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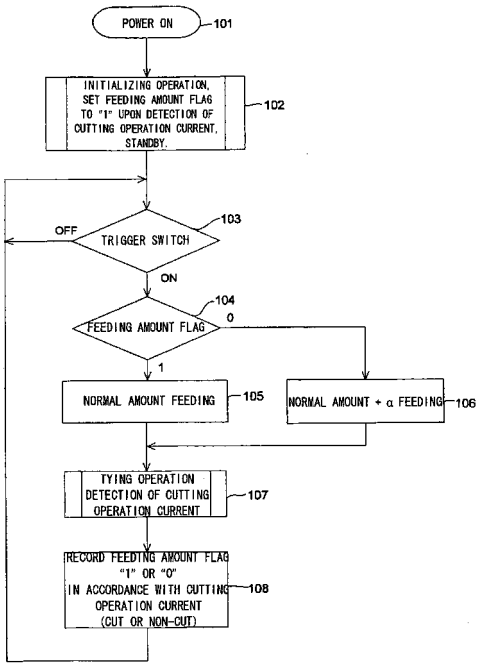
(54) REINFORCING ROD BINDING MACHINE

(57) It includes a driving load detecting device which detects a driving load amount of a tie wire cutting mechanism, and a tie wire feeding amount control device which controls a feeding amount of the tie wire in a subsequent tying operation in accordance with the detected driving load amount. If the driving load amount when cutting the tie wire is equal to or less than a cutting determination reference value, the tie wire is fed by a normal feeding amount with a predetermined amount being added thereto in the subsequent tying operation to compensate the tie wire feeding amount, whereby a tip end of the tie wire is fed to a position which is same as the position in the normal state. The subsequent tying cycle is executed normally even if the tip end of the biding wire is failed to be clamped due to the failure of the feeding operation of the tie wire and the tie wire is pulled excessively.

FIG. 5



EP 1 840 030 A1

Description

Technical Field

[0001] The present invention relates a reinforcing bar tying tool.

Background Art

[0002] An electric reinforcing bar tying tool is widely used as means for saving labor and for improving efficiency in a reinforcing bar tying work. For example, Japanese Patent No. 3496463 discloses an electric reinforcing bar tying tool including a tie wire feeding mechanism which feeds a tie wire wound around a reel so as to wind it around reinforcing bars, a tie wire cutting mechanism which cuts a rear end of a tie wire loop wound around the reinforcing bars so as to separate it from the succeeding tie wire, and a tie wire twisting mechanism which twists the tie wire loop to tie the reinforcing bars, in which, when a trigger lever is pulled, one cycle operation from the feeding of the tie wire to the twisting of the tie wire and the tying of the reinforcing bars can be executed in quite a short time.

[0003] Further, such as JP-A-2003-267307, JP-A-2004-142813, JP-A-2004-142814 disclose an electric reinforcing bar tying tool in which, after a tie wire is fed to form a tie wire loop surrounding reinforcing bars, a tie wire twisting mechanism clamps a tip end portion of the tie wire and the tie wire feeding mechanism is driven reversely to pull back the tie wire to wind the tie wire around the reinforcing bars, and then the tie wire twisting mechanism twists the tie wire loop to tie the reinforcing bars, whereby a length of the tie wire loop is adjusted in accordance with the thickness of the reinforcing bar so that a required amount of the tie wire is reduced and a binding finish is improved.

[0004] An explanation will be made below as to a problem of such a reinforcing bar tying tool in which, after a tie wire is fed to forma tie wire loop surrounding reinforcing bars, a tie wire twisting mechanism clamps a tip end portion of the tie wire and the tie wire feeding mechanism is driven reversely to pull back the tie wire to wind the tie wire around the reinforcing bars, and then the tie wire twisting mechanism twists the tie wire loop to tie the reinforcing bars.

[0005] When reversely driving the tie wire feeding mechanism to pull back the tie wire and to wind the tie wire around the reinforcing bars the tie wire twisting mechanism needs to clamp the tip end portion of the tie wire. However, there is a case where the tie wire is not placed between clamps of the tie wire twisting mechanism for some reasons such as an excessive curvature of the tie wire or an abnormality of the feeding, so that the tie wire cannot be clamped. If the tie wire is not clamped, the entire tie wire loop is pulled back at the time when the tie wire feeding mechanism is reversely driven, so that a tip end of the tie wire may move backward than a feeding start position (a cutting position of a cutter of the tie wire cutting mechanism).

[0006] Because a feeding amount of the tie wire is controlled to be constant in a reinforcing bar tying tool, when the tip end of the tie wire is moved backward than a regular position, a feeding length of the tie wire becomes insufficient in a subsequent tying cycle, whereby a tying operation cannot be performed like the preceding tying cycle which has been failed. Thus, in such a case, the tying operation is interrupted and troublesome works are required such as manually feeding the tip end of the tie wire to the regular position and setting the tie wire again.

Disclosure of the invention

[0007] One or more embodiments of the present invention provide a reinforcing bar tying tool which can execute a subsequent tying cycle properly even in a case where a tying operation is failed due to a failure in a tie wire feeing operation, whereby a troublesome work such as a resetting operation of a tie wire is eliminated.

[0008] According to one or more embodiments of the invention, a reinforcing bar tying tool includes a tie wire feeding mechanism which feeds a tie wire wound around a reel toward a tie wire guide nose so as to form a tie wire loop around reinforcing bars, a tie wire cutting mechanism which cuts a rear end portion of the tie wire loop to separate the tie wire loop from a succeeding tie wire, and a tie wire twisting mechanism which clamps and twists the tie wire loop, wherein, after forming the tie wire loop, the reinforcing bar tying tool performs steps of clamping a tip end portion of the tie wire loop, driving the tie wire feeding mechanism reversely to pull back the tie wire, cutting the rear end portion of the tie wire loop while the tie wire loop is in close contact with the reinforcing bars, and clamping and twisting both end portions of the tie wire loop, wherein the reinforcing bar tying tool further includes a driving load detecting device which detects a driving load amount of the tie wire cutting mechanism, and a tie wire feeding amount control device which controls a tie wire feeding amount in a subsequent tying operation in accordance with the driving load amount detected by the driving load detecting device, wherein, when the driving load amount is equal to or less than a cutting determination reference value in the step of cutting the tie wire, the tie wire feeding amount is compensated by feeding the tie wire with a predetermined amount being added to a normal feeding amount in the subsequent tie wire feeding.

