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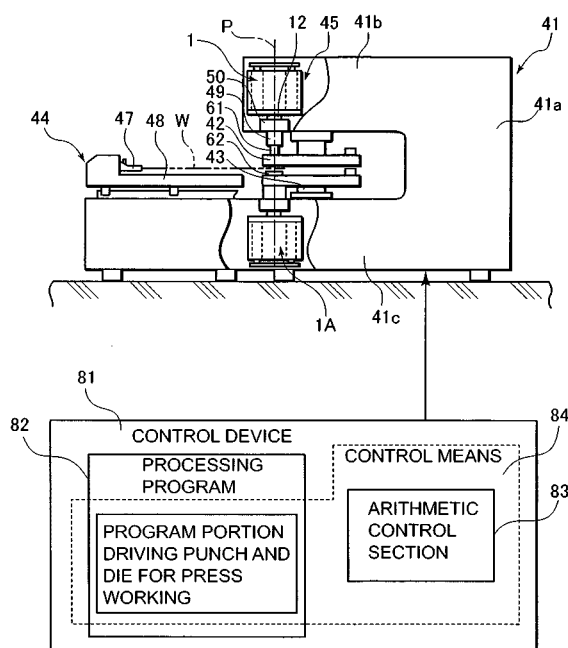
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(54) **Linear motor mounted press machine and press working method**

(57) The present invention provides a linear motor mounted press machine that allows both a punch and a die to be driven to enable various types of machining, the linear motor mounted press machine having a simple configuration and enabling accurate machining. The present invention is applied to a press machine that per-

forms a press working on a workpiece W by means of a punch 61 and a die 62. A punch linear motor 1 is installed in an upper frame 41b of a press frame 41 to drivingly elevate and lower the punch 61. A die linear motor 1A is installed in a lower frame 41c of the press frame 41 to drivingly elevate and lower the die 62 (Fig.1).

FIGURE 1



Description

Field of the Invention

[0001] The present invention relates to a press machine such as a punch press which uses linear motors as a driving source, and a press working method for performing a press working by using the press machine.

Background of the Invention

[0002] Press machines such as punch presses commonly use, as a press driving source that moves punches forward and backward, a mechanism that converts rotary motion of rotary type electric motors into rectilinear motion via a crank mechanism and so on, or hydraulic cylinders. A proposal has also been made of press machines using servo motors as electric motors to vary punch speed during strokes.

[0003] However, press machines using rotary type electric motors require a mechanism that converts rotary motion into rectilinear motion and thus have complicated configurations. Further, since rotary motion is converted into rectilinear motion, lost motion or the like may occur, degrading controllability. Press machines using a hydraulic cylinder require a hydraulic supply system such as a hydraulic unit and thus have complicated structures.

[0004] Attempts have also been made to use linear motors as a press driving source. When used to drive punches, linear motors, unlike rotary type motors, eliminate the use of a mechanism that converts a rotation into a rectilinear motion. The linear motor thus reduces the number of parts required and simplifies the structure.

[0005] Some conventional punch presses are used for a forming process. It is well known that punch presses can be commonly used for hole making and shape forming. Some punch presses include a die constituting a lower tool and configured as a recessed tool, and a punch configured as a projecting tool, to perform shape forming on a plate-like workpiece such that the work piece has a portion projecting from its bottom surface. The portion resulting from the shape forming projects from the bottom surface of the workpiece and may thus interfere with feeding of the workpiece on a table.

[0006] On the other hand, some commercialized punch presses include a die constituting a lower tool, and configured as a projecting tool, and a punch configured as a recessed tool as opposed to the above press machines, to perform shape forming on the workpiece such that the workpiece has a portion projecting from its top surface. When the die is thus configured as a projecting tool and always projects above a die height, the bottom surface of the workpiece may be damaged by the die when the workpiece is fed. A proposal has thus been made of punch presses which normally allow such a projecting shape forming die to stand by below the die height and which project the die above the die height during operation (for example, the Unexamined Japanese Pat-

ent Application Publication (Tokkai-Hei) No. 11-156459). The die is elevated and lowered by a cylinder device that moves forward and backward in a horizontal direction and a cam, a link mechanism, or the like which converts the horizontal operation of the cylinder device into a vertical operation.

[0007] In the conventional press machines using linear motors, the punch is driven, and the die is fixed. When such a press machine has a shape-forming or hole-making die installed so as to be able to elevate and lower in order to provide multiple functions, where a cylinder device is used as a mechanism for elevating and lowering the die, elevating and lowering strokes are fixed. This precludes the forming process such that the resulting workpieces have different projection heights. Press machines using servo motors and ball screws as a die elevating and lowering mechanism can achieve the forming process such that the resulting workpieces have different projection heights. However, these press machines have complicated configurations like those which drive the punch.

Summary of the Invention

[0008] It is an object of the present invention to provide a linear motor mounted press machine that allows both a punch and a die to be driven to enable various types of machining, the linear motor mounted press having a simple configuration and enabling accurate machining. It is another object of the present invention to provide high power while avoiding difficulties with manufacture. It is yet another object of the present invention to facilitate discharge of slag resulting from hole making or the like while enabling the die to be driven by a linear motor located immediately below the die. It is still another object of the present invention to drive both the die and the punch to machine a workpiece, enabling various types of machining.

[0009] A linear motor mounted press machine in accordance with the present invention presses a workpiece using a punch and a die both located in a press drive axis center. The press machine comprises a press frame having an upper frame and a lower frame, a punch linear motor provided in the upper frame to drivingly elevate and lower the punch, and a die linear motor provided in the lower frame to drivingly elevate and lower the die.

[0010] This configuration uses the linear motor to drivingly elevate and lower the punch. Thus, unlike configurations using rotary type motors, this configuration eliminates the need for a mechanism that converts the rotation into the rectilinear motion. This reduces the number of parts required and simplifies the structure of the press machine. Further, the die is also drivingly elevated and lowered by the linear motor. Thus, compared to configurations that drivingly elevate and lower the die via a horizontal cylinder device and a cam, a link mechanism, or the like, this configuration is simple and offers excellent controllability to allow die elevating and lowering strokes

to be accurately controlled. This configuration thus allows both the punch and the die to be driven to enable various types of machining and drives both the punch and the die using the linear motor. This simplifies the configuration and enables accurate machining.

