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Shimizu et al.

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(54) **BLADE INTERVAL ADJUSTING DEVICE**

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H01L 21/687 (2006.01)

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CPC ***B25J 15/0052*** (2013.01); ***H01L 21/68707*** (2013.01)

(58) **Field of Classification Search**
CPC B25J 15/0052; H01L 21/68707
USPC 294/213; 414/941
See application file for complete search history.

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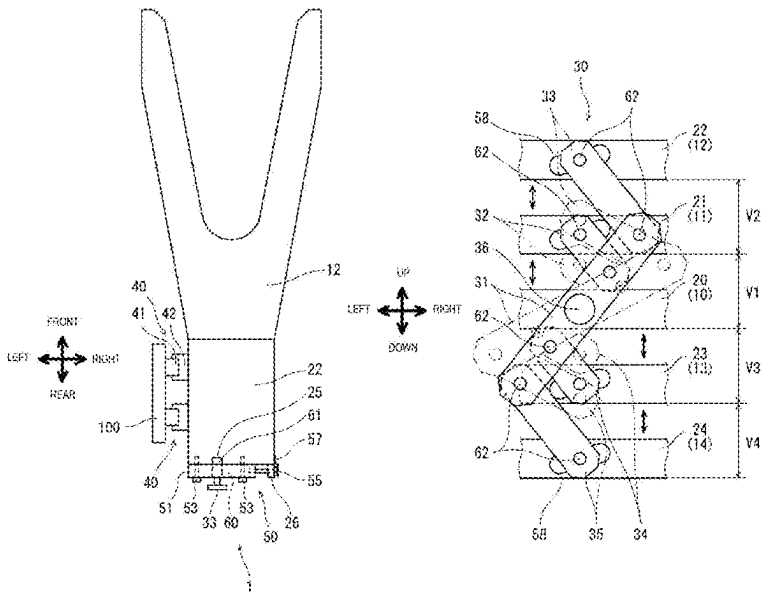
(57) **ABSTRACT**

Blades, base parts to which the blades are fixed, a guide mechanism configured to guide movement of the base parts in a direction in which the base parts are arranged side by side, and a linkage mechanism configured to parallelly change intervals of the base parts according to angle changes of link members coupled to the base parts, are included. An interval fine-adjustment mechanism is provided at each of coupling parts between the base pars and the link members, the interval fine-adjustment mechanism being configured to finely adjust positions of the base parts in the direction in which the base parts are arranged side by side, individually. According to this, a blade interval adjusting device capable of finely adjusting the intervals of the blades which transfer wafers etc., is provided.

20 Claims, 6 Drawing Sheets



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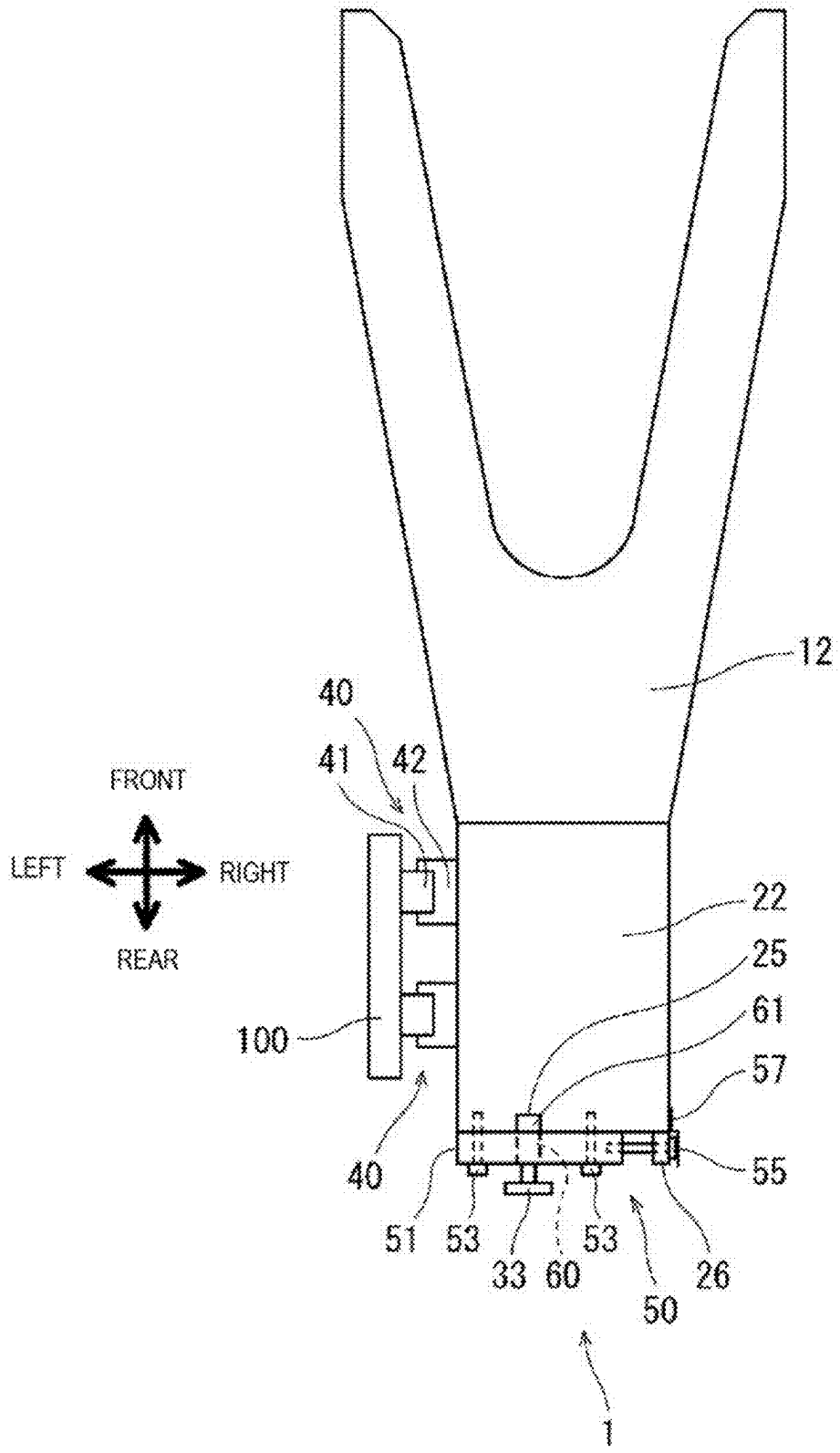