[0009] According to the above configuration, in a case where the tie wire twisting mechanism fails to clamp the tie wire after feeding the tie wire so that the tie wire is pulled back to a position backward from an initial position passing through the tie wire cutting mechanism, a load increase due to a shearing resistance does not appear at the time of the cutting operation. Thus, it is recognized that the tie wire is pulled back to the position backward from the predetermined initial position, and the feeding

amount is increased than the normal tie wire feeding amount when starting the subsequent tying operation. Therefore, the shortage of the feeding length of the tie wire is compensated so that the tie wire is fed out to a position where the tie wire twisting mechanism can clamp the tie wire, whereby a normal tying operation is made possible.

[0010] According to one or more embodiments of the invention, the reinforcing bar tying tool monitors the driving load amount in a cutting step after the pulling step of tie wire to determine whether the cutting operation is carried out or not, and controls the subsequent tie wire feeding amount in accordance with the determination result. In a case where the clamping of the tip end portion of the tie wire is failed so that the tie wire is pulled back to the position backward from the predetermined initial position, the feeding amount is increased than the normal tie wire feeding amount when starting of the subsequent tying operation. Thus, the shortage of the feeding length of the tie wire in the subsequent tying operation is compensated, whereby awork for manually adjusting a position of the tie wire becomes unnecessary so that a degradation of working efficiency due to an interruption of the tying operation or due to a restoration work can be prevented.

Brief Description of the Drawings

[0011]

[Fig. 1] A side view of a reinforcing bar tying tool.
[Fig. 2(a)] A front view of a tie wire feeding mechanism and a tie wire cutting mechanism.
[Fig. 2(b)] A side view of the tie wire feeding mechanism and the tie wire cutting mechanism.
[Fig. 3] A side view of the tie wire feeding mechanism showing a state in which a tie wire is cut.
[Fig. 4 (a)] A front view of the tie wire feeding mechanism showing a state in which the tie wire is pulled back.
[Fig. 4(b)] A side view of the tie wire feeding mechanism showing the state in which the tie wire is pulled back.
[Fig. 5] An operational flowchart of the reinforcing bar tying tool.
[Fig. 6] A graph showing a driving current in a tie wire cutting step.

[Explanation of Reference Numerals]

[0012]

1 reinforcing bar tying tool
2 casing
3 tie wire feeding mechanism
4 tie wire twisting mechanism
5 grip portion
6 magazine
7 battery pack
8 power supply switch
9 alarm detection LED
10 twisting torque setting dial
11 tie wire guide nose
12 trigger lever
13 feed motor
14 V-grooved driving gear
15 V-grooved driven gear
19 rotary cutter
20 pin
21 cutter lever
R reinforcing bar
W tie wire

Best Mode for Carrying Out the Invention

[0013] An embodiment of the invention will be described with reference to the drawings.

[Embodiment 1]

[0014] Fig. 1 shows a reinforcing bar tying tool 1, and a tie wire feeding mechanism 3 and a tie wire twisting mechanism 4 are accommodated inside a casing 2. A tie wire reel (not shown) is loaded inside a magazine 6 disposed on a front side of the grip portion 5 of the casing 2. A battery pack 7 accommodating an NiMH battery is attached to an end portion of the grip portion 5, and supplies electric power to a feed motor of the tie wire feeding mechanism 3 and a twist motor of the tie wire twisting mechanism 4 via a power supply circuit board (not shown). A power supply switch 8, an alarm detection LED 9 and a twisting torque setting dial 10 are disposed on an upper surface of a rear portion of the reinforcing bar tying tool 1, an alarm detection buzzer (not shown) is accommodated inside the casing 2.

[0015] When the battery pack 7 is attached to the reinforcing bar tying tool 1 and the power supply switch 8 is turned on, the reinforcing bar tying tool 1 executes an initializing operation, whereby the tie wire feeding mechanism 3 feeds the tie wire by a certain length toward a tie wire guide nose 11 disposed on an upper side, and a rotary cutter of a tie wire cutting mechanism, which will be described later, cuts a tip end portion of the tie wire to position a tip end of the tie wire. The tie wire twisting mechanism 4 performs a series of operations including a clamping operation and a twisting operation in a state in which the tie wire is not clamped, and then stops at its initial position and is placed in a standby state. After being placed in the standby state, and once a trigger lever 12 is pulled, one cycle of a reinforcing bar tying operation including a tie wire feeding, a tie wire clamping, a tie wire pulling back, a tie wire cutting and a tie wire twisting is continuously executed.

[0016] A control portion (not shown) monitors a voltage of the battery pack 7 during the tying operation via a voltage detection circuit, and when the voltage of the battery pack 7 reduces to a predetermined charge recommen-

dation voltage, the control portion sounds a buzzer and lights the alarm detection LED 9 to notify the voltage reduction. Further, the control portion monitors a driving current of the twist motor during the tying operation via the current detection circuit serving as a driving load detecting device, and controls a tie wire feeding amount, which will be described later, in accordance with a current value at the time when the tie wire cutting mechanism driven by the twist motor performs the cutting operation.

