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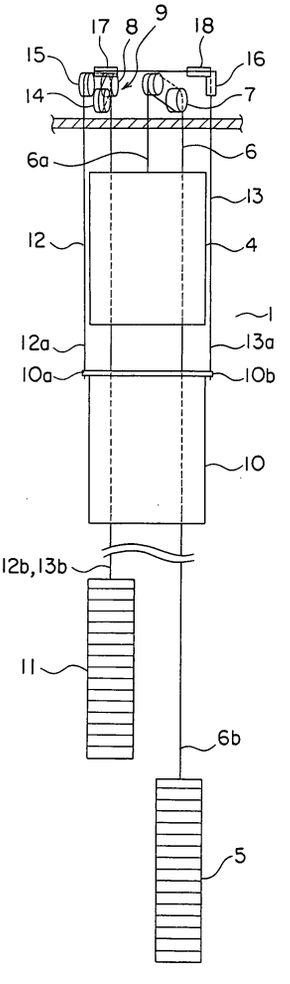
(54) **ELEVATOR EQUIPMENT**

(57) In an elevator apparatus, an upper car and a first counterweight are suspended by first main ropes wound around a first drive sheave on a first driving machine. Second and third main ropes are wound around a second drive sheave on a second driving machine. A lower car and a second counterweight are suspended by the second and third main ropes. First and second lower car suspension portions are disposed on the lower car. The first and second lower car suspension portions are disposed symmetrically on opposite sides of a center of gravity of the lower car from each other. The second main ropes have second car end portions connected to the first lower car suspension portion and second counterweight end portions connected to the second counterweight. The third main ropes have third car end portions connected to the second lower car suspension portion and third counterweight end portions connected to the second counterweight.

FIG. 1



EP 1 564 177 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a single-shaft multi-car elevator apparatus in which a plurality of cars are raised and lowered inside a shared hoistway.

BACKGROUND ART

[0002] An elevator apparatus is disclosed in Japanese Patent Laid-Open No. SHO 59-133188, for example, in which two cars are disposed vertically inside a shared hoistway. However, in this elevator apparatus, since two cars and two counterweights are suspended by two-to-one (2: 1) roping, the construction of the apparatus is complex. Furthermore, since the rope speed and the rotational speed of the sheaves are twice those of one-to-one (1:1) roping, noise is increased, making it impossible to operate the cars at high speed.

DISCLOSURE OF THE INVENTION

[0003] The present invention aims to solve the above problems and an object of the present invention is to provide an elevator apparatus enabling an upper car and a first counterweight, and a lower car and a second counterweight, respectively, to be suspended by one-to-one (1:1) roping, thereby enabling noise to be reduced and the upper car and the lower car to be operated at high speed.

[0004] In order to achieve the above object, according to one aspect of the present invention, there is provided an elevator apparatus including: a first driving machine having a first drive sheave disposed in an upper portion of a hoistway; an upper car and a first counterweight raised and lowered inside the hoistway by a driving force from the first driving machine; a first main rope wound around the first drive sheave, the first main rope having a first car end portion connected to the upper car, and a first counterweight end portion connected to the first counterweight; a second driving machine having a second drive sheave disposed in an upper portion of the hoistway; a lower car having first and second lower car suspension portions, the lower car being disposed below the upper car and raised and lowered inside the hoistway by a driving force from the second driving machine; a second counterweight raised and lowered inside the hoistway by a driving force from the second driving machine; a second main rope wound around the second drive sheave, the second main rope having a second car end portion connected to the first lower car suspension portion, and a second counterweight end portion connected to the second counterweight; and a third main rope wound around the second drive sheave, the third main rope having:

a third car end portion connected to the second lower car suspension portion; and a third counterweight end portion connected to the second counterweight, wherein: the first and second lower car suspension portions are symmetrically disposed on opposite sides of a center of gravity of the lower car from each other.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005]

Figure 1 is a front elevation showing an elevator apparatus according to Embodiment 1 of the present invention;
Figure 2 is a side elevation showing the elevator apparatus in Figure 1;
Figure 3 is a plan showing the elevator apparatus in Figure 1;
Figure 4 is a front elevation showing an upper portion of a hoistway from Figure 1 enlarged;
Figure 5 is a side elevation showing the upper portion of the hoistway from Figure 1 enlarged;
Figure 6 is a plan showing an elevator apparatus according to Embodiment 2 of the present invention; and
Figure 7 is a plan showing an elevator apparatus according to Embodiment 3 of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0006] Preferred embodiments of the present invention will now be explained with reference to the drawings.

