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(54) SEWING MACHINE WITH A FEED DOG DEVICE

(57) A feed dog device of a sewing machine includes a driving unit (1), a needle plate unit (2), a feed dog unit (3), an up-down transmitting unit (4), a horizontal transmitting unit (5) and a direction adjusting unit (6). The direction adjusting unit (6) includes a stepper motor (63) with a variable rotational speed controlled in accordance with a speed of the driving shaft (12) of the driving unit (1), and a linkage mechanism (64) actuatable by the stepper motor (63) to be moved to different positions so as to interfere with a horizontal reciprocating motion by the horizontal transmitting unit (5) such that the horizontal reciprocating motion cooperates with the up-down reciprocating motion by the up-down transmitting unit (4) to bring the feed dog unit (3) into performing a variable moving course.

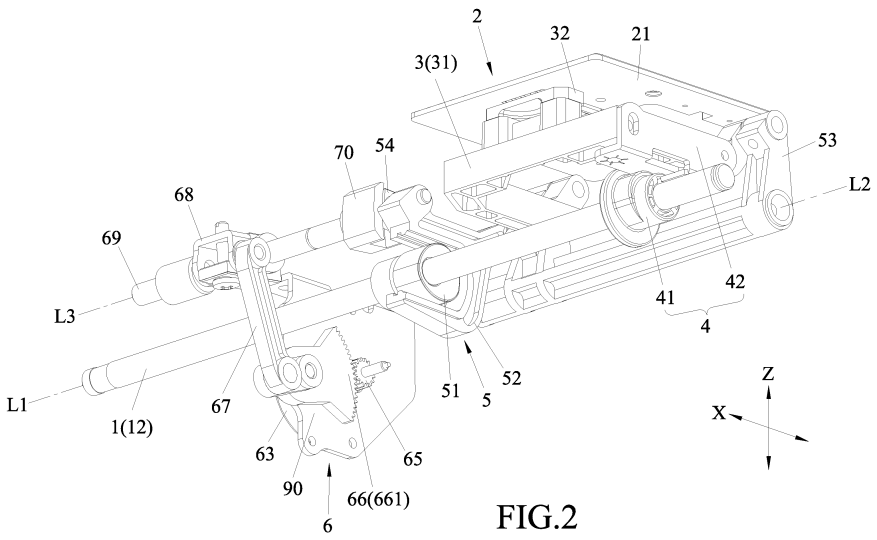

FIG.2

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Description

[0001] The disclosure relates to a sewing machine, and more particularly to a feed dog device of a sewing machine.

[0002] A conventional sewing machine has a rotatable driving shaft to drive a horizontal transmitting mechanism and an up-down transmitting mechanism to move a feed dog in both front to back and up and down motions reciprocately, and to combine the horizontal reciprocating motion with the up-down reciprocating motion to perform feeding movement of a fabric. Through a stepper motor with a constant rotational speed which drives a regulator connected with the horizontal transmitting mechanism, a moving direction of the feed dog is adjusted to control a clockwise sewing operation and a counterclockwise sewing operation of the sewing machine. The speed of the reciprocating motion of the feed dog is controlled by changing the rotational speed of the driving shaft.

[0003] However, owing to the constant rotational speed of the stepper motor, at a higher rotational speed of the driving shaft, during changing of the moving direction of the feed dog, a large speed difference between the driving shaft and the stepper motor may result in significant vibration and noise upon the coupling transmission of the regulator and the horizontal transmitting mechanism.

[0004] Therefore, an object of the disclosure is to provide a feed dog device of a sewing machine that can alleviate at least one of the drawbacks of the prior art.

[0005] According to the disclosure, the feed dog device includes a driving unit, a needle plate unit, a feed dog unit, an up-down transmitting unit, a horizontal transmitting unit and a direction adjusting unit. The driving unit includes a driving shaft drivable by a driving member to rotate about a first axis in a longitudinal direction. The needle plate unit includes a needle plate, a needle hole formed in the needle plate, and a plurality of slots formed adjacent to the needle hole. The feed dog unit includes a feed dog mount which receives a transmitting drive from the driving shaft to perform a reciprocating motion, and a feed dog which is mounted on the feed dog mount and which has a plurality of teeth aligned with and extending through the slots. The up-down transmitting unit is coupled between the driving shaft and the feed dog mount to produce an up-down transmitting drive by rotation of the driving shaft to make an up-down reciprocating motion of the feed dog mount in an up-down direction. The horizontal transmitting unit is coupled between the driving shaft and the feed dog mount to produce a horizontal transmitting drive by rotation of the driving shaft to make a horizontal reciprocating motion of the feed dog mount in a horizontal direction that is perpendicular to both the up-down direction and the longitudinal direction. The direction adjusting unit includes a stepper motor with a variable rotational speed controlled in accordance with a speed of the driving shaft, and a linkage mechanism disposed between the stepper motor and the horizontal transmitting unit. The linkage mechanism is actuatable by the stepper motor to be moved between a first linking position and a second linking position, and to interfere with the horizontal reciprocating motion by the horizontal transmitting unit such that the horizontal reciprocating motion cooperates with the up-down reciprocating motion by the up-down transmitting unit to bring the feed dog mount into performing a variable moving course.

[0006] Other features and advantages of the disclosure will become apparent in the following detailed description of the embodiment with reference to the accompanying drawings, of which:

FIG. 1 is a perspective view illustrating an embodiment of a feed dog device of a sewing machine according to the disclosure;
FIG. 2 is a perspective view of the embodiment taken from another angle;
FIG. 3 is an exploded perspective view of the embodiment;
FIG. 4 is a block diagram of an electrical system of the embodiment;
FIGS. 5 and 6 are fragmentary side views of the embodiment, illustrating a state when a transmitting member and a rotary member are in a first meshing position, a regulator is in a first regulating position, and a feed dog unit is performing a clockwise feeding moving course; and
FIGS. 7 and 8 are fragmentary side views of the embodiment, illustrating a state when the transmitting member and the rotary member are in a second meshing position, the regulator is in a second regulating position, and the feed dog unit is performing a counterclockwise feeding moving course.

[0007] Referring to FIGS. 1 and 2, an embodiment of a feed dog device of a sewing machine according to the present disclosure includes a driving unit 1, a needle plate unit 2, a feed dog unit 3, an up-down transmitting unit 4, a horizontal transmitting unit 5 and a direction adjusting unit 6.

[0008] Referring to FIGS. 2, 3 and 4, the driving unit 1 includes a drive motor 11 and a driving shaft 12 drivable by the drive motor 11 to rotate about a first axis (L1) in a longitudinal direction. The drive motor 11 can control the driving shaft 12 to rotate at a variable rotational speed ω_1.