FRONT
LEFT
RIGHT
REAR
12
40
41
42
22
25
61
57
100
40
55
51
53
33
60
53
26
50
1

FIG. 1

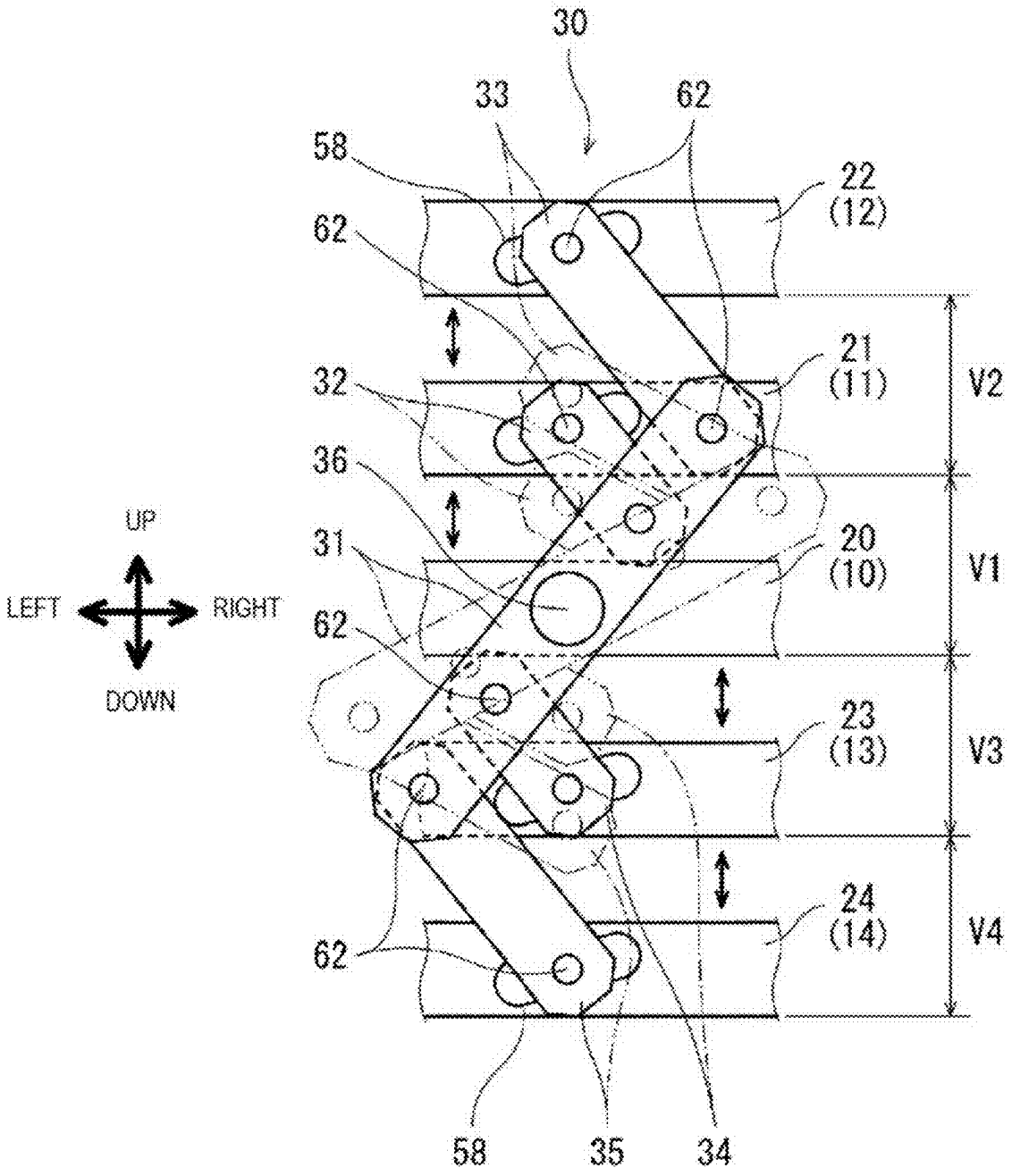

30
33
62
58
22
(12)
62
21
(11)
V2
32
36
20
(10)
V1
31
62
23
(13)
V3
24
(14)
V4
62
58
35
34
UP
LEFT
RIGHT
DOWN

