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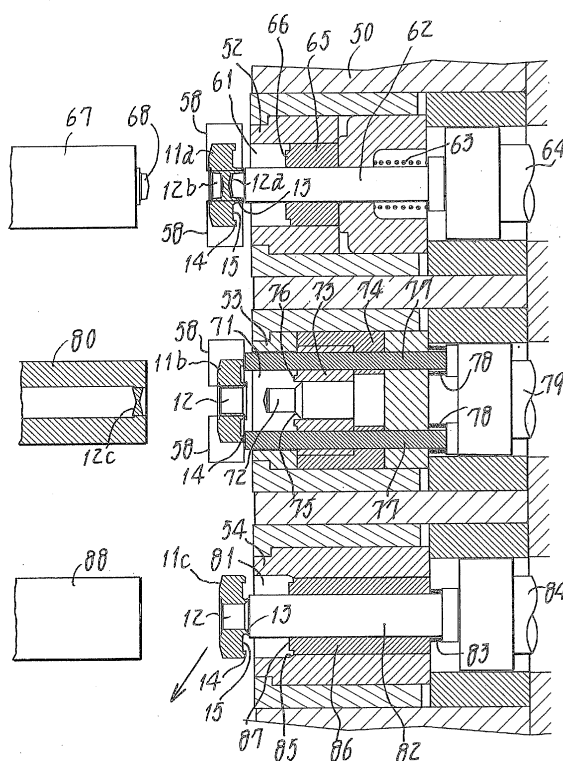
(54) **Piercing nut manufacturing apparatus**

(57) A piercing nut manufacturing apparatus uses a nut former for forming a nut blank 11 for a high stress type piercing nut 1.

The undercut screw-hole 12 is pierced and the end surface portion of pilot portion 13 radially widened, and the four diagonal corner end surfaces of nut blank 11b

finished with the forming process of slanting and enlarging the peripheral side wall surface of pilot portion 13 for defining annular groove 15 are pushed out by four knock-out pins 77 and then pushed in between a pair of fingers 58, 58 of a transfer mechanism located in the vicinity of end surface of a die 53.

Fig. 5



Description

[Technical Field]

[0001] The present invention relates to a piercing nut manufacturing apparatus wherein a nut itself pierces a metal plate, and a peripheral edge portion of the pierced hole is swaged and fastened to the metal plate. Particularly, it relates to the improvement of a high stress type piercing nut manufacturing apparatus that can be realized due to great clinching forces actually obtained as proposed by the inventor in JP H8 - 29392, namely USP5,618,237 and EP0663247A1, (Patent document 1).

[Background Art]

[0002] The piercing nut manufacturing apparatus mentioned above in JP H8 - 29362 performs the operation by using a nut former and has such an excellent advantage that, when both opposing side walls defining an annular groove formed between a cylindrical pilot portion, of which an end portion thereof disposed centrally of a square nut body serves as a punch for piercing a metal plate, and a side wall protruding along the peripheral edge of the nut body so as to surround the pilot portion are slanted against the axial line (central axis of the nut body) in order to form the annular groove into a dovetail groove, it is possible to realize mass-production of high-quality high-stress type piercing nuts capable of obtaining constant and great clinching forces because of high dimensional accuracy with respect to the inside and outside dimensions of the annular groove as well as excellent piercing operation by the pilot portion.

[0003] When a high-stress type piercing nut as described above is manufactured by using a nut former, a nut blank finished with each forming process shown in Fig. 1 ~ 3 of the Patent document 1 (JPH 8 - 29392) is pushed out in front of the die for each process, and it is held by a pair of opposing fingers of a transfer mechanism reciprocating along the front vicinity of the die and is transferred to the die for the next process in order to perform the next process. However, when the nut blank finished with the forming operation in the piercing and pilot portion enlarging process shown in Fig. 2 of the Patent document 1 is transferred to the side wall slanting forming process shown in Fig. 3, there arises a problem described in the following.

[0004] Fig. 14 and Fig. 15 are explanatory diagrams showing the operational process such that nut blank 11 finished with the piercing and pilot portion enlarging process shown in Fig. 2 of the Patent document 1 (JPH 8 - 29392) is pushed out from die 31 and held by a pair of opposing fingers 39, 39 of the transfer mechanism reciprocating along the front of die 31. Both fingers 39, 39 are activated by a spring (not shown) in the direction of approaching each other, and the space between the two fingers is a little smaller than the opposite side dimension of nut blank 11.

[0005] Taper wall 34 widening outwardly is disposed at the base portion of piercing punch 33 installed in concave (cavity) 32 of die 31, and annular protrusion 36 which protrudes so as to surround taper wall 34 is disposed at the end surface of cylindrical insert 35 arranged externally (radially outwards) of piercing punch 33, and cylindrical insert 35 is securely held by holder 37.

[0006] When nut blank 11 inserted into concave 32 of die 31 is pressed by cylindrical punch 38, the cylindrical punch 38 and piercing punch 33 cooperate to punch out preliminary undercut hole, not a through-hole, of nut blank 11 in order to form undercut screw-hole 12. Subsequently, in a state such that the annular protrusion 36 of cylindrical insert 35 is inserted into annular groove 15, the end surface of pilot portion 13 is radially widened by taper wall 34, causing the peripheral side wall surface 16 thereof to be slanted against the axial line and the cross section of annular groove 15 to be formed into a dovetail shape widening in the depth direction of the annular groove 15. Also, the outer end edge (the edge of peripheral side wall surface 16 as well) of pilot portion 13 is abutted on the inner side surface of annular protrusion 36 and is restrained from the occurrence of excessive slanting deformation, thereby enabling dimensionally accurate and constant finishing of the end outer diameter of pilot portion 13, that is, the inside dimension of annular groove 15.

[0007] When the piercing and pilot portion 13 enlarging process is completed for undercut screw-hole 12, as shown in Fig. 14, cylindrical punch 38 first moves backward so as to move away from die 31, and both fingers 39, 39 come to the front vicinity of die 31. Then, waste chip 12c created by piercing punch 33 is collected into the tube hole of cylindrical punch 38 and removed. Subsequently, as shown in Fig. 15, piercing punch 33 moves forward and protrudes from die 31 and pushes up the nut blank 11 so that it is held between both fingers 39, 39, then piercing punch 33 moves backward into die 31, and the nut blank 11 held by both fingers 39, 39 is transferred to the front of the die for the next process.

[0008] On the other hand, since the outer diameter d of tip portion 33a of piercing punch 33 is nearly same as that of undercut screw-hole 12 formed in nut blank 11, when piercing punch 33 moves backward into die 31, the tip portion 33a thereof interferes with nut blank 11, causing the generation of a stress that causes the nut blank 11 to be shifted back into die 31. However, in the normal operation, there will be no hindrance because of the high spring tension that activates both fingers 39, 39, but in the case of long-time operation, the activating force generated by the springs of both fingers 39, 39 becomes weakened or a trouble such as roughening or cracking of piercing punch 33 takes place, and as a result, sometimes there arises a problem such that, when piercing punch 33 moves backward, nut blank 11 is shifted back into die 31, and then nut blank 11 cannot be transferred to the next process, causing the generation of serious trouble such as stop of the operation.

[Summary of the Invention]

[0009] An aspect of the present invention provides a pierce nut manufacturing apparatus using a nut former for forming nut blank for high stress type piercing nut, which is configured in that cylindrical pilot portion of which an end portion thereof serves as a punch for piercing a metal plate is disposed at a central portion thereof including undercut screw-hole of a square nut body, and also, protruding side wall is disposed so as to surround the pilot portion along the outer periphery of the nut body, annular groove is formed between the pilot portion and the side wall, and a peripheral side wall of the pilot portion and the side wall for defining the annular groove are slanted against an axial line so that the annular groove is formed to have a dovetail shape widening in the direction of depth, wherein the undercut screw-hole is pierced and an end surface of the pilot portion is radially widened, and four diagonal corner end surfaces of nut blank finished with a forming process of slanting and enlarging a peripheral side wall surface of the pilot portion for defining the annular groove are pushed out by four knockout pins and pushed in between a pair of fingers of a transfer mechanism located in the vicinity of end surface of die.

[0010] Another aspect of the present invention provides a pierce nut manufacturing apparatus using a nut former, which is configured in that knockout pin is disposed in such manner as to be able to axially move forward and backward in concave of die, into which pre-formed blank is inserted, and activated by spring in the retreating position, annular protrusion is disposed at the end of first cylindrical insert fixedly arranged deep in the concave externally of the knockout pin, and on the other hand, protrusion for forming preliminary hole for undercut screw-hole is provided at the front end of punch opposing to the die, and the blank inserted into the concave is held and pressed between the punch and the knockout pin in order to form preliminary holes, not through-holes, and also, the annular protrusion is pressed into blank, and cylindrical pilot portion of which an end portion thereof serves as a punch for punching out a metal plate is disposed at a central portion including the preliminary hole of a square nut body, and also, side wall is disposed protruding so as to surround the pilot portion along the outer periphery of the nut body, and there are provided forming die/punch for nut blank formed with annular groove between the pilot portion and the side wall, and taper wall widening outside is disposed at the base portion of piercing punch arranged in concave of die for the next process into which the nut blank is inserted, annular protrusion to be inserted into the annular groove is disposed at the end of second cylindrical insert externally of the piercing punch, and with the nut blank inserted and pressed in concave of die for the next process, due to the cooperative action of cylindrical punch and the piercing punch, the preliminary hole is pierced to form undercut screw-hole, and an end portion of the pilot portion is

radially widened by the taper wall, a peripheral wall surface of the pilot portion for defining the annular groove is slanted to form the annular groove into a dovetail groove widening in the direction of depth, and also, there are provided piercing and pilot portion enlarging forming die/punch configured in that an outer end periphery of the pilot portion is abutted in a restraining fashion on an inner side surface of the annular protrusion, and knockout pin activated by spring in the retreating position, which is disposed in such a manner as to be able to axially move forward and backward in concave of die for the process after next into which the nut blank finished with piercing and enlarging pilot portion, taper wall for slanting the side wall of the nut blank toward the axial line is disposed deep in the concave, annular protrusion to be inserted into the annular groove is disposed at the end of third cylindrical insert arranged at the bottom of concave of die for the process after next, and with the nut blank inserted and pressed in concave of die for the process after next by means of punch opposing to the die for the process after next, the side wall is slanted by the taper wall toward the axial line in order to form the annular groove into a dovetail groove widening in the direction of depth, and there is also provided side wall slanting forming die/punch having such a configuration that an inner end periphery of the side wall slanted toward the axial line is abutted in a restraining fashion on an outer side surface of the annular protrusion, wherein the piercing punch and the second cylindrical insert of the piercing and pilot portion enlarging die/punch are securely held in concave of die for the next process, and four knockout pins are provided so as to surround the piercing punch, and with the nut blank inserted and pressed in concave of die for the next process, due to the cooperative action of the cylindrical punch and the piercing punch, four diagonal corner end surfaces of the nut blank finished with piercing the undercut screw-hole and enlarging the pilot portion are pushed out by the four knockout pins and are pushed in between a pair of fingers of a transfer mechanism located in the vicinity of end surface of the die.

