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Kinoshita et al.

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(54) **AUTOMATED BOBBIN EXCHANGER DEVICE**

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D05B 57/26 (2006.01)

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CPC ***D05B 59/04*** (2013.01); ***D05B 57/26*** (2013.01); *D05D 2207/05* (2013.01)

(58) **Field of Classification Search**
CPC D05B 59/04; D05B 57/14
USPC 112/186, 180, 196, 228, 470.05; 242/473.5, 473.9
See application file for complete search history.

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(57) **ABSTRACT**

In an automated bobbin-exchanger device (**3**), a guide groove (**6**) which is provided on a vertical transfer base (**5**) has a horizontal portion (**6***a*), a vertical portion (**6***c*) and an arcuate portion (**6***b*). A bobbin chuck (**18**) reciprocally moves pivotably along the guide groove (**6**) to make a travel distance minimum, thus enabling users to quickly exchange the bobbin case (**12**). By placing a bobbin holder (**13***a*), a chuck-drive lever (**14**) and a chuck-drive air-cylinder (**26**) circumferentially, it is possible to make a whole structure compact and space-saving. The bobbin-exchanger device (**3**) requires only two bobbin cases (**12**) available to make their check and maintenance easy.

5 Claims, 11 Drawing Sheets

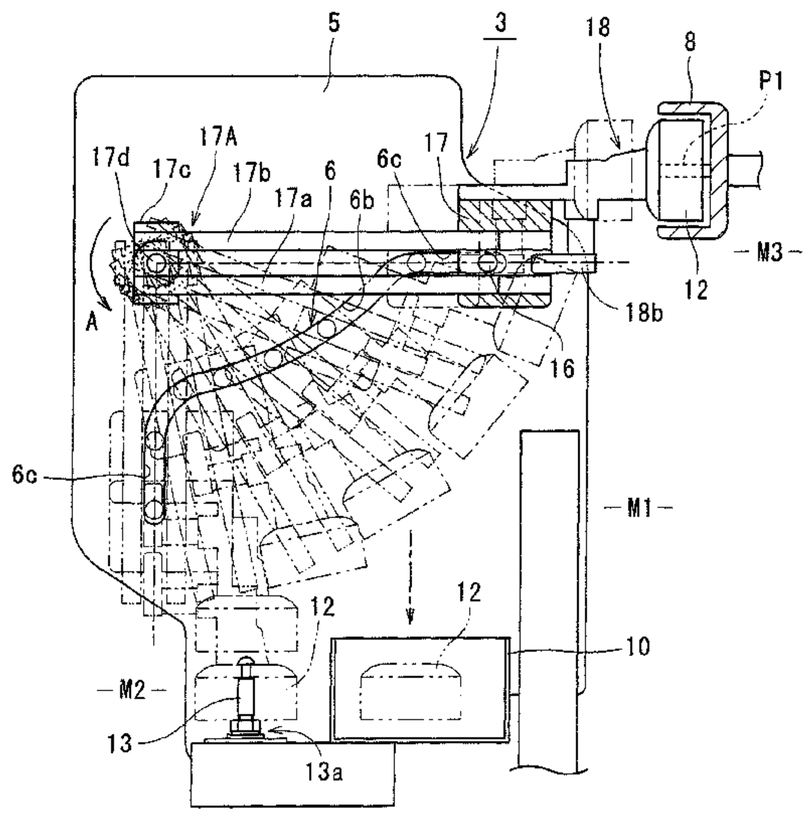

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Fig. 1

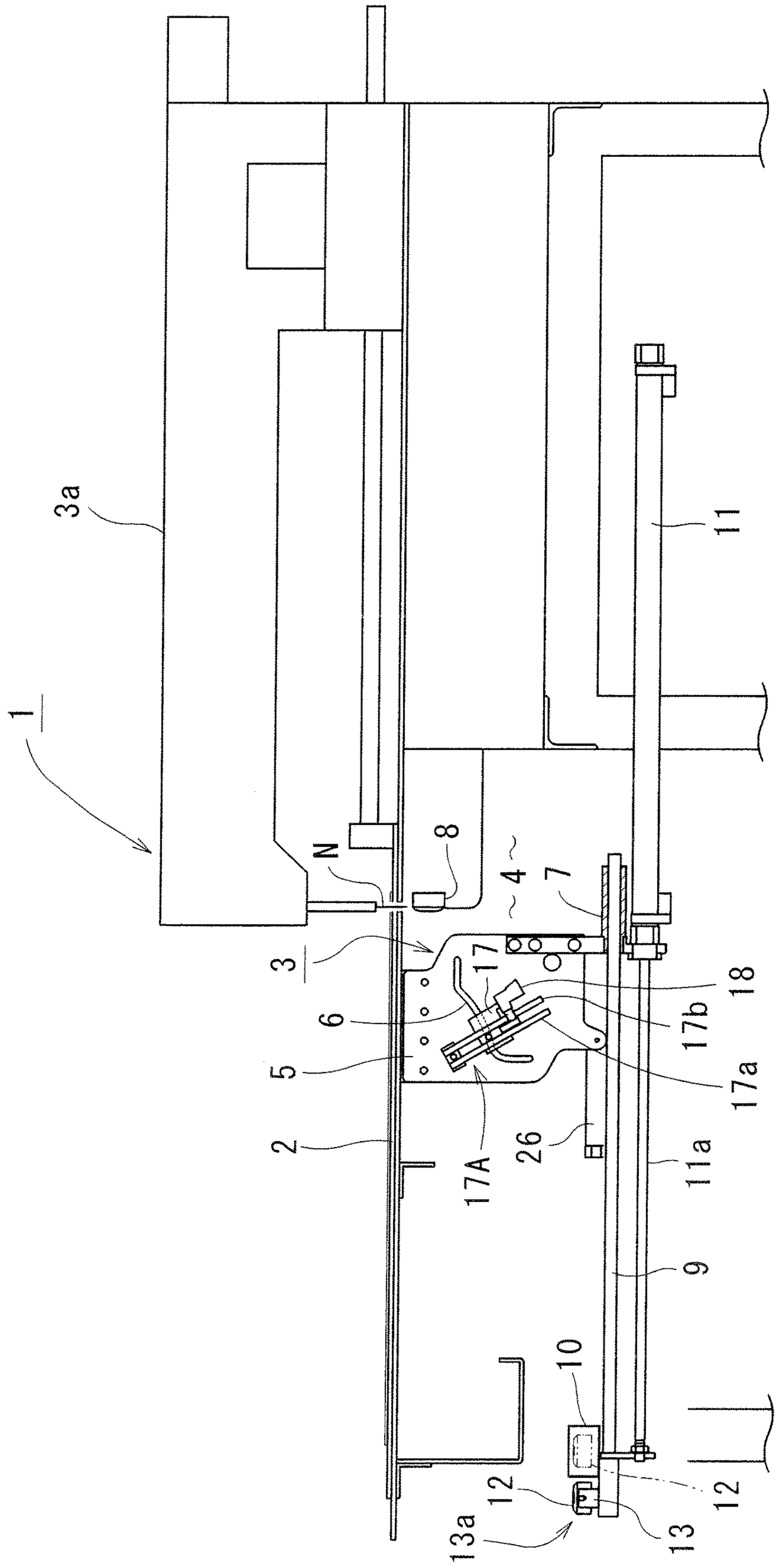
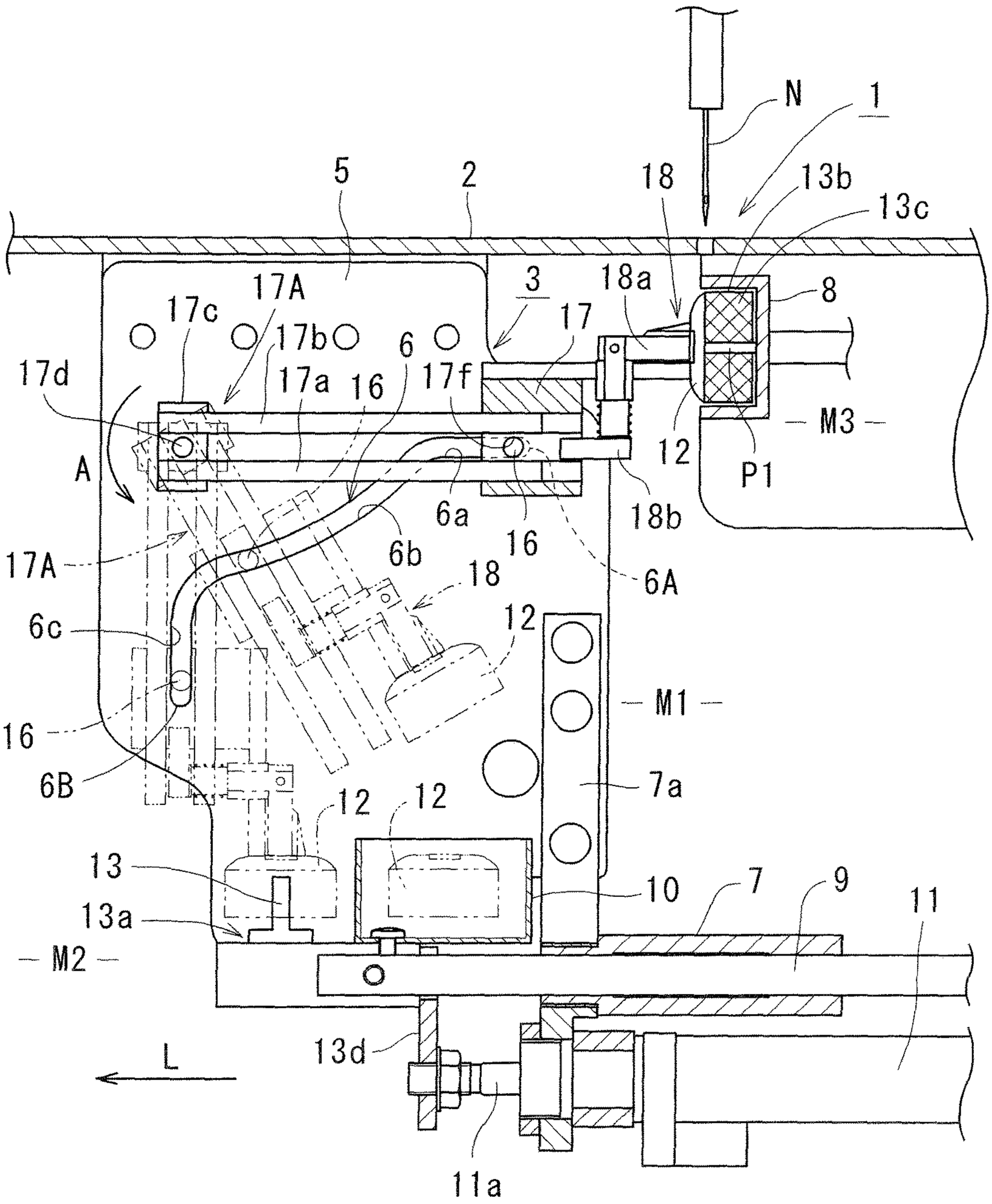