[0017] As shown in Fig. 2 (a), the tie wire feeding mechanism 3 includes a V-grooved driving gear 14 driven by a feed motor 13, and a V-grooved driven gear 15 engaging with the V-grooved driving gear 14, and is configured in such a manner that the V-grooved driving gear 14 and the V-grooved driven gear 15 clamp and feed the tie wire. The tie wire W is fed out upwardly from a tie wire reel inside the magazine. The tie wire W thus fed out is formed in an arc shape along the guide groove on an inner periphery of the tie wire guide nose 11 shown in Fig. 1, and goes around an outer periphery of reinforcing bars R, and the tip end of the tie wire passes between clamps of the tie wire twisting mechanism 4.

[0018] As shown in Figs. 2 (a) and 2 (b), the V-grooved driven gear 15 is attached to a lever 16, and is elastically brought in contact with the V-grooved driving gear 14 by a spring force of a compression coil spring 17 attached to the lever 16. When a lower end portion of the lever 16 is pushed toward a center side (a left side in Fig. 2(a)), the V-grooved driven gear 15 attached to an upper portion of the lever 16 moves away from the V-grooved driving gear 14 disposed on a side of the feed motor 13, whereby the tie wire W can be passed between the V-grooved driving gear 14 and the V-grooved driven gear 15. A tie wire guide 18 of a funnel shape is provided beneath a center portion between the V-grooveddriving gear 14 and the V-grooved driven gear 15, so that the tie wire W is passed through the tie wire guide 18 from below and is set between the V-grooved driving gear 14 and the V-grooved driven gear 15.

[0019] A rotary cutter 19 which cuts a tie wire is disposed above the tie wire feeding mechanism 3. The rotary cutter 19 has a known including a pin 20 of a column shape formed with a groove along its diameter direction, and a cutter lever 21 fitted to the pin 20. A cutter portion 21a corresponding to the groove of the pin 20 is formed at a portion where the cutter lever 21 is fitted to the pin, and when the cutter lever 21 is rotated with the tie wire being passed through the groove of the pin 20, the cutter portion 21a of the cutter lever 21 cuts the tie wire W at an outer peripheral position of the pin 20.

[0020] Although not shown, an end portion of the cutter lever 21 is coupled to a slider of the tie wire twisting mechanism 4 via a link, and the end portion of the cutter lever 21 rotates from its initial position shown in Fig. 2(b) in a direction shown by an arrow interlockingly with a movement of the tie wire twisting mechanism 4 to cut the tie wire, and returns to the initial position interlockingly with the tie wire twisting mechanism after the cutting of the tie wire as shown in Fig. 3.

[0021] The tie wire twisting mechanism 4 is a known mechanism including a twist shaft not shown in Fig. 1, and three clamp plates attached to an end of the twist shaft. The three clamp plates is disposed at an inner side of a side cover 23 located between the tie wire guide nose 11 and a lower side guard 22, and two of the clamp plates disposed on respective sides of a fixed center clamp plate are opened and closed by a cam mechanism.

[0022] The tie wire is fed out through a space between the center clamp plate and one of the outer side clamp plates. The control portion stops the feeding of the tie wire after feeding the tie wire by a length corresponding to a set number of turns, whereat the tip end of the tie wire reaches a predetermined position at the tie wire guide nose 11. Then, the clamp plates of the tie wire twisting mechanism 4 clamp the tip end side of the tie wire loop and pull the tie wire back, and at the same time, the tie wire twisting mechanism 4 slides so that the cutter lever 21 of the tie wire cutting mechanism is rotated via the link to cut the rear end of the tie wire loop, whereby the tie wire loop is separated from the succeeding tie wire. Subsequently, the clamp plates of the tie wire twisting mechanism 4 also clamp the rear end side of the tie wire loop, and twists the tie wire loop by rotating the twist shaft and the clamp plates, so that the reinforcing bars are tied together, and the twisting operation is stopped when the twisting torque of the twist motor reaches up to a certain set value. Thereafter, the twist motor is rotated reversely to open the clamp plates to return the twist shaft to its initial position, where by one cycle of the tying operation is completed.

[0023] After the initializing operation at the time when turning-on of the power supply, and after the normal tying operation, the tip end of the tie wire W on a side of the reel is positioned at the outer peripheral position of the pin 20 of the rotary cutter 19 as shown in Fig. 3. However, in a case where the clamp of the tie wire twist mechanism failed to clamp the tip end of the tie wire after the feeding of the tie wire, the tie wire W is pulled back by a length equal to or larger than a fed length upon the tie wire pulling back step after the tie wire feeding step. Thus, as shown in Figs. 4 (a) and 4 (b), the tip end of the tie wire W is moved backward than the predetermined position shown in Fig. 3. As described as the problem of the background art, there is a trouble in the tying operation of the subsequent cycle in such a case.

[0024] A counter measure of the present invention against this problem will be explained in accordance with a flowchart shown in Fig. 5. When the tie wire W is passed between the V-grooved driving gear 14 and the V-grooved driven gear 15 of the tie wire feeding mechanism and the power supply switch 8 is turned on (step 101), the control portion of the reinforcing bar tying tool 1 executes the initializing operation (step 102). At this time, the tie wire feeding mechanism 3 slightly feeds the tie wire W, and the tie wire W is cut at the predetermined position as shown in Fig. 4, while the tie wire twisting

mechanism 4 executes the clamping and twisting operations in a state in which the tie wire is not supplied, whereby all the mechanisms are stopped at their initial positions, and are placed in the standby state.

[0025] As described above, the control portion monitors the driving current of the twist motor via the current detection circuit, and determines whether it is a cutting operation or a lost operation in which the tie wire is not passed through the rotary cutter 19, in accordance with a current value at the time when the rotary cutter 19 driven by the twist motor performs the cutting operation. The control portion writes "1" as a feeding amount flag in a RAM when the cutting operation is detected, and writes "0" as the feeding amount flag in the RAM in a case of a non-cutting operation. A graph in Fig. 6 shows the driving current of the twist motor. As shown in the graph, a high current peak appears due to a shearing resistance at the time of cutting of the tie wire. In contrast, when it is an abnormal state (the case of the non-cutting operation), a high current peak does not appear and the graph shows a flat current line since there is no shearing resistance of the tie wire. The control portion determines whether the operation is normal or abnormal in accordance with a presence or an absence of such a peak. A cutting determination reference value for determining the cutting operation is predetermined in accordance with a verification result of measuring the current at the time of an actual operation.

