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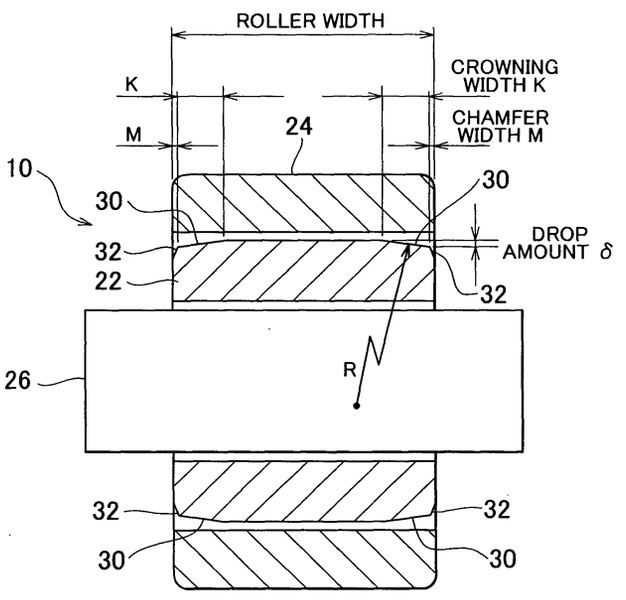
(54) Valve train with roller rocker arm

(57) A roller rocker arm type valve train (10) is provided with an inner roller (22) that is rotatably supported at a roller pin (26) fixed to a rocker arm (12) and an outer roller (24) that is rotatably supported around the inner roller (22) coaxially thereto. In the roller rocker arm type valve train, inclined surfaces (30, 32, 42, 44, 48) are formed on an outer peripheral edge of at least one of an outer circumferential surface of the inner roller (22) and an inner circumferential surface of the outer roller (24) in a predetermined range along a radial direction of the roller.

F I G . 2



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Description

BACKGROUND OF THE INVENTION

1. Field of Invention

[0001] The invention relates to a roller rocker arm type valve train.

2. Description of Related Art

[0002] A roller rocker arm type valve train disclosed in JP-A-2000-34907 is well known as the valve train employed for an internal combustion engine.

[0003] The aforementioned roller rocker arm type valve train includes an inner roller and an outer roller (formed into a double ring structure) which are coaxially supported at a roller pin. An outer circumferential surface of the outer roller is pressed by a cam so as to operate a valve (intake or exhaust valve). This may reduce the friction force generated between the rocker arm (the inner roller and the outer roller) and the cam, thus improving the fuel consumption rate and the like.

[0004] In the valve train to which the above-described roller rocker arm is applied, an alignment error is likely to occur in the process of manufacturing or operating conditions. The contact surfaces of the cam and the outer roller in the axial direction are, thus, relatively inclined to a slight degree. If the cam abuts on the outer roller in the state where both the cam and the outer roller are inclined, the contact surface of the outer roller tends to adapt itself to the contact surface of the cam owing to its high support rigidity. So-called edge loads occur at each end portions of the inner circumferential surface of the outer roller that inclines to adapt to the contact surface of the cam and the outer circumferential surface of the inner roller in the axial direction.

[0005] In case of a thick oil film formed between sliding contact surfaces of the rollers under the operation condition at high speed and low oil temperature, the aforementioned inclination of the outer roller may be covered by the thick oil film. However, in case of a thin oil film formed under the operation condition at low speed and high oil temperature, the inclination of the outer roller cannot be covered by the thin oil film. The frequency of direct contact between the sliding surfaces is increased, thus increasing the friction loss.

SUMMARY OF THE INVENTION

[0006] It is an object of the invention to provide a roller rocker arm type valve train that prevents generation of edge loads by avoiding increase in the frequency of direct contact between contact surfaces of the outer roller and the inner roller so as to reduce the friction loss while maintaining fluid lubrication under an operation condition at low speed and high oil temperature where the oil film formed between the sliding surfaces becomes thin.

[0007] The roller rocker arm type valve train according to the invention is provided with an inner roller that is rotatably supported at a roller pin fixed to a rocker arm and an outer roller that is rotatably supported around the inner roller coaxially thereto. In the roller rocker arm type valve train, an inclined surface is formed on an outer peripheral edge of at least one of an outer circumferential surface of the inner roller and an inner circumferential surface of the outer roller in a predetermined range along a radial direction thereof.

[0008] In the roller rocker arm type valve train as aforementioned, the inner roller and the outer roller are assembled into a double ring structure.

[0009] Assuming that an alignment error has occurred in the process of manufacturing or operation conditions, and contact surfaces of the cam and the outer roller in the axial direction are relatively inclined, in other words, the outer roller is inclined upon its abutment on the cam, the thick oil film formed between the sliding surfaces under the operation condition at high speed and low oil temperature may cover such inclination of the outer roller. Accordingly, the fluid lubrication for the contact surfaces between the outer roller and the inner roller can be maintained.