Fig. 2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18
13b
13c
3
18a
8
17A
17c
17b
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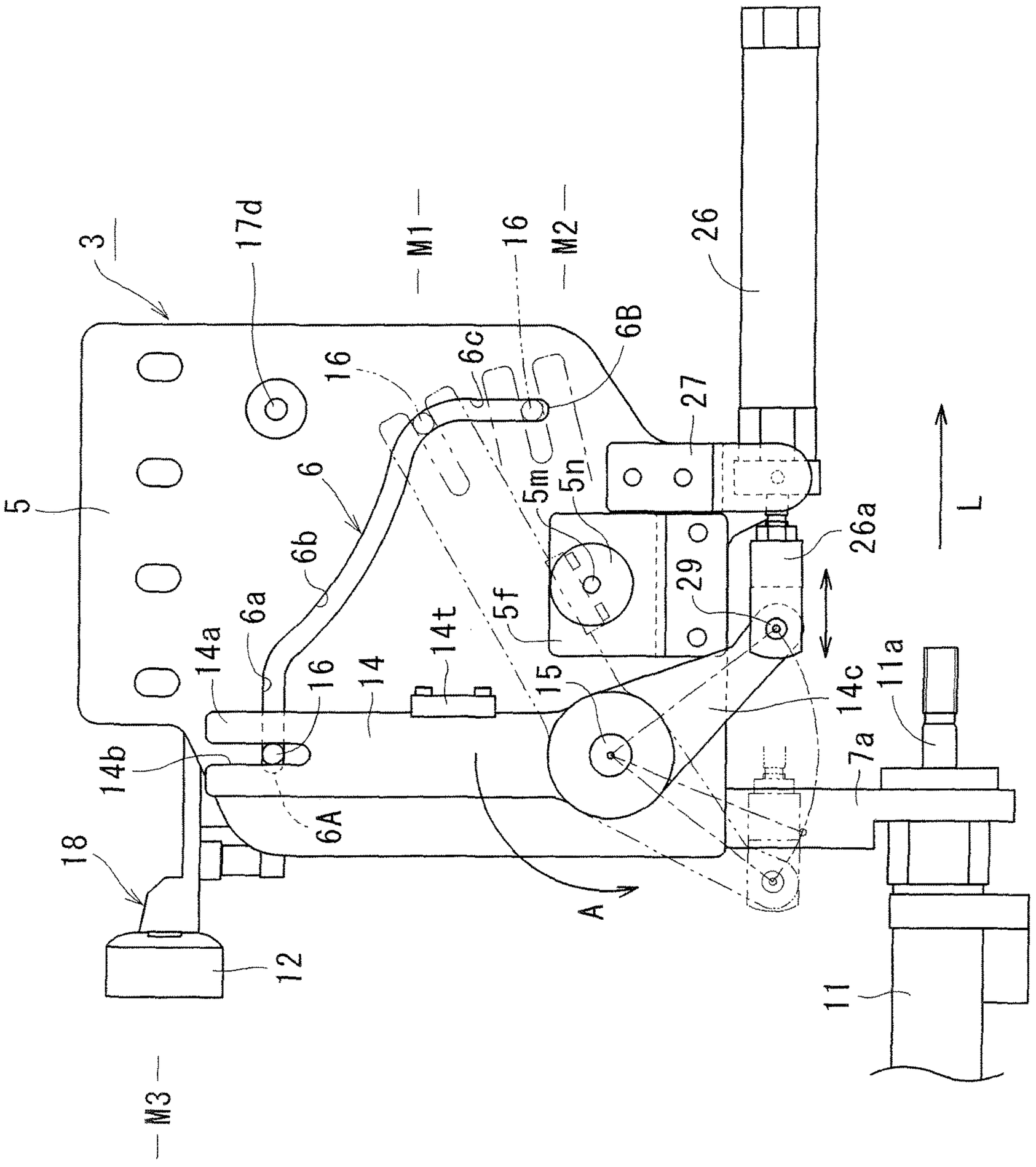
17d
17a
16
6
17f
M3
12
P1
A
6a
18b
6b
16
17A
18
6A
6c
12
M1
16
6B
7a
12
12
13
10
7
9
11
13a
M2
13d
L
11a

Fig. 3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17d
M1
16
M2
26
6B
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16
27
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6
5m
5n
L
6b
26a
6a
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14b
7a
6A
18
A
12
M3
11

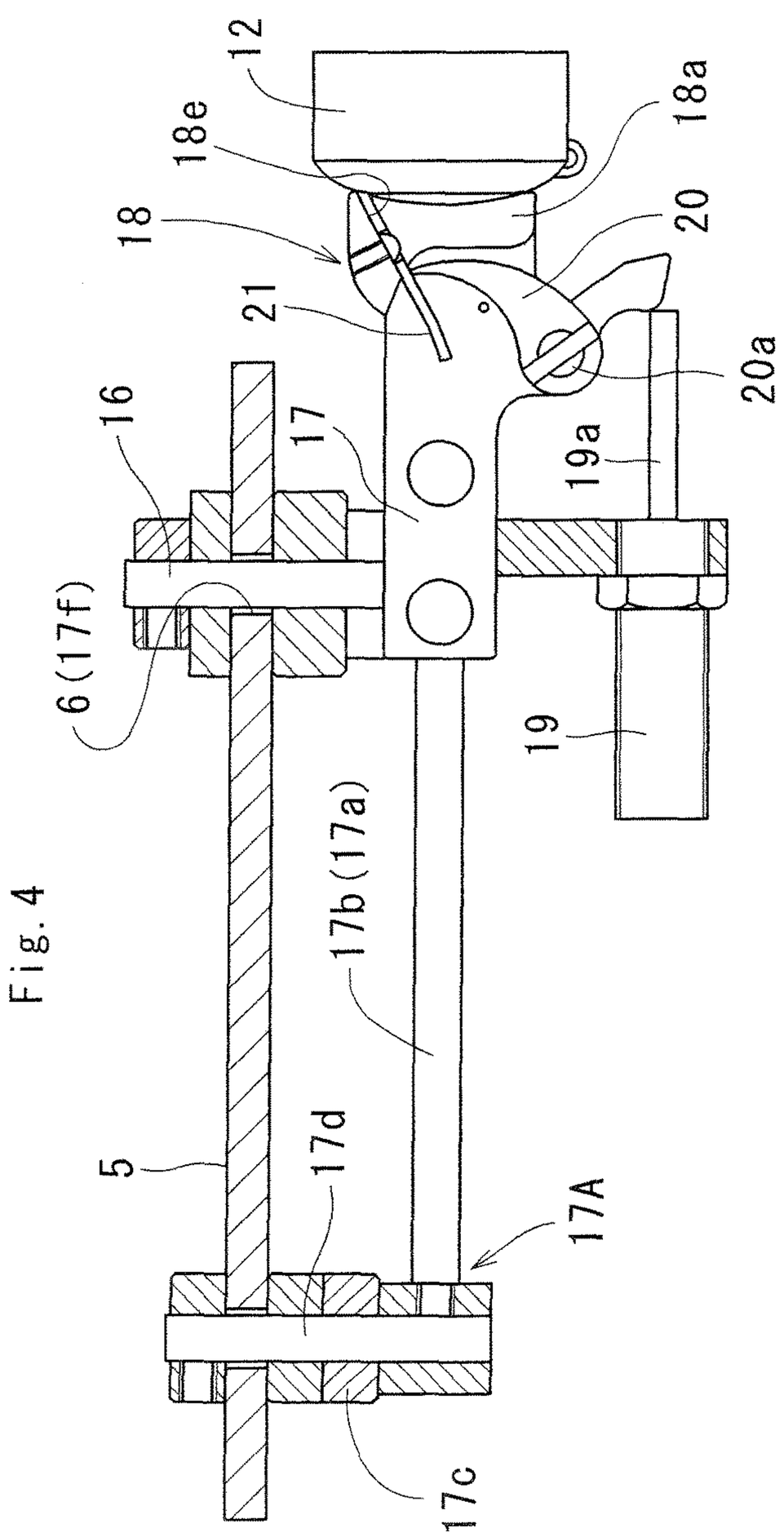
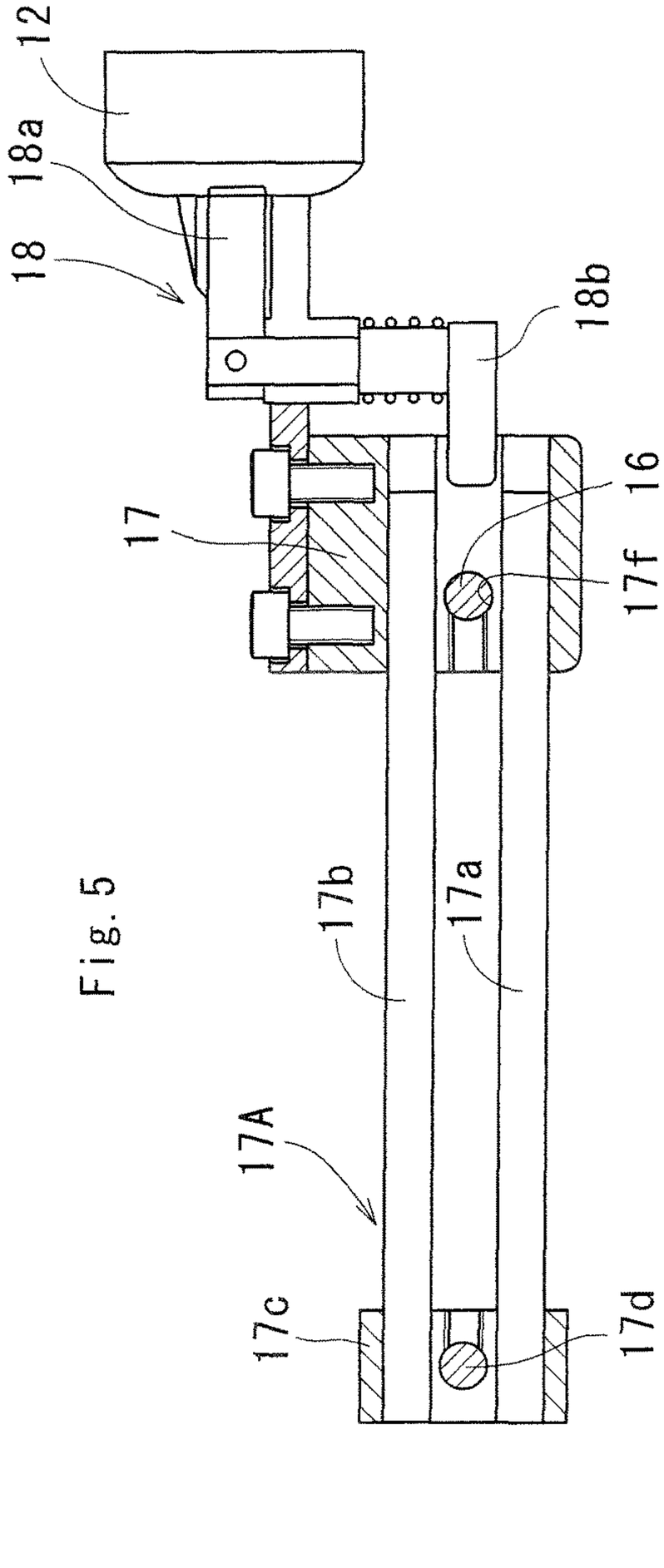

12
18e
18a
18
20
21
20a
16
17
19a
6(17f)
19
17b(17a)
5
17d
17A
17c

Fig. 4


12
18a
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18b
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17d