Embodiment 1

[0007] Figure 1 is a front elevation showing an elevator apparatus according to Embodiment 1 of the present invention, Figure 2 is a side elevation showing the elevator apparatus in Figure 1, Figure 3 is a plan showing the elevator apparatus in Figure 1, Figure 4 is a front elevation showing an upper portion of a hoistway from Figure 1 enlarged, and Figure 5 is a side elevation showing the upper portion of the hoistway from Figure 1 enlarged. Moreover, Figure 4 is a view in the direction of arrow IV in Figure 3, and Figure 5 is a view in the direction of arrow V in Figure 3.

[0008] In the figures, a first driving machine 3 having a first drive sheave 2 is disposed in an upper portion of a hoistway 1. An upper car 4 and a first counterweight 5 are raised and lowered inside the hoistway 1 by a driving force from the first driving machine 3.

[0009] A plurality of first main ropes 6 (only one is shown in the figures) for suspending the upper car 4 and the first counterweight 5 inside the hoistway 1 are wound around the first drive sheave 2. The first main ropes 6 have: first car end portions 6a connected to an upper

portion of the upper car 4; and first counterweight end portions 6b connected to an upper portion of the first counterweight 5.

[0010] The upper car 4 is suspended by the first main ropes 6 at its center of gravity. The first counterweight 5 is also suspended by the first main ropes 6 at its center of gravity. In addition, the upper car 4 and the first counterweight 5 are suspended by a one-to-one (1:1) roping method.

[0011] The first driving machine 3 is disposed directly above the upper car 4 such that an axis of rotation of the first drive sheave 2 extends horizontally. A first deflection sheave 7 around which the first main ropes 6 are wound is disposed in an upper portion of the hoistway 1. The first deflection sheave 7 directs the first main ropes 6 from the first drive sheave 2 toward the first counterweight 5.

[0012] The first deflection sheave 7 is disposed such that that an axis of rotation thereof extends parallel to the axis of rotation of the first drive sheave 2. In addition, the first main ropes 6 are wound around the first drive sheave 2 and the first deflection sheave 7 using a full winding method.

[0013] A second driving machine 9 having a second drive sheave 8 is disposed in an upper portion of the hoistway 1. A lower car 10 and a second counterweight 11 are raised and lowered inside the hoistway 1 by a driving force from the second driving machine 9. The lower car 10 is disposed below the upper car 4 inside the hoistway 1. The first and second counterweights 5 and 11 are disposed behind the upper car 4 and the lower car 10 inside the hoistway 1 so as to line up in a direction of frontage of the upper car 4 and the lower car 10.

[0014] First and second lower car suspension portions 10a and 10b are disposed on first and second side portions of an upper end of the lower car 10. The first and second lower car suspension portions 10a and 10b are symmetrically disposed on opposite sides of the center of gravity of the lower car 10 from each other.

[0015] A plurality of second main ropes 12 (only one is shown in the figures) and a plurality of third main ropes 13 (only one is shown in the figures) for suspending the lower car 10 and the second counterweight 11 inside the hoistway 1 are wound around the second drive sheave 8.

[0016] The second main ropes 12 have: second car end portions 12a connected to the first lower car suspension portion 10a; and second counterweight end portions 12b connected to the second counterweight 11. The third main ropes 13 have: third car end portions 13a connected to the second lower car suspension portion 10b; and third counterweight end portions 13b connected to the second counterweight 11.

[0017] The lower car 10 is suspended by the second and third main ropes 12 and 13 at its center of gravity. The second counterweight 11 is also suspended by the second and third main ropes 12 and 13 at its center of gravity. In addition, the lower car 10 and the second counterweight 11 are suspended by a one-to-one (1:1) roping method.

[0018] A second deflection sheave 14 around which the second and third main ropes 12 and 13 are wound is disposed in an upper portion of the hoistway 1. The second and third main ropes 12 and 13 are wound around the second deflection sheave 14 using a full winding method.