[0011] In the present invention, one or both of the punch linear motor and the die linear motor may be unit linear motor assemblies each including a plurality of unit linear motors around the press drive axis center, each of the unit linear motors having an output shaft that is parallel to the press drive axis center. Punch working may require a high thrust. Linear motors generally use permanent magnets with a strong magnetic force. However, it is difficult to manufacture motors each providing a high thrust owing to the manufacturing limit on the size of magnets, limitations on supply voltage, or the like. However, the assembly of the plurality of unit linear motors described above allows the power of the individual unit linear motors to be collectively utilized, providing the high power.

[0012] In the present invention, the die linear motor may have a hole in an area thereof which coincides with the press drive axis center, slag resulting from the press working being discharged from the hole. The press drive axis center corresponds to the center of a ram shaft, that is, the center of the punch and die. The die-side linear motor is located below the die. Thus, the die-side linear motor does not pose any problem during shape forming but may interfere with discharge of slag during hole making. Accordingly, the hole for slag discharge is formed in the area of the die linear motor which coincides with the press drive axis center. This enables slag to be smoothly discharged while the die is being driven using the linear motor.

[0013] In particular, where the die linear motor is a unit linear motor assembly including a plurality of unit linear motors around the press drive axis center, each of the unit linear motors having an output shaft that is parallel to the press drive axis center, the die linear motor preferably has a hole in an area thereof which coincides with the press drive axis center, slag resulting from the press working being discharged from the hole. Where the die linear motor is the assembly of the unit linear motors, the press machine can be easily configured so that the hole for slag discharge is formed in the press drive axis center.

[0014] The linear motor mounted press machine in accordance with the present invention may comprise a control means for drivingly elevating and lowering both the punch and the die relative to the workpiece for performing the press working. Various types of machining can be performed on the workpiece by simultaneously driving both the punch and the die or sequentially driving the punch and the die to machine one point. When both the punch and the die are thus drivingly elevated and lowered for the press working, the excellent controllability of the linear motors can be effectively utilized. Therefore, the present invention, using the linear motor as a driving source for both the punch and the die, can effectively

increase accuracy.

[0015] A press working method in accordance with the present invention uses the linear motor mounted press machine having one of the above configurations, and to drivingly elevate and lower both the punch and the die relative to the workpiece for performing the press working. According to this method, the linear motor mounted press machine in accordance with the present invention, using the linear motor as a driving source for both the punch and the die, can effectively increase accuracy, and this allows various types of punch working to be accurately performed. The term "punch working" as used herein refers to hole making or shape forming.

[0016] The linear motor mounted press machine in accordance with the present invention performs the press working on the workpiece by means of the punch and the die both located in the press drive axis center. The linear motor mounted press machine comprises the press frame having the upper frame and the lower frame, the punch linear motor provided in the upper frame to drivingly elevate and lower the punch, and the die linear motor provided in the lower frame to drivingly elevate and lower the die. This configuration thus allows both the punch and the die to be driven to enable various types of machining. In spite of this function, the configuration is simple and enables accurate machining.

[0017] When one or both of the punch linear motor and the die linear motor are the unit linear motor assemblies each including the plurality of unit linear motors around the press drive axis center, each of the unit linear motors having the output shaft that is parallel to the press drive axis center, the difficulties with the manufacture of the linear motors can be avoided, and high power is provided.

[0018] Where the die linear motor has a hole in an area thereof which coincides with the press drive axis center, slag resulting from the press working being discharged from the hole, then slag resulting from hole making or the like can be easily discharged, while enabling the die to be driven.

[0019] Where the die linear motor is a unit linear motor assembly including a plurality of unit linear motors around the press drive axis center, each of the unit linear motors having the output shaft that is parallel to the press drive axis center, and the die linear motor has a hole in an area thereof which coincides with the press drive axis center, slag resulting from the press working being discharged from the hole, then the difficulties with the manufacture of the linear motors can be avoided, and the high power is provided. Further, slag resulting from hole making or the like can be easily discharged.

[0020] Where the linear motor mounted press machine includes a control means for drivingly elevating and lowering both the punch and the die relative to the workpiece for performing the press working, various types of machining can be performed on the workpiece by driving both the die and the punch to machine the workpiece. Furthermore, the machining can be accurately performed.

[0021] The press working method in accordance with the present invention performs the press working by using the linear motor mounted press machine of the present invention, to drivingly elevate and lower both the punch and the die relative to the workpiece. Various types of machining can thus be performed on the workpiece by driving both the die and the punch to machine the workpiece. Furthermore, the machining can be accurately performed.

[0022] Other features, elements, processes, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments of the present invention with reference to the attached drawings.

Brief Description of the Drawings

[0023]

Figure 1 is an exploded side view of a linear motor mounted press machine in accordance with an embodiment of the present invention.

Figure 2 is a vertical sectional view of a punch linear motor in the press machine.

Figure 3 is a sectional view of the punch linear motor along line III-III in Figure 2.

Figure 4 is a vertical sectional view of a die linear motor in the press machine.

Figure 5 is a diagram illustrating the operation of the press machine.

Figure 6 is a vertical sectional view of a variation of the die linear motor in the press machine.

Detailed Description of the Preferred Embodiments

[0024] An embodiment of the present invention will be described with reference to Figures 1 to 5.

[0025] The press machine is a punch press that uses a punch 61 and a die 62 to perform a press working on a plate-like workpiece W such as a sheet metal. The press machine comprises a press frame 41, a punch linear motor 1 provided in an upper frame 41b of the press frame 41 to elevate and lower the punch 61, and a die linear motor 1A provided in a lower frame 41c to elevate and lower the die 62.

