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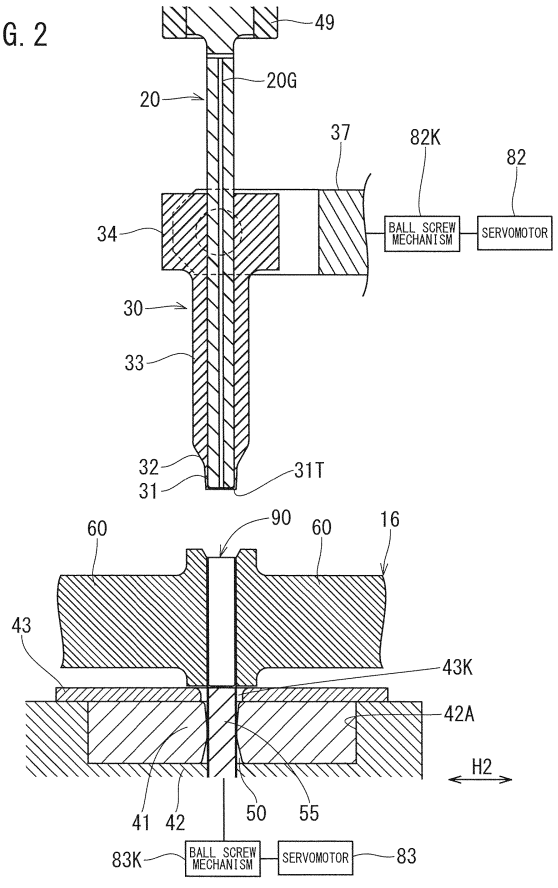
(54) PRESSING MACHINE AND PRESS FORMING METHOD

(57) Provided is a pressing machine and a press forming method in which sliding contact marks are hardly to be formed on a workpiece.

A pressing machine (10) of the present disclosure includes a punch (20), which is in a state of being inserted into a cylindrical workpiece (90), enters a forming hole (50) of a die (41) to strip off or draw a cylindrical wall (91) of the workpiece (90) between the outer surface of the punch (20) and the inner surface of the forming hole (50). The pressing machine (10) includes a stripper (30) configured to come into contact with the workpiece (90) to retain the workpiece (90) within the forming hole (50) wherein the punch (20) moves toward the top dead center, and a knockout pin (55) configured to push the workpiece (90) out of the forming hole (50) after the punch (20) has come out of the workpiece (90).

FIG. 2



EP 3 738 690 A1

Description

Technical Field

[0001] The present disclosure relates to a pressing machine and a press forming method for forming a cylindrical workpiece.

Background Art

[0002] Conventionally, this type of pressing machine has been known, in which a punch, while in a state of being inserted into a cylindrical workpiece, enters a forming hole of a die to strip off or draw a cylindrical wall of the workpiece between the outer surface of the punch and the inner surface of the forming hole (e.g., see Patent Literature 1).

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2016-182640 A (Figs. 11 to 13)

Summary of Invention

Technical Problem

[0004] In the above conventional pressing machine, sliding contact marks are formed on the outer surface of the workpiece due to sliding contact with the inner surface of the forming hole, resulting in poor appearance. The development of technology to suppress the occurrence of such sliding contact marks has been demanded.

Solution to Problem

[0005] The invention made in order to solve the above problem is a pressing machine including a punch, which is in a state of being inserted into a cylindrical workpiece, enters a forming hole of a die to strip off or draw a cylindrical wall of the workpiece between the outer surface of the punch and the inner surface of the forming hole, and the pressing machine includes: a stripper configured to come into contact with the workpiece to retain part or a whole of the workpiece within the forming hole wherein the punch moves toward the top dead center; and a knockout pin configured to push the workpiece out of the forming hole after the part or the whole of the punch has come out of the workpiece.

[0006] Moreover, the invention is a press forming method in which a punch of a pressing machine, while in a state of being inserted into a cylindrical workpiece, enters a forming hole of a die to strip off or draw a cylindrical wall of the workpiece between the outer surface of the punch and the inner surface of the forming hole, and the press forming method includes: retaining part or a whole of the workpiece within the forming hole wherein the punch moves toward a top dead center; and pushing the workpiece out of the forming hole by a knockout pin after the part or the whole of the punch has come out of the workpiece. Brief Description of Drawings

Fig. 1 is a front view of a pressing machine according to a first embodiment.
Fig. 2 is a side sectional view of a working stage
Fig. 3 is a side sectional view of a forming hole.
Fig. 4 is a side sectional view showing a state where a punch is inserted into a workpiece.
Fig. 5 is a side sectional view showing a state where the workpiece is pushed into the forming hole.
Fig. 6 is a side sectional view showing a state where the punch has come out of the workpiece within the forming hole.
Fig. 7 is a side sectional view showing a state where the workpiece is pushed out of the forming hole.
Fig. 8 is a side sectional view of a working stage of a pressing machine according to a second embodiment.
Fig. 9 is a side sectional view of a working stage of a pressing machine according to a third embodiment.
Fig. 10 is a side sectional view of a pressing machine according to a modification.
Fig. 11 is a side sectional view of a pressing machine according to a modification.

Description of Embodiments

[First Embodiment]

[0007] Hereinafter, a pressing machine 10 of the present embodiment will be described with reference to Figs. 1 to 7. Fig. 1 shows the entire pressing machine 10. Hereinafter, the lateral direction in Fig. 1 is referred to as a lateral direction H1 of the pressing machine 10, and the direction orthogonal to the paper surface of Fig. 1 is referred to as a front-back direction H2 (see Fig. 2) of the pressing machine 10. Moreover, the side of the pressing machine 10 shown in Fig. 1 is referred to as a "front side" of the pressing machine 10, the opposite side is referred to as a "back side," and the "right side" and the "left side" in Fig. 1 are simply referred to as a "right side" and a "left side" of the pressing machine 10 and the like, respectively.

[0008] The pressing machine 10 of the present embodiment is a so-called transfer pressing machine and includes a plurality of working stages aligned in a line as well as a transfer device 16. Each working stage has a punch 20 and a die 41 facing each other in the vertical direction as shown in Fig. 1, and the transfer device 16 transfers a workpiece 90 (see Fig. 2) between the working stages.

[0009] The plurality of punches 20 at the plurality of working stages are held by punch holders 49 provided

at the lower portion of a ram 12 and are aligned in a line at regular intervals. The plurality of dies 41 are held by die holders 42 on a bolster 14 and aligned in a line at regular intervals. Furthermore, a workpiece supply device 18 is provided on the left side of the left end working stage. The workpiece supply device 18 punches out a blank material from a sheet metal to form a tubular workpiece 90 with a bottom at one end by drawing.

[0010] The transfer device 16 includes a pair of rails 16A (only one rail 16A is shown in Fig. 1) which extend in the lateral direction H1 over the plurality of working stages and are aligned at the front and the back. In addition, for the pair of rails 16A, a plurality of pairs of fingers 60 (see Fig. 2) are disposed facing each other and aligned at regular intervals in the lateral direction H1.

[0011] Each finger 60 is movably supported in the movement direction in the front-back direction H2 with respect to the pair of rails 16A. Moreover, the plurality of pairs of fingers 60 receive power from an air cylinder to open and close so as to approach and separate from each other. Furthermore, the pair of rails 16A receive power from a servomotor 81 (see Fig. 1), which is a driving source of the ram 12, and reciprocate in the lateral direction H1 with a stroke at regular intervals.

[0012] Then, in synchronization with ascending and descending motion of the ram 12, the transfer device 16 repeats cycle operation, in which the plurality of the pairs of fingers 60 are closed and grip the workpiece 90 when the pair of rails 16A are positioned at the left end position of the stroke, the plurality of the pairs of fingers 60 are opened and release the workpiece 90 after the pair of rails 16A move to the right end position of the stroke while keeping the closed and gripping state, and the plurality of the pairs of the fingers 60 are closed after the pair of rails 16A move to the left end position of the stroke while keeping the open state.

[0013] Thus, each time the ram 12 ascends and descends, the workpiece 90 supplied from the workpiece supply device 18 is sequentially transferred to the next right working stage by the transfer device 16 and, for example, is formed so as to be gradually longer and thinner. Then, the workpiece 90 having been processed at the working stage at the end in the transfer direction is passed to a belt conveyor (not shown), a chute (not shown) and the like by the transfer device 16 to be transferred to the next step.

[0014] Note that the final shape of the workpiece 90 of the present embodiment is a tubular shape, but is not limited thereto, and may be an elliptical tubular shape or a quadrangle tubular shape. Moreover, the cross-sectional shape of the quadrangle tubular workpiece 90 is not limited to a quadrangle and may be a polygon other than a quadrangle. Furthermore, the cylindrical shape of the workpiece 90 with a bottom at one end formed by the workpiece supply device 18 may be selected as appropriate depending on the final cylindrical shape of the workpiece 90. Specifically, when the cross section of the final cylindrical workpiece 90 is an elongated rectangle, the cylindrical shape of the workpiece 90 with a bottom at one end formed by the workpiece supply device 18 should have an elliptical cross section.

