to the window 97. After that, the bending tool 92 is moved toward the deepest side while the bottom of the groove 98 is brought in sliding contact with the internal surface of the one side (front side) of the accommodating hole 85 located on the forward end side relative to the window 97 and while the projecting section 99 being inserted in the window 97, and the proximal end section of the bending tool 92 is inserted far more deeply into the accommodating hole 85. Then, the bending tool 92 is translated toward the other side (rear side) to bring the bending engagement section 94 into engagement with the locking engagement section 87. After that, the lever 108 is swung toward the proximal end to cause the cam 106 to perform an approximately half rotation.

[0037] In this manner, the lock member 86 and the bending tool 92 moves to the deep side of the accommodating hole 85, but the movement of the lock member 86 and the bending tool 92 comes to a stop when at least a part of the projecting section 99; in this embodiment, the whole of the projecting section 99, reaches the deep side relative to the window 97 and the step 109 comes into abutment with the forward end surface of the mounting case 82. At this time, the bending tool 92 is highly accurately and firmly mounted on the slider 84 while being positioned in the width direction by the press cam 100. Then, the above-mentioned process is performed on each of the bending slide units 72 to replace the previous kind of bending tool 92 with the bending tool 92 appropriate for the new kind of die 50. In this case, the replacement of the bending tools 92 can be performed only by moving the bending tools 92 in a crank-like manner and swinging the lever 108, so that the replacement process can be easily and rapidly performed.

[0038] Then, the strip material 21 to be formed at this time is loaded into the forming machine 20 and passed through the gap between the top and bottom rollers 25 and 26 of the feeder 23, and the leading end of the strip material 21 is located approximately immediately below the punch 33 of the press machine 28. In this state, as mentioned above in connection with the forming process, the feeder 23, the press machine 28, the cutting machine 49 and the bending machine 46 are activated to perform a forming process on a trial basis. In this step, since burrs are produced at the cut ends of the pieces 54 cut by the cutting machine 49, the strip material 21 is forced back toward a supply side due to accumulation of burrs produced at each of the pieces by their accumulating amount. However, since the sizes of the burrs differ among the kinds of strip materials 21, the distance between the processed holes 12 and the cutting position 13 differs between the previous process and the present process, as mentioned previously in the Related Art.

[0039] Since the forced-back amount of the strip material 21 varies with changes of the kind of strip material 21, the amount of variation is detected through the above-mentioned trial forming process, and after that, the driving section 41 is activated by control signals from the control section 42 to rotate the screw shaft 39, thereby causing the press machine 28 to move together with the table 22 in the longitudinal direction of the strip material 21 by the amount of variation of the forced-back amount so as to set off the amount of variation of the forced-back amount. Accordingly, only by moving the table 22 and the press machine 28 by the amount of variation by means of the moving unit 43, it is possible to adjust to a design value the distance between the position of processing (punching) of the strip material 21 by the press machine 28 and the position of cutting of the strip material 21 by the cutting machine 49, whereby it is possible to rapidly and easily perform the replacement process.

[0040] In addition, the sizes of the burrs vary with the lapse of time due to the abrasion or the like of the punch 33 or a die, so that the forced-back amount may also vary. Even this case can be easily coped with only by moving the table 22 and the press machine 28 by means of the moving unit 43. Furthermore, there is a case where the center of action of driving force applied to the punch holder 34 by the lifting unit and the center of the punch 33 deviate from each other due to the relationship between the length of each of the pieces 54 and the processed position of the processed holes 12. In this case, in the related art, since the position of the press machine 14 cannot be changed, a press process must be performed with an eccentric load remaining acting, so that a decrease in the life of the die set 15 and a failure of the apparatus are incurred. However, this embodiment can easily cope with the above-mentioned case only by causing the center of action of driving force and the center of the punch 33 to coincide with each other and then moving the table 22 and the press machine 28 by means of the moving unit 43 until the punch 33 reaches a position immediately above a predetermined process position.