[0009] The needle plate unit 2 includes a needle plate 21, a needle hole 22 formed in the needle plate 21, and a plurality of slots 23 formed adjacent to the needle hole 22.

[0010] The feed dog unit 3 includes a feed dog mount 31 which receives a transmitting drive from the driving shaft 12 to perform a reciprocating motion to be described in detail hereinafter, and a feed dog 32 which is mounted on the feed dog mount 31 and which has a plurality of teeth 33 aligned with and extending through the slots 23.

[0011] The up-down transmitting unit 4 is coupled between the driving shaft 12 and the feed dog mount 31 to

produce an up-down transmitting drive by rotation of the driving shaft 12 to make an up-down reciprocating motion of the feed dog mount 31 in an up-down direction (Z). Specifically, the up-down transmitting unit 4 includes an up-down cam 41 which is disposed on and synchronously rotatable with the driving shaft 12, and a swing arm 42 which is disposed on and swingable with the up-down cam 41 and which is connected with the feed dog mount 31 so as to make the up-down reciprocating motion of the feed dog mount 31. The teeth 33 are movable reciprocately relative to the slots 23 in the up-down direction (Z) with the movement of the feed dog mount 31.

[0012] The horizontal transmitting unit 5 is coupled between the driving shaft 12 and the feed dog mount 31 to produce a horizontal transmitting drive by rotation of the driving shaft 12 to make a horizontal reciprocating motion of the feed dog mount 31 in a horizontal direction (X) that is perpendicular to both the up-down direction (Z) and the longitudinal direction. The horizontal transmitting unit 5 includes a horizontal cam 51 which is disposed on and synchronously rotatable with the driving shaft 12, a swingable member 52 which is disposed on and swingable with the horizontal cam 51, a connecting member 53 which is pivotably connected with both the swingable member 52 and the feed dog mount 31 and rotatable about a second axis (L2) that is parallel to and offset from the first axis (L1), and a sliding member 54 which is pivotally connected with an end of the swingable member 52 and engaged with the direction adjusting unit 6 to be described in detail hereinafter. The swingable member 52 is swingable with the rotation of the horizontal cam 51 to bring the feed dog mount 31 into the horizontal reciprocating motion through the connecting member 53. The teeth 33 are movable reciprocately relative to the slots 23 in the horizontal direction (X) with the movement of the feed dog mount 31.

[0013] With reference to FIGS. 3 and 4, the direction adjusting unit 6 includes a controller 61 electrically connected with the drive motor 11 and generating and outputting a pulse signal P_s according to the rotational speed ω_1 of the driving shaft 12, a driver 62 electrically connected with the controller 61 and adjusting and outputting a drive current I according to the pulse signal P_s output from the controller 61, a stepper motor 63 electrically connected with the driver 62 and receiving the drive current I output from the driver 62 to rotate at a variable rotational speed ω_2, and a linkage mechanism 64 connected between the stepper motor 63 and the horizontal transmitting unit 5. The stepper motor 63 is mounted on a bracket 90 of the sewing machine.

[0014] It should be appreciated that the relationship among the rotational speed ω_1 of the driving shaft 12, the pulse signal P_s output from the controller 61 and the drive current I output from the driver 62 is expressed in the following formulas:

$$P_s = 1580(\omega_1/600) \quad (1)$$

and

$$I = 0.3P_s + 300 \quad (2)$$

wherein the unit used for the rotational speed ω_1 is RPM, and the unit used for the pulse signal P_s is pulse-per-second (PPS) . The controller 61 adjusts and outputs the pulse signal P_s for controlling the operation amount and speed of the stepping motor 63 according to the rotational speed ω_1 of the driving shaft 12 and by formula (1), which controls the operation amount and speed of the rotation of the stepper motor 63. The driver 62 then adjusts the drive current I according to the pulse signal P_s and by formula (2), which drives the rotation of the stepper motor 63. It can be seen from formulas (1) and (2) that, when the rotational speed ω_1 of the driving shaft 12 is higher, the value of the pulse signal P_s is larger, the drive current I output from the driver 62 is larger, and the rotational speed ω_2 of the stepper motor 63 is higher, and vice versa. Hence, the rotational speed ω_2 of the stepper motor 63 can be adjusted according to the rotational speed ω_1 of the driving shaft 12.

[0015] Referring to FIG. 3 and FIGS. 5 to 8, the linkage mechanism 64 is actuated by the stepper motor 63 to be moved between a first linking position (see FIGS. 5 and 6) and a second linking position (see FIGS. 7 and 8), and to interfere with the horizontal reciprocating motion of the feed dog mount 31 by the horizontal transmitting unit 5. Specifically, the linkage mechanism 64 has a transmitting member 65 which is connected with and drivable by the stepper motor 63 to be rotated in both clockwise and counterclockwise directions, a rotary member 66 which is pivotally mounted on the bracket 90 and rotatable with the transmitting member 65, a linking bar 67 which is pivotally connected with an end of the rotary member 66 opposite to the transmitting member 65, a regulating arm 68 which is pivotally connected with an opposite end of the linking bar 67 relative to the rotary member 66, a regulating shaft 69 which is drivable by the regulating arm 68 to be rotated about a regulating axis (L3) that is parallel to and offset from the first axis (L1) of the driving shaft 12, and a regulator 70 which is connected and rotatable with the regulating shaft 69. The regulator 70 and the regulating shaft 69 are rotatable synchronously to be moved at a variable speed between a first regulating position and a second regulating position. The transmitting member 65 is in the form of a pinion. The rotary member 66 has a sector-shaped toothed end portion 661 which meshes with the transmitting member 65 and which has a first toothed section 662 and a second toothed section 663. The transmitting member 65 and the rotary member 66 are movable forward and backward with a forward and backward reciprocating drive of the stepper motor 63 between a first meshing position and a second meshing position. The regulator 70 has a rail portion 701 such that the sliding member 54 is slidable along the rail portion 701 of the regulator 70.

[0016] When the linkage mechanism 64 is in the first linking position, the transmitting member 65 and the rotary member 66 are in the first meshing position (see FIG. 5), where the transmitting member 65 meshes with the first toothed section 662. Though the rotary member 66, the linking bar 67, the regulating arm 68 and the regulating shaft 69, the regulator 70 is brought by the regulating shaft 69 into rotation about the regulating axis (L3) to be moved to the first regulating position. When the linkage mechanism 64 is in the second linking position, the transmitting member 65 and the rotary member 66 are in the second meshing position (see FIG. 7), where the transmitting member 65 meshes with the second toothed section 662. Though the rotary member 66, the linking bar 67, the regulating arm 68 and the regulating shaft 69, the regulator 70 is brought by the regulating shaft 69 into rotation about the regulating axis (L3) to be moved to the second regulating position.