[0026] When the trigger lever 12 is turned on in the standby state after the execution of the initialization (step 103), the tie wire feeding amount control is executed in such a manner that the tie wire feeding amount of the tie wire feeding mechanism 3 is controlled based on the feeding amount flag (step 104). Right after the initialization, the feeding amount flag is "1" which represents the normal state so that the tie wire is fed by a regular amount (step 105), whereby the series of the tying operation is executed in which the tie wire twisting mechanism 4 clamps the tip end portion of the tie wire, the tie wire feeding mechanism is driven reversely to pull back the tie wire, the rear end portion of the tie wire is clamped, the tie wire cutting mechanism performs the cutting, and then the tie wire twisting mechanism performs the twisting (step 107).

[0027] It is determined whether the rotary cutter 19 has cut the tie wire or the lost operation is executed in accordance with the presence or the absence of the prescribed peak of the driving current of the twist motor during the tying operation, and the feeding amount flag "1" (the normal state) or "0" (the abnormal state) is recorded accordingly, and is placed in the standby state.

[0028] When an abnormal state arises in which the tie wire twisting mechanism 4 failed to clamp the tie wire W after the feeding of the tie wire and the tie wire W is pulled back to the predetermined position or more as shown in Fig. 4, the rotary cutter 19 cannot cut the tie wire so it performs the lost operation. Since the predetermined peak of the twist motor driving current does not appear in this case, the feeding amount flag "0" is written in step 108. When the trigger lever 12 is turned on in the subsequent operation, the process proceeds from step 103 to step 106 in accordance with the feeding amount flag "0", whereby an amount obtained by adding a predetermined amount α (a difference L between the predetermined position shown in the figure and the pulled back position) to the normal feeding amount is fed. Thus, the tip end of the tie wire W passes between the clamps of the tie wire twisting mechanism 4 and is clamped normally, whereby a manual resetting work of the tie wire can be eliminated, unless there is a remarkable deformation or damage in the tie wire W.

[0029] Meanwhile, although the configuration in which the driving load detecting device detects the load amount fro, the current value, instead of such a configuration, a driving load detecting device may be configured to detect the load amount from a voltage or a rotation speed of the twist motor, and various modification may be made within the technical scope of the invention. It is apparent that the invention covers such modifications.

[0030] Although the invention is explained with reference to a particular embodiment, it will be obvious for those skilled in the art that various changes and modifications may be made without departing from the scope and spirit of the invention.

[0031] The present application is based on Japanese Patent Application (Japanese Patent Application No. 2005-012209) filed on January 20, 2005, the content of which is incorporated herein by reference.

Industrial Applicability

[0032] In a reinforcing bar tying tool in which a tie wire wound around reinforcing bars is pulled back to place in a closely contact state and is twisted thereafter to tie the reinforcing bars, the subsequent tie wire feeding operation can be performed normally even in a case where the tip end of the biding wire is failed to be clamped so that the tie wire is pulled back excessively.

Claims

1. A reinforcing bar tying tool comprising:

a tie wire feeding mechanism which feeds a tie wire to form a tie wire loop around reinforcing bars;
a tie wire cutting mechanism which cuts a rear end of the tie wire loop to separate the tie wire loop from a succeeding tie wire;
a tie wire twisting mechanism which clamps and twists the tie wire loop;
a driving load detecting device which detects a driving load amount of the tie wire cutting mechanism; and
a tie wire feeding amount control device which

controls a tie wire feeding amount of the tie wire feeding mechanism in a subsequent tying operation in accordance with the driving load amount detected by the driving load detecting device.

2. The reinforcing bar tying tool according to claim 1, wherein when the driving load amount detected by the driving load detecting device is equal to or less than a cutting determination reference value, the tie wire feeding amount control device controls so as to feed the tie wire by a normal tie wire feeding amount with an a predetermined amount added thereto in a subsequent tie wire feeding.

3. The reinforcing bar tying tool according to claim 1, wherein when the driving load amount detected by the driving load detecting device is larger than a cutting determination reference value, the tie wire feeding amount control device controls so as to feed the tie wire by a normal tie wire feeding amount with an a predetermined amount added thereto in a subsequent tie wire feeding.

4. The reinforcing bar tying tool according to claim 1, wherein the tie wire cutting mechanism cuts the rear end of the tie wire loop in a state in which the tie wire loop is brought into a close contact with the reinforcing bars by clamping a tip end of the tie wire loop with the tie wire twisting mechanism and by driving the tie wire feeding mechanism reversely to pull back the tie wire.

5. The reinforcing bar tying tool according to claim 1, wherein the driving load detecting device detects the driving load amount of the tie wire cutting mechanism based on a current value.

6. The reinforcing bar tying tool according to claim 1, wherein the driving load detecting device detects the driving load amount of the tie wire cutting mechanism based on a voltage value.

7. The reinforcing bar tying tool according to claim 1, wherein the driving load detecting device detects the driving load amount of the tie wire cutting mechanism based on a rotation speed of a motor which drives the tie wire cutting mechanism.

