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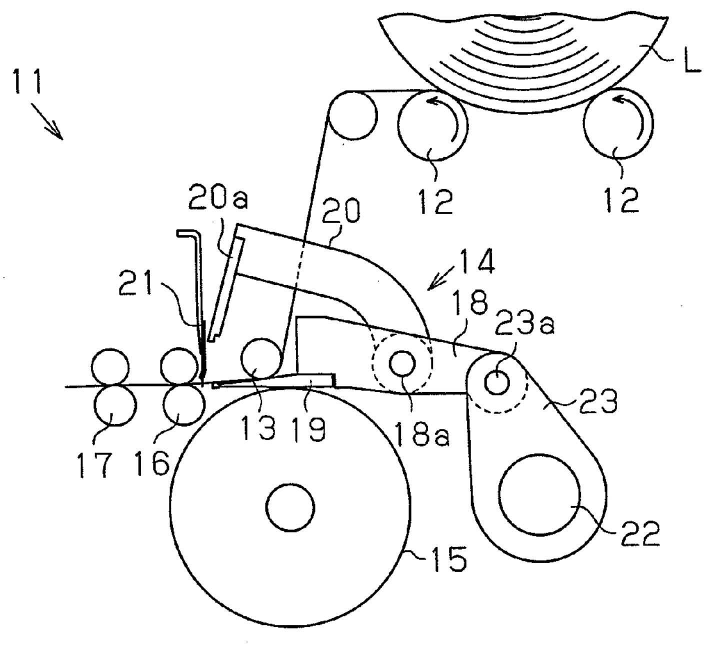
(54) **Comber**

(57) A comber includes first and second detaching rollers arranged forward of and rearward of each other. The first and second detaching rollers are rotated in a forward direction and a reverse direction in synchronization with swinging motion of a nipper frame. A first roller shaft of the first detaching roller is driven at both axial ends by two first motors, which can rotate in a forward direction and a reverse direction. A second roller shaft of the second detaching roller is driven at both axial ends by two second motors, which can rotate in a forward direction and a reverse direction. The first motors and the second motors are driven in synchronization with each other.

Fig.1



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a comber, and more specifically, to a comber characterized in the structure of detaching rollers.

[0002] A comber includes a nipper device and a combing cylinder. Supplied lap is held by the nipper device at a retreat position of the nipper device. The distal end of the combed lap is combed with the combing cylinder. This removes short fibers from the lap, turning the lap into fleece. As the nipper device advances, the fleece is moved toward detaching rollers. The detaching rollers are rotated in a reverse direction in response to the advance of the fleece, and fleece that has been taken before (preceding fleece) is retreated. Then, the trailing end of the preceding fleece and the advancing end of the newly combed fleece (succeeding fleece) are overlapped. Thereafter, the detaching rollers are rotated in a forward direction, so as to take the fleece from the nipper device for joining the succeeding fleece to the preceding fleece. The trailing end of the succeeding fleece is combed with a top comb.

[0003] Detaching rollers are typically driven by rotation of the drive shaft of a combing cylinder driven by a main motor, which rotation is transmitted via a gear device. The gear device has a very complicated structure, and an object having a relatively great mass needs to be pivoted back and forth by the detaching rollers. Accordingly, a comber has been proposed in which detaching rollers are driven by a dedicated motor (see Japanese Laid-Open Patent Publication No. 2-216225). In the comber of Japanese Laid-Open Patent Publication No. 2-216225, gears 53a, 54a are fixed to first ends of shafts 53, 54 of detaching rollers 51, 52 as shown in Fig. 4. The gears 53a, 54a are integrally rotatable with the shafts 53, 54. The gears 53a, 54a are meshed with a gear 57, which is driven by an electric motor 55 via a belt transmission device 56. The electric motor 55 can be rotated in a forward direction and in a reverse direction. In this device, the detaching rollers 51, 52 are rotated in a forward direction or in a reverse direction in accordance with the rotation direction of the electric motor 55.

[0004] Japanese Laid-Open Patent Publication No. 2-216225 also discloses a structure in which the shafts 53, 54 are driven by different electric motors 55. Specifically, the structure shown in Fig. 4 is modified by removing the gear 54a of the shaft 54, such that the motor 55 drives only the shaft 53 via the belt transmission device 56 and the gears 57, 53a. On the other hand, a second electric motor, which rotates in forward and reverse directions, is provided at a second end of the shaft 54. The shaft 54 is driven by the second electric motor via a belt transmission device and a gear that are similar to the ones provided at the first end.