[0010] Meanwhile, if the oil film is thin under the operation condition at low speed and high oil temperature, the inclination of the outer roller cannot be covered. Accordingly the frequency of the direct contact between the sliding surfaces is increased, thus increasing the friction loss.

[0011] In the roller rocker arm type valve train according to the invention, the inclined surfaces are formed on the outer peripheral edge of at least one of the outer circumferential surface of the inner roller and the inner circumferential surface of the outer roller along the radial direction of the roller such that a total width of the inclined surfaces is within a predetermined range Even if the outer roller is inclined, edge loads in the axial direction at the end portions of the inner circumferential surface of the outer roller and the outer circumferential surface of the inner roller are not increased, preventing the oil film from running out. This makes it possible to maintain the fluid lubrication under the operation condition at low speed and high oil temperature, and to prevent increase in the friction loss owing to the increase in the frequency in the direct contact between the sliding surfaces of the inner and the outer rollers.

[0012] The inclined surfaces formed on at least one of the outer circumferential surface of the inner roller and the inner circumferential surface of the outer roller may be formed as a crowning surface, a tapered surface, a chamfer surface, or an arbitrary combination thereof.

[0013] In the roller rocker arm type valve train according to the invention, the inclined surface is formed such that a total width of the inclined surfaces is in a range between 15% and 45% of an outer diameter of the roller.

[0014] If the width of the inclined surface which is formed on at least one of the outer circumferential sur-

face of the inner roller and the inner circumferential surface of the outer roller is relatively small, the edge loads cannot be sufficiently reduced. Meanwhile if the width of the inclined surface is relatively large, the average surface pressure increases owing to the decrease in the contact width. There may be a concern with respect to the direct contact between the outer and the inner rollers at the portion other than the outer peripheral edge of the roller.

[0015] In the roller rocker arm type valve train according to the invention, the inclined surface is formed such that the total width of the inclined surfaces is in a predetermined range. Accordingly, the significant effect for reducing the friction loss may be obtained.

[0016] In the roller rocker arm type valve train according to the invention, the increase in the frequency of direct contact between the outer and the inner rollers is avoided so as to prevent generation of the edge load as well as to provide the effect for reducing the friction loss while maintaining the fluid lubrication under the operation condition at low speed and high oil temperature where the oil film formed between the sliding surfaces becomes thin.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The foregoing and further objects, features and advantages of the invention will become apparent from the following description of preferred embodiments with reference to the accompanying drawings, wherein like numerals are used to represent like elements and wherein:

Fig. 1 is a front view showing a structure of a roller rocker arm type valve train according to an embodiment of the invention;

Fig. 2 is a sectional view taken along lines 2-2 of Fig. 1, showing a structure of a main portion of the roller rocker arm type valve train according to the embodiment of the invention;

Fig. 3 is a graph showing a relationship between an oil temperature and a friction loss at a slide bearing;

Fig. 4 is a graph showing a relationship between a width of an inclined surface formed on the roller and the friction force;

Fig. 5 is a sectional view corresponding to Fig. 2, showing another example of the inclined surface of the roller rocker arm type valve train according to the invention; and

Fig. 6 is a sectional view corresponding to Fig. 2, showing another example of the inclined surface of the roller rocker arm type valve train according to the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0018] Fig. 1 is a front view showing a structure of a roller rocker arm type valve train 10 according to an embodiment of the invention. Fig. 2 is a sectional view taken along lines 2-2 of Fig. 1 showing the roller rocker arm type valve train 10.

[0019] The roller rocker arm type valve train 10 is provided with a rocker arm 12 having one end portion supported at a pivot portion 14 such that the other top portion is moveable up and down. A pressure portion 16 at the top portion of the rocker arm 12 abuts on a cap 20 crowned on an axial top portion of a valve 18 (for example, an intake valve or an exhaust valve).

[0020] An inner roller 22 and an outer roller 24 are attached to the center of the rocker arm 12 in the longitudinal direction. The inner roller 22 is rotatably supported at a roller pin 26 fixed to the rocker arm 12. The outer roller 24 is rotatably supported around the inner roller 22 coaxially thereto. The inner roller 22 and the outer roller 24 are assembled into a double ring structure. The outer roller 24 is disposed to be in contact with a cam 28 that presses the outer circumferential surface of the outer roller 24. The pressure portion 16 of the rocker arm 12 then applies a pressure force to the cap 20 crowned on the valve 18 so as to be operated.

[0021] Referring to Fig. 2, crowning surfaces 30 as the inclined surface are formed on the outer peripheral edge of the outer circumferential surface of the inner roller 22 in a predetermined range along the roller radial direction. Chamfers 32 are further formed at edge portions of the crowning surfaces 30, respectively.