[0019] First and second guide pulleys 15 and 16 are also disposed in an upper portion of the hoistway 1. The first guide pulley 15 is disposed directly above the first lower car suspension portion 10a and directs the second main ropes 12 from the second drive sheave 8 toward the first lower car suspension portion 10a. The second guide pulley 16 is disposed directly above the second lower car suspension portion 10b and directs the third main ropes 13 toward the second lower car suspension portion 10b. The second and third main ropes 12 and 13 pass along first and second sides of the upper car 4 so as not to interfere with the upper car 4 and are connected to the lower car suspension portions 10a and 10b.

[0020] In addition, first and second direction-changing pulleys 17 and 18 for directing the third main ropes 13 from the second drive sheave 8 toward the second guide pulley 16 are also disposed in an upper portion of the hoistway 1.

[0021] Axes of rotation of the second drive sheave 8, the second deflection sheave 14, and the first guide pulley 15 extend horizontally parallel to each other. An axis of rotation of the second guide pulley 16 extends horizontally parallel to the direction of frontage of the upper car 4 and the lower car 10. Axes of rotation of the first and second direction-changing pulleys 17 and 18 extend vertically.

[0022] As shown in Figure 3, a pair of car guide rails 19 for guiding raising and lowering of the upper car 4 and the lower car 10, a pair of first counterweight guide rails 20 for guiding raising and lowering of the first counterweight 5, and a pair of second counterweight guide rails 21 for guiding raising and lowering of the second counterweight 11 are installed inside the hoistway 1.

[0023] The car guide rails 19 are disposed such that a straight line connecting them extends parallel to a direction of frontage of the upper car 4 and the lower car 10 and passes through the centers of gravity of the upper car 4 and the lower car 10 in a vertical plane of projection. Furthermore, the first lower car suspension portion 10a is disposed closer to a front surface of the lower car 10 than the car guide rails 19 in a vertical plane of projection, and the second lower car suspension portion 10b is disposed closer to a rear surface of the lower car 10 than the car guide rails 19.

[0024] In an elevator apparatus of this kind, because the lower car 10 and the second counterweight 11 are suspended by second and third main ropes 12 and 13, and a first lower car suspension portion 10a to which the

second main ropes 12 are connected and a second lower car suspension portion 10b to which the third main ropes 13 are connected are disposed on first and second sides of the lower car 10, the upper car 4 and the lower car 10 can each be suspended by one-to-one (1:1) roping. Thus, noise from the first and second driving machines 3 and 9 is reduced, enabling the upper car 4 and the lower car 10 to be operated at high speed.

[0025] Because the first and second lower car suspension portions 10a and 10b are symmetrically disposed on opposite sides of the center of gravity of the lower car 10 from each other, the upper car 4 and the lower car 10 can each be suspended at positions of their centers of gravity, thereby preventing eccentric loads from acting on the upper car 4 and the lower car 10, and enabling the upper car 4 and the lower car 10 to be operated stably.

[0026] In addition, because the first guide pulley 15 is disposed directly above the first lower car suspension portion 10a, and the second guide pulley 16 was disposed directly above the second lower car suspension portion 10b, the second and third main ropes 12 and 13 can be directed to the first and second lower car suspension portions 10a and 10b by a simple construction, enabling the upper car 4 and the lower car 10 to be operated stably.

[0027] Furthermore, because direction-changing pulleys 17 and 18 are used to direct the third main ropes 13 from the second drive sheave 8 to toward the second guide pulley 16, the third main ropes 13 can be prevented from interfering with the first driving machine 3 by a simple construction.

[0028] Because the first and second counterweights 5 and 11 are disposed behind the upper car 4 and the lower car 10 inside the hoistway 1 so as to line up in a direction of frontage of the upper car 4 and the lower car 10, space inside the hoistway 1 can be used effectively, enabling frontage dimensions of the hoistway 1 to be reduced.

Embodiment 2

[0029] Next, Figure 6 is a plan showing an elevator apparatus according to Embodiment 2 of the present invention. In Embodiment 1, the first and second counterweights 5 and 11 are disposed behind the upper car 4 and the lower car 10, but as shown in Figure 6, the first and second counterweights 5 and 11 may also be disposed beside the upper car 4 and the lower car 10 inside the hoistway 1.

[0030] In an elevator apparatus of this kind, because the first and second counterweights 5 and 11 are disposed beside the upper car 4 and the lower car 10 inside the hoistway 1 so as to line up in a depth direction of the upper car 4 and the lower car 10, space inside the hoistway 1 can be used effectively, enabling depth dimensions of the hoistway 1 to be reduced.