FIG. 1

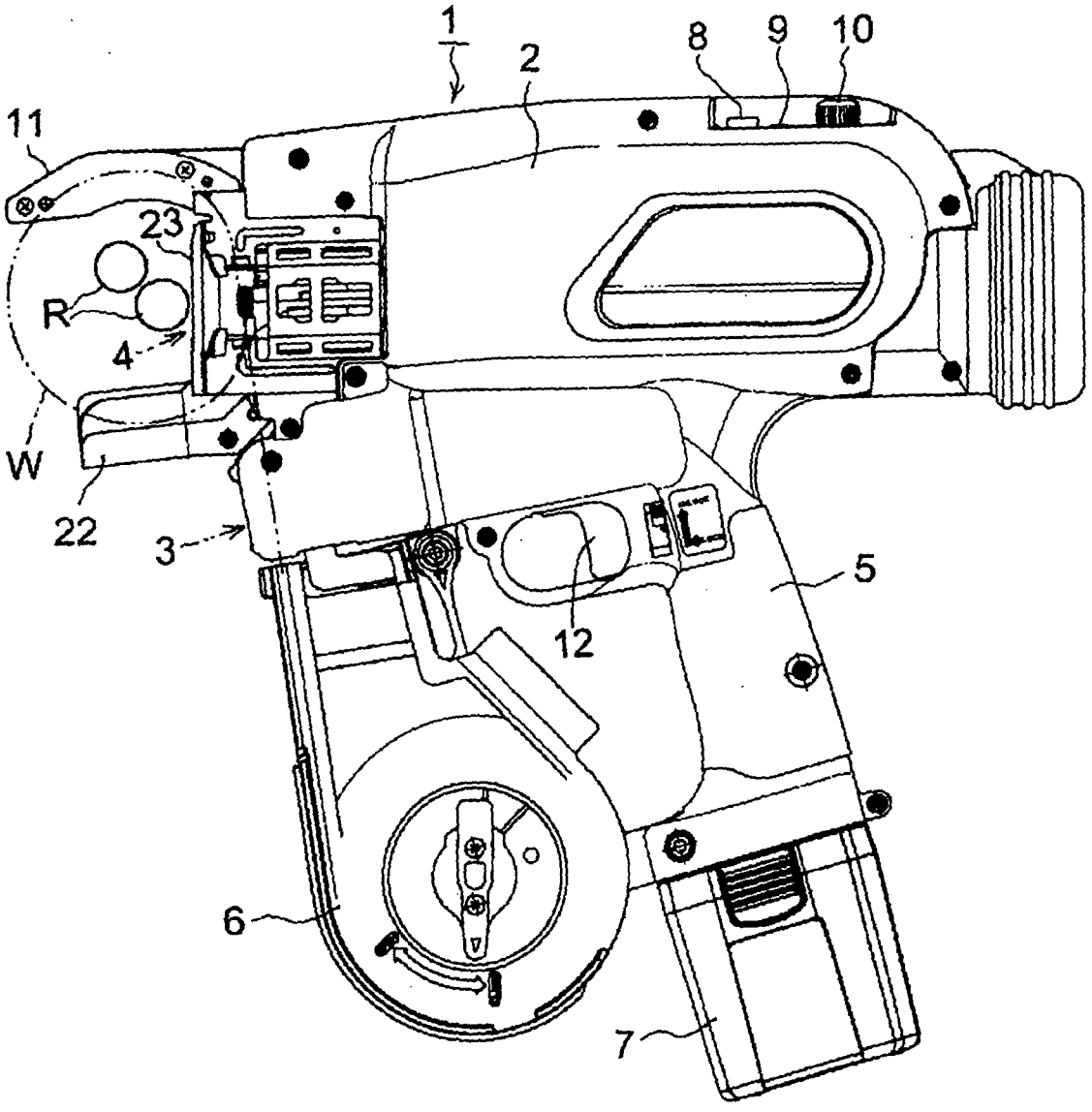


FIG. 2(b)

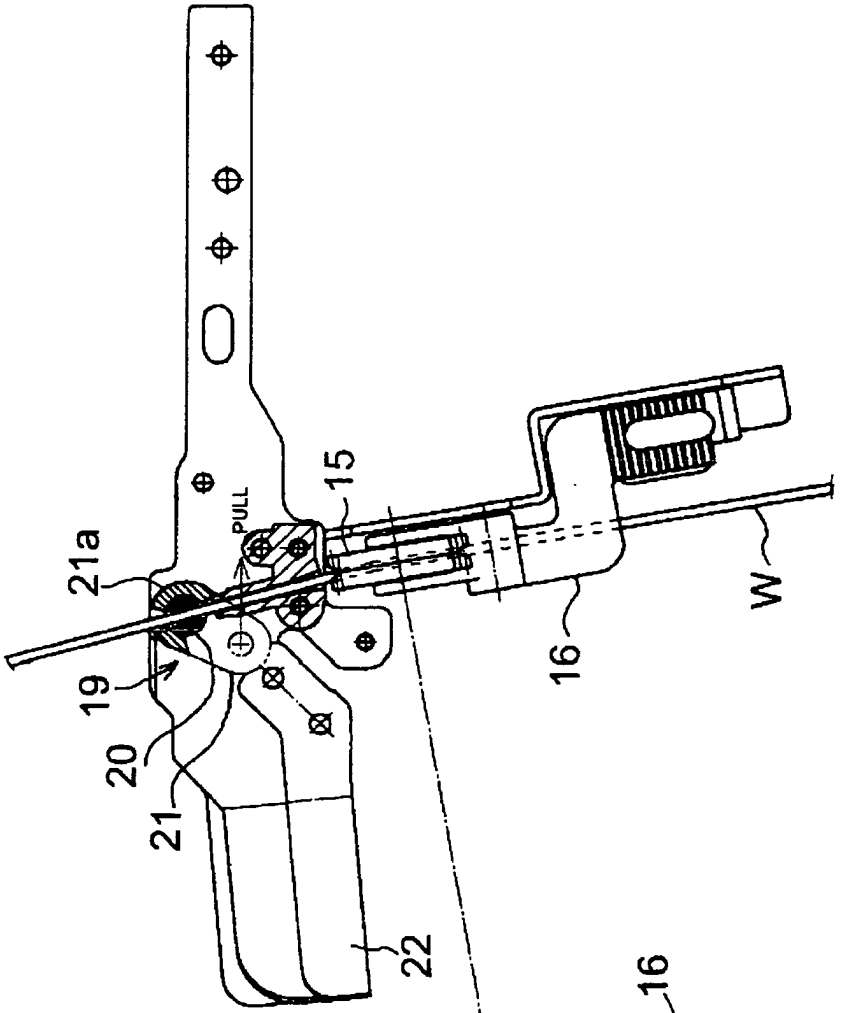


FIG. 2(a)