[0015] Figs. 2 to 7 show the structure of the working stage at the end or near the end. Hereinafter, with this working stage as an example, the structure of each working stage will be detailed. As shown in Fig. 2, the die 41 is fitted into a recessed portion 42A in the upper surface of the die holder 42 and is prevented from coming out by a retaining plate 43 from above. Moreover, as shown in Fig. 3, the die 41 includes a forming hole 50 penetrating vertically, and the die holder 42 and the retaining plate 43 has through holes 42K and 43K formed coaxially with the forming hole 50, respectively.

[0016] The forming hole 50 includes a first tapered portion 51, a narrowest portion 52 and a second tapered portion 53 in order from the top. The first tapered portion 51 is formed from the upper end portion to the upper center position of the die 41 in the vertical direction, and the diameter thereof is reduced downward. The narrowest portion 52 extends straight with a uniform inner diameter from the lower end of the first tapered portion 51 to the lower center position of the die 41 in the vertical direction. And, the second tapered portion 53 is formed from the lower end of the narrowest portion 52 to the lower end portion of the die 41, and the diameter thereof is expanded with a taper angle greater than that of the first tapered portion 51. In the forming hole 50 of the die 41 of the present embodiment, the narrowest portion 52 extends straight with a uniform inner diameter between the first and second tapered portions 51 and 53, however, the first and second tapered portions 51 and 53 may be configured to intersect with each other. The intersecting part of the tapered portions 51 and 53 may serve as the narrowest portion.

[0017] Moreover, the through hole 42K of the die holder 42 is wider than the narrowest portion 56 of the forming hole 50, and the workpiece 90 having passed through the forming hole 50 is inserted into the through hole 42K of the die holder 42 without interference. And, the through hole 43K of the retaining plate 43 is wider than the through hole 42K of the die holder 42.

[0018] As shown in Fig. 2, for example, the punch 20 extends such that the cross-sectional shape thereof is on the distal end side relative to the portion held by the punch holder 49 is uniform, and this cross-sectional shape is slightly smaller than the cross-sectional opening at the narrowest portion 56 (see Fig. 3) of the forming hole 50. Moreover, the gap between the narrowest portion 56 of the forming hole 50 and the outer surface of the punch 20 is smaller than the wall thickness of a cylindrical wall 91 of the workpiece 90 before being pushed into the forming hole 50. Note that a gas venting hole 20G is formed in the punch 20 from the distal end portion to a position near the proximal end. Thus, when the punch 20 is inserted into or ejected from the workpiece 90, the pressure within the workpiece 90 does not greatly differ from the atmospheric pressure.

[0019] The punch 20 is inserted into the workpiece 90 outside the forming hole 50 as shown in Fig. 4 and enters the forming hole 50 together with the workpiece 90 as shown in Fig. 5 after the distal end of the punch 20 comes into contact with the cylindrical wall 91 of the workpiece 90. At this time, the cylindrical wall 91 of the workpiece 90 is stripped off or drawn by passing through between the narrowest portion 52 of the forming hole 50 and the punch 20, where it is narrower than the wall thickness of the cylindrical wall. Furthermore, when the punch 20 has reached the bottom dead center, for example, only the upper end portion of the workpiece 90 is positioned above the lower end 56 of the aforementioned narrowest portion 52, and part of the workpiece 90 is positioned within the through hole 42K of the die holder 42.

[0020] Note that the upper end portion of the workpiece 90 is removed by a trimming device (not shown) in a step after the pressing machine 10 in consideration of variation in the shape of the upper surface of the workpiece 90.

[0021] As shown in Fig. 2, each working stage is provided with a knockout pin 55 for pushing out the workpiece 90 upward from the forming hole 50. The knockout pin 55 has a cross section substantially the same as that of the punch 20, extends in the vertical direction, and is disposed coaxially below the punch 20. Moreover, the knockout pin 55 is coupled to the output portion of a ball screw mechanism 83K that uses a servomotor 83 as a driving source. Then, the knockout pin 55 reciprocates between the upper limit position and the lower limit position. The upper limit position is where the upper surface of the knockout pin 55 is substantially flush with the upper surface of the retaining plate 43 as shown in Fig. 2, and the lower limit position is slightly lower than the bottom dead center of the punch 20 as shown in Fig. 5.

[0022] Note that, when the workpiece 90 is pushed into the forming hole 50, the knockout pin 55 descends while pressing a bottom wall 92 of the workpiece 90 toward the punch 20. This prevents the bottom wall 92 of the workpiece 90 from bulging away from the punch 20. For the press as described above, an elastic member may be provided between the output portion of the ball screw mechanism 83K and the knockout pin 55, or the pressing force may be applied to the bottom wall 92 by the control of the servomotor 83.

[0023] As shown in Fig. 1, each working stage is provided with a stripper 30 for detaching the workpiece 90 from the punch 20. As shown in Fig. 2, the stripper 30 is fitted to the outer side of the punch 20 and has a cylindrical shape shorter than the punch 20. Specifically, the stripper 30 has, for example, a tubular-shaped base cylindrical portion 33 extending in the vertical direction and includes a coupling portion 34 formed by thickening sideways the upper end portion of the base cylindrical portion 33. Then, an arm 37 provided at the output portion of a ball screw mechanism 82K, which uses a servomotor 82 as the driving source, is coupled to the coupling portion 34, thereby moving the stripper 30 between the upper limit position and the lower limit position described later.

[0024] A tapered portion 32 whose diameter is reduced downward in a tapered manner is provided at the lower end portion of the base cylindrical portion 33, and a thin cylindrical portion 31 extends downward from the lower end of the tapered portion 32. As shown in Fig. 5, the diameter of the thin cylindrical portion 31 is reduced toward the distal end (lower end) with a taper angle smaller than the first tapered portion 51 of the forming hole 50, and the axial length of the thin cylindrical portion 31 is the same as or slightly longer than the axial length of the first tapered portion 51. Furthermore, a distal end surface 31T of the thin cylindrical portion 31 (also the distal end surface 31T of the stripper 30) is a flat surface orthogonal to the axial direction of the stripper 30.

[0025] Then, when the stripper 30 is disposed at the lower limit position shown in Fig. 5, the lower portion of the tapered portion 32 is received in the through hole 43K of the retaining plate 43 as well as the thin cylindrical portion 31 is received in the forming hole 50, and the distal end surface 31T is positioned slightly above a boundary portion 55 between the first tapered portion 51 and the narrowest portion 52 in the forming hole 50. And, when the stripper 30 is disposed at the upper limit position shown in Fig. 2, the stripper 30 is away upward from the fingers 60.

[0026] Although not shown, a controller of the pressing machine 10 includes a control circuit having a CPU, and a servo amplifier of each servomotor previously mentioned is connected to the control circuit. Furthermore, a driving circuit of a solenoid valve for controlling the supply of compressed air to an air cylinder of the transfer device 16 is also connected to the control circuit. Then, the control circuit controls each servomotor and the solenoid valve so that the punch 20, the stripper 30 and the knockout pin 55 perform the following motions in synchronization.

[0027] That is, in each working stage, as shown in Fig. 2, when the ram 12 is positioned at the top dead center or while descending from the top dead center, the rails 16A of the transfer device 16 are positioned at the right end of the stroke, and the workpiece 90 sandwiched between the pair of fingers 60 is disposed coaxially with the forming hole 50 of the die 41. At this time, the knockout pin 55 is positioned at the upper limit position, and the stripper 30 is positioned at the upper limit position.

[0028] Then, when the punch 20 descends, the stripper 30 descends at a lower speed than the punch 20. Then, the punch 20 projects downward from the stripper 30, and the distal end portion of the punch 20 is inserted into the workpiece 90 before the stripper 30 reaches the fingers 60. Thereupon, the pair of fingers 60 are opened and move sideways from the position just under the stripper 30, and the rails 16A of the transfer device 16 move to the left side of the stroke. During this time, the punch 20 is further inserted into the workpiece 90 and eventually reaches the bottom wall 92 of the workpiece 90, and the bottom wall 92 of the workpiece 90 is sandwiched between the punch 20 and the knockout pin 55.

[0029] From there, the punch 20 further descends, and the workpiece 90 is pushed into the forming hole 50. Along with that, the knockout pin 55 descends together with the punch 20 while maintaining the state where the bottom wall 92 of the workpiece 90 is pressed upward, and the stripper 30 descends together with the punch 20 while maintaining a space above the workpiece 90. Then, the cylindrical wall 91 of the workpiece 90 is stripped off or drawn by passing through between the inner surface of the forming hole 50 and the outer surface of the punch 20.

[0030] More specifically, the gap between at least the narrowest portion 56 of the forming hole 50 and the punch 20 is smaller than the thickness of the cylindrical wall 91 of the workpiece 90. Thus, the cylindrical wall 91 passes therethrough to be stripped off or drawn so that the wall thickness of the cylindrical wall 91 becomes the same size as the gap between the narrowest portion 56 and the punch 20.

