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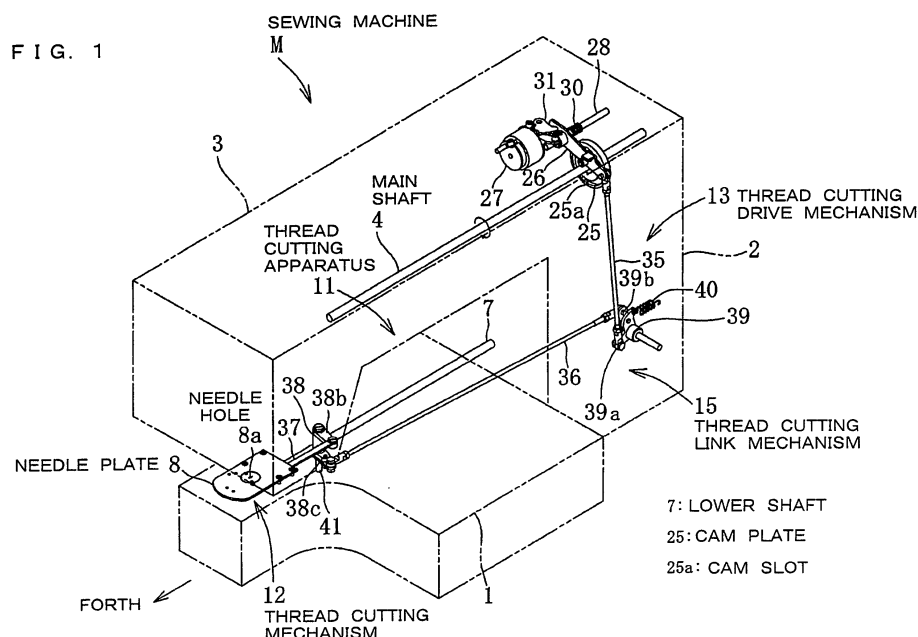
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(54) **Thread cutting apparatus for sewing machine**

(57) A thread cutting apparatus for a sewing machine according to the present invention is arranged in which a spindle for supporting a movable knife beneath a needle plate is located closer to the location of an upper thread loop than the location of a needle hole provided in the needle plate. The apical portion of the movable knife faces the loop opening of the upper thread loop frontwardly

of the location of the needle hole. The apical portion of the movable knife that oscillates forward and backward around the spindle enters the loop opening of the upper thread loop from a direction perpendicular to the loop opening. Even when the upper thread loop is interrupted in the shape by the development of a hitch stitch, the movable knife can certainly catch the upper thread loop and cut the threads in combination with a stationary knife.



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a thread cutting apparatus installed in a sewing machine equipped with a looper and, in particular, to a thread cutting apparatus that comprises a thread cutting mechanism which cuts an upper thread and a lower thread by a stationary knife and a movable knife and a thread cutting drive mechanism which drives the thread cutting mechanism.

2. Description of Related Art

[0002] A sewing machine is known to have a thread cutting apparatus which has a movable knife and a stationary knife and is disposed between a needle plate and a looper located under the needle plate. The movable knife is moved by driving force of a main shaft of the sewing machine at end of a sewing action. As the movable knife is moved, it catches an upper thread and a lower thread which extend from a workpiece fabric and then cuts them in combination with the stationary knife.

[0003] For example, a sewing machine disclosed in Japanese Patent Laid-Open Publication No. 58-4596 includes a thread cutting apparatus of a linear moving type which moves forward and backward along a linear guide rail(s). The thread cutting apparatus has a thread catching section (corresponding to the movable knife). The guide rail is located on undersurface of a shield plate provided at left side of a needle plate. The thread catching section is connected by a ball joint to one end of a two-arm lever. The other end of the two-arm lever is connected by a ball joint to a tip of a draw bar. The draw bar is an electromagnet.

[0004] The electromagnet is activated by a command released from a controller of the sewing machine at end of sewing action. When the electromagnet is activated, the draw bar pulls the other end of the two-arm lever. The two-arm lever is oscillated by the pulling action of the draw bar so that the thread catching section connected to the one end of the two-arm lever linearly moves forwardly from a start position at left to an end position at right of the guide rail. When a tip of the thread catching section passes a location where a needle is lifted down, it enters a loop formed by needle carrying thread (upper thread) which has been enlarged by tip of a rotating looper.

[0005] When the electromagnet is inactivated, the draw bar restores by a spring force of a return spring. The restoring movement of the draw bar causes the thread catching section to move backward from the end position to the start position. When the thread catching section moves backward, it catches, inside of V-shaped recess provided at the middle therein, the loop of the upper thread and a looper thread (lower thread).

[0006] The thread catching section presses the upper thread and lower thread caught in the recess against the stationary knife for cutting off at end of the backward movement.

SUMMARY OF THE INVENTION

[0007] Such a conventional thread cutting apparatus is provided a converting mechanism in a complicated construction to convert the linear pulling action of the draw bar into the non-linear oscillating movement of the two-arm lever and then converting from the non-linear oscillating movement of the two-arm lever into the linear movement of the thread catching section. Accordingly, a problem of the conventional thread cutting apparatus lies in enlargement of the apparatus size and following requirement of high cost.

[0008] The thread catching section of the conventional thread cutting apparatus linearly moves from the start position to the end position. The tip of the thread catching section enters the loop of the upper thread when passing the location where a needle is lifted down. The upper thread passes from an eye hole of the needle and the loop of the upper thread is created through expanding the upper thread by a point portion of the rotating looper. The upper thread loop has an opening and a direction of the opening is changed by rotation of the point portion. At the moment when the point portion catches the upper thread, the opening is directed perpendicular to moving direction of the thread catching section. Then, as the point portion rotates further, the direction of the opening is changed and the opening is directed obliquely to the moving direction of the thread catching section. Therefore, a disadvantage of the conventional thread cutting apparatus lies in the fact that the tip of the thread catching section could fail to enter the opening of the upper thread loop and thus it is difficult to ensure cutting the threads.

[0009] A direction of the lower thread passing from the looper to the location where the needle is lifted down may differ, depending on a feeding direction the workpiece fabric, from a direction of the upper thread passing from the eye hole of the needle to the needle. In such a case, the twisted upper thread makes a stitch with the lower thread, and then it will cause a so-called "hitch stitch". When the hitch stitch is generated, the upper thread caught by the point portion of the looper remains twisted. Therefore, a shape of the upper thread loop is collapsed, and an area where the tip of the thread catching section can enter becomes narrow. Then, the tip of the thread catching section more likely fail to enter the opening of the upper thread loop.

[0010] An object of the present invention is to allow the movable knife to certainly catch both the upper and lower threads, and to ensure cutting off the caught upper and lower threads, even when the direction of the opening of the upper thread loop is changed by the rotating movement of the point portion of the looper after the hitched stitch is developed.

[0011] A thread cutting apparatus according to a first aspect of the invention is a thread cutting apparatus for a sewing machine to cut upper thread and lower thread according to a first aspect of the invention, having a movable knife which is supported under a needle plate by a spindle extending vertical to the needle plate and arranged to oscillate forward and backward, and a thread cutting drive mechanism which drives the movable knife to interlock upward and downward movement of a sewing needle derived from rotation of a main shaft provided to the machine and rotating movement of a looper, the thread cutting drive mechanism driving the movable knife to oscillate forward so that an apical portion of the movable knife catches, under a needle hole provided in the needle plate, an upper thread loop formed by a point portion of the looper, the thread cutting drive mechanism driving the movable knife to oscillate backward so that both the upper thread and the lower thread are cut off by a combination of the movable knife and a stationary knife, wherein the spindle of the movable knife is located closer to a location where the upper thread loop are formed than a location of the needle hole, and the apical portion of the movable knife at a standby position before oscillating movement faces an opening of the upper thread loop and is located closer to the stationary knife than the needle hole.

[0012] The movable knife oscillates forward and backward around the spindle located at the side of the upper thread loop (at the downstream side of the direction of the rotating movement of the looper) which is one of the two, right and left, sides of the location of the needle hole. Before starting the oscillating movement, the movable knife stays at the standby position where the apical portion faces, from front side more than the needle hole, the opening of the upper thread loop formed by the point portion of the looper. When starting the oscillating movement, the apical portion of the movable knife starts to oscillate from the standby position and enters the opening of the upper thread loop from a perpendicular direction to the opening. Therefore, the apical portion of the movable knife certainly enters the opening of the upper thread loop, even when the hitch stitch is generated and the shape of the upper thread loop is collapsed. Thus, the apical portion of the movable knife certainly catches the upper thread.

[0013] A thread cutting apparatus according to a second aspect of the invention comprises the thread cutting drive mechanism that preferably comprises a first control section which temporarily stops the oscillating movement of the movable knife when the apical portion of the movable knife enters the opening of the upper thread loop.

[0014] The first control section of the thread cutting drive mechanism temporarily stops the movable knife at the moment when the apical portion enters the opening of the upper thread loop. The movable knife stopped temporarily thus permits the upper thread caught by the point portion of the looper to expand widely as passing the front side of the looper. The looper forms the upper thread

loop and certainly produces a final stitch in cooperation with the upward and downward movement of the needle.

[0015] A thread cutting apparatus according to a third aspect of the invention comprises the thread cutting drive mechanism that preferably comprises a second control section which drives the movable knife to oscillate at faster speed than that before the first control section temporarily stops the oscillating movement of the movable knife.

[0016] The second control section drives the movable knife at a higher speed after the temporal stop than before the temporal stop. Thus, the delay time for the movable knife by the temporal stop is regained. The apical portion of the movable knife oscillating at the higher speed can certainly catch the upper thread loop of which opening is entered by the movable knife before the temporal stop.

[0017] A cutting apparatus according to a fourth, fifth, and sixth aspects of the invention comprises the thread cutting drive mechanism that preferably comprises a third control section which stops the oscillating movement of the movable knife for a predetermined time if the movable knife reaches a position corresponding to a maximum oscillation amplitude of the oscillating movement.

[0018] The third control section stops the movable knife for a predetermined time after the movable knife reaches the position corresponding to a maximum oscillation amplitude of the oscillating movement. The upper thread caught by the movable knife tightly entwines itself around the movable knife by tightening action of a thread take-up during the stop for the predetermined time. Therefore, it prevents the upper thread caught by the movable knife from coming off the movable knife, even when the movable knife oscillates backward.

[0019] A thread cutting apparatus according to a seventh aspect of the invention comprises the thread cutting drive mechanism that preferably comprises: a cam plate which moves in response to the rotation of the main shaft; and a driving arm which engages at one end with a cam section provided in the cam plate and at the other end with a link mechanism connected to the movable knife; and the first control section is comprised by the cam section.

[0020] The thread cutting drive mechanism is possible to be constructed simply by a combination of the cam plate having cam sections and the driving arm. A shape-modification of the cam section can easily adjust both the speed and the timing of the oscillating movement of the movable knife.

[0021] A thread cutting apparatus according to an eighth aspect of the invention comprises the thread cutting drive mechanism that preferably comprises: a cam plate which moves in response to the rotation of the main shaft; and a driving arm which engages at one end with a cam section provided in the cam plate and at the other end with a link mechanism connected to the movable knife; and the first control section and the second control section are comprised by the cam section.

[0022] The thread cutting drive mechanism is possible

to be constructed simply by a combination of the cam plate having cam sections and the driving arm. A shape-modification of the cam section can easily adjust both the speed and the timing of the oscillating movement of the movable knife.

[0023] A thread cutting apparatus according to a ninth aspect of the invention comprises the thread cutting drive mechanism that preferably comprises: a cam plate which moves in response to the rotation of the main shaft; and a driving arm which engages at one end with a cam section provided in the cam plate and at the other end with a link mechanism connected to the movable knife; and the third control section is comprised by the cam section.

[0024] The thread cutting drive mechanism is possible to be constructed simply by a combination of the cam plate having cam sections and the driving arm. A shape-modification of the cam section can easily adjust both the speed and the timing of the oscillating movement of the movable knife. A thread cutting apparatus according to a tenth aspect of the invention comprises the thread cutting drive mechanism that preferably comprises: a cam plate which moves in response to the rotation of the main shaft; and a driving arm which engages at one end with a cam section provided in the cam plate and at the other end with a link mechanism connected to the movable knife; and the first control section and the third control section are comprised by the cam section.