[0017] With reference to FIGS. 5 and 6, when the regulator 70 is moved to the first regulating position, the horizontal cam 51 is rotated synchronously with the driving shaft 12 to actuate swing of the swingable member 52 so as to bring the sliding member 54 into reciprocate sliding along the rail portion 701, and to bring the connecting member 53 into reciprocate swing about the second axis (L2) such that the feed dog mount 31 is made to be in the horizontal reciprocating motion in the horizontal direction (X). Meanwhile, the up-down cam 41 is rotated synchronously with the driving shaft 12 to actuate swing of the swing arm 42 to make the up-down reciprocating motion of the feed dog mount 31 in the up-down direction (Z). The horizontal reciprocating motion cooperates with the up-down reciprocating motion to bring the feed dog mount 31 into performing a clockwise feeding moving course (as schematically indicated by an arrow direction A in FIGS. 5 and 6) relative to the needle plate 21, where the teeth 33 are moved reciprocately and clockwise relative to the slots 23, so as to clockwise feed a fabric (not shown) on the needle plate 21.

[0018] With reference to FIGS. 7 and 8, when the regulator 70 is moved to the second regulating position, the regulator 70 is deflected relative to the regulating axis (L3) as compared with that in the first regulating position. Thus, the sliding path of the sliding member 54 is changed with the position of the regulator 70. The horizontal cam 51 is rotated synchronously with the driving shaft 12 to actuate swing of the swingable member 52 so as to bring the sliding member 54 into reciprocate sliding along the rail portion 701, and to bring the connecting member 53 into reciprocate swing about the second axis (L2) such that the feed dog mount 31 is made to be in the horizontal reciprocating motion in the horizontal direction (X). Meanwhile, the up-down cam 41 is rotated synchronously with the driving shaft 12 to actuate swing of the swing arm 42 to make the up-down reciprocating motion of the feed dog mount 31 in the up-down direction (Z). The horizontal reciprocating motion cooperates with the up-down reciprocating motion to bring the feed dog mount 31 into performing a counterclockwise feeding moving course (as schematically indicated by an arrow direction B in FIGS. 7 and 8) relative to the needle plate 21, where the teeth 33 are moved reciprocately and counterclockwise relative to the slots 23, so as to counterclockwise feed a fabric on the needle plate 21.

[0019] When the driving shaft 12 is kept rotating and it is desired to shift the feeding moving courses, the regulator 70 is actuatable to be moved between the first regulating position and the second regulating position so as to correspondingly adjust the sliding path of the sliding member 54. With the rotational speed ω_2 of the stepper motor 63 adjustable according to the rotational speed ω_1 of the driving shaft 12, a moving rate of the transmitting member 65 and the rotary member 66 between the first meshing position and the second meshing position is controlled so as to control a moving rate of the regulator 70 between the first regulating position and the second regulating position. Specifically, the moving rate of the regulator 70 is proportional to the rotational speed ω_1 of the driving shaft 12. Thus, friction between the sliding member 54 and the regulator 70 can be decreased so as to reduce noise and vibration generated therebetween. Moreover, the regulator 70 can be correspondingly adjusted when the rotational speed ω_1 of the driving shaft 12 is changed so as to adapt to a variety of conditions.

[0020] As illustrated, with the direction adjusting unit 6, during the shifting of the clockwise feeding moving course and the counterclockwise feeding moving course, the regulator 70 is moved between the first regulating position and the second regulating position so as to change the sliding path of the sliding member 54. With the rotational speed ω_2 of the stepper motor 63 adjustable according to the rotational speed ω_1 of the driving shaft 12, the moving rate of the regulator 70 is controlled between the first regulating position and the second regulating position so as to reduce noise and vibration generated as a result of friction between the regulator 70 and the sliding member 54.

Claims

1. A feed dog device of a sewing machine comprising:

a driving unit (1) including a driving shaft (12) drivable by a driving member to rotate about a first axis (L1) in a longitudinal direction;

a needle plate unit (2) including a needle plate (21), a needle hole (22) formed in said needle plate (21), and a plurality of slots (23) formed adjacent to said needle hole (22);

a feed dog unit (3) including a feed dog mount (31) which receives a transmitting drive from said driving shaft (12) to perform a reciprocating motion, and a feed dog (32) which is mounted on said feed dog mount (31) and which has a

plurality of teeth (33) aligned with and extending through said slots (23) ;

an up-down transmitting unit (4) coupled between said driving shaft (12) and said feed dog mount (31) to produce an up-down transmitting drive by rotation of said driving shaft (12) to make an up-down reciprocating motion of said feed dog mount (31) in an up-down direction (Z); and

a horizontal transmitting unit (5) coupled between said driving shaft (12) and said feed dog mount (31) to produce a horizontal transmitting drive by rotation of said driving shaft (12) to make a horizontal reciprocating motion of said feed dog mount (31) in a horizontal direction (X) that is perpendicular to both the up-down direction (Z) and the longitudinal direction, **characterized by**:

a direction adjusting unit (6) including a stepper motor (63) with a variable rotational speed controlled in accordance with a speed of said driving shaft (12), and a linkage mechanism (64) disposed between said stepper motor (63) and said horizontal transmitting unit (5), said linkage mechanism (64) being actuated by said stepper motor (63) to be moved between a first linking position and a second linking position, and to interfere with the horizontal reciprocating motion by said horizontal transmitting unit (5) such that the horizontal reciprocating motion cooperates with the up-down reciprocating motion by said up-down transmitting unit (4) to bring said feed dog mount (31) into performing a variable moving course.

2. The feed dog device as claimed in Claim 1, **characterized in that** said driving unit (1) further includes a drive motor (11) which serves as said driving member and which drives said driving shaft (12) and controls the speed of said driving shaft (12), said direction adjusting unit (6) further including a controller (61) electrically connected with both said drive motor (11) and said stepper motor (63), said controller (61) generating pulse signals in accordance with the speed of said driving shaft (12) and sending the pulse signals to said stepper motor (63) so as to control rotation of said stepper motor (63) at the rotational speed proportional to the speed of said driving shaft (12).

