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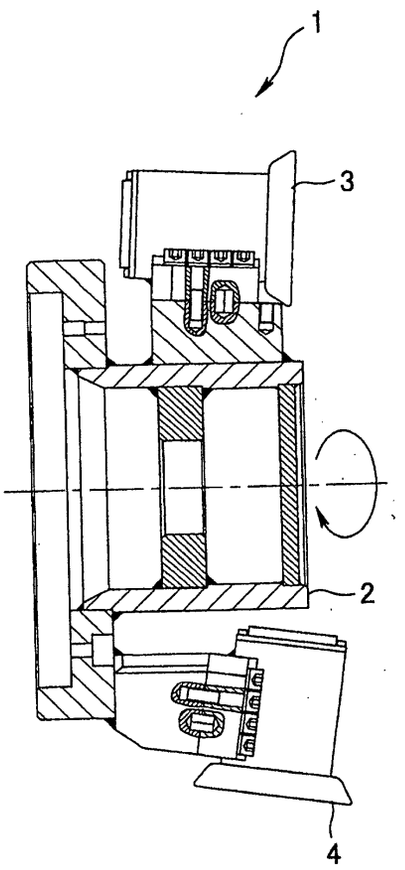
(54) CUTTER HEAD AND ROCK EXCAVATOR

(57) The present invention relates to a cutter head and a rock excavator provided therewith utilized for excavating base rocks in free section to proceed excavating a mine gallery, a tunnel, a shaft and the like.

In the conventional excavator having the construction in which the base rock is cut against the tensile strength of the base rock by a disk roller cutter, the cutter receives reaction from the base rock in the vicinity of coming in contact with rocks to be pushed back to make it difficult to form a deep cut-in in the base rock. Therefore, two kinds of disk roller cutters (3, 4) having different cutting-lines with a direction of a support shaft and a position of a disk edge differentiated are arranged on a cutter head drum (2), and one is a disk roller cutter for undercut for cutting off the base rock whereas the other is a disk roller cutter for scraper for crushing the base rock to constitute a cutter head (1).

FIG. 1



EP 1 344 894 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a cutter head and a rock excavator provided therewith suitable for excavating base rocks in free section to proceed excavating a mine gallery, a tunnel, a shaft and the like.

BACKGROUND

[0002] As a rock excavator for excavating base rocks in free section to proceed excavating a mine gallery, a tunnel and the like, there has been heretofore known a rock excavator in which a cutter head having a plurality of bits arranged or a cutter head having a plurality of roller cutters arranged is mounted on the extreme end of an excavating boom.

[0003] As shown in FIG. 19, a rock excavator 201, on which is mounted the aforesaid cutter head having the bits arranged, excavates by rotating a cutter head 202 while pressing it against the base rock and crushing the base rock against the compression strength of rocks by the bits. When the compression strength of the rocks increases, it is difficult to excavate the base rock and the bits are severely worn out, resulting in uneconomical.

[0004] Rock excavators 301 and 401, on which is mounted the aforesaid cutter head having the roller cutters arranged, excavates by rotating cutter heads 302 and 402 while pressing them against the base rocks and crushing the base rocks against the compression strength of rocks by a disk roller cutter, a button roller cutter or the like as shown in FIGS. 20 and 21, or excavates by cutting off, or so-called "undercutting," the base rocks against the tensile strength of rocks by a disk roller cutter as shown in FIGS. 22 and 23.

[0005] However, in the case where the base rocks are crushed by the disk roller cutter or the button roller cutter, it is necessary to strengthen the pressure of the cutter head against the base rock, thus requiring a machine of large size and great weight, but the excavating ability is not so large as to correspond thereto, so that the efficiency is poor.

[0006] Further, in the case where the base rocks are cut off by the disk roller cutter, a relatively small pressure is used, the roller cutter is less worn out to make it possible to carry out a large amount of cutting, and the base rocks in which the compression strength of rocks is great can be excavated. As shown in FIG. 23, however, in the vicinity of the point of the disk roller cutter in contact with the base rock, the base rock is hard to be cut in deeply, so that leftover L is apt to occur in a curve-like fashion along the force-exerting line.

[0007] Therefore, the disk roller cutter successively in contact with the base rock cannot cut into the base rock sufficiently so that the disk roller cutter floats from the base rock along the leftover-curve L, or the base rock is scrubbed by the disk roller cutter to produce dust.

[0008] Further, portions except an edge of the disk roller cutter of the cutter head 402 come in contact with the base rock to impair cutting of the disk roller cutter into the base rock, and sometimes, the whole cutter head 402 receives reaction from the base rock to be pushed back, and greatly vibrates to make the cut-off difficult.

DISCLOSURE OF THE INVENTION

[0009] It is an object of the present invention to provide a cutter head and a rock excavator on which is mounted the cutter head, wherein the base rock can be excavated easily even if the compression strength of the rocks is great, the wear of the roller cutter is relatively small, the roller cutter does not float from the base rock, the base rock is not scrubbed to produce dust, the cutting of the roller cutter into the rock is not impaired, and the whole cutter head is not pushed back from the base rock.

[0010] A cutter head according to the present invention is characterized in structure that two kinds of disk roller cutters having different cutting lines with a direction of a support shaft and a position of a disk edge differentiated are arranged on a cutter head drum, and one is a disk roller cutter for undercut to cut off the base rock, whereas the other is a disk roller cutter for scraper to crush the base rock.

[0011] In a preferred embodiment, the two kinds of disk roller cutters are arranged in many rows front and rear, and in the vertical direction, in order to make the cut-in depth of the base rock large, and in order that a plurality of disk roller cutters are placed in contact with rocks to effectively cut into the base rock and cut the leftover Further, the disk roller cutter may include a both-side-type disk roller cutter having disks disposed on both sides so as not to occupy space in the arrangement of the disk roller cutter. Further, for scraper a button roller cutter, a rotating-type round pick, a fixed bit or a buried-type tip for cutting may be mounted in place of the disk roller cutter for scraper. There may be equipped with a mucking vane in order to efficiently remove the muck.

[0012] A rock excavator according to the present invention is characterized in structure that the cutter head constituted as described above is mounted on an excavating boom.

[0013] In a preferred embodiment, a shaft of the cutter head constituted as described above is mounted nearly parallel to a shaft of an excavating boom. Further, there is constituted a road-header-type rock excavator wherein a

shaft of the cutter head constituted as described above is mounted nearly vertical to a shaft of an excavating boom. Further, there is constituted a shovel-type rock excavator wherein the cutter head constituted as mentioned above is mounted as an attachment. Furthermore, there is constituted a surface-miner-type rock excavator wherein the cutter head constituted as mentioned above is mounted.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

FIG. 1 is a side sectional view of a cutter head according to the present invention.
FIG. 2 is a front view of the cutter head of FIG. 1.
FIG. 3 is an explanatory view showing a positional relation of disk roller cutters in a state that the cutter head of FIG. 1 is rotated.
FIG. 4 is an explanatory view showing the function of a disk roller cutter for undercut and a disk roller cutter for scraper.
FIG. 5 is an explanatory view showing the case where a disk roller cutter for undercut and a disk roller cutter for scraper are arranged in many stages particularly in order to make the cut-in depth great.
FIG. 6 is an explanatory view showing the case where, in the case that a cutting face of the base rock has no free section, a cutter head is mounted so that a rotating shaft thereof is nearly parallel to a boom, and particularly, a cutter head having disk roller cutters arranged in many stages for back cutting is thrust into the base rock for cutting.
FIG. 7 is an explanatory view showing, in the case shown in FIG. 6, a cutting track by each roller cutter traced on the base rock.
FIG. 8 is an explanatory view showing the case where two cutter heads are mounted so that their rotating shafts are nearly vertical to a boom, and the cutter head is thrust into the base rock for cutting.
FIG. 9 shows one embodiment of a cutter head in which the cutter head is arranged nearly parallel to a cutting face of the base rock, (A) being a front view of the cutter head, and (B) being a side sectional view showing a positional relation of a roller cutter.
FIG. 10 shows another embodiment of a cutter head in which the cutter head is arranged nearly parallel to a cutting face of the base rock, (A) being a front view of the cutter head, and (B) being a side sectional view showing a positional relation of a roller cutter.
FIG. 11 shows one embodiment of a cutter head in which the cutter head is arranged nearly vertical to a cutting face of the base rock, (A) being a front view of the cutter head, and (B) being a side sectional view showing a positional relation of a roller cutter.
FIG. 12 is a front view of another embodiment of a cutter head in which the cutter head is arranged nearly vertical to a cutting face of the base rock.
FIG. 13 is a side view of a road-header-type rock excavator on which is mounted the cutter head shown in FIG. 9.
FIG. 14 is a plan view of the rock excavator shown in FIG. 13.
FIG. 15 is a side view of a road-header-type rock excavator on which is mounted the cutter head shown in FIG. 11.
FIG. 16 is a plan view of the rock excavator of FIG. 15.
FIG. 17 is an external view of a shovel-type rock excavator in which the cutter head of FIG. 9 is mounted as an attachment.
FIG. 18 is a side view of a surface-miner-type rock excavator in which the cutter head of FIG. 9 is mounted.
FIG. 19 is a side view of a rock excavator in which a cutter head having a bit arranged is mounted.
FIG. 20 is a side view of a rock excavator in which the cutter head shown in FIG. 21 having a roller cutter arranged is mounted.
FIG. 21 is an explanatory view showing the case where the base rock is crushed by a disk roller cutter.
FIG. 22 is a side view of a rock excavator in which the cutter head shown in FIG. 23 having a roller cutter arranged is mounted.
FIG. 23 is an explanatory view showing the case where the rock is cut off by a disk roller cutter.

BEST MODE FOR CARRYING OUT THE INVENTION

[0015] FIG. 1 is a side sectional view of a curter head according to the present invention, FIG. 2 is a front view thereof, and FIG. 3 is an explanatory view showing a positional relation of each disk roller cutter in a state that the cutter head is rotated. As seen in these drawings, two kinds of disk roller cutters having different cutting lines with a direction of a support shaft and a position of a disk edge differentiated are arranged on a cutter head drum.

[0016] In a cutter head 1, as shown in FIGS. 1 and 2, two kinds of disk roller cutters 3, 4 are arranged at predetermined spaces in a circumferential direction on a cutter head drum 2 mounted on a excavating boom through a drive shaft,

and the same kind of disk roller cutters 3, 3, 3 and 4, 4, 4 are also arranged at predetermined spaces in a circumferential direction.

[0017] Two kinds of the disk roller cutters 3, 4 are arranged with a direction of the support shaft and a position of the disk edge differentiated, and one is a disk roller cutter for undercut and the other is a disk roller cutter for scraper corresponding to a moving direction of the cutter head 1, that is, a main cutting direction.

[0018] The support shafts of the disk roller cutters 3, 4 are that one is nearly parallel to a rotating shaft of the cutter head 1 and the other is nearly vertical thereto. Angles α 3 and α 4 formed between the support shafts of the disk roller cutters 3, 4 and the rotating shaft of the cutter head 1 can be suitably set so that the circular plane portion of the disk roller cutter is hard to come in contact with the rock, and a cutting angle of the disk roller cutter into the base rock is selected adjusting to properties of the base rock or the pressure of the head against the base rock.

[0019] As shown in FIG. 3, where the cutter head 1 moves in the X direction along the cutting face of the base rock I to cut a free section 5, the disk roller cutter 3 works as a disk roller cutter for undercut, the disk roller cutter 4 works as a disk roller cutter for scraper, X3 is a main base-rock cutting-line and X4 is a scraper cutting-line.

[0020] On the other hand, where the cutter head 1 moves in the Y direction along the cutting face of the base rock I to cut a free section 6, the disk roller cutter 4 works as a disk roller cutter for undercut, the disk roller cutter 3 works as a disk roller cutter for scraper, Y4 is a main base-rock cutting-line and Y3 is a scraper cutting-line.

[0021] A positional relation in all directions of the edges of the disk roller cutters 3, 4 or the spacing of the cutting lines X3/X4, Y3/Y4 can be suitably set in consideration of the properties of base rocks, the rotational frequency of the cutter head 1, the turning speed of a excavating boom, and angles α 3, α 4 formed between the support shafts of the disk roller cutters 3, 4 and the rotating shaft of the cutter head 1.

[0022] FIG. 4 is an explanatory view showing the function of a disk roller cutter for undercut and a disk roller cutter for scraper. When the cutter head 1 moves in the X direction while rotating, a disk roller cutter 3A for undercut first cuts in a free section 5 formed in the base rock I to cut it along a main base-rock-cutting-line X3, but the free section 5 traces a crushing curve 7 which starts from the vicinity of a cutter edge. At this time, a succeeding disk roller cutter for scraper is at a position of 4A0 in the X direction.