[0011] In a preferred embodiment, the piercing punch and the second cylindrical insert are securely held via holder in concave of die for the next process, and the four knockout pins are disposed in such a manner as to be able to axially move forward and backward in the holder in phase of 90 degrees around the piercing punch, which are activated by spring in the retreating position, and when in the retreating position, the front end surface thereof is flush with the front end surface of the second cylindrical insert, and in the mode of moving forward, the pins are abutted on four diagonal corner end surfaces of the nut blank, and then the nut blank is pushed out and pushed in between the pair of fingers.

[0012] The present invention is intended to address the above-mentioned problem of the prior art, and in the preferred embodiments of the invention a piercing nut manufacturing apparatus is configured such that a nut

blank finished with the piercing and pilot portion enlarging process is pushed out by knockout pins, instead of by the piercing punch. The pins are disposed around the piercing punch, and the nut blank can be securely and reliably held between the fingers of the transfer mechanism, and there is no hindrance to the transfer of the nut blank.

[0013] An aspect of the present invention provides a piercing nut manufacturing apparatus for forming a nut blank for a high stress type piercing nut by using a nut former, wherein a cylindrical pilot portion, of which an end portion thereof serves as a punch for punching out a metal plate, is disposed at a central portion including the undercut screw-hole of a square nut body, and also, there is provided a side wall protruding so as to surround the pilot portion along the outer periphery of the nut body, thereby forming an annular groove between the pilot portion and the side wall, and the peripheral side wall surface of the pilot portion and the side wall for defining the annular groove are slanted against the axial line in order to form the annular groove into a dovetail groove widening in the direction of depth. It is configured in that the four diagonal corner end surfaces of the nut blank finished with piercing the undercut screw-hole and radially widening the end surface of the pilot portion as well as the forming process of slanting and widening the peripheral side wall of the pilot portion for defining the annular groove are pushed out by four knockout pins in order to push them in between a pair of fingers of a transfer mechanism located in the vicinity of end surface of the die.

[0014] Another aspect of the present invention provides a manufacturing apparatus, wherein the configuration of the forming die/ punch for the main process of forming a nut blank by using a nut former is specifically described. It is configured in that there are provided knockout pins disposed in such a manner as to be able to axially move forward and backward in the concave of a die into which a blank preliminarily formed is inserted, and are activated by springs in the retreating position, and an annular protrusion is disposed at the end surface of the first cylindrical insert securely disposed deep inside the concave externally of the knockout pin. On the other hand, a protrusion for forming a preliminary hole for an undercut screw-hole is disposed at the front end of the punch opposing to the die, and the blank inserted into the concave is held and pressed by the punch and the knockout pin in order to form the preliminary hole that is not a through-hole, and also, the annular protrusion is pressed into the blank, and a cylindrical pilot portion, of which the end portion thereof serves as a metal plate piercing punch, is disposed at the central portion including the preliminary hole of a square nut body. Further, a side wall protruding so as to surround the pilot portion is disposed along the outer periphery of the nut body, and there is provided a forming die/punch for a nut blank formed with an annular groove between the pilot portion and the side wall as well as a taper wall widening outside at the base of the piercing punch disposed in the concave

of the die for the next process into which the nut blank is inserted. An annular protrusion to be inserted into the annular groove is disposed at the end surface of the second cylindrical insert disposed externally of the piercing punch, and the cooperative action of the cylindrical punch and the piercing punch for inserting and pressing the nut blank into the concave of the die for the next process serves to punch out the preliminary hole to form an undercut screw-hole, and the end surface of the pilot portion is radially widened by the taper wall, and the peripheral side wall of the pilot portion for defining the annular groove is slanted in order to form the annular groove into a dovetail groove widening in the direction of depth. Also it includes a piercing and pilot portion enlarging forming die/punch having such a configuration that the outer end periphery of the pilot portion is abutted in a restraining fashion on the inner side surface of the annular protrusion, and a knockout pin activated by spring in the retreating position, which is arranged in such a manner as to be able to axially move forward and backward in the concave of the die for the process after next into which the nut blank finished with the piercing and pilot portion enlarging process is inserted, and there is provided a taper wall for slanting the side wall of the nut blank toward the axial line deep in the concave, and an annular protrusion inserted into the annular groove is provided at the end surface of the third cylindrical insert disposed at the bottom of the concave of the die for the process after next. By using a punch opposing to the die for the process after next, the nut blank is inserted and pressed in the concave of the die for the process after next by means of the punch, then the side wall is slanted by the taper wall toward the axial line, thereby forming the annular groove into a dovetail groove widening in the direction of depth, and at the same time, the inner side edge of the end of the side wall slanted toward the axial line is abutted in a restraining fashion on the outer side surface of the annular protrusion. In the pierce nut manufacturing apparatus using a nut former provided with a side wall slanting forming die/punch having such a configuration as described, the piercing punch of the piercing and pilot portion enlarging die/punch and the second cylindrical insert are securely held in the concave of the die for the next process, and also there are provided four knockout pins in such manner as to surround the piercing punch. Due to the cooperative action of the cylindrical punch by which the nut blank inserted into the concave of the die for the next process is pressed and the piercing punch, the end surfaces of four diagonal corners of the nut blank finished with the undercut screw-hole piercing and pilot portion enlarging process are pushed out by the four knockout pins and are pushed in between a pair of fingers of the transfer mechanism located in the vicinity of end surface of the die.

[0015] In a preferred embodiment, the configuration of the piercing and pilot portion enlarging forming die/punch is more specifically described. The piercing punch and the second cylindrical insert are securely held in the con-

cave of the die for the next process via a holder, and the four knockout pins are disposed in the holder in such manner as to be able to axially move forward and backward around the piercing punch in phase of 90 degrees and are also activated by springs in the retreating position, and when they are in the retreating position, the front end surface is flush with the front end surface of the second cylindrical insert, and in the mode of moving forward, it abuts the four diagonal corner end surfaces of the nut blank and pushes out the nut blank to push it in between the pair of fingers.

[0016] As described above, when a nut blank is formed by using a nut former, the undercut screw-hole is pierced and the end surface of the pilot portion is widened in the radial direction, and the four diagonal corner end surfaces of the nut blank finished with the forming process of slanting to enlarge the peripheral side wall surface of the pilot portion for defining an annual groove are pushed out by four knockout pins and are pushed in between a pair of fingers of a transfer mechanism located in the vicinity of the end surface of a die. Because of this configuration, the nut blank is reliably and smoothly pushed out from the die and then held by both of the fingers, and there is no fear of causing hindrance to the transfer to the next process. Accordingly, it is possible to efficiently mass-produce high-quality high-stress type square pierce nuts which are high in dimensional accuracy and capable of obtaining reliable clinching forces.

[Brief Description of the Drawings]

[0017]

Fig. 1 is a front view showing a main portion of a nut former of the present invention.

Fig. 2 is an explanatory diagram showing the machining processes of a nut blank formed by the nut former.

Fig. 3 is a plan view showing the outline of a transfer mechanism for transferring a nut blank machined in each forming process of the nut former to the next process.

Fig. 4 is a front view showing a state of operation of the transfer mechanism which has moved from the position shown in Fig. 1.

Fig. 5 is a cross-sectional plan view of a main portion of a forming die/punch showing a state of being pushed out from the forming die after finishing each forming process of a nut blank formed by the nut former.

Fig. 6 is a cross-sectional plan view of a main portion of the forming die/punch, showing a state of being transferred to the next process of each nut blank finished with main forming process by the nut former.

Fig. 7 is a cross-sectional plan view of a main portion of the forming die/punch, showing a state of being transferred to the front of the forming die for the next process of a nut blank finished with main forming

process by the nut former.

Fig. 8 is a cross-sectional plan view of the forming die/punch, showing a state of being transferred to the next process, pressed and formed by a punch of each nut blank finished with main forming process by the nut former.

Fig. 9 is a cross-sectional plan view of the forming die/punch, showing a state of completion of forming operation by the forming die and punch in the next process with respect to each nut blank finished with main forming process by the nut former.

Fig. 10 is a cross-sectional view of a main portion of the forming die/punch, showing a state of the punch for each forming process moving backward away from the forming die after finishing forming operation by the forming die and punch for the next process shown in Fig. 9.

Fig. 11 is an enlarged plan view of a main portion of a piercing and pilot portion enlarging forming die of the nut former.

Fig. 12 is an explanatory diagram showing a state of being pushed out by four knockout pins of a nut blank finished with the undercut screw-hole piercing and pilot portion enlarging process by the piercing and pilot portion enlarging forming die/punch of the nut former.

Fig. 13 is a perspective view of a square piercing nut completed by threading a nut blank manufactured by the apparatus of the present invention.

Fig. 14 is an explanatory diagram showing a state of preparation for pushing out a nut blank finished with the piercing and pilot portion enlarging process shown in Fig. 2 of JPH8 - 29392.

Fig. 15 is an explanatory diagram showing a state of a nut blank shown in Fig. 14 in a state of being held by a pair of fingers opposing each other of the transfer mechanism after being push out from the forming die.

[Description of the Preferred Embodiments]

[0018] The preferred embodiments of the present invention will be described in the following with reference to the drawings.