FIG. 2

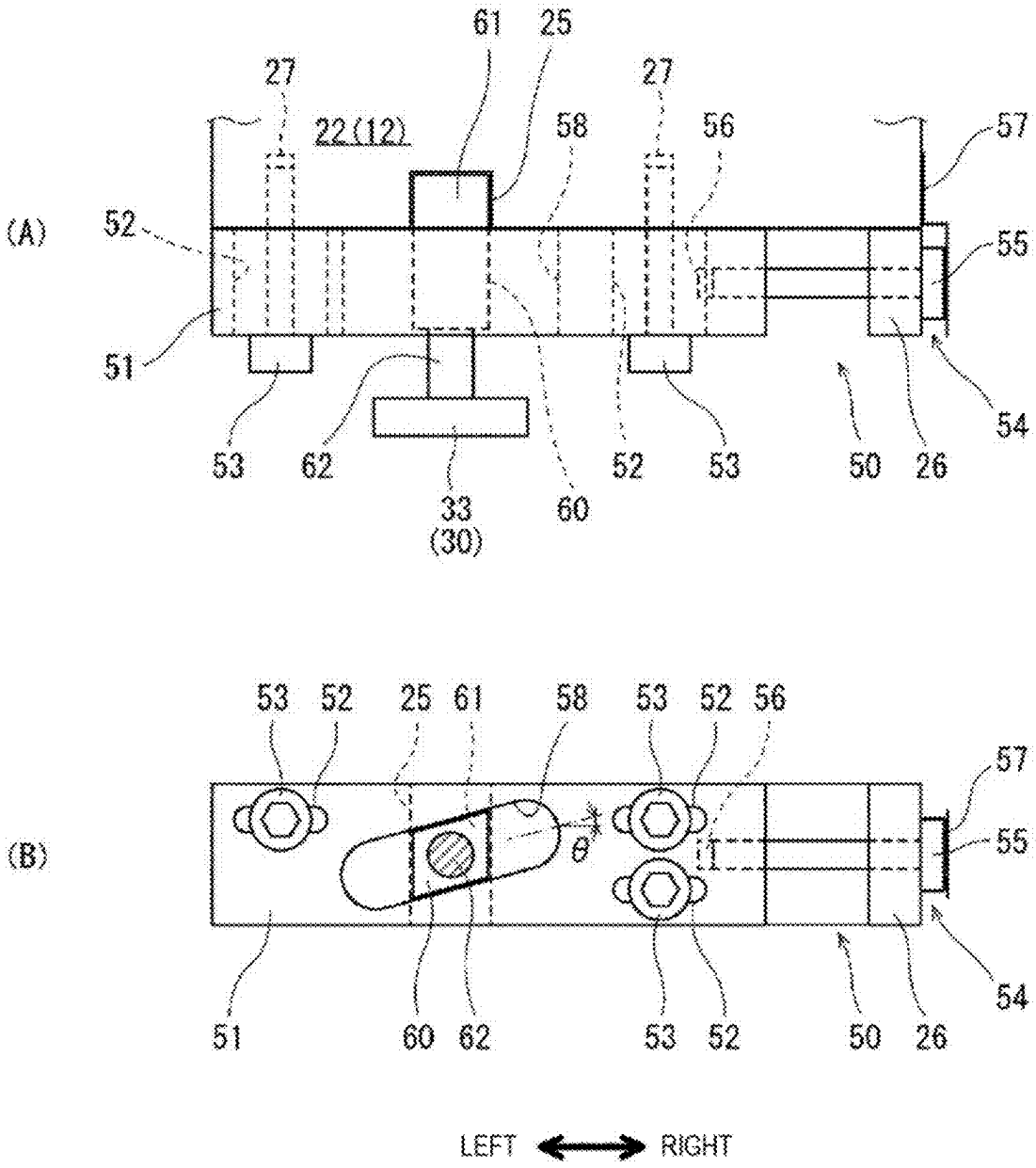
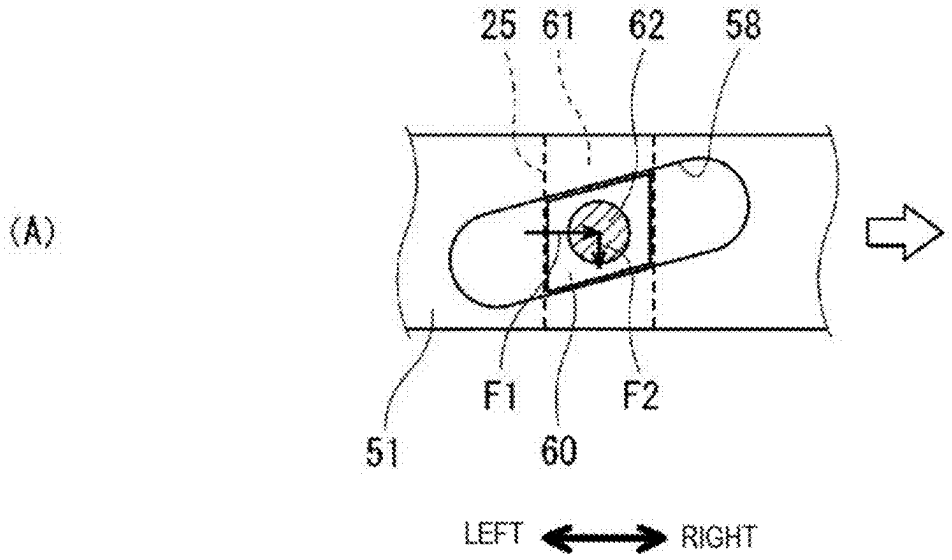

(A)
61
25
27
27
22(12)
58
56
57
52
55
51
54
53
62
33
(30)
60
52
53
50
26
(B)
53
52
25
61
58
53
52
56
57
55
θ
54
51
60
62
53
52
50
26
LEFT
RIGHT