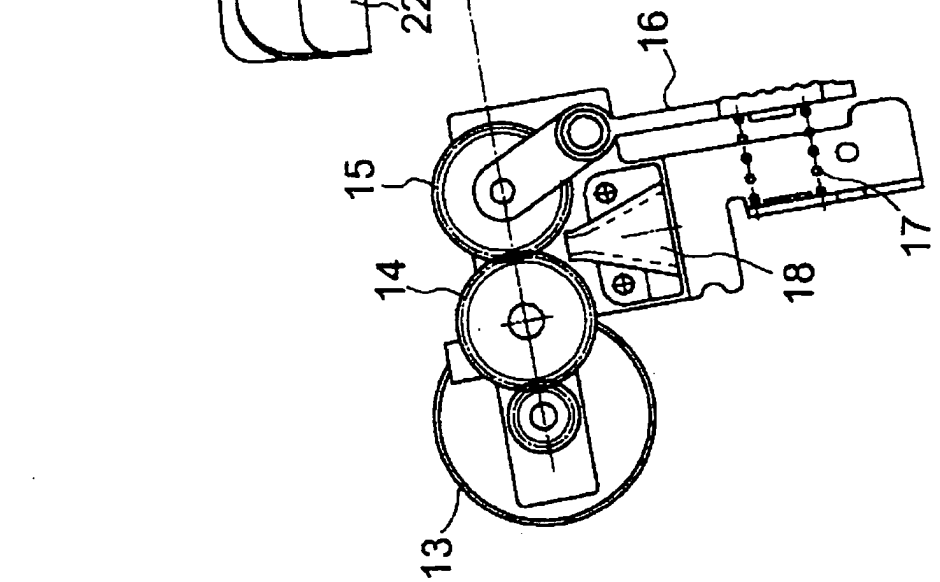


FIG. 3

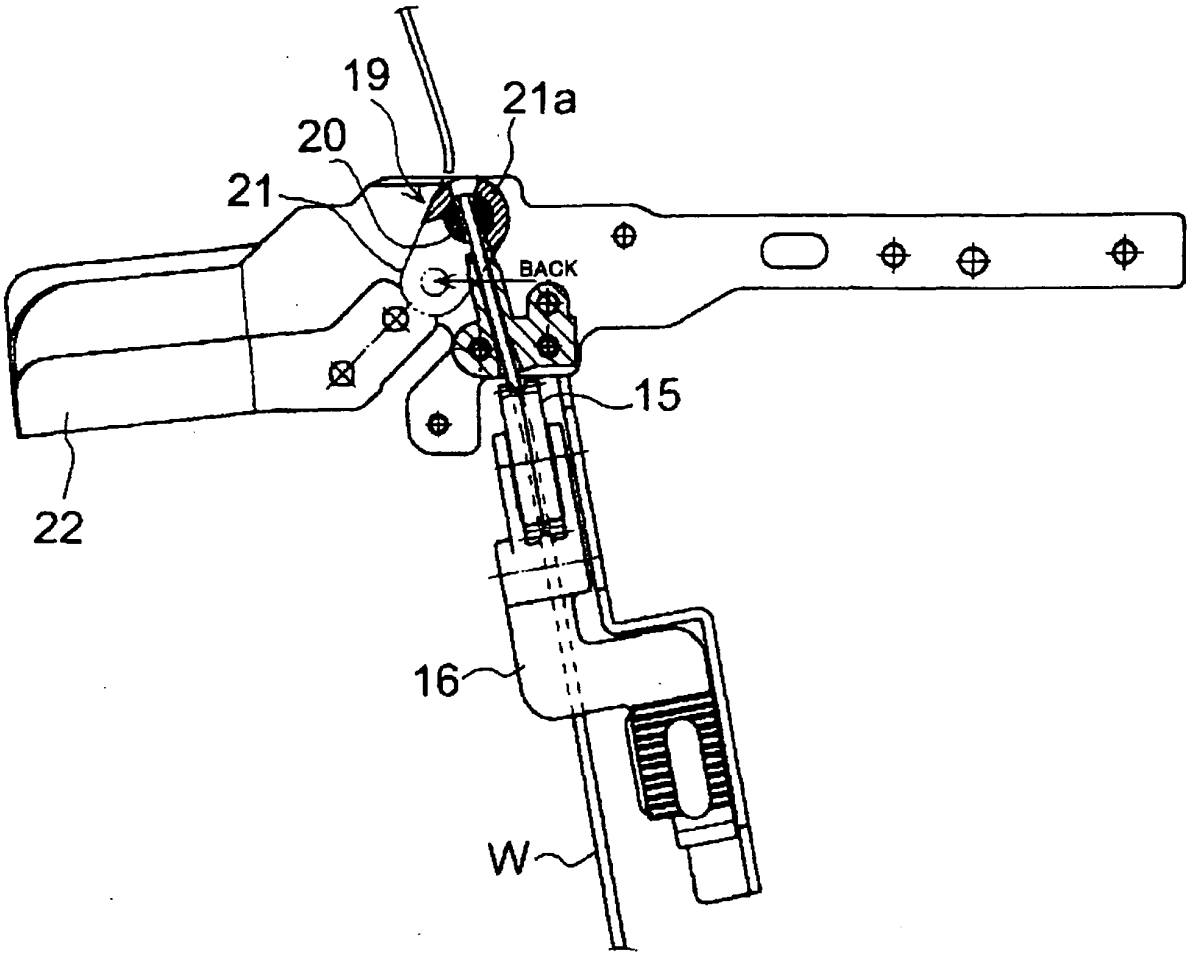


FIG. 4(b)