[0031] At this time, the die 41 may be deformed due to diameter expansion with a very small amount. As a result, the wall thickness of the cylindrical wall 91 having passed through the narrowest portion 56 is slightly larger than the gap between the narrowest portion 56 and the punch 20 in some cases. In addition, the wall thickness of the cylindrical wall 91 may be slightly elastically restored by the elasticity remaining slightly in the cylindrical wall 91, and the wall thickness of the cylindrical wall 91 having passed through the narrowest portion 56 is slightly larger than the gap between the narrowest portion 56 and the punch 20 in some cases. Thus, if the workpiece 90 ascends inside the forming hole 50 together with the punch 20 in a state where the punch 20 is inserted inside the workpiece 90, the inner surface of the forming hole 50 is in sliding contact with the outer surface of the workpiece 90 in a state of being strongly pressed. As a result, deep sliding contact marks may be formed on the outer surface of the workpiece 90.

[0032] In order to avoid this, in the pressing machine 10 of the present embodiment, the stripper 30 reaches the lower limit position before or at substantially the same timing that the punch 20 reaches the bottom dead center. Then, as shown in Fig. 5, the thin cylindrical portion 31 of the stripper 30 stands by slightly above the workpiece 90 in the forming hole 50. At this time, the stripper 30 may be brought into contact with the workpiece 90, but this may cause the workpiece 90 to be pushed into the deeper side of the forming hole 50 by the stripper 30 due to variation in the axial length of the workpiece 90. On the other hand, the stripper 30 of the pressing machine 10 of the present embodiment stands by above the workpiece 90 with a gap therebetween before the punch 20 moves toward the top dead center. Thus, the workpiece 90 is prevented from being pushed into the deeper side of the forming hole 50 due to the stripper 30.

[0033] When the punch 20 moves from the bottom dead center to the top dead center, as shown in Fig. 6, the workpiece 90 slightly ascends together with the punch 20, and the distal end surface 31T of the stripper 30 and the upper surface of the workpiece 90 come into contact with each other. Thus, the upward movement of the workpiece 90 is restricted. At this time, the knockout pin 55 is stopped, and the workpiece 90 is slightly away upward from the knockout pin 55. Then, in the state where the upward movement of the workpiece 90 is restricted by the stripper 30, the punch 20 further ascends and comes out of the workpiece 90.

[0034] Note that the stripper 30 may come into contact with the upper surface of the workpiece 90 when only the upper portion of the workpiece 90 is pushed out of the forming hole 50. However, since the stripper 30 of the present embodiment comes into contact with the workpiece 90 in a state where the entire workpiece 90 is received in the forming hole 50, the distance that the workpiece 90 moves together with the punch 20 toward the top dead center is suppressed, and the occurrence of sliding contact marks on the workpiece 90 is also effectively suppressed. In addition, the entire stripper 30 may be thin in order to be brought into contact with the workpiece 90 within the forming hole 50. However, since the stripper 30 of the present embodiment has a structure provided with the thin cylindrical portion 31 which is capable of entering the forming hole 50 and which is closer to the distal end side relative to the base cylindrical portion 33 incapable of entering the forming hole 50, the strength can be increased.

[0035] Now, after the punch 20 has come out of the workpiece 90, the knockout pin 55 ascends and comes into contact with the bottom wall 92 of the workpiece 90. Then, for example, as shown in Fig. 7, the workpiece 90 ascends in a state of being sandwiched between the knockout pin 55 and the stripper 30, and moves upward inside the forming hole 50. At this time, since the punch 20 has already come out of the workpiece 90, the cylindrical wall 91 of the workpiece 90 easily bends inward. Accordingly, the sliding contact pressure when the narrowest portion 56 comes into sliding contact with the cylindrical wall 91 of the workpiece 90 is suppressed, and the occurrence of sliding contact marks is suppressed.

[0036] Moreover, before the knockout pin 55 reaches the upper limit position, the rails 16A of the transfer device 16 are positioned at the left end of the stroke and stands by in a state where the pair of fingers 60 are open. Then, when the knockout pin 55 reaches the upper limit position, that is, when the workpiece 90 is pushed out of the forming hole 50, the pair of fingers 60 close, and the workpiece 90 is sandwiched. Thereafter, the stripper 30 is separated upward from the workpiece 90. Meanwhile, the rails 16A of the transfer device 16 move to the right side of the stroke to a position spaced apart at regular intervals. Thus, the pressing machine 10 returns to the original state, and the same operation is repeated thereafter.

[0037] As described above, in the pressing machine 10 and the press forming method of the present embodiment, when the punch 20 moves toward the bottom dead

center, the cylindrical wall 91 of the workpiece 90 is pushed into the forming hole 50 to be stripped off or drawn in a state where inward deformation is restricted by the punch 20. On the other hand, when the punch 20 moves toward the top dead center, the punch 20 comes out of the workpiece 90 in a state where the workpiece 90 is stayed within the forming hole 50 by the stripper 30. Thereafter, the workpiece 90 is pushed out of the forming hole 50 by the knockout pin 55. That is, the workpiece 90 is pushed out of the forming hole 50 in a state where the cylindrical wall 91 can easily bend inward, and the sliding contact pressure applied to the outer surface of the cylindrical wall 91 is suppressed. Accordingly, the occurrence of sliding contact marks on the workpiece 90 is suppressed. Furthermore, the pressing machine 10 is a transfer pressing machine, in which the workpiece 90 pushed out of the forming hole 50 is sandwiched by the fingers 60 of the transfer device 16 and transferred. Thus, the occurrence of sliding contact marks on the workpiece 90 after being pushed out of the forming hole 50 is also suppressed.

[Second Embodiment]

[0038] In the pressing machine 10 of the above embodiment, the workpiece 90 is pushed out of the forming hole 50 after the entire punch 20 has come out of the workpiece 90. However, in a pressing machine 10A of the present embodiment, as shown in Fig. 8, a stripper 30 ascends together with a punch 20 and separates from a workpiece 90 after the punch 20 has come out of the workpiece 90. Then, a pair of fingers 60 stand by above a forming hole 50, and the workpiece 90 is pushed between the pair of fingers 60 by a knockout pin 55. Note that the sandwiching surfaces of the pair of fingers 60 are smooth, and it is not likely to form sliding contact marks by the fingers 60.

[Third Embodiment]

[0039] In the pressing machine 10 of the above embodiments, the stripper 30 restricts the upward movement of the workpiece 90 until the entire punch 20 comes out of the workpiece 90. However, in a pressing machine 10B of the present embodiment, for example, as shown in Fig. 9, a stripper 30 restricts the upward movement of a workpiece 90 until the distal end portion of a punch 20 is in a state of slightly fitting to the upper end portion of the workpiece 90. Thereafter, while the state where the distal end portion of the punch 20 is slightly fitted to the upper end portion of the workpiece 90 is maintained, the stripper 30 and the punch 20 integrally ascends together with a knockout pin 55, and the workpiece 90 is pushed out of a forming hole 50. Then, immediately before the workpiece 90 is sandwiched between a pair of fingers 60, the ascending speed of the stripper 30 becomes slower than the ascending speed of the punch 20, the punch 20 is detached from the workpiece 90, and the workpiece 90 is passed to the pair of fingers 60. According to this configuration, the posture when the workpiece 90 is pushed out of the forming hole 50 is stabilized.

[Other Embodiments]

[0040]

(1) In the pressing machine 10 of the above embodiment, the punch 20 is detached from the workpiece 90 in the state where the stripper 30 retains the workpiece 90 within the forming hole 50 as described above in all of the plurality of working stages, and then the workpiece 90 is pushed out of the forming hole 50 by the knockout pin 55. However, this may be performed in only some of the plurality of working stages in the configuration. In other working stages, a workpiece 90 is pushed out of a forming hole 50 together with a punch 20. Then the stripper 30 may come into contact with the workpiece 90 to detach the punch 20 from the workpiece 90.

(2) The stripper 30 of the above embodiments has a cylindrical shape fitted to the outer side of the punch 20. However, a stripper may move in a direction perpendicular to the movement direction of a punch. Specifically, the aforementioned stripper 30 is eliminated, and the aforementioned pair of fingers 60 are also used as the stripper. For example, when the punch 20 has reached the bottom dead center, the pair of fingers 60 are closed and attached to the side surface of the punch 20. When the punch 20 moves upward in this state and only the upper portion of a workpiece 90 is pushed out of a forming hole 50, this upper portion may come into contact with the lower surfaces of the pair of fingers 60. Then, after part or the whole of the punch 20 has come out of the workpiece 90, the pair of fingers 60 may be slightly opened in the configuration so that a knockout pin 55 pushes out the workpiece 90 between the pair of fingers 60.

(3) In the pressing machine 10 of the above embodiment, the stripper 30 and the knockout pin 55 use the servomotors 82 and 83 as the driving sources, which are different from the servomotor 81 that is the driving source of the ram 12. However, one or both of the stripper 30 and the knockout pins 55 may use, as the driving sources, the servomotor 81 that is the driving source of the ram 12. Specifically, a rotating shaft 72 parallel to a cam shaft 12S (see Fig. 1) for driving the ram 12 may be provided below a bolster 14 as shown in Fig. 10, and a knockout pin 55 may ascend and descend following a cam 72B that rotates integrally with the rotating shaft 72. Moreover, an upper lever 73A and a lower lever 73B may be provided at the upper portion and the lower portion of the bolster 14, respectively. The upper lever 73A and the lower lever 73B are coupled by a link 74, and the distal end of the upper lever 73A is coupled

to a stripper 30. The stripper 30 may ascend and descend by causing the lower lever 73B to follow a cam 72A that rotates integrally with the rotating shaft 72. Furthermore, as shown in Fig. 11, a rotating member 75A is provided to a rotating shaft 75 parallel to the cam shaft 12S (see Fig. 1). Then, a bracket 76 fixed to the bolster 14 and the lower end portion of the knockout pin 55 may be hinged to a lever member 77, and the position near the other end of the lever member 77 may be hinged to the rotating member 75A.