[0005] Chinese Patent Publication No. CN100999837A proposes a configuration in which a single detaching roller is driven by motors each provided at one of the ends. According to Chinese Patent Publication No. CN100999837A, a first detaching roller 61 is driven by servomotors 62, 63 at both ends as shown in Fig. 5, and a second detaching roller 64 is driven via timing belts 65.

[0006] Atypical comber has an operational portion in which eight combing heads are arranged, and the shafts of detaching rollers have a length extending over the entire length of the operational portion. According to the structure of Japanese Laid-Open Patent Publication No. 2-216225, one end of the shaft of each detaching roller is driven. This configuration is likely to generate torsion in the shaft. In recent years, the speed of combers has been desired to be increased to raise the productivity. However, increased speed of a comber creates greater torsion.

[0007] In the configuration of Chinese Patent Publication No. CN100999837A, in which the ends of the first detaching roller are driven by motors, and the second detaching roller is driven via timing belts, the durability of the timing belts is not sufficient for rotating the detaching roller at an increased rotational speed (for example, a rotational speed corresponding to a rotational speed of a combing cylinder that is 300 rpm or higher).

SUMMARY OF THE INVENTION

[0008] Accordingly, it is an objective of the present invention to provide a comber capable of driving detaching rollers, which require high torque, at a high speed.

[0009] To achieve the foregoing objective and in accordance with one aspect of the present invention, a comber is provided that includes first and second detaching rollers arranged forward of and rearward of each other. The first and second detaching rollers are rotated in a forward direction and a reverse direction in synchronization with swinging motion of a nipper frame. A first roller shaft of the first detaching roller is driven at both axial ends by two first motors, which can rotate in a forward direction and a reverse direction. A second roller shaft of the second detaching roller is driven at both axial ends by two second motors, which can rotate in a forward direction and a reverse direction. The first motors and the second motors are driven in synchronization with each other.

[0010] Other aspects and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The invention, together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

Fig. 1 is a schematic side view showing a combing head according to one embodiment of the present invention;

Fig. 2A is schematic plan view illustrating the detaching rollers shown in Fig. 1;

Fig. 2B is a diagram showing the positional relationship between the detaching rollers and the motors;

Fig. 3 is a diagram corresponding to Fig. 2B, showing another embodiment;

Fig. 4 is a schematic plan view showing a conventional detaching roller driving portion; and

Fig. 5 is a schematic plan view showing another conventional detaching roller driving portion.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0012] One embodiment of the present invention will now be described with reference to Figs. 1 to 2B.

[0013] A typical comber has an operational portion, in which eight combing heads are arranged. As shown in Fig. 1, a combing head 11 includes a nipper device 14 having a pair of lap rollers 12 and a feed roller 13, a combing cylinder 15, and two pairs of detaching rollers 16, 17, each pair of which are arranged along the front-back direction. The nipper device 14 has a nipper frame 18, which is located above the combing cylinder 15 to be swingable along the advancing and retreating directions. A bottom nipper 19 is provided at the bottom of the nipper frame 18. A nipper arm 20 is pivotably connected to the nipper frame 18 with a support shaft 18a, and a top nipper 20a is fixed to the distal end of the nipper arm 20. In synchronization with the motion of the nipper frame 18 in the advancing and retreating directions, the top nipper 20a opens and closes at predetermined timing to pinch lap L in cooperation with the bottom nipper 19. A top comb 21 is attached to the nipper frame 18. The top comb 21 is located forward of the bottom nipper 19 and performs a predetermined action in synchronization with the nipper frame 18.

[0014] A nipper shaft 22 that is pivoted back and forth is located rearward of the combing cylinder 15 and below the nipper frame 18. A first end of a nipper frame driving arm 23 is fixed to the nipper shaft 22 to pivot integrally with the nipper shaft 22. The rear end of the nipper frame 18 is pivotally supported by a second end of the nipper frame driving arm 23 with a support shaft 23a. The nipper frame 18 is configured to be swung back and forth such that the distal end of the bottom nipper 19 approaches and separates from the detaching rollers 16, 17 by back-and-forth pivoting (swinging motion) of the nipper shaft 22.