Embodiment 3

[0031] Next, Figure 7 is a plan showing an elevator apparatus according to Embodiment 3 of the present invention. In Embodiment 1, the car guide rails 19 are disposed at an intermediate portion in a depth direction of the upper car 4 and the lower car 10, but because eccentric loads will not act on the car guide rails 19 if the upper car 4 and the lower car 10 are suspended at their center of gravity, the position of installation of the car guide rails is not limited to that of Figure 3.

[0032] Consequently, as shown in Figure 7, for example, the lower car the suspension portions 10a and 10b may also be disposed at an intermediate portion in the depth direction of the lower car 10, and the car guide rails 19 disposed in a vicinity of corner portions in symmetrical positions relative to the centers of gravity of the upper car 4 and the lower car 10. In that case, the guide pulleys 15 and the direction-changing pulleys 18 in Figure 3 can be omitted, enabling the layout to be simplified.

[0033] Moreover, the driving machines 3 and 9, the deflection sheaves 7 and 14, the guide pulleys 15 and 16, and the direction-changing pulleys 17 and 18 may also be disposed in a machine room positioned in an upper portion of the hoistway 1, or they may also be disposed in an upper portion inside the hoistway 1. In other words, the present invention can be applied both to elevator apparatuses having a machine room, and to machine-roomless elevators.

[0034] Furthermore, in the above examples, the driving machines 3 and 9 are disposed such that the axes of rotation of the drive sheaves 2 and 8 extend horizontally, but driving machines may also be disposed such that axes of rotation of drive sheaves extend vertically.

[0035] In addition, in the above examples, one or two direction-changing pulleys are used, but three or more may also be used in order to avoid interference between the third main ropes and other equipment in the upper portion of the hoistway.

[0036] Furthermore, in the above examples, the main ropes are wound around the drive sheaves and the deflection sheaves by a full winding method, but a half winding method may also be used provided that sufficient traction can be provided. The deflection sheaves may also be omitted provided that sufficient traction can be provided.

Claims

1. An elevator apparatus comprising:

a first driving machine having a first drive sheave disposed in an upper portion of a hoistway;

an upper car and a first counterweight raised and lowered inside the hoistway by a driving

force from the first driving machine;
a first main rope wound around the first drive sheave, the first main rope having a first car end portion connected to the upper car, and a first counterweight end portion connected to the first counterweight;
a second driving machine having a second drive sheave disposed in an upper portion of the hoistway;
a lower car having first and second lower car suspension portions, the lower car being disposed below the upper car and raised and lowered inside the hoistway by a driving force from the second driving machine;
a second counterweight raised and lowered inside the hoistway by a driving force from the second driving machine;
a second main rope wound around the second drive sheave, the second main rope having a second car end portion connected to the first lower car suspension portion, and a second counterweight end portion connected to the second counterweight; and
a third main rope wound around the second drive sheave, the third main rope having a third car end portion connected to the second lower car suspension portion, and a third counterweight end portion connected to the second counterweight,

wherein the first and second lower car suspension portions are symmetrically disposed on opposite sides of a center of gravity of the lower car from each other.

2. The elevator apparatus according to Claim 1, wherein:

a first guide pulley for directing the second main rope toward the first lower car suspension portion is disposed in an upper portion of the hoistway directly above the first lower car suspension portion; and
a second guide pulley for directing the third main rope toward the second lower car suspension portion is disposed in an upper portion of the hoistway directly above the second lower car suspension portion.

3. The elevator apparatus according to Claim 1, wherein:

a guide pulley for directing the third main rope toward the second lower car suspension portion is disposed in an upper portion of the hoistway directly above the second lower car suspension portion; and
a direction-changing pulley for directing the third main rope from the second drive sheave toward the guide pulley is disposed in an upper portion of the hoistway.

4. The elevator apparatus according to Claim 1, wherein the first and second counterweights are disposed behind the upper car and the lower car inside the hoistway so as to line up in a direction of frontage of the upper car and the lower car.

5. The elevator apparatus according to Claim 1, wherein the first and second counterweights are disposed beside the upper car and the lower car inside the hoistway so as to line up in a depth direction of the upper car and the lower car.

