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(71) Applicant: **KOMATSU LTD.**
Minato-ku Tokyo 107 (JP)

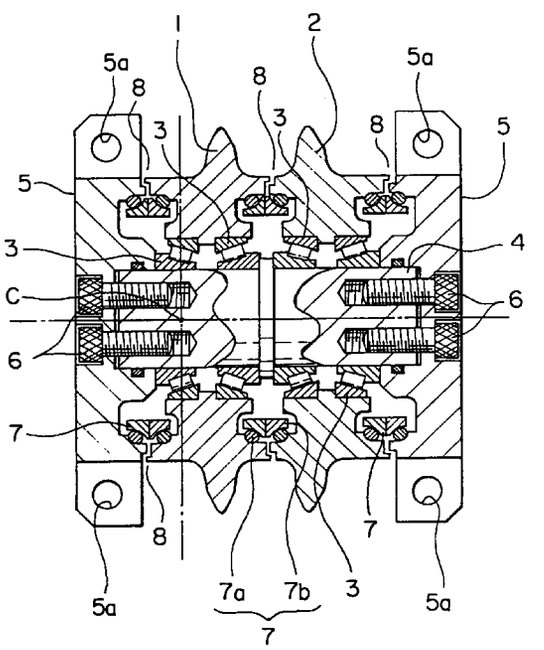
(72) Inventors:
- **KASUYA, Tetsuyuki**
  Hirakata-shi Osaka 573 (JP)
- **YAMAZAKI, Toshihiro**
  Hirakata-shi Osaka 573 (JP)

(74) Representative:
Viering, Jentschura & Partner
Postfach 22 14 43
80504 München (DE)

(54) DISC CUTTER STRUCTURE

(57) The disc cutter structure of the present invention includes a rotation axis (C), a supporting shaft (4) extending in a direction that crosses the rotation axis (C), and a cutting member through which the support shaft (4) is axially passed, and the cutting member has a plurality of rotary blades (1, 2) rotatable around the support shaft (4) as the center. According to the disc cutter structure, the respective rotary blades (1, 2) are rotated independently, therefore the life of the cutting member can be extended.

FIG.1



EP 0 841 466 A1

Description

Technical Field

The present invention relates to a disc cutter structure, and particularly to a disc cutter structure which is attached, for example, to a TBM (tunnel boring machine) which does not restrict the presence or absence of a shield mechanism, and to a small-diameter pipe propulsion machine or the like for excavating conduits for water and sewage, and a well.

Background Art

Fig. 3 shows a plan view of a cutter head 20 which is attached to a TBM for excavating a tunnel almost cylindrically to a face, or to a small-diameter pipe propulsion machine or the like for excavating conduits for water and sewage, and a well.

The cutter head 20 is formed to be almost in a disc form, and has four disc cutters (with tapers) 21 and eight tool bits 22 attached at the outer edge so as to be attachable and detachable, with cutting members (straight) 23, 24, 25, and 26 being disposed in series along the diameter direction (refer to an alternate long and short dash line in the drawing) of the cutter head 20. The cutter head 20 can be rotated around a rotation axis C, which passes through the axial core, in a clockwise direction in the drawing, or in a counterclockwise direction in the drawing with the rotation axis C as the center.

The cutting members (straight) 23 to 26 have bodies 27 in an almost cylindrical form through which a support shaft (not illustrated in the drawing) almost intersecting the rotational axis of the cutter head 20 is passed, and have a plurality of rotary blades 28 which are formed integrally on the circumferential surface of the body 27. Specifically, the bodies 27 of the cutter members 23 and 26 are respectively provided with three of the rotary blades 28, and the bodies 27 of the cutting members 24 and 25 are respectively provided with two of the rotary blades 28.

As Fig. 4 shows, two of apical angle portions 29, which project in a radial direction from the circumferential surface of the body 27, are formed along the axial direction of the body 27. The apical angle portion 29 is formed so as to have a V-shaped section which is tapering toward the edge of the circumference, and the rotary blade 28 is constructed by fixing a bit 30 at the foremost end of the section. This structure is not peculiar to the cutting members 24 and 25, and in the cutting members 23 and 26, the bodies 27 and each of the rotary blades 28 are also integrally formed. The rotary blades 28 of the cutting members 23 to 26 respectively have the diameters equal to one another.