[0023] When the cutter head 1 further moves in the X direction while rotating, the succeeding disk roller cutter for scraper comes to the position of 4A in the X direction to crush the base rock along the scraper-cutting-line X4 to form a free section 8 having a shape similar to the original free section 5.

[0024] Thereby, a succeeding disk roller cutter 3B for undercut deeply cuts in the free section 8 similar to the preceding disk roller cutter 3A for undercut to cut it along a main base-rock cutting-line X3. Thereafter, in the similar procedure, the base rock I is cut by disk roller cutters for scraper 4B, 4C, 4D, ... and disk roller cutters for undercut 3C, 3D,

[0025] FIG. 5 is an explanatory view showing one example where the disk roller cutters for undercut and the disk roller cutters for scraper are arranged in many stages so that a deep cut-in in the base rock I can be formed. When a cutter head 11 moves in the X direction, the disk roller cutters for undercut 3, 13 cut the base rock along the main base-rock-cutting-lines X3, X13, while forming two stages of the free sections 5, 15 in the base rock I. Further, the disk roller cutters for scraper 4, 14 crush the base rock I along the scraper-cutting-lines X4, X14 to form free sections having a shape similar to the original free sections 5, 15.

[0026] FIG. 6 is an explanatory view showing the case that, where there is no free section in a cutting face of the base rock I, the disk roller cutters for undercut and the disk roller cutters for scraper are arranged in many stages, and the cutter head is thrust in the base rock I to cut it. The boom is extended or the rock excavator is moved in the direction of the base rock I first, and a cutter head 21 is pressed against the base rock to rotate. Then, the boom is turned in the X direction, and the cutter head 21 is encroached into the base rock I to cut it.

[0027] At this time, a disk roller cutter for undercut 23 arranged on the front side in the cutting direction cuts the base rock I along the main base-rock-cutting-line X23, and a disk roller cutter for scraper 24 crushes the base rock I along the scraper-cutting-line X24 to cut off a front cutting-face of base rock 25. Further, a disk roller cutter for undercut 33 arranged at the rear in the cutting direction cuts the base rock I along the main base-rock-cutting-line X33, and a disk roller cutter for scraper 34 crushes the base rock I along the scraper-cutting-line X34 to cut off a rock portion sandwiched between the scraper-cutting-lines X24 and X33.

[0028] When the disk roller cutters 33, 34 are moved on the front side in the cutting direction by the rotation of the cutter head 21, particularly a disk roller cutter 340 cuts the base rock I along the cutting-line X340.

[0029] At this time, since the cutter head 21 turns in the X direction while the boom is pressed in the direction of the rock I while rotating, as shown in FIG. 7, the disk roller cutters 23, 24 and 33, 34 cut while tracing a cutting track of a plurality of modification of cubic cycloid curves at the predetermined spaces on the base rock I, in contact with rocks according to the rotational frequency of the cutter head 21, the turning speed of the boom and the pressing degree.

[0030] Here, it may happen that when the disk roller cutters 33, 34 on the rear side are not present, portions except the edges of the disk roller cutters 23, 24, the cutter body or the drum portion 21 of the cutter head come in contact with the base rock I at the rear of the cutting line X24 to be pressed back. In order to avoid this, the cutter head 21 has to be turn sideways to thrust into the base rock I by deviating the turning center of the rock excavator or the boom,

which is very inconvenient in the excavating work.

[0031] Further, even if the cutting face is formed in the free section, the leftover of the base rock I is sometimes produced due to vibrations of the machine, which can be however cut off by the disk roller cutters 33, 34 on the back side (back cutting).

[0032] FIG. 8 is an explanatory view showing the case where two cutter heads 51, 52 are mounted so that their rotating shafts are nearly vertical to the axis of the excavating boom, and the cutter heads 51, 52 are thrust into the base rock I to cut it. Disk roller cutters 56, 57 and 58, 59 on the excavating-boom side of the cutter heads 51, 52 perform the function similar to the function mentioned previously.

[0033] Further, in FIG. 8, when the cutter heads 51, 52 are thrust in the X direction to cut, and on the contrary, cutting is intended in the Y direction, a difference-in-level portion 53 of the base rock I formed between the cutter heads 51, 52 has to be cut off. At this time, the disk roller cutter for undercut 56 and the disk roller cutter for scraper 57 on the boom side of the cutter head 51 cut off the difference-in-level portion 53 and the leftover. The disk roller cutter for undercut 58 and the disk roller cutter for scraper 59 on the excavating-boom side of the cutter head 52 perform the function similar to the former.

[0034] FIG. 9 shows one embodiment of a cutter head 61 having a cutter head nearly parallel to the cutting face of the base rock arranged for cutting. The cutter head 61 moves in the Y direction or in the direction opposite thereto while rotating to cut the base rock I.

[0035] G1, G2 and G3 denote disk roller cutters for undercut on the front row in the cutting direction arranged nearly at the same position with respect to the rotating shaft of the cutter head 61; and N1, N2 and N3 denote succeeding disk roller cutters for scraper arranged nearly at the same position with respect to the rotating shaft of the cutter head 61. R1, R2 and R3 denote disk roller cutters for undercut on the rear row in the cutting direction arranged nearly at the same position with respect to the rotating shaft of the cutter head 61; and S1, S2 and S3 denote succeeding disk roller cutters for scraper arranged nearly at the same position with respect to the rotating shaft of the cutter head 61. The function of these disk roller cutters is as mentioned previously.

[0036] One embodiment of a positional relation of the disk roller cutters, and an angle formed between the support shaft and the rotating shaft are given in the following Table.

Roller cutter symbol	Disposition angle ψ (°)	Radial position (mm)	Axial position (mm)	Angle relative to rotating shaft
S1	30	508	1090	αS: 90° ≦ 93°≦ 96°
R1	60	628	1198	αR: 06° ≦ 09° ≦ 12°
N1	90	790	1054	αN: 83° ≦ 86° ≦ 89°
G1	120	670	1186	αG: 01° ≦ 02° ≦ 05°
S2	150	508	1090	αS: 90° ≦ 93° ≦ 96°
R2	180	628	1198	αR: 06° ≦ 09° ≦ 12°
N2	210	790	1054	αN: 83° ≦ 86° ≦ 89°
G2	240	670	1186	αG: 01° ≦ 02° ≦ 05°
S3	270	508	1090	αS: 90° ≦ 93° ≦ 96°
R3	300	628	1198	αS: 90° ≦ 93° ≦ 97°
N3	330	790	1054	αS: 90° ≦ 93° ≦ 98°
G3	360	670	1186	αS: 90° ≦ 93° ≦ 99°

[0037] FIG. 10 shows another embodiment of a cutter head 71 having a cutter head arranged nearly parallel to the cutting face of the base rock to cut. The cutter head 71, also, moves in the Y direction or in the direction opposite thereto while rotating to cut the base rock I.

[0038] G1, G2 and G3 denote disk roller cutters for undercut on the front row in the cutting direction arranged nearly at the same position with respect to the rotating shaft of the cutter head 71; and N1, N2 and N3 denote succeeding disk roller cutters for scraper arranged nearly at the same position with respect to the rotating shaft of the cutter head 71. E1, E2, and up to E9 denote disk roller cutters for scraper arranged while being deviated in order in the radial direction and in the rotating shaft direction of the cutter head 71. The function of these disk roller cutters is also as mentioned previously.

[0039] P denotes a disk roller cutter for undercut positioned away from the base rock more than G1, G2 and G3 from

the base rock I, and on the rear row with respect to the base rock in which where G1, G2 and G3 produce leftover, the leftover are cut off so that plate surfaces of N1, N2 and N3 do not come in contact of the leftover to the utmost.

[0040] E1+5 and E2+6 denote a both-side type disk roller cutter, employing a cutter arrangement not occupying space. Others are a one-side type disk roller cutter.

[0041] FIG. 11 shows one embodiment of a cutter head 81 having a cutter head arranged nearly vertical to the cutting face of the base rock to cut. The cutter head 81 moves in the X direction while rotating to cut the base rock I.

[0042] GV1, GV2 and GV3 denote disk roller cutters for undercut on the front row in the cutting direction arranged nearly at the same position with respect to the rotating shaft of the cutter head 81; and PD1, PD2 and PD3 denote succeeding disk roller cutters for scraper arranged nearly at the same position with respect to the rotating shaft of the cutter head 81. GN1, GN2 and GN3 denote disk roller cutters for undercut on the rear row in the cutting direction arranged nearly at the same position with respect to the rotating shaft of the cutter head 81; and PD4, PD5 and PD6 denote succeeding disk roller cutters for scraper arranged nearly at the same position with respect to the rotating shaft of the cutter head 81. The function of these disk roller cutters is also as mentioned previously.

[0043] PD1+4, PD2+5 and PD3+6 denote a both-side type disk roller cutter, employing a cutter arrangement without occupying space. Others are a one-side type disk roller cutter.

[0044] One embodiment of a positional relation of the disk roller cutters, and an angle formed between the support shaft and the rotating shaft are given in the following Table.

Roller cutter symbol	Disposition angle ψ (°)	Radial position (mm)	Axial position (mm)	Angle relative to rotating shaft
GV1	40	660	584	αGV: 95°≦99° ≦ 103°
PD1	80	582	672	αPD: 10° ≦ 12° ≦ 14°
GN1	120	721	475	αGN: 68° ≦ 69° ≦ 79°
GV2	160	660	584	αGV: 95°≦99°≦ 103°
PD2	200	582	672	αPD: 10° ≦ 12° ≦ 14°
GN2	240	721	475	αGN: 68° ≦ 69° ≦ 79°
GV3	280	660	584	αGV: 95° ≦ 99° ≦ 103°
PD3	320	582	672	αPD: 10° ≦ 12° ≦ 14°
GN3	360	721	475	αGN: 68°≦ 69° ≦ 79°

[0045] FIG. 12 shows another embodiment of a cutter head 91 having a cutter head arranged nearly vertical to the cutting face of the base rock. The cutter head 91, also, moves in the X direction while rotating to cut the base rock I.

[0046] In this embodiment, many disk roller cutters are arranged in a multi-stage in the front cutting-direction, which arrangement is realized using a both-side type disk roller cutter without occupying space.

[0047] Next, a preferred embodiment of a rock excavator having a cutter head mounted thereon according to the present invention will be described.

[0048] FIG. 13 shows a rock excavator of a road-header type having the cutter head shown in FIG. 9 mounted thereon.

[0049] In a rock excavator 101, a base 103 is disposed above a crawler 102, and an excavating boom 104 is disposed before the base 103. The excavating boom 104 is expanded forward and backward by an expanding cylinder 105, swung vertically by a swinging cylinder 106 and is also turned to left and right.

[0050] Further, the cutter head is mounted on the extreme end of the excavating boom 104, so that the cutter head can be rotated about the rotating axis by a drive mechanism (not shown) in both normal and reverse directions, with the desired rotational frequency and rotational torque.

[0051] Whereby, the excavating boom 104 is expanded forward and backward, and swung up and down to press

the cutter head in the diametrical direction against the cutting face of the base rock; and the excavating boom 104 is turned to left and right to press the cutter head in the direction of the rotating shaft against the cutting face of the base rock, the disk roller cutter of the cutter head comes in contact with the base rock to cut.

[0052] FIG. 15 shows a rock excavator 114 of a road header type in which the cutter head shown in FIG. 11 is mounted.

[0053] FIG. 17 shows a rock excavator 121 of a shovel type in which the cutter head shown in FIG. 9 is mounted as an attachment. Alternatively, the cutter head of FIG. 11 may be mounted in place of the cutter head shown in FIG. 9.

[0054] FIG. 18 shows a rock excavator 131 of a surface-miner type in which the cutter head shown in FIG. 9 is mounted.

[0055] According to the rock excavator having the cutter head of the present invention mounted thereon, the base rock can be excavated easily even if the compression strength of the rocks is great, the wear of the roller cutter is relatively small, the roller cutter does not float from the base rock, the base rock is not scrubbed to produce muck, the cutting of the roller cutter into the rock is not impaired, and the whole cutter head is not pushed back from the base rock.

Claims

1. A cutter head **characterized in that** two kinds of disk roller cutters having different cutting lines with a direction of a support shaft and a position of a disk edge differentiated are arranged on a cutter head drum, and one is a disk roller cutter for undercut for undercutting the base rock whereas the other is a disk roller cutter for scraper for crushing the base rock.

2. The cutter head according to Claim 1, wherein the two kinds of disk roller cutters are arranged in many rows front and rear, and in the vertical direction.