[0041] In addition, not only the press machine 28 but also the feeder 23 is fixed to the table 22 as mentioned above, so that when the table 22 and the press machine 28 are made to move, the feeder 23 also move integrally. During such movement, the rotations of the top and bottom rollers 25 and 26 of the feeder 23 are made to stop so that the top and bottom rollers 25 and 26 grasp the strip material 21 and the strip material 21 also move in-

tegrally with the table 22. Accordingly, the position of the strip material 21 relative to the cutting machine 49 can be simultaneously adjusted to control the cutting position of the strip material 21 located between the cutting machine 49 and the press machine 28 according to a designed position. Accordingly, it becomes unnecessary to discard a partially processed strip material 21 located between the press machine 28 and the cutting machine 49, whereby it is possible to improve the yield of products. On the other hand, in the case where the feeder 23 is independent from the table 22 without being fixed thereto, when the press machine 28 is moved to perform position adjustment, the strip material 21 remains stationary and the cutting position of the strip material 21 between the press machine 28 and the cutting machine 49 remains deviated, so that such strip material 21 must be discarded.

[0042] In addition, in this embodiment, the cutting machine 49 is arranged in the vicinity of the bending position of the bending machine 46 (the position where the die 50 is placed) as mentioned above, the number of pieces 54 to exist between the cutting machine 49 and the bending position can be reduced to decrease the forced-back amount due to the above-mentioned burrs. Particularly when one of the pieces 54 is cut obliquely with respect to the width direction thereof, it is possible to effectively prevent the problem that the obliquely cut piece 54 hides under or rides on an adjacent piece 54. After the distance between the process center of the press machine 28 and the bending position of the bending machine 46 has been adjusted in this manner, a forming process similar to the above-mentioned one is repeatedly performed, so that the pieces 54 are sequentially bent into a predetermined shape.

[0043] The above-mentioned forced-back amount due to burrs is approximately the same for the same kind of strip material 21. Accordingly, it is also preferable to adopt a construction in which forced-back amounts for individual kinds of strip materials 21 are stored in a storage unit as shown in Fig. 8 and when the kind of strip material 21 is changed, a computer 113 reads forced-back amounts appropriate for the previous and present kinds of strip materials 21 from the storage unit 112, calculates the difference (variation) therebetween, and outputs a control signal corresponding to the difference to the driving section 41 through the control section 42, thereby moving the table 22, press machine 28 and the feeder 23. According to this construction, it is possible to exclude the above-mentioned trial forming process and far more rapidly and easily perform the replacement process.

[0044] Although the invention has been described in detail with reference to a particular embodiment, it is apparent to those skilled in the art that various changes and modifications can be made without departing from the scope and spirit of the invention.

[0045] This application is based on Japanese Patent Application (Serial No. 2003-21467) filed on January 30, 2003, the disclosure of which is hereby incorporated by reference.

<Industrial Applicability>

[0046] As described hereinabove, according to this invention, it is possible to rapidly and easily execute a replacement process to be performed when the kind of strip material is changed.

Claims

1. A forming apparatus for strip materials comprising:

a feeder for intermittently feeding a strip material in a longitudinal direction thereof at a constant pitch;
a partial processing machine placed on a downstream side of the feeder and operative to perform partial processing on the strip material;
a cutting machine placed on a downstream side of the partial processing machine and operative to cut out a piece having a length substantially equal to the constant pitch by cutting the strip material approximately in a width direction thereof; and
a bending machine placed on a downstream side of the cutting machine and operative to bend the piece into a predetermined shape;
the partial processing machine being fixed to a table movable in the longitudinal direction of the strip material,
a moving unit being provided for moving the table.

2. A forming apparatus for strip materials according to claim 1, wherein the cutting machine is arranged in the vicinity of a bending position of the bending machine.