3. The feed dog device as claimed in Claim 2, **characterized in that** said linkage mechanism (64) has a regulating shaft (69) which is indirectly coupled with and actuatable by said stepper motor (63) to be rotated about a regulating axis (L3) that is parallel to and offset from the first axis (L1) of said driving shaft (12), and a regulator (70) which is connected and rotated with said regulating shaft (69), said regulator (70) having a rail portion (701), said horizontal transmitting unit (5) including a horizontal cam (51) which is disposed on and synchronously rotatable with said driving shaft (12), a swingable member (52) which is disposed on and swingable with said horizontal cam (51), a connecting member (53) which is pivotably connected with both said swingable member (52) and said feed dog mount (31) and rotatable about a second axis (L2) that is parallel to and offset from the first axis (L1), and a sliding member (54) which is pivotally connected with an end of said swingable member (52) and slidable along said rail portion (701) of said regulator (70), said regulator (70) being rotatable synchronously with said regulating shaft (69) to be moved between a first regulating position and a second regulating position at a variable speed,

wherein, when said linkage mechanism (64) is in the first linking position, said regulator (70) is moved to the first regulating position, said horizontal cam (51) is rotated synchronously with said driving shaft (12) to actuate swing of said swingable member (52) so as to bring said sliding member (54) into reciprocate sliding along said rail portion (701), and to bring said connecting member (53) into reciprocate swing about the second axis (L2) such that said feed dog mount (31) is made to be in the horizontal reciprocating motion in the horizontal direction (X), and the horizontal reciprocating motion cooperates with the up-down reciprocating motion by said up-down transmitting unit (4) which is driven by said driving shaft (12) to bring said feed dog mount (31) into performing a clockwise feeding moving course relative to said needle plate (21), where said teeth (33) are moved reciprocately and clockwise relative to said slots (23), and

wherein, when said linkage mechanism (64) is in the second linking position, said regulator (70) is moved to the second regulating position, said horizontal cam (51) is rotated synchronously with said driving shaft (12) to actuate swing of said swingable member (52) so as to bring said sliding member (54) into reciprocate sliding along said rail portion (701), and to bring said connecting member (53) into reciprocate swing about the second axis (L2) such that said feed dog mount (31) is made to be in the horizontal reciprocating motion in the horizontal direction (X), and the horizontal reciprocating motion cooperates with the up-down reciprocating motion by said up-down transmitting unit (4) to bring said feed dog mount (31) into performing a counterclockwise feeding moving course relative to said needle plate (21), where said teeth (33) are moved reciprocately and counterclockwise relative to said slots (23).

4. The feed dog device as claimed in Claim 3, **characterized in that** said linkage mechanism (64) further has a transmitting member (65) which is connected with and drivable by said stepper motor (63) to be rotated in both clockwise and counterclockwise directions, a rotary member (66) which is rotatable with said transmitting member (65), a linking bar (67) which is pivotally connected with an end of said rotary member (66) opposite to said transmitting member (65), and a regulating arm (68) which is pivotally connected with both said linking bar (67) and said regulating shaft (69) to bring said regulating shaft (69) into rotation about the regulating axis (L3), and wherein, when said linkage mechanism (64) is actuated by said stepper motor (63) to be moved between the first linking position and the second linking position, said regulating arm (68) drives synchronous rotation of said regulating shaft (69) and said regulator (70) to be moved between the first regulating position and the second regulating position.

5. The feed dog device as claimed in Claim 4, **characterized in that** said transmitting member (65) is in form of a pinion, said rotary member (66) having a toothed end portion (661) which meshes with said transmitting member (65) and which has a first toothed section (662) and a second toothed section (663), said transmitting member (65) and said rotary member (66) being movable forward and backward with a forward and backward reciprocating drive of said stepper motor (63) between a first meshing position and a second meshing position, wherein, when said linkage mechanism (64) is in the first linking position, said transmitting member (65) and said rotary member (66) are in the first meshing position, where said transmitting member (65) meshes with said first toothed section (662), and said regulator (70) is moved through said linking bar (67), said regulating arm (68) and said regulating shaft (69) to the first regulating position, and wherein, when said linkage mechanism (64) is in the second linking position, said transmitting member (65) and said rotary member (66) are in the second meshing position, where said transmitting member (65) meshes with said second toothed section (663), and said regulator (70) is moved through said linking bar (67), said regulating arm (68) and said regulating shaft (69) to the second regulating position.

6. The feed dog device as claimed in Claim 5, **characterized in that** said up-down transmitting unit (4) includes an up-down cam (41) which is disposed on and synchronously rotatable with said driving shaft (12), and a swing arm (42) which is disposed on and swingable with said up-down cam (41) and which is connected with said feed dog mount (31) to make the up-down reciprocating motion of said feed dog mount (31).

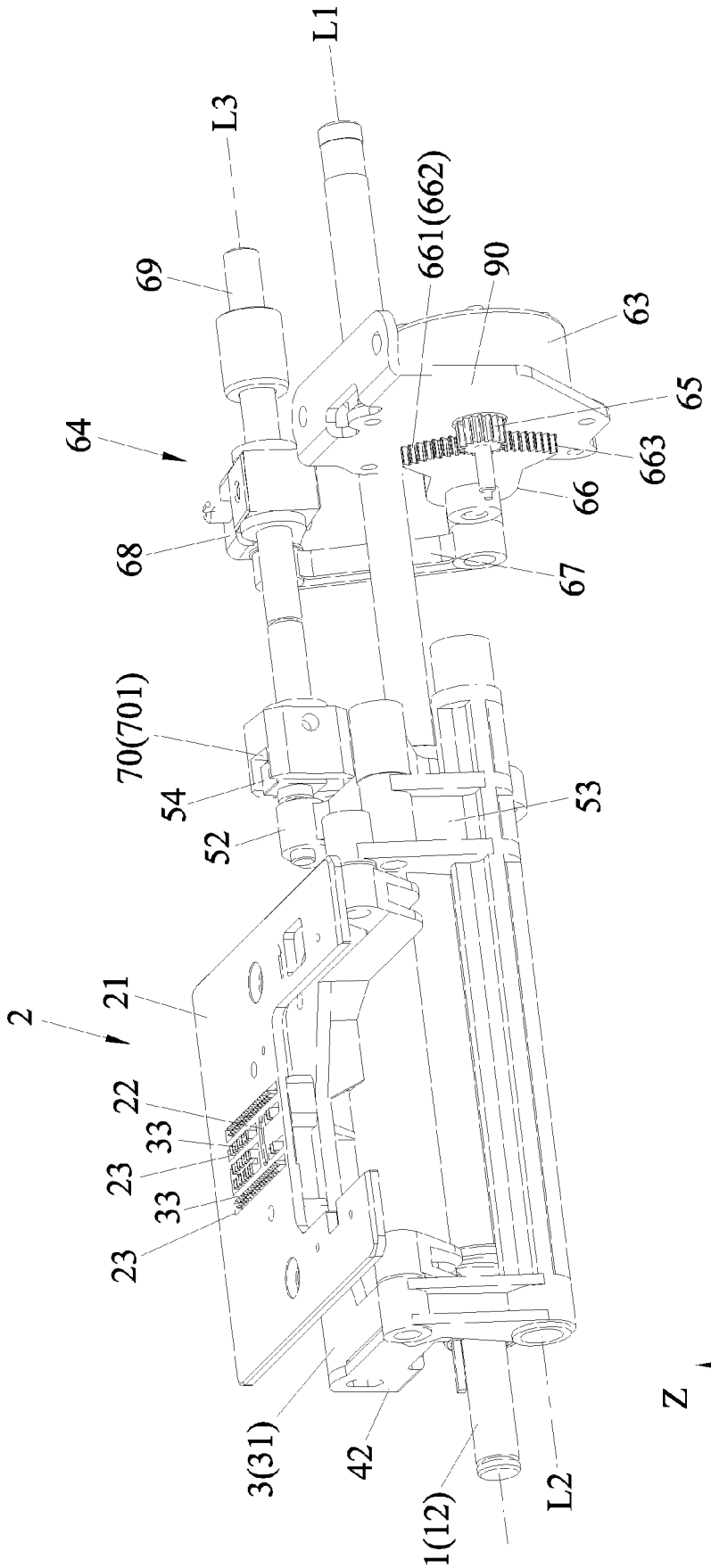
L1
L3
661(662)
90
69
63
65
64
663
66
68
67
70(701)
54
53
52
2
21
22
33
23
33
23
3(31)
42
1(12)
L2
Z
X

