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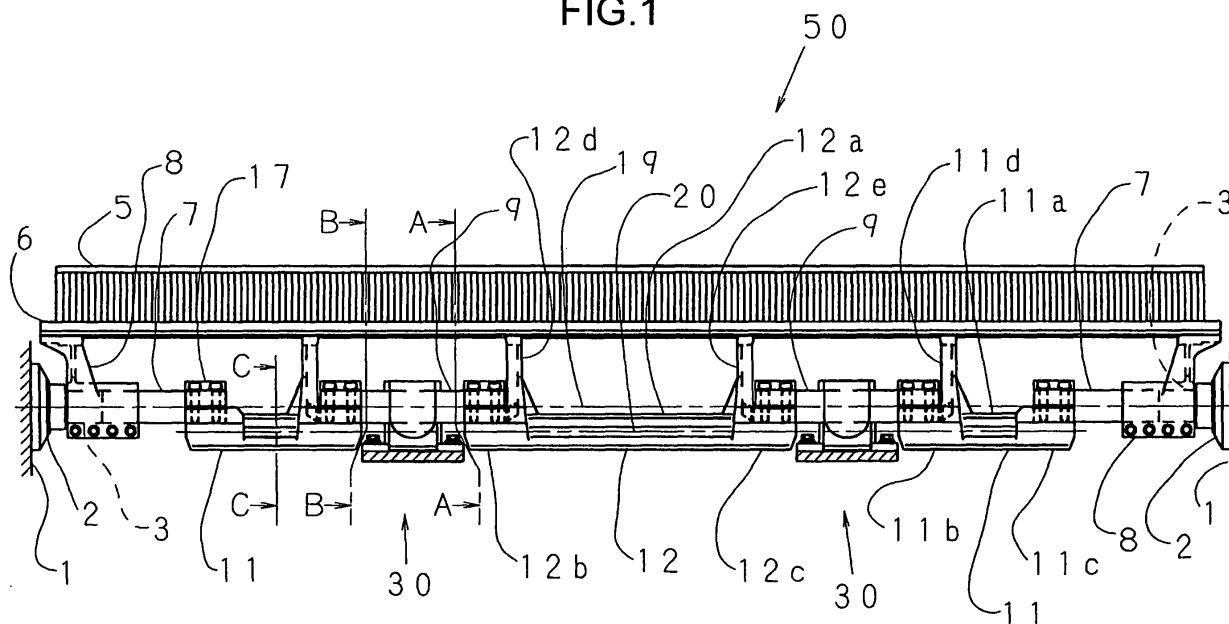
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(54) **Beating device for loom**

(57) A beating device (50) for a loom includes a plurality of rocking shafts (7, 9, 61i, 61j, 62i, 62j, 71i, 72i) disposed distant from each other in a width direction of cloth to be woven by the loom; a balance shaft (11a, 12a, 61a, 62a, 71a, 72aa, 72ab, 74) disposed farther away from a reed (5) than the rocking shafts and extending in said width direction, the balance shaft being disposed between the neighboring rocking shafts; a pair

of connecting portions (11b and 11c, 12b and 12c, 61b and 61c, 62b and 62c, 71b and 72c, 72b and 72b) for respectively connecting two opposite ends of the balance shaft with ends of the neighboring rocking shafts; and a plurality of sley swords (8, 11d, 12d, 12e, 61d, 63, 73). At least one of opposite end-segments of the balance shaft is formed integrally with at least one of the connecting portions and/or at least one of the sley swords to define an integrally molded unit.

FIG.1



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to beating devices used in looms.

2. Description of the Related Art

[0002] Beating devices for looms are generally provided with a rocking shaft which is rotated in response to a rotational force received from a main shaft of a loom, a plurality of sley swords attached to the rocking shaft, a reed holder supported by the sley swords, and a reed securely held by the reed holder. The reed, the reed holder, and the sley swords are thus linked with the rocking shaft so as to be movable in a rocking motion with respect to the rocking shaft acting as the axis of rocking motion so that a beating operation can be performed in response to a rotational force from the main shaft of the loom. However, the center of mass of the rocking shaft and its linked components is disposed closer to the reed than the axis of rocking motion, meaning that there is a significant positional difference between the center of mass and the axis of rocking motion. In other words, this can induce an unbalanced state of the rocking shaft and its linked components. Such an unbalanced state can cause vibration during the beating operation, which may lead to abrasion of the components or generation of noise. Moreover, such vibration is one of the main causes that prevent looms from operating at higher speeds. Japanese Examined Utility Model Registration Application Publication No. 57-23514 (P.3, Fig. 1), for example, discloses a beating device for solving the above-mentioned problem of the unbalanced state of the rocking shaft and its integrally-linked components.

[0003] According to Japanese Examined Utility Model Registration Application Publication No. 57-23514, three rocking shafts are provided such that the rocking shafts are disposed longitudinally in the width direction of cloth to be woven and distant from one another. Moreover, two balance shafts are disposed between the neighboring rocking shafts and are positioned farther away from a reed than the rocking shafts. Furthermore, connecting members having through-holes are provided such that the rocking shafts and the balance shafts extend through these through-holes so as to be linked with one another. In detail, each balance shaft is provided with a pair of the connecting members respectively at its opposite ends so that the opposite ends of the balance shaft can respectively be connected with the ends of two of the rocking shafts. The balance shafts allow the center of mass of the rocking shafts and their linked components to be positioned near the axis of rocking motion in order to prevent an unbalanced state. Moreover, the balance shafts move the sley swords in a rock-

ing motion in order to perform the beating operation. Since the rocking shafts are disposed in a discontinuous fashion in the width direction instead of being disposed entirely across the width direction, the overall weight of the beating device is reduced. As a result, this reduces the workload of the beating device and thus contributes to a high-speed operation of the loom.

[0004] In Japanese Examined Utility Model Registration Application Publication No. 57-23514, however, since the connecting members and the balance shafts are connected with each other via bolts, and the balance shafts and the sley swords are also connected with each other via bolts, the strength of these connections is low. This can lead to vibration and may therefore cause difficulties in performing an accurate beating operation. To increase the strength of the connections, the connecting sections between the connecting members and the balance shafts and between the sley swords and the balance shafts must be made larger. This, however, can increase the weight. The increase in weight leads to a larger power consumption and thus deteriorates the high-speed function of the loom. Moreover, the increase in weight can also generate a larger inertia force, which increases the workload of a driver unit for rotating the rocking shafts in forward and reverse directions. In such a case, the rigidity of the driver unit must be increased. Furthermore, the forming accuracy or the assembling accuracy of the connecting members, the balance shafts, and the sley swords may be adversely affected, meaning that it is difficult to maintain these components with high accuracy when these components are linked with one another. As a result, this can lead to vibration and may thus cause difficulties in performing an accurate beating operation.

SUMMARY OF THE INVENTION

[0005] Accordingly, it is an object of the present invention to provide a beating device for a loom which achieves high-strength and high-precision connections between balance shafts and rocking shafts and between balance shafts and sley swords while also achieving weight reduction in these connecting sections.

[0006] In order to achieve the above-mentioned object, the present invention provides a beating device for a loom, which includes a plurality of rocking shafts disposed distant from each other in a width direction of cloth to be woven by the loom; a balance shaft disposed farther away from a reed than the rocking shafts and extending in said width direction, the balance shaft being disposed between the neighboring rocking shafts; a pair of connecting portions for respectively connecting two opposite ends of the balance shaft with ends of the neighboring rocking shafts; and a plurality of sley swords. At least one of opposite end-segments of the balance shaft is formed integrally with at least one of the connecting portions and/or at least one of the sley swords to define an integrally molded unit.

[0007] Accordingly, at least one of the opposite end-segments of the balance shaft and at least one sley sword, and/or at least one of the opposite end-segments of the balance shaft and at least one of the connecting portions are integrally molded without being joined together by, for example, welding or using bolts. This contributes to the weight reduction as well as achieving high-strength and high-precision connections. Consequently, this reduces vibration and thus allows the beating device to perform a proper beating operation.

[0008] Furthermore, the integrally molded unit may be formed by integrally molding said at least one of the opposite end-segments of the balance shaft, said at least one of the connecting portions, and at least one of the rocking shafts disposed adjacent to the corresponding connecting portion.

[0009] Accordingly, this contributes to the weight reduction as well as achieving high-strength and high-precision connections between the balance shaft and the rocking shafts.

[0010] Furthermore, the integrally molded unit is preferably composed of cast iron or cast steel.

[0011] Accordingly, since at least one of the opposite end-segments of the balance shaft is formed by casting using cast iron or cast steel, the balance shaft can absorb vibration better than a balance shaft formed of steel. Balance shafts composed of cast iron are especially highly absorptive against vibration and can thus reduce adverse effects such as abrasion or noise caused by the vibration. As a result, this contributes to the high-speed function of the loom.

[0012] Furthermore, the balance shaft is preferably non-circular in cross-section such that a rocking-direction flexural-rigidity of the balance shaft is greater than a flexural-rigidity of the balance shaft in a direction perpendicular to a rocking direction.

[0013] When the balance shaft receives a rotational torque from the rocking shafts via the connecting portions so as to move in a rocking motion with respect to the rocking shafts as the axis of rocking motion, since the balance shaft is non-circular in cross-section such that flexural rigidity of the balance shaft in the direction in which the balance shaft receives the rotational torque, i.e. the rocking-direction flexural-rigidity, is greater than the flexural rigidity of the balance shaft in the direction in which the balance shaft does not receive the rotational torque, i.e. the flexural-rigidity in the direction perpendicular to the rocking direction, the balance shaft can be prevented from bending in response to the rotational torque, thus preventing vibration and improper beating operation. Moreover, the lower flexural-rigidity in the direction perpendicular to the rocking direction contributes to the weight reduction of the balance shaft. This reduces the weight of the rocking components in the beating device as well as the inertia force of the rocking motion in the forward and reverse directions. As a result, a high-speed operation of the loom can be achieved.

[0014] Furthermore, the balance shaft may either be

rectangular, oval, or substantially elliptic in cross-section such that a cross-sectional dimension of the balance shaft in the rocking direction is longer than that in the direction perpendicular to the rocking direction.

[0015] Accordingly, this ensures that the rocking-direction flexural-rigidity of the balance shaft is greater than the flexural-rigidity of the balance shaft in the direction perpendicular to the rocking direction.

[0016] Furthermore, the balance shaft may either be trapezoidal or fan-shaped in cross-section. If the balance shaft is trapezoidal in cross-section, a side of the balance shaft distant from the reed is set longer than a side of the balance shaft closer to the reed, and the rocking-direction flexural-rigidity is thus set greater than the flexural-rigidity in the direction perpendicular to the rocking direction. On the other hand, if the balance shaft is fan-shaped in cross-section, a side of the balance shaft distant from the reed forms a circular-arc substantially around an axis of rocking motion being the center of curvature and is thus set longer than a side of the balance shaft closer to the reed, and the rocking-direction flexural-rigidity is thus set greater than the flexural-rigidity in the direction perpendicular to the rocking direction.

[0017] Accordingly, this ensures that the rocking-direction flexural-rigidity of the balance shaft is greater than the flexural-rigidity of the balance shaft in the direction perpendicular to the rocking direction.