(4) The pressing machine 10 of the above embodiment is a transfer pressing machine. However, a pressing machine without the transfer device 16 may include a stripper 30 and a knockout pin 55 as in the pressing machine 10 of the above embodiment.

[0041] It is explicitly stated that all features disclosed in the description and/or the claims are intended to be disclosed separately and independently from each other for the purpose of original disclosure as well as for the purpose of restricting the claimed invention independent of the composition of the features in the embodiments and/or the claims. It is explicitly stated that all value ranges or indications of groups of entities disclose every possible intermediate value or intermediate entity for the purpose of original disclosure as well as for the purpose of restricting the claimed invention, in particular as limits of value ranges.

Claims

1. A pressing machine (10) including a punch (20), which is in a state of being inserted into a cylindrical workpiece (90), enters a forming hole (50) of a die (41) to strip off or draw a cylindrical wall (91) of the workpiece (90) between an outer surface of the punch (20) and an inner surface of the forming hole (50), the pressing machine (10) comprising:

   a stripper (30) configured to come into contact with the workpiece (90) to retain part or a whole of the workpiece (90) within the forming hole (50) wherein the punch (20) moves toward a top dead center; and
   a knockout pin (55) configured to push the workpiece (90) out of the forming hole (50) after the part or the whole of the punch (20) has come out of the workpiece (90).

2. The pressing machine (10) according to claim 1, **characterized in that** the stripper (30) has a cylindrical shape and is fitted to an outer side of the punch (20).

3. The pressing machine (10) according to claim 2, **characterized in that** the stripper (30) comes into contact with the workpiece (90) within the forming hole (50).

4. The pressing machine (10) according to claim 3, **characterized in that** the stripper (30) includes:

   a base cylindrical portion (33) with a thickness incapable of entering the forming hole (50); and
   a thin cylindrical portion (31) which extends from a distal end of the base cylindrical portion (33) and is capable of entering the forming hole (50).

5. The pressing machine (10) according to any one of claims 1 to 4, **characterized in that** the stripper (30) stands by above the workpiece (90) with a gap therebetween before the punch (20) moves toward the top dead center.

6. The pressing machine (10) according to any one of claims 1 to 5, **characterized in that**
   a plurality of the punches (20) are aligned in a line at regular intervals, and
   the pressing machine (10) further comprises a transfer device (16) that transfers, at the regular intervals, a plurality of the workpieces (90) which are processed by the plurality of the punches (20) at one time and sandwiched by a plurality of pairs of fingers (60) at one time.

7. A press forming method in which a punch (20) of a pressing machine (10), while in a state of being inserted into a cylindrical workpiece (90), enters a forming hole (50) of a die (41) to strip off or draw a cylindrical wall (91) of the workpiece (90) between an outer surface of the punch (20) and an inner surface of the forming hole (50), the press forming method comprising:

   retaining part or a whole of the workpiece (90) within the forming hole (50) wherein the punch (20) moves toward a top dead center; and
   pushing the workpiece (90) out of the forming hole (50) by a knockout pin (55) after the part or the whole of the punch (20) has come out of the workpiece (90).

FIG. 1

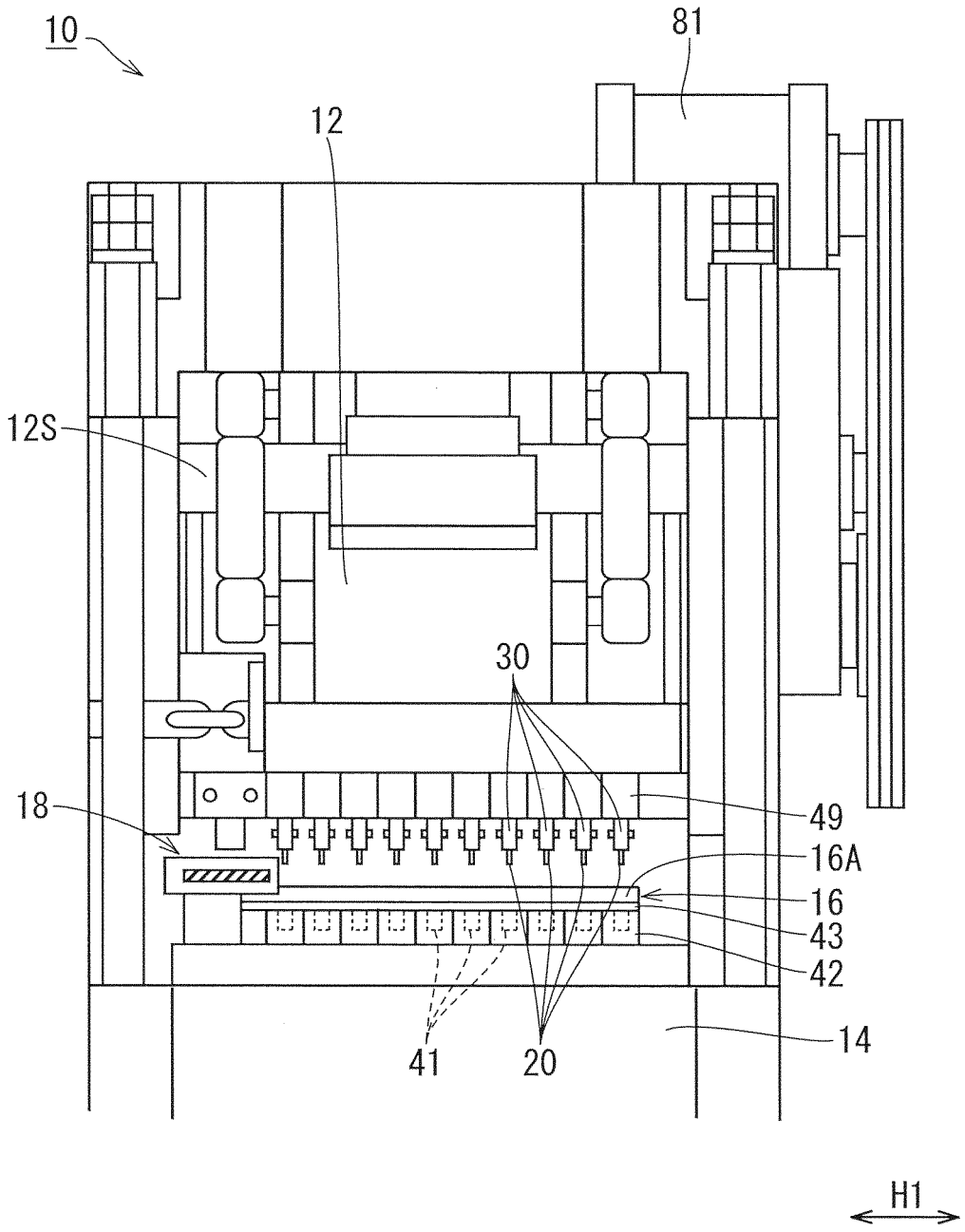
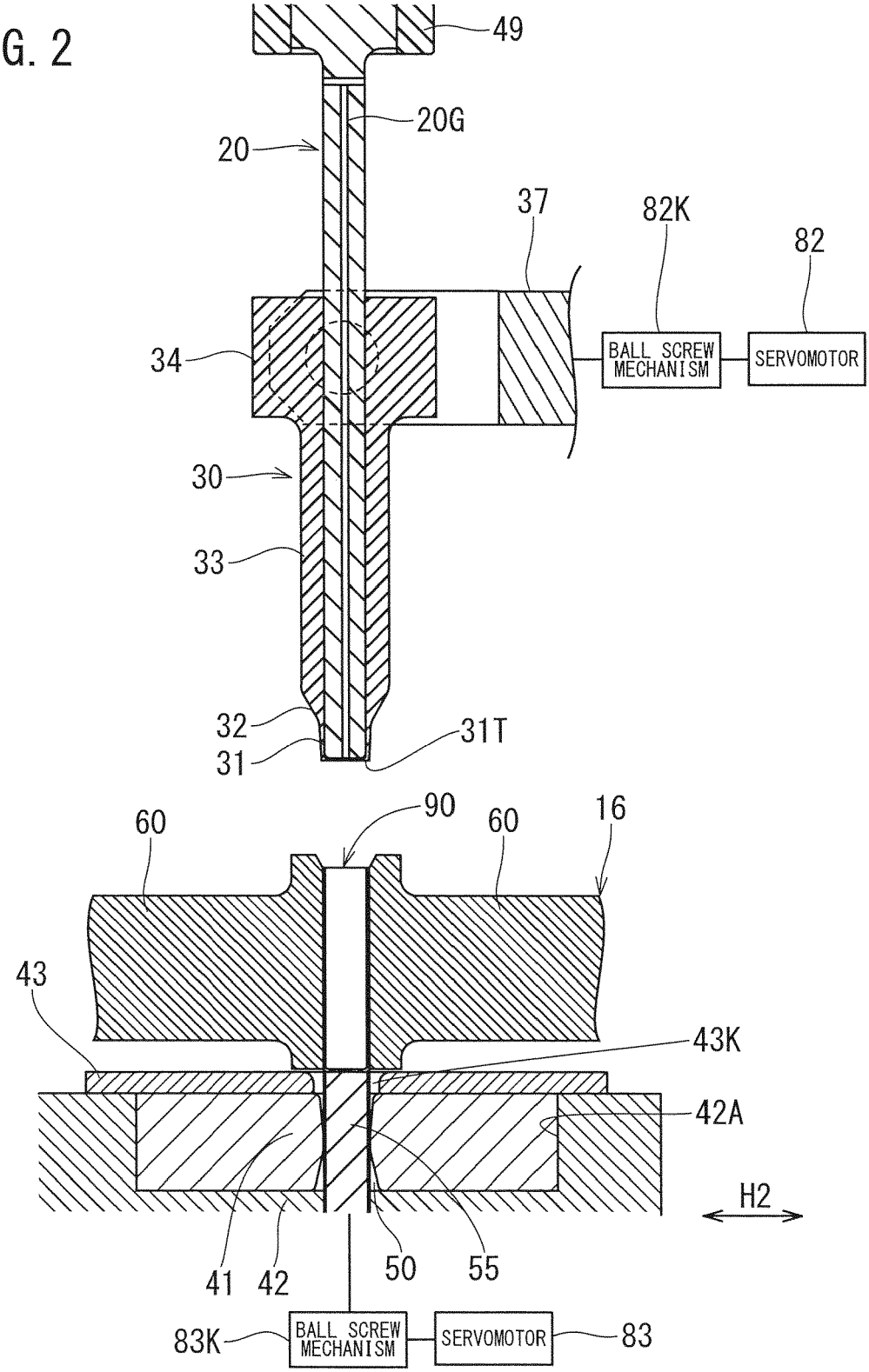