[0026] The press frame 41 comprises the upper frame 41b, the lower frame 41c and a column portion 41a to which the upper frame 41b and the lower frame 41c are coupled, and the press frame 41 is open in a front surface and has a C-shaped side surface. A vertical pair of tool supports 42, 43 and a workpiece feeding mechanism 44 are installed between the upper frame 41b and the lower frame 41c. A press mechanism 45 using the punch linear motor 1 as a driving source is installed in the upper frame 41b. The press frame 41 may be a gate-, ring-, or hollow-rectangle-like frame in which the upper and lower frame portions with an equivalent length are coupled together at a front end and a rear end by the column portion.

[0027] The tool supports 42, 43 comprise an upper turret and a lower turret which are concentrically installed and each of which has punches 61 and dies 62 mounted at a plurality of points in a circumferential direction thereof. Rotation of the tool supports 42, 43 allows each of the punches 61 and the dies 62 to be indexed to a predetermined punch position P.

[0028] In Figure 1, the workpiece feeding mechanism 44 uses a workpiece holder 47 to grip an edge of the plate-like workpiece W to move it on a table 48 forward, backward, rightward, and leftward.

[0029] The press mechanism 45 supports a ram 49 that elevates and lowers the punch 61 indexed to the punch portion P in the tool support 42 so that the ram 49 can be freely elevated and lowered by a ram guide 50. The ram 49 is drivingly elevated and lowered by an output shaft 12 of the linear motor 1.

[0030] As shown in Figure 2 and Figure 3, the punch linear motor 1 has a plurality of unit linear motors 2 composed of cylindrical linear motors and juxtaposed in a motor case 25. In this example, the juxtaposition form is such that the cylindrical linear motors 2 made in accordance with the same specifications are arranged on a virtual circle around the center O of the output shaft, that is, a press drive axis center, in its circumferential direction.

[0031] Each of the unit linear motors 2 comprises a shaft member 3 composed of a permanent magnet having alternately arranged N pole and S pole, and a coil unit 4 through which the shaft member 3 is movable in an axial direction relative to the coil unit 4. The coil unit 4 is composed of a plurality of coils 5 arranged in a cylindrical coil case 7 in the axial direction and surrounding the shaft member 3. The coil unit 4 constitutes a stator, and the shaft member 3 constitutes the output shaft of the motor 2, which constitutes a moving member of the unit linear motor 2. The shaft member 3 is composed of one round bar-like member but may be composed of a plurality of permanent magnets arranged in the axial direction.

[0032] The motor case 25 has an inner cylinder 26 and an outer cylinder 27 arranged concentrically with each other, and end plates 28, 29 that couple the opposite ends of the inner cylinder 26 and the outer cylinder 27 together. The unit linear motors 2 are arranged in the annular space between the inner cylinder 26 and the outer cylinder 27 in the circumferential direction. The opposite ends plates 28, 29 have a plurality of shaft member insertion holes 28a, 29a through which the shaft member 3 of each unit linear motor 2 is inserted, and the end plate 28 has a guide shaft insertion hole 28b in its center.

[0033] The shaft members 3 of the unit linear motors 2 are coupled together at their opposite ends by coupling members 10, 11, and the plurality of shaft members 3 and the coupling members 10, 11 constitute a moving member 30. The coupling member 11 of the moving member 30 has the output shaft 12 located in the center O of the arrangement of the unit linear motors 2.

[0034] A guide mechanism 32 is provided between the

motor case 25 and the moving member 30 to guide movement of the shaft members 3 of the plurality of unit linear motors 2. The guide mechanism 32 is composed of an inner cylinder 26 of the motor case 25, a bush 15 that is a guide portion fixedly fitted into the inner cylinder 26, and a guide shaft 13, as a guided portion, provided at the center of one end side of the coupling member 10 and fitted into a bush 15 so as to be movable in the axial direction. The bush 15 constitutes a sliding shaft. Instead of the bush 15, a direct-acting roll bearing may be interposed.

[0035] The guide mechanism 32 has a rotation inhibiting means 16 for inhibiting rotation of the moving member 30 relative to the motor case 25. The rotation inhibiting means 16 comprises a key groove 17 formed in the guide shaft 13 along the axial direction and a key portion 18 fixed to the inner cylinder 26 of the motor case 25 and slidably engaged with the key 17.

[0036] Figure 4 shows the die linear motor 1A. The die linear motor 1A has a slag discharge hole 70 formed in its center. Each unit linear motor 2 has a bush 15A in place of the guide mechanism 32 of the punch linear motor 1 in Figure 2 and Figure 3. The slag discharge hole 70 comprises the internal space in the inner cylinder 26 of the motor case 25. The center of the slag discharge hole 70 coincides with the press drive axis center that is the center of the punch position P.

[0037] The coupling member 11 on an output side of the die linear motor 1A has an output shaft 12A comprising a hollow shaft and internally constituting a slag discharge hole, the output shaft 12A projecting upward. The remaining part of the configuration of the die linear motor 1A is similar to that of the punch linear motor 1, described with reference to Figure 2 and Figure 3, and duplicate descriptions are thus omitted.

[0038] The punches 61 installed on the upper tool support 42 and the dies 62 installed on the lower tool support 43 in Figure 1 include a punch 61₁ and a die 62₁ for hole making shown in Figure 5A and a punch 61₂ and a die 62₂ for shape forming shown in Figure 5B and Figure 5C. The hole-making punch 61₁ is fixedly installed on the lower tool support 43 via a die holder 63.

[0039] The shape-forming punch 61₂ is recessed and has a recessed portion 65 on its bottom surface. The shape forming die 62₂ is projecting and has a projecting portion 66 at the top. The shape forming die 62₂ is installed so as to be able to elevate from and lower to the die holder 63, installed on the lower tool support 43. In a lowered condition, the shape forming die 62₂ is located below a die height DH. The shape forming die 62₂ is pushed up above the die height DH by the output shaft 12A of the die linear motor 1A.

[0040] The shape forming die 62₂ has an output shaft engaging projection 67 provided on its bottom surface. During elevation, an upper end of the output shaft 12A of the die linear motor 1A is pressed against the bottom surface of the output shaft engaging projection 67. The shape forming die 62₂ is urged downward by a return

spring (not shown in the drawings).