3. A forming apparatus for strip materials according to claim 1, wherein the feeder is fixed to the table.

4. A forming apparatus for strip materials comprising:

a feeder for intermittently feeding a strip material in a longitudinal direction thereof at a constant pitch;
a partial processing machine placed on a downstream side of the feeder and operative to perform partial processing on the strip material;
a cutting machine placed on a downstream side of the partial processing machine and operative to cut out a piece having a length substantially equal to the constant pitch by cutting the strip material approximately in a width direction thereof; and

a bending machine placed on a downstream side of the cutting machine and operative to bend the piece into a predetermined shape;
the bending machine including:

openable and closable paired grasping claws each having a front section projecting forwardly from a front wall of a frame of the bending machine;
an opening and closing unit placed in the frame and operative to apply opening and closing driving forces to the grasping claws and operative to close the grasping claws and grasp and lock a die placed in abutment with the front wall of the frame; and
a plurality of bending slide units supported on the frame so as to surround the die and operative to bend the piece by sequentially pressing their bending tools against the die via the piece.

5. A forming apparatus for strip materials according to claim 4, wherein each of the bending slide units includes:

a slider movable toward and away from the die and provided with an accommodating hole formed in a forward end section thereof;
a bending tool mounted on the forward end section of the slider; and
a transport unit operative to move the slider toward and away from the die,
a lock member having at a forward end thereof a locking engagement section with an L-like cross-sectional shape being movably accommodated in the accommodating hole, and a window being formed in an internal surface of one side of the accommodating hole,
a bending engagement section with an L-like cross-sectional shape, capable of engaging with the locking engagement section, a groove on one side of the bending tool, and a projecting section projecting from a proximal end of the bending tool being provided at the proximal end of the bending tool to be inserted into the accommodating hole,
the bending tool being mounted on the slider by inserting a proximal end section of the bending tool into the accommodating hole while the bottom of the groove is brought in sliding contact with the internal surface of the one side of the accommodating hole located on the forward end side relative to the window and while the projecting section is inserted in the window, then translating the bending tool toward another side to engage the bending engagement section with the locking engagement section, and then moving the lock member toward a deep side of the accommodating hole by a moving mechanism until at least a part of the projecting section reaches a side deeper than the window.

FIG. 1

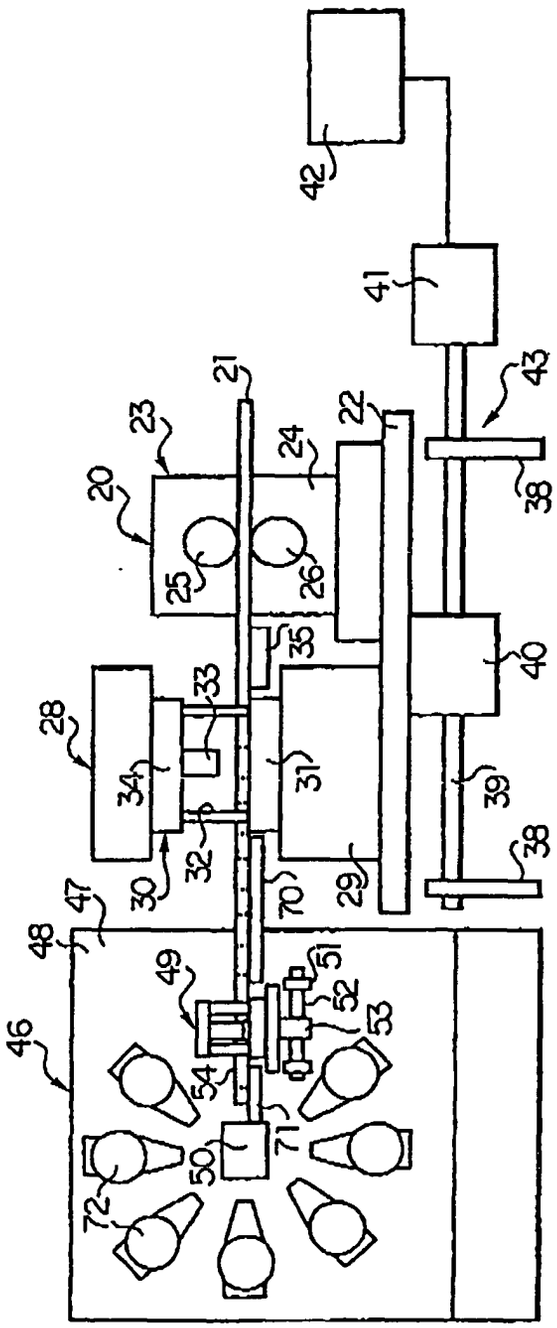
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FIG. 2