[0025] The thread cutting drive mechanism is possible to be constructed simply by a combination of the cam plate having cam sections and the driving arm. A shape-modification of the cam section can easily adjust both the speed and the timing of the oscillating movement of the movable knife.

[0026] A thread cutting apparatus according to an eleventh aspect of the present invention comprises the thread cutting drive mechanism that preferably comprises: a cam plate which moves in response to the rotation of the main shaft; and a driving arm which engages at one end with a cam section provided in the cam plate and at the other end with a link mechanism connected to the movable knife; and the first control section, the second control section, and the third control section are comprised by the cam section.

[0027] The thread cutting drive mechanism is possible to be constructed simply by a combination of the cam plate having cam sections and the driving arm. A shape-modification of the cam section can easily adjust both the speed and the timing of the oscillating movement of the movable knife.

[0028] A thread cutting apparatus according to a twelfth aspect of the invention comprises the cam plate that preferably is fixedly mounted to the main shaft.

[0029] The cam plate of the thread cutting drive mechanism is fixedly mounted to the main shaft. Therefore, the oscillating movement of the movable knife generated by the rotation of the cam plate certainly synchronizes with upward and downward movement of the sewing needle derived from rotation of the main shaft and the rotating

movement of the looper.

BRIEF DESCRIPTION OF THE DRAWINGS

5 [0030]

Fig. 1 is a perspective view of a thread cutting apparatus according to the invention;

Fig. 2 is a side view of the thread cutting apparatus according to the invention;

Fig. 3 is a plan view of a machine bed of a sewing machine showing a primary part;

Fig. 4 is a bottom view of a machine bed of a sewing machine showing a primary part;

Fig. 5 is a front view of a cam plate for the thread cutting;

Fig. 6 is a timing chart explaining movements of a thread take-up, a needle bar, and a movable knife;

Fig. 7 is a plan view of a thread cutting mechanism;

Fig. 8 is a longitudinally cross sectional side view of a looper showing a primary part;

Fig. 9 is a front view of the looper;

Fig. 10 is a plan view of the looper and the thread cutting mechanism before the thread cutting action;

Fig. 11 is a plan view of the looper and the thread cutting mechanism when the movable knife is temporarily stopped;

Fig. 12 is a plan view of the looper and the thread cutting mechanism when the movable knife reaches to a maximum oscillating position;

Fig. 13 is a plan view of the looper and the thread cutting mechanism immediately before the thread cutting action;

Fig. 14 is a plan view of the looper and the thread cutting mechanism when the movable knife returns back to the standby position after the thread cutting action;

Fig. 15 is a front view of the looper with an outlet for the lower thread showing that the outlet is at the left side of the location where a needle is lifted down;

Fig. 16 is a plan view of the looper and the thread cutting mechanism with the outlet for the lower thread showing that the outlet is at the left side of the location where a needle is lifted down;

Fig. 17 is a front view of the looper with the outlet for the lower thread showing that the outlet is at the apex of a bobbin case; and

Fig. 18 is a plan view of the looper and the thread cutting mechanism with the outlet for the lower showing that the outlet is at the apex of the bobbin case.

BEST MODE FOR CARRYING OUT THE INVENTION

[0031] The present invention will be described in more detail, referring to the relevant drawings which illustrate one preferred embodiment.

[0032] As shown in Figs. 1 to 4, the sewing machine M comprises a machine bed 1, a pedestal 2, and an arm

3. A needle plate 8 is detachably mounted on the upper surface at the front of the machine bed 1. The pedestal 2 stands up on the upper surface at the rear of the machine bed 1. The arm 3 extends forth, in opposition to the machine bed 1, from the upper end of the pedestal 2.

[0033] The arm 3 has an interior main shaft 4 which extends back and forth. A machine motor, not shown, rotates the main shaft 4. The main shaft 4 drives a needle bar drive mechanism and a thread take-up drive mechanism provided in the front region of the arm 3. The needle bar drive mechanism drives a needle bar 5 (See Fig. 2) upward and downward. The thread take-up drive mechanism drives upward and downward a thread take-up (not shown) which supports an upper thread 16. The needle bar drive mechanism and the thread take-up drive mechanism are known mechanisms. Detailed descriptions and illustrations of them are omitted. The pedestal 2 has interiorly a thread cutting drive mechanism 13. The thread cutting drive mechanism 13 drives a movable knife 19 provided to a thread cutting mechanism 12 which is described later.

[0034] The machine bed 1 has interiorly a lower shaft 7 which extends back and forth. The driving force of the main shaft 4 rotates the lower shaft 7. The lower shaft 7 induces a rotating movement of a looper 9 located under the needle plate 8. The needle plate 8 has a needle hole 8a where a sewing needle 6 passes (See Fig. 2). The thread cutting mechanism 12 comprises a stationary knife 18 and the movable knife 19 arranged under the needle plate 8. The thread cutting mechanism 12 cuts the upper thread 16 and a lower thread 17, with a action described later at the end of a sewing action.

[0035] The thread cutting apparatus 11 according to the invention comprises the thread cutting mechanism 12 and the thread cutting drive mechanism 13. The thread cutting mechanism 12 and the thread cutting drive mechanism 13 are linked to each other by a thread cutting link mechanism 15 provided in the machine bed 1 and the pedestal 2.

[0036] The thread cutting mechanism 12 is described below. The thread cutting mechanism 12 comprises the stationary knife 18 and the movable knife 19 as described above. Referring to Fig. 7, the stationary knife 18 is an elastically deformable plate which has an L shape in the plan view. Setscrews 20 fixes the stationary knife 18 at the forth end to the lower surface of the needle plate 8. The stationary knife 18 inclines from the forth end to a back end, and the back end is positioned at the right-forth of the needle hole 8a. The stationary knife 18 has a knife portion 18a provided at the back end.

[0037] The movable knife 19 is a planar plate with substantial oval shape. A spindle 21 is provided under the needle plate 8 to extend perpendicularly to the needle plate 8. The spindle 21 supports and allows the movable knife 19 to oscillate forward and backward. As shown in Fig. 7, the spindle 21 is located at the right-back of the needle hole 8a. A pin 22 links a back end of the movable knife 19 to a forth end of a third link 37 which extends

from the thread cutting link mechanism 15.

[0038] The third link 37 moves back and forth, as described later. During the sewing action, the third link 37 stays at withdrawn position (See Fig. 10). At the moment, the movable knife 19 is at a standby position. In Fig. 10, a position of the movable knife 19 represents the standby position.

[0039] The third link 37 moves forth and pushes forth the linked back end of the movable knife 19 for thread cutting action. As shown in Figs. 11 and 12, the forth movement of the third link 37 drives the movable knife 19 to oscillate forward. The movable knife 19 turns clockwise (when the needle plate 8 is viewed from the upper) around the spindle 21, and reaches to a position corresponding to a maximum oscillation amplitude of the oscillating movement (maximum oscillating position: See Fig. 12). Then, the third link 37 moves back and pulls the linked back end of the movable knife 19. The back movement of the third link 37 drives the movable knife 19 to oscillate backward. The movable knife 19 turns counter-clockwise (when the needle plate 8 is viewed from the upper) around the spindle 21, and returns to the standby position.

[0040] The movable knife 19 has a first apical portion 19a at its forth end, which is at the right-forth of the needle hole 8a when the movable knife 19 is at the standby position. The first apical portion 19a moves because of the oscillating movement of the movable knife 19. In Fig. 10, an arcuate path NK represents a trace of movement of the first apical portion 19a. As shown in Fig. 10, the arcuate path NK extends at the slight right of the needle hole 8a. Referring to Fig. 9, the needle hole 8a of the needle plate 8 permits the sewing needle 6 with the upper thread 16 extending through an eye hole 6a of the sewing needle 6 to pass through. As described later, the looper 9 produces, under the needle plate 8, a loop of the upper thread 16 (upper thread loop 16a) which extends through the needle hole 8a. As shown in Figs. 10 to 12, the first apical portion 19a of the movable knife 19 moves along the arcuate path NK, enters into an opening of the upper thread loop 16a from the right-forth of the upper thread loop 16a, and catches the upper thread 16.

[0041] The movable knife 19 has a second apical portion 19b at its forth end, which extends oppositely to the first apical portion 19a. The second apical portion 19b moves and passes at the left of the arcuate path NK, because of the oscillating movement of the movable knife 19. As shown in Fig. 12, the second apical portion 19b is at the left-back of the needle hole 8a when the movable knife 19 reaches to the maximum oscillating position. When the movable knife 19 moves from the position shown in Fig. 11 to the position shown in Fig. 12, the first apical portion 19a and the second apical portion 19b move through the opening of the upper thread loop 16a. Meanwhile, the lower thread 17 extends from an outlet 53a provided to the looper 9 and remains under the needle hole 8a, as described later. Referring to Fig. 13, the second apical portion 19b catches the lower thread 17

before the movable knife 19 reaches to the standby position from the maximum oscillating position.

[0042] As shown in Fig. 14, the movable knife 19 comes beneath the stationary knife 18 when the movable knife 19 returns to the standby position. The movable knife 19 partially overlaps the stationary knife 18. Then, the movable knife 19 presses both the upper thread 16 caught by the first apical portion 19a and the lower thread 17 caught by the second apical portion 19b against the knife portion 18a of the stationary knife 18 for cutting off. In addition, the first apical portion 19a and the second apical portion 19b have a function for preventing the upper thread loop 16a from coming off the movable knife 19.

[0043] The thread cutting drive mechanism 13 is described below.

[0044] The thread cutting drive mechanism 13 is driven by the main shaft 4 provided in the arm 3 and oscillates the movable knife 19 of the thread cutting mechanism 12. As shown in Figs. 1 to 4, the thread cutting drive mechanism 13 comprises a thread cutting cam plate 25 disposed at the joint between the pedestal 2 and the arm 3. Furthermore, the thread cutting drive mechanism 13 comprises a driving arm 26, and a thread cutting solenoid 27.

[0045] The thread cutting cam plate 25 is fixedly mounted to a region close to the back end of the main shaft 4. As shown in Figs. 1 and 5, the thread cutting cam plate 25 has a cam section (a cam slot 25a) provided in one side thereof for the thread cutting action. A guide shaft 28 is provided at the left of the cam plate 25 in the arm 3 to extend back and forth. The guide shaft 28 supports a driving arm 26 which is arranged movable back and forth. The driving arm 26 extends right and left at the forth of the thread cutting cam plate 25. A compression coil spring 30 is mounted to the guide shaft 28, and biases the driving arm 26 forth.

[0046] The thread cutting solenoid 27 is located at the left-forth of the driving arm 26. The thread cutting solenoid 27 has an output end extending back. A pressing plate 31 is connected to the output end of the thread cutting solenoid 27. The pressing plate 31 is arranged turnable around a pin 32 which extends upward and downward. A front surface of the driving arm 26 contacts, at the left end, the pressing plate 31. When the thread cutting solenoid 27 is actuated, the pressing plate 31 turns around the pin 32 to press the driving arm 26 back. The driving arm 26 extends to the right along the front surface of the cam plate 25. The driving arm 26 supports, near the right end, a roller member 29 between the driving arm 26 and the cam plate 25 (See Figs. 3 and 4). As shown in Fig. 1, a front surface of the cam plate 25 has the cam slot 25a. Furthermore, the right end of the driving arm 26 is connected to the first link 35 as shown in Fig. 1. The first link 35 is comprised in the thread cutting link mechanism 15 which is described later.

[0047] The thread cutting solenoid 27 is actuated by turning on electricity for the thread cutting action just before the end of the sewing action. When the thread cutting

solenoid 27 remains not actuated, the compression coil spring 30 pushes and keeps the driving arm 26 forth at so-called non-operating position. When the thread cutting solenoid 27 is actuated, the driving arm 26 moves, against the compression coil spring 30, back to so-called operating position. In Figs. 3 and 4, real line for the driving arm 26 represents the non-operating position, and two-dot chain line represents the operating position.