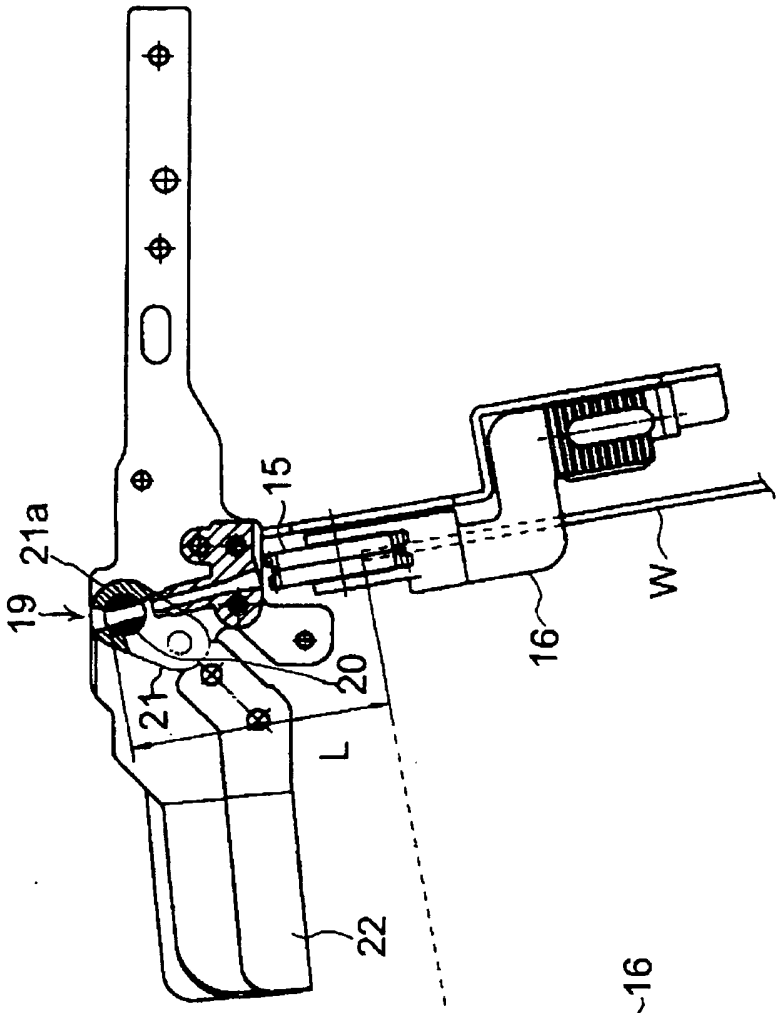


FIG. 4(a)