FIG. 3


(A)
25
61
62
58
F1
F2
51
60
LEFT
RIGHT

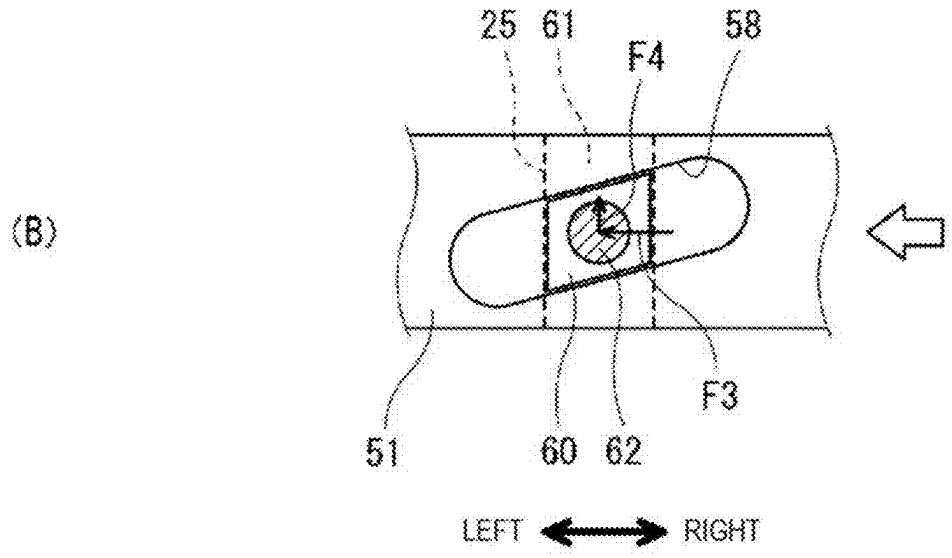

(B)
25
61
F4
58
F3
51
60
62
LEFT
RIGHT

FIG. 4

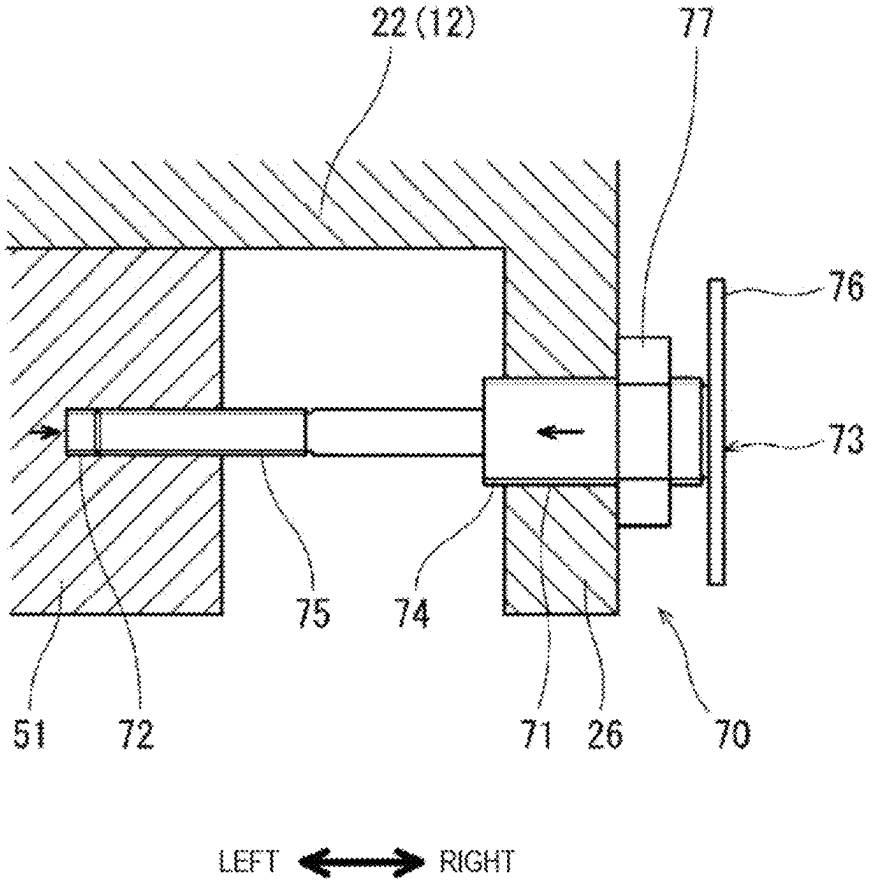


FIG. 5

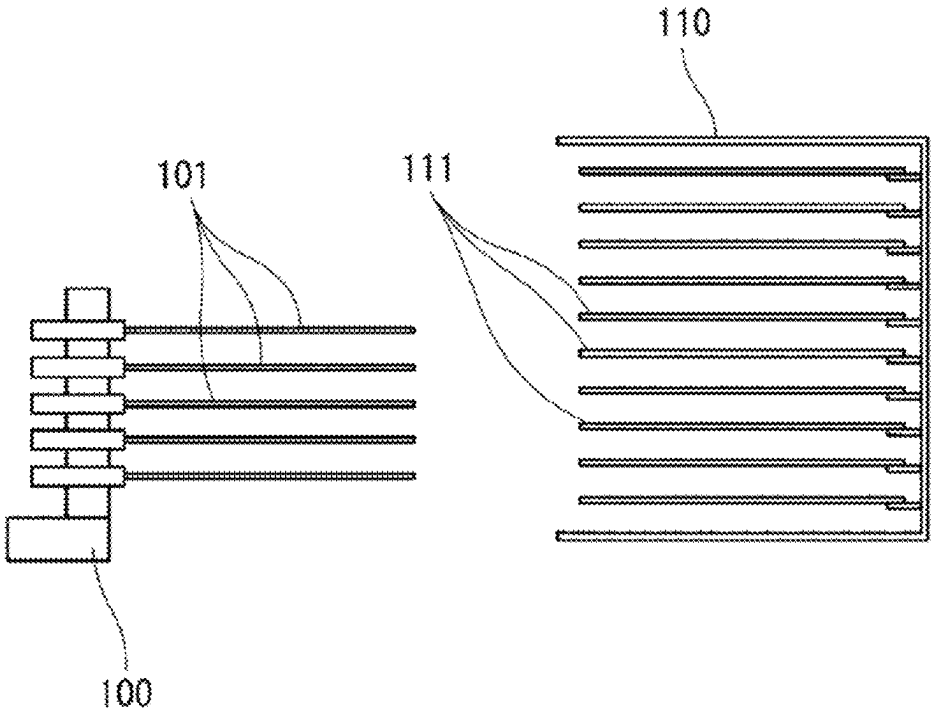


FIG. 6

BLADE INTERVAL ADJUSTING DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application is based on PCT filing PCT/JP2020/026775, filed Jul. 9, 2020, which claims priority to JP 2019-135250, filed Jul. 23, 2019, the entire contents of each are incorporated herein by reference.

TECHNICAL FIELD

The present disclosure relates to a device capable of finely adjusting intervals of blades which hold wafers etc.

BACKGROUND ART

Conventionally, in production of semiconductors, liquid crystal display panels, etc., it is necessary to transfer a substrate such as a wafer (hereinafter, the "wafer" is described as an example) from an accommodation container to a given device etc. In recent years, in such a transfer of the wafer, wafers may be moved together in order to reduce time etc. For example, a robot having a hand provided with blades is used for the wafer transfer. As illustrated in FIG. **6**, for example, this robot is provided with a hand **100** (partially illustrated) with blades **101** which are arranged side by side. These blades **101** hold simultaneously wafers **111** accommodated in an accommodation container **110**, and transfer them to the given device all together. Alternatively, the wafers may be held by the blades, and may be transferred to the accommodation container to be accommodated simultaneously.