3. The cutter head according to Claim 1 or 2, wherein the disk roller cutter includes a both-side type disk roller cutter having disks disposed on both sides.

4. The cutter head according to any of Claims 1 to 3, wherein a button roller cutter for scraper, a rotating-type round pick, a fixed bit or a cutting-buried-type tip is mounted in place of the disk roller cutter for scraper.

5. The cutter head according to any of Claims 1 to 4, being equipped with a mucking vent.

6. A rock excavator **characterized in that** the cutter head according to any of Claims 1 to 5 is mounted on an excavating boom.

7. A rock excavator of a road-header type **characterized in that** a shaft of the cutter head according to any of Claims 1 to 5 is mounted nearly parallel to a shaft of an excavating boom.

8. A rock excavator of a road-header type **characterized in that** a shaft of the cutter head according to any of Claims 1 to 5 is mounted nearly vertical to a shaft of an excavating boom.

9. A rock excavator of a shovel type **characterized in that** the cutter head according to any of Claims 1 to 5 is mounted as an attachment.

10. A rock excavator of a surface-miner type **characterized in that** the cutter head according to any of Claims 1 to 5 is mounted.

FIG. 1

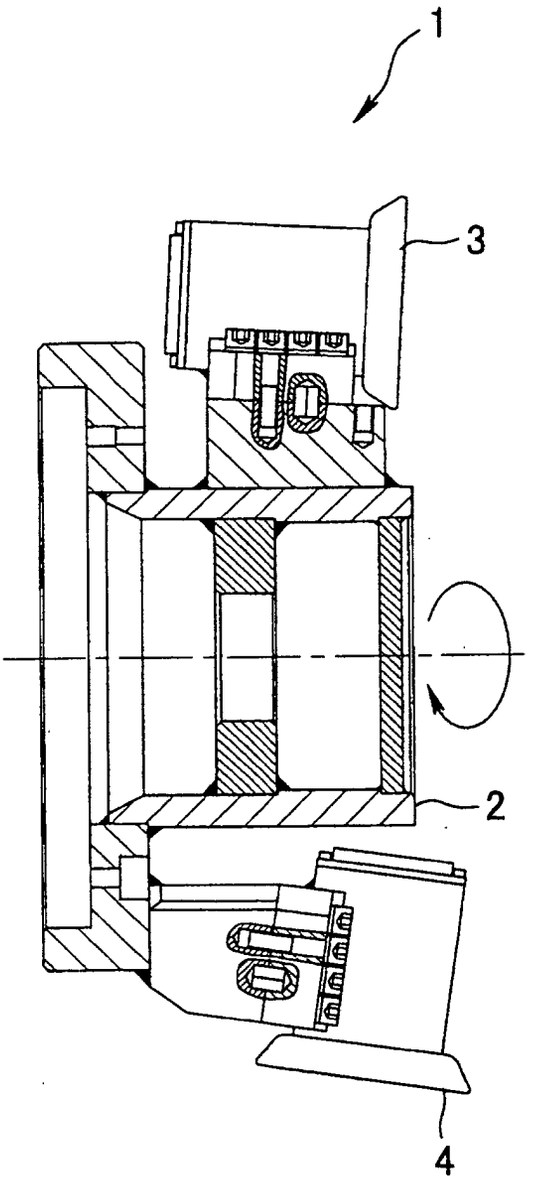


FIG.2

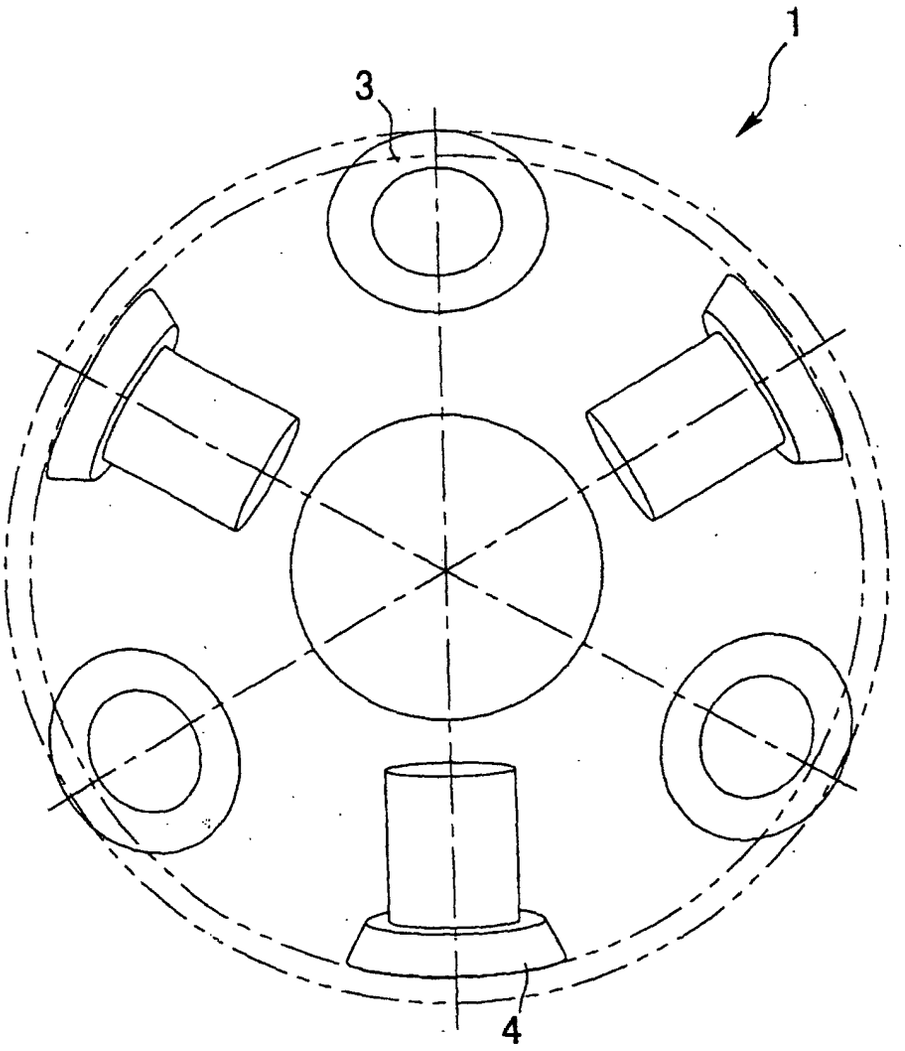


FIG.3

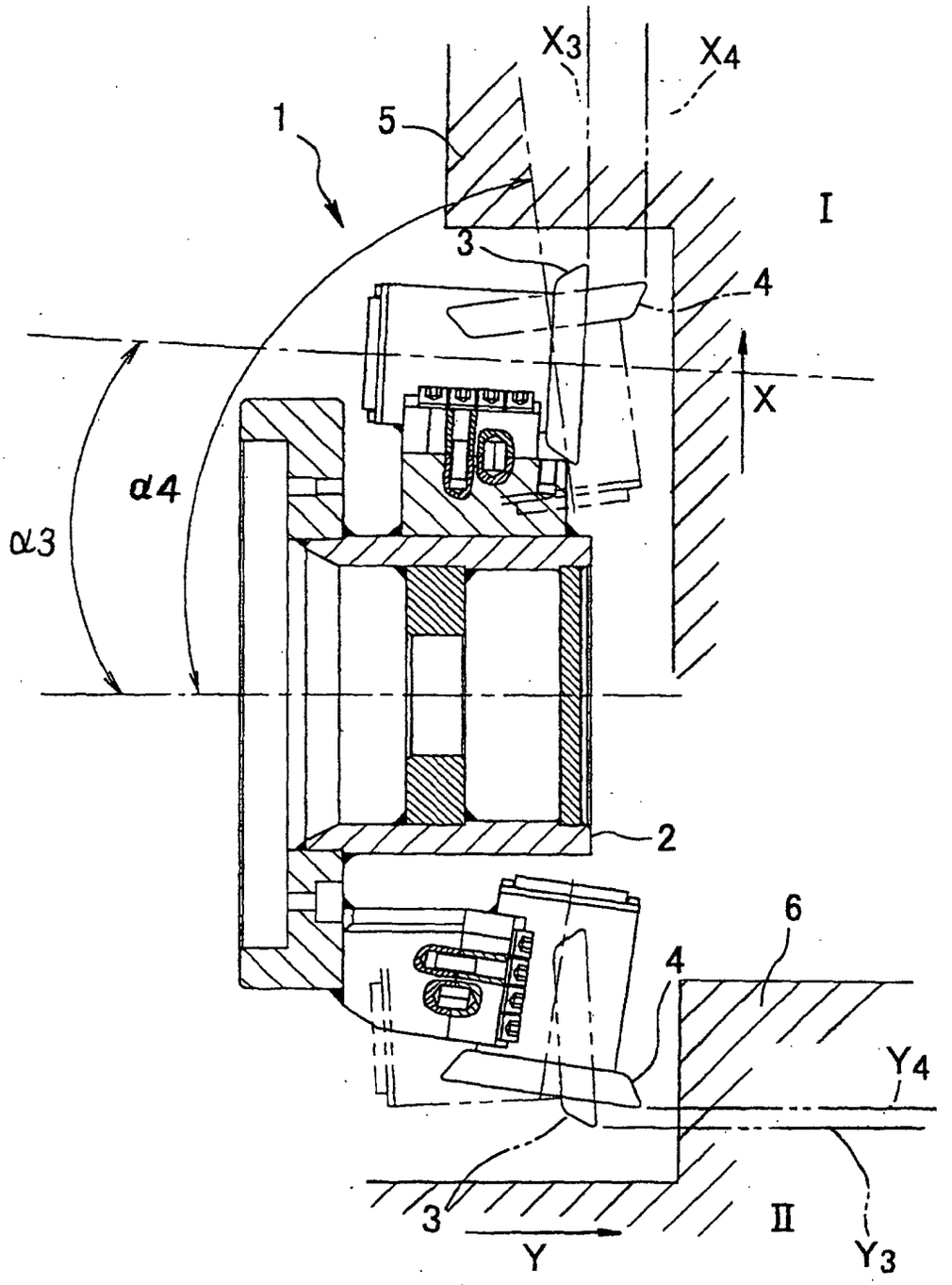


FIG.4

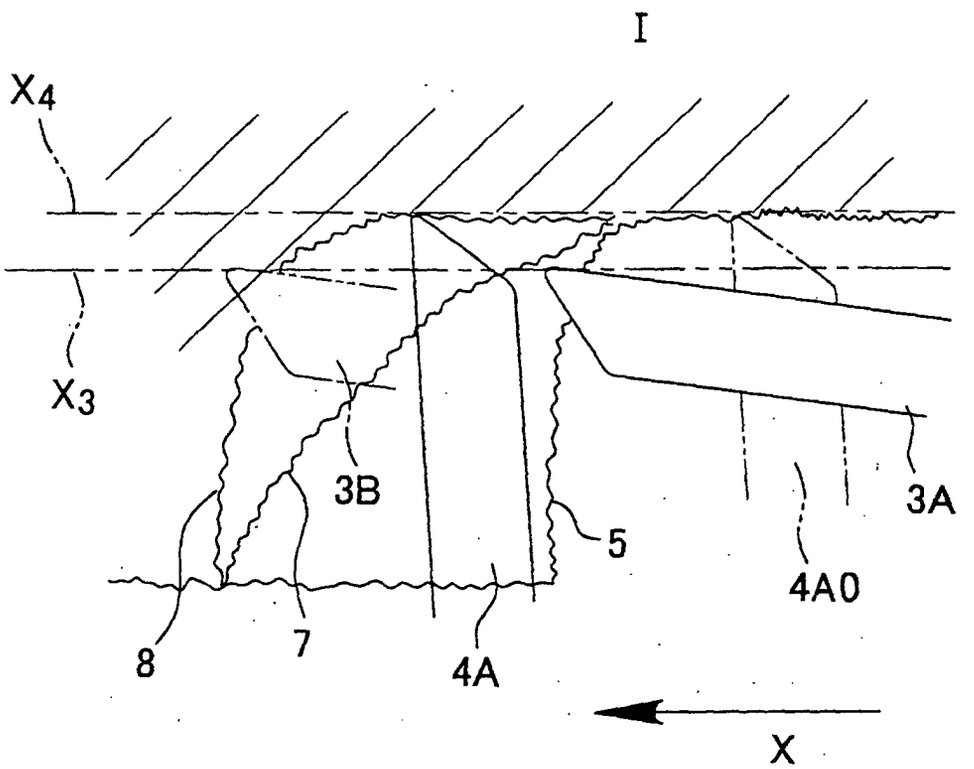


FIG.5

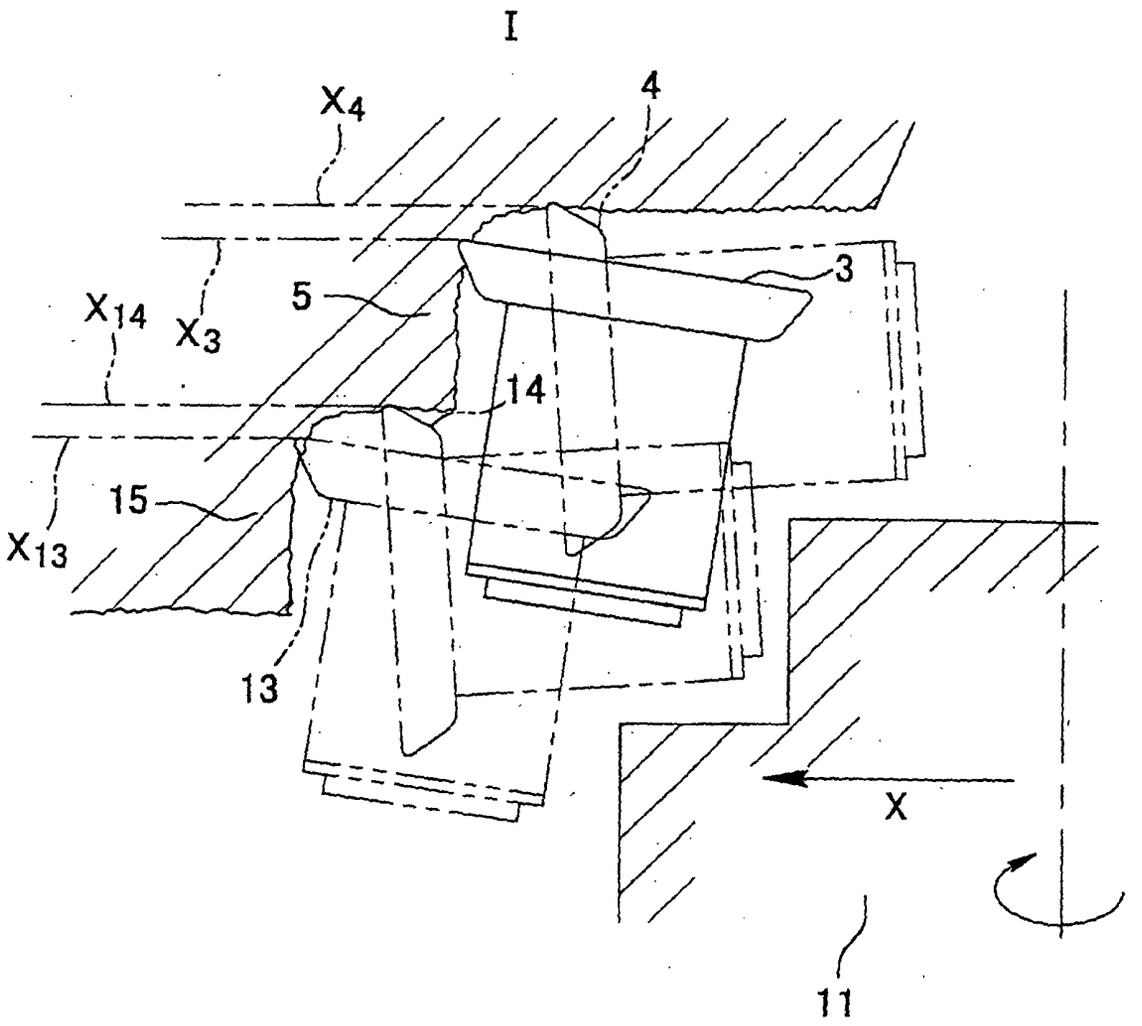


FIG.6

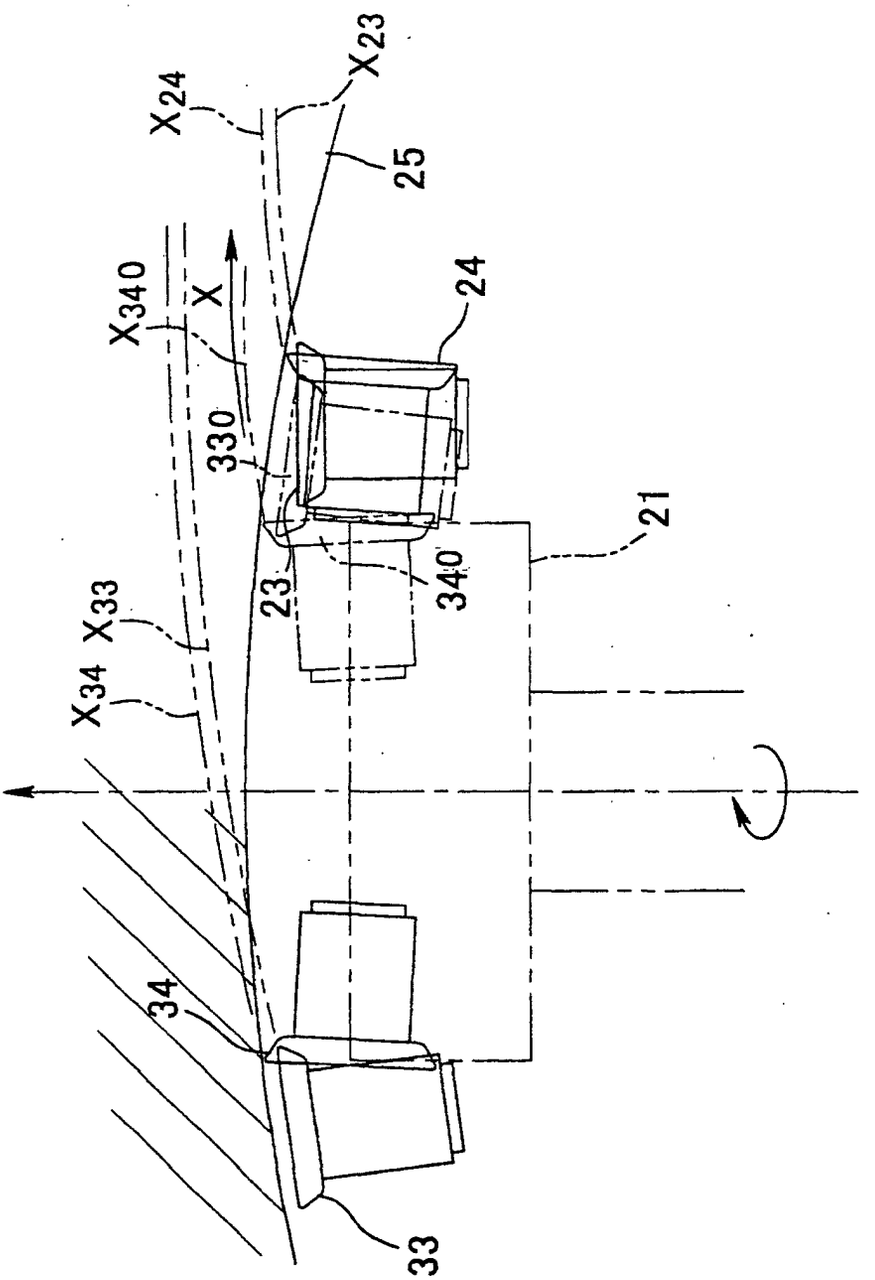


FIG.7

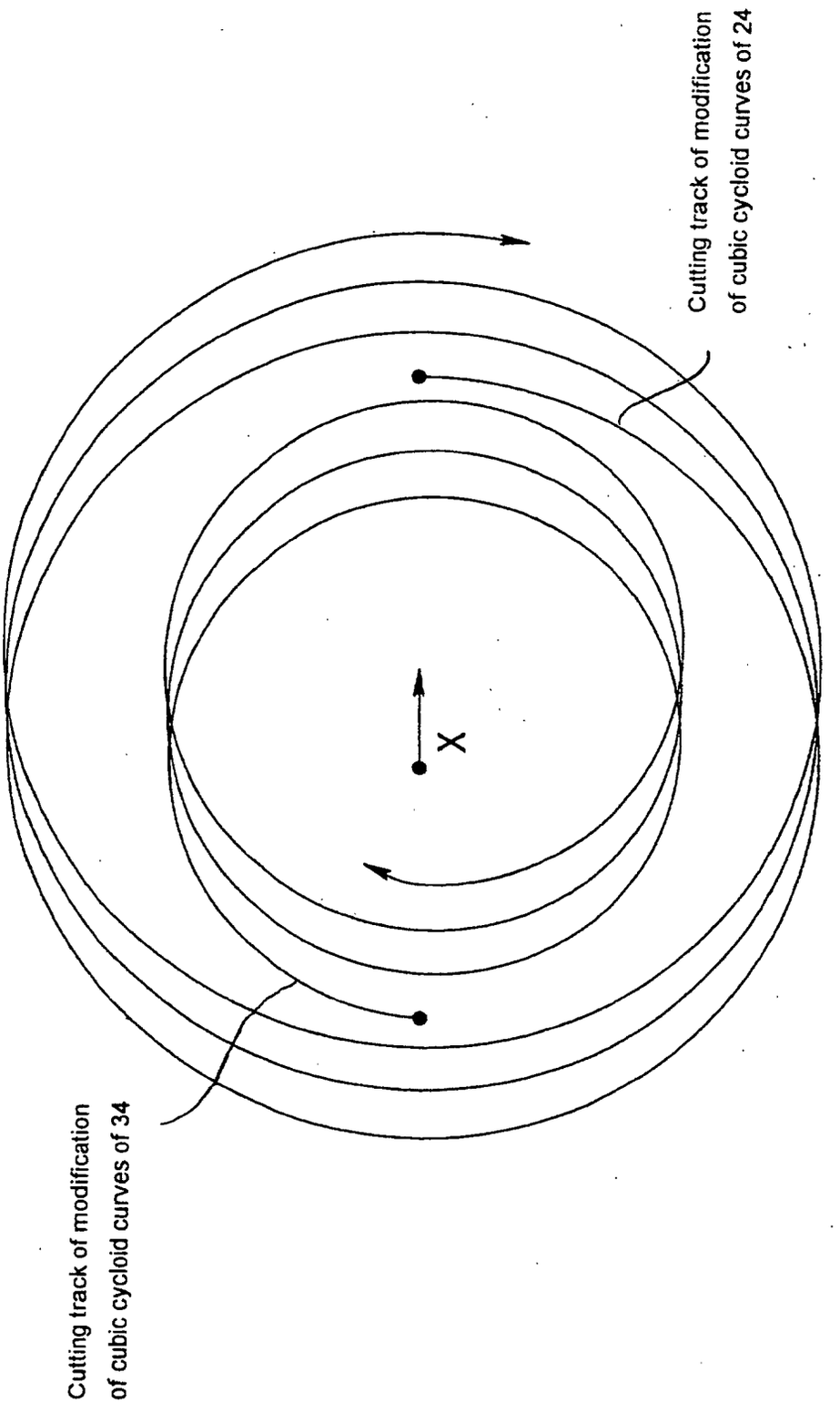

Cutting track of modification
of cubic cycloid curves of 24
X
Cutting track of modification
of cubic cycloid curves of 34