[0015] The structure of a driving portion of the detaching rollers 16, 17 will now be described with reference to Figs. 2A and 2B. As shown in Fig. 2A, a gear box 24 is provided at each end of the comber along the longitudinal direction (left-right direction as viewed in Fig. 2A). Shafts 25, 26 of the detaching rollers 16, 17 are arranged to be parallel to each other between the gear boxes 24. The ends of the shafts 25, 26 protrude into the gear boxes 24 and rotatably supported by the gear boxes 24 via bearings (not shown). Gears 27, 28 are fixed to the ends of the shafts 25, 26, respectively, to rotate integrally with the shafts 25, 26. The gears 27, 28 are formed to have the same number of teeth and the same diameter.

[0016] Two servomotors 29, 30 are attached to each gear box 24 to correspond to the shafts 25, 26, respectively. The servomotors 29, 30 have motor shafts 29a, 30a projecting into the gear boxes 24, respectively. Drive gears 31, 32 are fixed to the motor shafts 29a, 30a to rotate integrally, respectively. The drive gears 31, 32 are formed to have the same number of teeth and the same diameter with the gears 27, 28. Each gear box 24 has in it an idle gear 33, which is meshed with the gear 27 and the drive gear 31, and an idle gear 34, which is meshed with the gear 28 and the drive gear 32. The idle gears 33, 34 are formed to have the same number of teeth and the same diameter. That is, the shafts 25, 26 are driven via gear trains between the motor shafts 29a, 30a and the shafts 25, 26, and the gear trains include the idle gears 33, 34. The shafts 25, 26 are rotated at the same rotational speed as the motor shaft 29a, 30a, respectively (a ratio of rotational speed of 1:1). The servomotors 29, 30 are driven in synchronization by a controller (not shown) to rotate in a forward direction or a reverse direction.

[0017] Operation of the device configured as described above will now be described.

[0018] The nipper shaft 22 is swung (pivoted back and forth) by a main motor (not shown).

[0019] In accordance with the swinging motion of the nipper shaft 22, the bottom nipper 19 is swung back and forth, and the top nipper 20a is swung up and down. Accordingly, the lap L is held and released between the top nipper 20a and the distal end of the bottom nipper 19. As the servomotors 29, 30 provide drive force, the detaching rollers 16, 17 are swung integrally with the shafts 25, 26 via the gear trains. The swinging motion of the detaching rollers 16, 17 is synchronized with advance and retreat of the bottom nipper 19. The detaching rollers 16, 17 are rotated in the reverse direction when the bottom nipper 19 advances, and are rotated in the forward direction when the bottom nipper 19 retreats.

[0020] The shaft 25 is driven at both axial ends by two servomotors 29. The shaft 26 is driven at both axial ends by two servomotors 30. The servomotors 29 and the servomotors 30 are driven in synchronization with each other so that the shafts 25, 26 are driven to be synchronized with each other. In other words, the two shafts 25, 26 are driven by four motors. Thus, if motors of the same performance are used, it is possible to drive the detaching rollers 16, 17 with a torque that is twice the torque of the conventional art. Since the shafts 25, 26 are swung (pivoted back and forth) at a high speed (for example, 300 rpm), the shafts 25, 26 have greater torsion than a case in which the shafts 25, 26 are rotated in one direction at a constant speed. However, since both ends of the shafts 25, 26 are driven by the servomotors 29 and the servomotors 30, respectively, the amount of torsion is quarter the torsion generated in a structure where shafts 25, 26 are driven only at one side. If the lengths of the shafts 25, 26 are not changed, the resonance frequency of the structure in which the shafts 25, 26 are driven at both ends is higher than the resonance frequency of a structure in which shafts 25, 26 are each driven at one end. Therefore, when the speed of the comber is increased, the rotational speed of each of the shafts 25, 26 will be different from the resonance frequency.

[0021] The present embodiment has the following advantages.

(1) High torque is required to drive the detaching rollers 16, 17. A motor inertia is expressed by the expression $J = MD^2$, where M represents the mass of the rotor, and D represents the outer diameter of the rotor, which is approximately equal to the outer diameter of the motor. Therefore, to reduce the inertia of the motor to allow the motor to rotate at a high speed, the outer diameter of the motor is preferably made as small as possible. On the other hand, the motor torque is determined by multiplying the motor outer diameter by the length of the motor. Therefore, the longer the motor length, the greater the motor torque becomes, given that the outer diameters are the same. However, in reality, the lengths of motors cannot be extended beyond a certain limit for manufacture reasons, for example, that the rotor clearance needs to be maintained at a constant value. According to the conventional art, the shafts of two detaching rollers are driven by two motors. In contrast, according to the present invention, both ends of the shafts 25, 26 are driven by the motors 29, 30, respectively, such that the shafts 25, 26 are synchronized. In other words, the two shafts 25, 26 of the detaching rollers 16, 17 are driven by four motors. Thus, it is possible to drive the detaching rollers 16, 17 by a torque that is twice the torque in the conventional art. Therefore, the detaching rollers 16, 17, which require a high torque, can be driven at a higher speed than the conventional art without increasing the sizes of the individual servomotors 29, 30.