Returning to Fig. 3, when the cutter head 20 is pressed against a face while rotating around the rotation axis C as the center, each of the disc cutters 21 and each of the cutting members 23 to 26 are rotated against the face to crush stones in collaboration with the tool bits 22. In the cutter head 20, in order that the respective rotary blades 28 of the cutting members 23 to 26 have the different space distances from the rotation axis C from one another, the cutting member 25 is disposed at the position closest to the rotation axis C with cutting member 23 disposed at the position furthest away from the rotation axis C. Consequently, the cutter head 20 draws rolling loci of concentric circles on a face with the space distances of the rotary blades 28 of the respective cutting members 23 to 26 from the rotation axis C as their radiuses.

Fig. 5 shows an enlarged view of a portion P in Fig. 3. In this drawing, when the cutting member 25 is rotated around the rotation axis C as the center, the rotary blades 28A and 28B which are formed integrally with the body 27 are rotated at the same circumferential speed. Here, rolling locus distances L1 and L2 of the rotary blades 28A and 28B which follow the rotation of the cutter head 20 are obtained from the following formula based on a space distance r1 between the rotation axis C of the cutter head 20 and the rotary blade 28A, based on a space distance r2 between the rotation axis C of the cutter head 20 and the rotary blade 28A, and based on a space distance a between the rotary blades 28A and 28B.

$$L1 = 2 \pi r1$$

$$L2 = 2 \pi r2 = 2 \pi (r1 + a)$$

In this cutter head 20, when the cutting member 25 is disposed at the position extremely close to the rotation axis C, the ratio between the rolling locus distances L1 and L2 becomes greater as the ratio of the space distance a to the space distance r1 becomes greater.

However, the cutting member 25 has the rotary blades 28A and 28B formed integrally with the body 27, therefore when, for example, the rotary blade 28B rotates as far as the distance of $2 \pi r2$ (L2), the rotary blade 28A also rotates as far as the distance of $2 \pi r2$ (L2). Specifically, the cutting member 25 slides against a face with the rotary 28A rotating more than necessary, therefore there is a disadvantage of the rotary blade 28A being worn out earlier as compared to the rotary blade 28B.

The above disadvantage does not occur only to the cutting member 25, but occurs similarly to the cutting members 23, 24, and 26. The space distance ratio of each rotary blades from the rotation axis C tends to be smaller as the cutting members 23 to 26 are further away from the rotation axis C. Accordingly, as Fig. 4 shows, for example, in the cutting member 26, the ratio between space distances r3 and r4 of the rotary blades 28C and 28E from the rotation axis C is comparatively small, therefore unbalanced wear develops more slowly as compared to the cutting member 25 described

above.

Disclosure of the Invention

The present invention is made to eliminate the above conventional disadvantages, and its object is to provide a disc cutter structure which extends the life of a cutting member.

In order to attain the above-described object, a disc cutter structure related to the present invention is a disc cutter structure including a rotation axis, a support shaft extending in a direction that crosses the rotation axis, and a cutting member through which the support shaft is axially passed, with the cutting member having a plurality of rotary blades which are rotated around the support shaft as the center, and is characterized by each of the rotary blades being rotated independently.

Here, the rotation axis does not mean a rotary shaft as a member, but means a center around which the support shaft is rotated. As a cutting member, it may be suitable if the cutting member has a plurality of rotary blades which are independently rotated, and the number of cutting members themselves can be determined at will. When placing a plurality of cutting members, they can be disposed in series along the same support shaft, or the selected numbers of cutting members can be respectively disposed at a plurality of rotation axes which are disposed so as to intersect one another.

In the disc cutter structure related to the present invention, the respective rotary blades are independently rotatable, and there is no fear that respective rotary blades slide against a face even if the space distances from the rotation axis are different from one another, therefore disadvantage of one of the respective rotary blades being worn out earlier than the other can be eliminated, and consequently the above object can be attained.