[0048] When the driving arm 26 is at the operating position, the roller member 29 fits into the cam slot 25a provided on the front surface of the cam plate 25. The cam plate 25 rotates together with the main shaft 4. Then, the driving arm 26 oscillates around the guide shaft 28 by the rotating action of the cam plate 25. The oscillating movement of the driving arm 26 lifts the first link 35 up and down. As described later, the upward and downward movement of the first link 35 is transferred to the movable knife 19, which oscillates forward and backward to cut both the upper thread 16 and the lower thread 17.

[0049] When the driving arm 26 is at the non-operating position, the roller member 29 departs out from the cam slot 25a. Then, the driving arm 26 has no effect of the rotating cam plate 25, and keeps the status without the upward and downward movement of the first link 35 and the oscillating movement of the movable knife 19.

[0050] As shown in Fig. 5, the cam slot 25a of the thread cutting cam plate 25 comprises a first cam section A, a second cam section B, a third cam section C, a fourth cam section D, a fifth cam section E, and a sixth cam section F. The second cam section B and the fourth cam section D are arranged of an arcuate shape which is coaxial with the thread cutting cam plate 25. Accordingly, when the roller member 29 engaged with the second cam section B or the fourth cam section D of the cam slot 25b, the driving arm 26 keeps stop state without oscillation even with the rotating movement of the thread cutting cam plate 25. Then, the first link 35 keeps stop state without upward and downward movement. Thus, the movable knife 19 keeps stop state without oscillation.

[0051] It is described about the thread cutting link mechanism 15 linking the thread cutting drive mechanism 13 to the thread cutting mechanism 12. The thread cutting link mechanism 15 comprises the first link 35, a second link 36, a third link 37, and an adjusting lever 38. The first link 35 is arranged to extend upward and downward in the pedestal 2. As described above, the first link 35 is connected at the upper end to the right end of the driving arm 26. The lower end of the first link 35 is connected to an intermediate lever 39 provided in the machine bed 1.

[0052] As shown in Fig. 2, the intermediate lever 39 has L shaped lateral faces and turns around a pin extending right and left. The intermediate lever 39 comprises a first arm portion 39a extending forth and a second arm portion 39b extending upward. A forth end of the first arm portion 39a is connected to the lower end of the first link 35. An upper end of the second arm portion 39b is connected to the second link 36 and a tension coil spring

40. The tension coil spring 40 pushes back the second arm portion 39b, and biases upward the first link 35 connected to the first arm portion 39a. The first arm portion 39a and the first link 35 are kept within their restricted position by a stopper (not shown).

[0053] The machine bed 1 comprises interiorly the adjusting lever 38 between the pedestal 2 and the needle plate 8. A spindle 41 extends upward and downward and supports turnably the adjusting lever 38. The adjusting lever 38 has an upper arm 38b at the upper end and a lower arm 38c at the lower end. Both arms 38b and 38c are extending in the same direction.

[0054] The second link 36 extends back and forth in the machine bed 1. A forth end of the second link 36 is connected to an end portion of the lower arm 38c of the adjusting lever 38 via an adjusting link member (not shown). As described previously, the back end of the second link 36 is connected to the upper end of the second arm portion 39b of the intermediate lever 39.

[0055] The third link 37 extends back and forth in the front region of the machine bed 1. A pin 23 connects a back end of the third link 37 to the upper arm 38b of the adjusting lever 38 (See Fig. 7). As described previously, the pin 22 connects the forth end of the third link 37 to the back end of the movable knife 19 (See Fig. 7).

[0056] It is described about the looper 9 located in the front region of the machine bed 1.

[0057] As shown in Fig. 8, the looper 9 comprises an outer looper 51, an intermediate looper 52, and a bobbin case 53. A joint 57 connects the outer looper 51 to a forth end of the lower shaft 7. The outer looper 51 supports rotatably the intermediate looper 52.

[0058] The outer looper 51 rotates clockwise (right-hand rotating), when it is viewed from the front, because of the rotating lower shaft 7. The lower shaft 7 is rotated by the driving force of the main shaft 4 provided in the arm 3. As described previously, the main shaft 4 brings the upward and downward movement of the sewing needle 6. Therefore, the rotation of the outer looper 51 is synchronized with the upward and downward movement of the sewing needle 6.

[0059] The intermediate looper 52 has, at the shaft center, a shaft 52a extending forth. The intermediate looper 52 is prevented from rotating by a not-shown stopper. As shown in Figs. 8 and 9, the bobbin case 53 is a cylindrical hollow shape of which forth end is obturated. The bobbin case 53 is disposed to obturate an opening of the intermediate looper 52 in which a lower thread bobbin 55 is accommodated. The lower thread bobbin 55, with the lower thread 17 wound on its circumferential side, threads the shaft 52a. The bobbin case 53 has a positioning projection that engages with a positioning recess provided to the intermediate looper 52. The engagement between the positioning projection and the positioning recess prevents the bobbin case 53 from rotating relative to the intermediate looper 52.

[0060] As shown in Fig. 9, the outer looper 51 has, at proximity of peripheral line, a point portion 51a extending

in rotational direction. The sewing needle 6 moves down to penetrate a workpiece W placed on the needle plate 8 and moves up across the needle hole 8a after entering the machine bed 1. The point portion 51a catches the upper thread 16 which extends from the eye hole 6a of the sewing needle 6, when the point portion 51a passes under a position of the sewing needle 6 with the rotation of the outer looper 51. The point portion 51a catching the upper thread 16 rotates external to the periphery of the intermediate looper 52 to expand the upper thread 16 and thus forms the upper thread loop 16a.

[0061] As shown in Fig. 9, a lower thread guide 53a is provided on the front side at the upper-left of the bobbin case 53. The lower thread guide 53a, shown in Fig. 9, is a plate with an oval shape viewed from the front and has a guide hole (not shown) near its peripheral line. The bobbin case 53 has a lower thread outlet 54a at an upper-right portion of peripheral wall. As shown in Fig. 9, the lower thread 17 in the bobbin case 53 passes from the outlet 54a, through the guide hole in the thread guide 53a from forth to back, to the needle hole 8a in the needle plate 8, and reaches to the workpiece W.

[0062] The upper thread 16 caught by the point portion 51a entwines itself with the lower thread 17 located between the needle hole 8a and the lower thread guide 53a, as the point portion 51a rotates. The upper thread 16 and the lower thread 17 then form a stitch with tightening action of a thread take-up.

[0063] The action of the thread cutting apparatus 11 according to the invention is described below, referring to the timing chart of Fig. 6. The horizontal axis in Fig. 6 represents a phase angle of the main shaft 4. It is assumed that the phase angle of the main shaft 4 is zero degree when the needle bar 5 (the sewing needle 6) is at uppermost position. Fig. 6 also illustrates traces of upward and downward movement of the needle bar 5 and the thread take-up.

[0064] The thread cutting apparatus 11 carries out the thread cutting action through use of the thread cutting solenoid 27. The thread cutting solenoid 27 is non-operating state during the sewing action while the driving arm 26 is at the non-operating position, described above. As described previously, the first link 35 connected to the driving arm 26 is moved upwardly by the pressing action of the intermediate lever 39 and held at the restricted position by the not-shown stopper. The second link 36 connected to the intermediate lever 39 is retracted, and the third link 37 connected to both the second link 36 and the adjusting lever 38 moves backward. As the third link 37 moves backward, the movable knife 19 in the thread cutting mechanism 12 comes to the standby position (See Fig. 10).

[0065] The thread cutting solenoid 27 is actuated by a thread cutting command received just before the end of the sewing action. As described previously, the driving arm 26 is moved to the operating position by the action of the thread cutting solenoid 27 so that the roller member 29 comes in engagement with the cam slot 25a provided

on the front surface of the cam plate 25. The roller member 29 engaged with the cam slot 25a then moves along the cam slot 25a as the cam plate 25 is rotated by the action of the main shaft 4. Then, the driving arm 26 oscillates. The oscillation of the driving arm 26 drives to move the first link 35 connected to the right end of the driving arm 26.

[0066] The thread cutting solenoid 27 is actuated at the predetermined timing (when the phase angle of the main shaft 4 comes to about 260 degrees). The roller member 29 engages with the first cam section A (See Fig. 5) and further moves from the first cam section A to the sixth cam section F. As shown in Figs. 7, 9, and 10, the upper thread 16 is caught by the point portion 51a and the upper thread loop 16a is formed under the needle plate 8. The lower thread 17 passes from the lower thread guide 53a of the bobbin case 53 towards the thread hole 8a in the needle plate 8.

[0067] The first link 35 is lifted down by the action of the first cam section A until the phase angle of the main shaft 4 comes to about 290 degrees. The downward movement of the first link 35 lifts down the first arm portion 39a of the intermediate lever 39. The intermediate lever 39 then turns (forward) as resisting the yielding force of the tension coil spring 40, and thus moves forth the second link 36 connected to the second arm portion 39b. The forth movement of second link 36 moves the adjusting lever 38 forth. Accordingly, the third link 37 moves forth together with the adjusting lever 38. As the third link 37 moves forth, the movable knife 19 turns (oscillates forward) clockwise (when viewed from the upper of the machine bed 1) from the standby position (Fig. 10) to a position to enter into the opening of the upper thread loop 16a (entering position: Fig. 11).

[0068] As oscillating forward to the position shown in Fig. 11, the first apical portion 19a of the movable knife 19 faces the oval upper thread loop 16a from the right-forth direction of the loop 16a and enters the opening of the loop 16a in substantially perpendicular direction. Therefore, the first apical portion 19a certainly catches the upper thread loop 16a located under the needle plate 8. In a case that the stitch is a hitch stitch, the upper thread 16 caught by the point portion 51a is twisted. In this case, the upper thread loop 16a collapses in the shape as described later. Since the first apical portion 19a of the movable knife 19 enters perpendicularly to the opening of the upper thread loop 16a, the first apical portion 19a certainly enters even into the collapsed upper thread loop 16a due to the hitched stitch. As described previously, the first apical portion 19a does not catch the lower thread 17. Therefore, the lower thread 17 remains to extend from the needle hole 8a to the bobbin case 53.

[0069] As described previously, the second cam section B connected to the first cam section A is arranged to be an arcuate shape which is coaxial to the cam plate 25. Therefore, the driving arm 26 does not oscillate while the roller member 29 moves along the second cam section B (until the phase angle of the main shaft 4 comes

to about 310 degrees). Thus, the movable knife 19 stops temporarily at the entering position shown in Fig. 11. The second cam section B corresponds to a first control section.

[0070] While the oscillating movement of the movable knife 19 is stopped, the upper thread loop 16a is hung up to the front side of the bobbin case 53 and passes across in front of the bobbin case 53 as the point portion 51a of the outer looper 51 rotates. The movable knife 19 does not disturb the movement of the upper thread loop 16a, as the oscillating movement is temporarily stopped. Therefore, the upper thread loop 16a moves smoothly, and the sewing machine M can produce a stitch, certainly.

[0071] While the roller member 29 moves along the third cam section C after passing the second cam section B (with the phase angle of the main shaft 4 shifting from substantially 310 degrees to 360 degrees), the first link 35 is lifted down by the action of the third cam section C. Simultaneously, the movable knife 19 turns (oscillates forward) clockwise (when viewed from the upper of the machine bed 1) from the entering position (Fig. 11) to the maximum oscillating position (Fig. 12).

[0072] As shown in Fig. 5, an inclination of the third cam section C is greater than that of the first cam section A. Therefore, the movable knife 19 oscillates (forward) faster from the entering position to the maximum oscillating position than from the standby position to the entering position. Thus, it regains the delay time for the movable knife 19 by the temporal stop. The third cam section C corresponds to a second control section.

[0073] The roller member 29 then moves along the fourth cam section D after passing the third cam section C (while the phase angle of the main shaft 4 shifts from substantially 360 degrees to 368 degrees). The fourth cam section D is arranged to be an arcuate shape which is coaxial to the cam plate 25, similar to the second cam section B. Accordingly, the movable knife 19 stops temporarily within an action range of the fourth cam section D, when the knife 19 reaches to the maximum oscillating position. As shown in Fig. 6, the thread take-up moves upward and pulls up the upper thread 16 during the temporal stop of the movable knife 19. The upward movement of the thread take-up tightens the upper thread loop 16a caught by the movable knife 19. Therefore, the upper thread loop 16a approximately entwines itself around the movable knife 19, after the first apical portion 19a and the second apical portion 19b of the movable knife 19 passes into the opening of the upper thread loop 16a. The upper thread loop 16a caught by the movable knife 19 does not come off even when another (backward) oscillating movement of the movable knife 19 follows, because the upper thread loop 16a entwined around the movable knife 19 passes the second apical portion 19b. The fourth cam section D corresponds to a third control section.