Fig. 5

Fig. 6

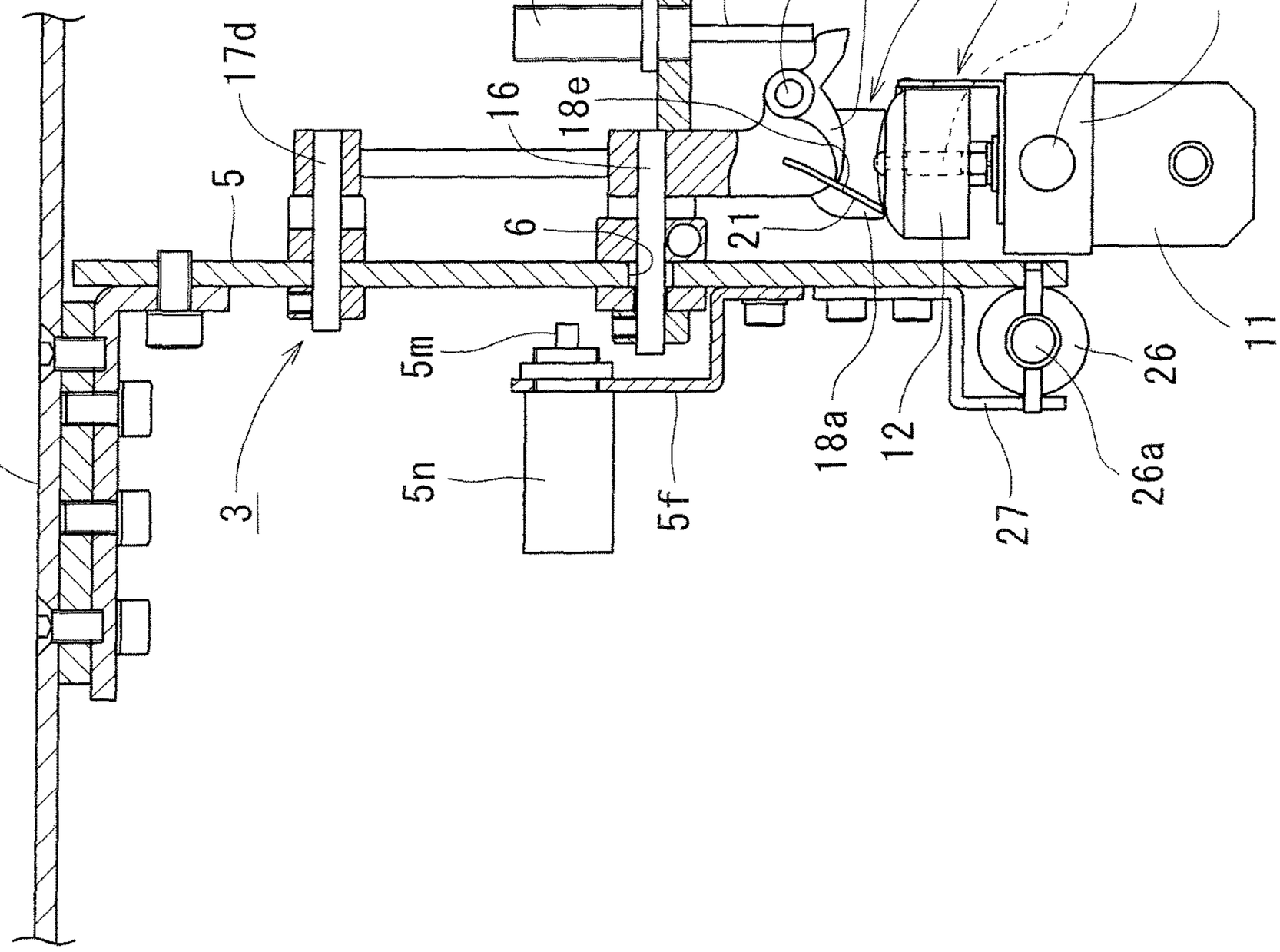

Fig. 7

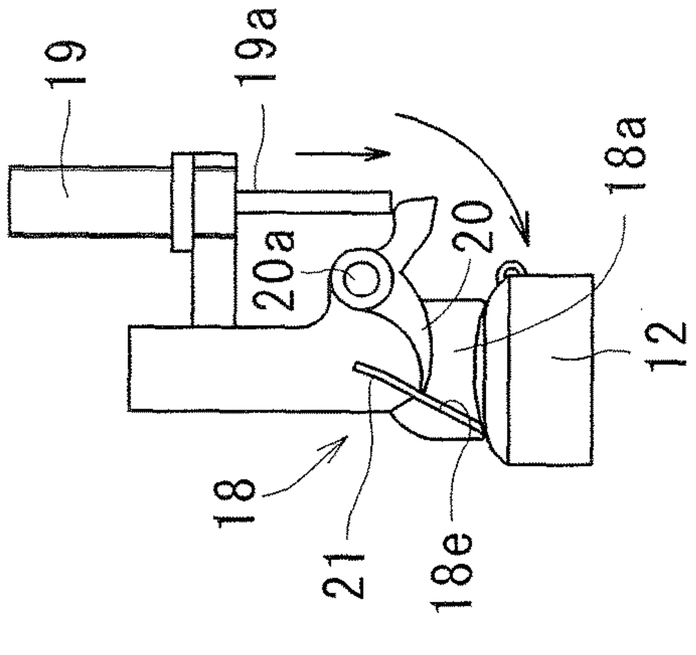

Fig. 8

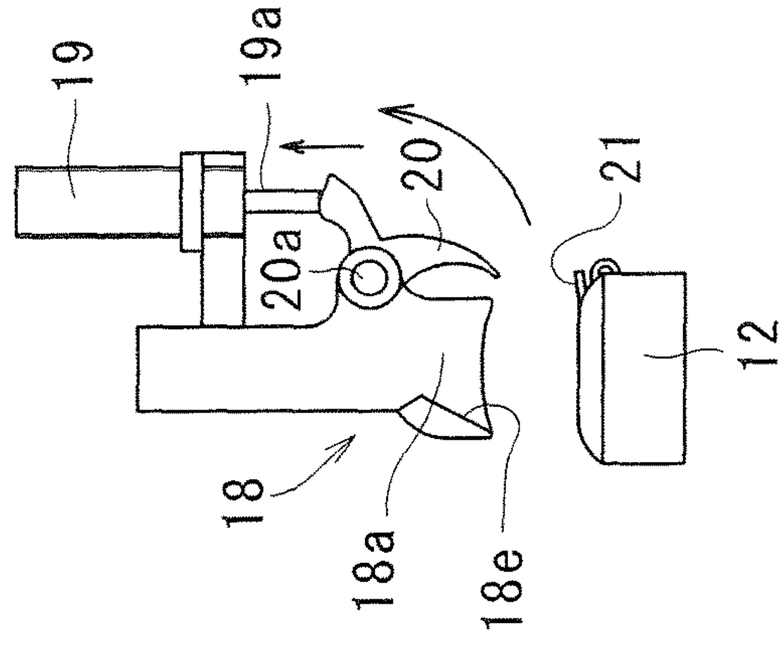

Fig. 10

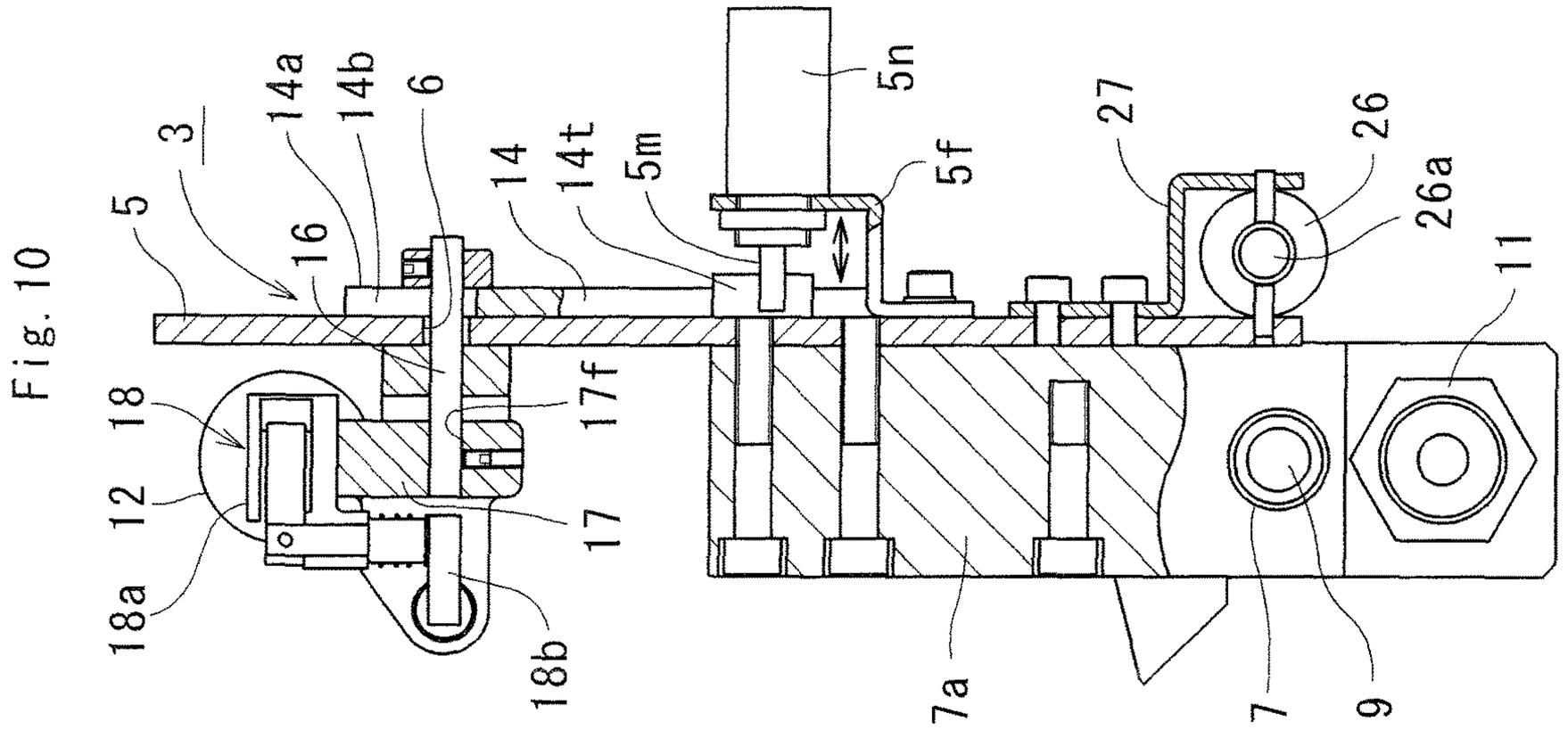
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Fig. 9