[0018] Furthermore, the balance shaft may be substantially U-shaped in cross-section such that a central portion of a side of the balance shaft closer to the reed is depressed, and the rocking-direction flexural-rigidity is thus set greater than the flexural-rigidity in the direction perpendicular to the rocking direction.

[0019] Accordingly, this ensures that the rocking-direction flexural-rigidity of the balance shaft is greater than the flexural-rigidity of the balance shaft in the direction perpendicular to the rocking direction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

Fig. 1 is a front view of a beating device viewed from a take-up side of a loom according to a first embodiment of the present invention;

Fig. 2 is a partially enlarged view of Fig. 1;

Fig. 3 is a cross-sectional view taken along line A-A in Figs. 1 and 2 and illustrates a beating state of a reed;

Fig. 4 is a cross-sectional view taken along line A-A in Figs. 1 and 2 and illustrates a state in which the reed is at its farthest drawn-back position;

Fig. 5 is a cross-sectional view taken along line B-B in Figs. 1 and 2;

Fig. 6 is a cross-sectional view taken along line C-C in Fig. 1;

Fig. 7 illustrates a first modification example of the first embodiment;

Fig. 8 illustrates a second modification example of the first embodiment;

Fig. 9 illustrates a third modification example of the first embodiment;

Fig. 10 illustrates a second embodiment according to the present invention;

Fig. 11 illustrates a third embodiment according to the present invention;

Fig. 12 illustrates a fourth embodiment according to the present invention;

Fig. 13 illustrates a first modification example of the fourth embodiment;

Fig. 14 illustrates a second modification example of the fourth embodiment;

Fig. 15 illustrates a fifth embodiment according to the present invention; and

Fig. 16 illustrates a sixth embodiment according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0021] Embodiments of the present invention will now be described with reference to the drawings. Figs. 1 to 6 illustrate a beating device 50 for an air-jet loom according to a first embodiment of the present invention. Fig. 1 is a front view of a take-up side of the loom, and Fig. 2 is a partially enlarged view of Fig. 1. Figs. 3 and 4 each illustrate a cross-sectional view taken along line A-A in Figs. 1 and 2. Specifically, Fig. 3 illustrates a beating state of a reed 5, whereas Fig. 4 illustrates a state in which the reed 5 is at its farthest drawn-back position. Fig. 5 is a cross-sectional view taken along line B-B in Figs. 1 and 2. Fig. 6 is a cross-sectional view taken along line C-C in Fig. 1.

[0022] Referring to Figs. 1 to 4, the beating device 50 includes a pair of side supporters 2, 2 respectively provided on left and right frames 1, 1 of the loom; a pair of first rocking shafts 3, 3 respectively supported by the two side supporters 2, 2 in a rotatable manner; two driving units, which are not shown in the drawings, respectively provided on the left and right sides of the loom for driving the two first rocking shafts 3, 3 in response to the rotation of a main shaft 4 of the loom; the reed 5 and a reed holder 6 both extending longitudinally to cover the whole width of cloth to be woven, which will be referred to as a weaving-width hereinafter; a pair of second rocking shafts 7, 7 disposed adjacent to the respective first rocking shafts 3, 3; two sley swords 8, 8 supporting the two longitudinal ends of the reed holder 6 and each having a through-hole through which one of the first rocking shafts 3, 3 and one of the second rocking shafts 7, 7 extend so as to connect the two shafts with each other; a pair of third rocking shafts 9, 9 which are disposed distant from each other in the weaving-width direction and are also distant from the two second rocking shafts 7, 7 in the weaving-width direction; a beam 10 extending in the weaving-width direction and having

its two longitudinal ends respectively supported by the left and right frames 1, 1; a pair of intermediate supporting units 30, 30 disposed on the beam 10 and respectively supporting the two third rocking shafts 9, 9 in a rotatable manner; a pair of first composite members 11, 11 each of which corresponds to a set of one of the second rocking shafts 7, 7 and one of the third rocking shafts 9, 9 and is disposed between the two rocking shafts 7 and 9 of the corresponding set; and a second composite member 12 disposed between a set of the third rocking shafts 9 and 9.

[0023] The neighboring second rocking shafts 7, 7 and third rocking shafts 9, 9 define two sets of rocking shafts 7 and 9, and moreover, the neighboring third rocking shafts 9, 9 define one set of rocking shafts 9 and 9. Each first composite member 11 is disposed between one of the two sets of rocking shafts 7 and 9. On the other hand, the second composite member 12 is disposed between the set of rocking shafts 9 and 9. Each of the first composite members 11, 11 includes a balance shaft 11a, and a pair of connecting portions 11b and 11c which are respectively disposed at two longitudinal ends of the balance shaft 11a and connect the ends of the balance shaft 11a with an end of the corresponding second rocking shaft 7 and an end of the corresponding third rocking shaft 9. On the other hand, the second composite member 12 includes a balance shaft 12a, and a pair of connecting portions 12b and 12c which are respectively disposed at two longitudinal ends of the balance shaft 12a and connect the ends of the balance shaft 12a with the ends of the two third rocking shafts 9, 9. Consequently, each balance shaft 11a is disposed between one of the two sets of the rocking shafts 7 and 9, whereas the balance shaft 12a is disposed between the set of rocking shafts 9 and 9.

[0024] The two first rocking shafts 3, 3, the two second rocking shafts 7, 7, and the two third rocking shafts 9, 9 are linked with one another via the two sley swords 8, 8, the two first composite members 11, 11, and the second composite member 12, and moreover, are coaxially supported by the two side supporters 2, 2 and the two intermediate supporting units 30, 30. Thus, the two driving units for respectively driving the two first rocking shafts 3, 3 move the first rocking shafts 3, 3, the second rocking shafts 7, 7, and the third rocking shafts 9, 9 in a rocking motion. The two longitudinal ends of the reed 5 are supported by the two sley swords 8, 8 via the reed holder 6, and four intermediate portions of the reed 5 are supported by the two first composite members 11, 11 and the second composite member 12 via the reed holder 6. Due to being linked with the rocking shafts 3, 7, and 9, the reed 5 and a plurality of sub-nozzles 31 supported by the reed holder 6 move together with the rocking shafts 3, 7, and 9 in a rocking motion. This will be described below in further detail.

[0025] Referring to Fig. 5, each intermediate supporting unit 30 includes a plate 13 fixed to the beam 10 via bolts; a bracket 14 fixed to the plate 13 via bolts; a bear-

ing holder 15 fixed to the bracket 14 via bolts; a bearing, not shown in the drawing; and a bearing cover 16 attached to the bearing holder 15 via bolts so as to secure the bearing in position. All of the rocking shafts 3, 3, 7, 7, 9, 9 are coaxially supported by the two side supporters 2, 2 and the two intermediate supporting units 30, 30, and are thus prevented from vibrating so as to perform a proper beating operation.

[0026] The sley swords 8, 8 for supporting the ends of the reed holder 6 are each provided with a slit at the connecting section between the sley sword 8 and the corresponding rocking shafts 3 and 7. The slit extends longitudinally across the sley sword 8 and extends radially into the sley sword 8 so as to communicate with the through-hole for the rocking shafts 3 and 7. Segments of the sley sword 8 are fastened together via bolts so as to close the slit, whereby the first rocking shaft 3 and the second rocking shaft 7 are tightly connected with each other.

[0027] Each first composite member 11 including the balance shaft 11a, the pair of connecting portions 11b and 11c, and a sley sword 11d extending from the balance shaft 11a towards the reed 5 is fabricated by casting. In detail, each first composite member 11 is formed by casting iron into a casting mold, such that the balance shaft 11a, the pair of connecting portions 11b and 11c and the sley sword 11d are integrally molded to form a single-piece unit.

[0028] Referring to Figs. 1 and 3, the pair of connecting portions 11b and 11c extend from the balance shaft 11a towards the reed 5, and are respectively provided with connection grooves 11f which are used for the connection with the rocking shafts 9 and 7. The connection groove 11f have a circular-arc surface. In a state where the rocking shafts 9 and 7 are set in the corresponding connection grooves 11f, a pair of shaft pressers 17 also having a circular-arc surface is respectively attached to the connecting portions 11b and 11c via bolts 18 so as to press the rocking shafts 9 and 7 against the corresponding connection grooves 11f. In other words, the rocking shafts 9 and 7 are tightly secured between the corresponding connection grooves 11f and the corresponding shaft pressers 17. This allows the pair of connecting portions 11b and 11c to be tightly connected with the respective rocking shafts 9 and 7, meaning that each first composite member 11 and the corresponding rocking shafts 7 and 9 are tightly connected to one another. Accordingly, the rocking shafts 7 and 9 are rockable about an axis of rocking motion 19.

[0029] Since the pair of connecting portions 11b and 11c is provided with the connection grooves 11f extending from the balance shaft 11a towards the reed 5 so as to be respectively connected with the rocking shafts 9 and 7, the balance shaft 11a is positioned farther away from the reed 5 than the rocking shafts 9 and 7, i.e. the axis of rocking motion 19. This means that the center of mass of the combination of the rocking shafts and the components linked with the shafts, such as the reed 5,

the reed holder 6, and the sub-nozzles 31, is set close to the the axis of rocking motion 19 so as to prevent an unbalanced state.

[0030] Referring to Fig. 6, the balance shaft 11a is substantially elliptic in cross-section such that dimension A is greater than dimension B. Specifically, dimension A is the length of the cross-sectional ellipsoid in the rocking direction, which is perpendicular to the direction in which the axis of rocking motion 19 extends and to an imaginary line extending through the axis of rocking motion 19 and the center of mass 20 of the balance shaft 11a, whereas dimension B is the width of the cross-sectional ellipsoid in the direction perpendicular to the rocking direction and parallel to the imaginary line. The center of mass 20 of the balance shaft 11a is aligned with the center of the ellipsoid in cross-section. Thus, the flexural rigidity of the balance shaft 11a in a direction in which the balance shaft 11a receives a rotational torque from the rocking shafts 7 and 9, which will be referred to as a rocking-direction flexural-rigidity, is greater than the flexural rigidity of the balance shaft 11a in a direction in which the balance shaft 11a does not receive the torque, which will be referred to as a flexural-rigidity in the direction perpendicular to the rocking direction. This prevents the balance shaft 11a from bending in response to the rotational torque so as to prevent an improper beating operation. Moreover, the lower flexural-rigidity in the direction perpendicular to the rocking direction contributes to the weight reduction of the balance shaft 11a, thus allowing the loom to operate at a higher rate.

[0031] Like the other segments in each first composite member 11, the balance shaft 11a is formed of cast iron that absorbs vibration. For this reason, vibration is reduced in the balance shaft 11a in comparison with, for example, steel shafts formed by, for example, a drawing process. This reduces adverse effects such as abrasion or noise caused by the vibration between engagement components such as shafts and bearings, and bearings and bearing houses. Moreover, this also contributes to the high-speed function of the loom.

[0032] Dimension A of the balance shaft 11a in cross-section shown in Fig. 6 is preferably at least 1.1 times greater than dimension B. This provides a higher rocking-direction flexural-rigidity while still achieving weight reduction of the balance shaft 11a.

[0033] Referring to Figs. 1 and 3, the sley sword 11d extends from a section of the balance shaft 11a near the connecting portion 11b towards the reed 5 and engages with an intermediate section of the reed holder 6 via a bolt to support a corresponding intermediate section of the reed 5. Furthermore, the sley sword 11d is substantially U-shaped in cross-section and has high rigidity, and moreover, is provided with a cored hole 11g for the purpose of weight reduction.