Note that there is a wafer handling robot which grasps and transfers waters as this kind of conventional art (for example, see Patent Document 1).

REFERENCE DOCUMENT OF CONVENTIONAL ART

Patent Document

[Patent Document 1] JP2008-300609A

DESCRIPTION OF THE DISCLOSURE

Problem to be Solved by the Disclosure

However, when arranging the blades side by side, a minute inclination difference etc. may be produced between the blades. In such a case, an adjustment is made so that other blades become horizontal to a reference blade, but this adjustment may produce a minute deviation in the intervals of the blades. Note that such a problem is not described at all in Patent Document 1.

Therefore, one purpose of the present disclosure is to provide a blade interval adjusting device capable of finely adjusting, intervals of blades which transfer wafers etc.

SUMMARY OF THE DISCLOSURE

In order to achieve the purpose, the present disclosure includes blades, base parts to which the blades are fixed, a guide mechanism configured to guide movement of the base parts in a direction in which the base parts are arranged side by side, and a linkage mechanism configured to parallelly change intervals of the base parts according to angle changes of link members coupled to the base parts. An interval fine-adjustment mechanism is provided at each of coupling parts between the base parts and the link members, the interval fine-adjustment mechanism being configured to finely adjust positions of the base parts in the direction in which the base parts are arranged side by side, individually.

According to this configuration, after the intervals of the base parts arranged side by side are changed by the linkage mechanism, the interval between each base part and the adjacent base part can finely be adjusted individually by the interval fine-adjustment mechanism provided at the coupling part between the base part and the link member. Therefore, it becomes possible to finely adjust the intervals of the blades individually.

Effect of the Disclosure

According to the present disclosure, intervals of blades which transfer wafers etc. can finely be adjusted individually.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a plan view illustrating a blade interval adjusting device according to one embodiment of the present disclosure, and a blade.

FIG. **2** is a rear view illustrating one example of a linkage mechanism which parallelly adjusts intervals of base parts to which blades are fixed.

FIGS. **3**(A) and **3**(B) are views illustrating a part of the blade interval adjusting device illustrated in FIG. **1**, where FIG. **3**(A) is a plan view and FIG. **3**(B) is a front view.

FIGS. **4**(A) and **4**(B) are enlarged views illustrating operation when adjusting intervals of the base parts by an interval fine-adjustment mechanism of the blade interval adjusting device illustrated in FIGS. **3**(A) and **3**(B).

FIG. **5** is a cross-sectional view illustrating another example of a drive part of the blade interval adjusting device.

FIG. **6** is a side view schematically illustrating a hand provided with blades and an accommodation container which accommodates wafers.

MODE FOR CARRYING OUT THE DISCLOSURE

Hereinafter, one embodiment of the present disclosure is described based on the drawings. In the following embodiment, a blade interval adjusting device **1** provided to a hand **100** of a robot is described as an example. This blade interval adjusting device **1** is illustrated as an example in which blades are arranged side by side in the up-and-down direction. In the following embodiment, the concept of the left-and-right direction and the front- and rear direction are in agreement with the concept of the left-and-right direction and the front- and rear direction illustrated in FIG. **1**, and the concept of the left-and-right direction and the up-and-down direction are in agreement with the concept of the left-and-right direction and the up-and-down direction illustrated in FIG. **2**.

(Configuration of Blade Interval Adjusting Device)

FIG. **1** is a plan view illustrating the blade interval adjusting device **1** according to one embodiment, and a blade **12**. FIG. **2** is a rear view illustrating one example of a linkage mechanism **30** which parallelly adjusts intervals

V1-V4 of base parts 20-24 to which blades 10-14 are fixed. In FIG. 1, the topmost blade 12 in FIG. 2 is described as an example.

As illustrated in FIG. 1, the blade 12 which holds a wafer 111 (FIG. 6) from below is fixed to a front part of the base part 22. The blade 12 is a thin-plate member of a fork shape where the point is divided into two. The shape of the blade 12 is not limited to this embodiment. The blade 12 is fixed to the base part 22 with bolts etc. As illustrated in FIG. 2, the base part 22 is arranged side by side in the up-and-down direction, and the base parts 20-24 are adjustable of the intervals V1-V4 in the up-and-down direction by link members 31-35 of the linkage mechanism 30, as will be described later. As illustrated in FIG. 1, the base part 22 is limited in the movement in the left-and-right direction by a guide mechanism 40 provided between the base part 22 and the hand 100, and is movable in the up-and-down direction in which the base part 22 is arranged side by side since it is guided by the guide mechanism 40. The guide mechanism 40 includes a guide rail 41 provided to the hand 100 and extending in the up-and-down direction, and a guide block 42 which is provided to the base part 22 and moves by being guided by the guide rail 41. The guide block 42 is provided to each of the base parts 20-24, and each of the base parts 20-24 moves in the up-and-down direction along the guide rail 41. A linear guide etc. can be used for the guide mechanism 40.

A coupling part between the base part 22 and the link member 33 is provided with an interval fine-adjustment mechanism 50 which finely adjusts the interval between the base part 22 and the adjacent base part 21. According to this interval fine-adjustment mechanism 50, the interval V2 of the base part 22 and another base part 21 can be finely adjusted in the up-and-down direction.

As illustrated in FIG. 2, the intervals of the base parts 20-24 to which the blades 10-14 arranged side by side in the up-and-down direction are fixed can be adjusted at a given interval in the up-and-down direction by the linkage mechanism 30. In this example, five base parts 20-24 are provided in the up-and-down direction, and a stationary base part 20 of which the position is fixed is provided to the center part. With respect to the stationary base part 20, a first movable base part 21 and a second movable base part 22 are provided above, and a third movable base part 23 and a fourth movable base part 24 are provided below.