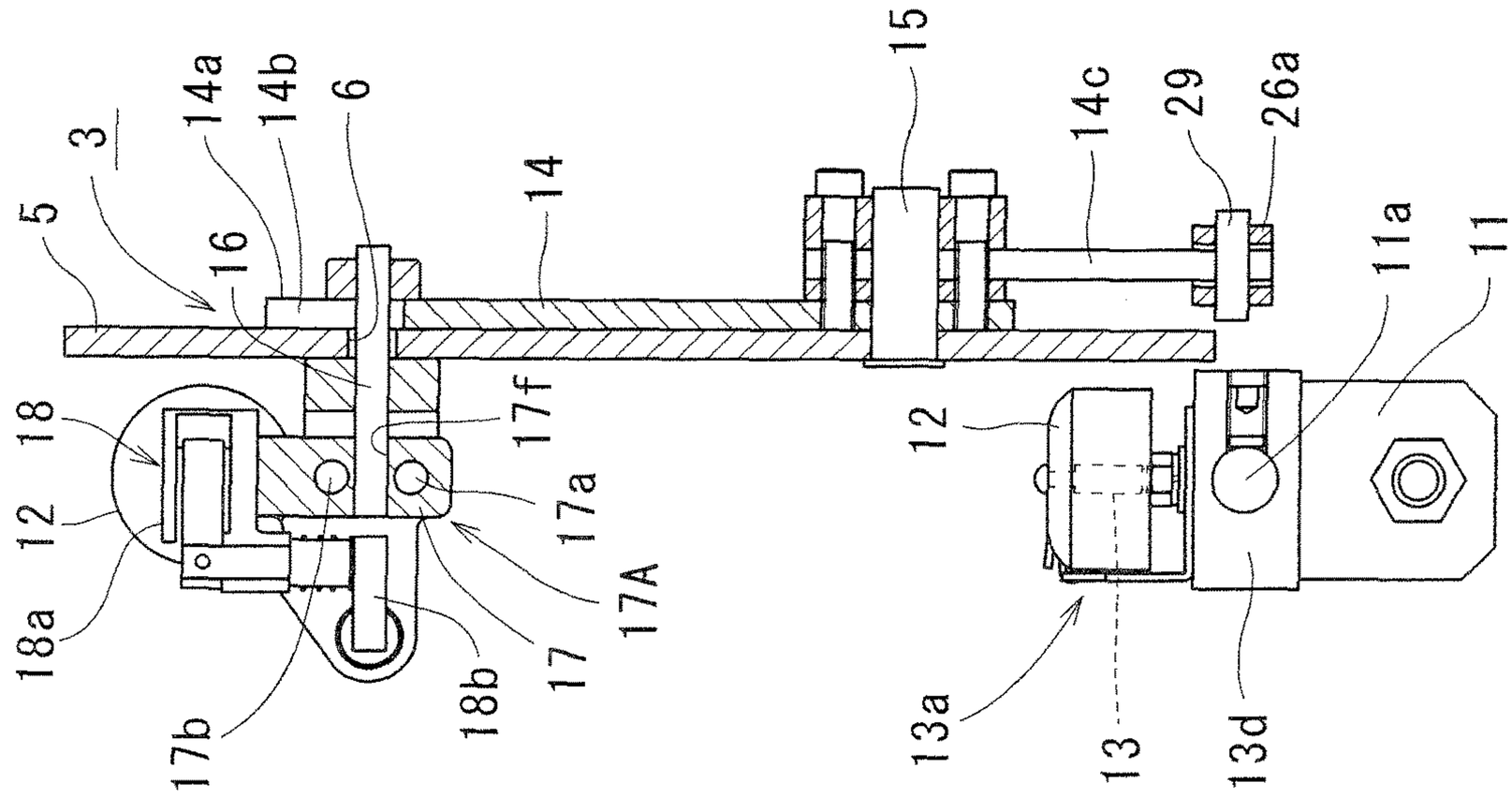
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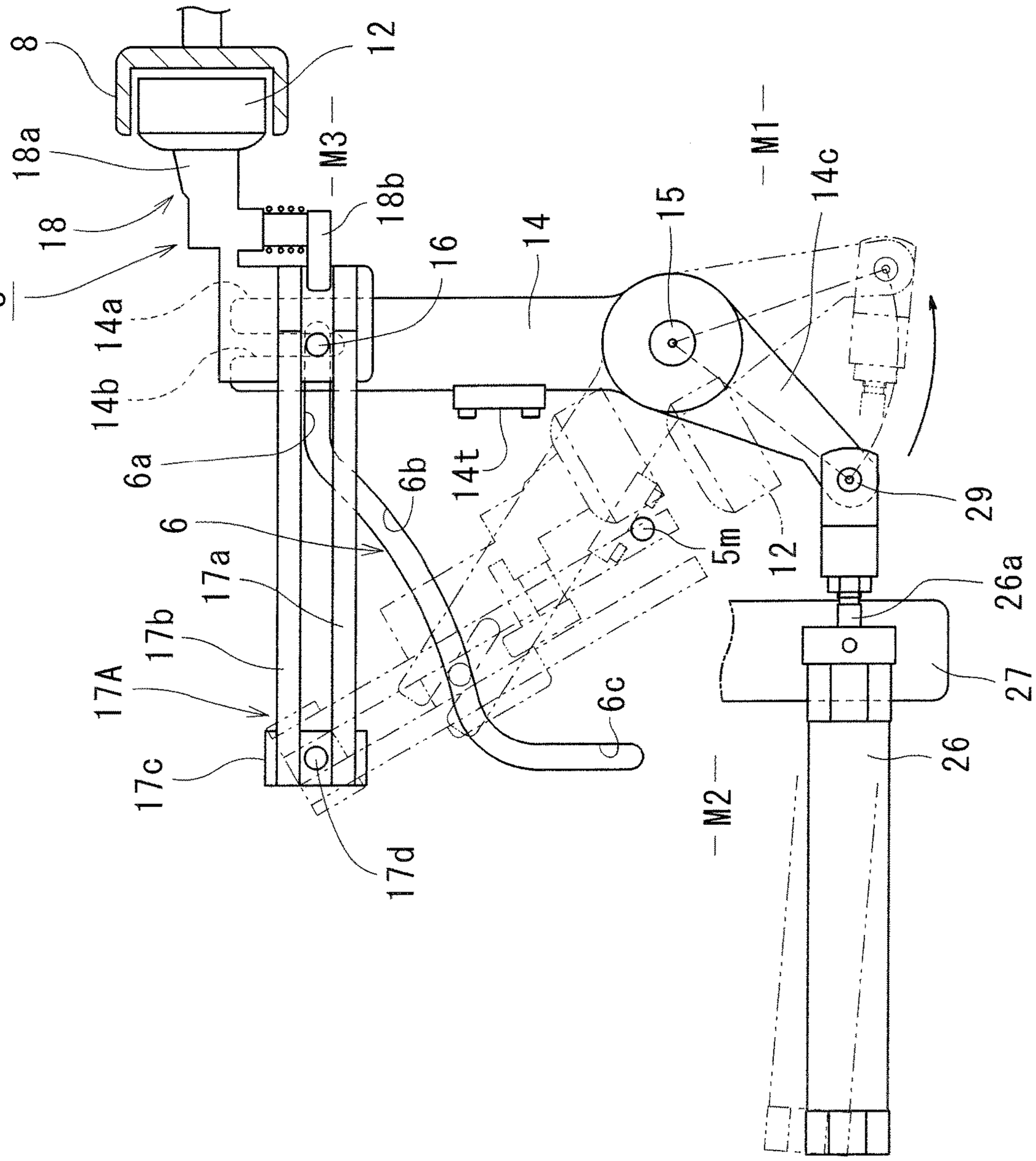
Fig. 11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18a
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17A
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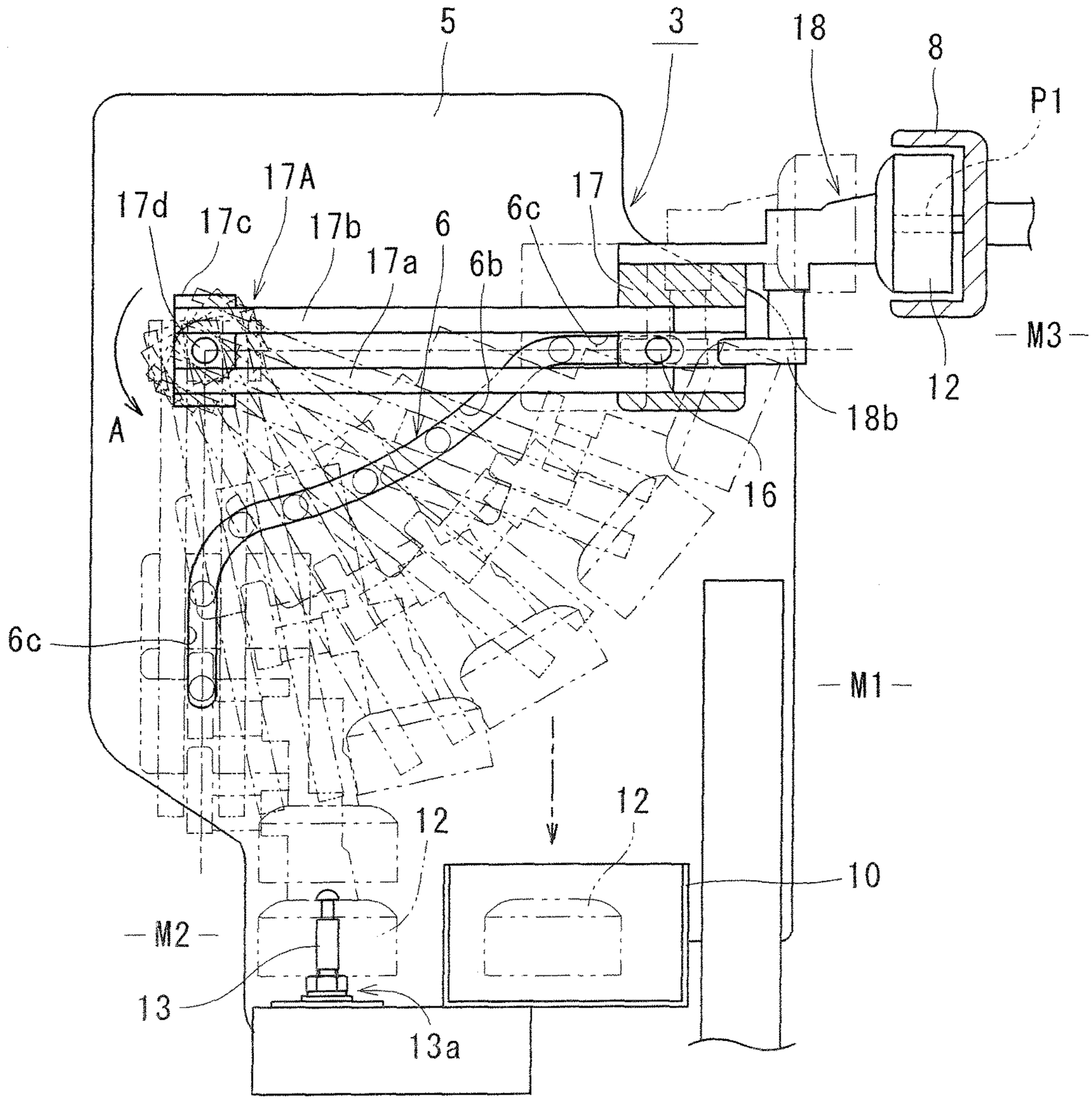
17c
6c
27
26
M2
17d