(2) Typically, the distance between the central axes of a pair of detaching rollers is as short as approximately 40 mm. On the other hand, to drive a shaft of a detaching roller, a motor having a high torque and operating at a high speed is required. In this case, the outer diameter of the motor is greater than the distance between the central axes of the shafts of the detaching rollers. Thus, when transmitting rotation of the motor shaft to the shaft of the detaching roller via gears, the ratio of the rotational speed of the motor shaft and the rotational speed of the shaft of the detaching roller cannot be made to 1:1 in a configuration where the gears fixed to the motor shafts and the gears fixed to the shafts of the detaching rollers directly mesh. However, the shafts 25, 26 of the present embodiment are driven via gear trains between the motor shafts 29a, 30a of the servomotors 29, 30 and the shafts 25, 26, and the gear trains include the idle gears 33, 34. The drive gears 31, 32 fixed to the motor shafts 29a, 30a and the gears 27, 28 fixed to the shafts 25, 26 have the same number of teeth. Therefore, even though the distance between the central axes of the shafts 25, 26 of the detaching rollers 16, 17 is as short as approximately 40 mm, and the outer diameter of the servomotors 29, 30 is greater than the distance between the axes of the shafts 25, 26, the ratio of the rotational speed of the motor shafts 29a, 30a and the rotational speed of the shafts 25, 26 can be made 1:1. Also, the sizes (diameters) and rotational speed of the motors can be more flexibly changed by changing the number of teeth of each gear in the gear train.

(3) Since the ratio of the rotational speed of the motor shafts 29a, 30a and the rotational speed of the shafts 25, 26 is set to 1:1, the rotational speed of the motor shafts 29a, 30a can be set easily when the rotational speed of the detaching rollers 16, 17 is changed by changing the condition of spinning.

(4) The servomotors 29, 30 are arranged such that the motor shafts 29a, 30a are located above the shafts 25, 26, and that an imaginary plane that contains the axes of the motor shafts 29a, 30a and the axes of the shafts 25, 26 is oriented slantingly in relation to the horizontal direction. Therefore, compared to a case in which the servomotors 29, 30 are arranged such that the imaginary plane is oriented horizontally, the space for accommodating the servomotors 29, 30 can be easily secured.

[0022] The present invention is not limited to the embodiment described above, but may be embodied as follows, for example.

[0023] The shafts 25, 26 may be coupled to each other via gears. For example, as shown in Fig. 3, a coupling gear 35 may be provided to mesh with the gears 27, 28. In this case, the shafts 25, 26 can be rotated in synchronization since the shafts 25, 26 are coupled to each other via a gear even if the accuracy of the synchronization between the servomotors 29, 30 is relatively low. The coupling gear 35 is preferably provided at both ends of the shafts 25, 26, but may be provided only at one end.

[0024] When the shafts 25, 26 are coupled to each other via a gear, the gears 27, 28 meshed with the drive gears 31, 32 may be omitted. For example, gears that rotate integrally with the shafts 25, 26 may be provided separately from the gears 27, 28, and a coupling gear meshed with the additional gears may be provided. However, the use of the gears 27, 28 is easier.

[0025] In a case where the gears 27, 28 are not used, and the shafts 25, 26 are coupled to each other via a gear, the gear for coupling the shafts 25, 26 to each other does not provided at ends of the shafts 25, 26, but may be provided at an intermediate part of the shafts 25, 26. However, providing the coupling gear at ends of the shafts 25, 26 makes it easier to secure the space for the coupling gear and facilitates the maintenance.

[0026] The rotational speed ratio of the motor shafts 29a, 30a and the shafts 25, 26 does not need to be 1:1. That is, the rotational speed the motor shafts 29a, 30a may be faster or slower than the rotational speed of the shafts 25, 26.

[0027] The gear trains for transmitting the rotation of the motor shafts 29a, 30a to the shafts 25, 26 do not necessarily have the idle gears 33, 34. Instead, gears fixed to the motor shafts 29a, 30a may be directly meshed with gears fixed to the shafts 25, 26.