In the stationary base part 20, the center part of the first link member 31 is supported by a shaft member 36, and the first link member 31 extends obliquely in the up-and-down direction. Between the first link member 31 and the first movable base part 21, it is coupled by the second link member 32. Between the first link member 31 and the second movable base part 22, it is coupled by the third link member 33. Between the first link member 31 and the third movable base part 23, it is coupled by the fourth link member 34, Between the first link member 31 and the fourth movable base part 24, it is coupled by the fifth link member 5. The coupling part between each of the link members 31-35 is rotatable by a shaft member 62.

By such a linkage mechanism 30, the interval V1 between the stationary base part 20 and the first movable base part 21 and the interval V2 between the first movable base part 21 and the second movable base part 22 are changed, above the stationary base part 20, according to an angle change in the first link member 31. In addition, below the stationary base part 20, the interval V3 between the stationary base part 20 and the third movable base part 23 and the interval V4 between the third, movable base part 23 and the fourth movable base part 24 are changed. Further, the intervals V1-V4 are changed at the same interval by the linkage mechanism 30.

That is, according to this linkage mechanism 30, the intervals V1 and V2 in the up-and-down direction of the first movable base part 21 and the second movable base part 22 above the stationary base part 20 which supports the first link member 31 can be parallelly adjusted by changing the angle of the first link member 31. Further, simultaneously, the intervals V3 and V4 in the up-and-down direction of the third movable base part 23 and the fourth movable base part 24 below the stationary base part 20 can be parallelly adjusted. The illustrated solid lines illustrate a state where the intervals V1-V4 are expanded, and the two-dot chain lines illustrate a state where the intervals V1-V4 are narrowed. Therefore, the link members 31-35 of the linkage mechanism 30 can adjust the intervals V1-V4 of the base parts 20-24 arranged side by side. The linkage mechanism 30 may be configured to control an angle of the first link member 31 by a motor, for example. Note that the linkage mechanism 30 is not limited to the linkage mechanism 30 of this embodiment. The linkage mechanism 30 may be configured to couple the base parts 20-24 by link members, respectively.

Then, after the linkage mechanism 30 adjusts the intervals V1-V4 of the base parts 20-24, the blades 10-15 are finely adjusted so as to be parallel to each other. The fine adjustment of the blades 10-15 is adjusted so that the first blade 11, the second blade 12, the third blade 13, and the fourth blade 14 become parallel to each other with respect to the fixed blade 10. The mechanism for finely adjusting the blades so that the blades 10-15 become parallel to each other is not limited. After the blades 10-15 are finely adjusted so that the blades become parallel to each other, the following fine adjustment by the interval fine-adjustment mechanism 50 is performed when minute errors are produced at the intervals V1-V4 of the blades 10-15.

(Detailed Configuration of Blade Interval Adjusting Device)

FIGS. 3(A) and 3(B) are views illustrating a part of the blade interval adjusting device 1 illustrated in FIG. 1, where FIG. 3(A) is a plan view and FIG. 3(B) is a front view. FIGS. 4(A) and 4(B) are enlarged views illustrating operation when adjusting the intervals of the base parts 21-24 by the interval fine-adjustment mechanism 50 of the blade interval adjusting device 1 illustrated in FIGS. 3(A) and 3(B). Although the base parts 21-24 are each provided with the interval fine-adjustment mechanism 50, the interval fine-adjustment mechanism 50 provided to the base part 22 is described as an example also in the following description.

As illustrated in FIGS. 3(A) and 3(B), the interval fine-adjustment mechanism 50 of the blade interval adjusting device 1 includes a displacement block 51 which moves in the left-and-right direction with respect to the base part 22, a drive part 54 which moves the displacement block 51 in the left-and-right direction, and a slide block 60 which moves in the up-and-down direction in association with the movement of the displacement block 51.

Although in this embodiment the displacement block 51 is moved in the direction (left-and-right direction) perpendicular to the direction in which the base parts 20-24 are arranged side by side (up-and-down direction), the displacement block 51 may be moved in a direction which intersects with the direction in which the base parts 20-24 are arranged side by side.

The displacement block 51 is formed, at a part of the shaft member 62 which is coupled to the link member 33, with an inclined slot 58 which is an inclined guide part. The guide

part of this example serves as the inclined slot **58** which is inclined at a small inclination angle θ, The slide block **60** is built inside the inclined slot **58** to be guided. Slotted holes **52** extending in the left-and-right direction are formed in the displacement block **51**, and the displacement block **51** is fixed to the base part **22** by threadedly engaging a securing bolt **53** which is a fixing part inserted into the slotted hole **52** with an internally-threaded part **27** of the base part **22**. The movement of the displacement block **51** is stopped by fixing the securing bolts **53**. The displacement block **51** becomes movable in the left-and-right direction with respect to the base part **22** by loosening the securing bolts **53**.

In this embodiment, the drive part **54** includes a threaded member **55** provided to a bracket part **26** provided to protrude rearwardly from the base part **22**. The threaded member **55** is threadedly engaged with an internally-threaded part **56** of which a tip-end part is provided to the displacement block **51**. The position of the head of the threaded member **55** is fixed by a keep plate **57** provided to the base part **22**. By fixing the position of the head of the threaded member **55** with the keep plate **57**, the displacement block **51** can be moved in the left-and-right direction, without the positional change in the head, even if the head of the threaded member **55** is rotated.

The slide block **60** is built inside a part of the inclined slot **58** of the displacement block **51**, and is formed in a substantially parallelogram shape along the inclined slot **58**. The slide block **60** includes a limiting part **61** protruding toward the base part **22** from the displacement block **51**, and this limiting part **61** is fitted in a limiting slot **25** formed in the base part **22**. In these drawings, gaps in the left-and-right-direction between the limiting part **61** and the limiting slot **25** are exaggeratedly illustrated. Therefore, the slide block **60** is permitted in the movement in the up-and-down direction, but the movement in the left-and-right direction is limited by the limiting slot **25**. The slide block **60** is provided with the shaft member **62** coupled to the link member **33** so that the shaft member **62** protrudes rearwardly (toward a viewer of the drawing). Therefore, the shaft members **62** coupled to the link members **31-35** move in the up-and-down direction along the limiting slots **25** formed in the base parts **22**.