[0019] Fig. 1 shows a main portion of a 4-stage nut former of an embodiment of the present invention. The die block 50 comprises a die for each forming process to form nut blanks, that is, pre-forming die 51, nut blank forming die 52, piercing and pilot portion enlarging forming die 53, and side wall slanting forming die 54 are laterally installed at equally spaced intervals in a parallel fashion. In the pre-process of pre-forming die 51, the technical means for cutting materials with a constant size out of a coil material, correcting and feeding them to pre-forming die 51 is a technical means customarily employed in an existing nut former as standard technology, and therefore, the description is omitted.

[0020] Also, transfer mechanism 55 which moves lat-

erally along the front vicinity of die block 50 is disposed. Regarding the transfer mechanism 55 it is also a technical means customarily employed in an existing nut former as standard technology, and therefore, the detailed description is omitted, but as shown in Fig. 1 and Fig. 3, three spindles 57 vertically extending are installed at same spaced intervals as for each forming die 51 to 54 around the axial line in a rotatable fashion on connecting plate 56 laterally reciprocating along the front vicinity of die block 50, and a pair of opposing fingers 58, 58 are installed on each spindle 57 in a laterally movable fashion and are activated by plate springs 59, 59 so as to approach each other. And, only both fingers 58, 58 arranged in front of pre-forming die 51 in Fig. 1 are reversed by 180 degrees as shown in Fig. 4 when pre-formed blank 10 is moved to the front of forming die 52, and the remaining two fingers 58, 58 horizontally move in a parallel fashion.

[0021] Fig. 5 shows a state of nut blank 11a, 11b, 11c formed by the nut former in each forming process, which are in a state of being pushed out from each forming die 52, 53, 54 respectively and transferred to the next process.

[0022] Nut blank forming die 52 is disposed in such manner as to be able to axially move forward and backward in concave (cavity) 61 into which blank 10 (see Fig. 2) preliminarily swaged by pre-forming die 51 is inserted, and it is provided with knockout pin 62 activated by (biased by) spring 63 in the retreating position, and the knockout pin 62 is pushed out by main pin 64 disposed at the back thereof coping with (acting against) spring 63. Also, annular protrusion 66 is disposed externally of (around) knockout pin 62 at the end of first cylindrical insert 65 fixedly arranged in the back of (bottom of) concave 61. On the other hand, the front end of punch 67 disposed opposite to forming die 52 is provided with protrusion 68 serving to form a preliminary hole for undercut screw-hole. And, blank 10 inserted into concave 61 is held and pressed by punch 67 and knockout pin 62 in order to form preliminary holes 12a, 12b for under cut screw-hole that is not yet a through-hole. Also, annular protrusion 66 is pressed into blank 10, and cylindrical pilot portion 13 of which the end portion thereof serves as a punch to punch out a metal plate is formed at the central portion of the nut body including preliminary hole 12a. Further, side wall 14 protrudes in parallel to the axial line (central axis of the nut body) so as to surround pilot portion 13 along the outer periphery of the nut body. And also, nut blank 11a is formed with annular groove 15 being formed between pilot portion 13 and side wall 14 (see Fig. 2). Nut blank 11a is formed this way is, as shown in Fig. 5, pushed out by knockout pin 62 from the forming die 52 after punch 67 first moves backward away from the forming die 52. The nut blank 11a is pushed towards and held between a pair of opposing fingers 58, 58.

[0023] Piercing and pilot portion enlarging forming die 53 is configured in that piercing punch 72 and second cylindrical insert 73 disposed externally of (around) the

piercing punch 72 are securely held via holder 74 in concave (cavity) 71 into which nut blank 11a is inserted. Taper wall 75 widening outwardly is disposed at the base portion of piercing punch 72, and annular protrusion 76 inserted into annular groove 15 of nut blank 11a is disposed at the end surface of second cylindrical insert 73. On the other hand, there are provided four slender knockout pins 77 in such manner as to surround piercing punch 72. The knockout pins 77 are arranged spaced apart by 90 degrees around piercing punch 72 (see Fig. 11) and disposed in such manner as to be able to axially move forward and backward through second cylindrical insert 73 and holder 74. The knockout pins 77 are biased by springs 78 in the retreating position (in the retraction direction), and when in the retreating position, the front end surfaces thereof are flush with the end surface of second cylindrical insert 73 or a little lower than the end surface thereof (see Figs. 7 to 10). Four knockout pins 77 are pushed out forward by main pin 79 disposed at the back thereof coping with (acting against) springs 78. On the other hand, there is provided cylindrical punch 80 opposing to the forming die 53. And, when nut blank 11a is inserted and pressed by cylindrical punch 80 into concave 71, as shown in Fig. 8 and Fig. 9, due to the cooperative action of cylindrical punch 80 and piercing punch 72, preliminary holes 12a, 12b are punched out to form undercut screw-hole 12, and at the same time, the end surface of pilot portion 13 is radially widened by taper wall 75 of piercing punch 72, and the peripheral side wall surface of pilot portion 13 for defining the annular groove 15 is slanted against the axial line (central axis of the nut blank) so that the cross-section of annular groove 15 has a dovetail shape widening in the depth direction of the annular groove 15. Also, the end surface outer periphery of pilot portion 13 is abutted in a restraining fashion on the inner side surface of annular protrusion 76 and thus restrained from the occurrence of excessive slanting deformation, and thereby, it is possible to form nut blank 11b which is dimensionally accurate and constant with respect to the end surface outer diameter of pilot portion 13, that is, the inner dimensions of annular groove 15. In this case, waste chip 12c punched out by piercing punch 72 is collected into the cylindrical hole of cylindrical punch 80 and discharged. As to nut blank 11b formed this way, as shown in Fig. 10, cylindrical punch 80 first moves backward away from forming die 53, and a pair of fingers 58, 58 of transfer mechanism 55 comes to the front vicinity of forming die 53. Subsequently, as shown in Fig. 5, four knockout pins 77 are pushed out by main pin 79 coping with (acting against) springs 78 and then abutted on the four diagonal corner end surfaces of nut blank 11b to push the nut blank 11b out of concave 71 of forming die 53. Thus, when nut blank 11b is pushed out by four knockout pins 77, the nut blank 11b is correctly pushed out along the axial line, and therefore, it is smoothly and reliably pushed out from concave 71 without interfering with piercing punch 72, and is pushed in and held between the pair of opposing fingers 58, 58.

[0024] Side wall slanting forming die 54 is disposed in concave (cavity) 81 into which nut blank 11b finished with undercut screw-hole 12 piercing and pilot portion 13 enlarging process is inserted in a state of being able to axially move forward and backward. The concave 81 is provided with knockout pin 82 biased by spring 83 in the retreating position (in the retraction direction), and the knockout pin 82 is pushed out by main pin 84 disposed at the back thereof coping with (acting against) spring 83. Also, there is provided taper wall 85 for slanting the side wall 14 of nut blank 11b toward the axial line (central axis of the nut blank) deep in (at the bottom of) concave 81. Further, annular protrusion 87 to be inserted into annular groove 15 of nut blank 11b is disposed on the end surface of third cylindrical insert 86 fixedly installed deep in (at the bottom of) the concave 81 externally of (around) knockout pin 82, opposing to taper wall 85 and at constant intervals. On the other hand, there is provided punch 88 opposing to forming die 54. And, when nut blank 11b inserted in concave 81 of forming die 54 is pressed by punch 88 (see Fig. 8 to 9), as shown in Fig. 9, in a state with annular protrusion 87 of third cylindrical insert 86 inserted into annular groove 15, side wall 14 is slanted by taper wall 85 toward the axial line (central axis of the nut blank), and inner side wall surface 17 for defining annular groove 15 is slanted against the axial line, then the cross-section of annular groove 15 is formed into a dovetail shape widening in the depth direction of the annular groove 15. At the same time, the inner side end edge of slanted side wall 14 is abutted in a restraining fashion on the outer side surface of annular protrusion 87 and is restrained from the occurrence of excessive slanting deformation. As a result, the outside dimensions of annular groove 15 are accurately finished in constant size. As to the nut blank 11b thus formed by side wall slanting forming die 54, as shown in Fig. 10, after punch 88 moves backward away from forming die 54, as shown in Fig. 5, it is pushed out by knockout pin 82 from concave 81 of forming die 54 and freely dropped to be transferred to the threading process (not shown).

[0025] Fig. 13 shows high-stress type square piercing nut 1 completed by threading female screw 2 in undercut screw-hole 12 of nut blank 11c formed as described above.

[0026] [Description of the Reference Numerals and Signs]

1	Square pierce nut
2	Screw hole
10	Blank
11	Nut blank
11a, 11b, 11c	Nut blank
12	Undercut screw-hole
13	Pilot portion
14	Side wall
15	Annular groove
50	Die block
51	Pre-forming die

52
53
54
55
5 58, 58
59, 59
61
62
65
10 66
67
71
72
73
15 74
75
76
77
80
20 81
82
85
86
87
25 88

Nut blank forming die
Piercing and pilot portion enlarging die
Side wall slanting forming die
Transfer mechanism
A pair of fingers
Plate spring
Concave (forming die 52)
Knockout pin
First cylindrical insert
Annular protrusion
Punch
Concave (forming die 53)
Piercing punch
Second cylindrical insert
Holder
Taper wall
Annular protrusion
Knockout pin
Cylindrical punch
Concave (forming die 54)
Knockout pin
Taper wall (concave 81)
Third cylindrical insert
Annular protrusion
Punch

Claims

1. A piercing nut manufacturing apparatus comprising a nut former for forming a nut blank (11) for a piercing nut (1), wherein the piercing nut (1) is configured such that a cylindrical pilot punch portion (13) is disposed at a central portion of a square nut body, and includes an undercut screw-hole (12), and a protruding side wall (14) is disposed so as to surround the pilot portion (13) along the outer periphery of the nut body, and an annular groove (15) is formed between the pilot portion (13) and the side wall (14), and a peripheral side wall of the pilot portion (13) and the side wall (14) defining the annular groove (15) are slanted relative to a central axis of the nut body so that the annular groove (15) is formed to have a dovetail shape widening in the depth direction of the annular groove (15), wherein the nut former includes a transfer mechanism (55) and a die (53) having first to fourth knockout pins (77) and the manufacturing apparatus is arranged such that, after the undercut screw-hole (12) is pierced and an end surface of the pilot portion (13) is radially widened, first to fourth diagonal corner end surfaces of the nut blank (11b) finished with a forming process of slanting and enlarging a peripheral side wall surface of the pilot portion (13) for defining the annular groove (15) are pushed out of the die (53) by the first to fourth knockout pins (77) and pushed in between first and second fingers (58, 58) of the transfer mechanism (55) located adjacent to the die

(53).