[0028] A comber includes first and second detaching rollers arranged forward of and rearward of each other. The first and second detaching rollers are rotated in a forward direction and a reverse direction in synchronization with swinging motion of a nipper frame. A first roller shaft of the first detaching roller is driven at both axial ends by two first motors, which can rotate in a forward direction and a reverse direction. A second roller shaft of the second detaching roller is driven at both axial ends by two second motors, which can rotate in a forward direction and a reverse direction. The first motors and the second motors are driven in synchronization with each other.

Claims

1. A comber comprising first and second detaching rollers arranged forward of and rearward of each other, the first and second detaching rollers are rotated in a forward direction and a reverse direction in synchronization with swinging motion of a nipper frame, the comber being **characterized in that** a first roller shaft of the first detaching roller is driven at both axial ends by two first motors, which can rotate in a forward direction and a reverse direction, a second roller shaft of the second detaching roller is driven at both axial ends by two second motors, which can rotate in a forward direction and a reverse direction, and the first motors and the second motors are driven in synchronization with each other.

2. The comber according to claim 1, **characterized in that** a first gear train is provided between a motor shaft of each first motor and the first roller shaft; a second gear train is provided between a motor shaft of the second motor and the second roller shaft; the first and second roller shafts are each driven by the corresponding gear trains; and each of the first and second gear trains has an idle gear.

3. The comber according to claim 2, **characterized in that** each of the first and second gear trains includes a plurality of gears, the numbers of teeth of the gears are set such that the rotational speed ratio of the corresponding motor shaft and the corresponding roller shaft is 1:1.

4. The comber according to any one of claims 1 to 3, **characterized in that** the first and second roller shafts are coupled to each other via gears.

5. The comber according to claim 4, **characterized in that** the gears coupling the first and second roller shafts to each other are provided to mesh with the gears fixed to the ends of the first and second roller shafts.