The present invention is also characterized by being provided with a retainer between at least one pair of rotary blades adjacent to each other of said respective rotary blades, therefore if the width of the retainer is suitably selected, the present invention can be generally used for a plurality of kinds of rotary blades with different width dimensions. Further, the present invention is characterized by being provided with seal means which arc adjacent to said respective rotary blades and prevent the entry of sludge. Here, as seal means, for example, O-rings, labyrinths, air nozzles can be adopted, and it is suitable if these seal means are appropriately disposed between respective rotary blades, or between the rotary blade and a labyrinth. In the present invention described in the above, seal means are provided adjacently to the rotary blades, therefore sludge is prevented from entering the centers of rotation of the rotary blades, and consequently the smooth rotation of the rotary blades can be maintained.

The present invention is characterized by the above-described seal means comprising O-rings, therefore excellent hermeticity can be obtained, and the entry of sludge can be surely prevented. Meanwhile, the present invention is characterized by the above-descried seal means comprising labyrinths, therefore the seal means do not become rotational resistance of the rotary blades, and mechanical loss can be reduced.

Further, the present invention is characterized by being provided with a plurality of above-described cutting members on the same axial line, with the above described respective rotary blades being disposed to draw rolling loci of concentric circles which do not overlap one another. Here, as for the respective cutting members, it is suitable if the respective cutting members are appropriately disposed so that respective rotary blades draw rolling loci of concentric circles which do not overlap one another. In the present invention, the respective rotary blades are disposed to draw rolling loci of concentric circles which do not overlap one another, therefore when excavating a face, stones are crushed into a small pieces of almost equal sizes.

The present invention is characterized by being applied to the machines for cylindrically excavating a face, therefore the life of the cutting member can be extended to be longer as compared to the conventional machines.

Brief Description of the Drawings

Fig. 1 is a sectional view showing a disc cutter structure of a first embodiment related to the present invention;

Fig. 2 is a sectional view of a disc cutter structure of a second embodiment related to the present invention;

Fig. 3 is a plan view of a conventional cutter head;

Fig. 4 is a fragmentary sectional view showing the conventional disc cutter structure; and

Fig. 5 is an enlarged view of a portion P in Fig. 3.

Best Mode for Carrying out the Invention

In the below, a first embodiment of the present invention will be explained with reference to the drawings. In the embodiment explained below, the same reference numerals and symbols will be used to designate the same components that have been already explained in Figs. 3 to 5, so that the explanation will be simplified or omitted.

Fig. 1 shows a disc cutter structure of the first embodiment related to the present invention. The disc cutter structure is applied to a cutter head 20 which is attached to a TBM for excavating a tunnel almost in a cylindrical form against a face, or a small-diameter pipe propulsion machine or the like for excavating conduits for water and sewage, and a well, and is constructed by including cutting members disposed along the direction of the diameter of the cutter head 20.

The cutting member has a support shaft 4 disposed along a direction intersecting a rotation axis C of the cutter head 20, a pair of brackets 5 and 5 supporting both end portions of the support shaft 4, and rotary blades 1 and 2 supported by the support shaft 4. This cutting member has the rotary blades 1 and 2 which are equivalent to the conventional disc cutter, and a plurality of cutting members are disposed in series along the direction of the diameter of the cutter head 20. The support shaft 4 has the diameter which becomes larger at the central portion in a shaft direction, with both end portions respectively supported by the brackets 5 and 5 through a plurality of end portion bolts 6. By screwing fixing bolts (not illustrated in the drawing) inserted through bolt holes 5a to the cutter head 20, the brackets 5 and 5 fixedly positioned the support shaft 4 along the direction of the diameter of the cutter head 20. The rotary blades 1 and 2 are almost in a ring shape which tapers to the edge of the circumference, and are respectively supported by the support shaft 4 through the bearings 3, which enables independent rotation.