Fig. 12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M1
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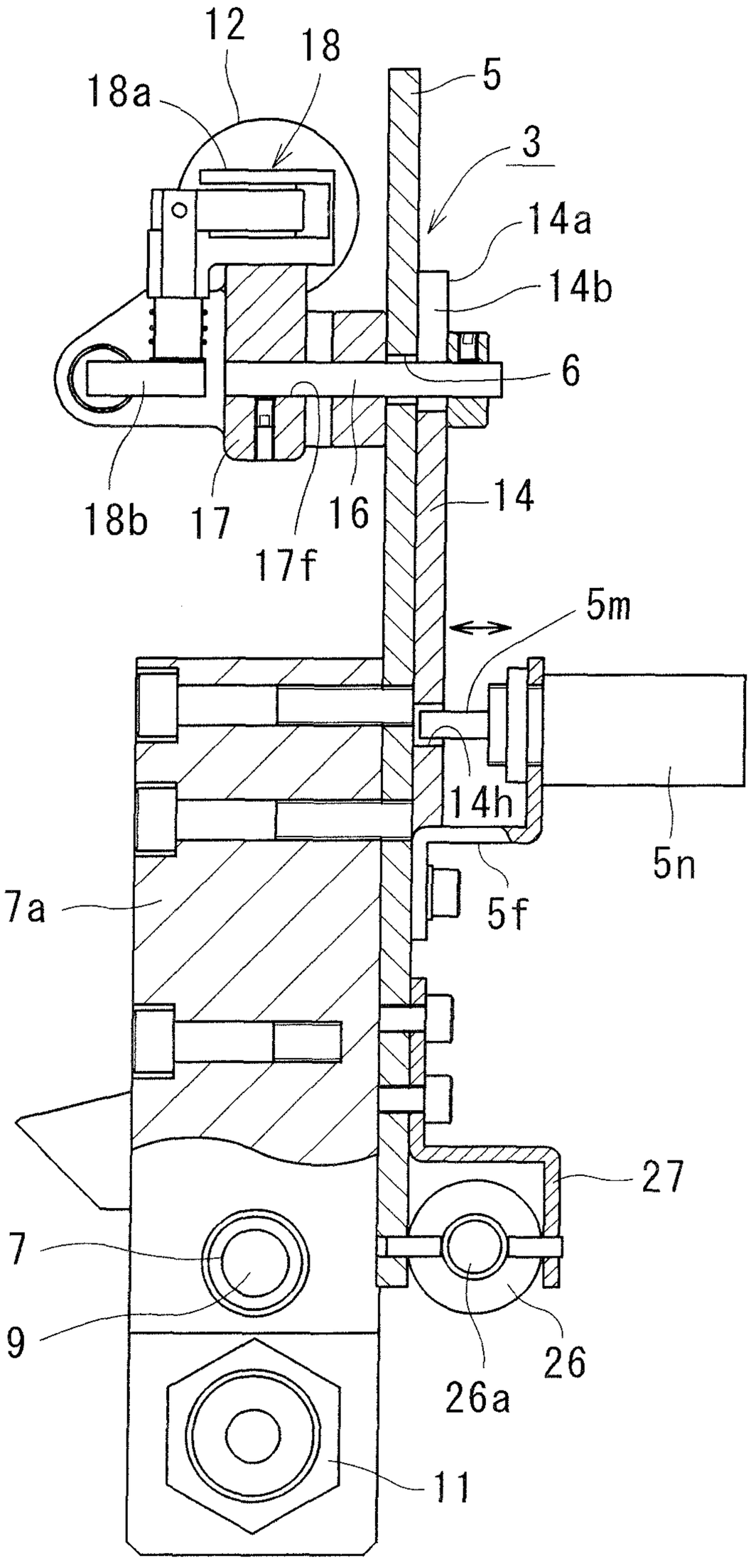
10
M2
13
13a

Fig. 13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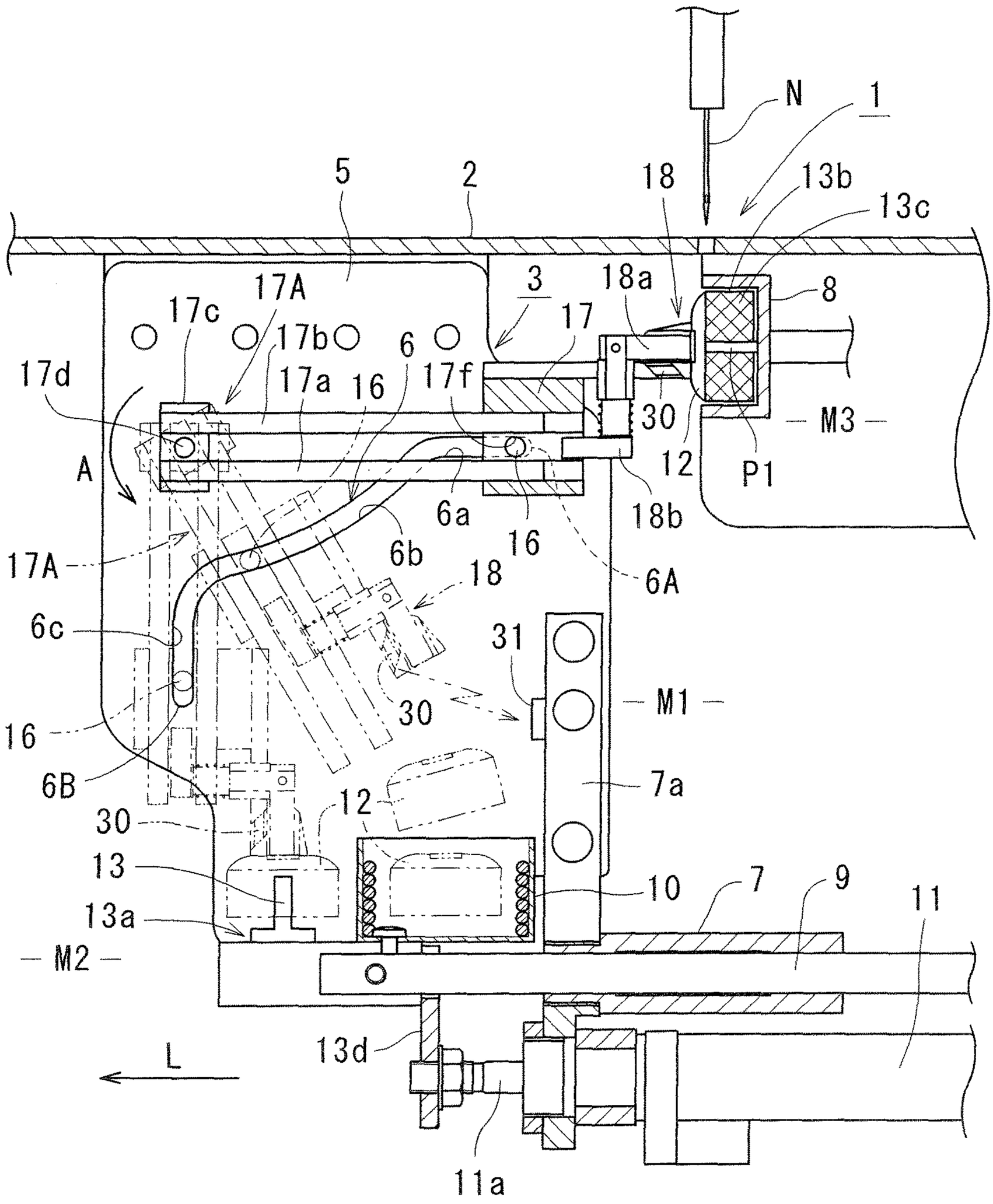
26a
11

Fig. 14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30
M3
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P1
A
6a
18b
6b
16
17A
18
6A
6c
31
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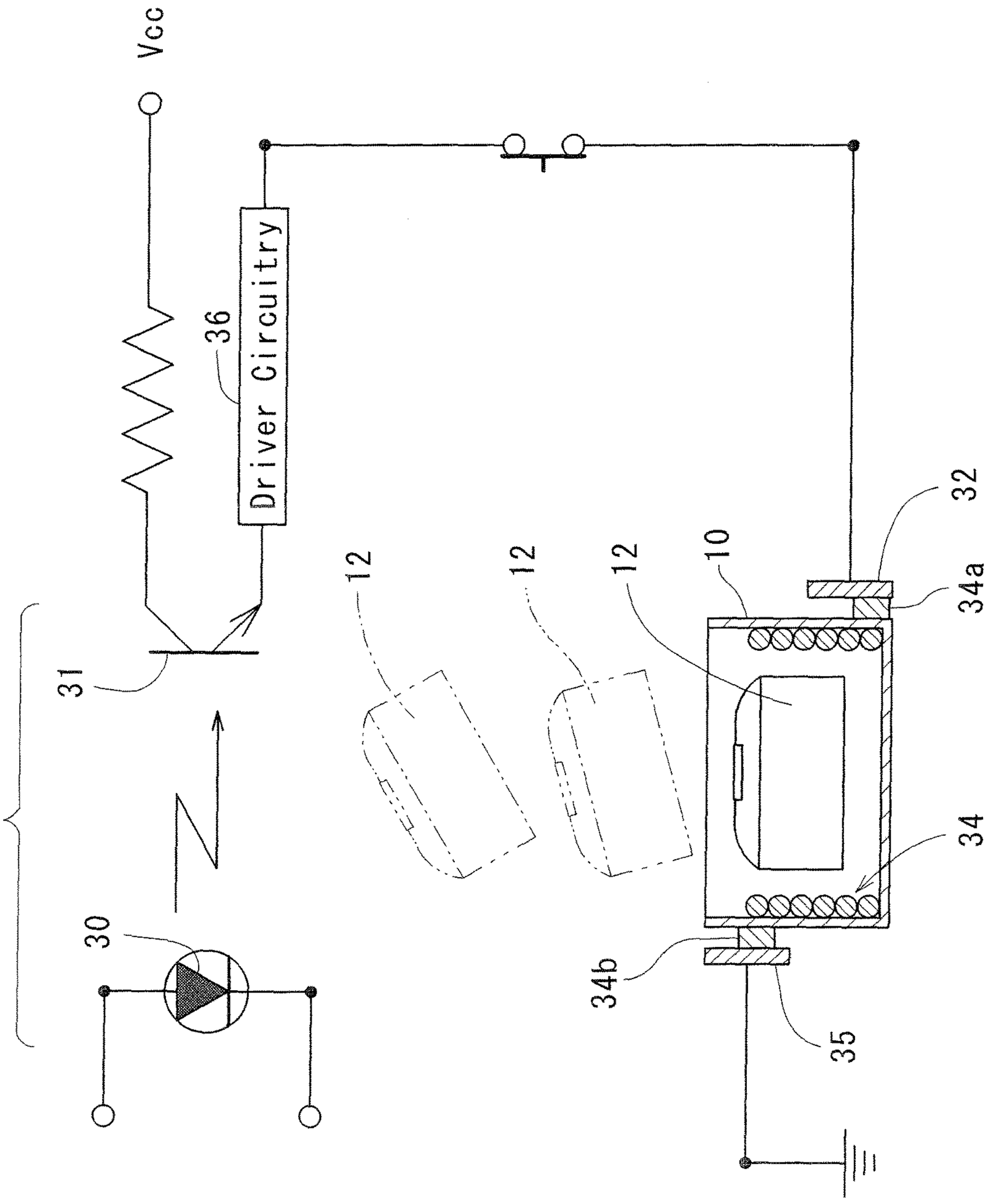
13a
M2
13d
L
11a

Fig. 15



AUTOMATED BOBBIN EXCHANGER DEVICE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an automated bobbin-exchanger device which is capable of automatically exchanging a bobbin case when an under thread is entirely released from a bobbin and consumed in accompany with a stitching operation of a sewing machine.

Description of Related Art

In an industrial sewing machine, a bobbin case attached to a rotary hook accommodates a bobbin around which an under thread is wound. During a stitching operation of a sewing machine, clothes, fabrics or leather products are sewn up with the under thread and the upper thread in turn released from the bobbin and supplied from a sewing needle. The bobbin accommodates the under thread, an amount of which is extremely small compared to that of the upper thread. Each time when the under thread is consumed, it becomes often necessary to take the bobbin case off from the rotary hook and exchange the bobbin with a new one full of under thread. Especially in an embroidery machine, there usually remains a limited space under the rotary hook. For this reason, a sewing operator often find it difficult to reach his or her hand for the rotary hook, thereby taking an extended time period to exchange the bobbin case so as to resultantly reduce a sewing efficiency. Efforts have been exerted to develop automated bobbin exchangers as represented by Japanese Laid-open Patent Application Nos. 8-196766, 8-280972 and 9-066181 (referred merely to as references hereinafter).

The bobbin exchangers that the above references have disclosed, have cammed grooves to guide the bobbin case between the rotary hook and a bobbin holder. The cammed grooves, however, are structurally complicated, thereby rendering the bobbin case to travel an extended distance. An air-cylinder provided to move a chuck along the cammed grooves, has to be located slantwise due to the complicated structure of the cammed grooves. This makes unavoidably to lengthen the horizontal and vertical distance so as to require an additional space.