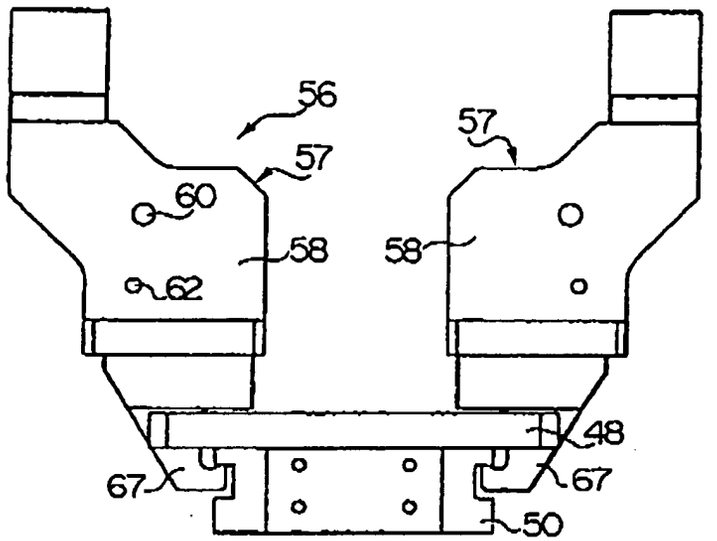

FIG. 3

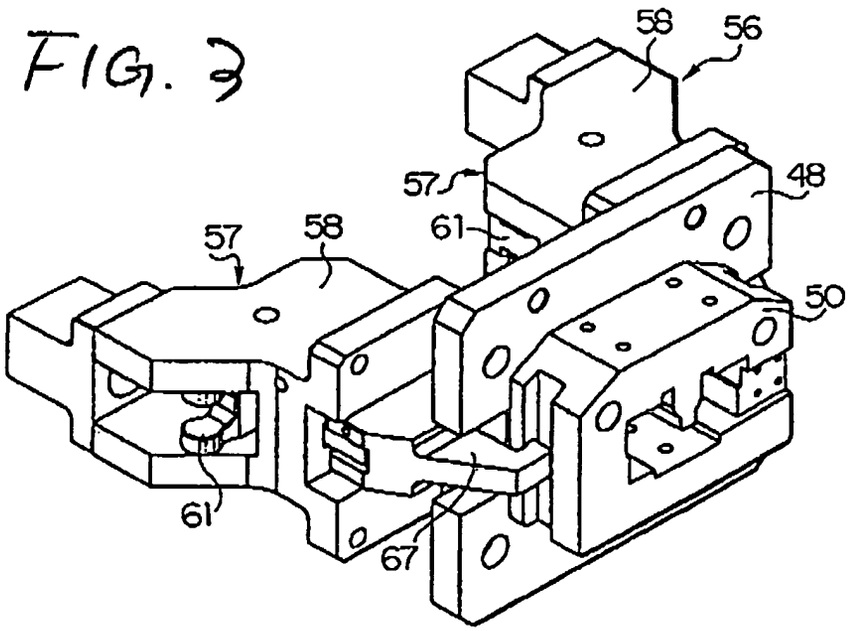

FIG. 4

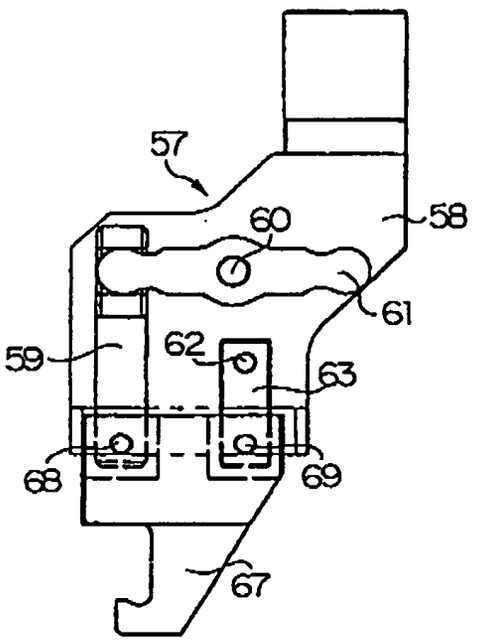