The disc cutter structure of the present embodiment is provided with seal means 7 and 8 which are adjacent to respective rotary blades 1 and 2 and which prevent the entry of sludge. The seal means 7 is constructed so as to include two of the synthetic resin O-rings 7a and two of the metal seal rings 7b, and the synthetic resin O-rings 7a can be respectively welded by pressure to the rotary blades 1 and 2, and the brackets 5. In the seal means 7, the seal ring 7b is compressed along the axial direction of the support shaft 4 by the elasticity of the synthetic resin O-ring 7a, and thereby securing hermeticity between the rotary blades 1 and 2, between the rotary blade 1 and the bracket 5, and between the rotary blade 2 and the brackets 5. The seal means 7 prevents the lubricant of the bearing 3 from leaking out of the cutting member, and prevents muddy water, earth, and sand from entering the inside of the cutting member. Meanwhile, the seal means 8 is a labyrinth which is provided at the faces of the rotary blades 1 and 2, and brackets 5 which are opposing to each other, and prevents the lubricant from leaking outside from the cutting member and prevents muddy water from entering the inside of the cutting member similarly to the seal means 7.

In the first embodiment, the cutting member having two rotary blades 1 and 2 is shown as an example, but the same structure as that in the present embodiment can be applied to the cutting member having three or more rotary blades, or the cutting member having a rotary blade with a superhard tip being attached to the outer edge thereof.

According to the disc cutter structure described in the above, each of the rotary blades 1 and 2 is independently rotatable, therefore there is no fear that each blade will slide on a face even if the space distances from the rotation axis C are different from each other. Consequently, in the disc cutter structure, there is no fear that one of the rotary blades 1 and 2 will be worn out earlier than the other. Further, the seal means 7 is provided so as to be adjacent to each of the rotary blades 1 and 2, so that excellent helmeticity is obtained, and resistance against sludge entering the inside of the cutter member is obtained. Meanwhile, the seal means 8 is a labyrinth, therefore it does not become the rotational resistance against the rotary blades 1 and 2, and the mechanical loss can be reduced. Further, the rotary blades 1 and 2 are respectively disposed so as to draw rolling loci of concentric circles which do not overlap one another, therefore when excavating a face, a stone is crushed into the pieces of almost equal sizes, and consequently the excavating efficiency is improved.

Fig. 2 shows a disc cutter structure of a second embodiment related to the present invention. Incidentally, in the embodiment explained in the below, the components which have been already explained in the first embodiment are designated by the identical reference numerals and symbols in the drawing, so that the explanation will be simplified or omitted.

In the disc cutter structure in the second embodiment, rotary blades 11 and 12 are respectively supported rotatably at a support shaft 14 through bearings 13 as in the disc cutter structure in the first embodiment described above. The rotary blades 11 and 12 are engagingly attached to rotary rings 11b and 12b, and have retaining rings 11c and 12c attached at one ends in an axial direction of cutter rings 11a and 12a. In the rotary blades 11 and 12, the cutter rings 11a and 12a, and the rotary rings 11b and 12b can be integrally formed.

In the disc cutter structure of the second embodiment, a retainer 16 is attached between the rotary blades 11 and 12. The retainer 16 is held between two bearings 13 and 13 which are adjacent to each other, and has the function of a spacer for adjusting the space between the cutter rings 11a and 12a. The retainer 16 is provided between the rotary blades 11 and 12, therefore the seal means 17 is provided between the rotary blade 11 and the retainer 16, and is provided between the rotary blade 12 and the retainer 16. The labyrinth 18 is provided between the rotary blade 11 and the retainer 16, and is provided between the rotary blade 12 and the retainer 16.

According to the disc cutter structure in the second embodiment described in the above, which basically has the structure similar to the aforementioned first embodiment, the effect similar to the disc cutter structure in the first embodiment is obtained. Meanwhile, according to the disc cutter structure in the second embodiment, the retainer 16 is provided between the rotary blades 11 and 12 which are independently rotatable, therefore by appropriately replacing the retainer 16, the space between the rotary blades 11 and 12, and the width of the rotary blades 11 and 12 can be more easily and readily changed.

Further, in the embodiment, the space between the

rotary blades 11 and 12 can be adjusted more precisely as compared to the structure in which a plurality of rotary blades 11 and 12 are independently placed one by one in parallel.