FIG.1

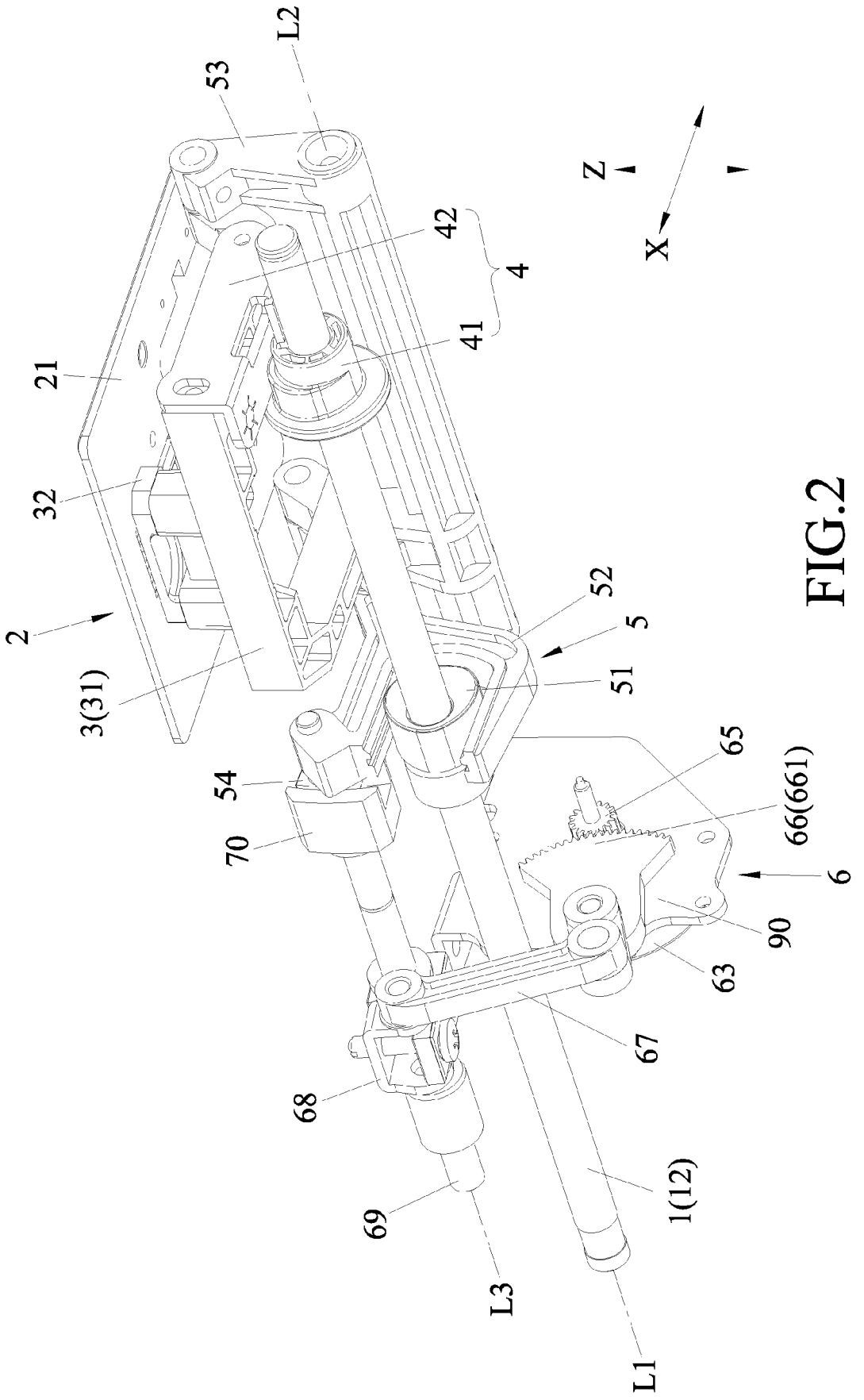
L2
53
42
4
41
21
32
2
3(31)
52
5
51
65
66(661)
54
70
6
90
63
67
68
1(12)
69
L3
L1
Z
X