FIG. 5

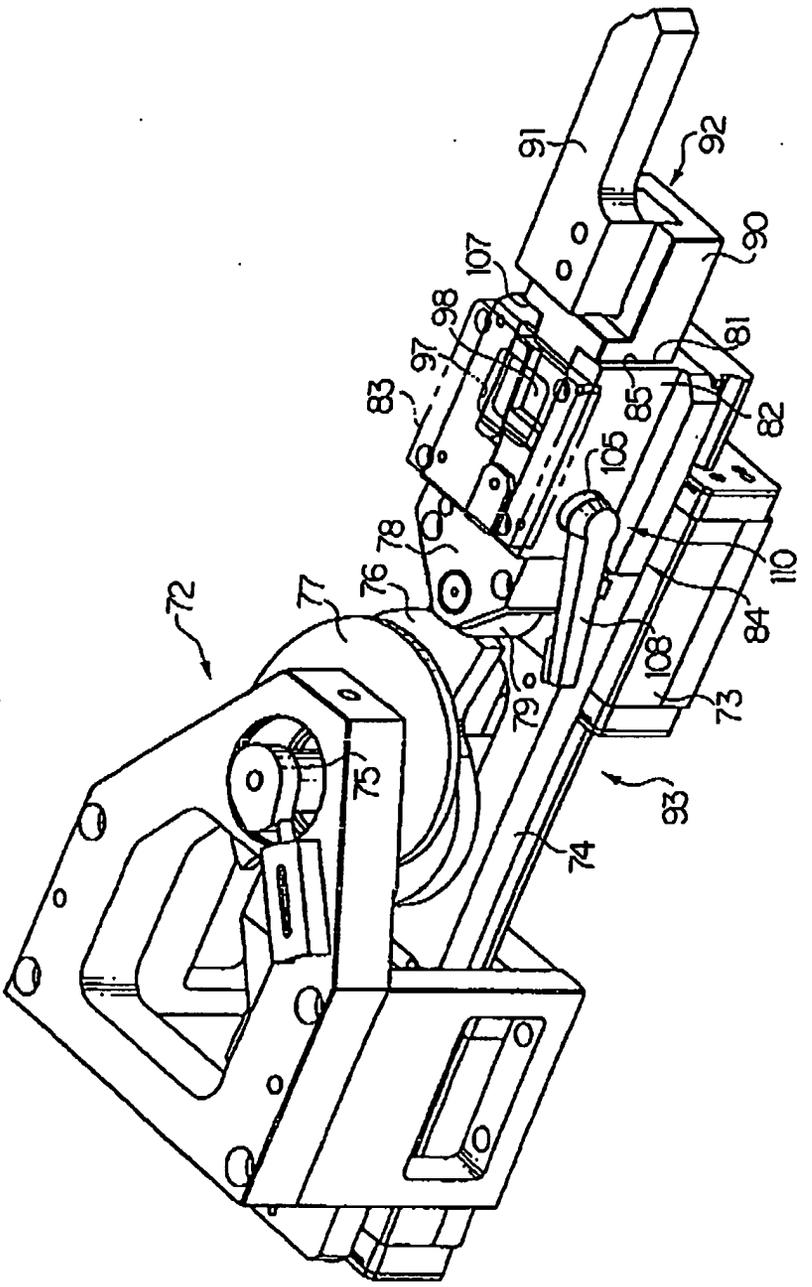
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FIG. 6