FIG. 2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BALL SCREW MECHANISM
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FIG. 3

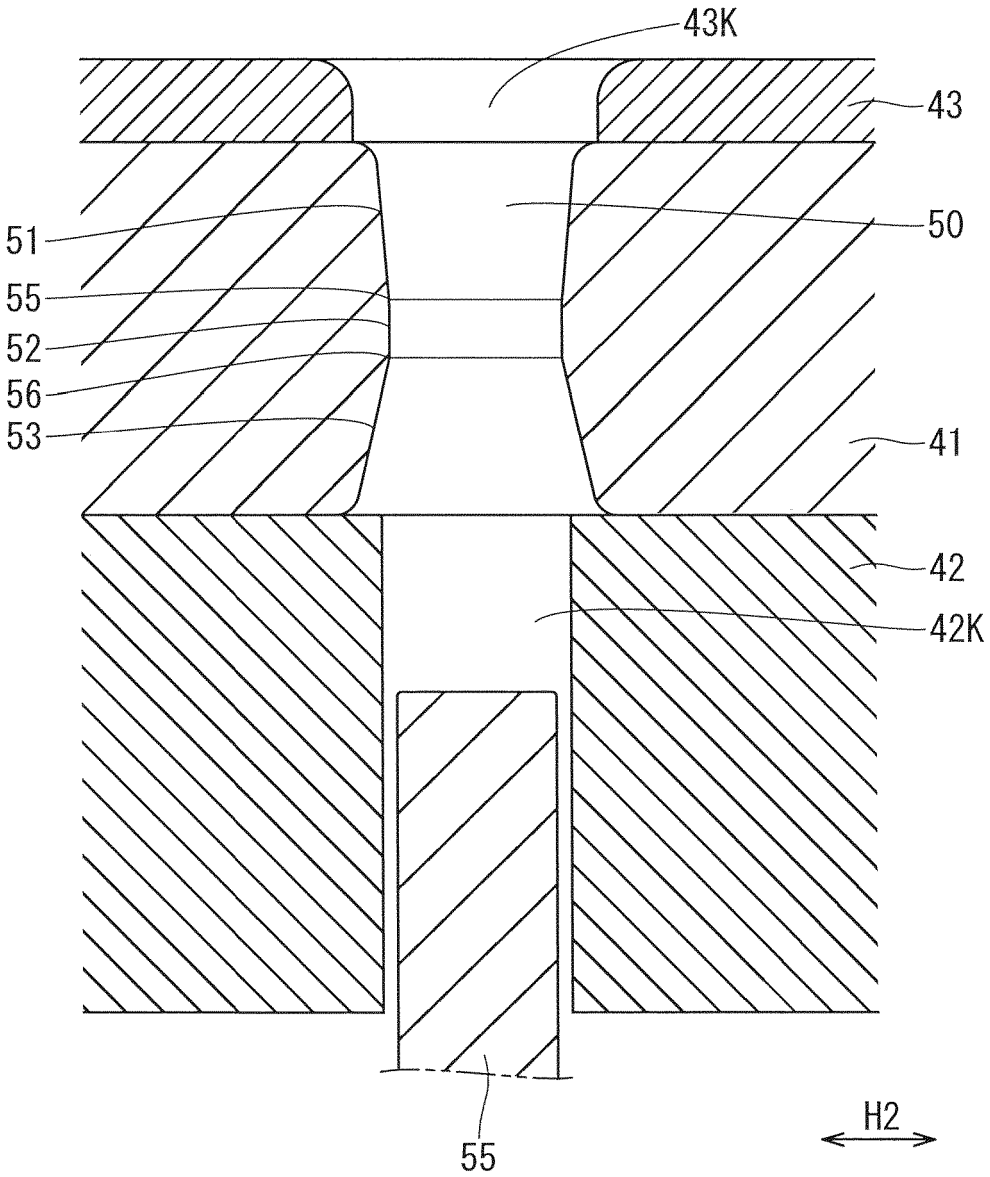