[0074] The roller member 29 further moves along the fifth cam section E and the sixth cam section F after passing the fourth cam section D (while the phase angle of

the main shaft 4 shifts from substantially 368 degrees to 415 degrees). As shown in Fig. 5, inclinations of the fifth cam section E and the sixth cam section F are opposite to those of the third cam section C and the first cam section A respectively. The first link 35 is lifted up by the action of the fifth cam section E and the sixth cam section F.

[0075] The upward movement of the first link 35 lifts up the first arm portion 39a of the intermediate lever 39. The intermediate lever 39 oscillates (forward) by the lifting action of the first link 35 and the yielding force of the tension coil spring 40, and then the second link 36 connected to the second arm portion 39b moves back. The back movement of the second link 36 brings oscillation (forward) of the adjusting lever 38, and then the third link 37 connected to the adjusting lever 38 moves back. As the third link 37 moves back, the movable knife 19 turns (oscillates forward) counterclockwise (when viewed from the upper of the machine bed 1) from the maximum turning position (See Fig. 12) to the standby position (See Fig. 14).

[0076] When the movable knife 19 passes under the needle hole 8a, the knife 19 catches the lower thread 17 with the second apical portion 19b and oscillates (forward) to the standby position. As shown in Fig. 14, the movable knife 19 partially overlaps under the stationary knife 18 with the knife 18, when the movable knife 19 returns back to the standby position. The movable knife 19 presses the upper thread 16 caught by the first apical portion 19a and the lower thread 17 caught by the second apical portion 19b against the knife portion 18a of the stationary knife 18 for cutting off.

[0077] Figs. 15 and 16 illustrate the upper thread 16 and the lower thread 17, when a hitch stitch is generated. In a case that a hitch stitch is caused, the lower thread 17 extending from the bobbin case 53 entwines itself wraparound with an upper portion of the upper thread loop 16a from the left-forth direction of the loop 16a, for forming a final stitch.

[0078] Unlike the bobbin case shown in Figs. 8 and 9, the bobbin case 53 may have a lower thread outlet 53b at the peak point (the uppermost) of peripheral wall, as shown in Fig. 17. The bobbin case 53 may not be equipped with a lower thread guide 53a.

[0079] When the bobbin case 53 shown in Figs. 17 and 18 is used, the lower thread 17 passes upwardly from the lower thread outlet 53b to the needle hole 8a in the needle plate 8. Accordingly, it is uncertain whether the path of the lower thread 17 is at the right side or the left side of the sewing needle 6 that moves through the needle hole 8a. When the lower thread 17 for forming a final stitch extends at the left side of the sewing needle 6, the thread 17 may be entangled with an upper part of the upper thread loop 16a.

[0080] The entanglement of the lower thread 17 makes the opening of the upper thread loop 16a narrower at the proximity of the needle hole 8a. As shown in Figs. 16 and 18, the opening of the upper thread loop 16a becomes

narrower where the first apical portion 19a of the movable knife 19 enters. As described previously, the first apical portion 19a of the movable knife 19 enters the opening of the upper thread loop 16a from the right-forth direction (a direction perpendicular to the loop). Therefore, the first apical portion 19a certainly catches the upper thread loop 16a even if the opening of the upper thread loop 16a is narrower (See Fig. 16).

[0081] Some modifications of the present embodiment that are partially varied are described below.

1) The timing chart shown in Fig. 6 is an example of the timing chart of the action of the thread cutting apparatus 11 (with the movable knife 19). The timing for actuating the movable knife 19 may be varied depending on the type (for example, a half-rotating looper) and the size of the looper 9. Even in this modification, the stop period of the movable knife 19 can be set equal to that of the present embodiment.

2) Although the present embodiment depicts the main shaft 4 acting as a driving source of the thread cutting mechanism 13, the lower shaft 7 or any other dedicated driver such as an electric motor, a solenoid, or a cylinder may act as the driving source of the thread cutting mechanism 13.

3) While the cam plate 25 in the present embodiment has the cam slot 25a acting as a cam section on one surface, a profile section of the cam plate 25 may act as the cam section.

[0082] As apparent from the foregoing detailed description, the thread cutting apparatus for a sewing machine according to the invention provides, at the place closer to the location of the upper thread loop than the location of the needle hole in the needle plate, the spindle allowing the movable knife to oscillate under the needle plate. The apical portion of the movable knife is arranged to face the opening of the upper thread loop at the position frontwardly of the needle hole. When the movable knife oscillates around the spindle, the apical portion enters perpendicularly to the opening of the upper thread loop that is enlarged by the rotating looper. Therefore, the movable knife can catch the upper thread loop even when the shape of the upper thread loop has collapsed due to the development of a hitch stitch, and the movable knife with backward oscillation can certainly cut both the upper thread and the lower thread with use of the stationary knife.

Claims

1. A thread cutting apparatus for a sewing machine to cut upper thread and lower thread, having a movable knife (19) which is supported under a needle plate (8) by a spindle (21) extending vertical to the needle plate (8) and arranged to oscillate forward and backward, and a thread cutting drive mechanism (13)

which drives the movable knife (19) to interlock upward and downward movement of a sewing needle (6) derived from rotation of a main shaft (4) provided to the machine and rotating movement of a looper (9), the thread cutting drive mechanism (13) driving the movable knife (19) to oscillate forward so that an apical portion (19a) of the movable knife (19) catches, under a needle hole (8a) provided in the needle plate (8), an upper thread loop (16a) formed by a point portion (51a) of the looper (9), the thread cutting drive mechanism (13) driving the movable knife (19) to oscillate backward so that both the upper thread and the lower thread are cut off by a combination of the movable knife (19) and a stationary knife (18), **characterized in that**

the spindle (21) of the movable knife (19) is located closer to a location where the upper thread loop (16a) are formed than a location of the needle hole (8a), and

the apical portion (19a) of the movable knife (19) at a standby position before oscillating movement faces an opening of the upper thread loop (16a) and is located closer to the stationary knife (18) than the needle hole (8a).

2. The thread cutting apparatus for a sewing machine according to claim 1, wherein the thread cutting drive mechanism (13) comprises a first control section (B) which temporarily stops the oscillating movement of the movable knife (19) when the apical portion (19a) of the movable knife (19) enters the opening of the upper thread loop (16a).
3. The thread cutting apparatus for a sewing machine according to claim 2, wherein the thread cutting drive mechanism (13) comprises a second control section (C) which drives the movable knife (19) to oscillate at faster speed than that before the first control section (B) temporarily stops the oscillating movement of the movable knife (19).
4. The thread cutting apparatus for a sewing machine according to one of claims 1 to 3, wherein the thread cutting drive mechanism (13) comprises a third control section (D) which stops the oscillating movement of the movable knife (19) for a predetermined time if the movable knife (19) reaches a position corresponding to a maximum oscillation amplitude of the oscillating movement.
5. The thread cutting apparatus for a sewing machine according to one of claims 2 to 4, wherein the thread cutting drive mechanism (13) comprises:

a cam plate (25) which moves in response to the rotation of the main shaft (4); and
a driving arm (26) which engages at one end with a cam section (25a) provided in the cam

plate (25) and at the other end with a link mechanism (15) connected to the movable knife (19); and

the first control section (B) is comprised by the cam section (25a).

6. The thread cutting apparatus for a sewing machine according to claim 3 or 4, wherein the thread cutting drive mechanism (13) comprises:

a cam plate (25) which moves in response to the rotation of the main shaft (4); and
a driving arm (26) which engages at one end with a cam section (25a) provided in the cam plate (25) and at the other end with a link mechanism (15) connected to the movable knife (19); and

the first control section (B) and the second control section (C) are comprised by the cam section (25a).

7. The thread cutting apparatus for a sewing machine according to claim 4, wherein the thread cutting drive mechanism (13) comprises:

a cam plate (25) which moves in response to the rotation of the main shaft (4); and
a driving arm (26) which engages at one end with a cam section (25a) provided in the cam plate (25) and at the other end with a link mechanism (15) connected to the movable knife (19); and

the third control section (D) is comprised by the cam section (25a).

8. The thread cutting apparatus for a sewing machine according to claim 4, wherein the thread cutting drive mechanism (13) comprises:

a cam plate (25) which moves in response to the rotation of the main shaft (4); and
a driving arm (26) which engages at one end with a cam section (25a) provided in the cam plate (25) and at the other end with a link mechanism (15) connected to the movable knife (19); and

the first control section (B) and the third control section (D) are comprised by the cam section (25a).

9. The thread cutting apparatus for a sewing machine according to claim 4, wherein the thread cutting drive mechanism (13) comprises:

a cam plate (25) which moves in response to the rotation of the main shaft (4); and

a driving arm (26) which engages at one end with a cam section (25a) provided in the cam plate (25) and at the other end with a link mechanism (15) connected to the movable knife (19); and

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the first control section (B), the second control section (C), and the third control section (D) are comprised by the cam section (25a).

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- 10.** The thread cutting apparatus for a sewing machine according to any of claims 5 to 9, wherein the cam plate (25) is fixedly mounted to the main shaft (4).