FIG. 1

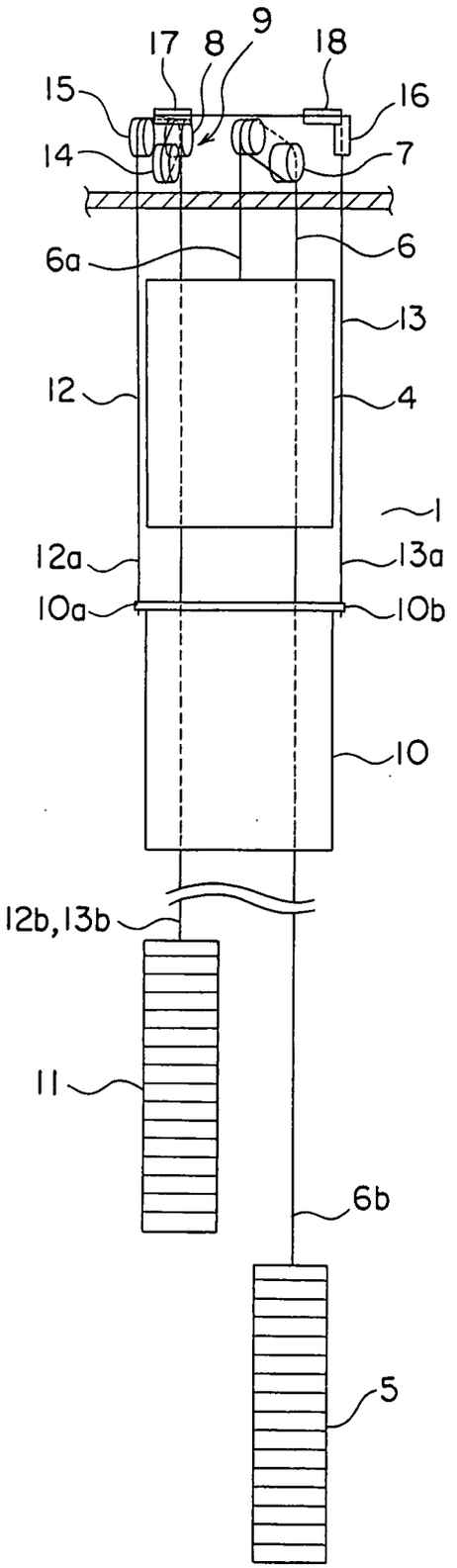


FIG. 2

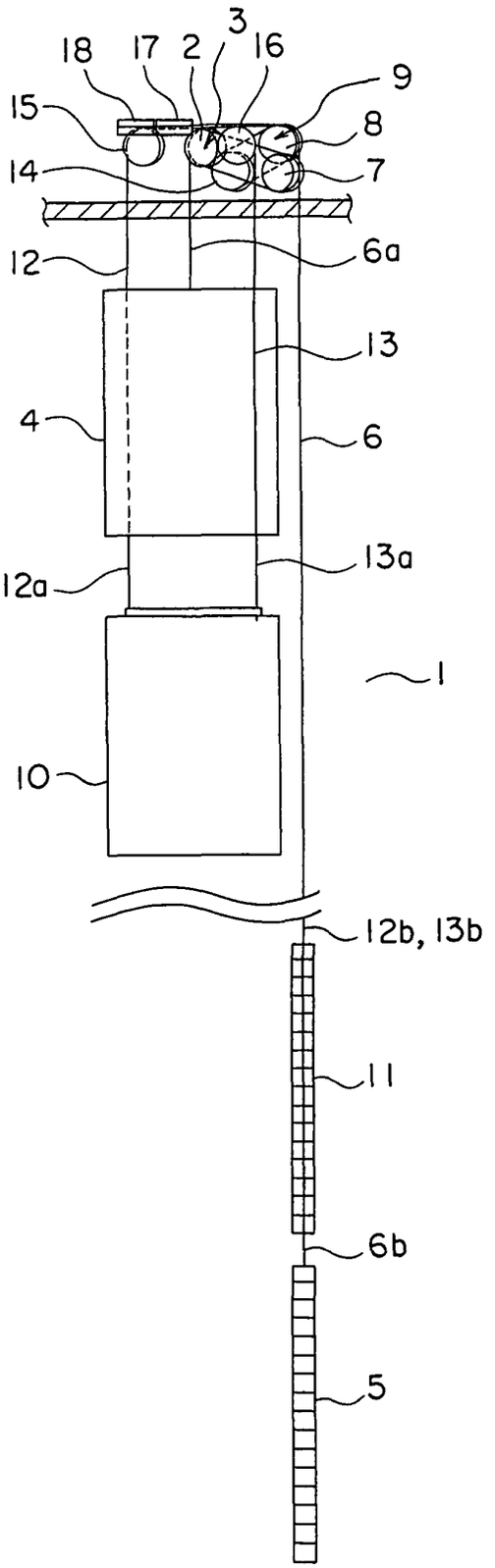


FIG. 3

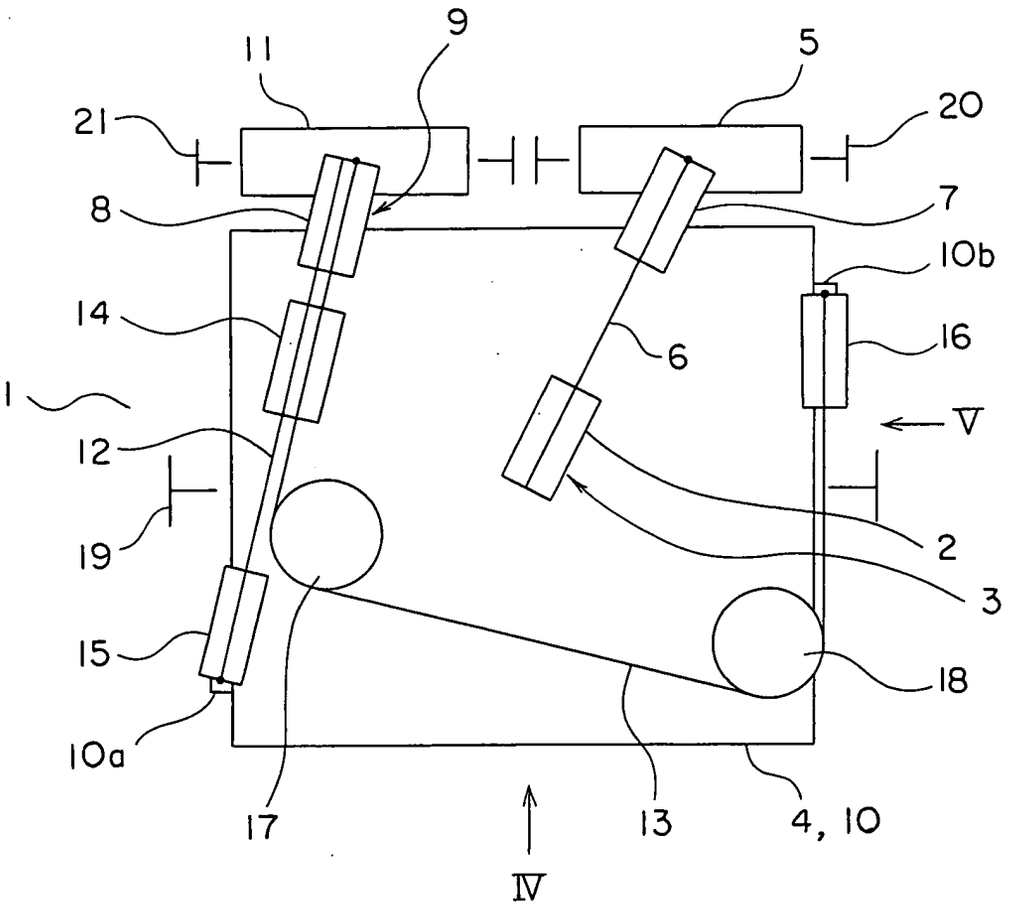


FIG. 4

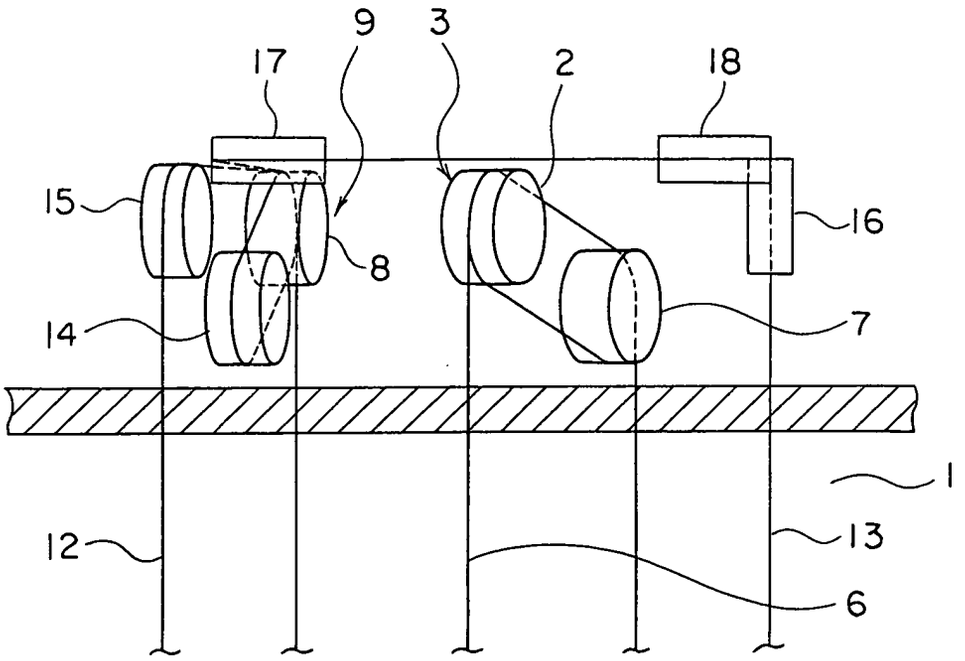


FIG. 5

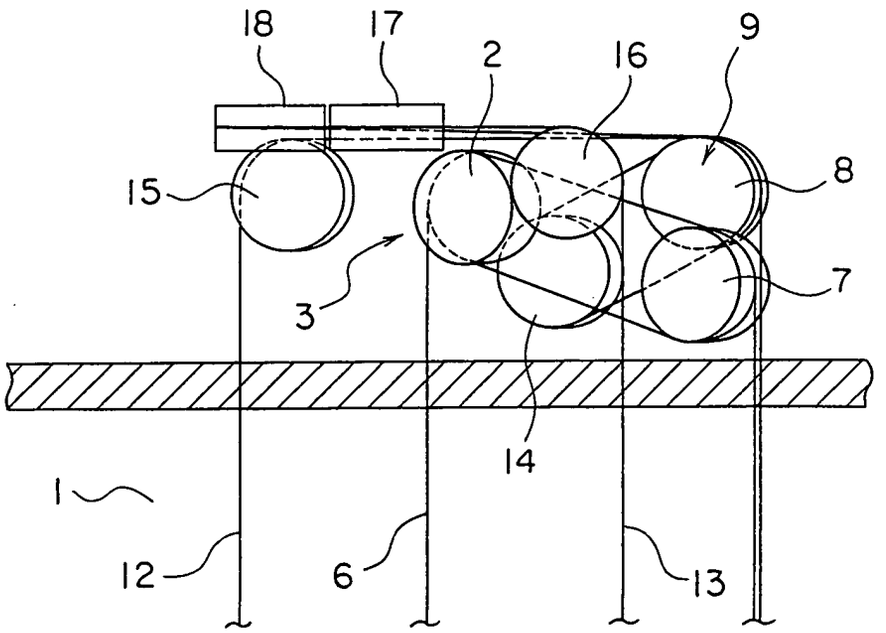


FIG. 6

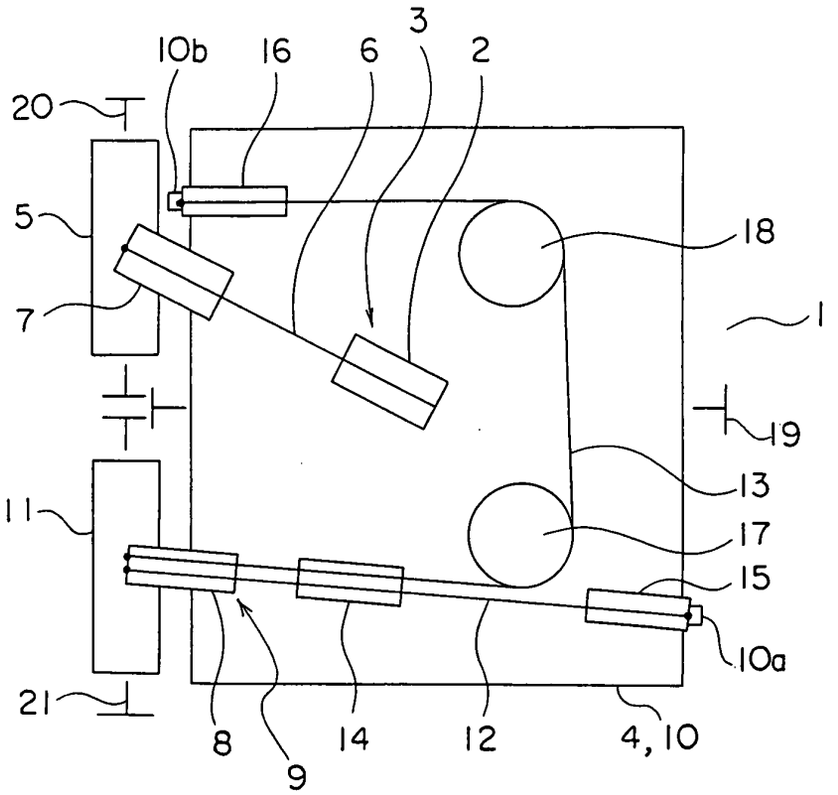