[0034] Like the first composite members 11, 11, the second composite member 12 including the balance shaft 12a, the pair of connecting portions 12b and 12c,

and a pair of sley swords 12d and 12e respectively extending from two sections of the balance shaft 12a near the connecting portions 12b and 12c towards the reed 5 is formed by casting iron into a casting mold. Thus, the balance shaft 12a, the pair of connecting portions 12b and 12c, and the two sley swords 12d and 12e are integrally molded to form a single-piece unit.

[0035] Furthermore, like the first composite members 11, 11, the pair of connecting portions 12b and 12c extend from the balance shaft 12a towards the reed 5, and are respectively provided with connection grooves 12f which are used for the connection with the rocking shafts 9, 9. The connection grooves 12f have a circular-arc surface. In a state where the third rocking shafts 9, 9 are set in the corresponding connection grooves 12f, a pair of shaft pressers 17 also provided for the second composite member 12 is respectively attached to the connecting portions 12b and 12c via the bolts 18 so as to press the third rocking shafts 9, 9 against the corresponding connection grooves 12f. This allows the pair of connecting portions 12b and 12c to be tightly connected with the respective third rocking shafts 9, 9, meaning that the second composite member 12 and the third rocking shafts 9, 9 are tightly connected to each other. Accordingly, the third rocking shafts 9, 9 are rockable about the axis of rocking motion 19.

[0036] Furthermore, like the first composite members 11, 11, the balance shaft 12a allows the center of mass of the combination of the rocking shafts and the components linked with the shafts to be set close to the axis of rocking motion 19 so as to prevent an unbalanced state. Moreover, the balance shaft 12a is provided with the same cross-sectional shape as the balance shaft 11a of each first composite member 11. Consequently, this prevents the balance shaft 12a from bending in response to the rotational torque from the third rocking shafts 9, 9, and contributes to the weight reduction of the balance shaft 12a so as to allow the loom to operate at a higher rate.

[0037] Referring to Figs. 1 and 3, the two sley swords 12d and 12e extend from the balance shaft 12a towards the reed 5 and engage with two respective intermediate sections of the reed holder 6 via bolts so as to support two respective intermediate sections of the reed 5. Furthermore, each of the sley swords 12d and 12e is substantially U-shaped in cross-section and has high rigidity, and moreover, is provided with a cored hole 12g for the purpose of weight reduction.

[0038] Although the balance shafts 11a and 12a of the respective first composite members 11 and second composite member 12 are substantially elliptic in cross-section, the balance shafts 11a and 12a may alternatively be rectangular or oval in cross-section. As a further alternative, each of the balance shafts 11a and 12a may be provided with a reinforcement rib.

[0039] Fig. 7 illustrates a first modification example of the first embodiment, in which each of the balance shafts 11a and the balance shaft 12a is provided with a

rib on a side of the balance shafts 11a or 12a closer to the axis of rocking motion 19. The dimension of the rib in the direction perpendicular to the rocking direction is defined as dimension C. This structure according to the first modification example provides a higher flexural-rigidity in the direction perpendicular to the rocking direction. The cross-sectional shape of each of the balance shafts 11a and the balance shaft 12a is determined without taking into consideration the rib since the rib is supplemental and does not significantly affect the flexural rigidity. However, providing a large rib such that the flexural-rigidity in the direction perpendicular to the rocking direction exceeds the rocking-direction flexural-rigidity is not preferable. This is due to the fact that the large rib may lead to an increase in weight, which goes against the object of achieving weight reduction for allowing the loom to operate at a higher rate while at the same time providing a higher rocking-direction flexural-rigidity.

[0040] Alternatively, the balance shafts 11a and the balance shaft 12a of the respective first composite members 11, 11 and second composite member 12 may be trapezoidal, fan-shaped, or U-shaped in cross-section.

[0041] Fig. 8 illustrates a second modification example of the first embodiment. In this example, the balance shafts 11a and the balance shaft 12a of the respective first composite members 11, 11 and second composite member 12 are substantially fan-shaped in cross-section such that a side of each of the balance shafts 11a and the balance shaft 12a distant from the reed 5 forms a circular-arc and is therefore longer than a side closer to the reed 5. Since the side distant from the reed 5 forms a circular-arc substantially around the axis of rocking motion 19 being the center of curvature, each balance shaft 11a or 12a is prevented from interfering with peripheral units disposed near that side when the balance shaft 11a or 12a is rocking, and moreover, is capable of maintaining a good balance. In other words, because the center of mass 20 of each of the balance shafts 11a and 12a is disposed farther away from the axis of rocking motion 19, the center of mass of the entire combination of the rocking shafts and the components linked with the shafts can be set close to the axis of rocking motion 19 even if the balance shafts 11a and 12a are not heavy components. Consequently, this contributes to the reduction of the overall weight of the rocking components in the beating device 50.

[0042] Fig. 9 illustrates a third modification example of the first embodiment, in which each of the balance shafts 11a and the balance shaft 12a of the respective first composite members 11, 11 and second composite member 12 is substantially U-shaped in cross-section, such that the central portion of the side closer to the reed 5 is depressed. Similar to the second modification example shown in Fig. 8, the center of mass 20 of each of the balance shafts 11a and 12a is disposed farther away from the axis of rocking motion 19 so as to achieve a good balance.

[0043] In the first embodiment, although the two longitudinal ends of the reed 5 are respectively supported by the two sley swords 8, 8, the longitudinal ends of the reed 5 may alternatively be supported by the composite members.

[0044] Fig. 10 illustrates a second embodiment in which a plurality of second composite members 12 are provided such that two of the second composite members 12 are engaged with the longitudinal ends of the reed holder 6 in order to support the longitudinal ends of the reed 5.

[0045] As described above, in the first and second embodiments, the connecting portions 11b, 11c, 12b, and 12c are provided with the connection grooves 11f and 12f, and the rocking shafts 7 and 9 and the composite members 11 and 12 are linked with one another via the shaft pressers 17 disposed above the corresponding connection grooves 11f and 12f. Alternatively, the connecting portions 11b, 11c, 12b, and 12c may be provided with through-holes through which the corresponding rocking shafts 7 and 9 extend so as to allow the rocking shafts 7 and 9 and the composite members 11 and 12 to be linked with one another.

[0046] Fig. 11 illustrates a third embodiment in which each pair of the connecting portions 11b and 11c is provided with through-holes 11h, and the pair of connecting portions 12b and 12c is provided with through-holes 12h. Furthermore, the connecting portions 11b, 11c, 12b, and 12c are each provided with a slit extending longitudinally across the connecting portion 11b, 11c, 12b, or 12c and extending radially inward so as to communicate with the corresponding one of the through-holes 11h and 12h. The rocking shafts 7 and 9 are firmly fixed in the corresponding through-holes 11h and 12h via the bolts 18, whereby the rocking shafts 7 and 9 and the composite members 11 and 12 are tightly connected with one another.

[0047] As described above, in the first, second, and third embodiments, the sley sword 11d of each first composite member 11 extends from the corresponding balance shaft 11a towards the reed 5, and the sley swords 12d and 12e of each second composite member 12 extend from the corresponding balance shaft 12a towards the reed 5. Alternatively, each of the sley swords 11d, 12d, and 12e may extend directly from the corresponding one of the connecting portions 11b, 11c, 12b, and 12c. Such a structure contributes to the weight reduction of the sley swords 11d, 12d, and 12e.

[0048] Fig. 12 illustrates a fourth embodiment; Fig. 13 illustrates a first modification example of the fourth embodiment; and Fig. 14 illustrates a second modification example of the fourth embodiment. According to the fourth embodiment and the first and second modification examples of the fourth embodiment, each of the sley swords 11d, 12d, and 12e extends directly from the corresponding one of the connecting portions 11b, 12b, and 12c. Similar to the third embodiment, each of the connecting portions 11b, 11c, 12b, and 12c in the fourth em-

bodiment is provided with the corresponding one of the through-holes 11h and 12h, and the slit extending longitudinally across the connecting portion 11b, 11c, 12b, or 12c and extending radially inward so as to communicate with the corresponding one of the through-holes 11h and 12h. On the other hand, according to the first modification example of the fourth embodiment, each of the rocking shafts 7 and 9 is cut longitudinally so as to form a flat surface on one side. Thus, the rocking shafts 7 and 9 are connected with the composite members 11 and 12 via the bolts 18 in a state such that the flat surfaces of the rocking shafts 7 and 9 are disposed on flat connection surfaces of the corresponding connecting portions 11b, 11c, 12b, and 12c. Furthermore, according to the second modification example of the fourth embodiment, two opposite sides of each of the rocking shafts 7 and 9 are cut longitudinally so as to form two flat surfaces parallel to each other. Thus, the rocking shafts 7 and 9 extend through the corresponding connecting portions 11b, 11c, 12b, and 12c in a state such that the flat surfaces face parallel connection surfaces provided in the connecting portions 11b, 11c, 12b, and 12c, whereby the rocking shafts 7 and 9 are connected with the composite members 11 and 12 via the bolts 18.

[0049] In the embodiments described above, each of the first composite members 11 is integrally molded to form a single-piece unit including the balance shaft 11a, the pair of connecting portions 11b and 11c, and the sley sword 11d. Alternatively, the balance shaft 11a and at least one of the pair of the connecting portions 11b and 11c and the sley sword 11d may be integrally molded to form a first unit, and the remaining one of the pair of the connecting portions 11b and 11c and the sley sword 11d may be made separately to form a second unit. In this case, the first and second units may be combined together into a single composite using bolts. Similarly, each second composite member 12 is integrally molded to form a single-piece unit including the balance shaft 12a, the pair of connecting portions 12b and 12c, and the pair of sley swords 12d and 12e. Alternatively, the balance shaft 12a and at least one of the pair of connecting portions 12b and 12c and the pair of sley swords 12d and 12e may be integrally molded to form a first unit, and the remaining one of the pair of connecting portions 12b and 12c and the pair of sley swords 12d and 12e may be made separately to form a second unit. In this case, the first and second units may be combined together into a single composite using bolts.

[0050] Furthermore, although not integrally molded in the above embodiments, the composite members 11 and 12 and the rocking shafts 7 and 9 may alternatively be formed in an integrally molded manner. Examples of such a structure will be described below in detail with reference to a fifth embodiment shown in Fig. 15 and a sixth embodiment shown in Fig. 6.

[0051] According to the fifth embodiment shown in Fig. 15, a pair of first composite members 61 is provided. Each first composite member 61 is formed by casting

iron into a casting mold to form a single-piece unit including a pair of rocking shafts 61i, 61j disposed distant from each other; a balance shaft 61a disposed between the two rocking shafts 61i, 61j; a pair of connecting portions 61b, 61c for respectively connecting the two longitudinal ends of the balance shaft 61a with the ends of the rocking shafts 61i, 61j; and a sley sword 61d extending from the balance shaft 61a towards the reed 5.

[0052] Furthermore, a second composite member 62 is connected with the two first composite members 61 via a pair of sley swords 63. Like the first composite members 61, the second composite member 62 is formed by casting iron into a casting mold to form a single-piece unit including a pair of rocking shafts 62i, 62j disposed distant from each other; a balance shaft 62a disposed between the two rocking shafts 62i, 62j; and a pair of connecting portions 62b, 62c for respectively connecting the two longitudinal ends of the balance shaft 62a with the ends of the rocking shafts 62i, 62j.