2. A piercing nut manufacturing apparatus according to claim 1, wherein:

the die (53) is a second die (53) in a sequence of dies (52, 53, 54) and is preceded by a first die (52) and is followed by a third die (54); the nut former is configured such that a knockout pin (62) is disposed in such manner as to be able to axially move forward and backward in a cavity (61) of the first die (52), into which a pre-formed blank (10) is insertable, and is biased by a spring (63) in the retraction direction, and an annular protrusion (66) is disposed at the end of a first cylindrical insert (65) fixedly arranged at the bottom of the cavity (61) around the knockout pin (62), and a protrusion (68) for forming a preliminary hole (12b) for the undercut screw-hole (12) is provided at the front end of a punch (67) opposing the first die (52), and the blank (11a) when inserted into the cavity (61) is held and pressed between the punch (67) and the knockout pin (62) in order to form preliminary holes (12a, 12b), whilst the annular protrusion (66) forms the cylindrical pilot portion (13) and the side wall (14);

a taper wall (75) widening outwardly is disposed at the base portion of a piercing punch (72) arranged in a cavity (71) of the second die (53) into which the nut blank (11a) is insertable, and an annular protrusion (76) to be inserted into the annular groove (15) is disposed at the end of a second cylindrical insert (73) disposed around the piercing punch (72), and when the nut blank (11a) is inserted and pressed in the cavity (71) of the second die (53), due to the cooperative action of a cylindrical punch (80) and the piercing punch (72), the preliminary holes (11a, 11b) are pierced to form the undercut screw-hole (12), and an end portion of the pilot portion (13) is radially widened by the taper wall (75), the peripheral side wall surface of the pilot portion (13) for defining the annular groove (15) is slanted to form the annular groove (15) into a dovetail groove widening in the depth direction of the annular groove (15), and an outer end periphery of the pilot portion (13) is abutted in a restraining fashion on an inner side surface of the annular protrusion (76);

a knockout pin (82) is biased by a spring (83) in the retraction direction and is disposed in such a manner as to be able to axially move forward and backward in a cavity (81) of the third die (54) into which the nut blank (11b) is insertable, and a taper wall (85) for slanting the side wall (14) of the nut blank (11b) toward the central axis of the nut blank (11b) is disposed at the bottom of

the cavity (81), and an annular protrusion (87) to be inserted into the annular groove (15) is disposed at the end of a third cylindrical insert (86) arranged at the bottom of the cavity (81) of the third die (54), and, when the nut blank (11b) is inserted and pressed in the cavity (81) of the third die (54) by means of a punch (88) opposing the third die (54), the side wall (14) is slanted by the taper wall (85) toward the central axis of the nut blank (11b) in order to form the annular groove (15) into a dovetail groove widening in the depth direction of the annular groove (15), and an inner end periphery of the side wall (14) slanted toward the central axis of the nut blank (11b) is abutted in a restraining fashion on an outer side surface of the annular protrusion (87); and

the piercing punch (72) and the second cylindrical insert (73) are securely held in the cavity (71) of the second die (53), and the first to fourth knockout pins (77) are provided around the piercing punch (72), and after the nut blank (11a) has been pressed in the cavity (71) of the second die (53), due to the cooperative action of the cylindrical punch (80) and the piercing punch (72), the first to fourth diagonal corner end surfaces of the nut blank (11b) are arranged to be pushed out of the second die (53) by the knockout pins (77) and pushed in between the fingers (58, 58) of the transfer mechanism (55).

3. The piercing nut manufacturing apparatus of claim 2, wherein the piercing punch (72) and the second cylindrical insert (73) are securely held via a holder (74) in the cavity (71) of the second die (53), and the knockout pins (77) are disposed in such a manner as to be able to axially move forward and backward in the holder (74) at positions spaced 90 degrees apart around the piercing punch (72), and are biased by springs (78) in the retraction direction so that, when retracted, the front end surfaces of the knockout pins (77) are flush with the front end surface of the second cylindrical insert (73), and, when moving forwards, the pins (77) are abutted on the first to fourth diagonal corner end surfaces of the nut blank (11b), such that the nut blank (11b) is pushed out and pushed in between the fingers (58, 58).