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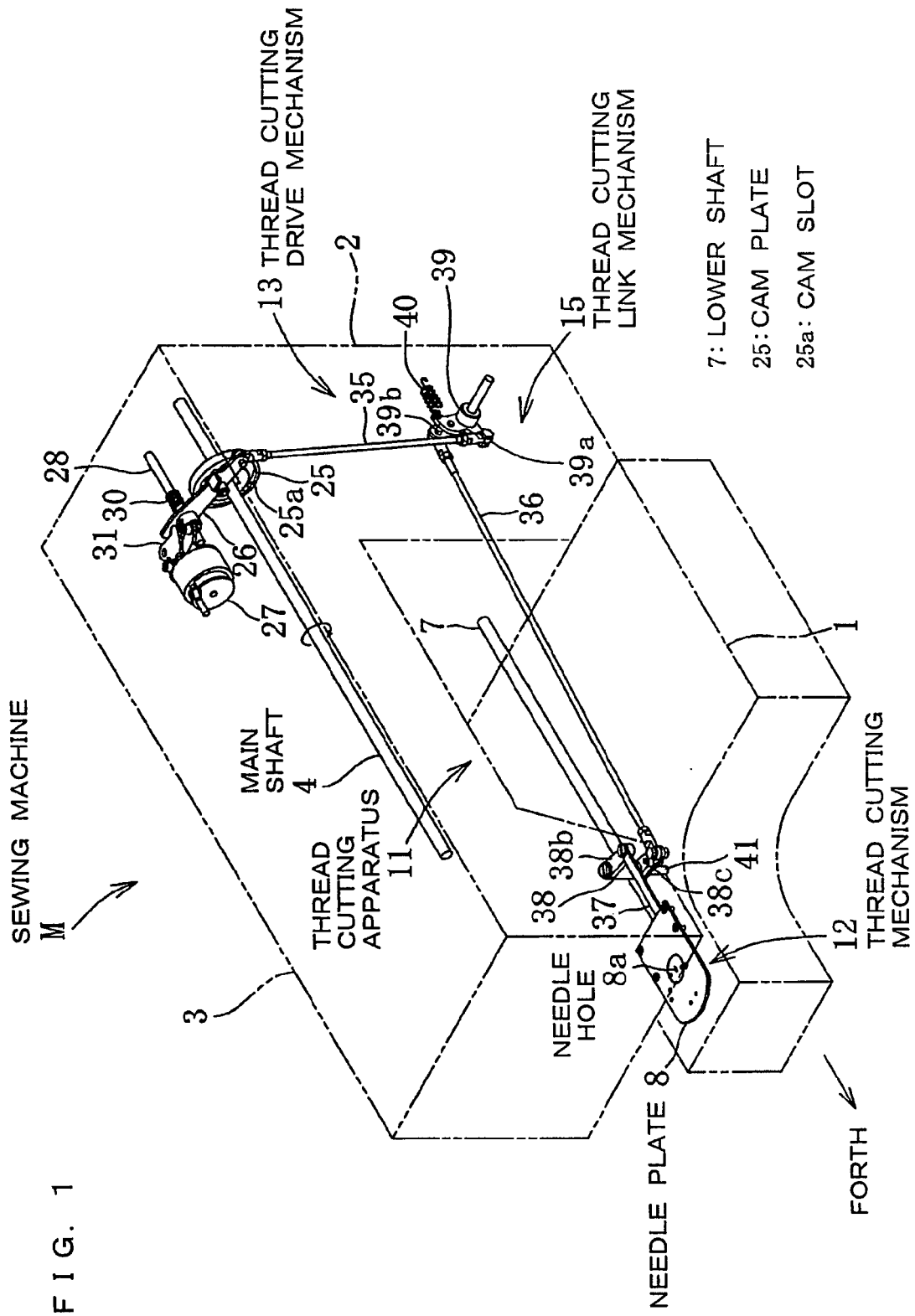
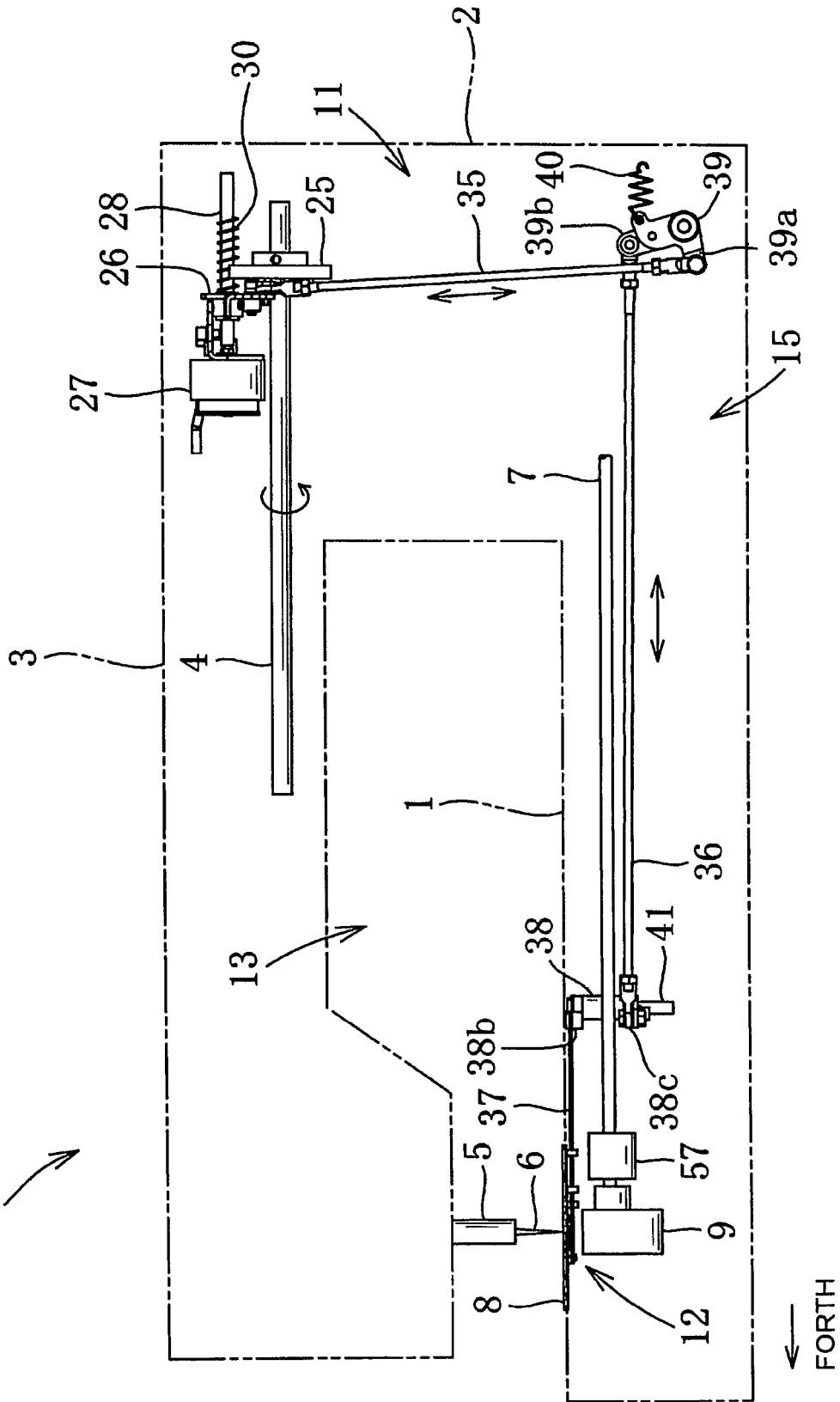