On the contrary, there is only a limited space under the sewing table, especially under the rotary hook, thereby remaining a room to amelioration in making the bobbin exchanger into a compact and space-saving structure.

Therefore, the present invention has been made with the above drawbacks in mind, it is a main object of the invention to provide an automated bobbin exchanger device which is capable of minimizing a transfer distance that a bobbin case travels, thus enabling users to exchange the bobbin case quickly with a simplified structure, and resultantly making the bobbin exchanger into a compact and space-saving structure.

SUMMARY OF THE INVENTION

According to the present invention, there is provided an automated bobbin exchanger device in which a bobbin holder has a holder pin. To the holder pin, a single bobbin case is detachably secured which is made of a magnetic material. The bobbin holder is placed under a rotary hook in which a hook pin is provided. A vertical transfer base is placed to depend from a sewing table. A guide groove is provided as a cammed groove piercingly on the vertical transfer base. The guide groove has a horizontal portion, a vertical portion and an arcuate portion, the latter of which is in communication with a passage (interface) between the horizontal portion and the vertical portion.

A chuck-drive lever is pivotably provided by a pivot pin under the guide groove, and a leading end of the chuck-drive lever has a forked portion in which a chuck pin is slidably provided. The chuck pin passes through the guide groove, and the chuck-drive lever is arranged to pivotably rotate around the pivot pin so as to move the chuck pin reciprocally along the guide groove. A bobbin chuck is connected to the chuck pin and provided to detachably hold the bobbin case placed within the bobbin holder.

A chuck driver is placed to pivotably move the chuck-drive lever reciprocally around the pivot pin between a standby position, an exchangeable position and a middle position. The standby position places the chuck pin slidably within the vertical portion in which the bobbin chuck takes the bobbin case off from the bobbin holder. The exchangeable position places the chuck pin slidably within the horizontal portion to secure the bobbin case to the rotary hook. The middle position places the chuck pin slidably between the standby position and the exchangeable position.

A catch box is placed to correspond to the middle position, to which the chuck-drive lever pivotably moves. A chuck controller is provided to pivotably move the bobbin chuck from the middle position to the exchangeable position through the horizontal portion so as to take the bobbin case off from the rotary hook. Then, the bobbin chuck pivotably moves back to the middle position with the bobbin case attached, and detaching the bobbin case therefrom at the middle position to let the bobbin case fall into the catch box. Thereafter, the bobbin chuck pivotably moves further to the standby position through the vertical portion to take the bobbin case off from the bobbin holder and still further pivotably moving back to the exchangeable position through the arcuate portion and the horizontal portion so as to secure the bobbin case to the rotary hook before returning to the middle position through the horizontal portion.

A coiled body is secured to an inner wall of the catch box and energized when the bobbin chuck detaches the bobbin case at the middle position so as to attract the bobbin case toward the catch box by means of an electromagnetic force established when the coiled body is energized. A transfer air-cylinder is mounted on the vertical transfer base to move the catch box outside across the vertical transfer base along the crosswise direction after the bobbin chuck let the bobbin case fall into the catch box.

With the guide groove having the horizontal portion, the vertical portion and the arcuate portion, through which the bobbin chuck pivotably moves, it is possible to minimize a transfer distance that a bobbin case travels, thereby enabling users to exchange the bobbin quickly.

Additionally, it is possible to place the bobbin holder, the chuck-drive lever, the catch box, the chuck driver and the transfer air-cylinder circumferentially around the vertical transfer base. This makes it possible to simplify a whole structure, so as to resultantly make the bobbin exchanger into a compact and space-saving structure.

Regarding the bobbin accommodated by the bobbin case which the bobbin chuck detaches to let it fall into the catch box, the bobbin is replaced with a new one full of the under thread, and detachably secured to the holder pin of the bobbin holder. This needs to place the bobbin case at two sections, i.e., the holder pin and the rotary hook. Namely, this structure requires only two bobbin cases, thus making easy the check and maintenance that the expensive bobbin cases need.

When the bobbin chuck pivotably moves to the middle position from the exchangeable position so as to release the bobbin case toward the catch box, the coil body is energized to establish the electromagnetic force. Because the bobbin case is made of the magnetic material, the electromagnetic force exerts the bobbin case to attract the bobbin case to let it fall into the catch box without let and hindrance.

With the transfer air-cylinder actuating the catch box to move the bobbin case outside the sewing table, it is possible for the users to easily reach their hand for the bobbin case, so that the users can take the bobbin case from the catch box so as to replace the bobbin with a new one full of under thread.

According to other aspect of the present invention, the bobbin case has an elastic lock lever movably provided by means of a chuck air-cylinder. The bobbin chuck has a chuck pawl removably engaged with the lock lever to detachably hold the bobbin case.

With the chuck pawl removably engaged with the lock lever, it is possible to detachably mount the bobbin case on the bobbin chuck with a simplified structure.

According to other aspect of the present invention, the vertical transfer base secures a drive air-cylinder which has a rod movably provided to protract and retract. The drive air-cylinder is arranged to protract the rod to engage with one side of the chuck-drive lever to prevent the chuck-drive lever from inadvertently shifting toward the standby position when the bobbin chuck returns to the middle position from the exchangeable position after securing the bobbin case to the rotary hook.

With the chuck-drive lever prevented from moving pivotably toward the standby position, it is possible to lock the chuck-drive lever at the middle position to block the chuck-drive lever from inadvertently shifting toward the standby position even when the chuck-drive lever is subjected to an exterior force.

According to other aspect of the present invention, the vertical transfer base has a rod movably provided to protract and retract by means of a drive air-cylinder and the chuck-drive lever has a stopper hole. The drive air-cylinder is arranged to protract the rod to engage with the stopper hole, so as to prevent the chuck-drive lever from inadvertently shifting toward the standby position when the bobbin chuck returns to the middle position from the exchangeable position after securing the bobbin case to the rotary hook.

With the chuck-drive lever prevented from shifting pivotably toward both the standby and exchangeable positions, it is possible to lock the chuck-drive lever at the middle position even when the chuck-drive lever is subjected to an exterior force.

According to other aspect of the present invention, the chuck-drive lever has an open-ended groove in a lengthwise direction. The groove has an inner side, along which the chuck pin is slidably arranged.

With the open-ended groove provided on the chuck-drive lever, it is possible to place the chuck pin on the chuck-drive lever with a simplified structure.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred form of the present invention is illustrated in the accompanying drawings in which:

FIG. **1** is a schematic view of a sewing machine in which an automated bobbin exchanger device is provided according to a first embodiment of the invention;

FIG. **2** is a longitudinal cross sectional view of the automated bobbin exchanger device;

FIG. **3** is a plan view of the automated bobbin exchanger device looked from a reverse side of FIG. **2**;

FIGS. **4** and **5** are longitudinal cross sectional views of a position-changing lever looked from different directions;

FIG. **6** is a longitudinal cross sectional view of the automated bobbin exchanger device;

FIGS. **7** and **8** are plan views of a chuck air-cylinder depicted to explain how the chuck air-cylinder works;

FIGS. **9** and **10** are longitudinal cross sectional views of the automated bobbin exchanger device sectioned from different perspectives;

FIG. **11** is a schematic view of the automated bobbin exchanger device;

FIG. **12** is a schematic view depicted how a bobbin case pivotably moves along a guide groove in sequence;

FIG. **13** is a longitudinal cross sectional view of the automated bobbin exchanger device according to a second embodiment of the invention;

FIG. **14** is a longitudinal cross sectional view of the automated bobbin exchanger device according to a third embodiment of the invention; and

FIG. **15** is an electronic circuitry including a photo-coupler having a light emitting element and a photo element.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In the following description of the depicted embodiments, the same reference numerals are used for features of the same type.

Referring to FIGS. **1** through **12** which show an automated bobbin exchanger device and its related structures according to a first embodiment of the invention, a sewing machine **1** has a sewing head **3***a*, a sewing needle (N) and a sewing table **2** as shown in FIGS. **1** and **2**. Under the sewing table **2**, there is provided an available space **4** in which the automated bobbin exchanger device **3** is provided to have a vertical transfer base **5** depended from the sewing table **2** in perpendicular to a base plate (not shown) of the bobbin exchanger device **3**. The vertical transfer base **5** has a guide groove **6** provided as a cammed groove piercingly. The guide groove **6** has a horizontal portion **6***a*, a vertical portion **6***c* and an arcuate portion **6***b*. The arcuate portion **6***b* is gradually curved to be in communication with a passage (interface) between the horizontal portion **6***a* and the vertical portion **6***c*.

The horizontal portion **6***a* is arranged to be somewhat longer than a drawing length of a hook pin P**1**, to which a rotary hook **8** is secured. The vertical portion **6***c* is determined to be slightly longer than a drawing length of a holder pin **13** which is to be described in detail hereinafter. A bobbin case **12** which accommodates a bobbin **13***b* is made of a magnetic material, and arranged to be detachably or removably received by the hook pin P**1** of the rotary hook **8**.

An angle at the circumference is determined to be 90±5 degrees between an opened end **6**A of the horizontal portion **6***a* and an opened end **6**C of the vertical portion **6***c*. At a lower end of the vertical transfer base **5**, as shown in FIG. **2**, a guide holder **7** is horizontally provided under the rotary hook **8** by means of a vertical fixing tool **7***a*.

An elongate guide bar **9** is slidably arranged on the guide holder **7** so as to reciprocally move in an axial direction. The guide bar **9** has a distal end on which a catch box **10** is located to correspond to a middle position M**1** so as to receive the bobbin case **12** detached by a bobbin chuck **18** as described in detail hereinafter.

Immediately under the guide holder **7**, a transfer air-cylinder **11** is provided by means of the vertical fixing tool **7***a*. The transfer air-cylinder **11** has a rod **11***a* connected to the guide bar **9** through a connector block **13***d* (refer to FIG. **9**). Upon driving the transfer air-cylinder **11**, the rod **11***a* is protracted to carry the catch box **10** outside across the vertical transfer base **5** along a crosswise direction L. This makes it possible for users to easily reach their hand for the bobbin case **12** and take off the bobbin **13***b* from the bobbin case **12** so as to replace the bobbin **13***b* with a new one full of an under thread **13***c*.

As shown in FIG. **9**, a bobbin holder **13***a* is provided by means of the connector block **13***d* to correspond to a standby position M**2** under the vertical transfer base **5**. The bobbin holder **13***a* has a holder pin **13**, to which the single bobbin case **12** is detachably secured. The bobbin holder **13***a* is located under the rotary hook **8**, to which the hook pin (P**1**) is secured. The bobbin case **12** is detachably accommodates the bobbin **13***b* in which the under thread **13***c* is provided. The bobbin case **12** is arranged to be temporarily taken out from the catch box **10** so as to replenish the under thread **13***c* with the bobbin **13***b*.

As shown in FIG. **3**, a chuck-drive lever **14** is pivotably provided around a pivot pin **15** under the guide groove **6** and adapted to be driven together with a bobbin chuck **18** by means of a chuck-drive air-cylinder **26** (chuck driver). On a basal end of the chuck-drive lever **14**, integrally provided is a driver arm **14***c*, to which the chuck-drive air-cylinder **26** connects the rod **26***a* by means of a connector pin **29**. A leading end of the chuck-drive lever **14** forms a forked portion **14***a* in which a chuck pin **16** slidably provided to be sandwiched between forked pieces of the forked portion **14***a*. Namely, the leading end of the chuck-drive lever **14** has an elongate notch **14***b* as an open-ended groove to form the forked portion **14***a* in a U-shaped configuration. The chuck pin **16** is connectedly placed to reciprocally slide along an inner side of the elongate notch **14***b* in a lengthwise direction.