Fig. 1

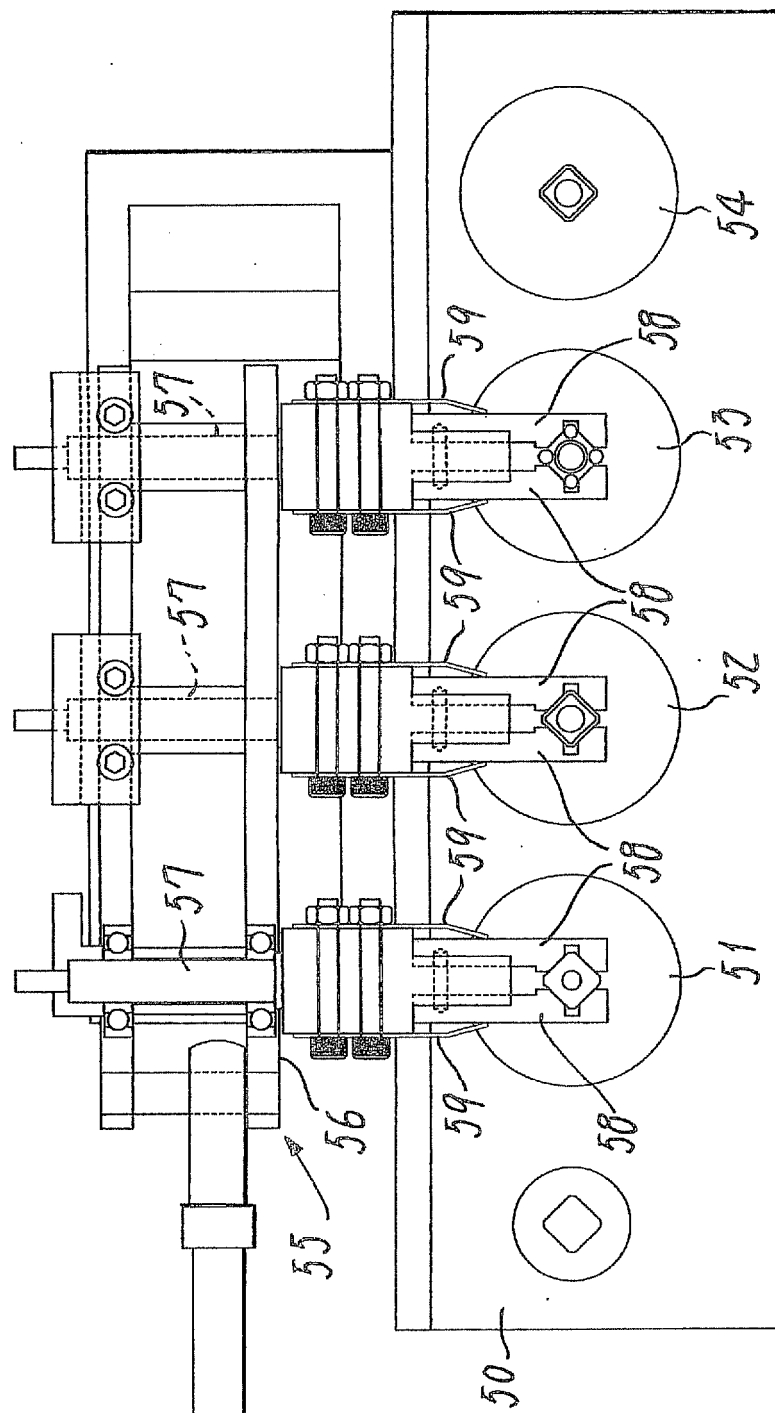


Fig. 2

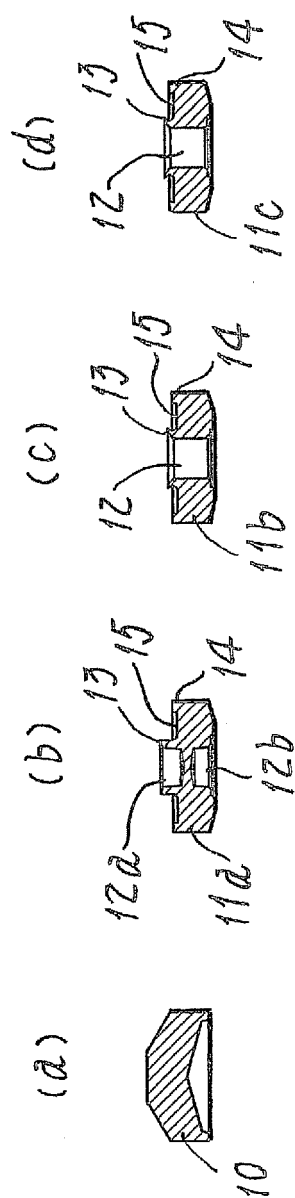


Fig. 3

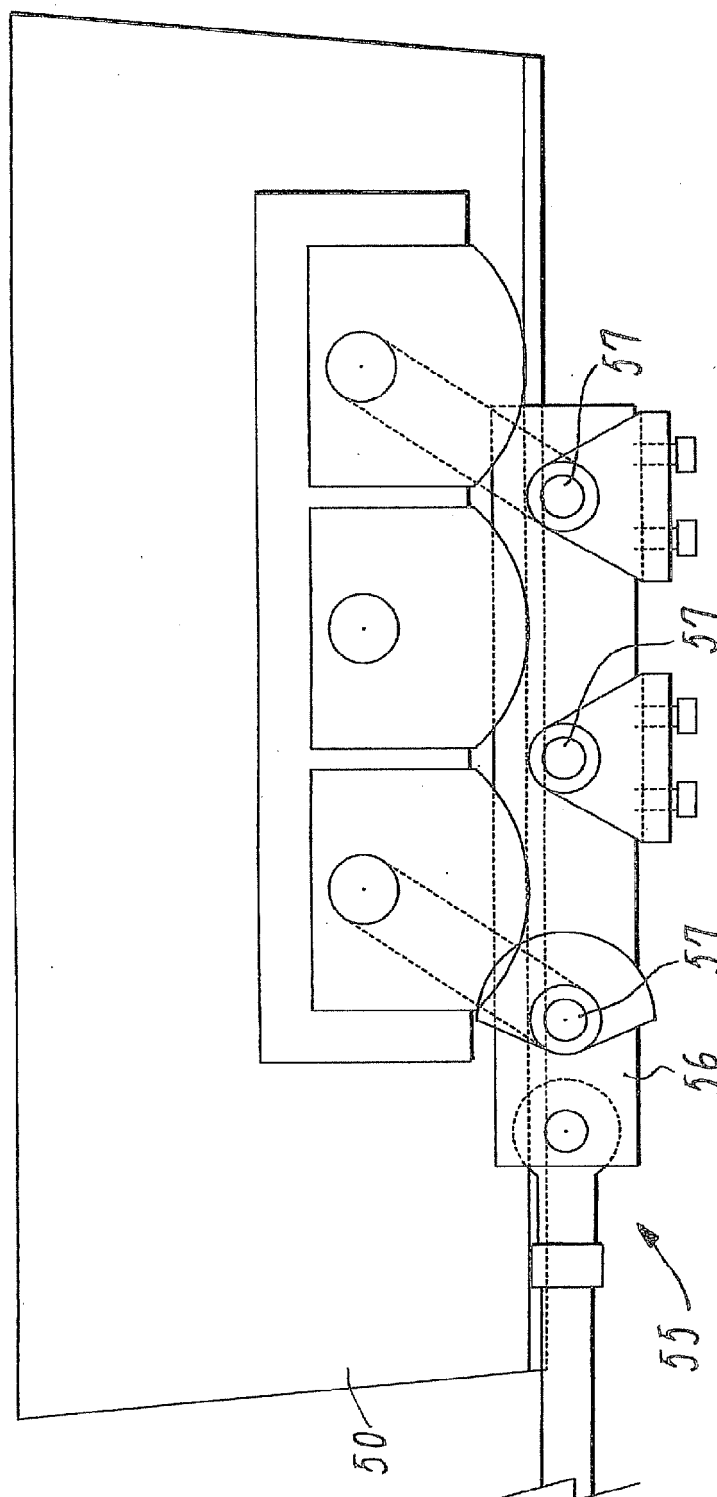


Fig. 4

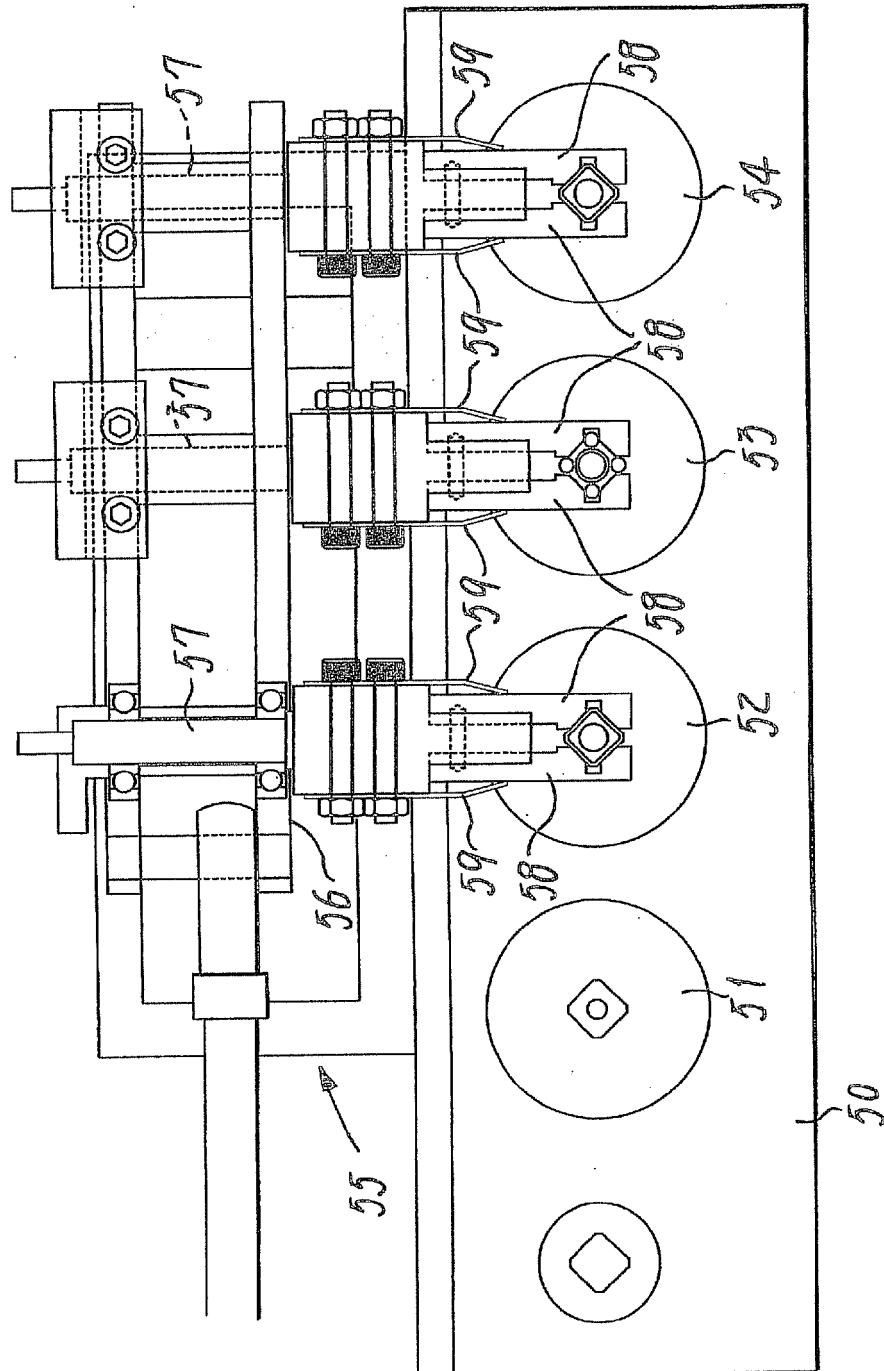


Fig. 5

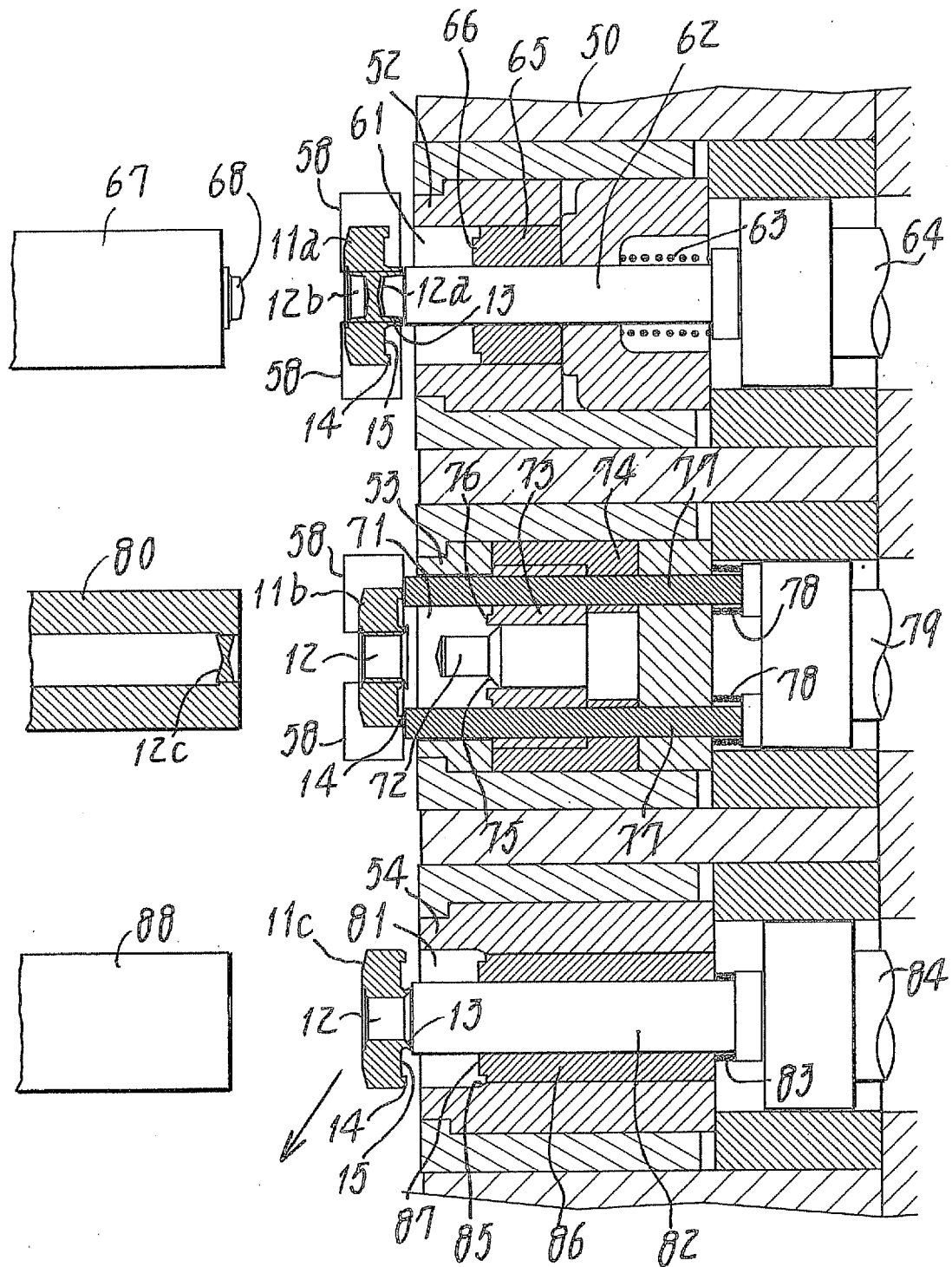


Fig. 6

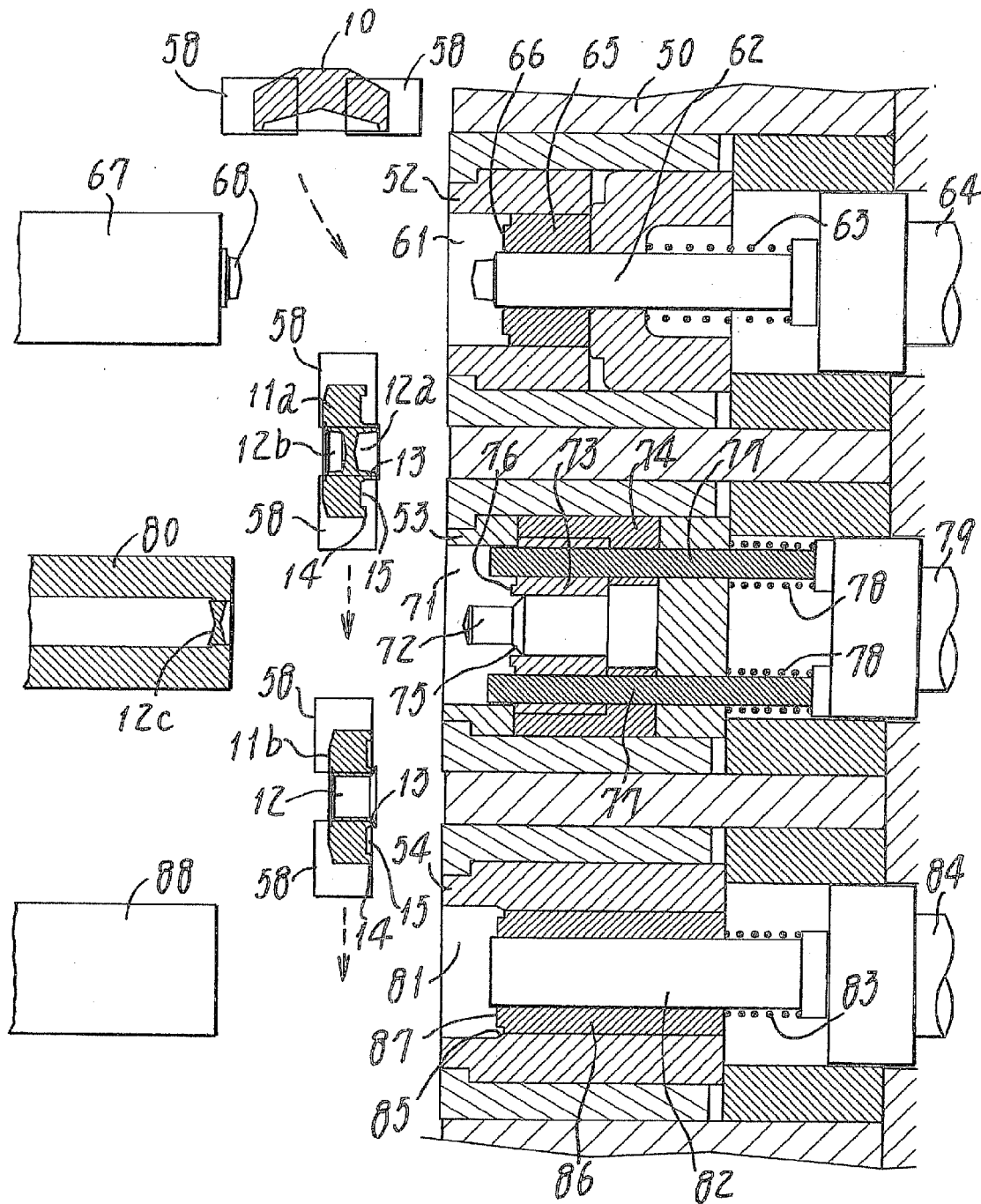


Fig. 7

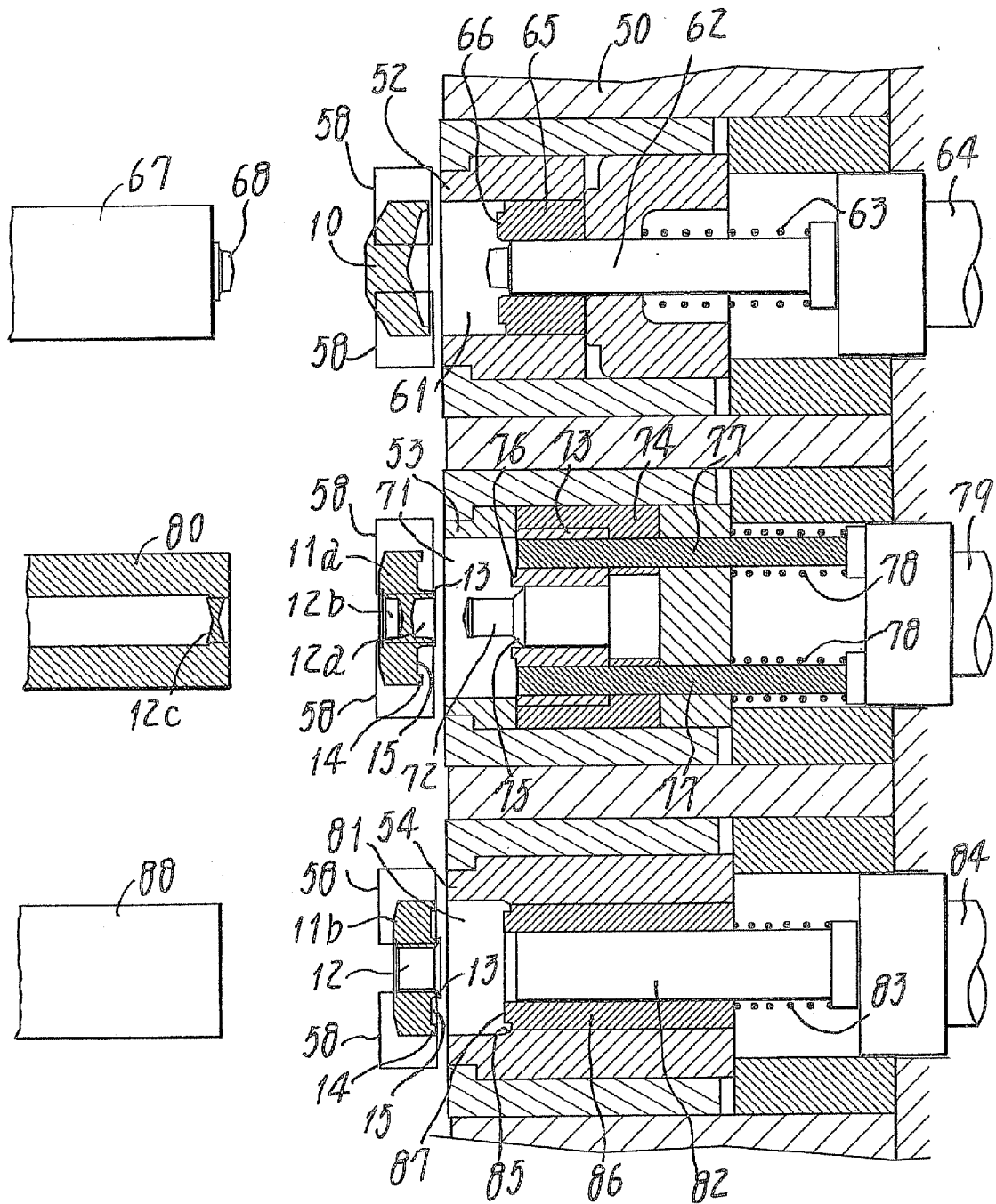


Fig. 8

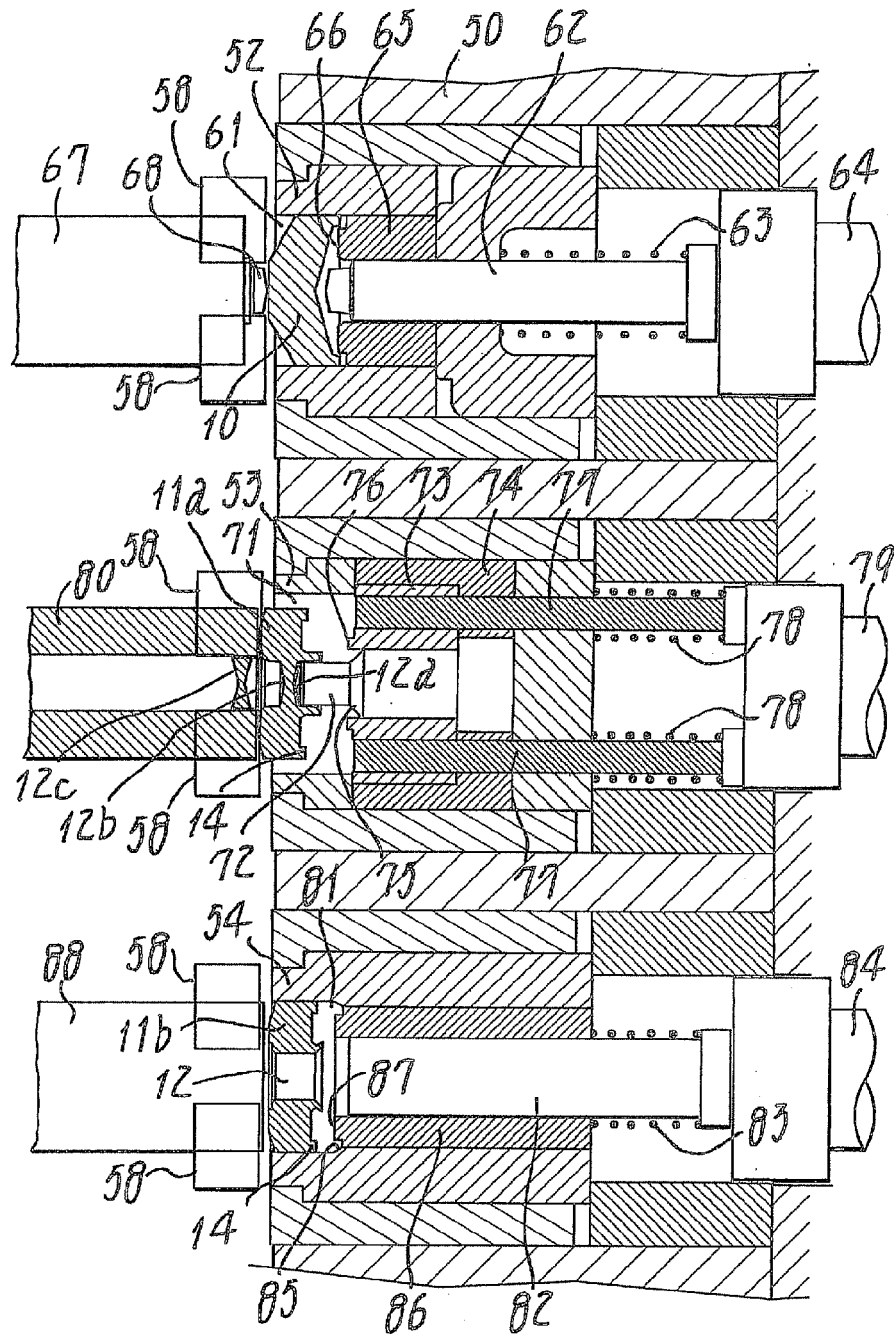