FIG. 2 M



6: SEWING NEEDLE
9: LOOPER

FIG. 3

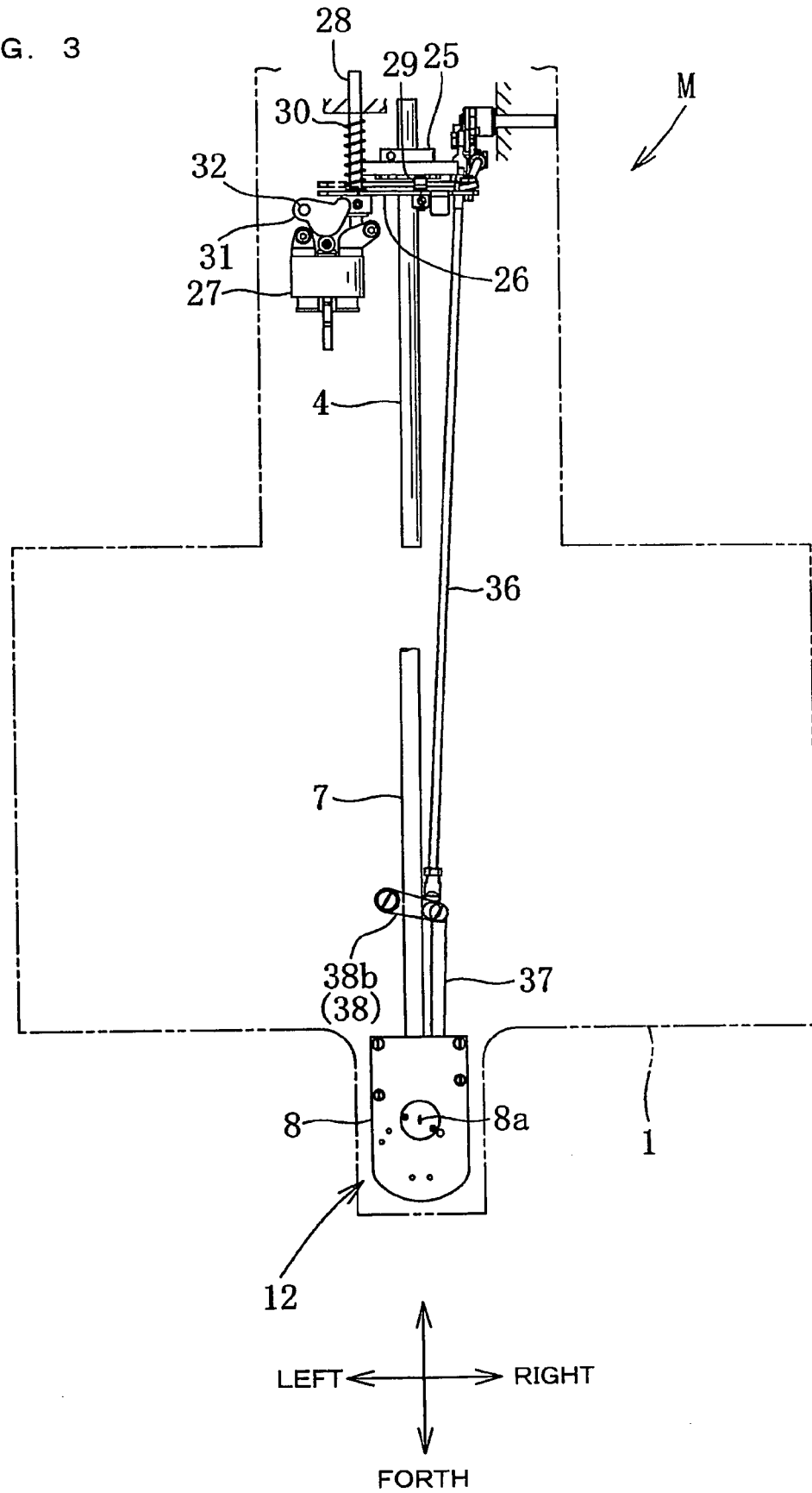


FIG. 4

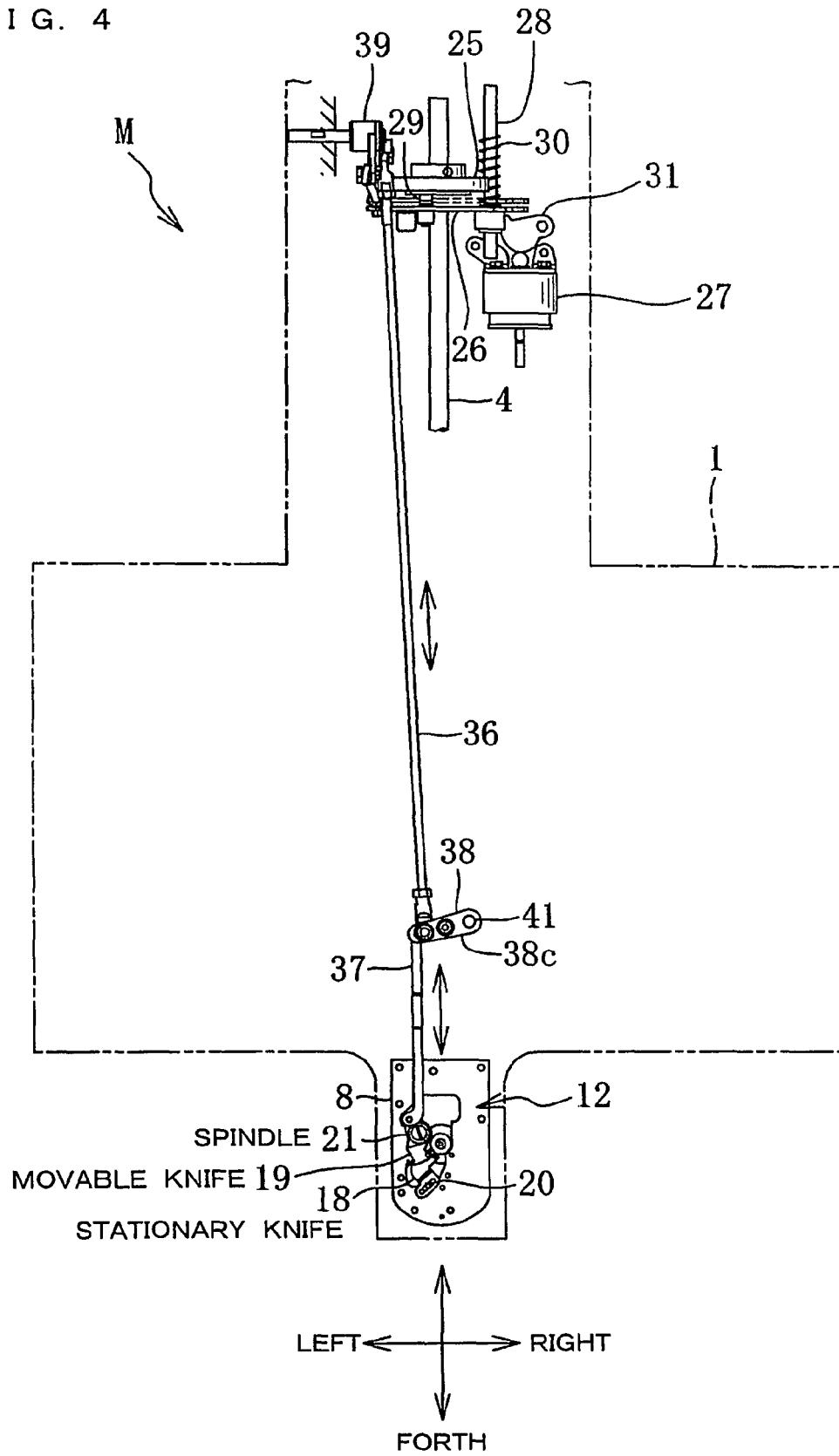


FIG. 5

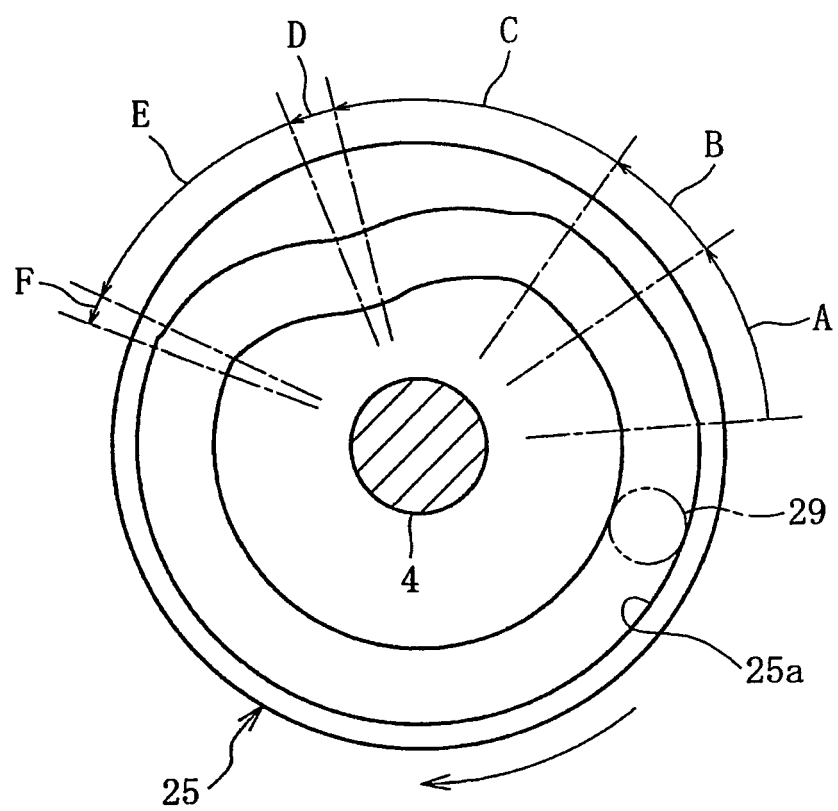


FIG. 6

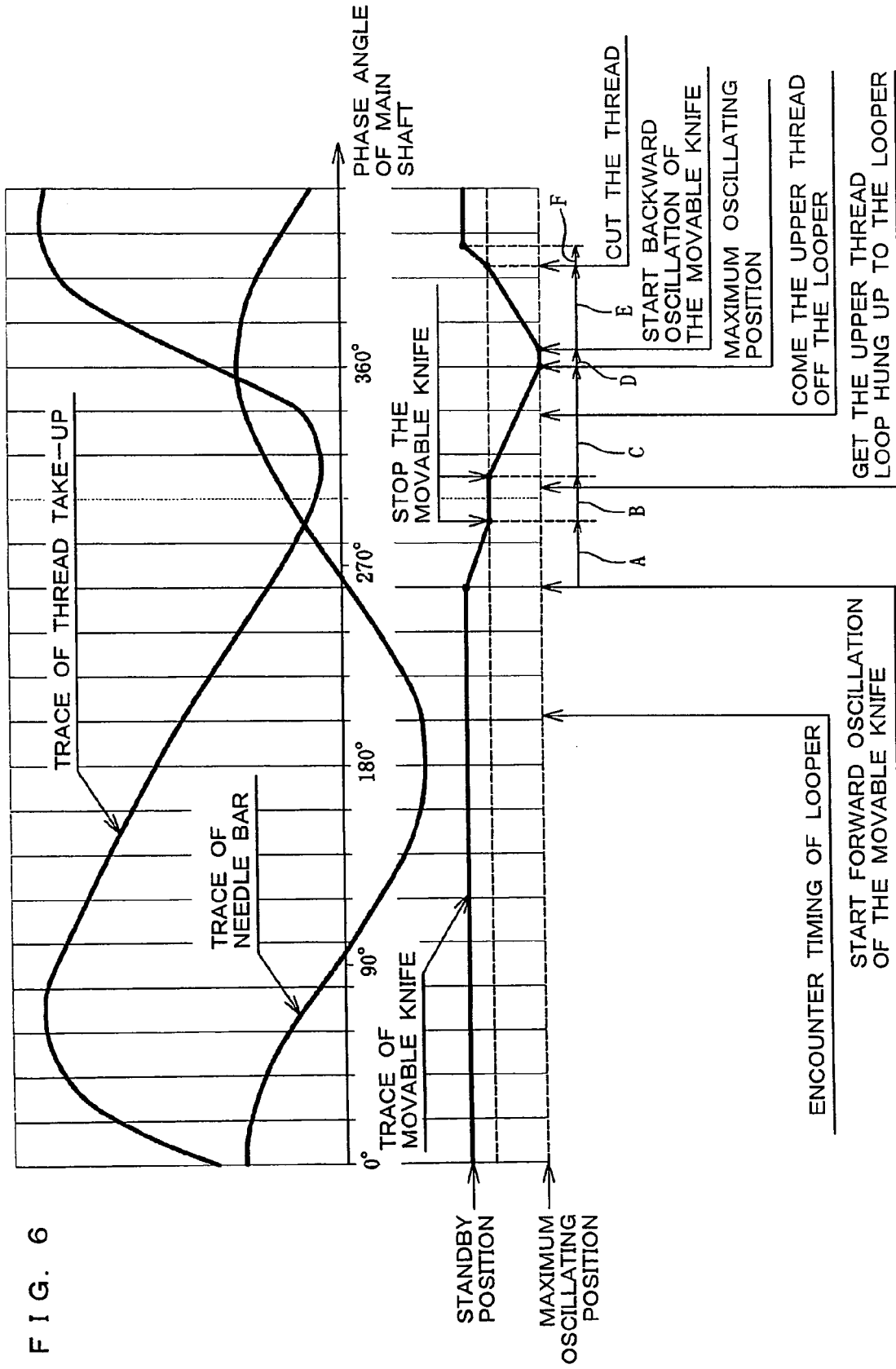


FIG. 7

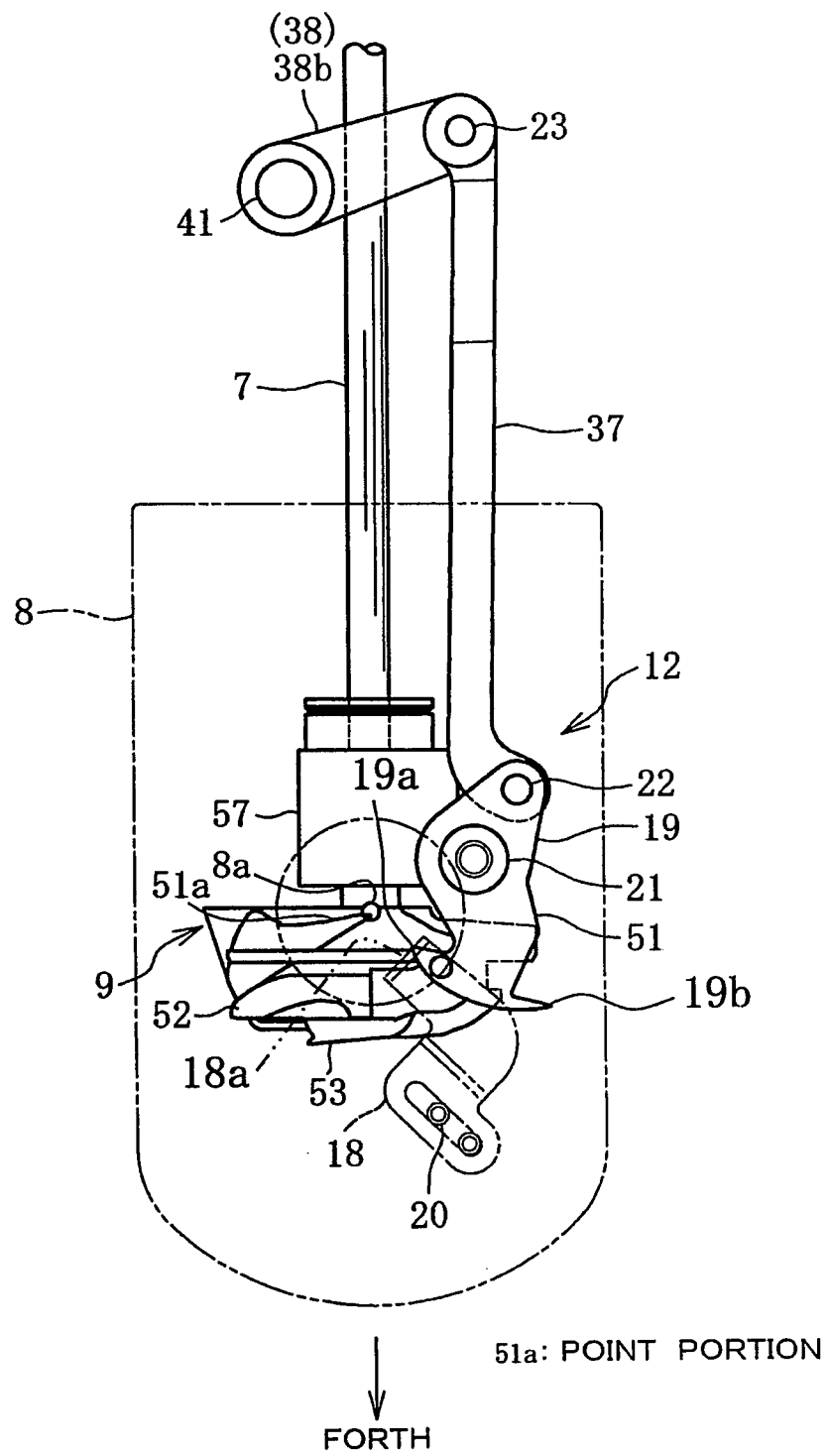


FIG. 8

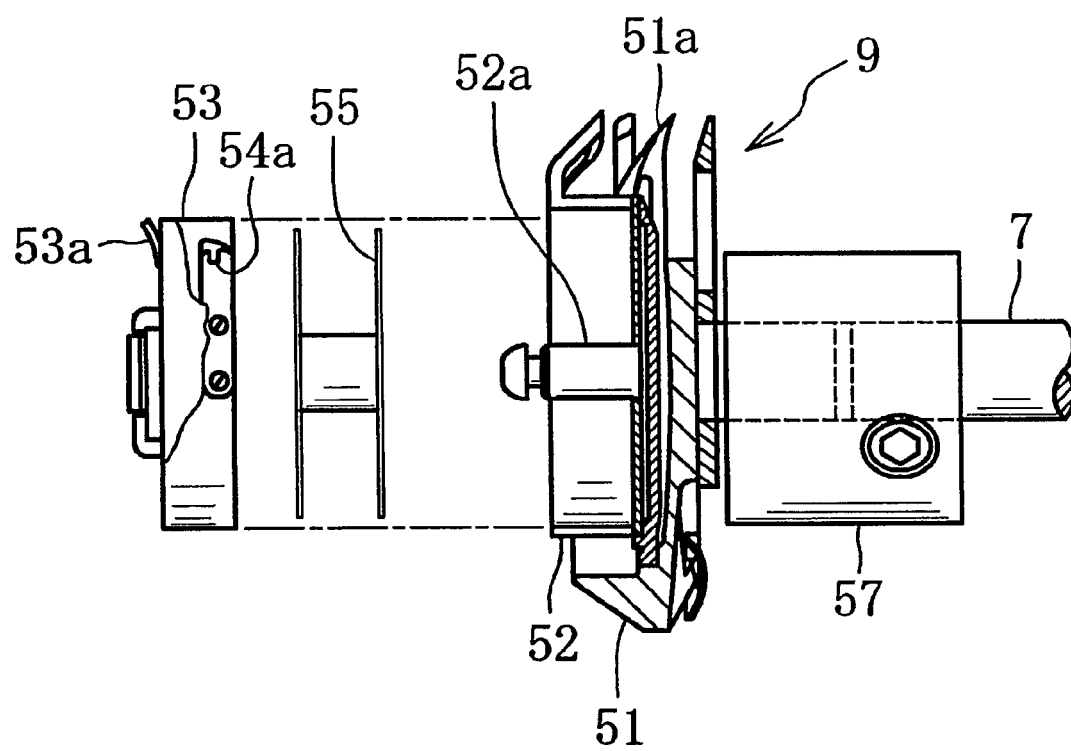


FIG. 9

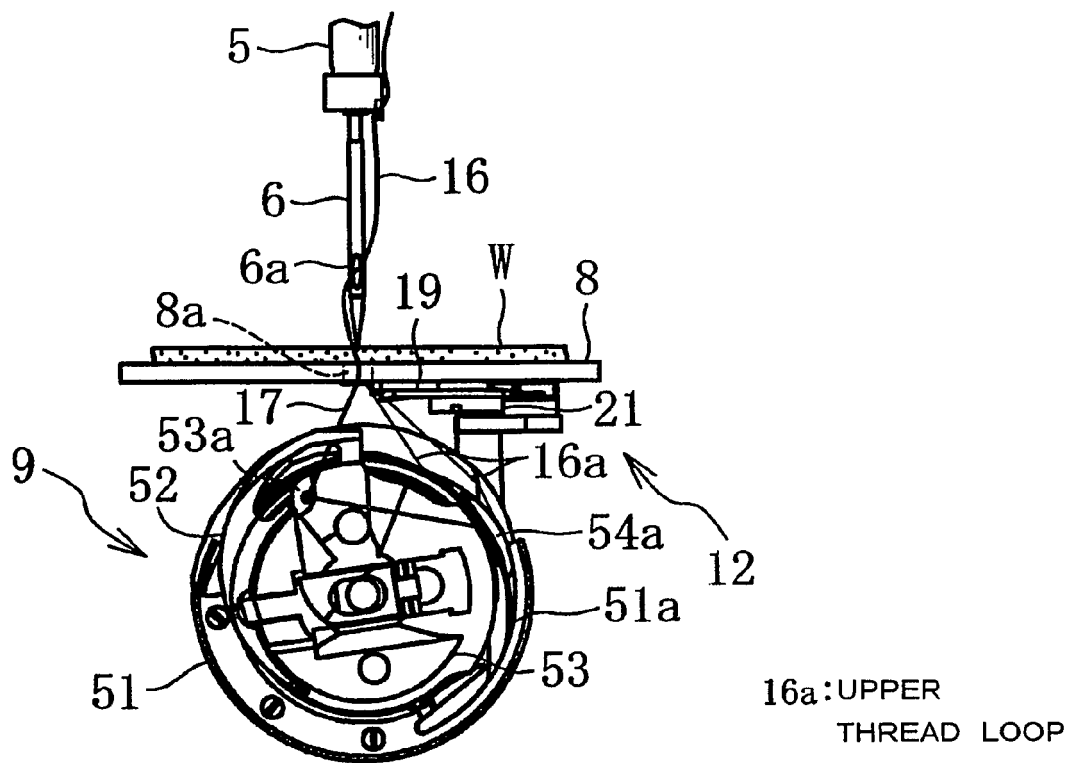