[0053] The rocking shaft 61j of the first composite member 61 on the left side of the drawing and the rocking shaft 62i of the second composite member 62 are connected with each other via the corresponding sley sword 63 so as to define a single rocking-shaft assembly. Similarly, the rocking shaft 61j of the first composite member 61 on the right side of the drawing and the rocking shaft 62j of the second composite member 62 are connected with each other via the corresponding sley sword 63 so as to define a single rocking-shaft assembly. Consequently, two sets of rocking-shaft assemblies are provided. Thus, each rocking shaft 61j defines a first segment of one of the rocking-shaft assemblies, and the corresponding one of the rocking shafts 62i and 62j defines a second segment of the rocking-shaft assembly. Consequently, the first composite members 61 and the second composite member 62 form an integrated structure including a balance shaft, a pair of connecting portions, and a pair of rocking shafts disposed distant from each other.

[0054] Like the first embodiment shown in Fig. 6, the balance shafts 61a and 62a of the respective first composite members 61 and second composite member 62 are substantially elliptic in cross-section. Specifically, the length of the cross-sectional ellipsoid in the rocking direction is greater than the width of the cross-sectional ellipsoid in the direction perpendicular to the rocking direction and parallel to the imaginary line extending through the axis of rocking motion 19 and the center of mass 20 of the balance shaft 11a. This allows the rocking-direction flexural-rigidity to be greater than the flexural-rigidity in the direction perpendicular to the rocking direction.

[0055] According to the sixth embodiment shown in Fig. 16, a pair of first composite members 71 is provided. Each first composite member 71 is formed by casting iron into a casting mold to form a single-piece unit including a balance shaft 71a; a connecting portion 71b disposed adjacent to an end of the balance shaft 71a;

and a rocking shaft 71i.

[0056] Furthermore, a pair of second composite members 72 is provided. The second composite members 72 are connected with the first composite members 71 via sley swords 73. Like the first composite members 71, each second composite member 72 is formed by casting iron into a casting mold to form a single-piece unit including balance shafts 72aa, 72ab disposed respectively at the two longitudinal ends of the second composite member 72; connecting portions 72c, 72b respectively disposed adjacent to ends of the balance shafts 72aa, 72ab; and a rocking shaft 72i. Furthermore, a pair of intermediate supporting units 80 is provided for rotatably supporting the corresponding rocking shafts 72i. The intermediate supporting units 80 are each provided with a shaft bearing of a two-body type, that is, a half-cut metal type.

[0057] The balance shaft 71a of each first composite member 71 and the balance shaft 72aa of one of the second composite members 72 are connected with each other via one of the sley swords 73 so as to define a single first balance-shaft assembly. This means that two first balance-shaft assemblies are provided. Each first balance-shaft assembly is disposed between a corresponding set of the rocking shafts 71i and 72i disposed distant from each other. Since each first balance-shaft assembly is defined by the balance shaft 71a, the balance shaft 72aa, and the sley sword 73 for connecting the two shafts, the balance shaft 71a defines a first segment of the balance-shaft assembly including a first end of the balance-shaft assembly, and the balance shaft 72aa defines a second segment of the balance-shaft assembly including a second end of the balance-shaft assembly. Consequently, each of the first composite members 71 is a single-piece unit which includes the first segment of one of the first balance-shaft assemblies, i.e. the balance shaft 71a; the connecting portion 71b disposed adjacent to an end of the first segment of the balance-shaft assembly; and the rocking shaft 71i.

[0058] The two second composite members 72 are disposed distant from each other. This means that the rocking shafts 72i, 72i of the two respective second composite members 72 are disposed distant from each other. Between the two rocking shafts 72i, 72i are disposed the two balance shafts 72ab, 72ab of the second composite members 72 and a balance shaft 74. The balance shaft 74 is connected between the two balance shafts 72ab, 72ab via two of the sley swords 73 so as to define a single second balance-shaft assembly. In other words, the second balance-shaft assembly is defined by the balance shaft 74 occupying the intermediate portion of the second balance-shaft assembly; one of the balance shafts 72ab including a first end of the second balance-shaft assembly; the other balance shaft 72ab including a second end of the second balance-shaft assembly; and the two sley swords 73 for connecting the shafts. Accordingly, each of the second composite members 72 is a single-piece unit which includes one rocking shaft,

a first balance shaft including an end of one of the first balance-shaft assemblies; a second balance shaft including an end of the second balance-shaft assembly; and a pair of connecting portions. In detail, the single-piece unit of each second composite member 72 includes the rocking shaft 72i; the balance shafts 72aa and 72ab respectively disposed adjacent to the two opposite longitudinal ends of the rocking shaft 72i, and respectively including an end of the corresponding first balance-shaft assembly and an end of the second balance-shaft assembly; and the connecting portions 72b and 72c respectively disposed at the two longitudinal ends of the rocking shaft 72i.

[0059] The balance shafts 71a of the first composite members 71 and the balance shafts 72aa and 72ab of the second composite members 72 are substantially elliptic in cross-section as shown in Fig. 6 and are thus non-circular in cross-section, except for the end segments of the shafts extending through the sley swords 73, which are circular in cross-section. Thus, the rocking-direction flexural-rigidity is set greater than the flexural-rigidity in the direction perpendicular to the rocking direction.

[0060] The balance shaft 74 connecting the two second composite members 72 disposed distant from each other is formed by a drawing process and is circular in cross-section. Alternatively, the balance shaft 74 may be formed by casting or forging, and moreover, may be formed into a non-circular shape in cross-section such that the rocking-direction flexural-rigidity is set greater than the flexural-rigidity in the direction perpendicular to the rocking direction.

[0061] The technical scope of the present invention is not limited to the above embodiments, and modifications are permissible within the scope and spirit of the present invention.

Claims

1. A beating device (50) for a loom comprising:

a plurality of rocking shafts (7, 9, 61i, 61j, 62i, 62j, 71i, 72i) disposed distant from each other in a width direction of cloth to be woven by the loom;

a balance shaft (11a, 12a, 61a, 62a, 71a, 72aa, 72ab, 74) disposed farther away from a reed (5) than the rocking shafts and extending in said width direction, the balance shaft being disposed between the neighboring rocking shafts; a pair of connecting portions (11b and 11c, 12b and 12c, 61b and 61c, 62b and 62c, 71b and 72c, 72b and 72b) for respectively connecting two opposite ends of the balance shaft with ends of the neighboring rocking shafts; and a plurality of sley swords (8, 11d, 12d, 12e, 61d, 63, 73),

the beating device (50) **characterized in that:**

at least one of opposite end-segments of the balance shaft is formed integrally with at least one of the connecting portions and/or at least one of the sley swords to define an integrally molded unit.

2. The beating device (50) according to Claim 1, wherein the integrally molded unit is formed by integrally molding said at least one of the opposite end-segments of the balance shaft, said at least one of the connecting portions, and at least one of the rocking shafts disposed adjacent to the corresponding connecting portion.

3. The beating device (50) according to one of Claims 1 and 2, wherein the integrally molded unit is composed of cast iron or cast steel.

4. The beating device (50) according to one of Claims 1 and 3, wherein the balance shaft is non-circular in cross-section such that a rocking-direction flexural-rigidity of the balance shaft is greater than a flexural-rigidity of the balance shaft in a direction perpendicular to a rocking direction.

5. The beating device (50) according to Claim 4, wherein the balance shaft is either rectangular, oval, or substantially elliptic in cross-section such that a cross-sectional dimension of the balance shaft in the rocking direction is longer than that in the direction perpendicular to the rocking direction.

6. The beating device (50) according to Claim 4, wherein the balance shaft is either trapezoidal or fan-shaped in cross-section,

wherein, if the balance shaft is trapezoidal in cross-section, a side of the balance shaft distant from the reed is set longer than a side of the balance shaft closer to the reed, and the rocking-direction flexural-rigidity is thus set greater than the flexural-rigidity in the direction perpendicular to the rocking direction, and

wherein, if the balance shaft is fan-shaped in cross-section, a side of the balance shaft distant from the reed forms a circular-arc substantially around an axis of rocking motion being the center of curvature and is thus set longer than a side of the balance shaft closer to the reed, and the rocking-direction flexural-rigidity is thus set greater than the flexural-rigidity in the direction perpendicular to the rocking direction.

7. The beating device (50) according to Claim 4, wherein the balance shaft is substantially U-shaped in cross-section such that a central portion of a side of the balance shaft closer to the reed is depressed,

and the rocking-direction flexural-rigidity is thus set greater than the flexural-rigidity in the direction perpendicular to the rocking direction.