Fig.1

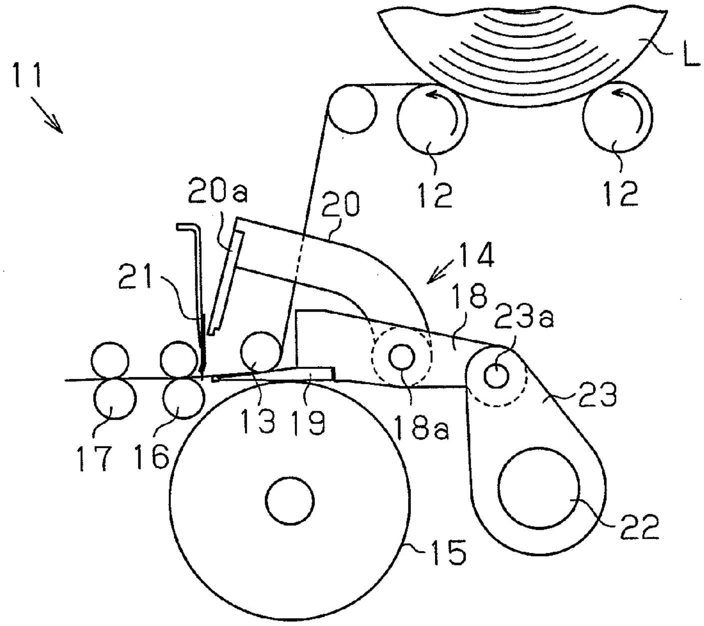


Fig.2A

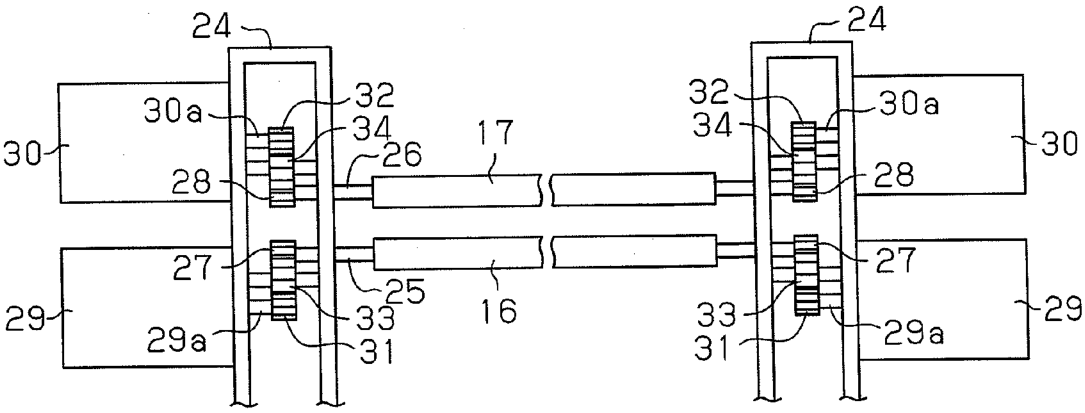


Fig.2B

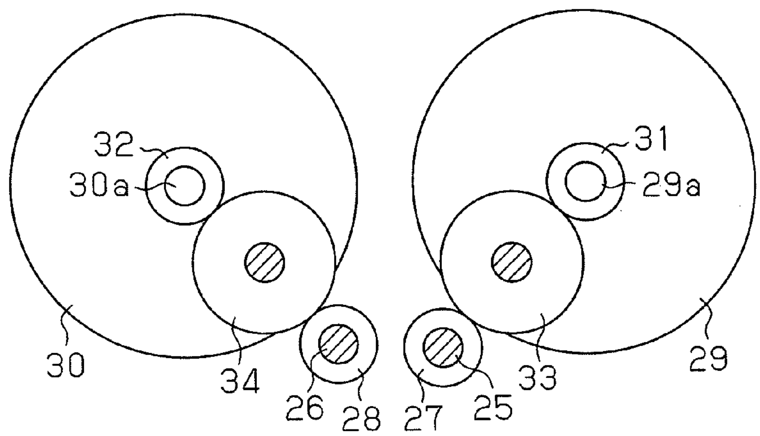


Fig.3

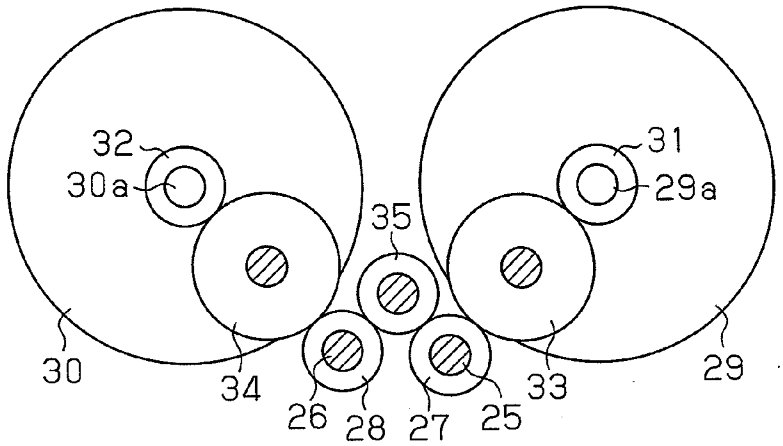


Fig.4

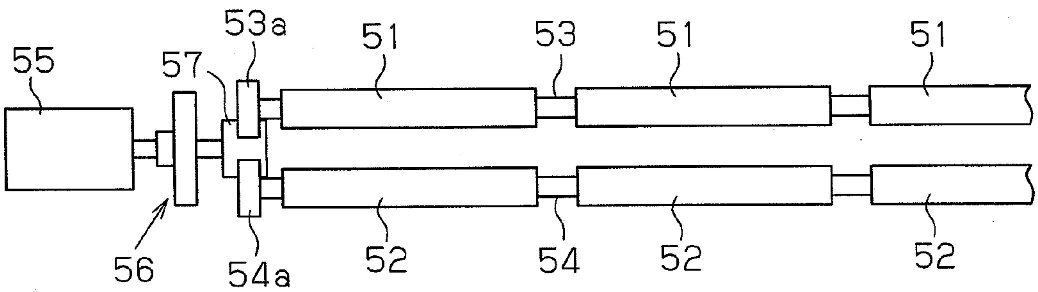
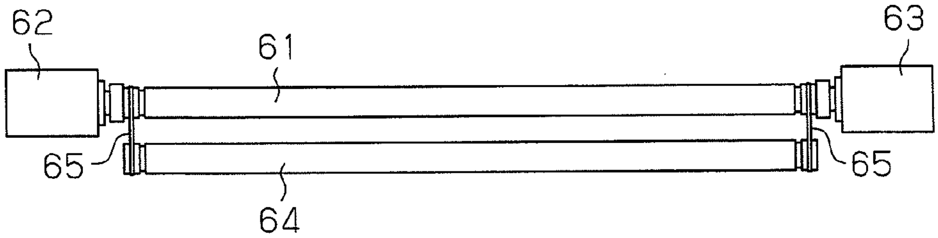


Fig.5



REFERENCES CITED IN THE DESCRIPTION

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- CN 100999837 A **[0005] [0007]**