FIG.8

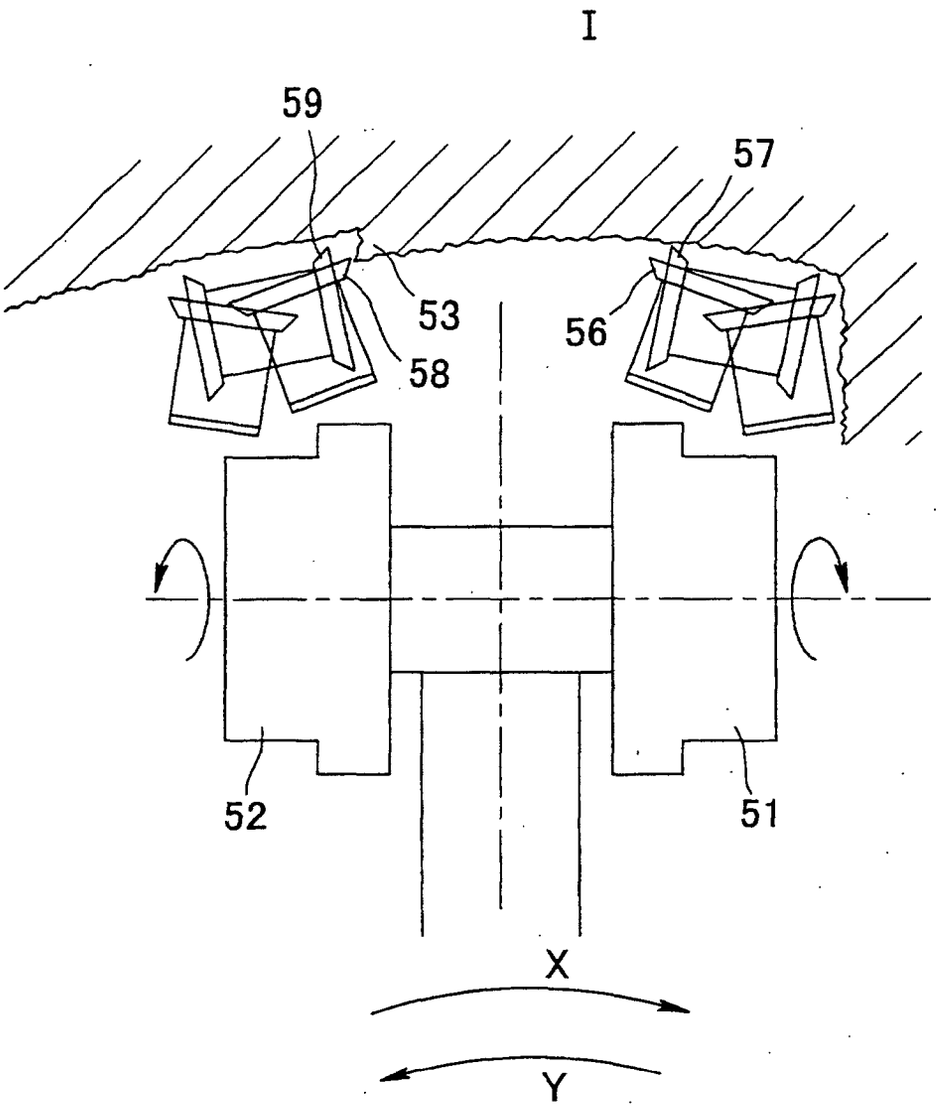


FIG.9

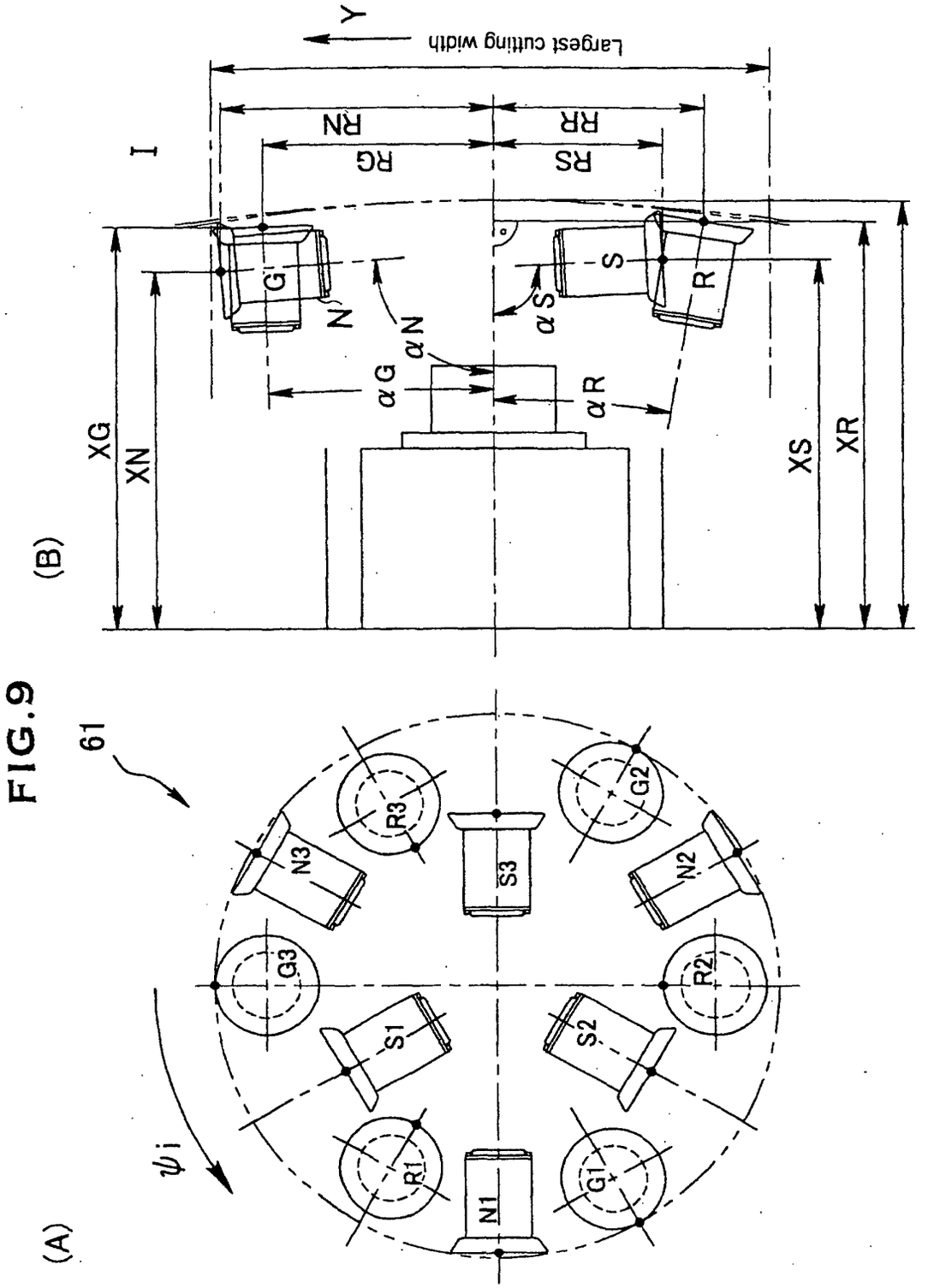

(A)
61
ψi
R3
G2
N3
S3
N2
G3
R2
S1
S2
R1
G1
N1
(B)
Y
Largest cutting width
I
RN
RR
RG
RS
G
N
αN
αG
αR
αS
S
R
XG
XN
XS
XR

FIG.10

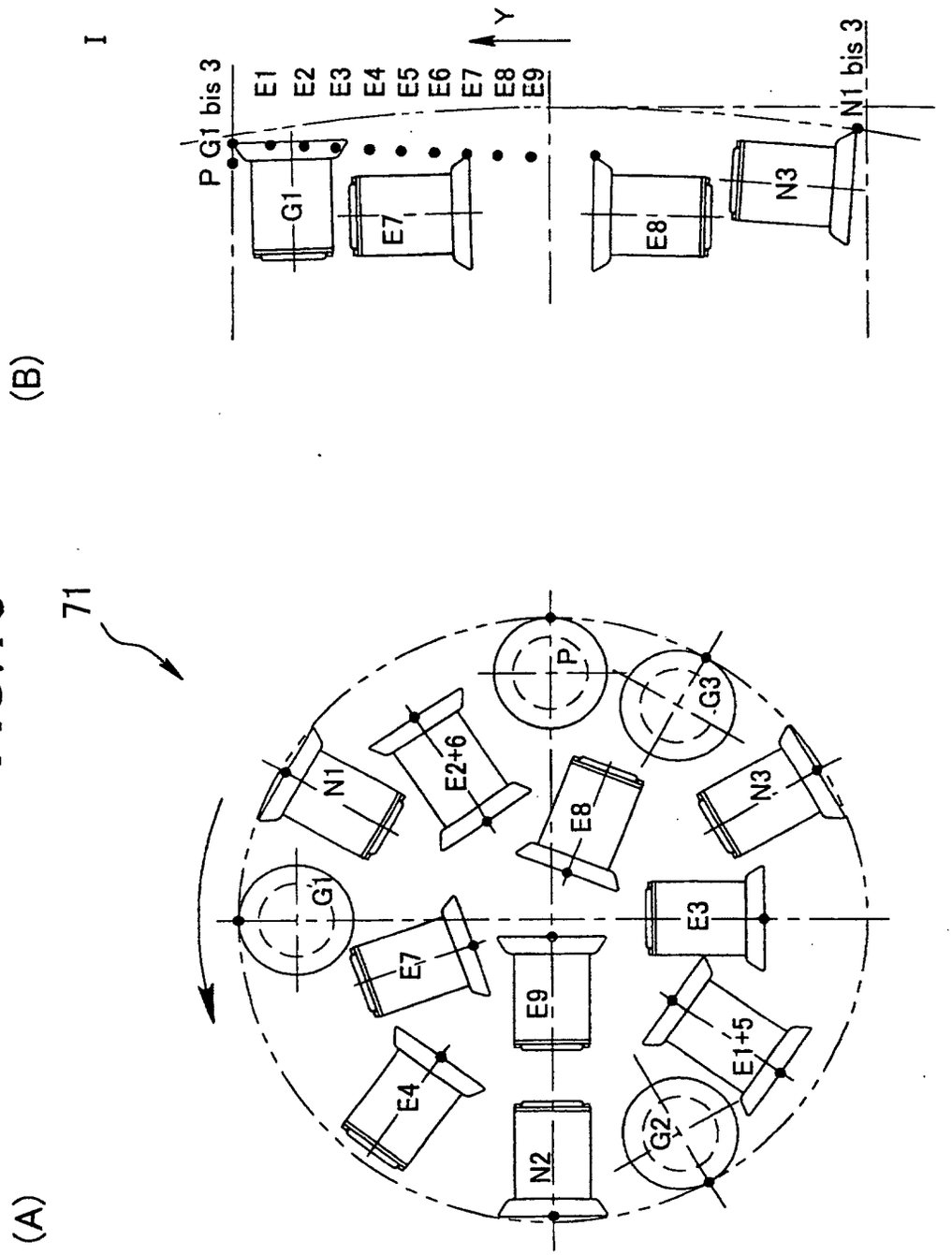

(A)
71
P
G3
N1
E2+6
E8
N3
G1
E3
E7
E9
E1+5
E4
G2
N2
(B)
I
Y
P G1 bis 3
E1
E2
E3
E4
E5
E6
E7
E8
E9
N1 bis 3
G1
E7
E8
N3

FIG. 11

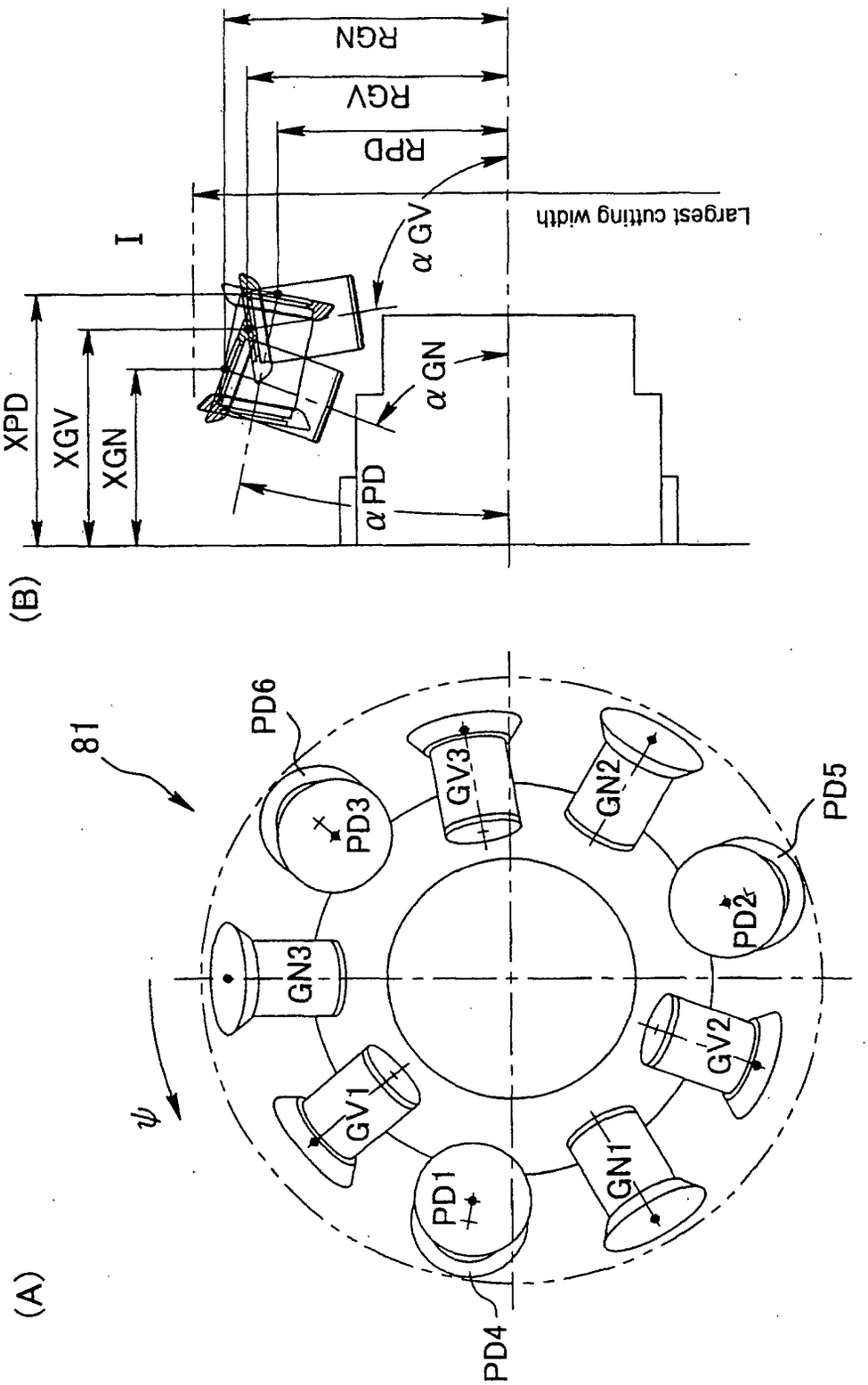

(A)
81
PD6
PD3
GV3
GN2
PD5
PD2
GN3
GV2
GV1
GN1
PD1
PD4
ψ
(B)
RGN
RGV
RPD
Largest cutting width
I
α GV
α GN
α PD
XPD
XGV
XGN