FIG. 4

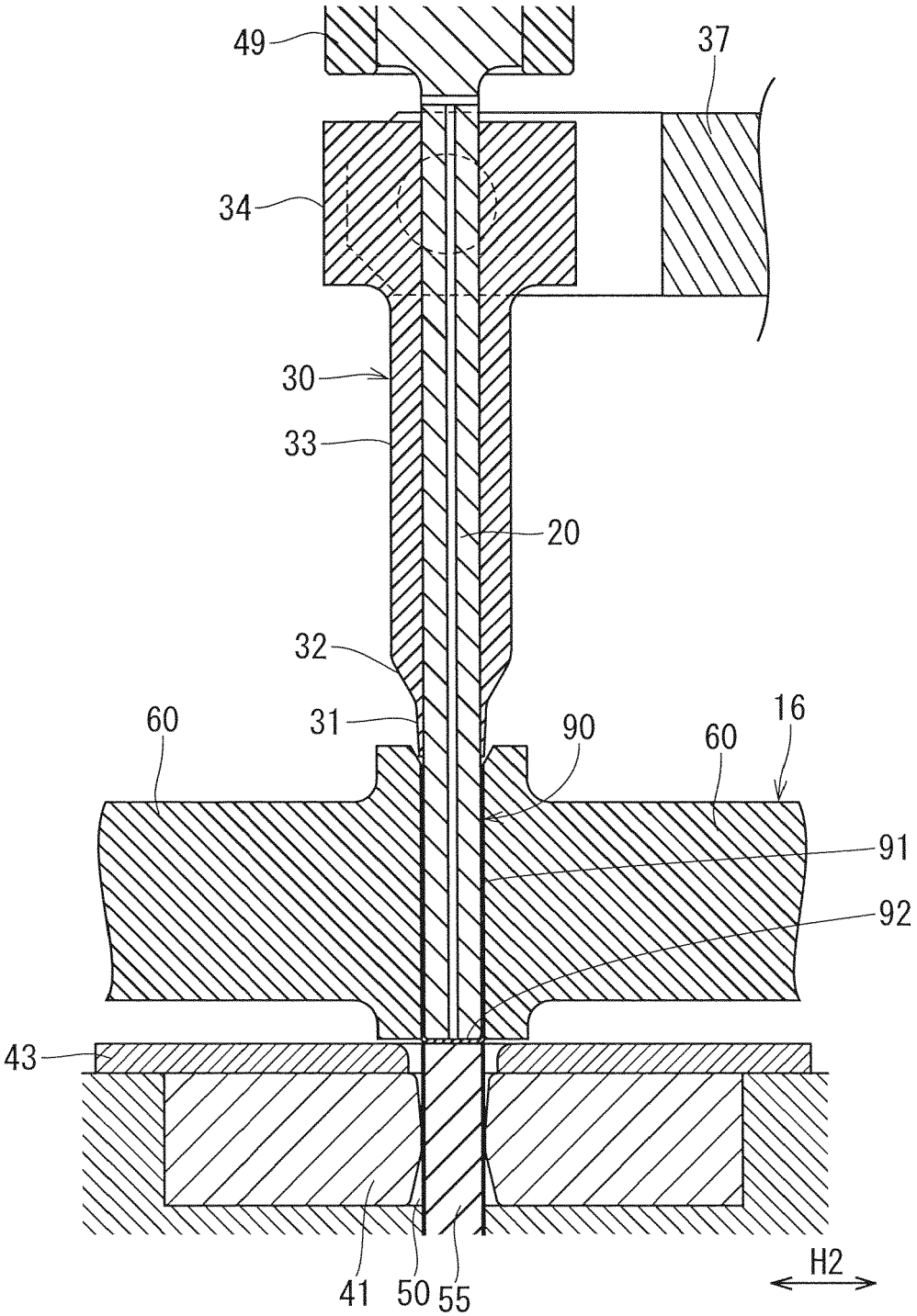

FIG. 5

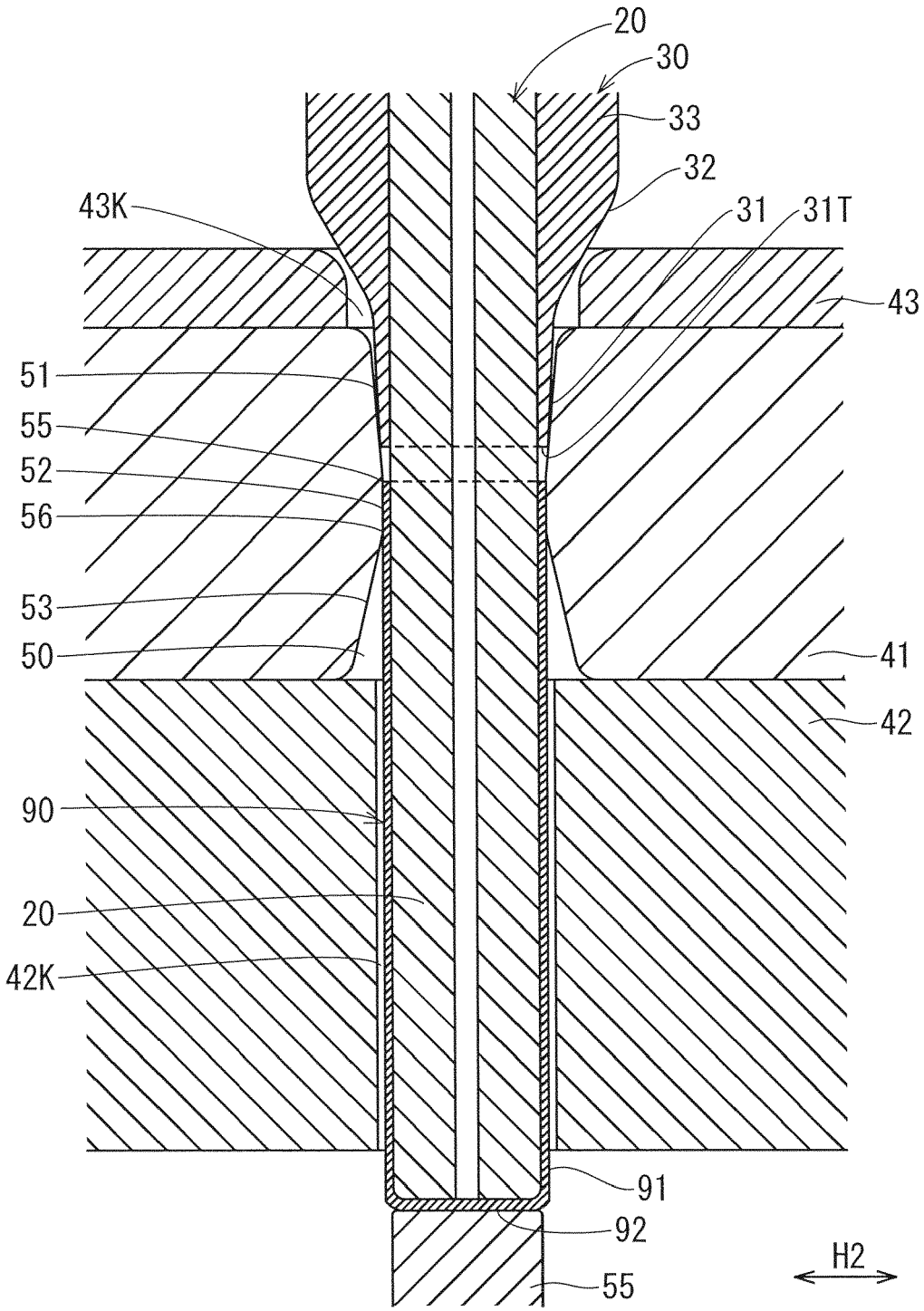

FIG. 6

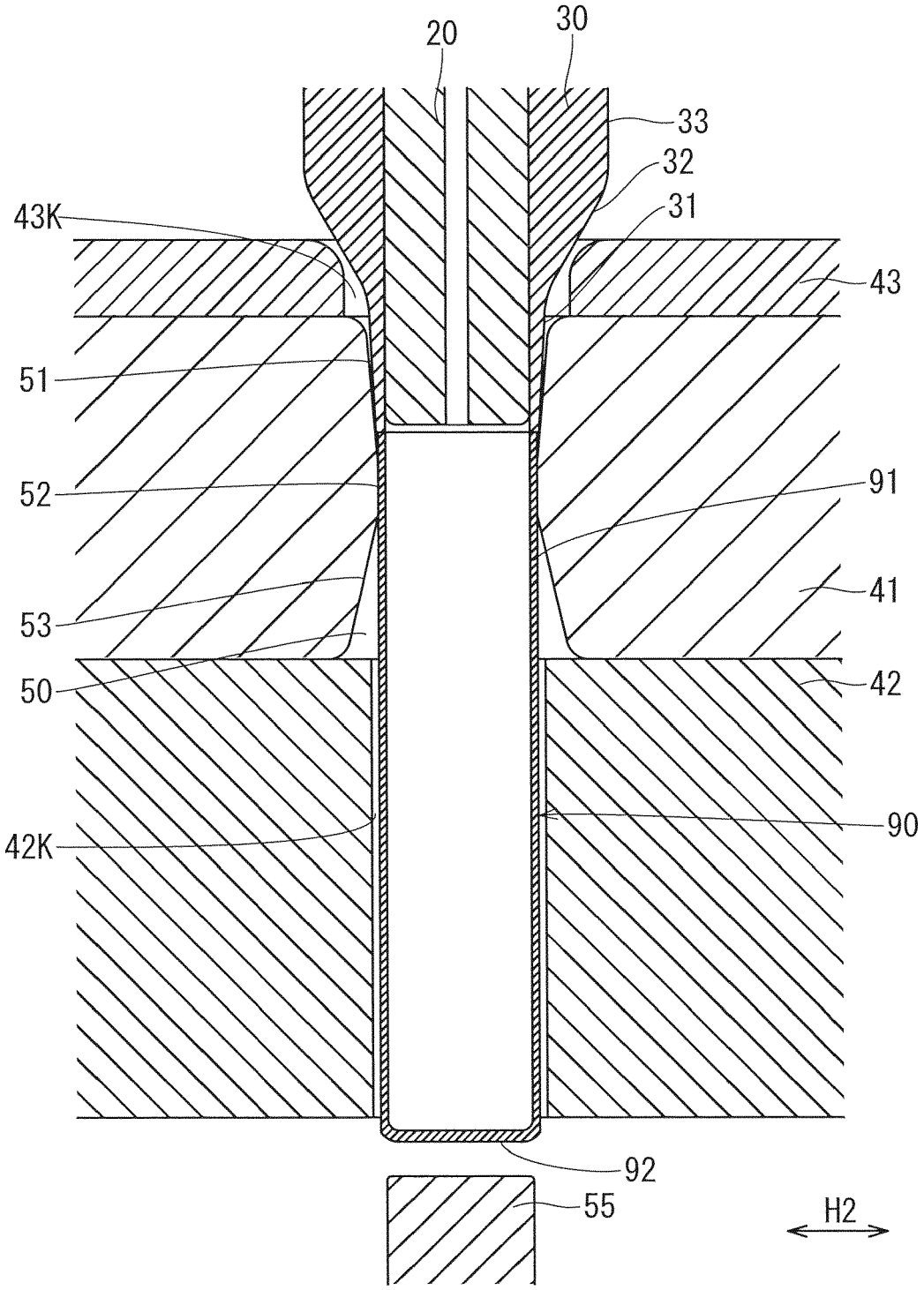