FIG.2

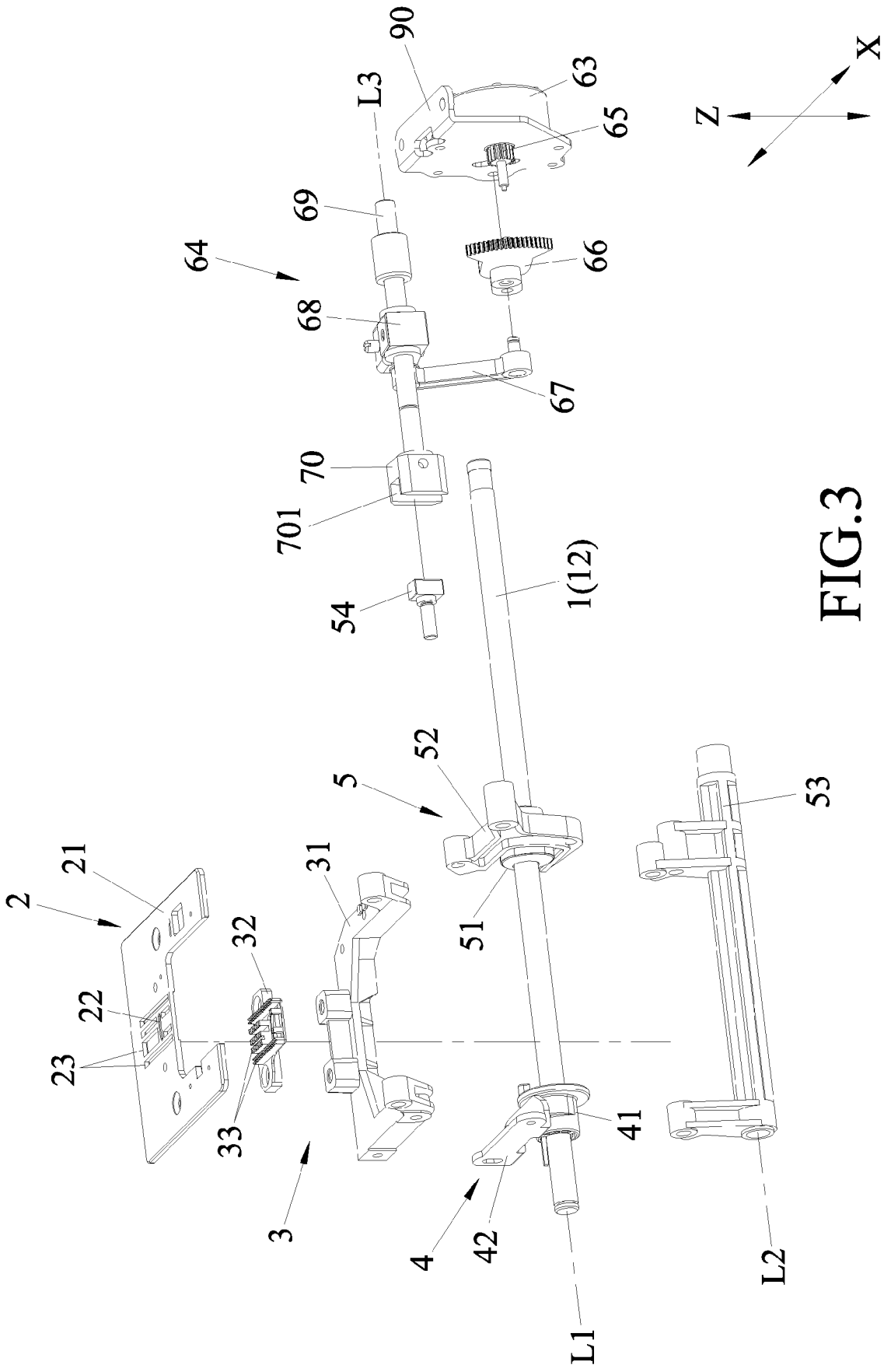
90
63
L3
65
69
64
66
68
67
70
701
54
1(12)
52
5
53
21
2
31
32
51
22
23
33
41
3
4
42
L1
L2
Z
X