The forked portion **14***a* works as an allowance for the chuck pin **16** during which the chuck pin **16** pivotably moves from the horizontal portion **6***a* to the arcuate portion **6***b* and vice versa. Namely, upon moving the chuck pin **16** pivotably to the arcuate portion **6***b*, the forked portion **14***a* allows redundant shift of the chuck pin **16**, i.e., a diametrical difference between the horizontal portion **6***a* and the arcuate portion **6***b*. This also makes it possible to smoothly move the chuck pin **16** from the arcuate portion **6***b* to the vertical portion **6***c* and vice versa.

The chuck pin **16** has an end portion opposite to the chuck-drive lever **14** as shown in FIG. **2**. To the end portion of the chuck pin **16**, the bobbin chuck **18** is connected by way of a mount base **17**. As also shown in FIGS. **4** and **5**, the bobbin chuck **18** has a bobbin head **18***a* placed to correspond to the rotary hook **8**, and further having a leg portion **18***b* fixedly connected to the mount base **17**.

Through the mount base **17**, parallel pins **17***a*, **17***b* are slidably pierced to constitute a position-changing lever **17**A which makes the mount base **17** reciprocally slide along the parallel pins **17***a*, **17***b* in an axial direction.

Each of the parallel pins **17***a*, **17***b* has one end rotationally connected to a support pin **17***d* via a fixing plate **17***c*, and having other end fixedly connected to the bobbin chuck **18** via the mount base **17**. This makes it possible to pivotably rotate the parallel pins **17***a*, **17***b* around the support pin **17***d* because the support pin **17***d* permits the parallel pins **17***a*, **17***b* to move in the right-to-left and up-to-down directions. The bobbin chuck **18** allows the bobbin head **18***a* to move together with the fixing plate **17***c* reciprocally along the parallel pins **17***a*, **17***b* in the axial direction. The mount base **17** has an insert hole **17***f* which permits an entry of the chuck pin **16**.

As shown in FIGS. **6-8**, the bobbin chuck **18** has a chuck pawl **20** removably engaged with an elastic lock lever **21** to detachably hold or retain the bobbin case **12** when a chuck air-cylinder **19** is actuated. Namely, upon actuating the chuck air-cylinder **19**, the chuck air-cylinder **19** advances the rod **19***a* to rotate the chuck pawl **20** around an axis pin **20***a* in the clockwise direction as shown in FIGS. **6** and **7**.

Because the bobbin case **12** allows the elastic lock lever **21** to rise and lie down around a pivot neck, the lock lever **21** is brought into engagement with the chuck pawl **20** to rise it up, so that the lock lever **21** abuts against a halfway wall **18***e* of the bobbin head **18***a* when the chuck pawl **20** rotates in the clockwise direction.

This makes it possible to accurately determine a connecting position in which the bobbin head **18***a* is normally connected to the bobbin case **12**.

Such is the structure that it becomes possible to prevent the connecting position from being shifted when subjected to an exterior force upon pivotably moving the bobbin case **12**.

Upon connecting the bobbin head **18***a* to the bobbin case **12**, if any variation or fluctuation would occur even slightly, it would hinder the bobbin case **12** from maintaining a transfer precision against the rotary hook **8**. The transfer precision has a tolerance within ±0.1 mm.

In order to maintain the transfer precision, playing an important role are the bobbin head **18***a*, the lock lever **21** and the halfway wall **18***e*.

When the chuck air-cylinder **19** retracts the rod **19***a* as shown in FIG. **8**, the lock lever **21** rotates the chuck pawl **20** due to the elastic force around the axis pin **20***a* in the counterclockwise direction so as to return to the original position. This permits the lock lever **21** to disengage from the bobbin head **18***a* so as to detach the bobbin chuck **18** from the bobbin case **12**. Because the bobbin chuck **18** has the chuck pawl **20** which detachably engaged with the bobbin case **12**, it is possible to removably secure the bobbin case **12** against the bobbin chuck **18** with a simplified structure.

To a lower end of the vertical transfer base **5**, the chuck-drive air-cylinder **26** is horizontally provided as a chuck driver by means of a bracket **27** as shown in FIG. **3**. The chuck-drive air-cylinder **26** has a rod **26***a* pivotably connected to the driver arm **14***c* of the chuck-drive lever **14** by way of the connector pin **29**. The chuck-drive lever **14** is arranged to be normally located at the middle position M**1** as shown at phantom line in FIG. **2**. To the vertical transfer base **5**, a drive air-cylinder **5***n* is secured by way of a securement arm **5***f* as shown in FIG. **3** (also see FIG. **10**).

When the bobbin chuck **18** secures the bobbin case **12** to the rotary hook **8** at the exchangeable position M**3** and return to the middle position M**1**, the drive air-cylinder **5***n* protracts the rod **5***m* to engage with one side of the chuck-drive lever **14** via a cushion pad **14***t* at a side corresponding to the standby position M**2**. The cushion pad **14***t* is secured to a outer side of chuck-drive lever **14** to serve as a shock-absorbing material. With the rod **5***m* engaged with the chuck-drive lever **14**, it is possible to prevent the chuck-drive lever **14** from inadvertently shifting toward the standby position M**3** when subjected to an exterior force upon returning the bobbin chuck **18** to the middle position M**1** after securing the bobbin case **12** to the rotary hook **8**.

When the bobbin **13***b* consumed its thread **13***c* in accompany with prolonged operation of the sewing machine **1**, a thread sensor (not shown) works to cease the operation of the sewing machine **1**. At this time, the drive air-cylinder **5***n* retracts the rod **5***m* to disengage from the chuck-drive lever **14**. In accompany with the cease of the sewing machine **1**, a chuck control diagram (a)-(e) acts as a chuck controller to control the pivotal or rotational movement of the chuck-drive lever **14** as shown in Table 1 (also see FIGS. **11** and **12**).

TABLE 1

Chuck Control Diagram

(a) Rotational Direction

Middle Position M1⇒Exchangeable Position M3
⇩
Chuck-drive Air-cylinder 26
⇩
Actuating Rod 26a-For Predetermined Time Period
⇩
Retracting Rod 26a Rearward
(b) Rotational Direction

Exchangeable Position M3⇒Middle Position M1
⇩
Chuck-drive Air-cylinder 26
⇩
Actuating Rod 26a For Predetermined Time Period
⇩
Protracting Rod 26a forward
(c) Rotational Direction

Middle Position M1⇒Standby Position M2
⇩
Chuck-drive Air-cylinder 26
⇩
Actuating Rod 26a For Predetermined Time Period
⇩
Protracting Rod 26a forward
(d) Rotational Direction

Standby Position M2⇒Exchangeable Position M3
⇩
Chuck-drive Air-cylinder 26
⇩
Actuating Rod 26a For Predetermined Time Period
⇩
Retracting Rod 26a Rearward
(e) Rotational Direction

Exchangeable Position M3⇒Middle Position M1
⇩
Chuck-drive Air-cylinder 26
⇩
Actuating Rod 26a For Predetermined Time Period
⇩
Protracting Rod 26a forward

With the actuation of the position-changing lever **17**A, the actuation pivotably moves the bobbin chuck **18** to the exchangeable position M**3** from the middle position M**1**. After taking the bobbin case **12** off from the rotary hook **8**, the bobbin chuck **18** returns to the middle position M**1** to let the bobbin case **12** fall into the catch box **10**. After letting the bobbin case **12** fall, the bobbin chuck **18** pivotably moves back to the standby position M**2** to take a new bobbin case **12** off from the holder pin **13** of the bobbin holder **13***a*. After taking the bobbin case **12** as the new one full of the under thread **13***c*, the bobbin chuck **18** pivotably moves to the exchangeable position M**3** from the standby position M**2**.

At the exchangeable position M**3**, the bobbin chuck **18** secures the bobbin case **12** detachably to the hook pin P**1** of the rotary hook **8**. After securing the bobbin case **12** to the rotary hook **8**, the bobbin chuck **18** returns to the middle position M**1** from the exchangeable position M**3**.

Referring to the chuck control diagram (a)-(e) and FIGS. **11**, **12**, the rotational or pivotal movement of the bobbin chuck **18** (middle position M**1**⇒ exchangeable position M**3** ⇒ middle position M**1**⇒ standby position M**2**⇒ exchangeable position M**3**⇒ middle position M**1**) is described in detail as follows.

Upon ceasing the operation of the sewing machine **1** by means of the thread sensor, the chuck-drive air-cylinder **26** is actuated to retract the rod **26***a* so as to rotate the chuck-drive lever **14** around the pivot pin **15** in the direction of arrow A in FIG. **2**. This makes the chuck pin **16** slide from the arcuate portion **6***b* to the horizontal portion **6***a* so as to pivotably move the chuck-drive lever **14** to the exchangeable position M**3** as shown at solid line in FIG. **2**.

At the exchangeable position M**3**, the position-changing lever **17**A moves fully around the support pin **17***d* in the counterclockwise direction. In accompany with the chuck pin **16** slid from the arcuate portion **6***b* to the horizontal portion **6***a*, the bobbin chuck **18** engages the bobbin head **18***a* with a head of the bobbin case **12**.

In this situation, the chuck air-cylinder **19** is actuated to pivotably move the chuck pawl **20** around the axis pin **20***a* in the clockwise direction as shown in FIGS. **6-8**. This makes the chuck pawl **20** engage with the lock lever **21** to rotationally rise up the lock lever **21**, so that the lock lever **21** abuts against the halfway wall **18***e* of the bobbin head **18***a* so as to detachably connect the bobbin chuck **18** to the bobbin case **12**.

Thereafter, the chuck-drive air-cylinder **26** is actuated to protract the rod **26***a* so as to rotate the chuck-drive lever **14** around the pivot pin **15** in the direction opposite to the arrow A in FIG. **2**. This makes the chuck pin **16** slide from the horizontal portion **6***a* to the arcuate portion **6***b* so as to pivotably move the chuck-drive lever **14** to the middle position M**1** as shown at the phantom line in FIG. **2**.

During the process in which the chuck pin **16** slides along the horizontal portion **6***a*, the bobbin case **12** moves away from the hook pin P**1** of the rotary hook **8**, so that the bobbin chuck **18** reaches the arcuate portion **6***b* with the bobbin case **12** attached.

At this time, the chuck air-cylinder **19** is actuated to retract the rod **19***a*, so that the lock lever **21** rotationally turns by its elastic force to makes the chuck pawl **20** pivot in the counterclockwise direction to set the bobbin case **12** free. This makes the lock lever **21** disengage from the bobbin head **18***a*, so that the bobbin chuck **18** detaches the bobbin case **12** and releases the bobbin case **12**. This means that the bobbin chuck **18** detaches the bobbin case **12** to let the bobbin case **12** fall into the catch box **10**.

With the chuck-drive air-cylinder **26** further protracting the rod **26***a*, the chuck-drive lever **14** pivotably moves to the standby position M**2** from the middle position M**1** as shown by dot-dash lines in FIG. **3**. In accompany with the movement of the chuck-drive lever **14**, the chuck pin **16** slides from the arcuate portion **6***b* to the vertical portion **6***c*, so that the position-changing lever **17**A pivotably moves around the support pin **17***d* in the clockwise direction so as to arrive at the standby position M**2**.

In this situation, the bobbin chuck **18** engages the bobbin head **18***a* with the head of the bobbin case **12** accommodated by the bobbin holder **13***a*. This actuates the chuck air-cylinder **19** to rotate the chuck pawl **20** around the axis pin **20***a* in the clockwise direction, so that the bobbin chuck **18** connects the bobbin case **12** in the same manner as mentioned above.