FIG. 10

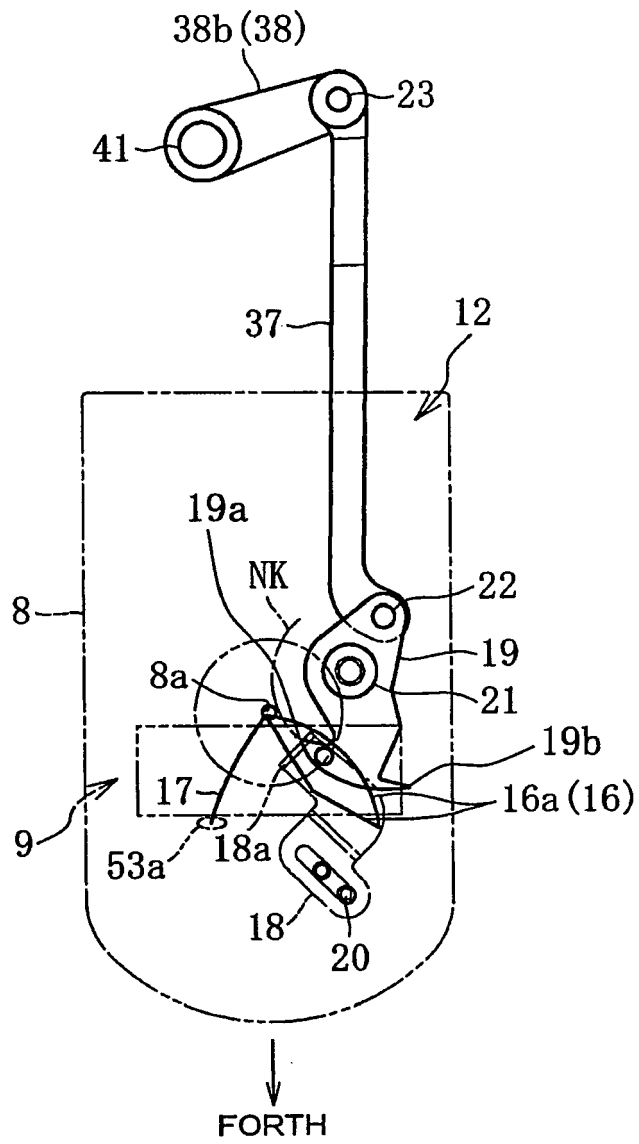


FIG. 11

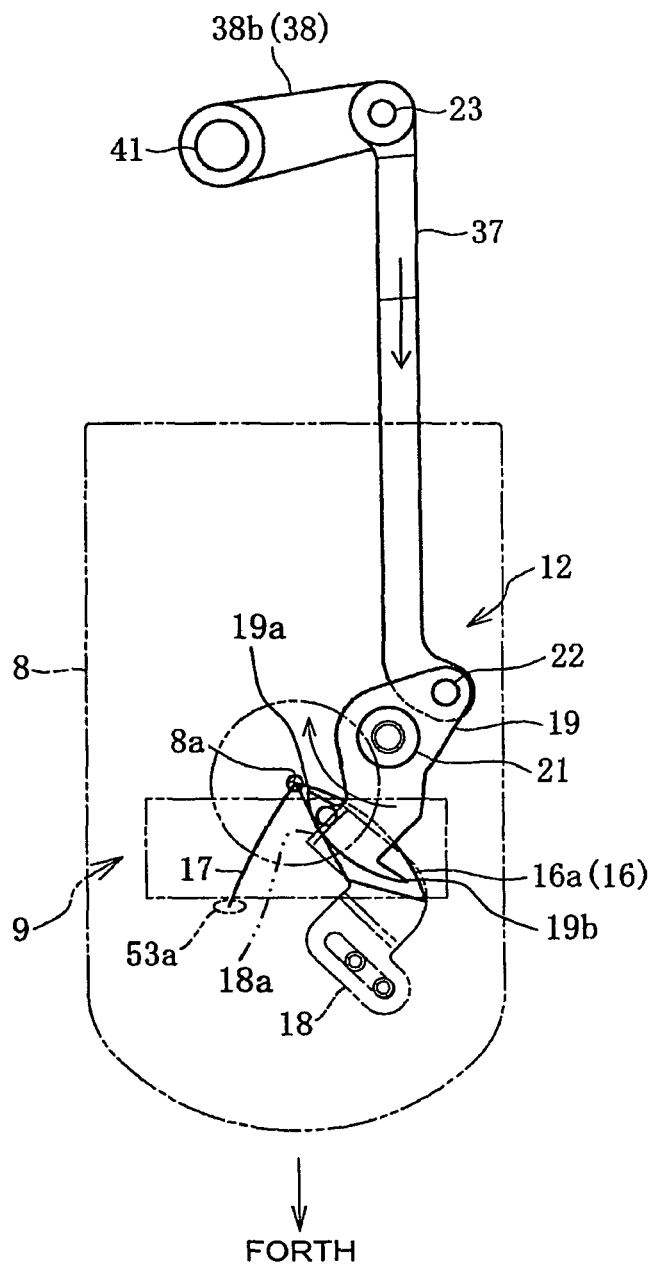


FIG. 12

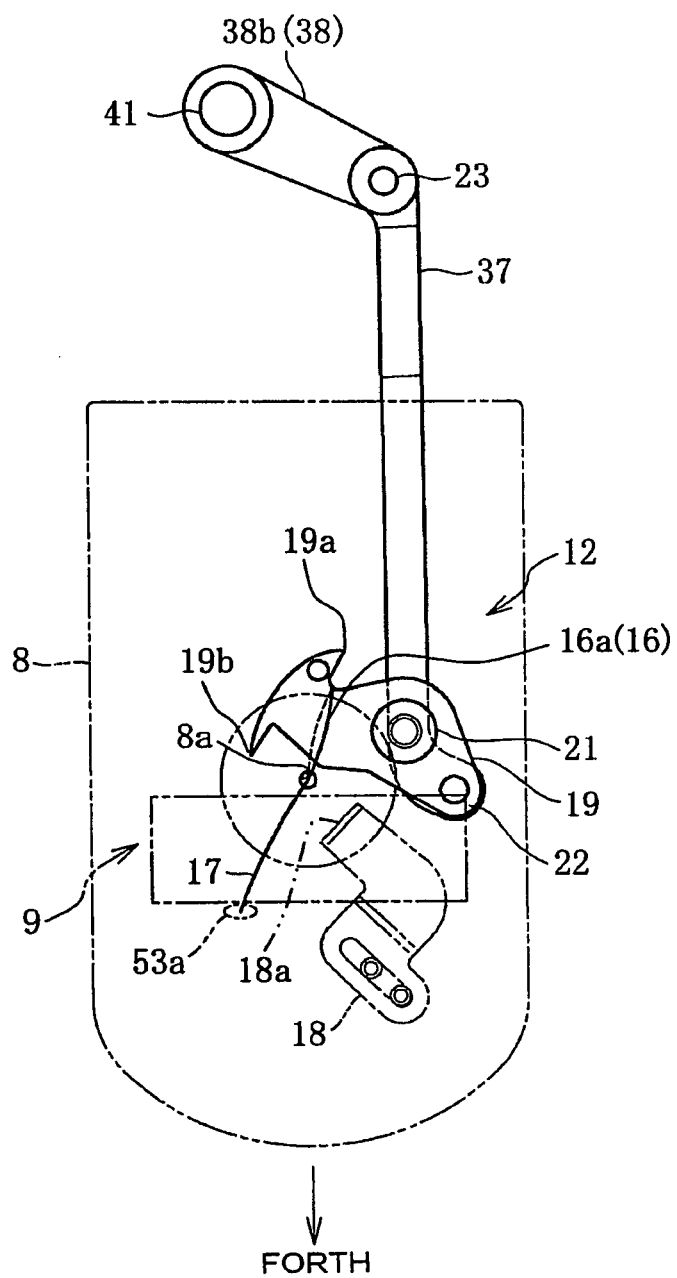


FIG. 13

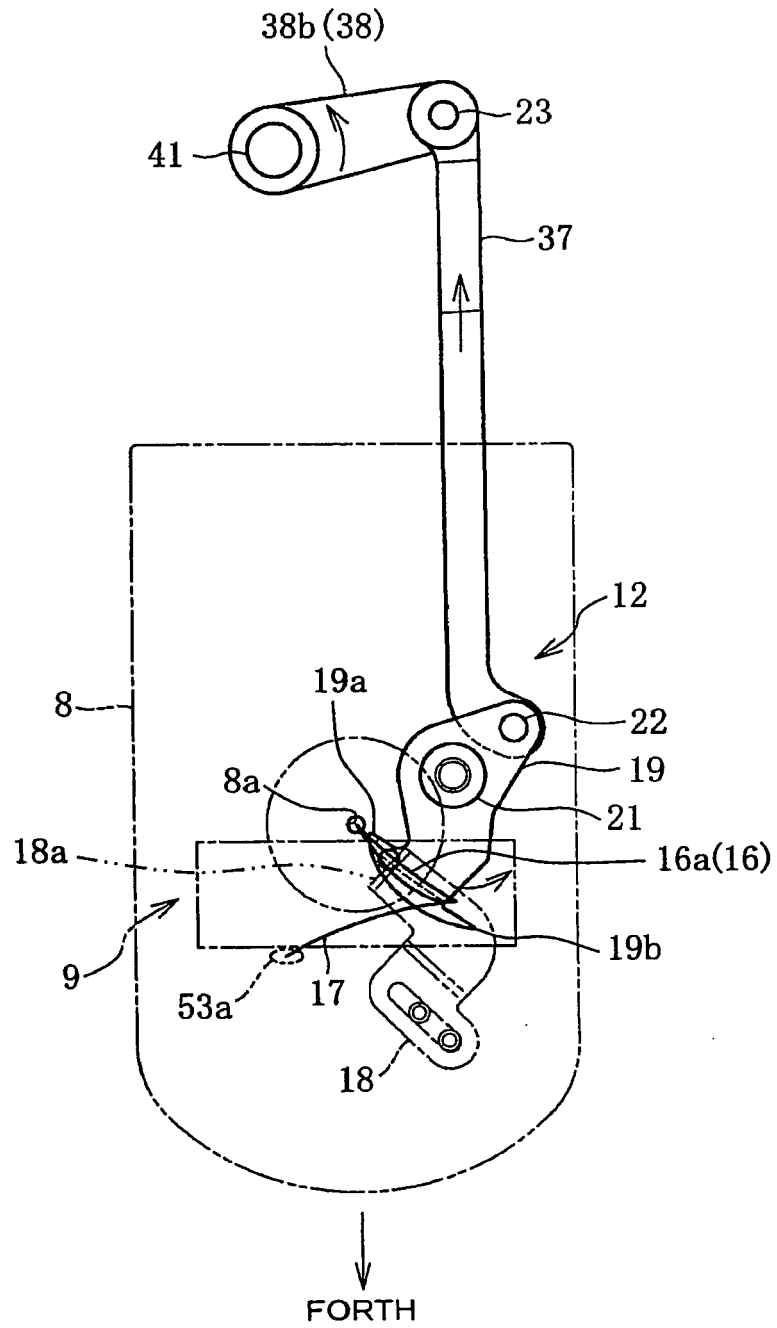


FIG. 14

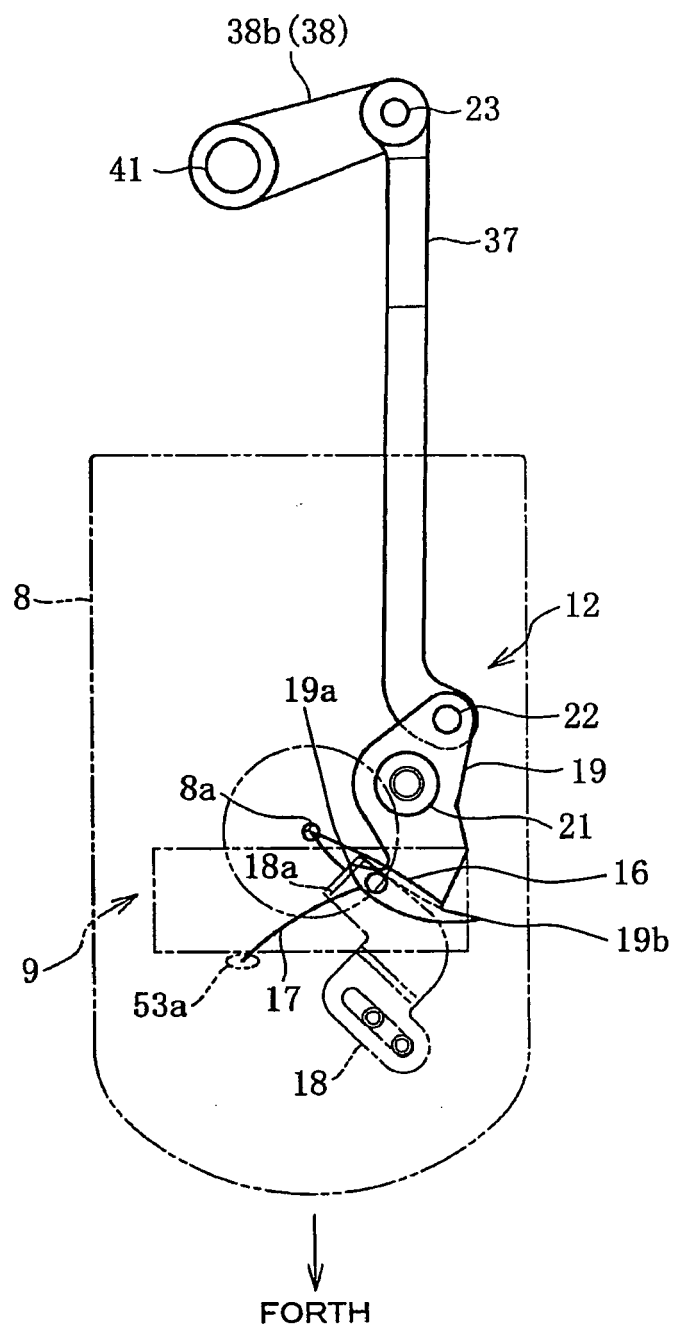


FIG. 15

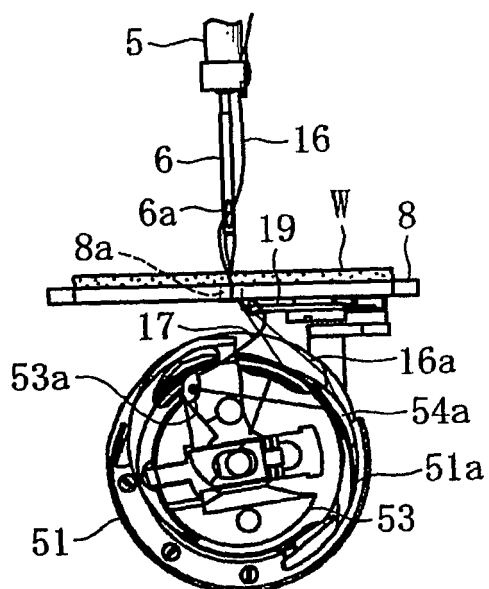


FIG. 16

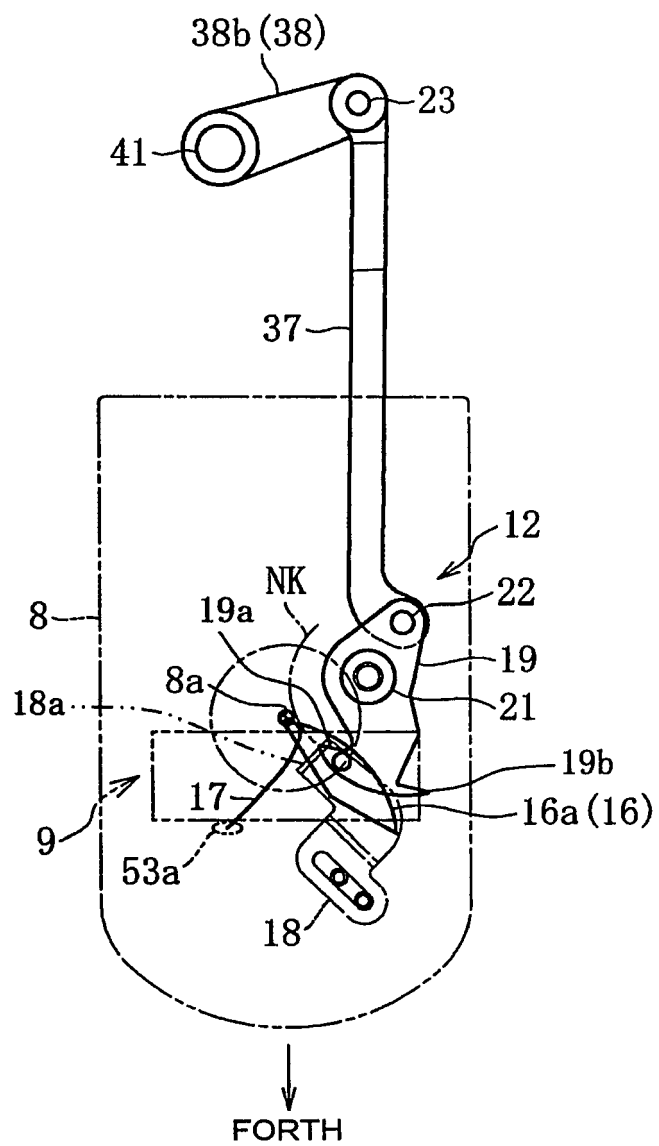