According to such an interval fine-adjustment mechanism **50**, when the intervals of the blades **10-15** need to be further finely adjusted individually after the linkage mechanism **30** adjusts the intervals V**1**-V**4** of the base parts **20-24** to the given intervals, the intervals V**1**-V**4** can be finely adjusted as follows.

As illustrated in FIG. **4**(A), when the threaded member **55** of the drive part **54** is rotated so that the displacement block **51** is moved to the right, the slide block **60** built inside the inclined slot **58** of the displacement block **51** receives a rightward force F**1** from the inclined slot **58**. However, since the movement in the left-and-right direction is limited to the limiting slot **25** by the limiting part **61**, the slide block **60** moves slightly downward by a downward force F**2** acting from the inclined slot **58**. Since the inclined slot **58** inclines with the small inclination angle θ, the movement of the slide block **60** becomes a small amount. For example, the moving amount becomes small enough to be absorbed by a gap of a bearing which supports the shaft member **62** at the third link member **33**, elastic deformation of the shaft member **62**, etc. Then, according to the small moving amount, the interval V**2** between the second movable base part **22** and the first movable base part **21** arranged side by side next thereto can be finely adjusted. This fine adjustment may be about 0.1 mm, for example.

As illustrated in FIG. **4**(B) when the threaded member **55** of the drive part **54** is rotated in the opposite direction to move the displacement block **51** to the left, the slide block **60** built inside the inclined slot **58** of the displacement block **51** receives a leftward force H from the inclined slot **58**. However, since the movement in the left-and-right direction is limited to the limiting slot **25** by the limiting part **61**, the slide block **60** moves slightly upward according to an upward force F**4** acting from the inclined slot **58**. Since the inclined slot **58** inclines with the small inclination angle θ, the movement of the slide block **60** becomes a small amount. This moving amount also becomes the small amount so as to be absorbed by the gap of the bearing which supports the shaft member **62** by the third link member **23**, the elastic deformation of the shaft member **62**, etc., for example. Then, by this small moving amount, the interval V**2** between the second movable base part **22** and the first movable base part **21** arranged side by side next thereto can be finely adjusted. This fine adjustment can also be about 0.1 mm, for example.

Therefore, according to the blade interval adjusting device **1**, since the linkage mechanism **30** adjusts the intervals V**1**-V**4** of the base parts **20-24**, and then, the interval fine-adjustment mechanisms **50** finely adjust the respective positions of the base parts **20-24** in the direction in which the base parts **20-24** are arranged side by side. Therefore, it becomes possible to finely adjust the respective intervals V**1**-V**4** of the blades **10-14**. The fine adjustment of the intervals V**1**-V**4** by the interval fine-adjustment mechanisms **50** can be performed efficiently, even when the number of blades **10-14** (base parts **20-24**) increases and, thus, it becomes possible, to shorten the operation time of the interval adjustment, reduce the labor, etc.

(Other Configurations)

FIG. **5** is a cross-sectional view illustrating another example of the drive part **54** in the blade interval adjusting device **1**. As illustrated, the drive part **54** may be a differential screw mechanism **70**. The differential screw mechanism **70** may be provided to all of the first to fourth movable base parts **21-24**. Note that the same reference characters are assigned to the same configuration as FIGS. **3**(A) and **3**(B) to omit the description.

In the differential screw mechanism **70** of this embodiment, a large pitch internally-threaded part **71** is provided to the bracket part **26** which protrudes rearward from the second movable base part **22**, and a small pitch internally-threaded part **72** is provided to the displacement block **51**. The large pitch internally-threaded part **71** includes the opposite thread from the small pitch internally-threaded part **72**. Then, a large thread part **74** of a differential screw **73** is threadedly engaged with the large pitch internally-threaded part **71** of the bracket part **26**, and a small thread part **75** is threadedly engaged with the small pitch internally-threaded part **72** of the displacement block **51**. A gripper **76** for rotating the differential screw **73** is provided to a part of the large thread part **74** of the differential screw **73**. Further, a lock nut **77** which fixes the position of the differential screw **73** is provided to the large thread part **74** located on the right side of the bracket part **26**. Note that the differential screw **73** is not limited to this embodiment.

If the drive part **54** is the differential screw mechanism **70**, when the gripper **76** is rotated once (one revolution) to move the large thread part **74** in the left-and-right direction by one pitch, since the displacement block **51** moves to the opposite side in the left-and-right direction by one pitch of the small thread part **75**, the displacement block **51** moves by the pitch difference. Therefore, a further minute adjustment becomes possible. For example, the differential screw **73** may have

such a configuration that the small thread part **75** moves to the right by 1 pitch (for example, 0.5 mm), when the gripper **76** is rotated once (one revolution) to move the large thread part **74** to the left by 1 pitch (for example, 1 mm). In this case, even if the gripper **76** is rotated one the displacement block **51** only moves to the left by the difference between one pitch of the large thread part **74** and the pitch of the small thread part **75** (in this example, 1 mm−0.5 mm=0.5 mm). Therefore, a further minute adjustment is possible. Note that the pitch of the large thread part **74** and the pitch of the small thread part **75** in the differential screw mechanism **70** may arbitrarily be set.

Thus, if the drive part **54** of the interval fine-adjustment mechanism **50** is the differential screw mechanism **70**, it is possible to make the interval variation with respect to the adjusting amount by the drive part **54** much smaller, and a further minute interval adjustment becomes possible.