When the bobbin chuck **18** connects the bobbin case **12**, the chuck-drive air-cylinder **26** further retracts the rod **26***a*, so that the chuck-drive lever **14** pivotably moves around the pivot pin **15** in the direction as shown by the arrow A in FIG. **2**. In accompany with the pivotal movement of the chuck-drive lever **14**, the chuck pin **16** slides to the horizontal portion **6***a* from the vertical portion **6***c* through the arcuate portion **6***b*. This makes the position changing lever **17**A rotate to the exchangeable position M**3** from the standby position M**2** through the middle position M**1** with the bobbin case **12** attached. At the exchangeable position M**3**, the bobbin case **12** moves to the hook pin P**1** and detachably secured by the rotary hook **8**. This makes it possible automatically to replace the bobbin case **12** held by the rotary hook **8** with the new one accommodated by the bobbin holder **13***a*.

Thereafter, the chuck air-cylinder **19** is actuated to retract the rod **19***a*, so that the lock lever **21** lies down on the bobbin case **12** by the elastic force so as to rotate the chuck pawl **20** in the counterclockwise direction. This detaches the bobbin case **12** and releases it from the bobbin chuck **18** to set the bobbin case **12** free.

After detaching the bobbin case **12**, the chuck-drive air-cylinder **26** advances the rod **26***a*, so that the chuck-drive lever **14** pivotably moves around the pivot pin **25** in the direction opposite to the arrow A in FIG. **2**. This makes the bobbin chuck **18** move away from the bobbin case **12** secured by the rotary hook **8**. In combination with the movement of the bobbin chuck **18**, the position-changing lever **17**A returns to the middle position M**1** from the exchangeable position M**3**, so that the bobbin chuck **18** is located to corresponds to the catch box **10**. At this moment, the drive air-cylinder **5***n* is actuated to protract the rod **5***m*, so that the rod **5***m* is brought into engagement with the chuck-drive lever **14** through the cushion pad **14***t*, thereby preventing the chuck-drive lever from inadvertently shifting toward the standby position M**2**.

At the exchangeable position M**3** in which the bobbin case **12** is secured detachably to the rotary hook **8**, a thread-exchange sensor (not shown) works to resume the operation of the sewing machine **1**.

When the bobbin chuck **18** detaches the bobbin case **12** to let it into the catch box **10**, a proximity sensor (not shown) detects the bobbin case **12** fallen into the catch box **10** to actuate the transfer air-cylinder **11**. Then, the transfer air-cylinder **11** extends its elongate rod **11***a* to move the guide bar **9** from the middle position M**1** along the guide holder **7** in the lengthwise direction. This carries the catch box **10** to move across the vertical transfer base **4** outside along the crosswise direction L, for which the users can easily reach their hand. It is to be noted that the transfer air-cylinder **11** may be actuated before or after the sewing machine **1** resumes its operation, instead of the time when the bobbin chuck **18** lets the bobbin case **12** fall into the catch box **10**.

When the catch box **10** is carried outside, the bobbin case **12** is taken out of the catch box **10** to replenish the bobbin **13***b* with the under thread **13***c*, which means to replace the bobbin **13***b* with the new one full of the under thread **13***c*. The bobbin case **12** which accommodates the newly replaced bobbin **13***b*, is secured to the bobbin holder **13***a* by inserting it into the holder pin **13**. Then, the transfer air-cylinder **11** protracts the rod **11***a* to move back the guide bar **9** along the guide holder **7** in the lengthwise direction so as to return to the middle position M**1**.

With the structure thus described, the guide groove **6** has the horizontal portion **6***a*, the vertical portion **6***b* and the arcuate portion **6***c*, through which the bobbin chuck **18** pivotably moves by means of the chuck pin **16**, it is possible to minimize a transfer distance that a bobbin case **12** travels, thus enabling the users to exchange the bobbin **13***b* quickly.

Additionally, it is possible place the bobbin holder **13***a*, the chuck-drive lever **14**, the catch box **10**, the chuck-drive air-cylinder **26** and the transfer air-cylinder **11** circumferentially around the vertical transfer base **5**. This makes it possible to simplify a whole structure, so as to resultantly make the bobbin exchanger into a compact and space-saving structure.

Regarding the bobbin **13***b* accommodated by the bobbin case **12** which the bobbin chuck detaches to let it fall into the catch box **10**, the bobbin **13***b* is replaced with a new one full of the under thread **13***c*, and detachably secured to the holder pin **13** of the bobbin holder **13***a*. This needs to place the bobbin case **12** at two sections, i.e., the holder pin **13** and the rotary hook **8**. Namely, this structure requires only two bobbin cases, thus making easy the check and maintenance that the expensive bobbin cases **12** need.

FIG. **13** shows a second embodiment of the invention in which the chuck-drive lever **14** has a stopper hole **14***h*, a location of which corresponds to the rod **5***m* of the drive air-cylinder **5***n*.

When the bobbin chuck **18** pivotably returns to the middle position M**1** from the exchangeable position M**3** after securing the bobbin case **12** to the rotary hook **8**, a position-detecting sensor (not shown) works to actuate the drive air-cylinder **5***n* to protract the rod **5***m* to engage with the stopper hole **14***h*. This prevents the chuck-drive lever **14** from inadvertently shifting toward both the standby and exchangeable positions M**2**, M**3**.

FIGS. **14** and **15** show a third embodiment of the invention in which a light emitting element **30** is secured to the bobbin head **18***a*, and a photo element **31** is mounted on a first sliding plate **32** extended from the vertical fixing tool **7***a*.

The light emitting element **30** and the photo element **31** constitute a photo-coupler **33**, and the light rays from the light emitting element **30** is usually shielded by the bobbin case **12** to prevent the light rays from reaching the photo element **31**. At the time when the bobbin chuck **18** takes the bobbin case **12** off from the rotary hook **8**, and moves back to the middle position M**1** to release the bobbin case **12** toward the catch box **10**, the light rays from the light emitting element **30** are adapted to reach the photo element **31**.

To an inner wall of the catch box **10**, a coiled body **34** is secured in contact with the catch box **10** as shown in FIG. **15**. It is to be noted that the coiled body **34** may be secured to an outer surface of the catch box **10**.

One end of the coiled body **34** has a positive terminal **34***a* extended outside to be in slidable contact with the first sliding plate **32**. The other end of the coiled body **34** has a negative terminal **34***b* extended outside to be in slidable contact with a second sliding plate **35**. The second sliding plate **35** is mounted on a stationary component part (not shown).

The negative terminal **34***b* is connected to the light emitting element **30** via the second sliding plate **35**, and the photo element **31** is connected to the positive terminal **34***a* via the first sliding plate **32**. As far as the layout in FIG. **14** is concerned, the first sliding plate **32** is located in a front-and-behind (obverse-and-reverse) relationship with the second sliding plate **35**.

Upon actuating the transfer air-cylinder **11** to protract the rod **11***a* in the crosswise direction L so as to carry the catch box **10** outside, the positive terminal **34***a* is arranged to

move away from the first sliding plate **32**, and the negative terminal **34***b* arranged to move away from the second sliding plate **35**.

At the time when the bobbin chuck **18** pivotably moves to the middle position M**1** from the exchangeable position M**3** so as to release the bobbin case **12** toward the catch box **10**, the light shield is cleared so that the light rays from the light emitting element **30** reaches the photo element **31**. For this reason, the photo-coupler **33** is energized via a driver circuitry **36** to draw an electric current through the coiled body **34**. This enables the coiled body **34** to establish an electromagnetic force exerting against the bobbin case **12**. The electromagnetic force attracts the bobbin case **12** to guide it into the catch box **10** at the middle position M**1** without let and hindrance.

It is to be appreciated that the words related to "pivotably move", "rotate", "return", "pivotably rotate" and "move back" described herein are considered to be categorically identical in the contextual sense.

While several illustrative embodiments of the invention have been shown and described, numerous variations and alternate embodiments will occur to those skilled in the art. Such variations and alternate embodiments are contemplated, and can be made without departing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. An automated bobbin-exchanger device comprising:

a bobbin holder having a holder pin, to which a single bobbin case is detachably secured, said bobbin case being made of a magnetic material and said bobbin holder being placed under a rotary hook in which a hook pin is provided;

a vertical transfer base placed to depend from a sewing table;

a guide groove provided as a cammed groove piercingly on said vertical transfer base, said guide groove having a horizontal portion, a vertical portion and an arcuate portion, said arcuate portion being in communication with an interface between said horizontal portion and said vertical portion;

a chuck-drive lever pivotably provided by a pivot pin under said guide groove, a leading end of said chuck-drive lever having a forked portion in which a chuck pin is slidably provided, said chuck pin passing through said guide groove, said chuck-drive lever being arranged to pivotably rotate around said pivot pin to move said chuck pin reciprocally along said guide groove;

a bobbin chuck connected to said chuck pin and provided to detachably hold said bobbin case placed within said bobbin holder;

a chuck driver placed to pivotably move said chuck-drive lever reciprocally around said pivot pin between a standby position, an exchangeable position and a middle position, said standby position placing said chuck pin slidably within said vertical portion in which said bobbin chuck takes said bobbin case off from said bobbin holder, said exchangeable position placing said chuck pin slidably within said horizontal portion to secure said bobbin case to said rotary hook, said middle position placing said chuck pin slidably between said standby position and said exchangeable position;

a catch box placed to correspond to said middle position, to which said chuck-drive lever pivotably moves;

a chuck controller provided to pivotably move said bobbin chuck from said middle position to said exchangeable position through said horizontal portion so as to take said bobbin case off from said rotary hook, and pivotably moving back to said middle position with said bobbin case attached, and detaching said bobbin case therefrom at said middle position to let said bobbin case fall into said catch box, and thereafter pivotably moving said bobbin chuck further to said standby position through said vertical portion to take said bobbin case off from said bobbin holder and still further pivotably moving back to said exchangeable position through said arcuate portion and said horizontal portion so as to secure said bobbin case to said rotary hook before returning to said middle position through said horizontal portion;

a coiled body secured to an inner wall of said catch box and energized when said bobbin chuck detaches said bobbin case at said middle position so as to attract said bobbin case toward said catch box by means of an electromagnetic force established when said coiled body is energized; and

a transfer air-cylinder mounted on said vertical transfer base to move said catch box outside across said vertical transfer base after said bobbin chuck let said bobbin case fall into said catch box.

2. An automated bobbin-exchanger device according to claim **1**, wherein said bobbin case has an elastic lock lever movably provided by means of a chuck air-cylinder and said bobbin chuck having a chuck pawl removably engaged with said lock lever to detachably hold said bobbin case.

3. An automated bobbin-exchanger device according to claim **1**, wherein said vertical transfer base has a rod movably provided to protract and retract by means of a drive air-cylinder, said drive air-cylinder protracting said rod to engage with one side of said chuck-drive lever to prevent said chuck-drive lever from inadvertently moving pivotably toward said standby position when said bobbin chuck pivotably returns to said middle position from said exchangeable position after securing said bobbin case to said rotary hook.

4. An automated bobbin-exchanger device according to claim **1**, wherein said vertical transfer base secures a drive air-cylinder which has a rod movably provided to protract and retract, said chuck-drive lever having a stopper hole,

said drive air-cylinder protracting said rod to engage with said stopper hole to prevent said chuck-drive lever from inadvertently shifting pivotably toward said standby position when said bobbin chuck pivotably returns to said middle position from said exchangeable position after securing said bobbin case to said rotary hook.

5. An automated bobbin-exchanger device according to claim **1**, wherein said chuck-drive lever has an open-ended groove in a lengthwise direction, said groove having an inner side, along which said chuck pin is slidably arranged.

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