FIG. 17

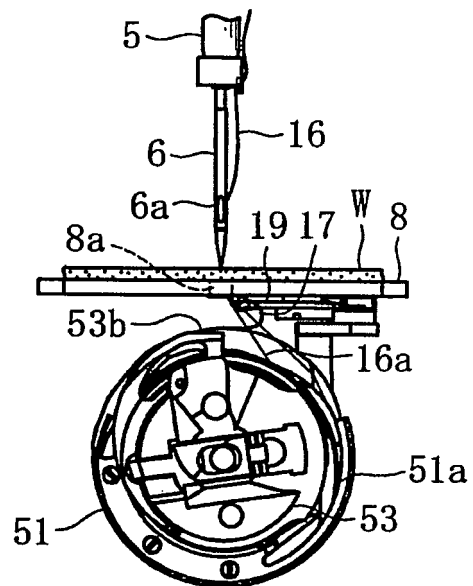
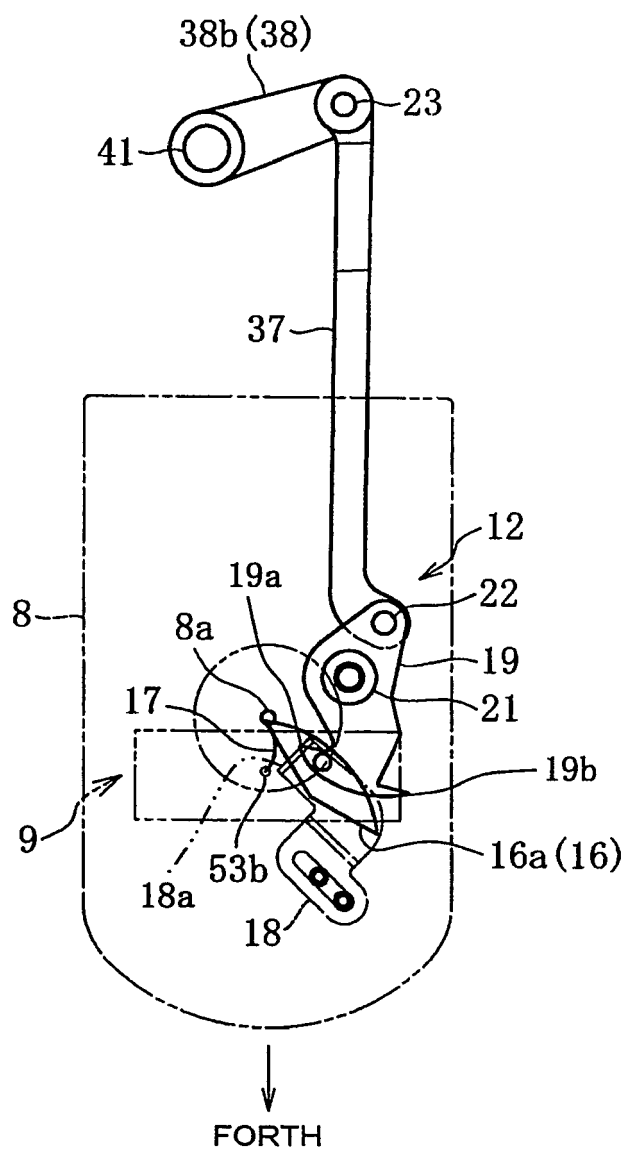


FIG. 18





EUROPEAN SEARCH REPORT

Application Number
EP 08 01 5762

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Place of search Munich		Date of completion of the search 21 January 2009	Examiner Herry-Martin, D
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