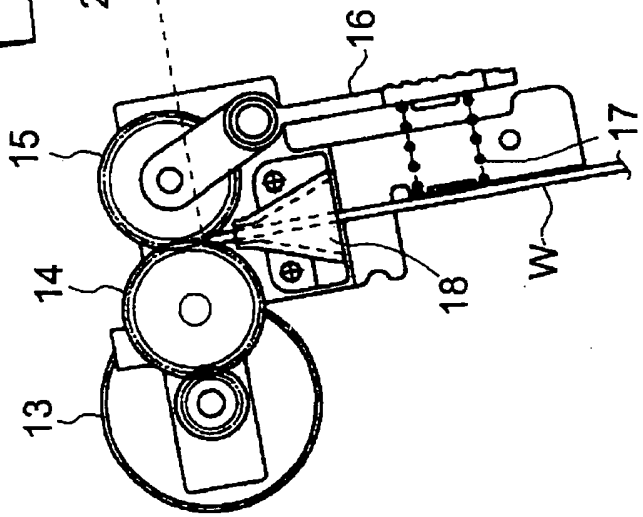


FIG. 5

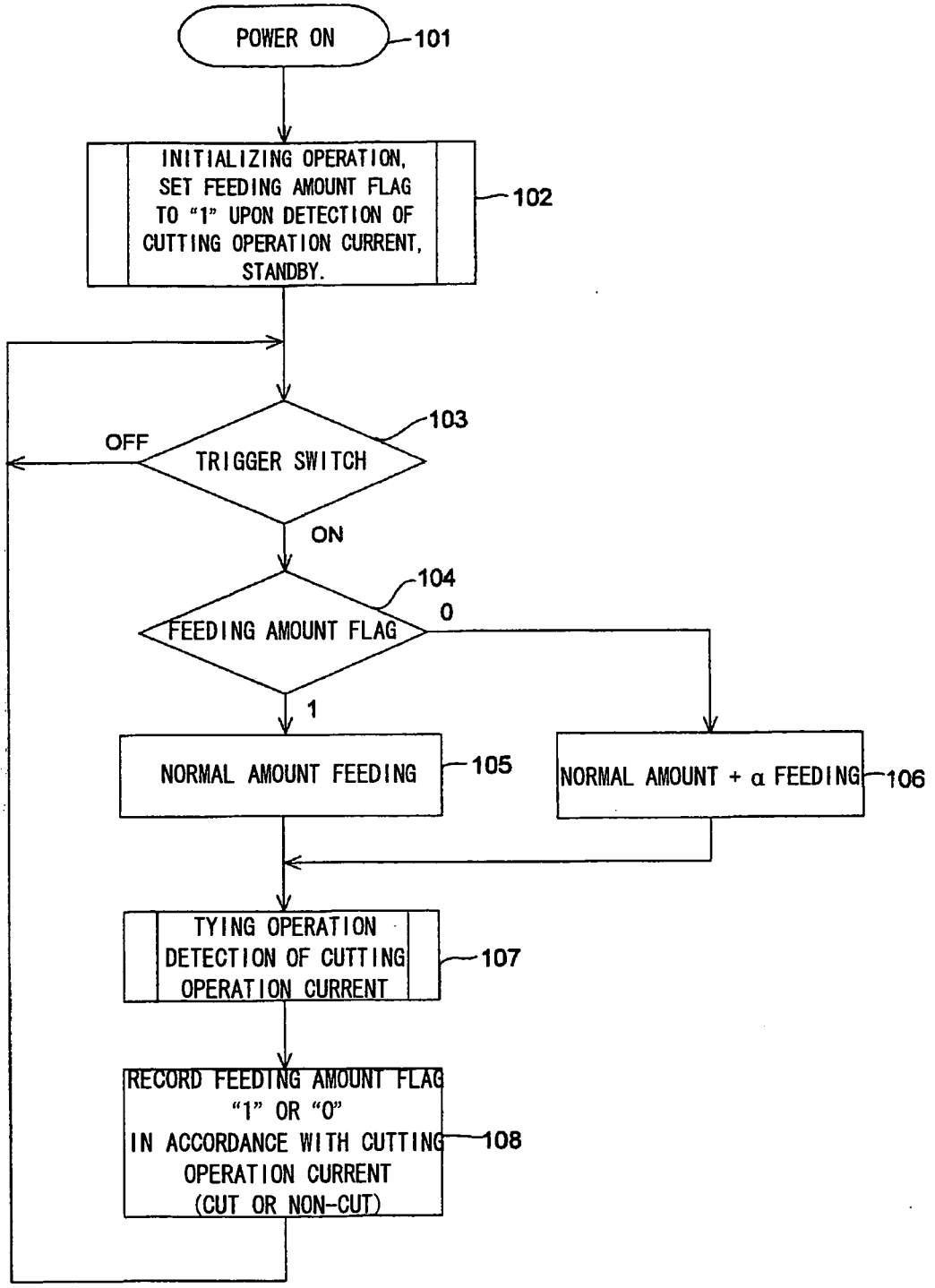
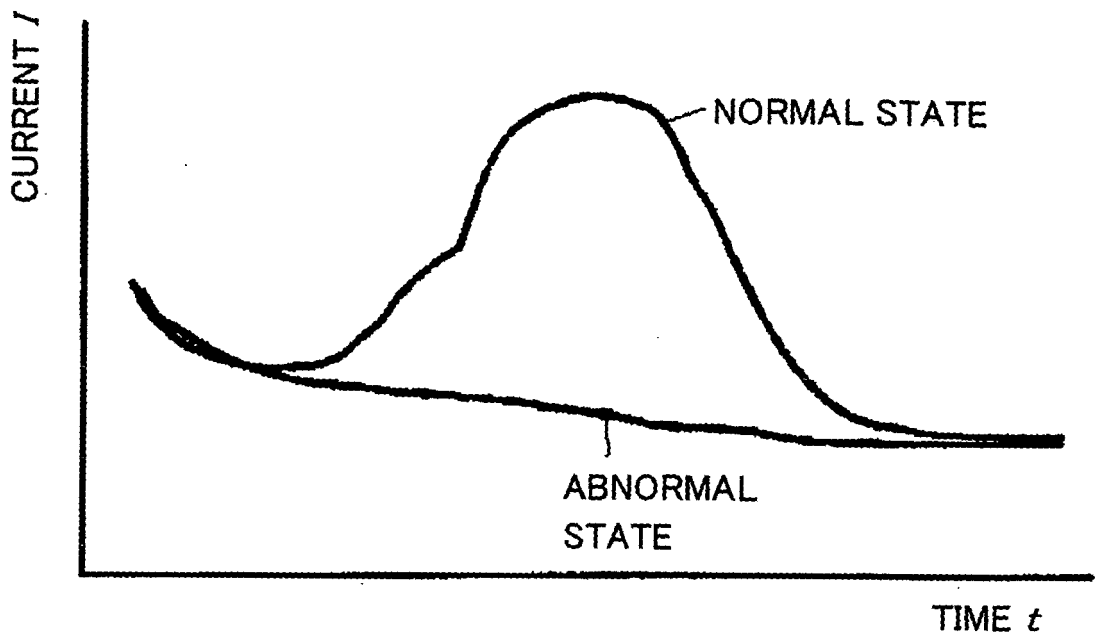

POWER ON
101
INITIALIZING OPERATION, SET FEEDING AMOUNT FLAG TO "1" UPON DETECTION OF CUTTING OPERATION CURRENT, STANDBY.
102
TRIGGER SWITCH
103
OFF
ON
FEEDING AMOUNT FLAG
104
0
1
NORMAL AMOUNT FEEDING
105
NORMAL AMOUNT + α FEEDING
106
TYING OPERATION DETECTION OF CUTTING OPERATION CURRENT
107
RECORD FEEDING AMOUNT FLAG "1" OR "0" IN ACCORDANCE WITH CUTTING OPERATION CURRENT (CUT OR NON-CUT)
108

FIG. 6



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2005/024235

A. CLASSIFICATION OF SUBJECT MATTER
B65B13/18(2006.01), ***B65B13/28***(2006.01), ***E04G21/12***(2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B65B13/00-13/34, B65B27/00-27/12, E04G21/12, B21F7/00, B21F15/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2006
Kokai Jitsuyo Shinan Koho 1971-2006 Toroku Jitsuyo Shinan Koho 1994-2006

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2004-142782 A (Max Co., Ltd.), 20 May, 2004 (20.05.04), Claims; Figs. 6 to 15, 17, 20 (Family: none)	1-7
A	JP 10-45105 A (Max Co., Ltd.), 17 February, 1998 (17.02.98), Par. Nos. [0013] to [0016]; Figs. 1, 3 to 4 & EP 822303 A1 & US 5874816 A	1-7

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 January, 2006 (24.01.06)	07 February, 2006 (07.02.06)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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