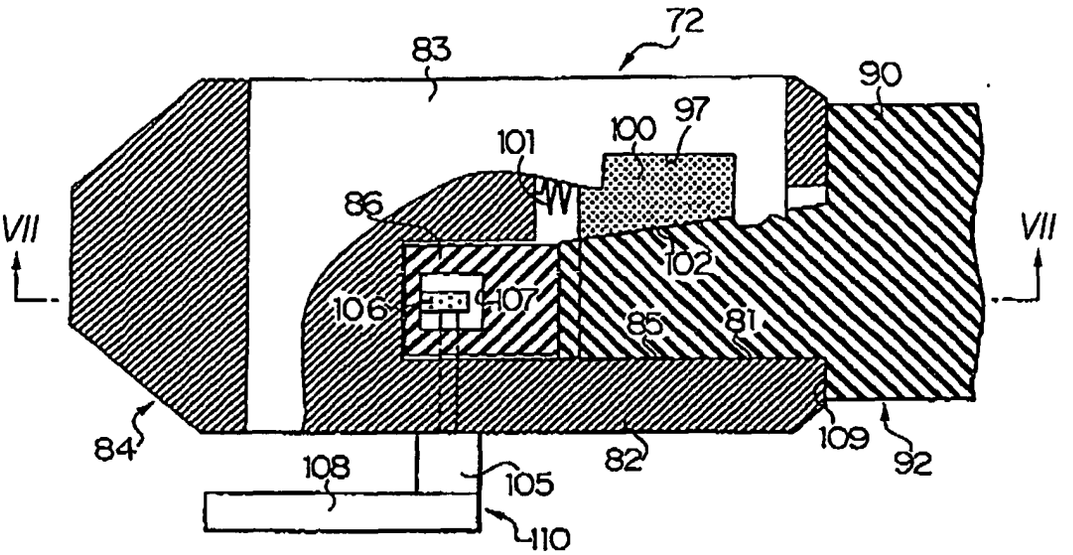
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FIG. 7

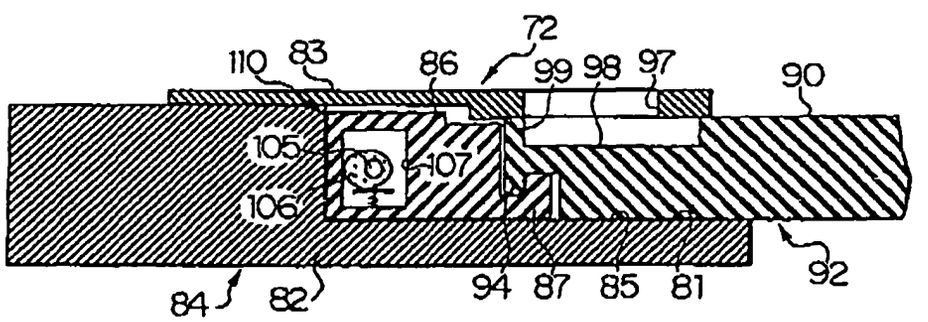
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FIG. 8