FIG.3

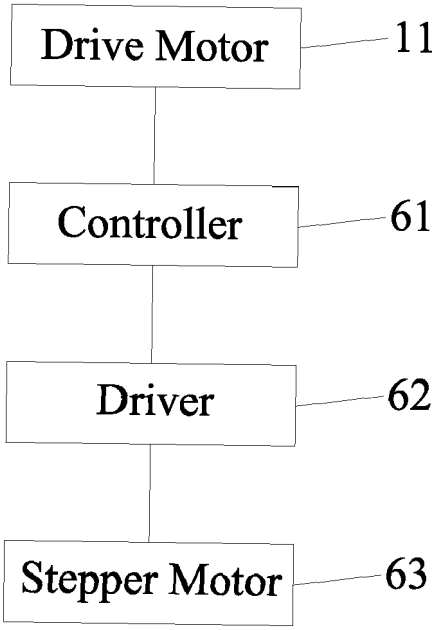

FIG.4

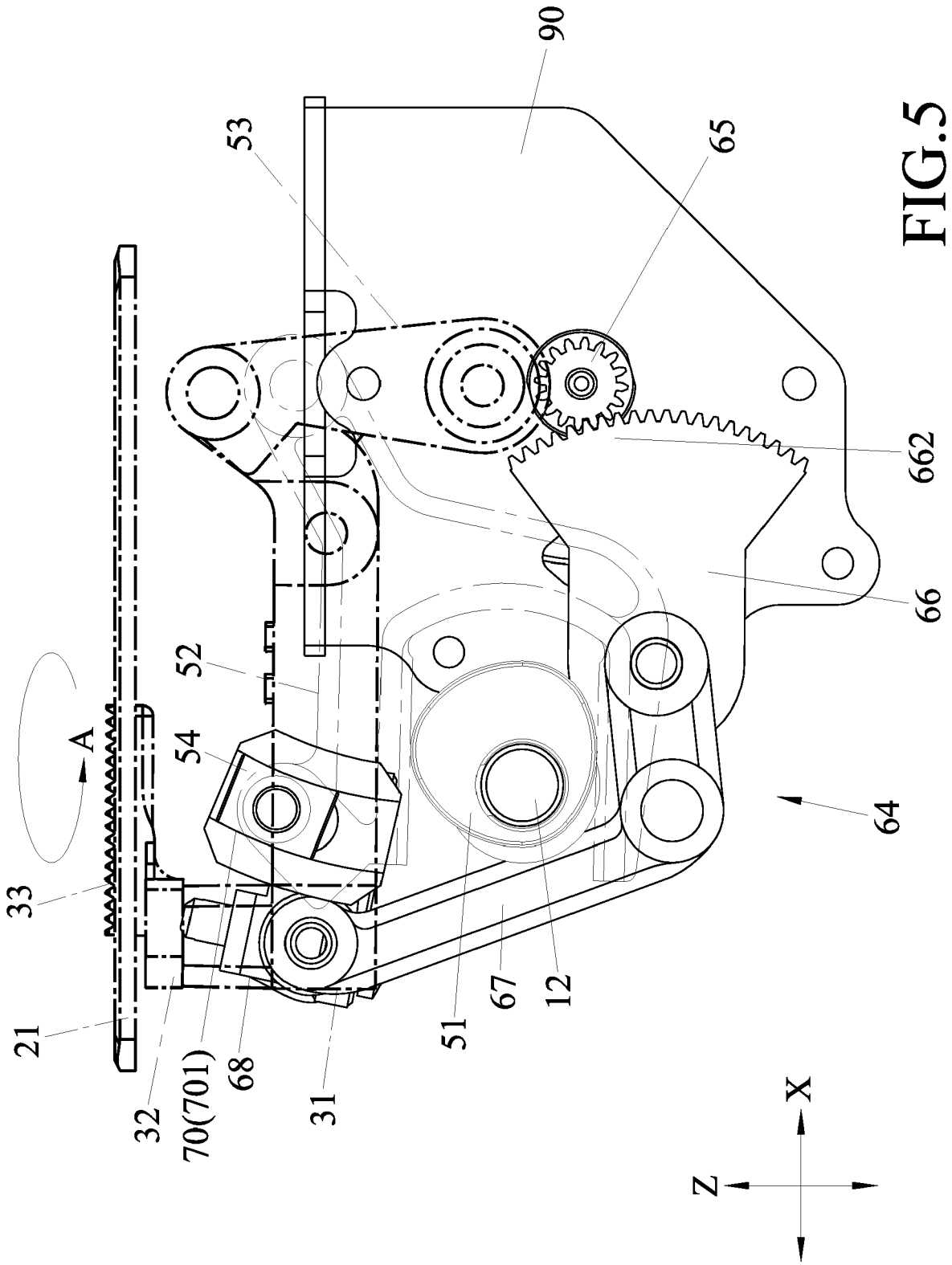

FIG.5

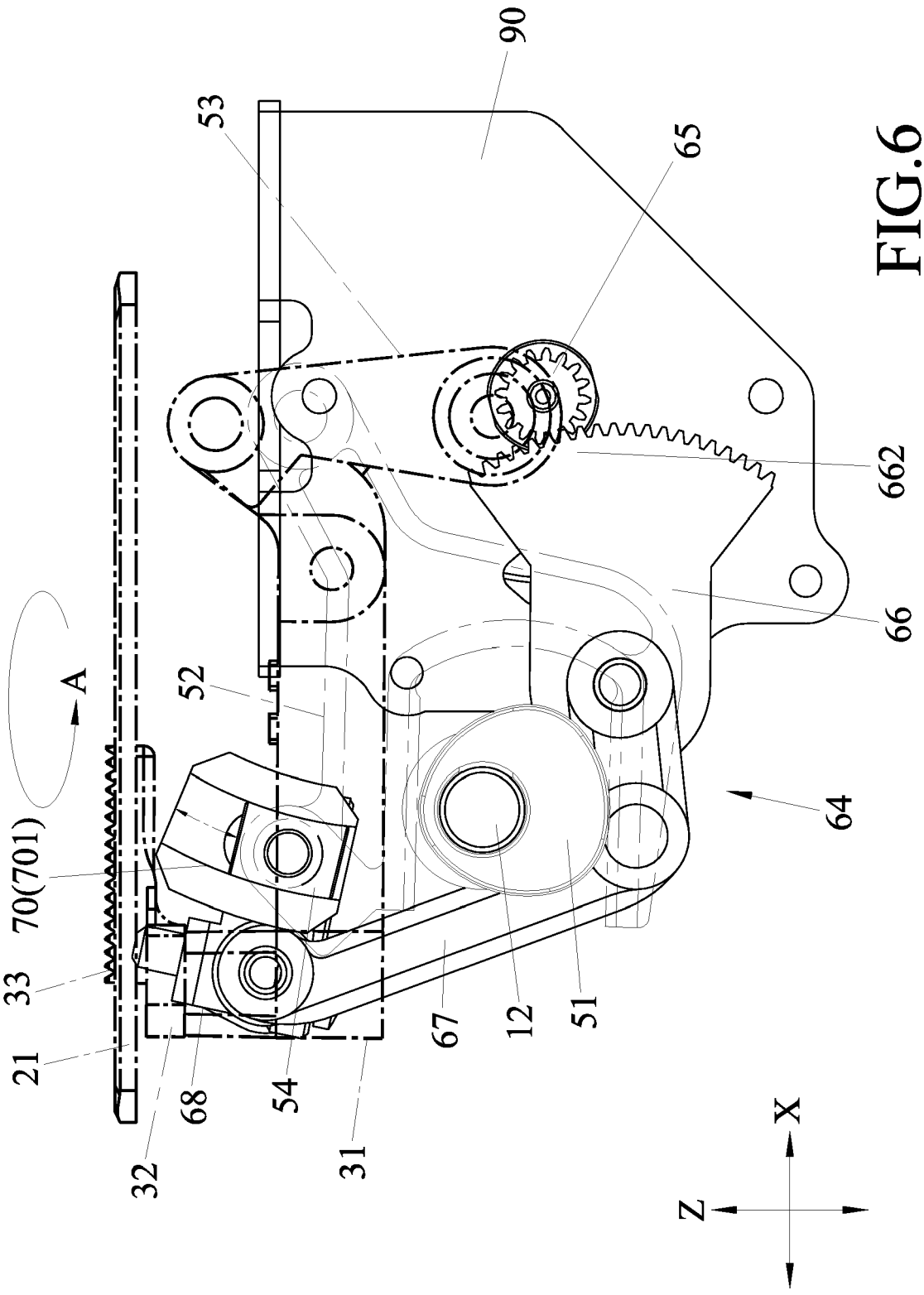

FIG.6

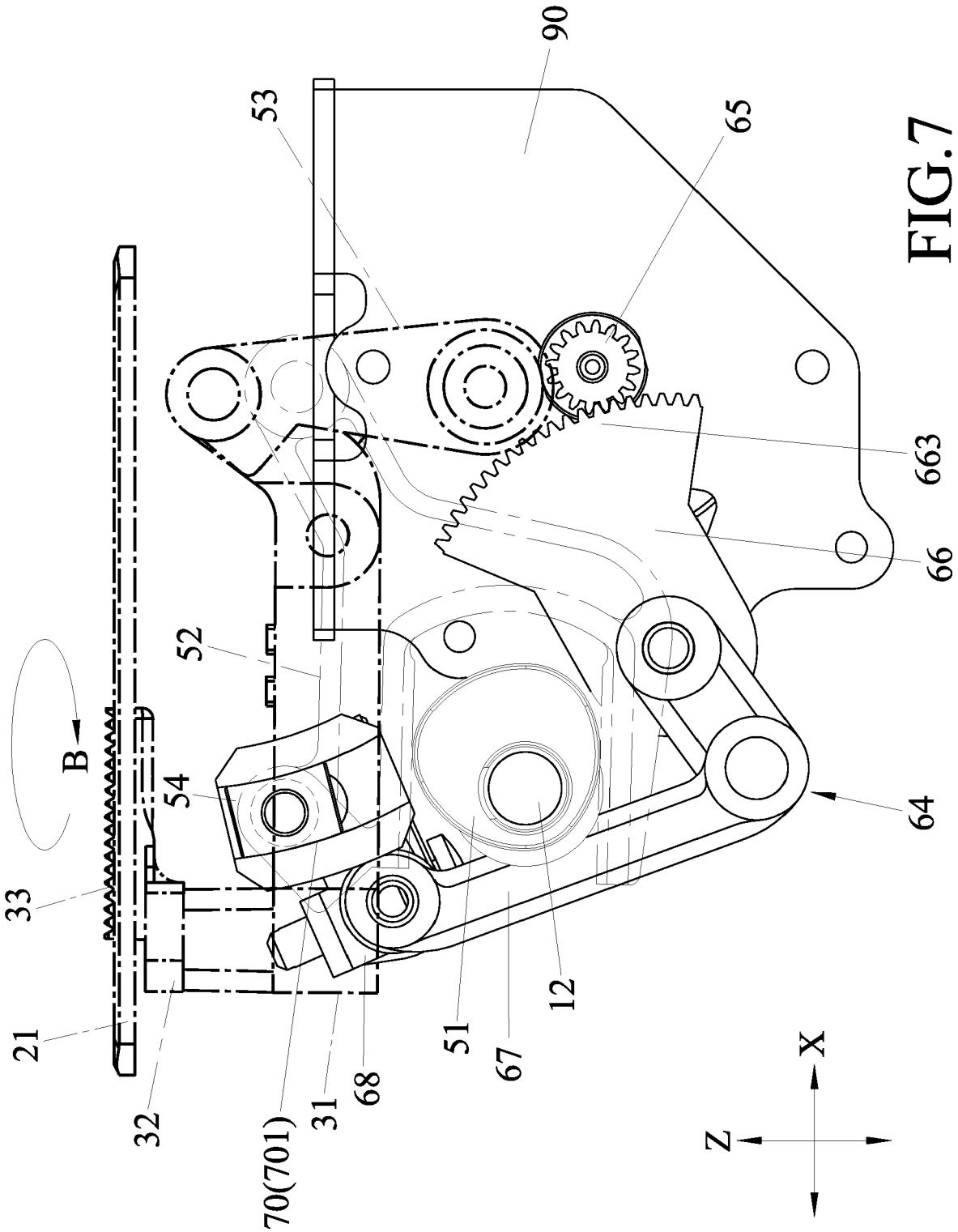

FIG.7

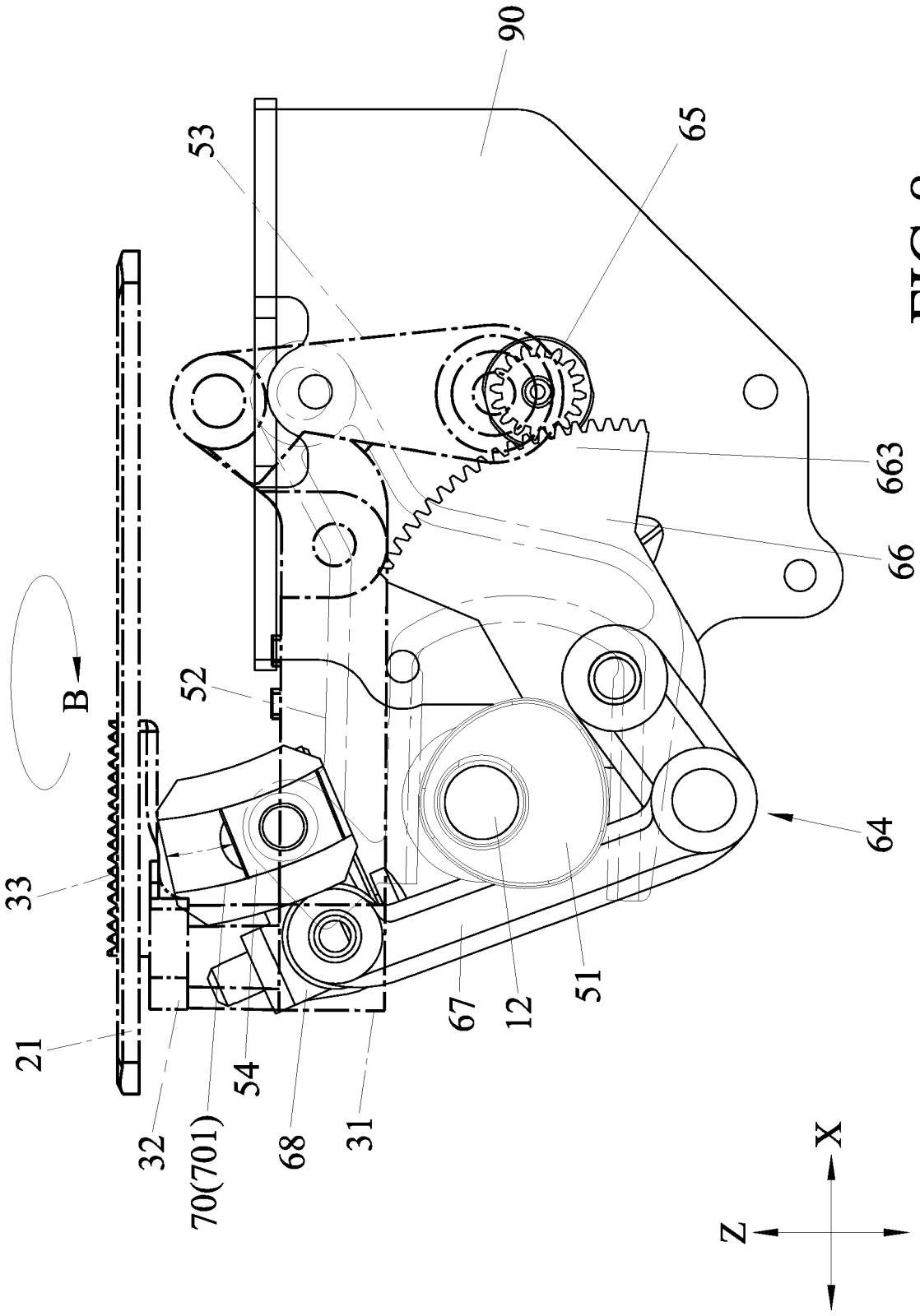

FIG.8

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 22 15 0275

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	CN 207 130 441 U (ZHEJIANG WINWAY MACHINERY CO LTD) 23 March 2018 (2018-03-23) * abstract * * claim 1 * * figures 1, 2 * * paragraph [0001] - paragraph [0006] * * paragraph [0010] * * paragraph [0014] * * paragraph [0017] * * paragraph [0020] - paragraph [0022] *	1-6	INV. D05B27/02
X	TW 201 009 153 A (S S INDUSTRY CO LTD [TW]) 1 March 2010 (2010-03-01) * abstract * * claims 1, 2, 15 * * figures 1-15 * * paragraph [0001] - paragraph [0004] * * paragraph [0006] * * paragraph [0007] * * paragraph [0011] * * paragraph [0013] * * paragraph [0015] * * paragraph [0019] - paragraph [0021] * * paragraph [0025] - paragraph [0032] *	1-6	TECHNICAL FIELDS SEARCHED (IPC) D05B
X	JP H07 328259 A (JUKI KK) 19 December 1995 (1995-12-19) * abstract * * claims 1, 2 * * figures 1, 2 * * paragraph [0001] * * paragraph [0002] * * paragraph [0004] - paragraph [0006] * * paragraph [0010] - paragraph [0012] * * paragraph [0014] * * paragraph [0016] * * paragraph [0019] * * paragraph [0020] *	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	22 June 2022	Heinzelmann, Eric

CATEGORY OF CITED DOCUMENTS

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