[0041] A hollow hole 69A is formed at the installation position of each die 62 of the lower tool support 43, comprising a turret; the output shaft 12A of the die linear motor 1A is advanced through the hollow hole 69A so as to be able to elevate and lower. A bolster 68 that receives the tool support 43 comprises a pair of bolster components, and the area between the bolster components constitutes a hollow space 69B through which the output shaft 12A of the die linear motor 1A is advanced so as to be able to elevate and lower.

[0042] In Figure 1, a control device 81 controlling the press machine comprises a computerized numerical control device, and the control device 81 has an arithmetic control section 83 that analyzes and executes a processing program 82. The control device 81 thus gives instructions to the linear motors 1, 1A, servo motors for shafts of the workpiece feeding mechanism 44, and a driving source (not shown in the drawings) for indexation rotation of the tool supports 42, 43. The control device 81 has a control means 84 for drivingly elevating and lowering the punches 61 and the dies 62 by means of the linear motors 1, 1A for performing the press working. The control means 84 is composed of instructions described in the processing program 82 as well as the arithmetic control section 83.

[0043] A description will be given of the operation of the press machine configured as described above.

[0044] As shown in Figure 5A, the die linear motor 1A is normally in the lowered condition, and the upper end of the output shaft 12A is located below the bottom surface of the lower tool support 43. This enables the tool support 43, comprising a turret, to be rotated without interfering with the output shaft 12A. Further, as shown in Figure 5B, the upper end of the form-shaping die 62₂ is located below the die height DH. In this condition, the upper tool support 42 and the lower tool support 43 are rotated to index any of the punches 61 and the dies 62 to the punch position P. This prevents the shape-forming die 62₂ from coming into sliding contact with the bottom surface of the workpiece W to damage it.

[0045] Punch working such as normal hole making is performed by drivingly lowering the punch 61 of the upper tool support 42 by means of the punch linear motor 1 with the die linear motor 1A thus lowered. Slag resulting from hole making falls down from the machine through the slag discharge hole 70, formed in the center of the die linear motor 1A.

[0046] For shape forming, the upper tool support 42 and the lower tool support 43 are rotated to index the shape forming die 62₂ to the punch center P as shown in Figure 5B. This positions the shape forming die 62₂ immediately above the output shaft 12A of the die linear motor 1A. In this condition, as shown in Figure 5C, the die linear motor 1A is allowed to perform elevational driving so that its output shaft 12A elevates the shape-forming die 62₂ to a predetermined height. Further, the shape-forming punch 61₂ is lowered by the punch linear motor

1 so as to sandwich the workpiece W between the shape-forming punch 61₂ and the shape-forming die 62₂. This allows a shape forming portion Wa to be formed in the workpiece W by pressing.

[0047] Once shape forming is finished, the punch linear motor 1 is elevated, and the die linear motor 1A is lowered. Thus, the shape forming portion Wa formed by the punch working projects upward from the workpiece W and thus does not interfere with feeding of the workpiece W on the table 48 by means of the workpiece feeding mechanism 44.

[0048] The press machine configured as described above uses the linear motor 1 as a press driving source. Compared to press machines using rotary motors, this press machine thus does not need any mechanism that converts the rotation into the rectilinear motion of the ram 49, and this also reduces the number of parts required for the press mechanism 45 and simplifies its configuration. Further, compared to press machines using a hydraulic cylinder as a press driving source, this press machine eliminates the need for the hydraulic unit, simplifying the configuration. Furthermore, the linear motor 1 offers excellent positional accuracy, enabling high-quality, accurate machining.

[0049] The shape forming die 62₂ is also drivingly elevated and lowered by the linear motor 1A. Thus, compared to conventional press machines using a horizontal cylinder device and a cam, a link mechanism, or the like for elevating and lowering driving, this press machine has a simple configuration, offers excellent controllability, and enables the accurate control of the elevating and lowering strokes of the shape-forming die 62₂. Thus, both the punch 61 and the die 62 can be driven to enable various types of machining, and the linear motors 1, 1A are used to drive the punch 61 and the die 62, respectively. This simplifies the configuration and enables accurate machining.

[0050] Each of the punch linear motor 1 and the die linear motor 1A is the unit linear motor assembly including the plurality of unit linear motors 2 around the press drive axis center; each of the unit linear motors 2 has the output shaft that is parallel to the press drive axis center. This provides high power. Punch working may require a high thrust. However, the linear motors generally use permanent magnets with a strong magnetic force. Accordingly, it is difficult to manufacture motors each providing a high thrust owing to the manufacturing limit on the size of magnets, limitations on supply voltage, or the like. However, in the present embodiment, each of the linear motors 1, 1A includes the assembly of the plurality of unit linear motors 2, allowing the power of the individual unit linear motors 2 to be collectively utilized, providing high power.

[0051] Further, the die linear motor 1A has the slag discharge hole 70 in the area thereof which coincides with the press drive axis center so that slag resulting from the press working can be discharged from the slag discharge hole 70. Slag can thus be smoothly discharged. This prevents the die linear motor 1A from interfering with

discharge of slag even though the die linear motor 1A is installed below the hole-making die 61₁. Since the die linear motor 1A is the assembly of the plurality of unit linear motors 2, the press machine can be easily configured so that the slag discharge hole 70 is formed in the press drive axis center.

[0052] Further, the present linear motor mounted press machine operates under the control of the control means 84 in Figure 1, and as described in conjunction with Figure 5C, both the punch 61 and the die 62 are drivingly elevated and lowered for the press working. Thus, various types of machining can be performed on the workpiece W by simultaneously driving both the punch 61 and the die 62 or sequentially driving the punch 61 and the die 62 to machine one point, the shape forming portion Wa. When both the punch 61 and the die 62 are thus drivingly elevated and lowered for the press working, the excellent controllability of the linear motors 1, 1A can be effectively utilized. Therefore, accuracy can be effectively increased by using the linear motors 1, 1A as a driving source for both the punch 61 and the die 62.