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FIG.1

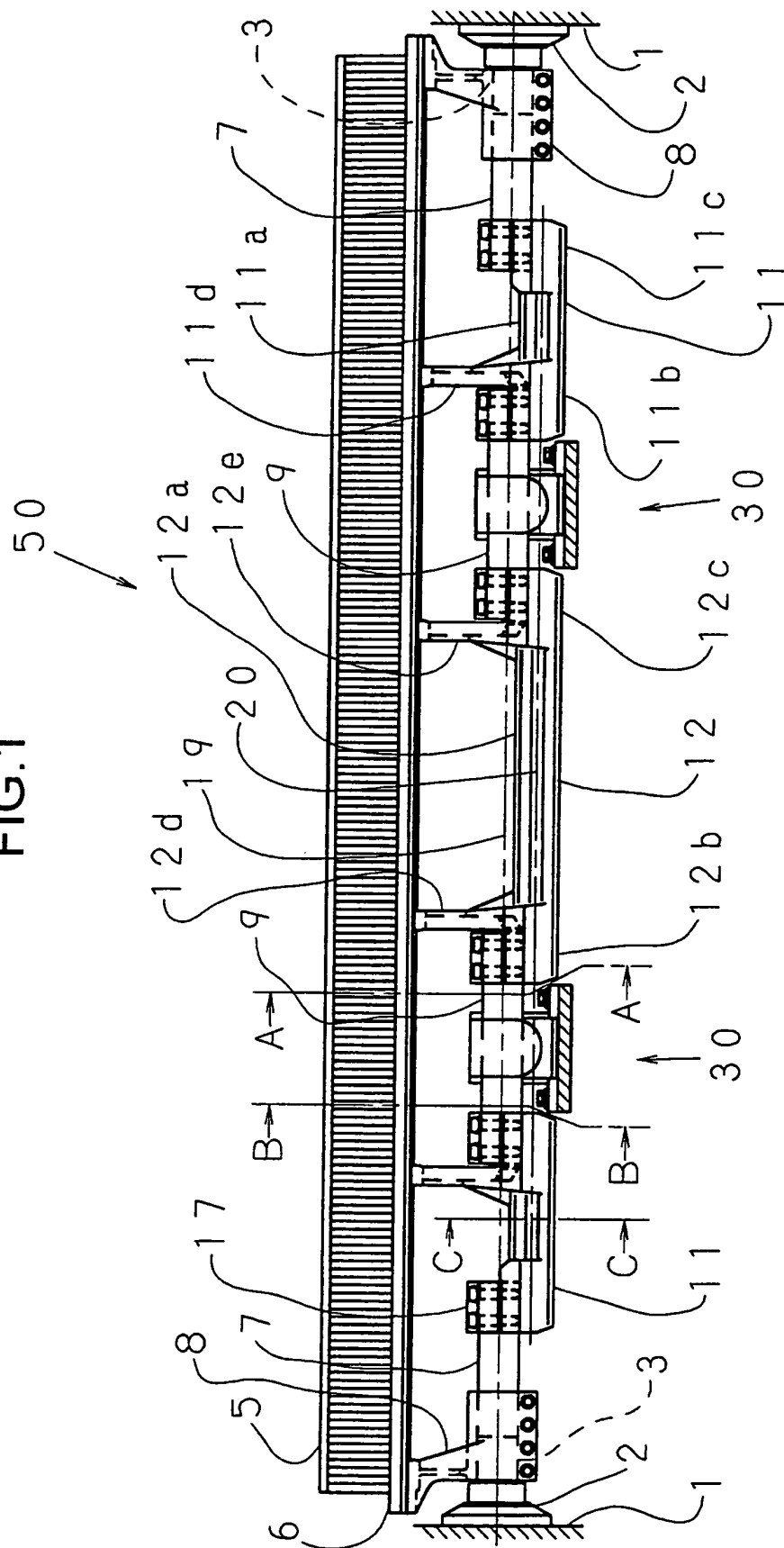


FIG.2

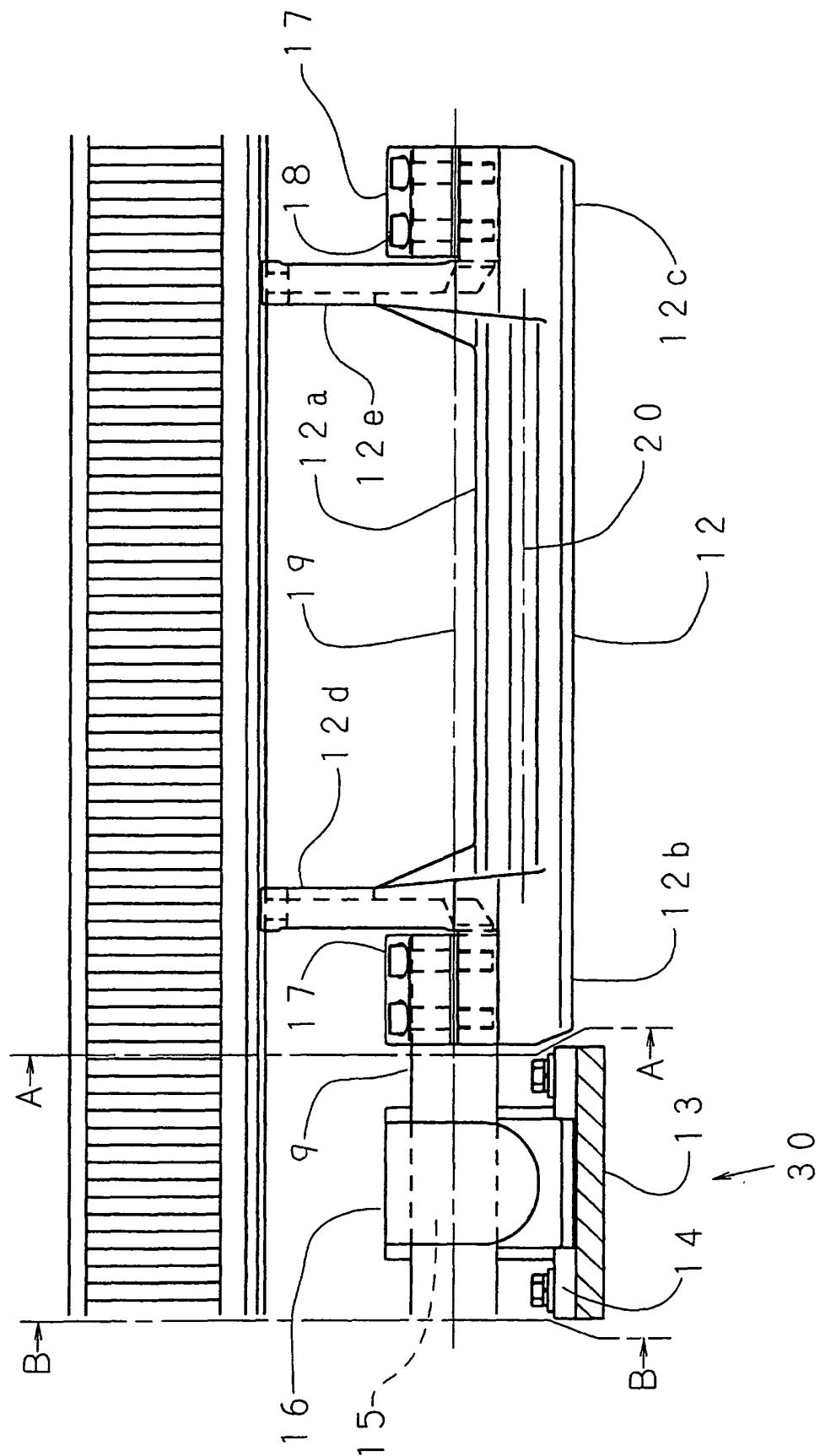


FIG.3

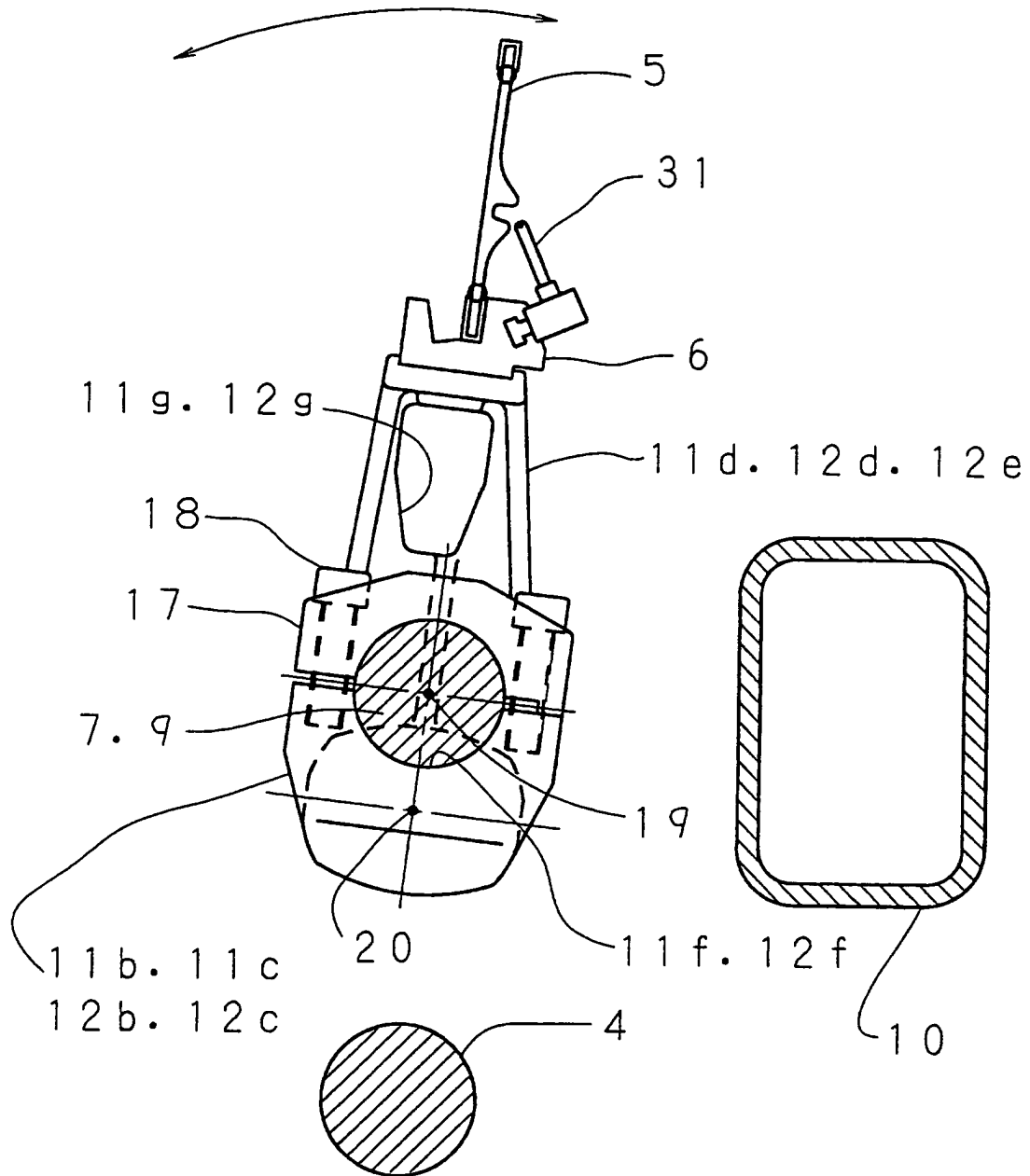


FIG.4

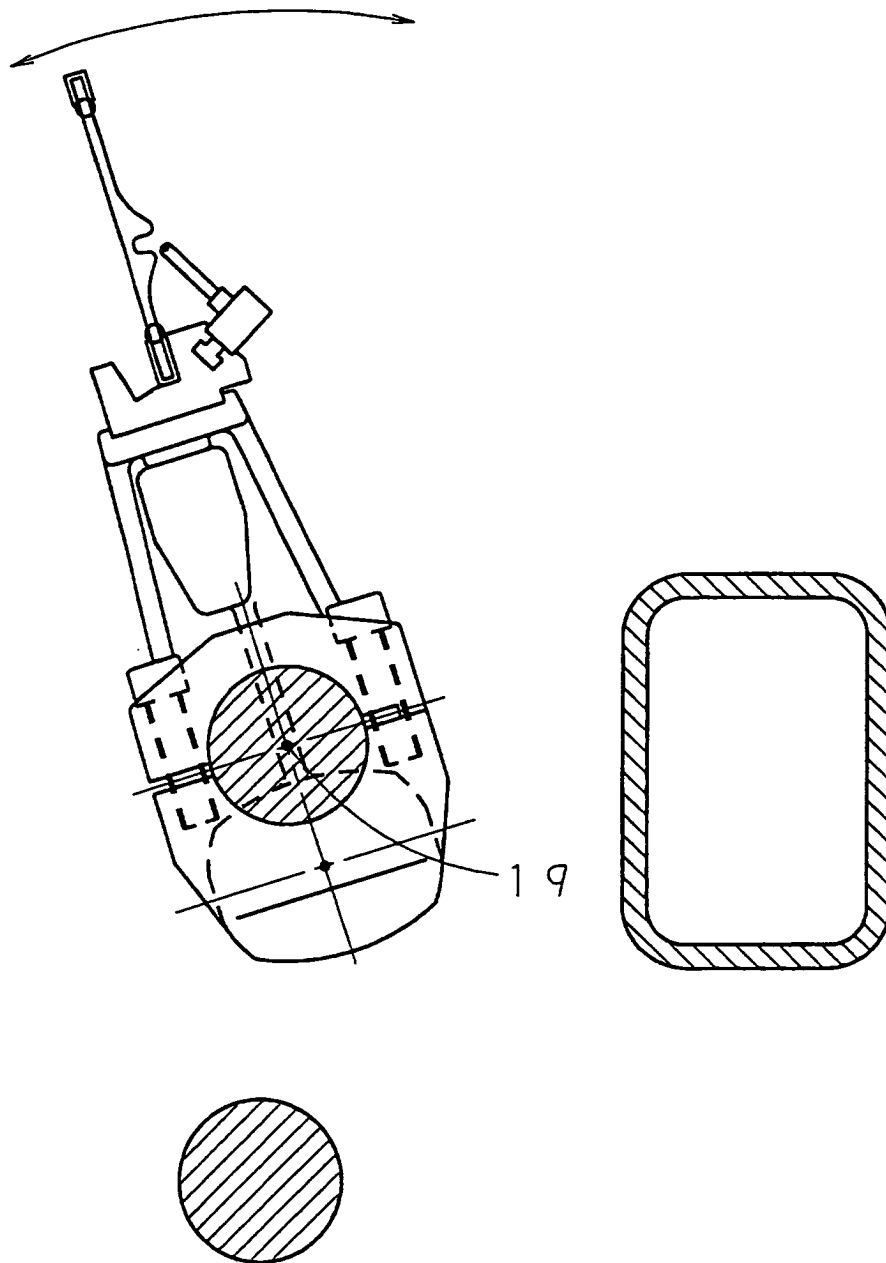


FIG.5

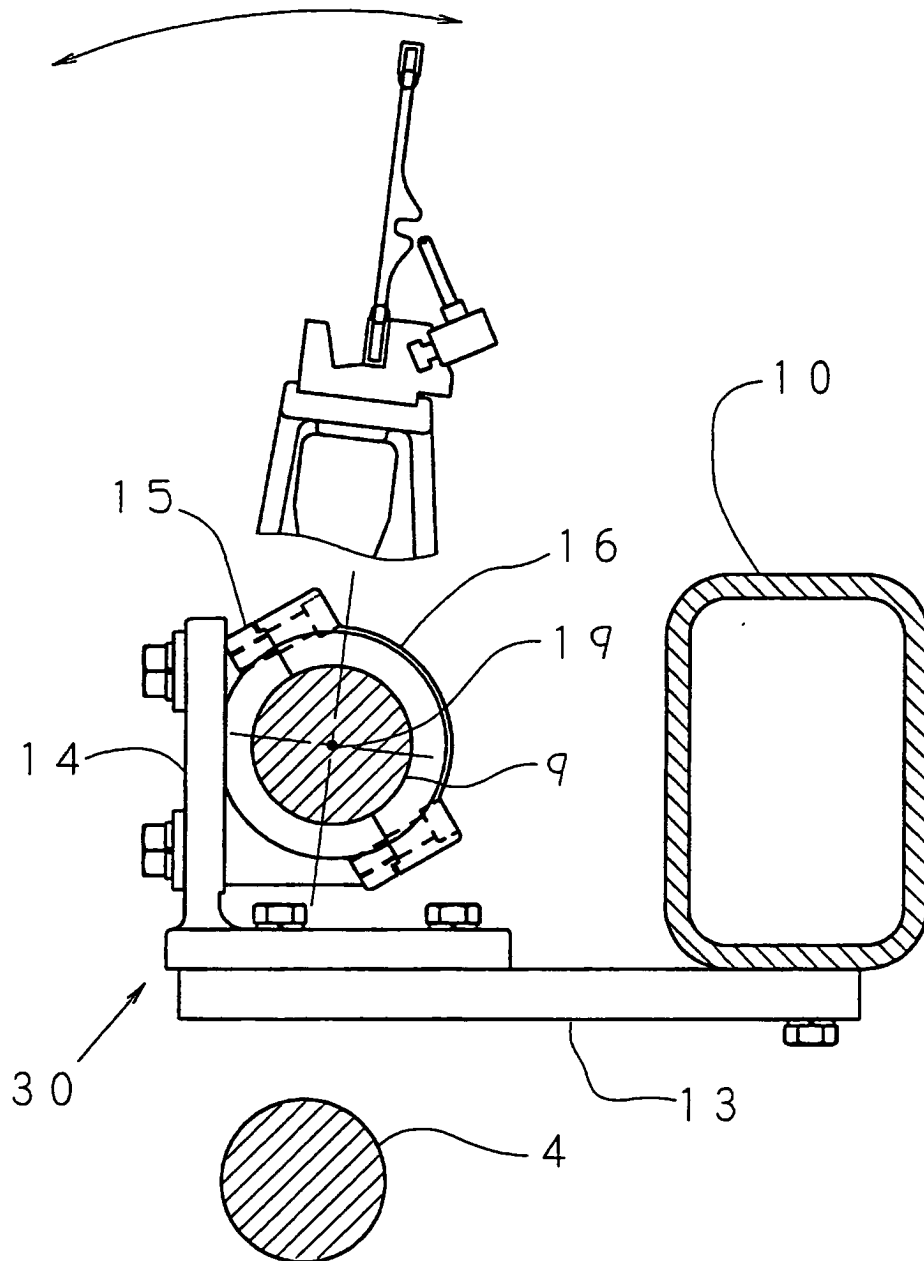


FIG.6

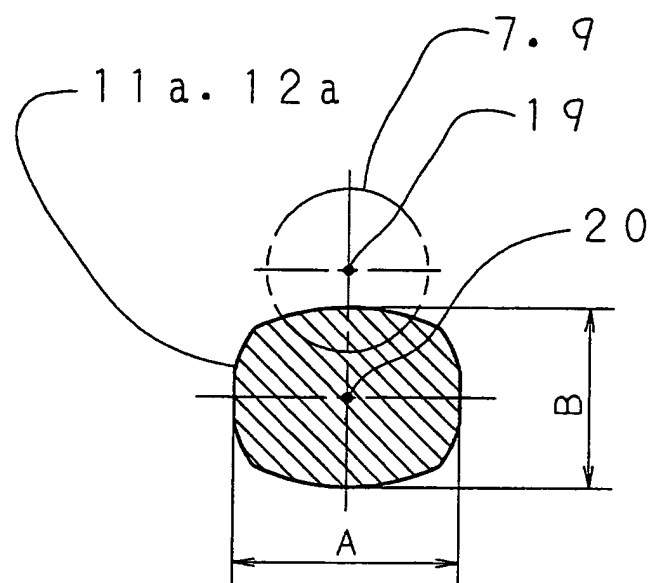


FIG.7