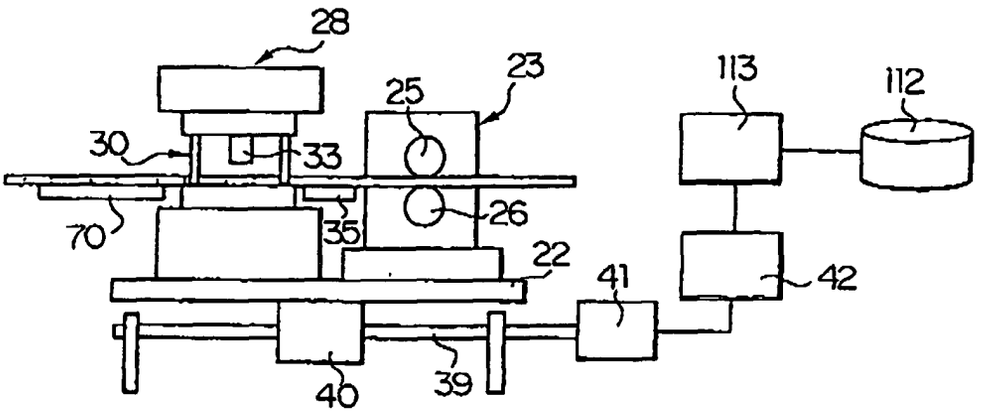


FIG. 9A

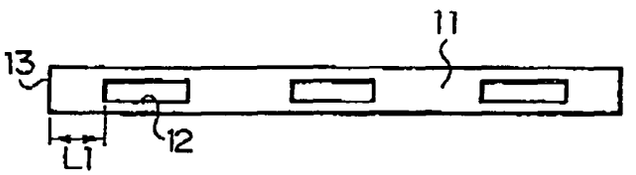


FIG. 9B

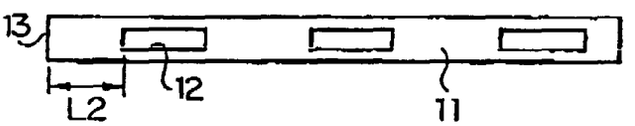
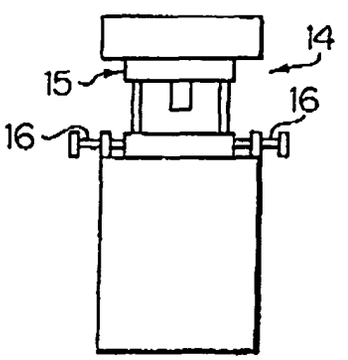


FIG. 10



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/000726

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] B21D43/28, B21D5/01

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] B21D43/28, B21D5/01

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	1996-2004
Kokai Jitsuyo Shinan Koho	1971-2004	Toroku Jitsuyo Shinan Koho	1994-2004

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	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 2450/1988(Laid-open No. 109316/1989) (Teijin Seiki Co., Ltd.), 24 July, 1989 (24.07.89), Full text; Fig. 1 (Family: none)	1-5
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 63594/1986(Laid-open No. 174738/1987) (Taiyo Jidoki Seizo Kabushiki Kaisha), 06 November, 1987 (06.11.87), Full text; Fig. 1 (Family: none)	1-5

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 April, 2004 (16.04.04)	11 May, 2004 (11.05.04)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/000726

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 18002/1982(Laid-open No. 121612/1983) (Toyota Motor Corp.), 18 August, 1983 (18.08.83), Full text; Fig. 2 (Family: none)	1-3
A	JP 55-153700 A (Aisin Seiki Co., Ltd., Satoshi SAKAI), 29 November, 1980 (29.11.80), Full text; drawings (Family: none)	1-3
Y	JP 55-55870 Y2 (Kabushiki Kaisha Sato Kikai Seisakusho), 24 December, 1980 (24.12.80), Column 2, lines 23 to 24; Figs. 1, 2 (Family: none)	4
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 128833/1989(Laid-open No. 68933/1991) (Tetsukazu TERASAKA), 08 July, 1991 (08.07.91), Full text; Figs. 1 to 4 (Family: none)	4
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 131045/1988(Laid-open No. 53815/1990) (Yamazaki Mazak Corp.), 18 April, 1990 (18.04.90), Full text; Figs. 1 to 3 (Family: none)	4
A	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model application no. 10826/1993(laid-open no. 70918/1994) (Teijin Seiki Co., Ltd.), 04 October, 1994 (04.10.94), Full text; Figs. 1, 3 (Family: none)	5

Form PCT/ISA/210 (continuation of second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/000726

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Claims 1-3 relate to a moving device fixing a partial working machine to a table movable in the longitudinal direction of a slender body and moving the table.
Claims 4 and 5 relate to an opening/closing device holding and locking a die in contact with the front wall of a frame by a holding claw and a plurality of bending slide units.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☒ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (January 2004)