[0053] In the above embodiment, each of the punch linear motor 1 and the die linear motor 1A comprises the assembly of the plurality of unit linear motors 2. However, a unitary linear motor that is a single larger unit linear motor 2 may be used. In this case, the die linear motor 1A preferably has the slag discharge hole 70 penetrating the center of the shaft member 3, for example, as shown in Figure 6.

[0054] While the present invention has been described with respect to preferred embodiments thereof, it will be apparent to those skilled in the art that the disclosed invention may be modified in numerous ways and may assume many embodiments other than those specifically set out and described above. Accordingly, it is intended by the appended claims to cover all modifications of the present invention that fall within the true spirit and scope of the invention.

Claims

1. A linear motor mounted press machine that presses a workpiece using a punch and a die both located in a press drive axis center, the press machine being **characterized by** comprising a press frame having an upper frame and a lower frame, a punch linear motor provided in the upper frame to drivingly elevate and lower the punch, and a die linear motor provided in the lower frame to drivingly elevate and lower the die.
2. A linear motor mounted press machine according to Claim 1, **characterized in that** one or both of the punch linear motor and the die linear motor are unit linear motor assemblies each including a plurality of unit linear motors around the press drive axis center, each of

the unit linear motors having an output shaft that is parallel to the press drive axis center.

3. A linear motor mounted press machine according to Claim 1,
characterized in that the die linear motor has a hole in an area thereof which coincides with the press drive axis center, slag resulting from the press working being discharged from the hole.

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4. A linear motor mounted press machine according to Claim 1,
characterized in that the die linear motor is a unit linear motor assembly including a plurality of unit linear motors around the press drive axis center, each of the unit linear motors having an output shaft that is parallel to the press drive axis center, the die linear motor having a hole in an area thereof which coincides with the press drive axis center, slag resulting from the press working being discharged from the hole.

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5. A linear motor mounted press machine according to Claim 1,
characterized by comprising control means for drivingly elevating and lowering both the punch and the die relative to the workpiece for the press working.

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6. A press working method for performing a press working on a workpiece by using a linear motor mounted press machine, the method being **characterized in that:**

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the press machine comprises a press frame having an upper frame and a lower frame, a punch linear motor provided in the upper frame to drivingly elevate and lower the punch, and a die linear motor provided in the lower frame to drivingly elevate and lower the die, and

the method performs punching by carrying out both lowering of the punch by means of the punch linear motor and elevation of the die by means of the die linear motor.