Incidentally, the present invention is not limited to each of the embodiments described above, and the materials, shapes, sizes, forms, numbers, locations, and so on of the rotation axis, the support shaft, the cutting member, the rotary blades, the retainers, the seal means, and so on can be freely modified and changed within the range in which the present invention can be attained.

According to the invention described to the details thus far, the disadvantage is eliminated that one of the rotary blades forming the cutting member is worn out earlier than the other as in the conventional art. In addition, according to the present invention, by appropriately selecting the width of the retainer, versatility can be obtained for a plurality of kinds of rotary blades with different width dimensions. Further, according to the present invention, smooth rotations of the rotary blades can be maintained. Furthermore, according to the present invention, sludge can be surely prevented from entering with the mechanical loss being reduced, and a face can be crushed into small pieces and almost equal sizes. According to the present invention, the life of the cutting member can be extended as compared to the conventional machines.

Industrial Availability

The present invention is useful as a disc cutter structure in which the service life of the disc cutter is extended, and an increase in the length in an axial direction caused by dividing the disc cutter dose not occur, the entry of earth and sand, muddy water, and so on is reduced, and the space between the disc cutters can be adjusted precisely at a desired value.

Claims

1. A disc cutter structure including a rotation axis, a support shaft extending in a direction that crosses said rotation axis, and a cutting member through which said support shaft is axially passed, with said cutting member having a plurality of rotary blades which are rotated around said support shaft as the center, wherein each of said rotary blades is rotated independently.

2. The disc cutter structure according to Claim 1, wherein between at least one pair of rotary blades, which are adjacent to each other, of said respective rotary blades, a retainer is provided.

3. The disc cutter structure according to Claim 1, wherein seal means are provided which are adjacent to said respective rotary blades and which prevent the entry of sludge.

4. The disc cutter structure according to Claim 3, wherein said seal means comprise O-rings.

5. The disc cutter structure according to Claim 3, wherein said seal means comprise labyrinths.

6. The disc cutter structure according to Claim 1, wherein a plurality of said cutting members are provided on the same axial line, and said respective rotary blades are disposed to draw rolling loci of concentric circles which do not overlap one another.

7. The disc cutter structure according to Claim 1, wherein said disc cutter structure is applied to a machine for cylindrically excavating a face.