Fig. 9

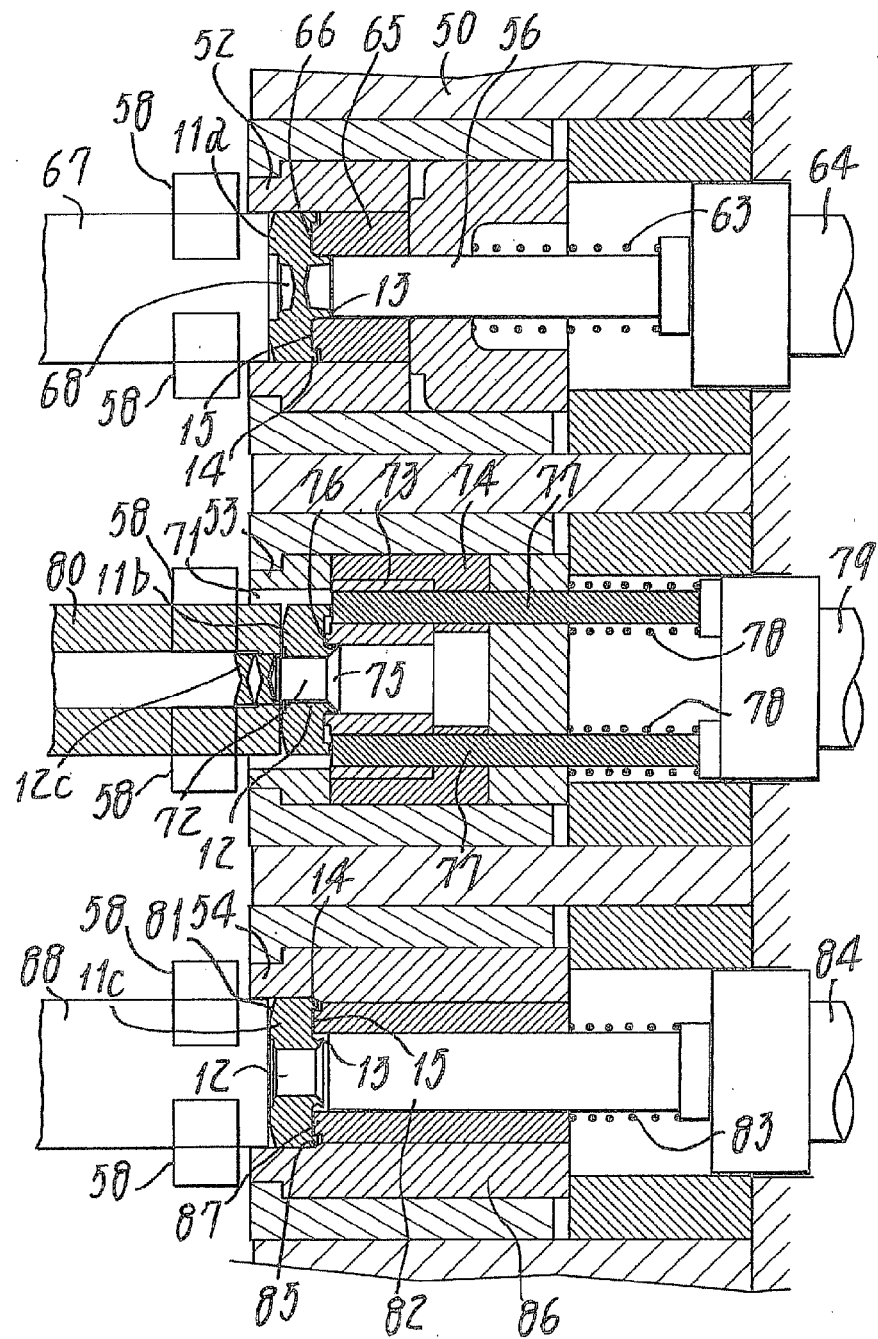


Fig. 10

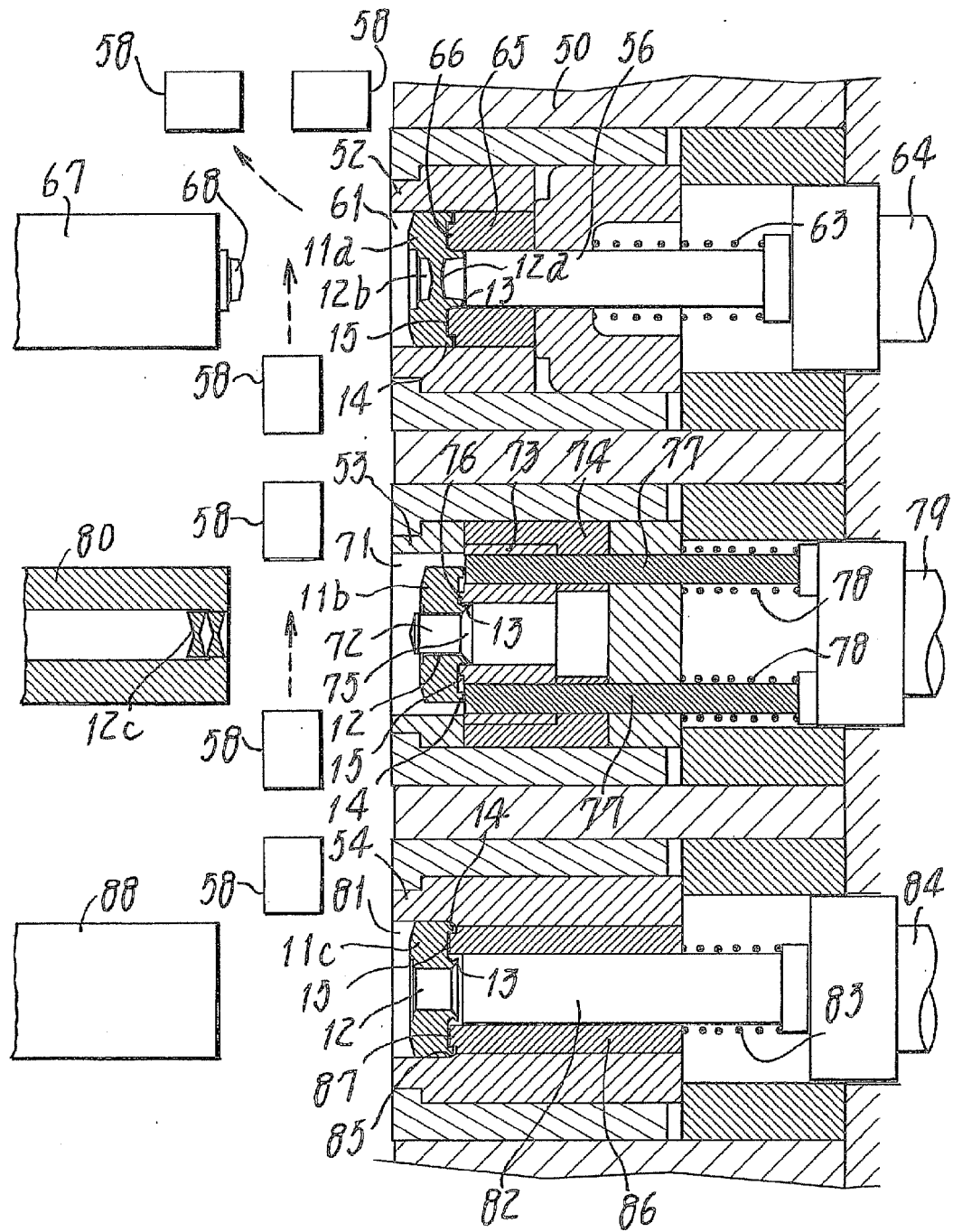


Fig. 11

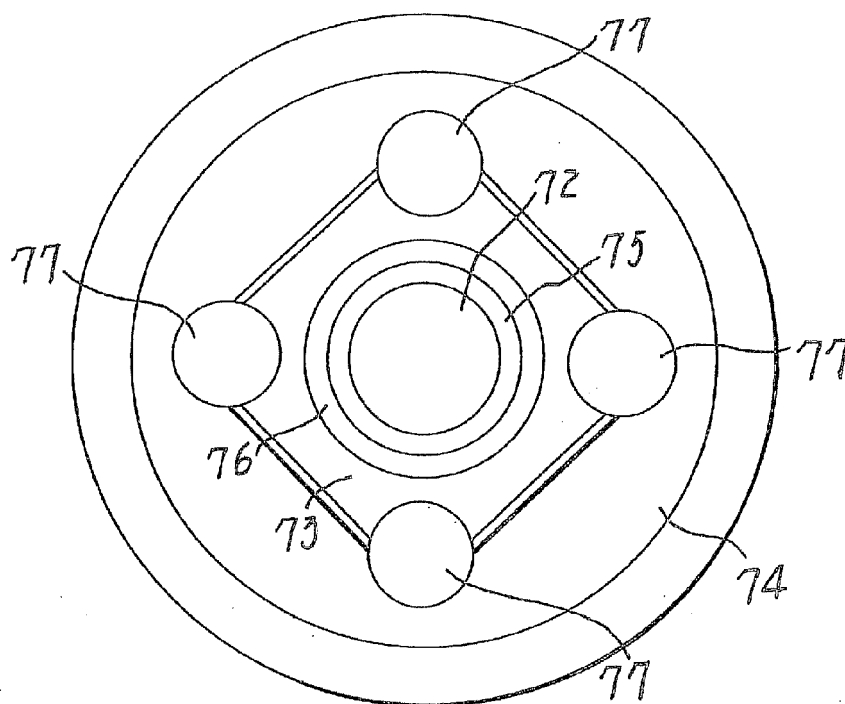


Fig. 12

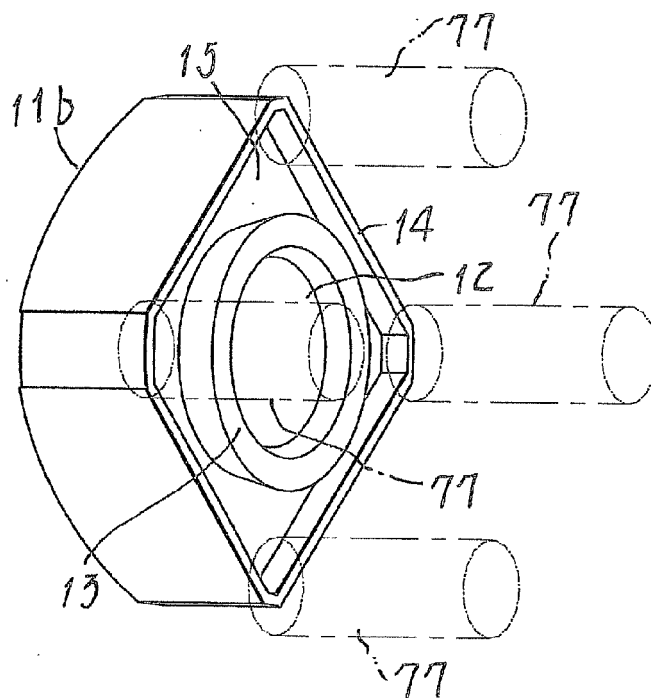


Fig. 13

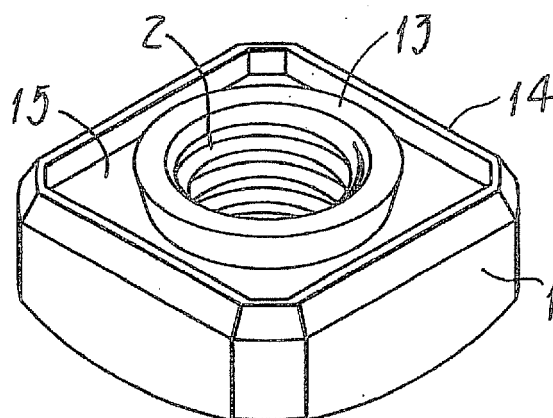


Fig. 14

Prior Art

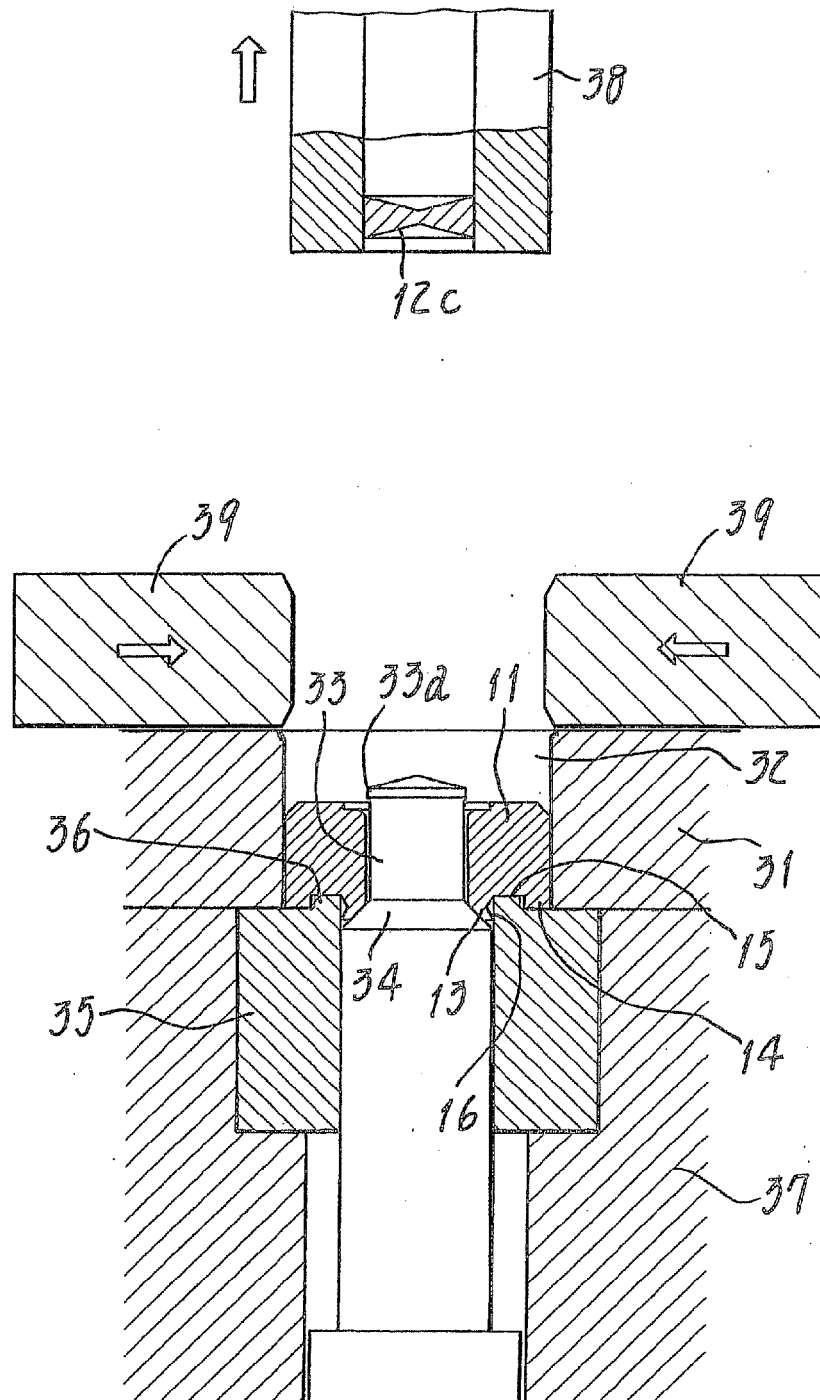
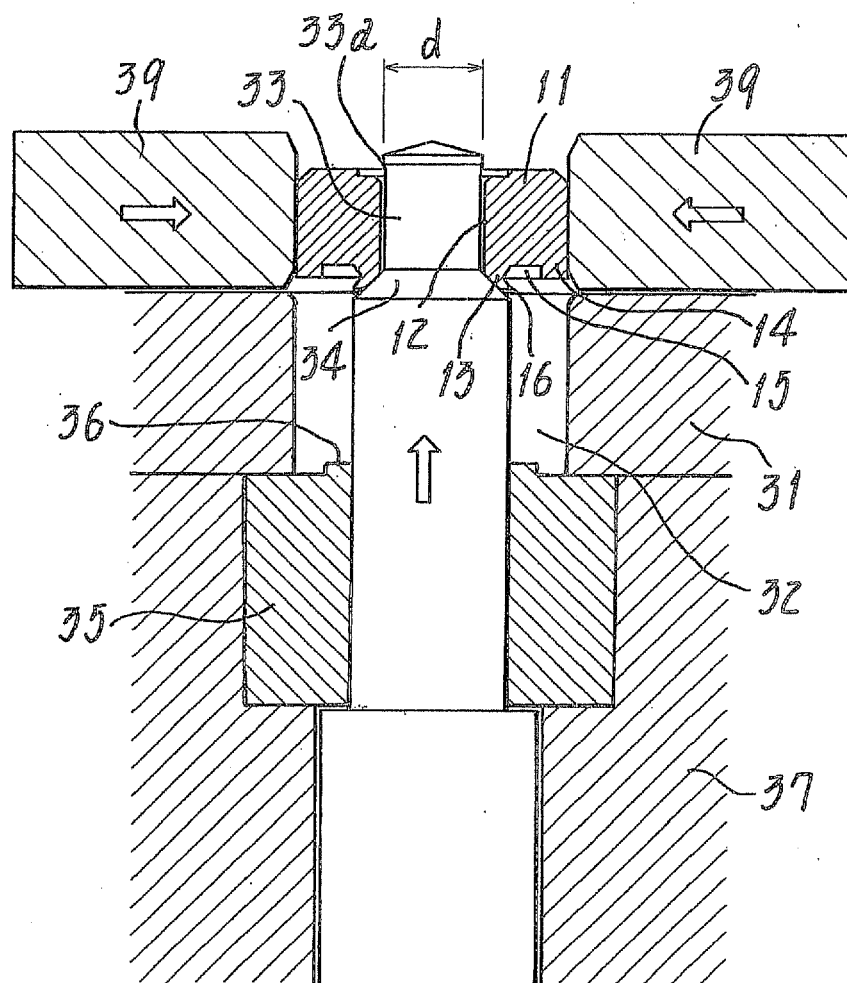


Fig. 15

Prior Art





EUROPEAN SEARCH REPORT

Application Number
EP 12 17 1181

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A,D	EP 0 663 247 A1 (SHINJO SEISAKUSHO YK [JP]) 19 July 1995 (1995-07-19) * the whole document *	1	INV. B21D53/24
A	US 2005/166381 A1 (BABEJ JIRI [DE] ET AL) 4 August 2005 (2005-08-04) * the whole document *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			B21D B21K
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 8 August 2012	Examiner Pieracci, Andrea
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EP 12 17 1181

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The members are as contained in the European Patent Office EDP file on
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08-08-2012

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