FIG. 7

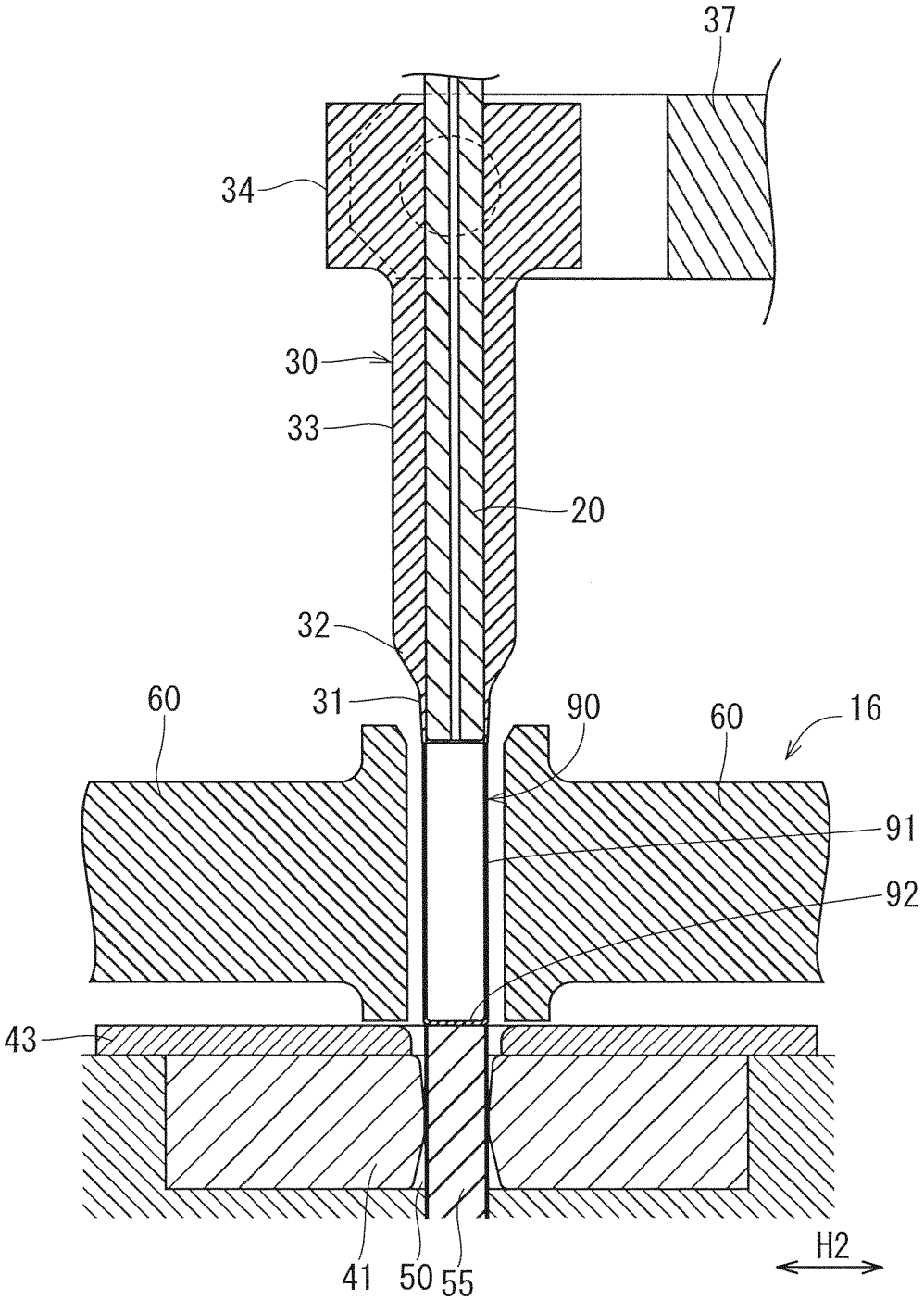

FIG. 8

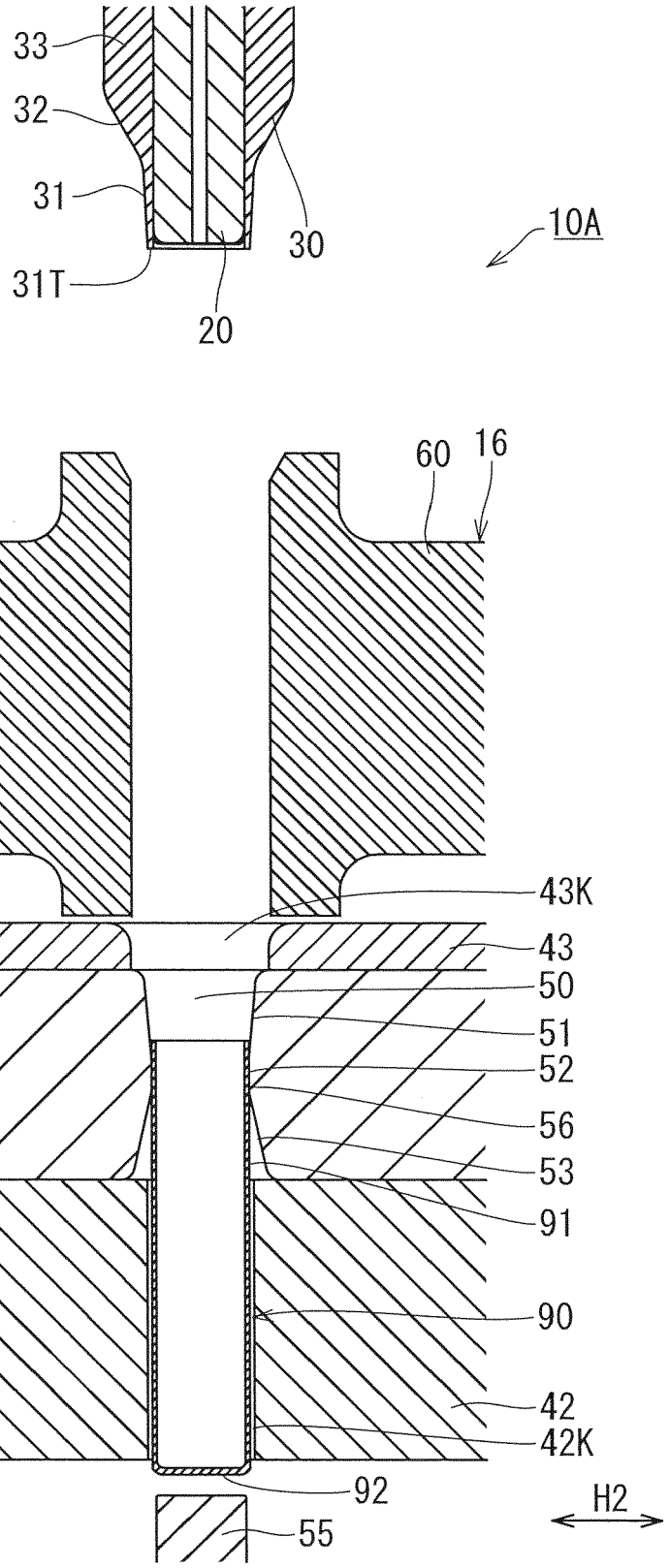
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FIG. 9