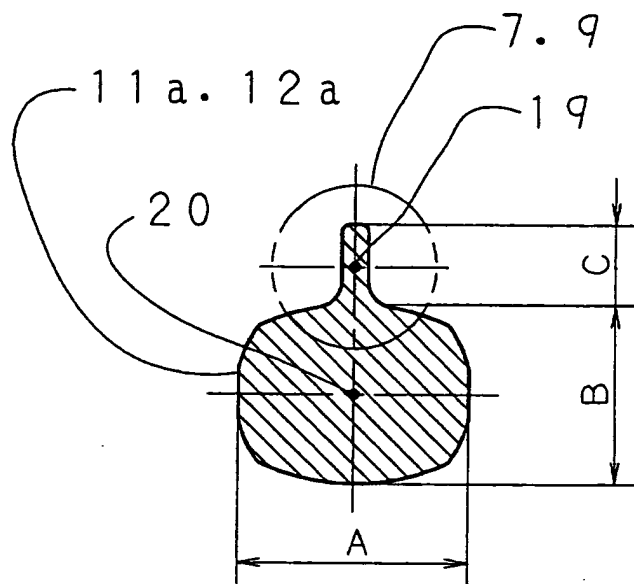


FIG.8

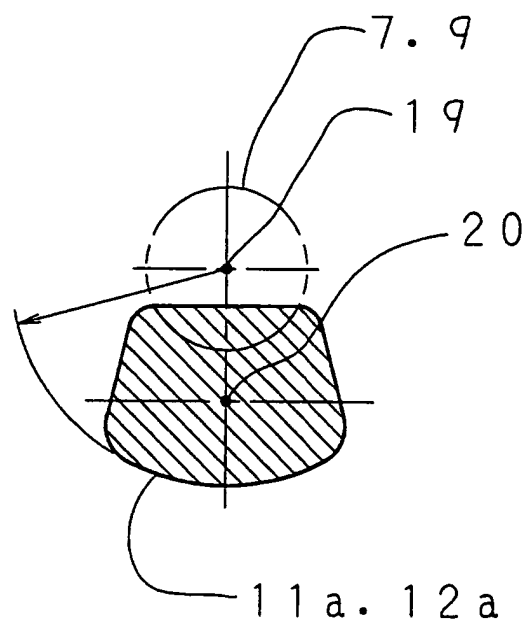


FIG.9

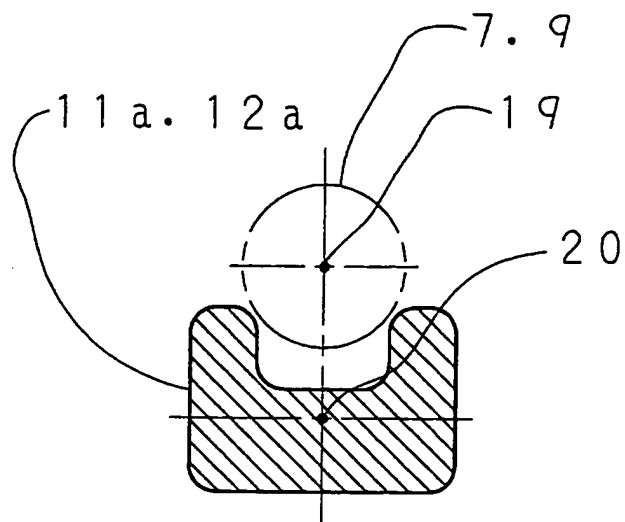


FIG.10

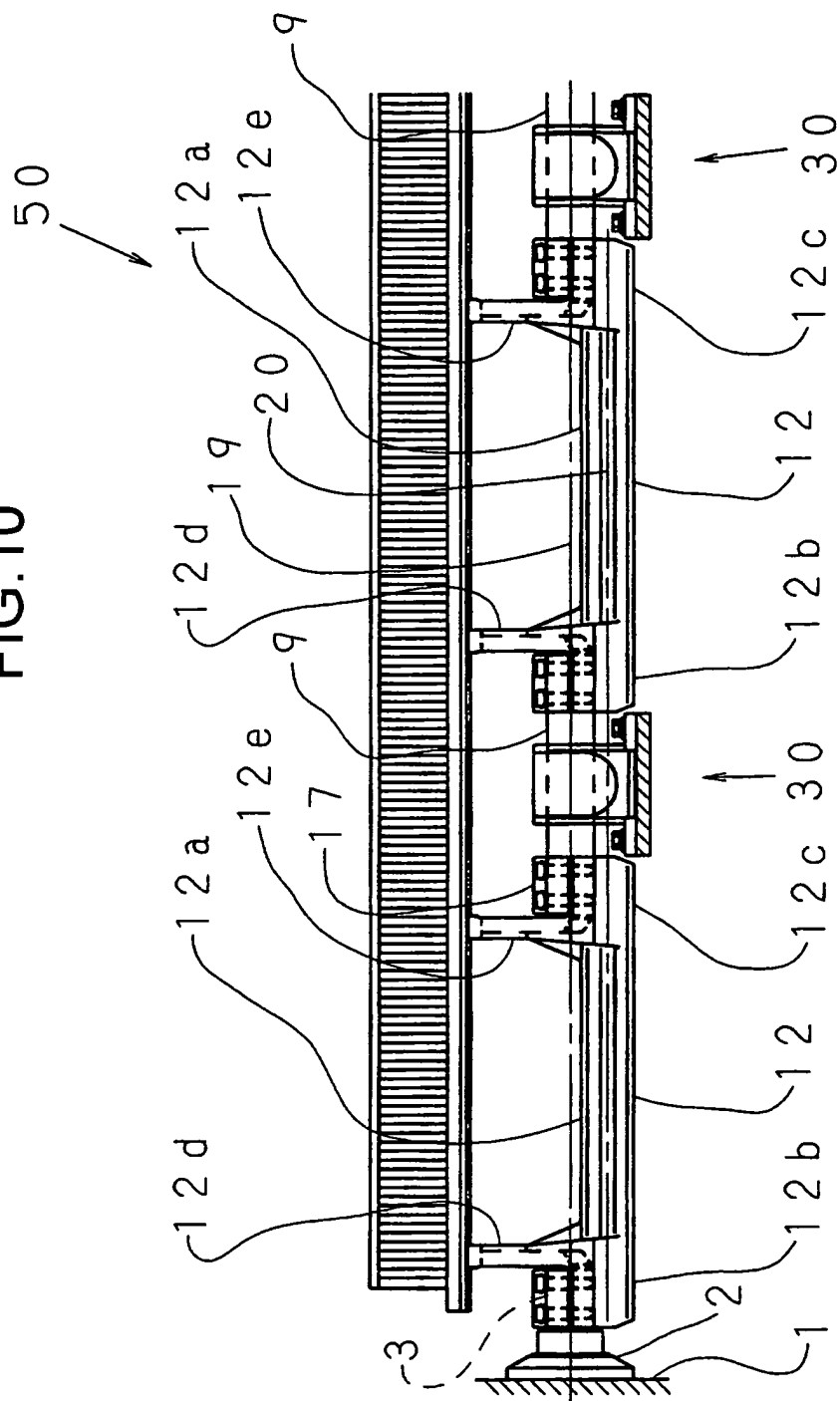


FIG.11

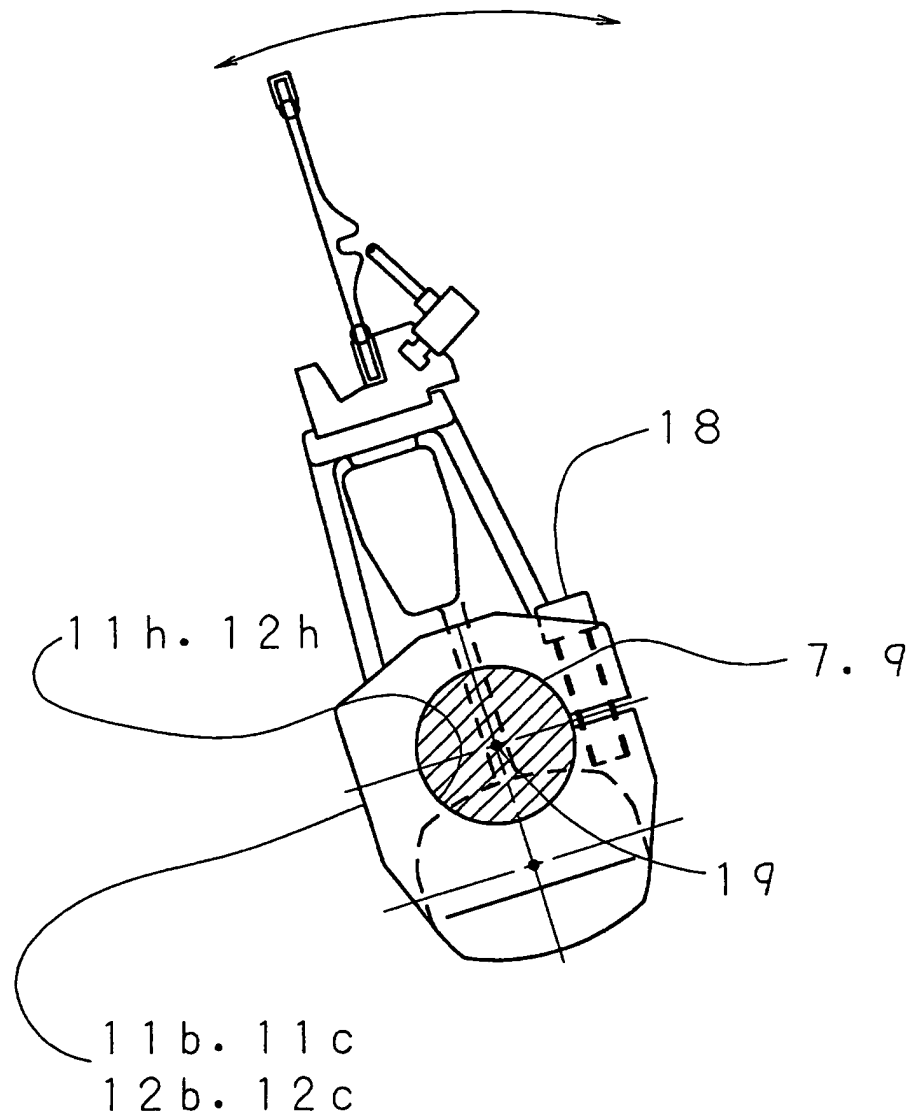


FIG. 12

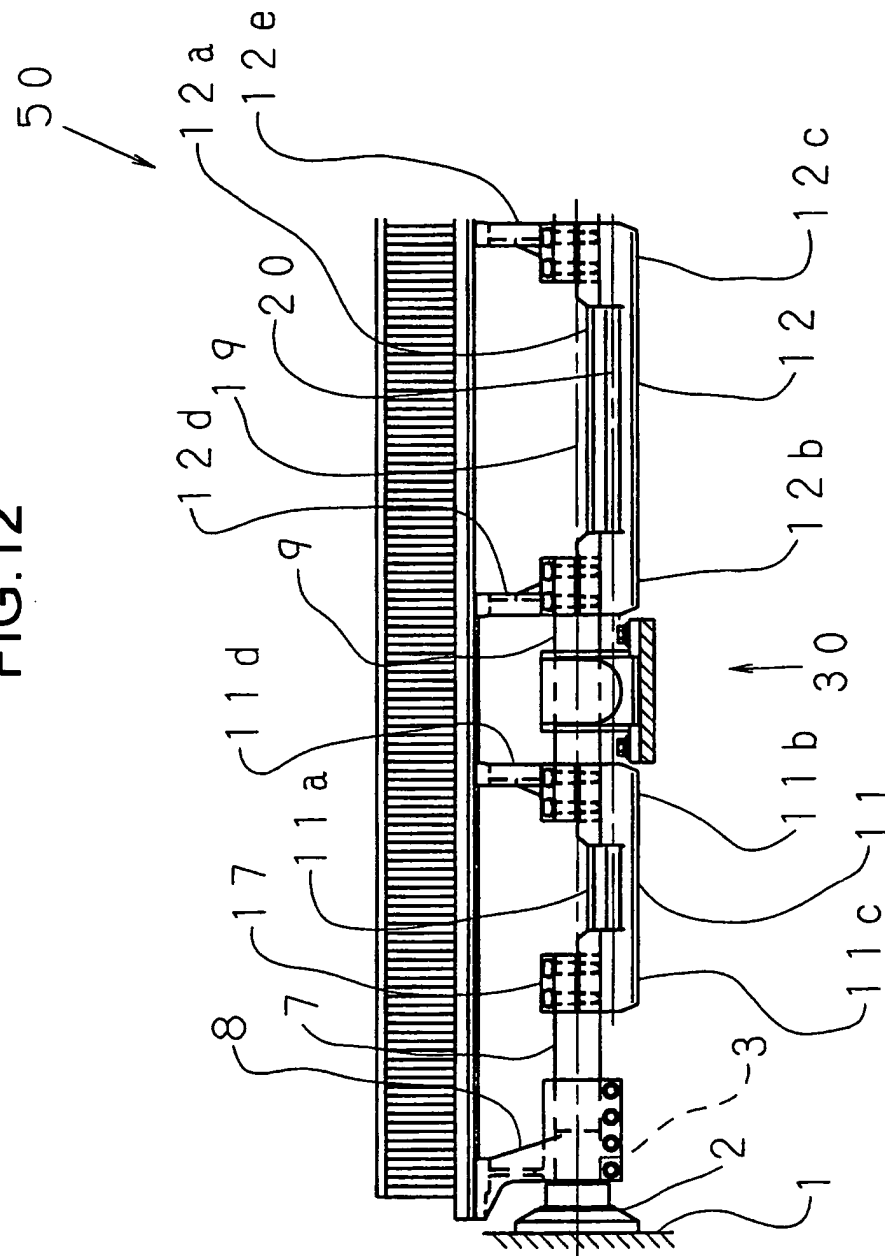


FIG.13

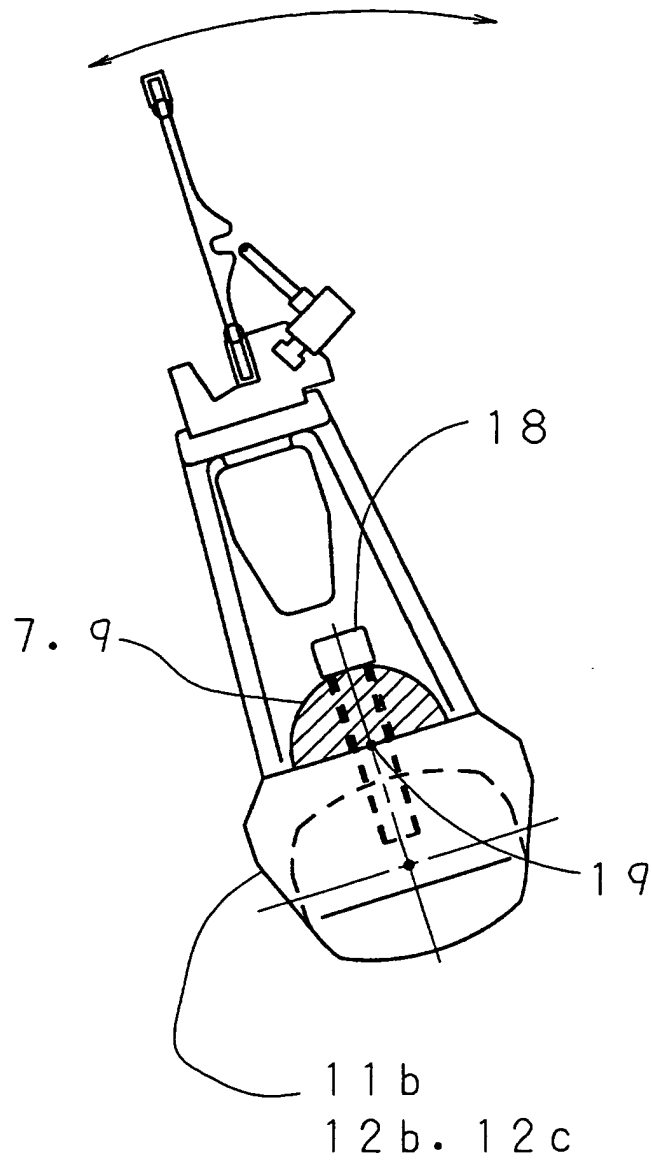


FIG.14

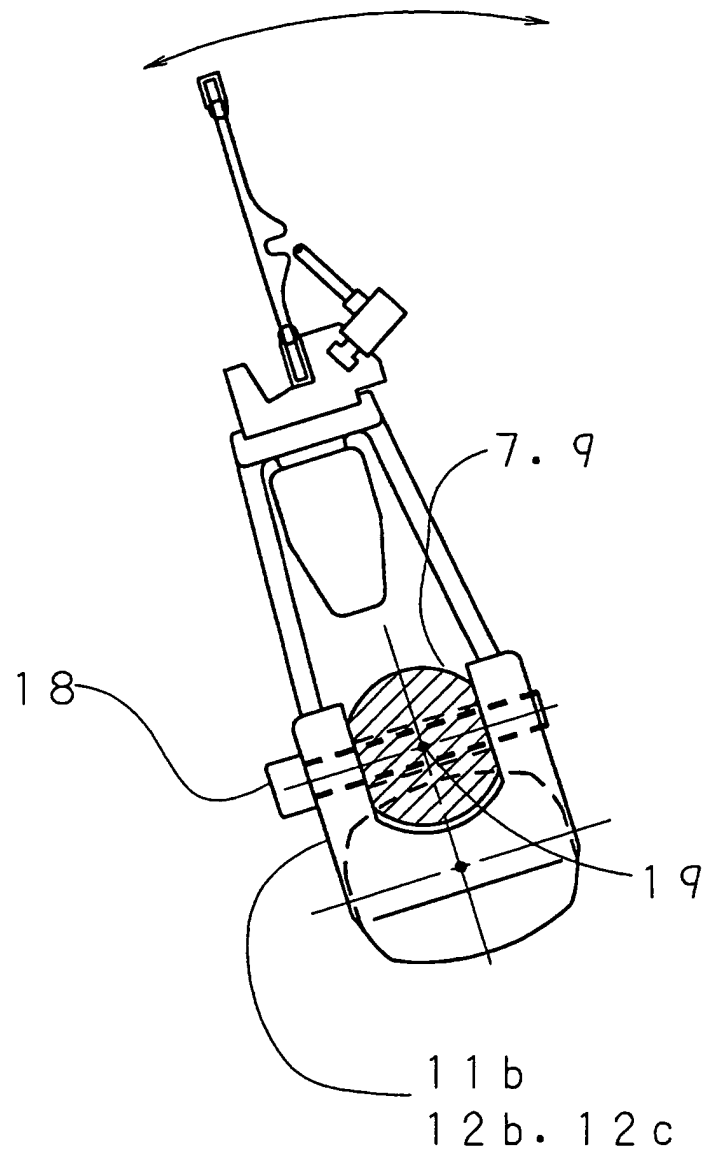