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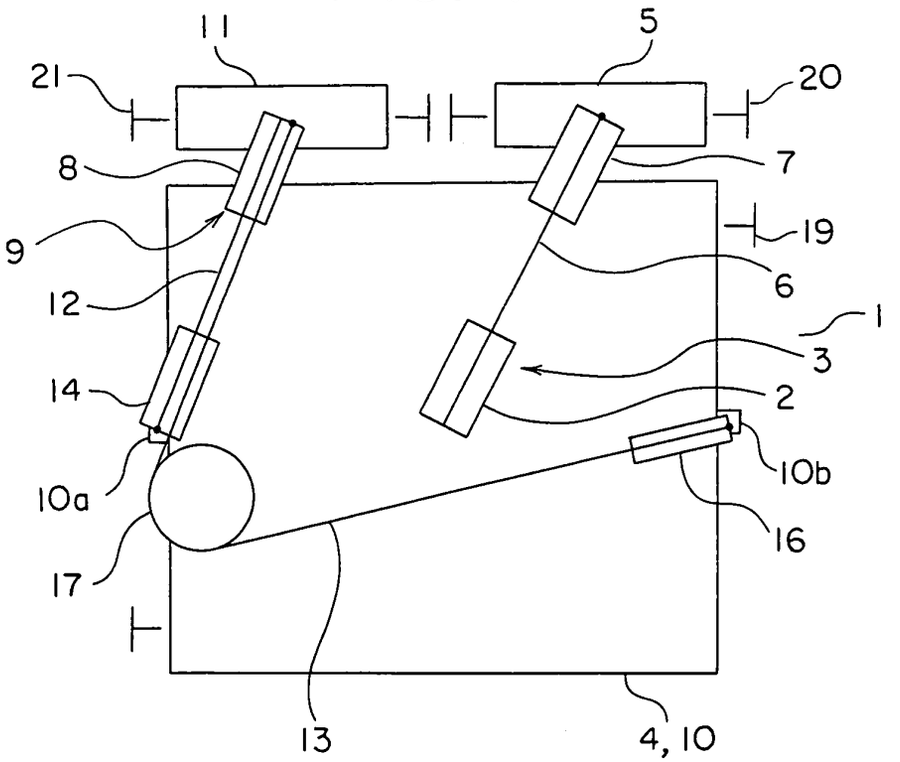
FIG. 7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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/11998

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] B66B7/06

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)
Int.Cl[7] B66B1/00-B66B11/08

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	1996-2003
Kokai Jitsuyo Shinan Koho	1971-2003	Toroku Jitsuyo Shinan Koho	1994-2003

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 Y	JP 7-187525 A (Masami SAKITA), 25 July, 1995 (25.07.95), & US 5419414 A	1 2-3
X Y	JP 59-133188 A (Toshiba Corp.), 31 July, 1984 (31.07.84), (Family: none)	1 2-3
A	JP 2-106570 A (Mitsubishi Electric Corp.), 18 April, 1990 (18.04.90), (Family: none)	4-5
A	JP 58-220075 A (Mitsubishi Electric Corp.), 21 December, 1983 (21.12.83), (Family: none)	4-5

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Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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