In the above embodiment, the interval fine-adjustment mechanism **50** includes the displacement block **51** which moves in the direction intersecting with the direction in which the base parts **20-24** are arranged side by side, the drive part **54** which moves the displacement block **51**, and the slide block **60** which moves the coupling part between the base parts **21-24** and the link members **31-35** in association with the movement of the displacement block **51**, and the securing bolts **53** which is the fixing part for stopping the movement of the displacement block **51**. The base parts **21-24** include the limiting slots **25** which permit the movement of the slide block **60** in the direction in which the base parts **21-24** are arranged side by side, and limit the movement of the slide block **60** in the direction perpendicular to the direction in which the base parts **21-24** are arranged side by side. According to this configuration, by the drive part **54** moving the displacement block **51** in the direction intersecting with the direction in which the base parts **21-24** are arranged side by side, it is possible to generate the force for moving the slide block **60** obliquely along the inclined slot **58**. Therefore, the force (F2, F4) in the direction in which the base parts **20-24** are arranged side by side acts on the slide block **60** to move, by the minute amount, the coupling part between the base parts **21-24** and the link members **31-35** in the direction in which the base parts **20-24** are arranged side by side. Thus, the intervals of the base parts **20-24** arranged side by side can be finely adjusted individually.

Further, the displacement block **51** includes the inclined slot **58** which is the inclined guide part for guiding the slide block **60**. The slide block **60** moves in the direction, in which the base parts **20-24** are arranged side by side, with respect to the inclined slot **58** which is the guide part, in association with the movement of the displacement block **51**. According to this configuration, the moving amount of the slide block **60** which moves in the direction in which the base parts **20-24** are arranged side by side can be reduced compared with the moving amount of the displacement block **51** which moves in the direction intersecting with the direction in which the base parts **20-24** are arranged side by side.

The drive part **54** may include the differential screw mechanism **70**. According to this configuration, the differential screw mechanism **70** of the drive part **54** can reduce the moving amount of the displacement block **51** with respect to the driving amount of the drive part **54**.

The above embodiment illustrates one example, and the interval fine-adjustment mechanism **50** may be a mechanism which moves the slide block **60** in the direction in which the base parts **20-24** are arranged side by side when the displacement block **51** is moved in the direction intersecting with the direction in which the base parts **20-24** are arranged side by side. The present disclosure may be variously changed without departing from the

What is claimed is:

1. A blade interval adjusting device, comprising:
- blades;
- base parts to which the blades are fixed;
- a guide mechanism configured to guide movement of the base parts in a direction in which the base parts are arranged side by side; and
- a linkage mechanism configured to parallelly change intervals of the base parts according to angle changes of link members coupled to the base parts,
- wherein an interval fine-adjustment mechanism is provided at each of coupling parts between the base parts and the link members, the interval fine-adjustment mechanism being configured to finely adjust positions of the base parts in the direction in which the base parts are arranged side by side, individually, wherein the interval fine-adjustment mechanism includes:
- a displacement block configured to move in a direction intersecting with the direction in which the base parts are arranged side by side;
- a drive part configured to move the displacement block;
- a slide block configured to move the coupling parts between the base parts and the link members in association with movement of the displacement block; and
- a fixing part configured to stop the movement of the displacement block,
- wherein the base parts include a limiting slot configured to permit movement of the slide block in the direction in which the base parts are arranged side by side and limit the movement of the slide block in a direction perpendicular to the direction in which the base parts are arranged side by side.

2. The blade interval adjusting device of claim **1**, wherein the displacement block includes an inclined guide part configured to guide the slide block, and
- wherein the slide block moves in the direction in which the base parts are arranged side by side with respect to the guide part in association with the movement of the displacement block.

3. The blade interval adjusting device of claim **2**, wherein the drive part includes a differential screw mechanism.

4. The blade interval adjusting device of claim **1**, wherein the drive part includes a differential screw mechanism.

5. The blade interval adjusting device of claim **1**, wherein:
- the displacement block includes a slotted hole.

6. The blade interval adjusting device of claim **1**, wherein:
- fixing part includes a securing bolt.

7. The blade interval adjusting device of claim **1**, wherein:
- the drive part includes an actuator.

8. The blade interval adjusting device of claim **1**, wherein:
- the drive part includes a threaded member.

9. The blade interval adjusting device of claim **1**, wherein:
- the inclined guide part includes an inclined slot.

10. The blade interval adjusting device of claim **1**, wherein:
- the slide block includes a limiter and a shaft.

11. A blade interval adjusting device, comprising:
- blades;
- base parts to which the blades are fixed;
- a guide to guide movement of the base parts in a direction in which the base parts are arranged side by side;
- a linkage to parallelly change intervals of the base parts according to angle changes of links coupled to the base parts;
- couplers between the base parts and the links;

an interval fine adjuster at each of the couplers between the base parts and the links, the interval fine-adjuster to finely adjust positions of the base parts in the direction in which the base parts are arranged side by side, individually, wherein the interval fine adjuster includes:

a displacement block to move in a direction intersecting with the direction in which the base parts are arranged side by side;

a driver to move the displacement block;

a slide block to move the couplers between the base parts and the links in association with movement of the displacement block; and

a stop to stop the movement of the displacement block,

wherein the base parts include a limiting slot to permit movement of the slide block in the direction in which the base parts are arranged side by side and limit the movement of the slide block in a direction perpendicular to the direction in which the base parts are arranged side by side.

12. The blade interval adjusting device of claim **11**, wherein:

the displacement block includes an inclined guide to guide the slide block, and

the slide block moves in the direction in which the base parts are arranged side by side with respect to the guide part in association with the movement of the displacement block.

13. The blade interval adjusting device of claim **12**, wherein the driver includes a differential screw mechanism.

14. The blade interval adjusting device of claim **11**, wherein the driver includes a differential screw mechanism.

15. The blade interval adjusting device of claim **11**, wherein:

the displacement block includes a slotted hole.

16. The blade interval adjusting device of claim **11**, wherein:

the stop includes a securing bolt.

17. The blade interval adjusting device of claim **11**, wherein:

the driver includes an actuator.

18. The blade interval adjusting device of claim **11**, wherein:

the driver includes a threaded structure.

19. The blade interval adjusting device of claim **11**, wherein:

the inclined guide includes an inclined slot.

20. The blade interval adjusting device of claim **11**, wherein:

the slide block includes a limiter and a shaft.

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