FIG.1

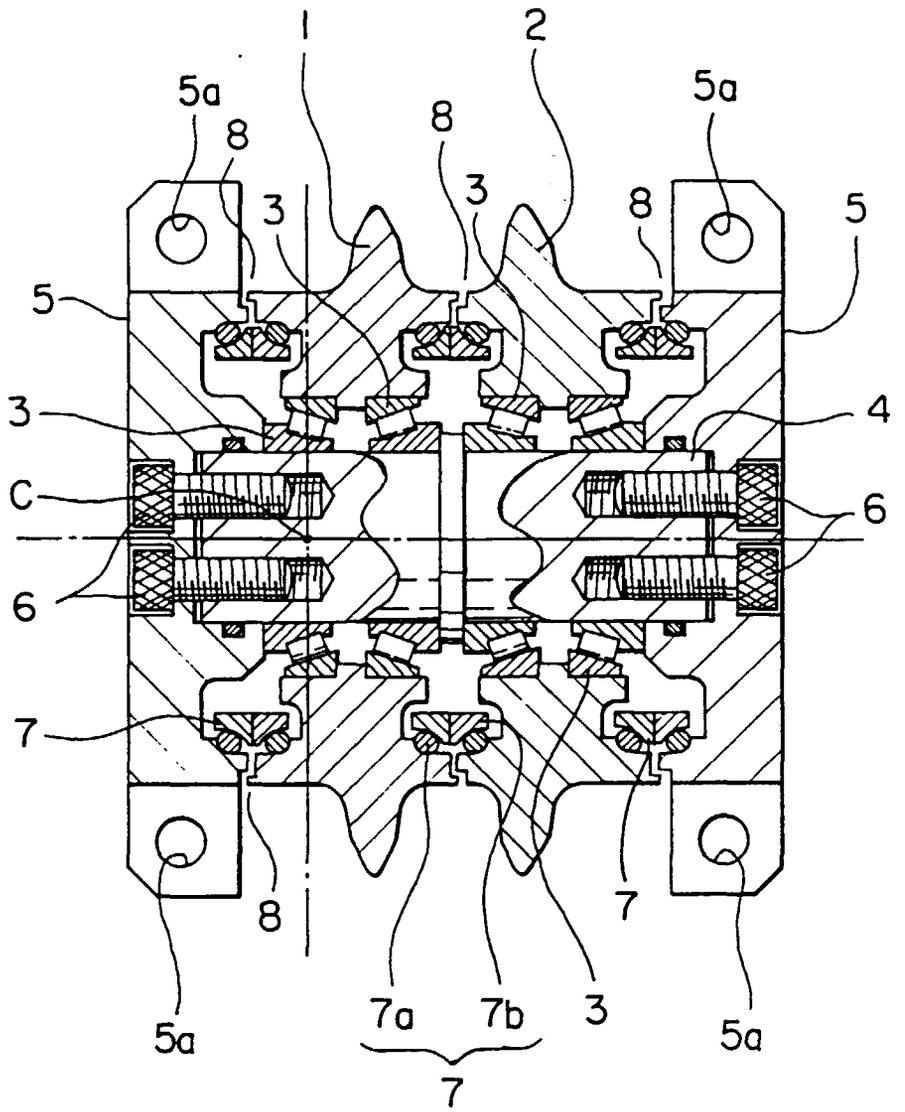


FIG.2

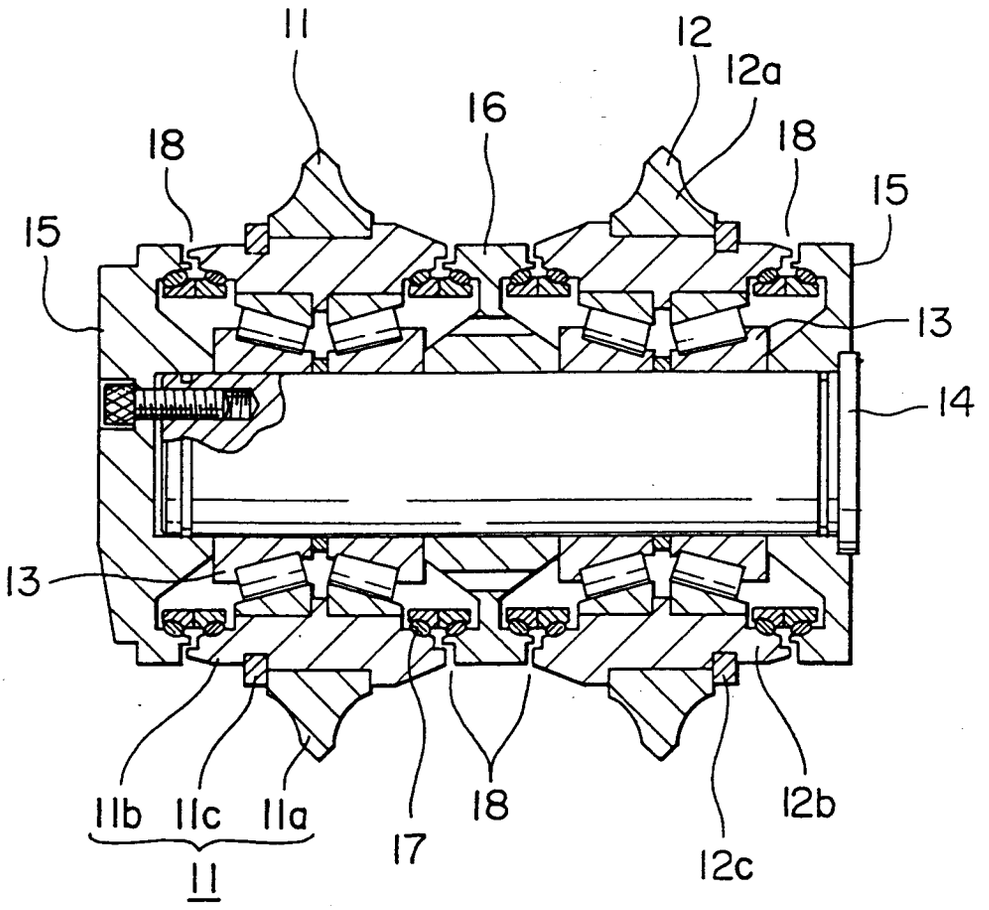


FIG.3 CONVENTIONAL ART

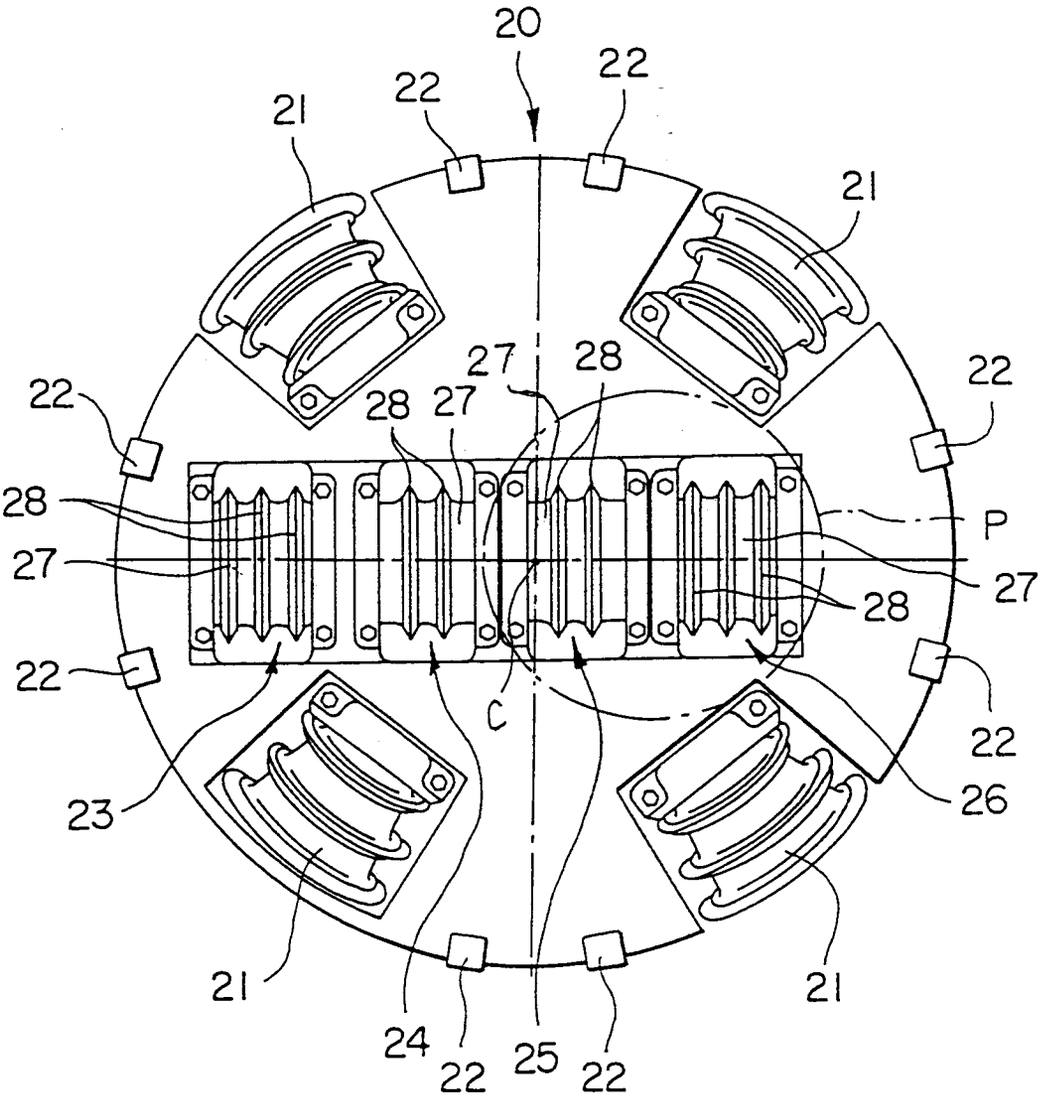


FIG.4 CONVENTIONAL ART

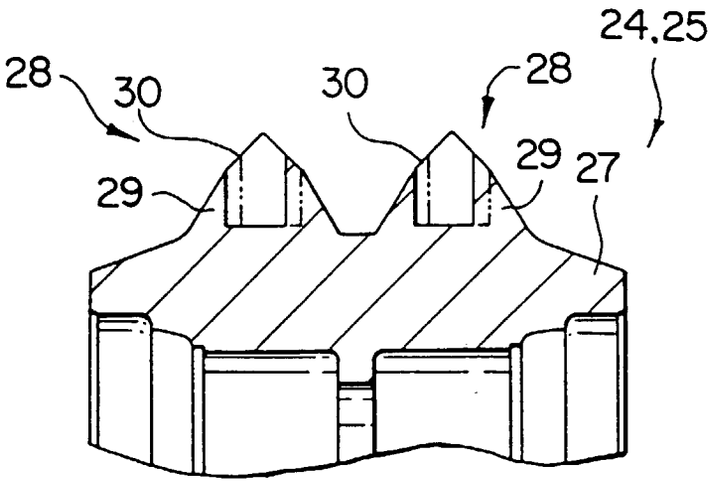
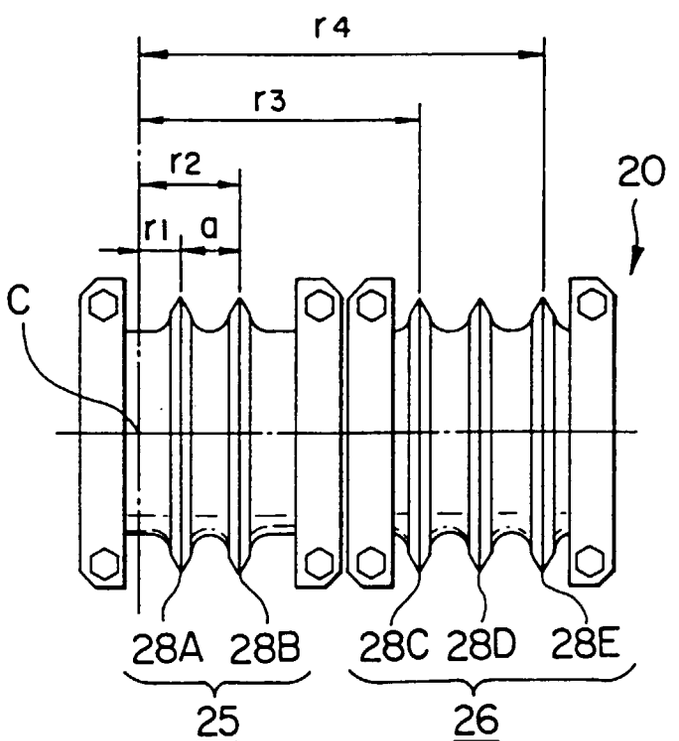


FIG.5 CONVENTIONAL ART



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP96/02062

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl^6 E21D9/10

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^6 E21D9/10

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1926 - 1996
Kokai Jitsuyo Shinan Koho	1971 - 1996
Toroku Jitsuyo Shinan Koho	1994 - 1996

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.
	JP, 54-33802, A (United Kingdom), March 12, 1979 (12. 03. 79),	
X	Claim 4	1
X	Fig. 4	2, 6
X	Page 8, line 20 to page 9, line 6	3, 4
Y	Fig. 4	5
X	Page 3, lines 5 to 15	7
	& IT, 7868192, A0 & SE, 7805939, A & DE, 2822501, A1 & FR, 2392218, A1 & GB, 1584752, A & US, 4298080, A & CH, 632180, A	
Y	JP, 6-67598, U (Komatsu Ltd.), September 22, 1994 (22. 09. 94), Fig. 6 (Family: none)	5

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

* Special categories of cited documents:

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search October 9, 1996 (09. 10. 96)	Date of mailing of the international search report October 22, 1996 (22. 10. 96)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)