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FIGURE 1

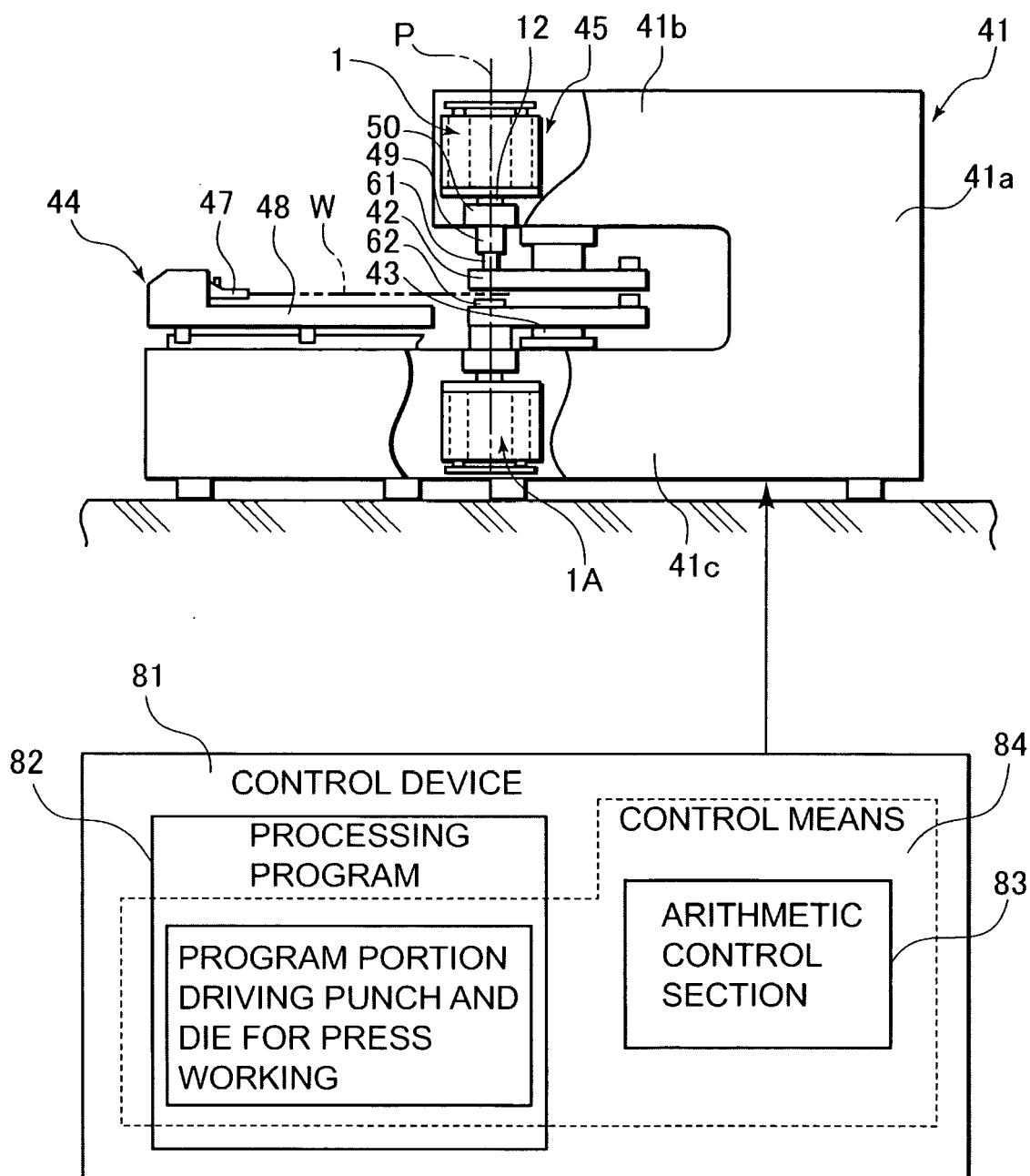


FIGURE 2

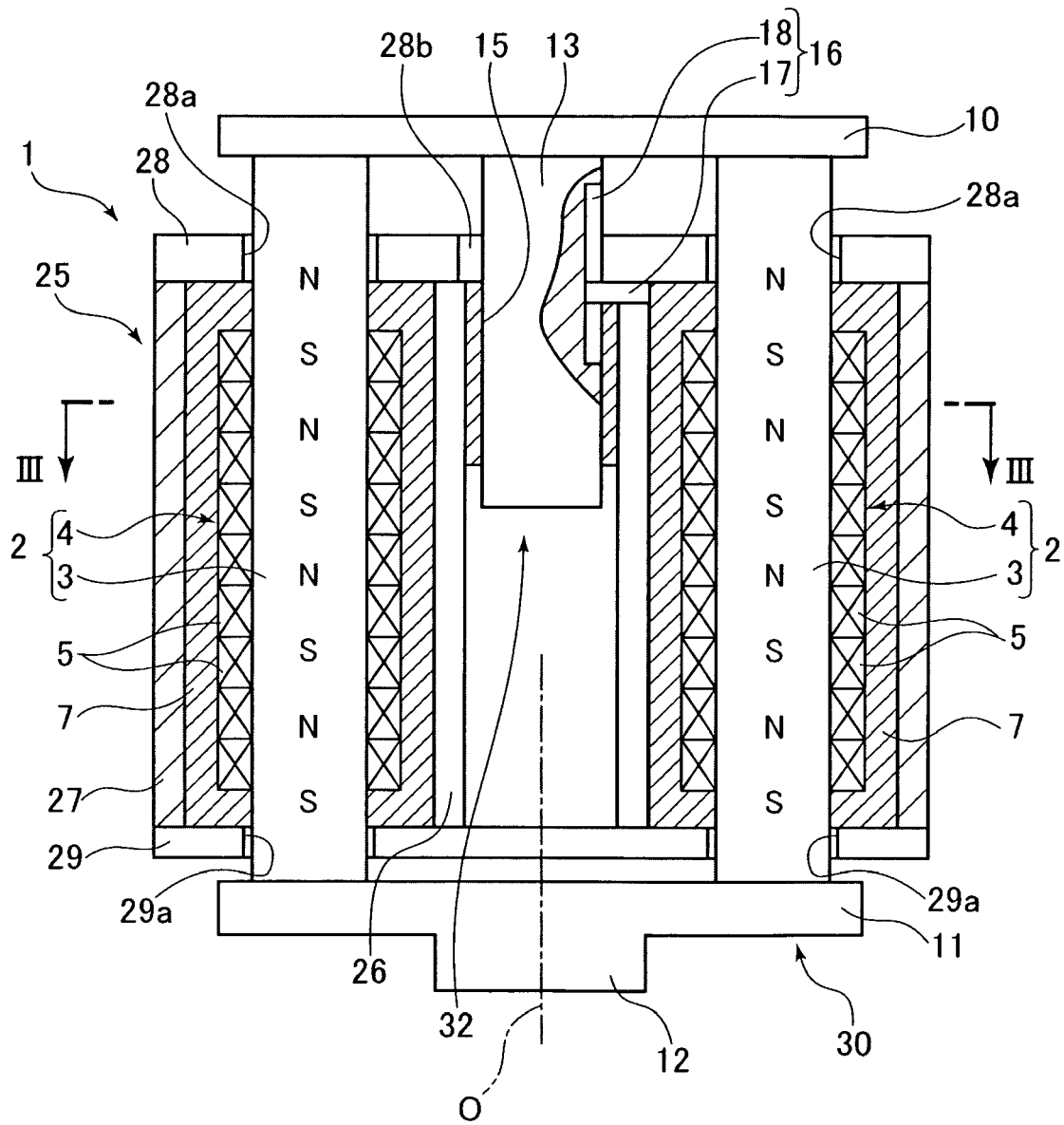


FIGURE 3