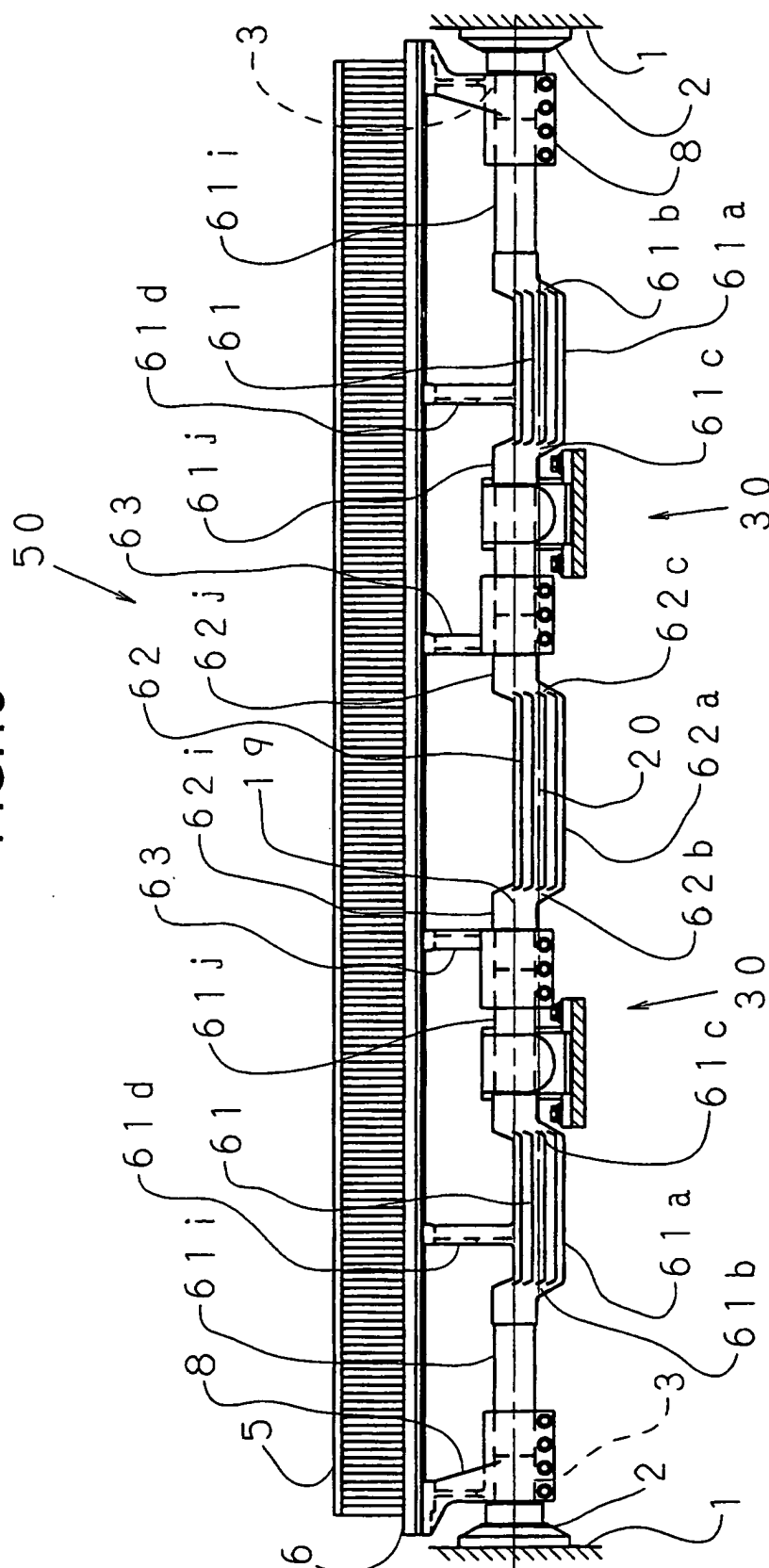
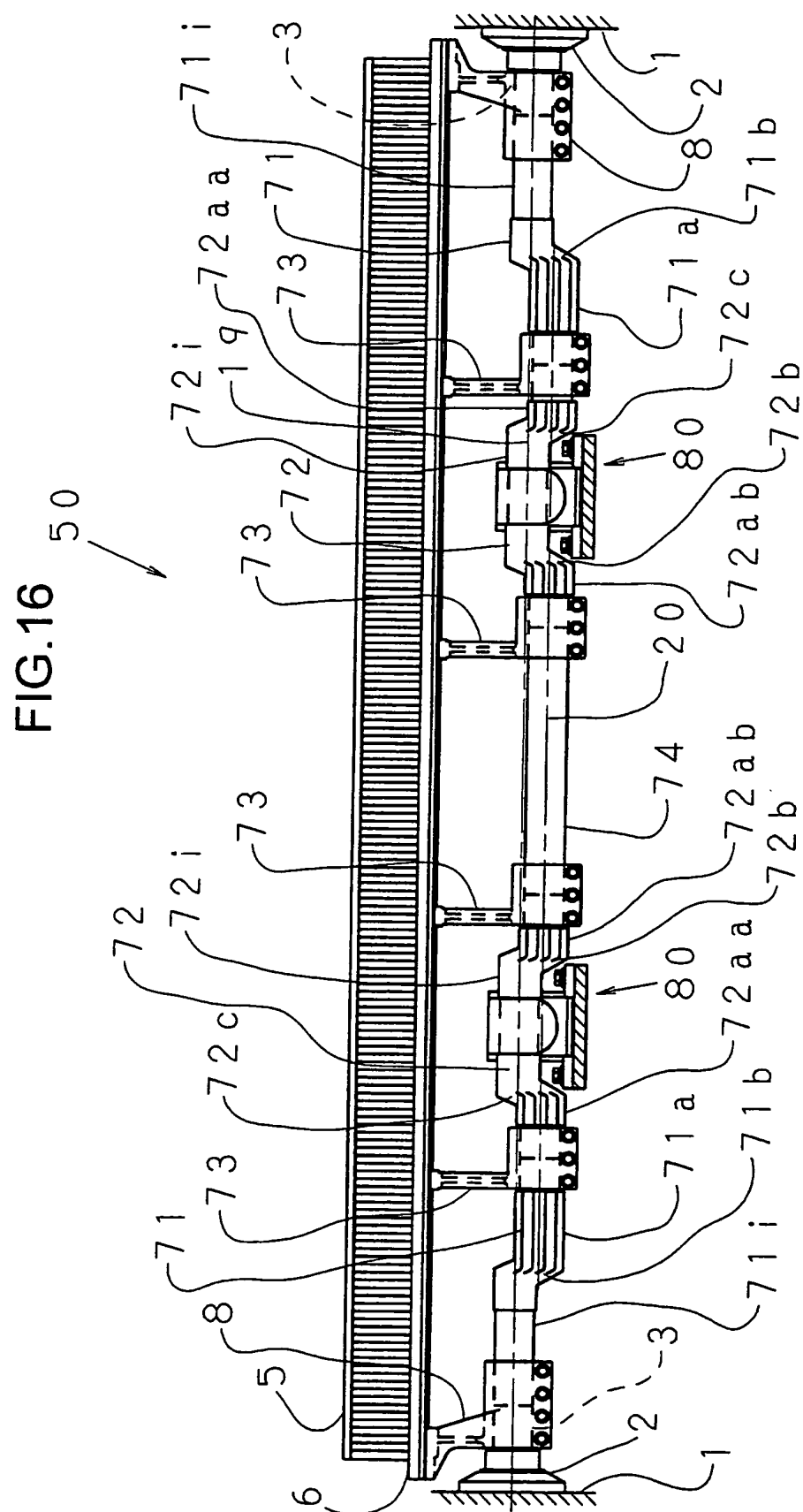


FIG. 15







European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 00 5523

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	US 4 076 048 A (BOLLETER ET AL) 28 February 1978 (1978-02-28) * column 2, line 28 - column 3, line 21; figures 1-6 *	1,4,5	D03D49/60
A	US 5 109 890 A (STACHER ET AL) 5 May 1992 (1992-05-05) * column 2, line 9 - column 3, line 57; figures 1-4 *	1,4,5	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			D03D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 5 September 2005	Examiner Louter, P
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 05 00 5523

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