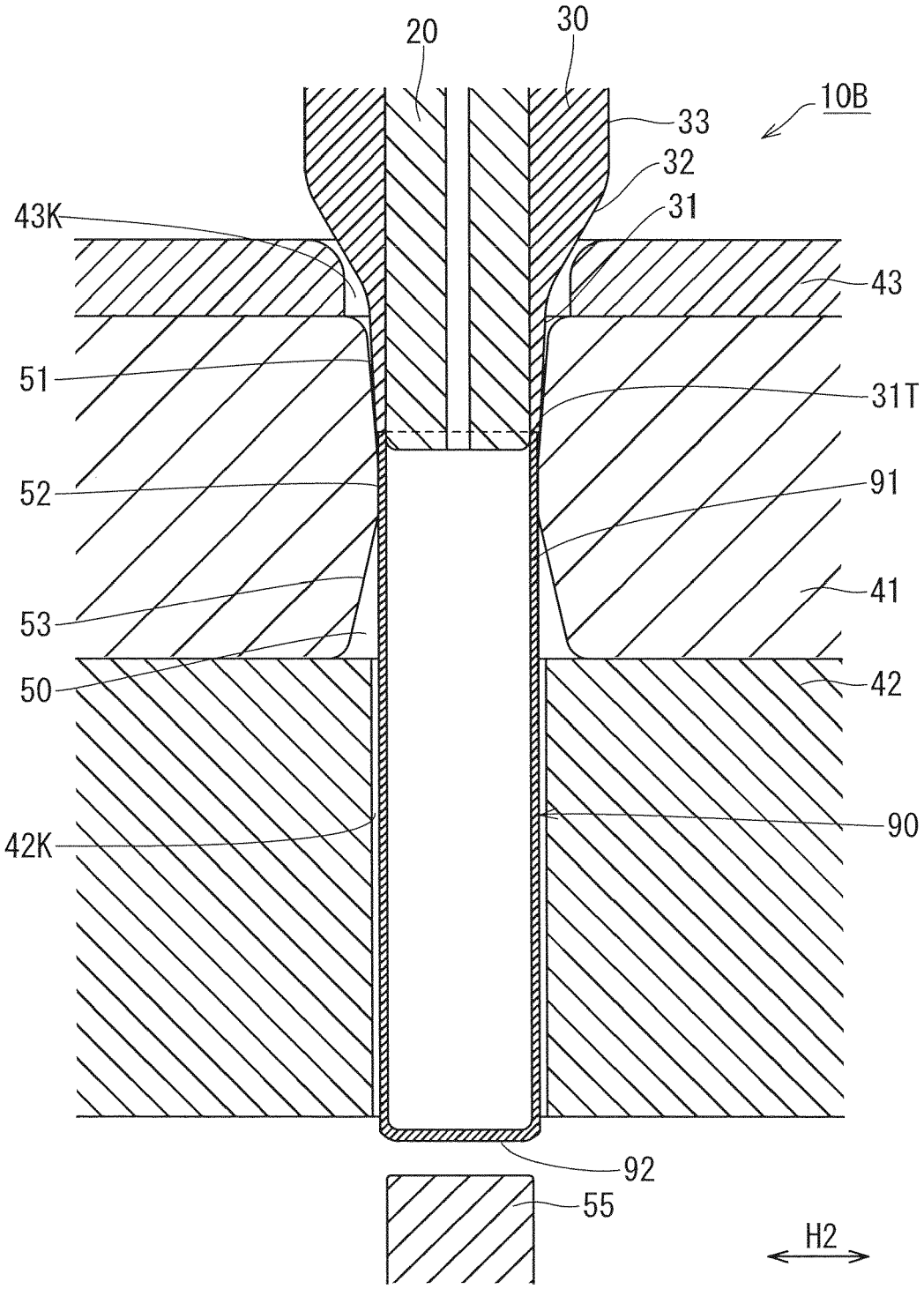


FIG. 10

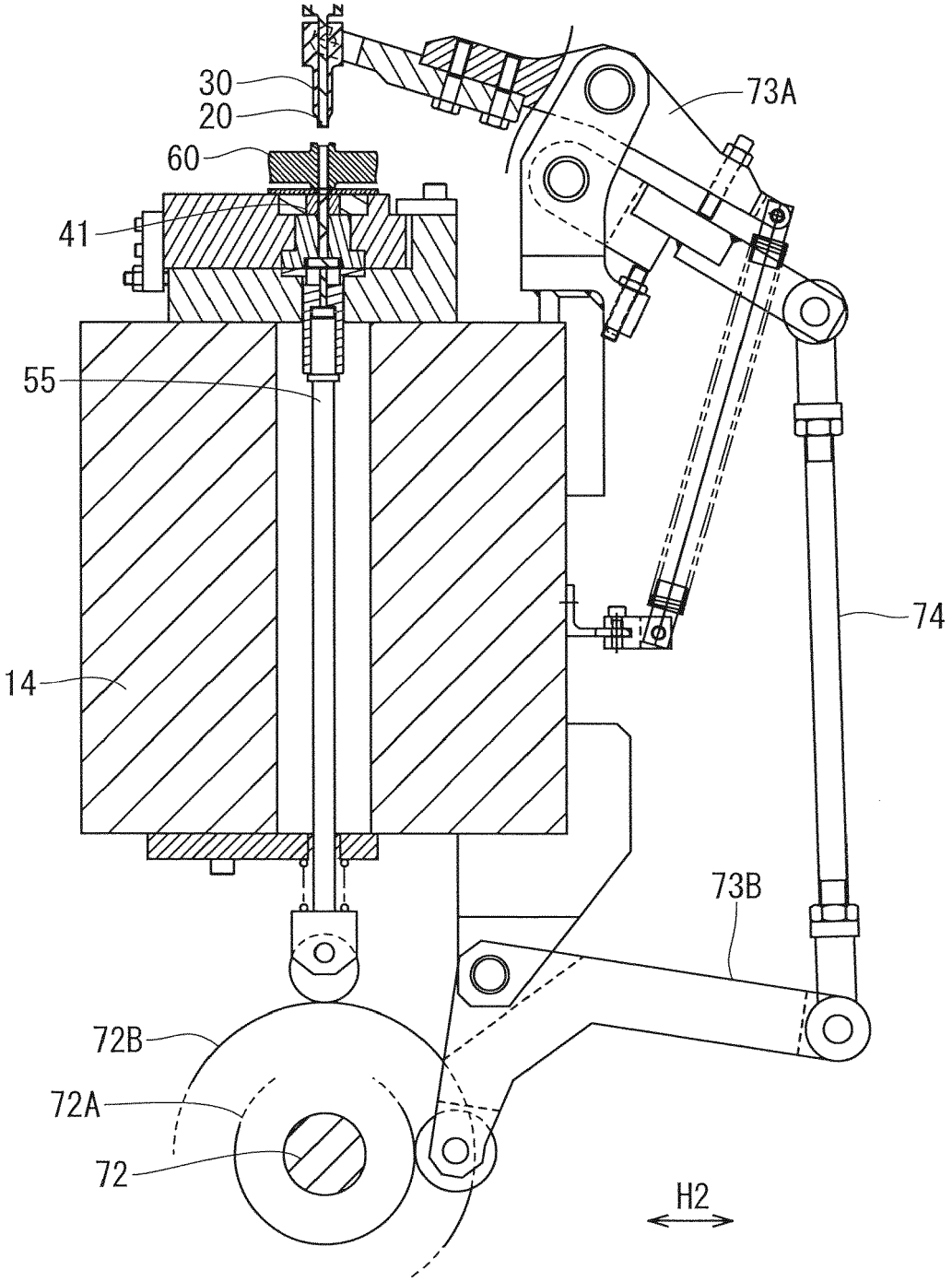
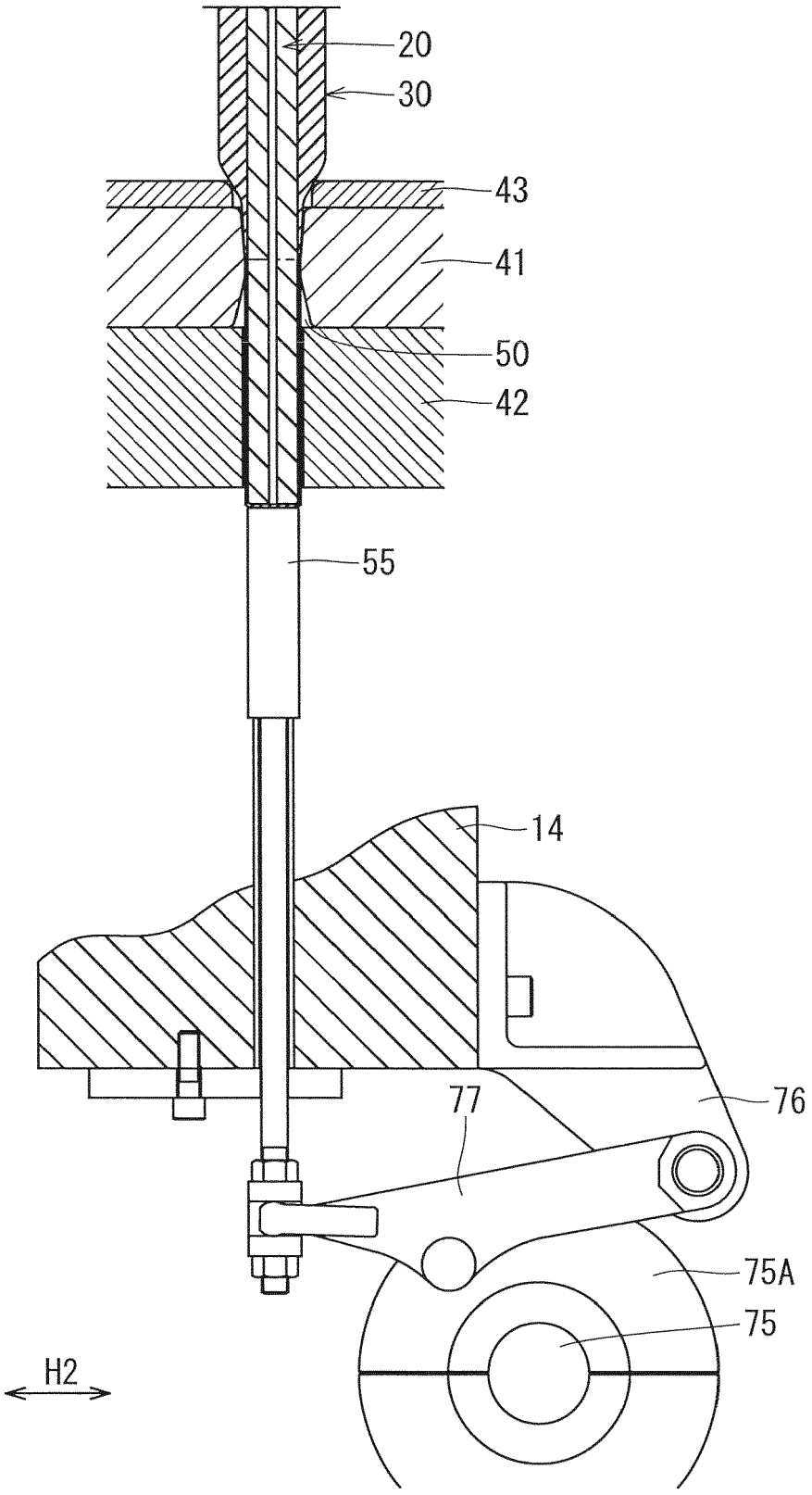


FIG. 11



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Place of search	Date of completion of the search	Examiner
Munich	27 August 2020	Stanic, Franjo

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