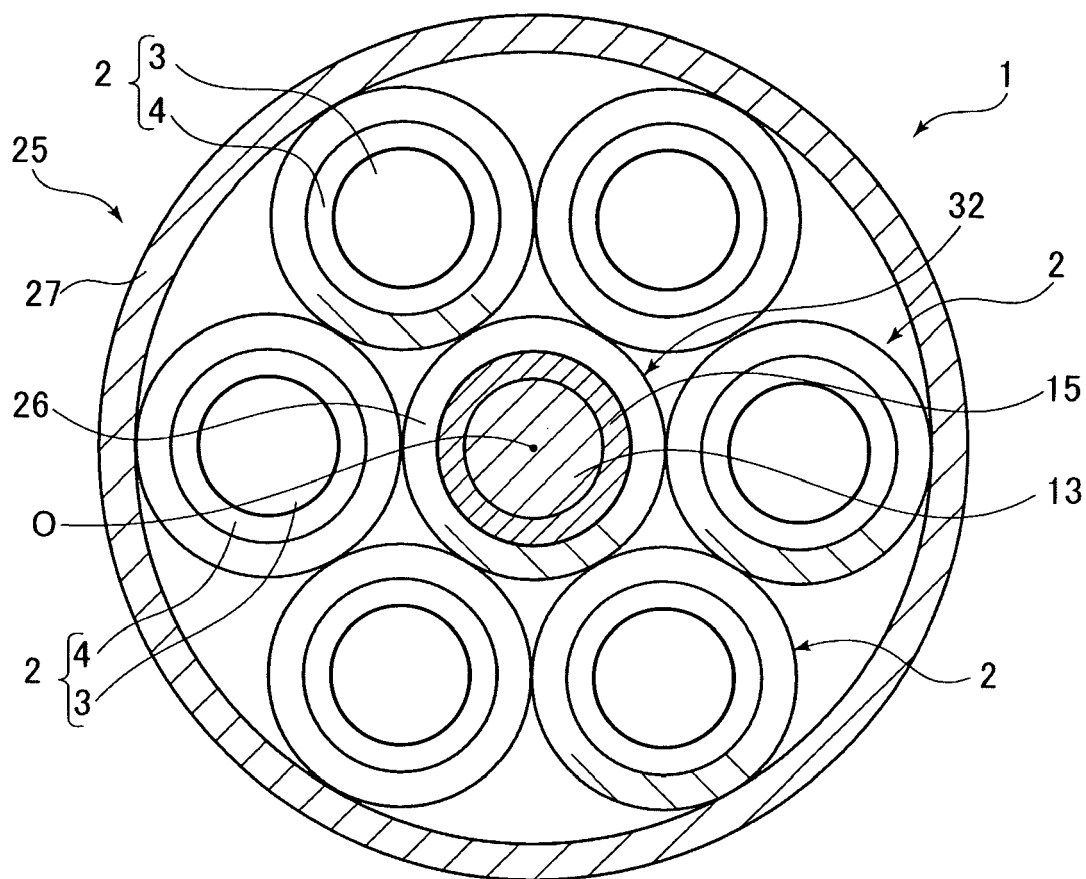


FIGURE 4

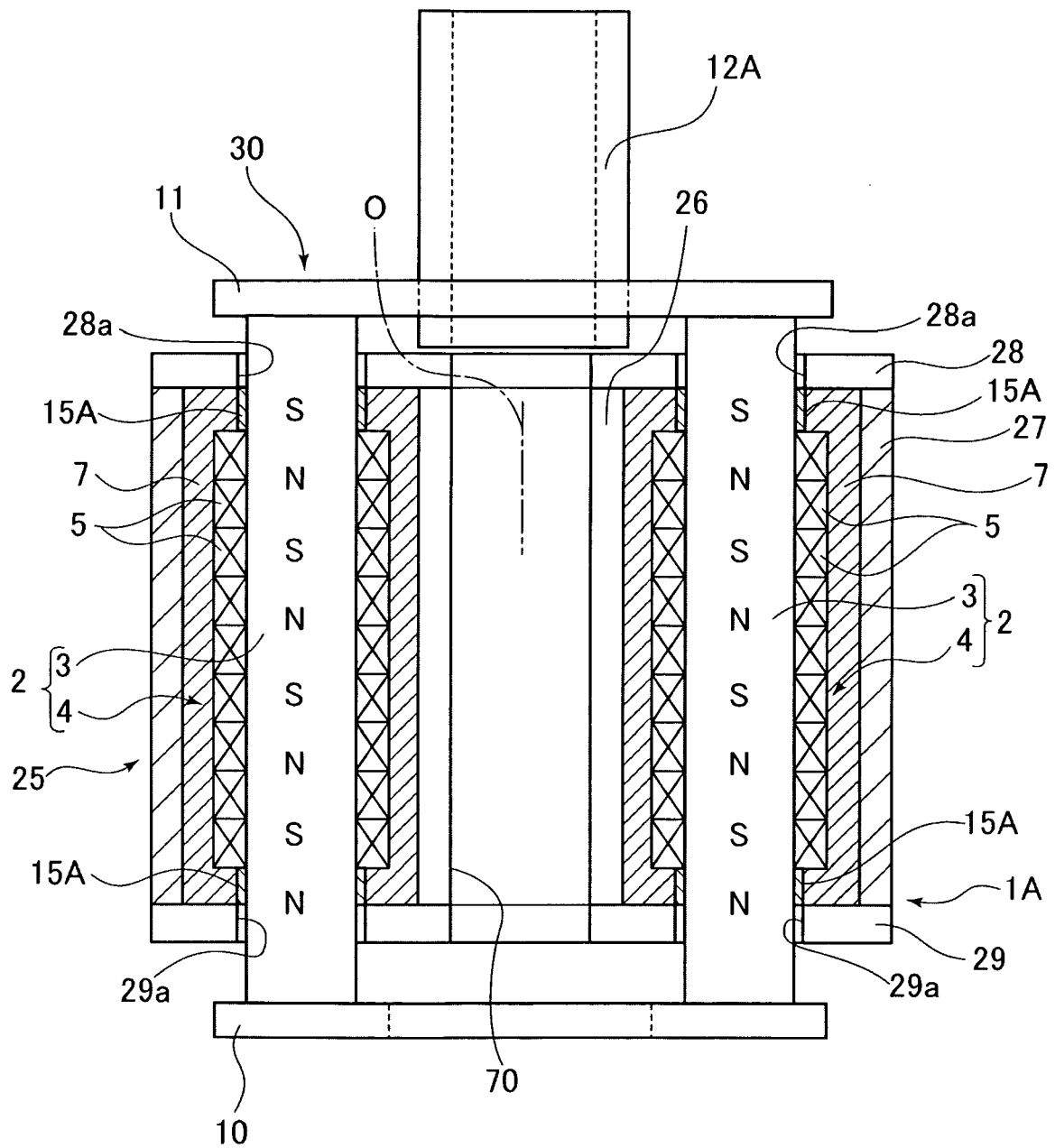


FIGURE 5A

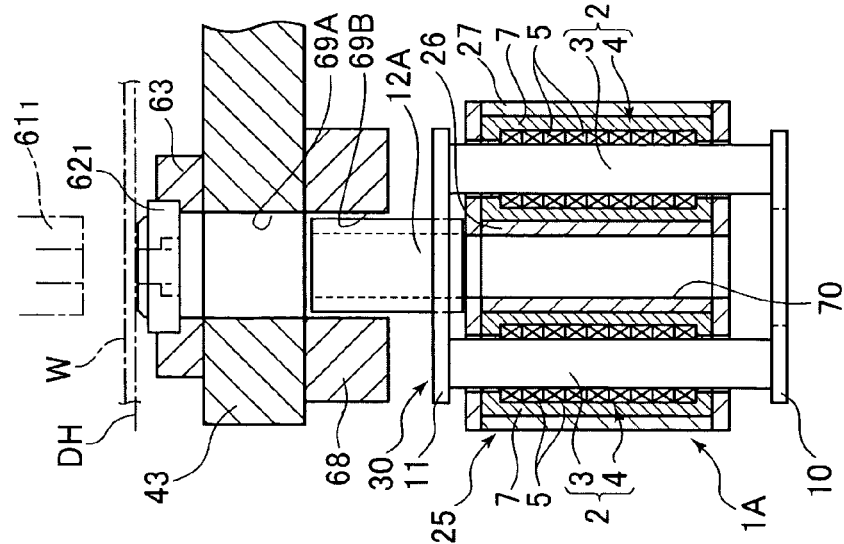


FIGURE 5B

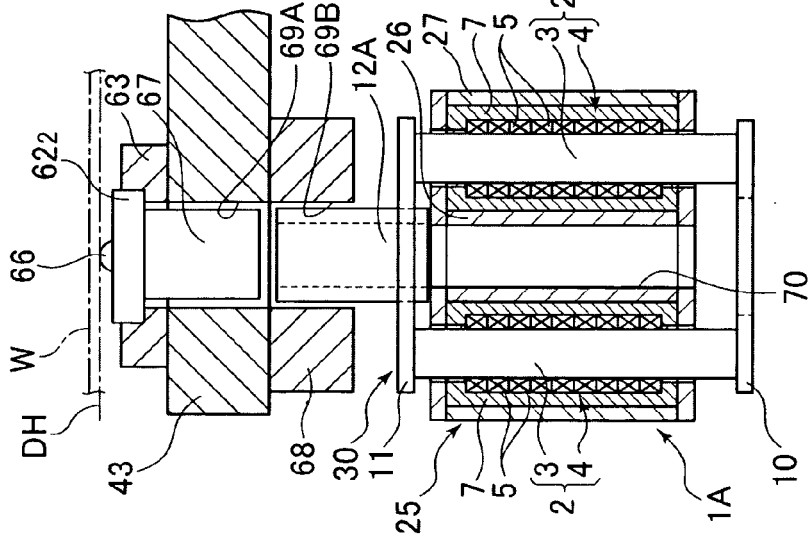


FIGURE 5C