FIG. 12

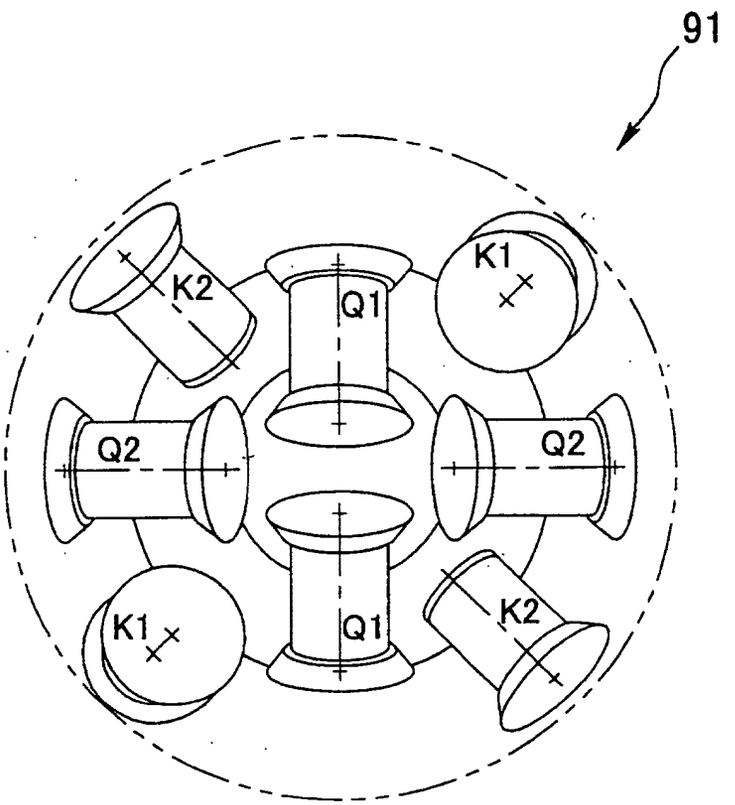


FIG. 13

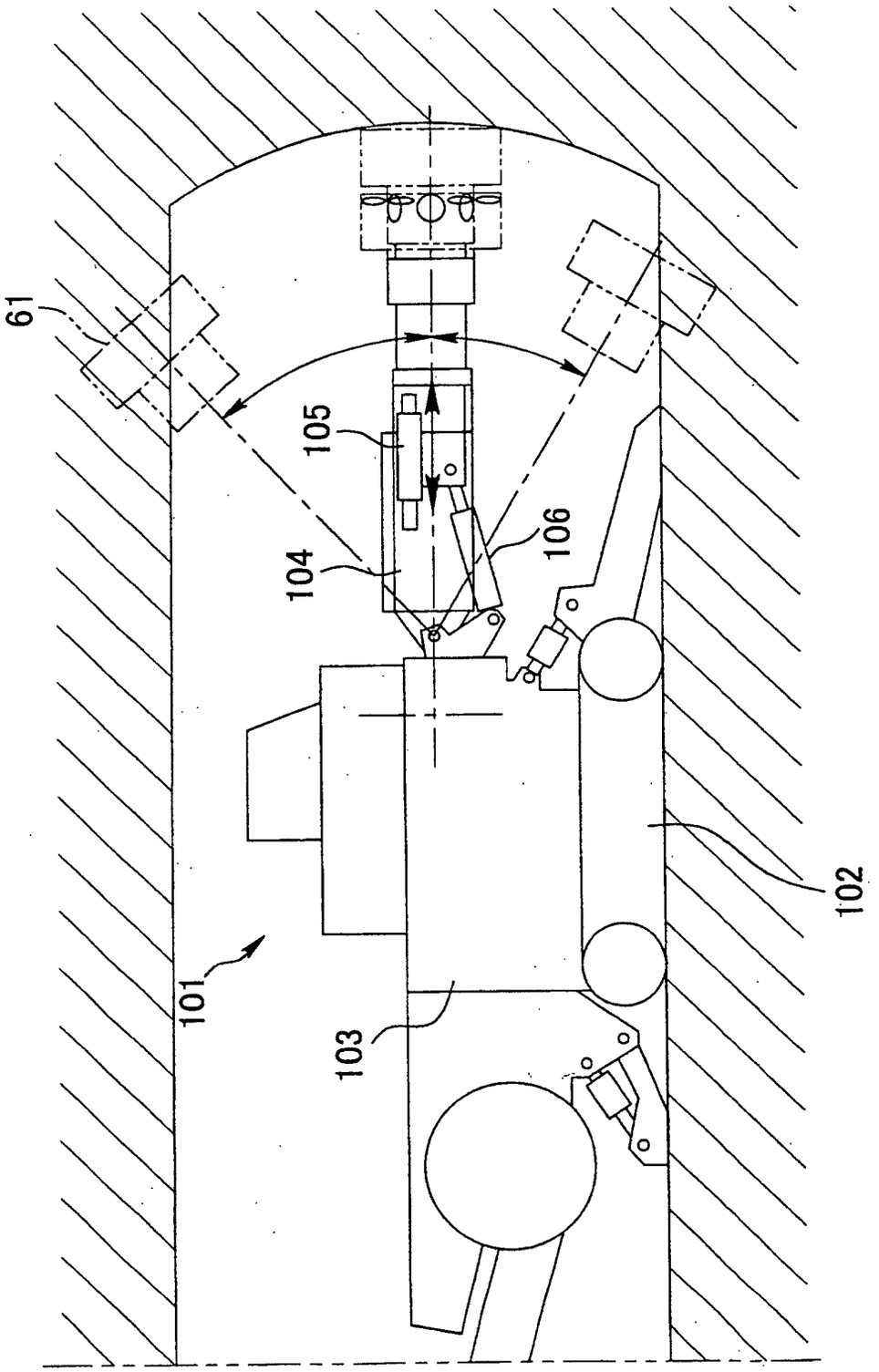


FIG.14

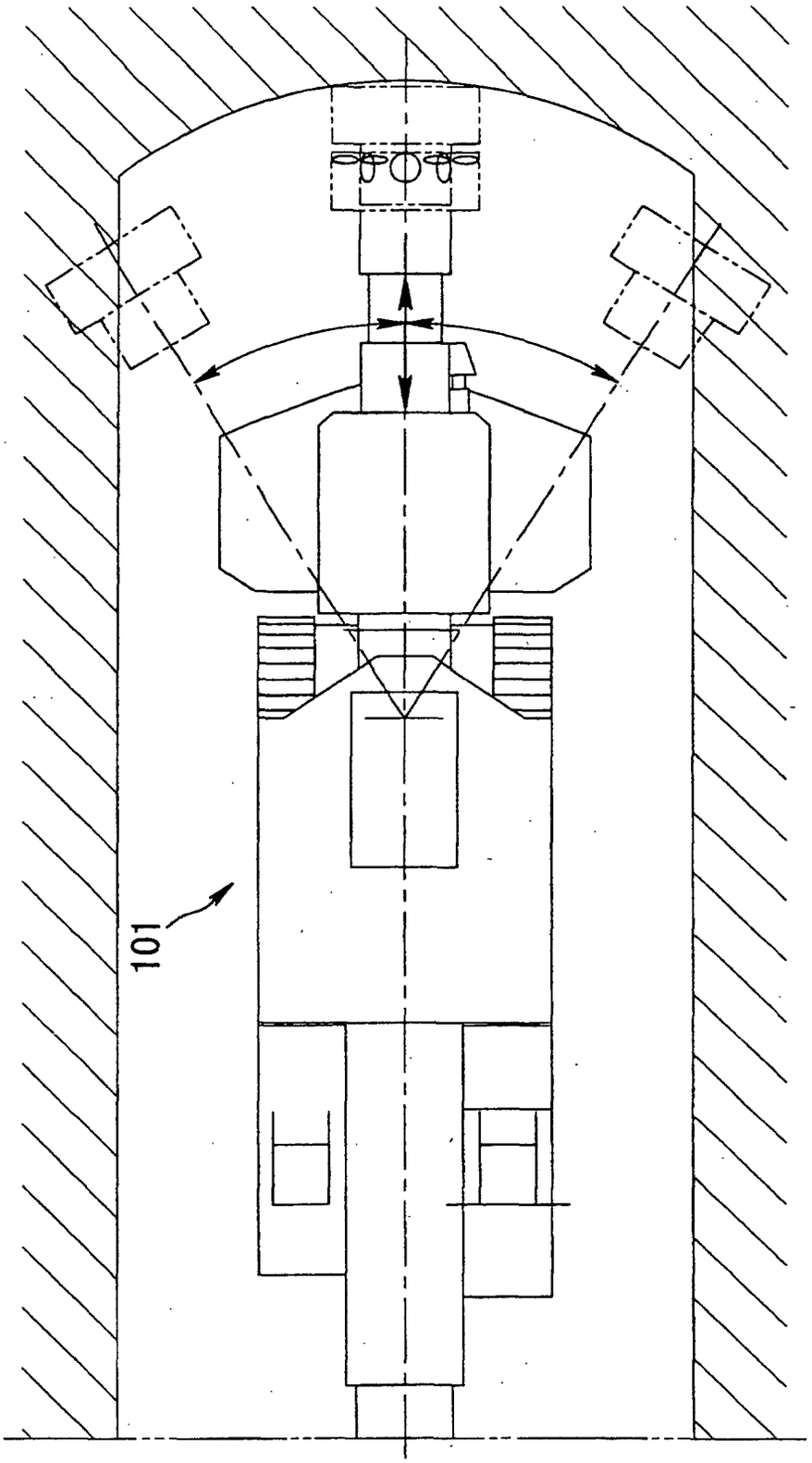


FIG.15

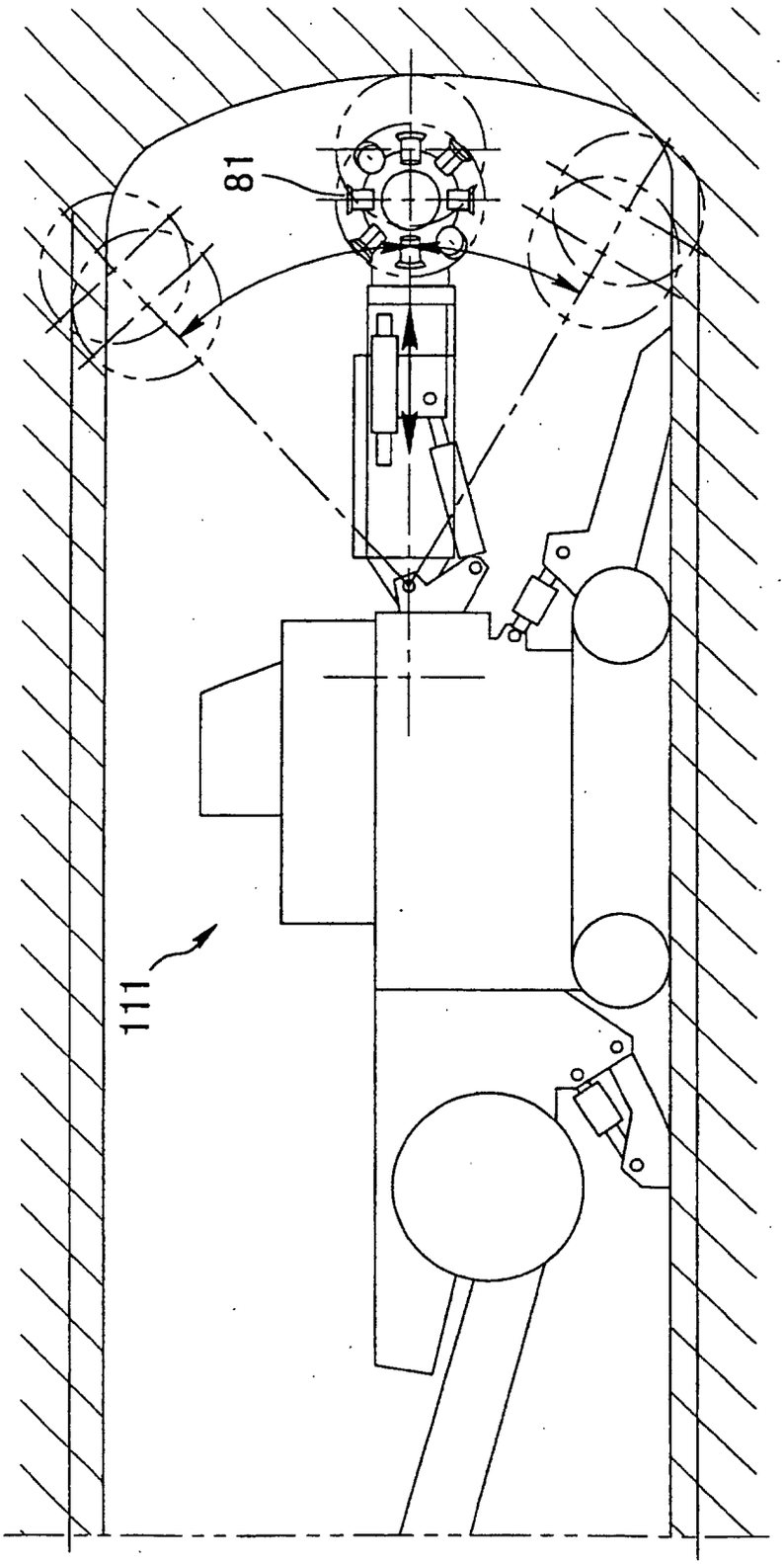


FIG.16

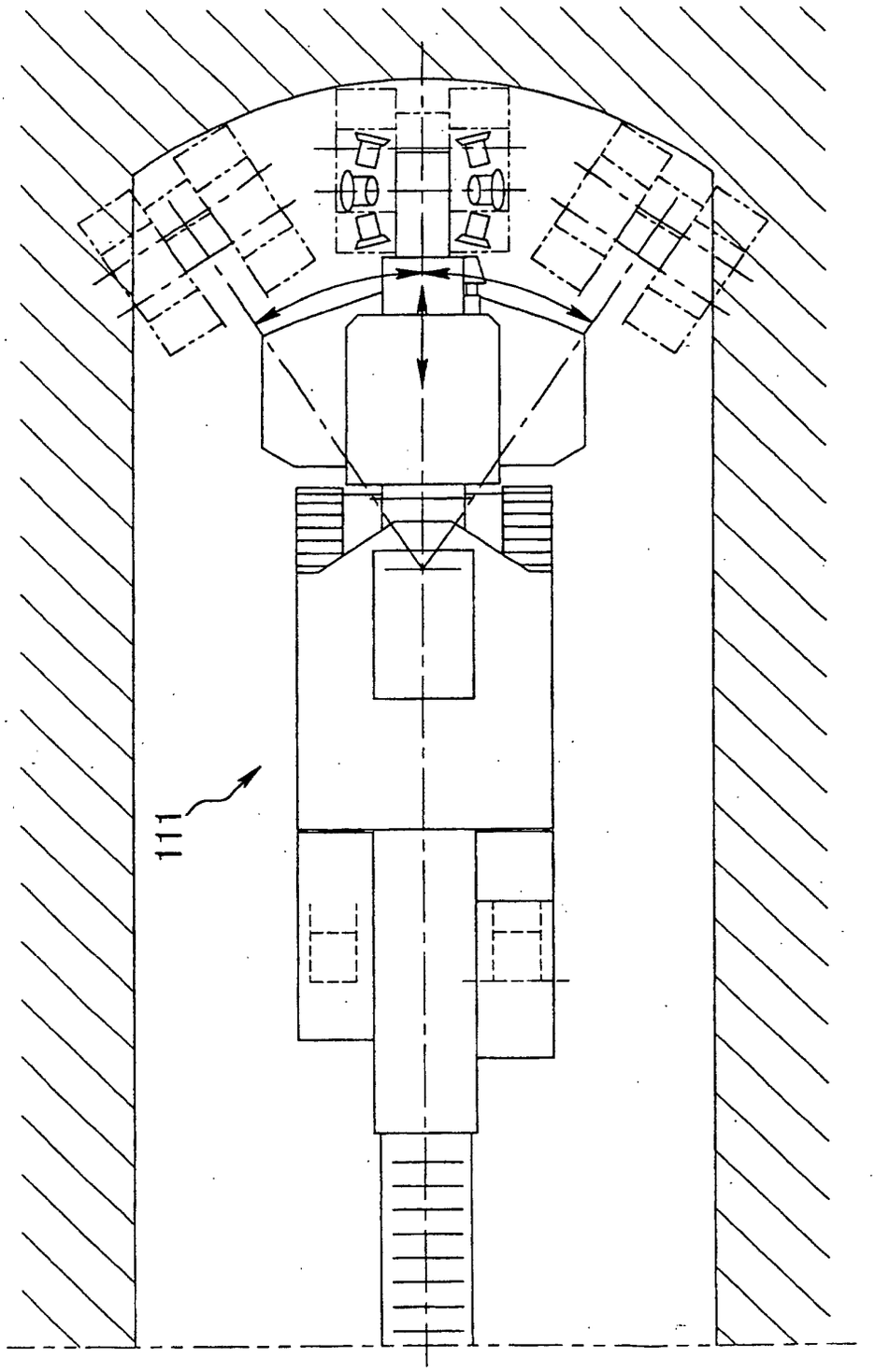


FIG.17

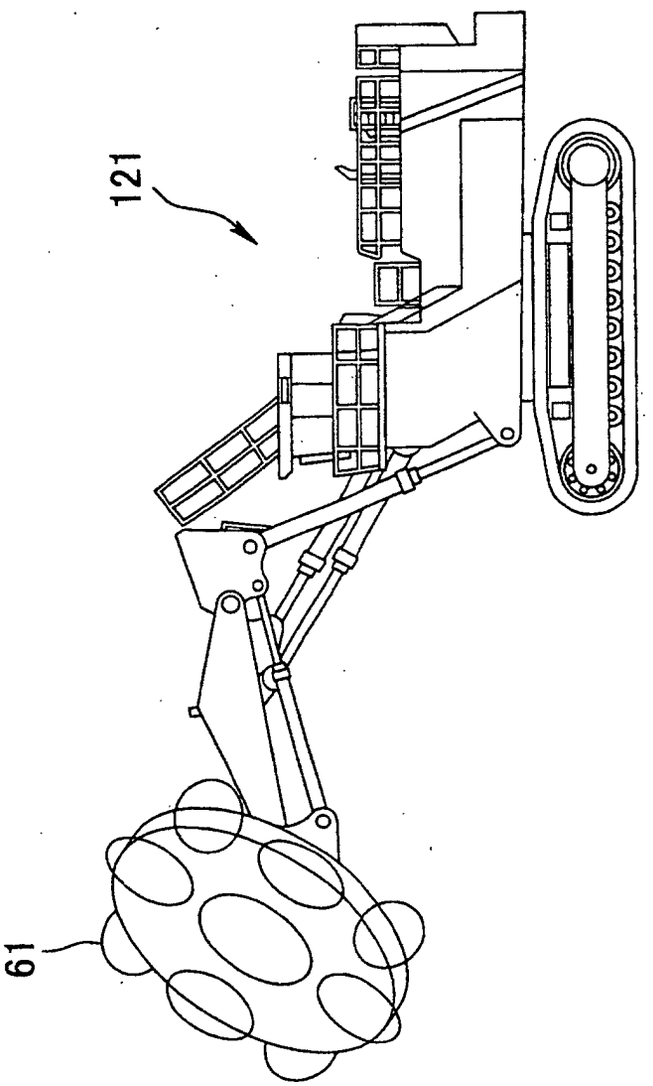


FIG.18

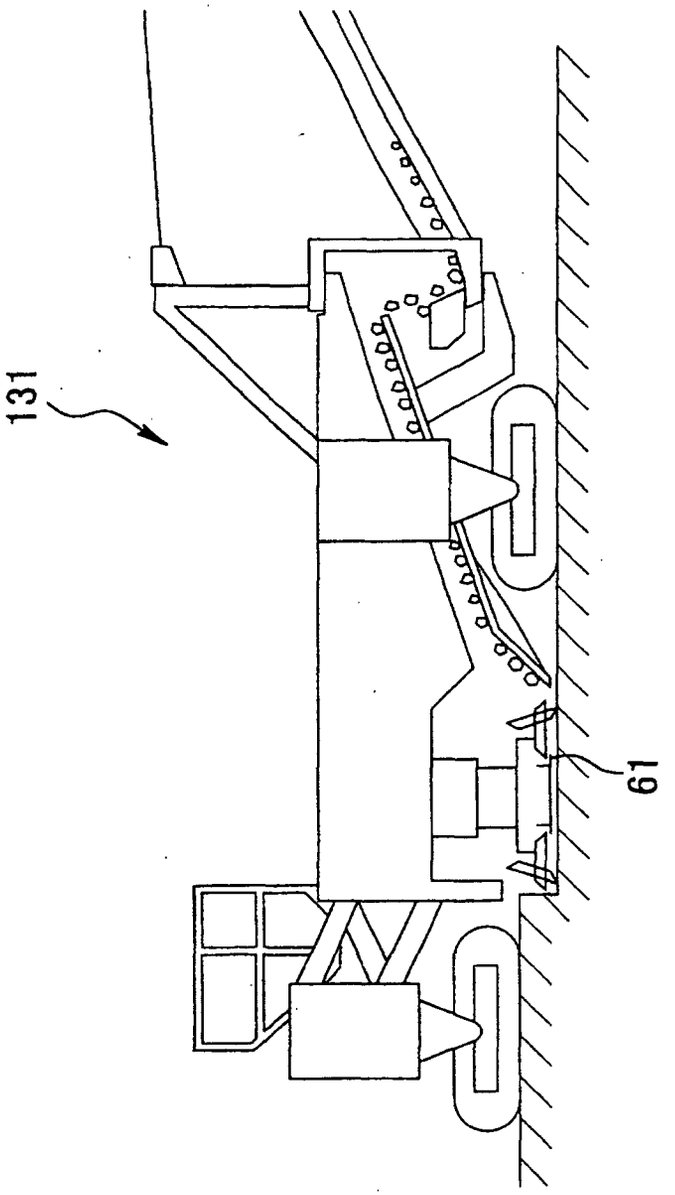


FIG.19

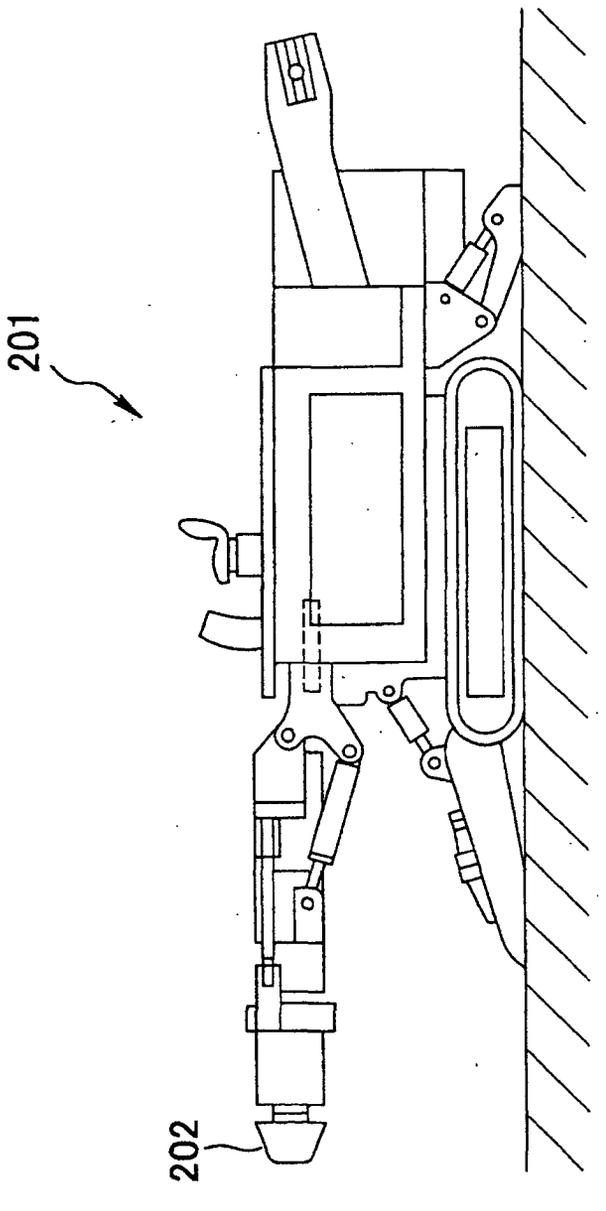


FIG.20

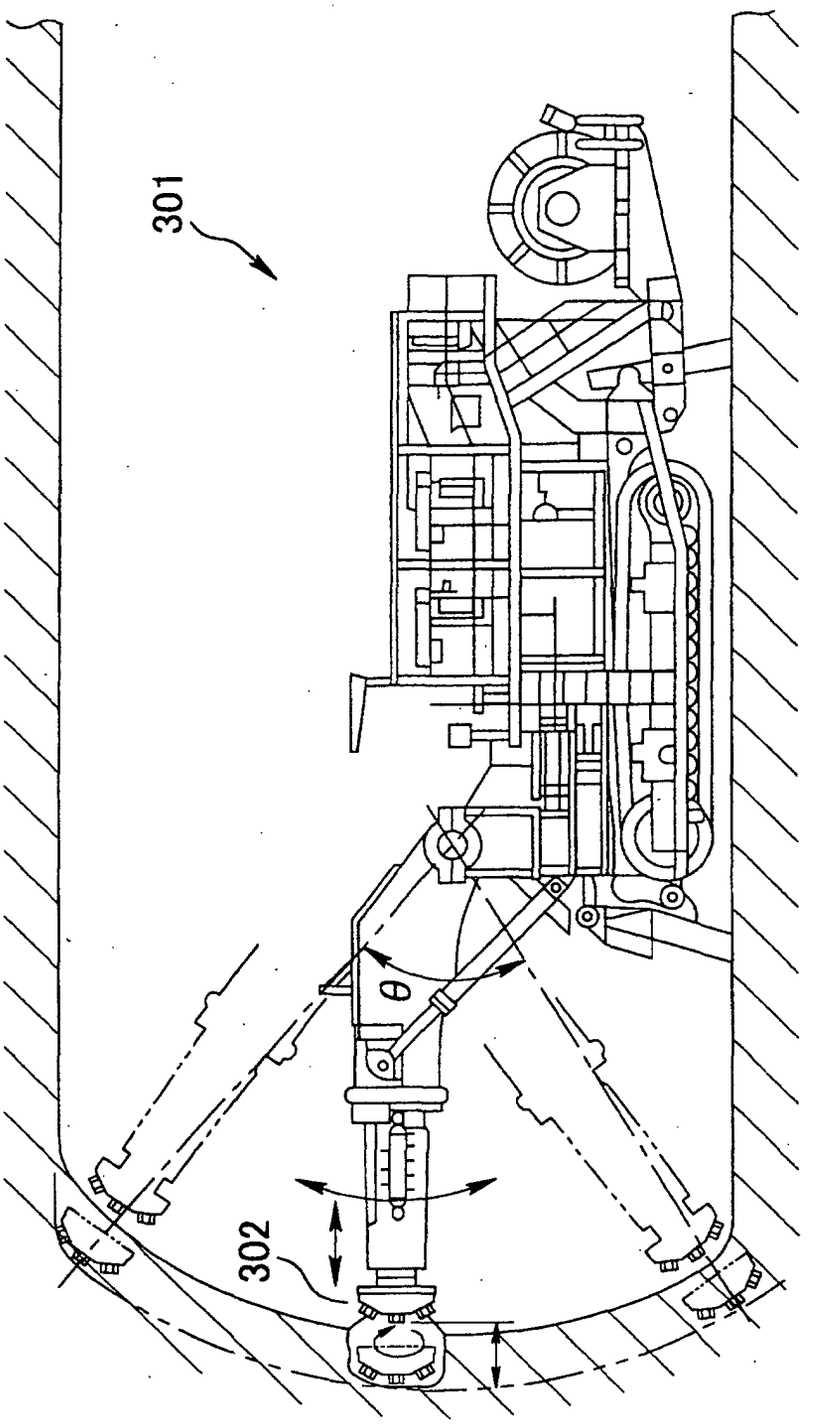


FIG.21

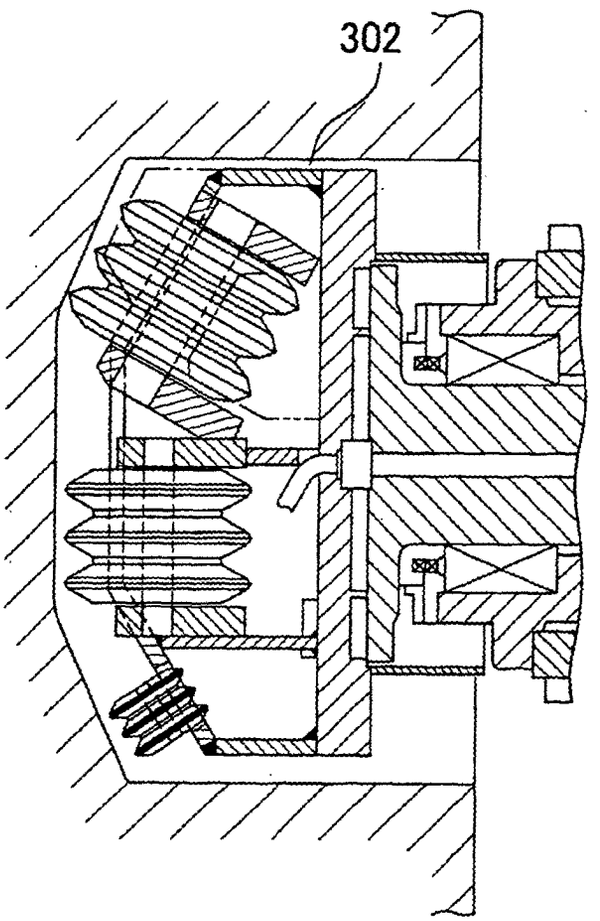


FIG.22

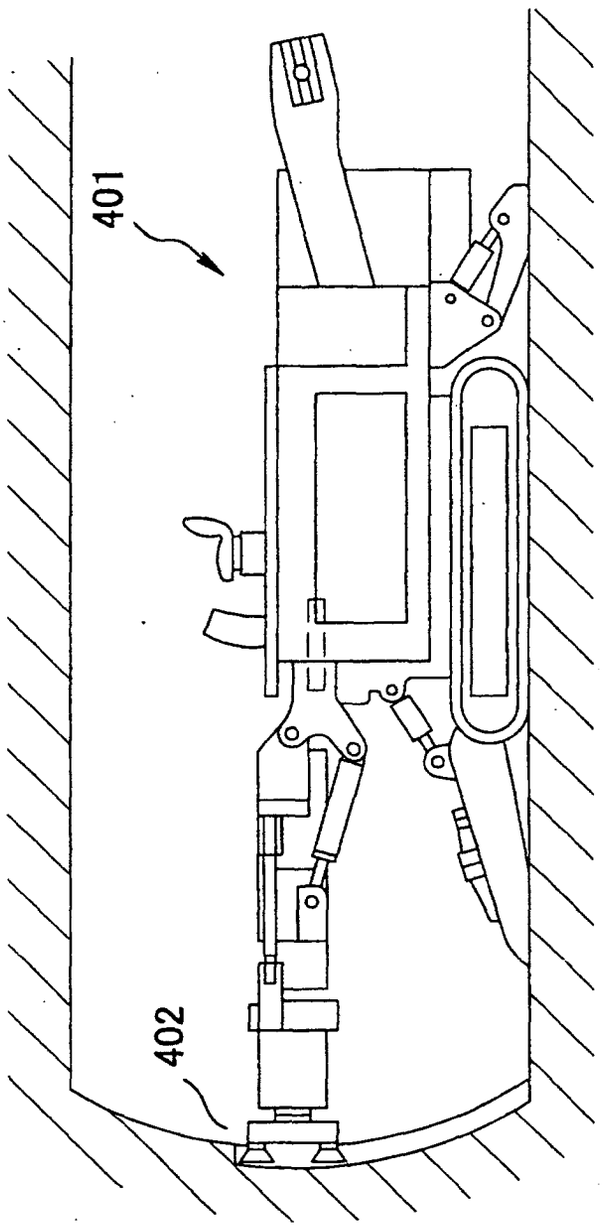
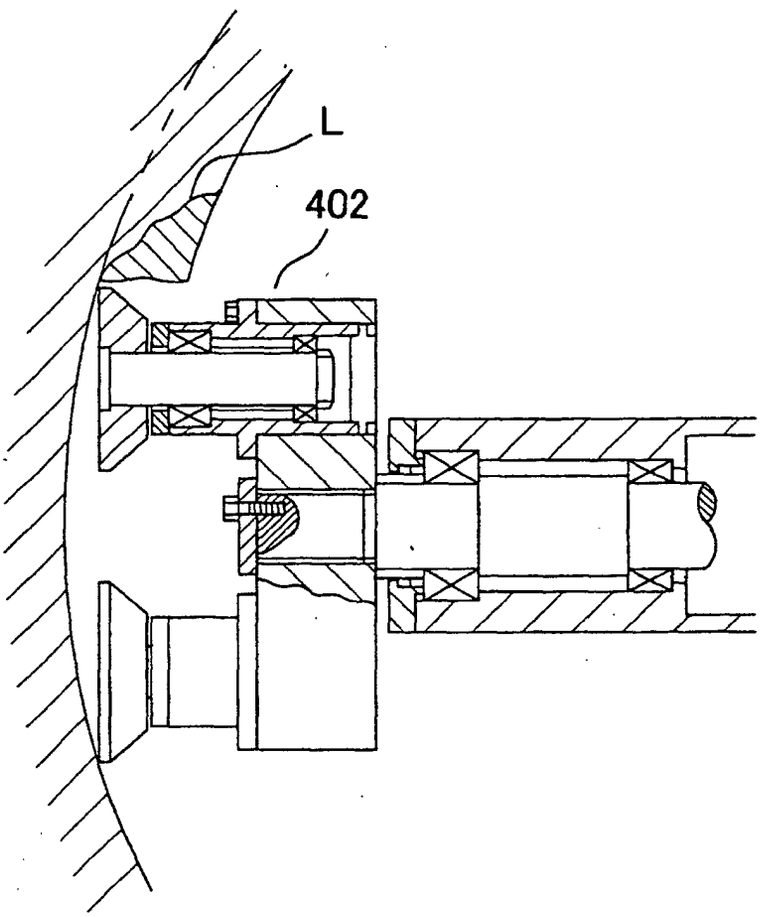


FIG.23



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP01/11043

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] E21D9/08

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] E21D9/08, E21D9/10, E21B3/00, E21B10/08

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	1996-2002
Kokai Jitsuyo Shinan Koho	1971-2002	Toroku Jitsuyo Shinan Koho	1994-2002

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.
Y	JP, 2000-328879, A (Oishi International Syscom K.K.), 28 November, 2000 (28.11.00), Full text; Figs. 1 to 5 (Family: none)	1-10
Y	JP, 50-139528, A (Komatsu Ltd.), 07 November, 1975 (07.11.75), Full text; Figs. 1 to 5 (Family: none)	1-10
Y	JP, 9-317385, A (Maeda Corp.), 09 December, 1997 (09.12.97), Full text; Figs. 1 to 3 (Family: none)	6,7,9
Y	JP, 11-148299, A (Toda Corp.), 02 June, 1999 (02.06.99), Full text; Figs. 1 to 8 (Family: none)	6,8,9

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 March, 2002 (12.03.02)	26 March, 2002 (26.03.02)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP01/11043

C (*Continuation*). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP, 8-218776, A (Chubu Electric Power Co., Inc.), 27 August, 1996 (27.08.96), Full text; Figs. 1 to 5 (Family: none)	10

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