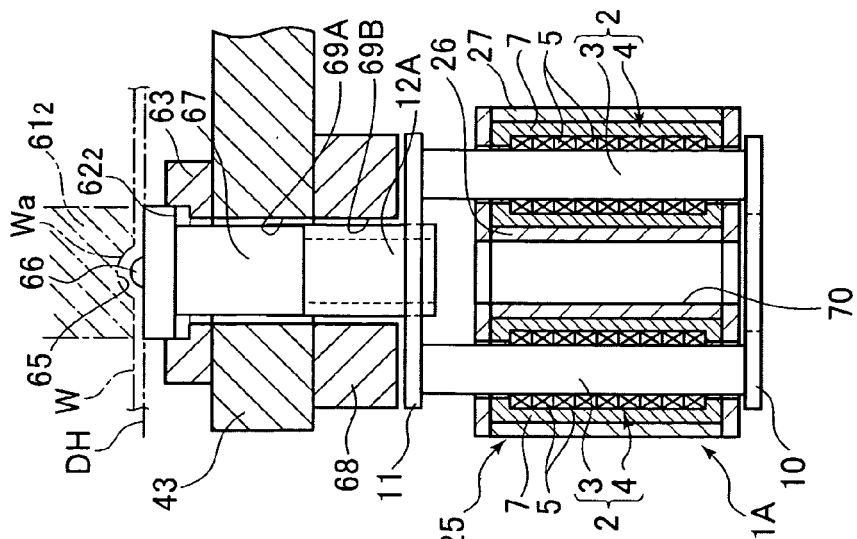
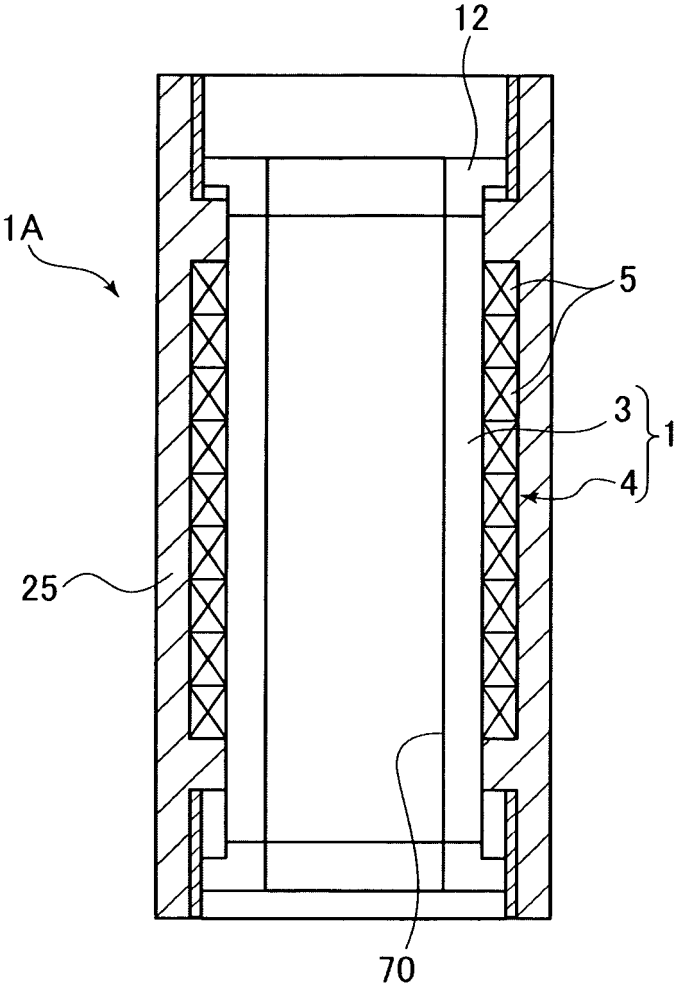


FIGURE 6



REFERENCES CITED IN THE DESCRIPTION

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