[0022] In the roller rocker arm type valve train of the embodiment, the curvature R of the crowning surface 30 is approximately 30 mm. The total width of the width K of the crowning surface 30 and the width M of the chamfer 32 is 33% of the outer diameter of the inner roller 22 with the cut amount δ of the crowning surface 30 of approximately 0.024 mm.

[0023] Operations of the roller rocker arm type valve train according to the embodiment of the invention will be described hereinafter.

[0024] The roller rocker arm type valve train 10 includes the inner roller 22 and the outer roller 24 which are assembled into a double ring structure.

[0025] Assuming that the axial contact surfaces of the cam 28 and the outer roller 24 are relatively inclined owing to an alignment error that has occurred in the process of manufacturing or operating conditions, that is, the outer roller 24 is inclined upon its abutment on the cam 28, if the oil film formed between the sliding surfaces is thick under the operation condition at high speed and low oil temperature, such inclination of the outer roller 24 may be covered by the oil film. Accordingly, the fluid lubrication between the outer roller 24 and the inner roller 22 may be maintained.

[0026] Meanwhile, if the oil film is thin in the aforementioned state under the operation condition at low speed and high oil temperature, the thin oil film cannot cover the inclination of the outer roller 24. The frequency of direct contact between the sliding surfaces of the outer

and the inner rollers is increased, thus increasing the friction loss. Fig. 3 shows the experimental results representing the increase in the friction loss as increase in the oil temperature.

[0027] In the roller rocker arm type valve train 10 according to the invention, the crowning surfaces 30 and the chamfers 32 that form the inclined surface are made on the outer peripheral edge of the outer circumferential surface of the inner roller 22 in the predetermined range along the roller radial direction. If the outer roller 24 is inclined, each edge load at the axial ends of the inner circumferential surface of the outer roller 24 and the outer circumferential surface of the inner roller 22 is not increased, preventing the oil film from running out. This makes it possible to maintain the fluid lubrication under the operation condition at low speed and high oil temperature while keeping the friction resistance as the advantageous feature of the slide bearing. Accordingly the increase in the friction loss owing to the increase in the frequency of direct contact between the sliding surfaces of the outer and the inner rollers may be prevented.

[0028] If the width of the inclined surface (the crowning surface 30 and the chamfer 32) is relatively small, the edge load cannot be reduced sufficiently. Meanwhile, if the width of the inclined surface is relatively large, the average surface pressure is increased owing to the decrease in the contact width. There may be a concern with respect to the direct contact at the portion other than the outer peripheral edge. It is preferable to form the inclined surface such that the total width thereof is in the range between 15% and 45% of the outer diameter of the roller. Fig. 4 shows the experimental results with respect to the influence of the change in the width of the inclined surface (the crowning surface 30) to the friction force. The significant friction loss reducing effect may be obtained especially when the total width of the inclined surface (crowning surface, tapered surface, chamfer surface) is in the range between 15% and 45% of the outer diameter of the roller.

[0029] In the roller rocker arm type valve train as aforementioned, the crowning surfaces 30 and chamfers 32 at both edge portions thereof are formed as the inclined surface. However, the chamfers 32 do not have to be necessarily provided.

[0030] In the roller rocker arm type valve train as described above, the crowning surfaces 30 as the inclined surface are formed on the outer circumferential surface of the inner roller 22. However, the inclined surface may be formed on the inner circumferential surface of the outer roller 24. Alternatively, the crowning surfaces 30 may be formed both on the outer circumferential surface of the inner roller 22 and the inner circumferential surface of the outer roller 24, respectively by setting the cut amount δ to half.

[0031] The inclined surface may include not only the crowning surfaces 30 but also simple tapered surfaces, chamfer surfaces, or arbitrary combinations thereof.

[0032] Referring to Fig. 5, the inclined surface may include tapered surfaces 42 and chamfers 44 formed on the outer circumferential surface of an inner roller 40 at an inclined angle of θ and the cut amount of δ. Alternatively as shown in Fig. 6, only tapered surfaces 48 are formed on the outer circumferential surface of an inner roller 46 as the inclined surface at an inclined angle of θ and the cut amount of δ.

Claims

1. A roller rocker arm type valve train (10) including an inner roller (22) that is rotatably supported at a roller pin (26) fixed to a rocker arm (12) and an outer roller (24) that is rotatably supported around the inner roller coaxially thereto, **characterized in that** inclined surfaces are formed on an outer peripheral edge of at least one of an outer circumferential surface of the inner roller (22) and an inner circumferential surface of the outer roller (24) in a predetermined range along a radial direction of the roller.

2. The roller rocker arm type valve train according to claim 1, **characterized in that** the inclined surface comprises at least one of a crowning surface (30), a tapered surface (42, 48), a chamfer surface (32, 44), and combinations thereof.

3. The roller rocker arm type valve train according to claim 1 or 2, **characterized in that** the inclined surface is formed such that a total width of the inclined surface is in a range between 15% and 45% of an outer diameter of the roller.

FIG. 1

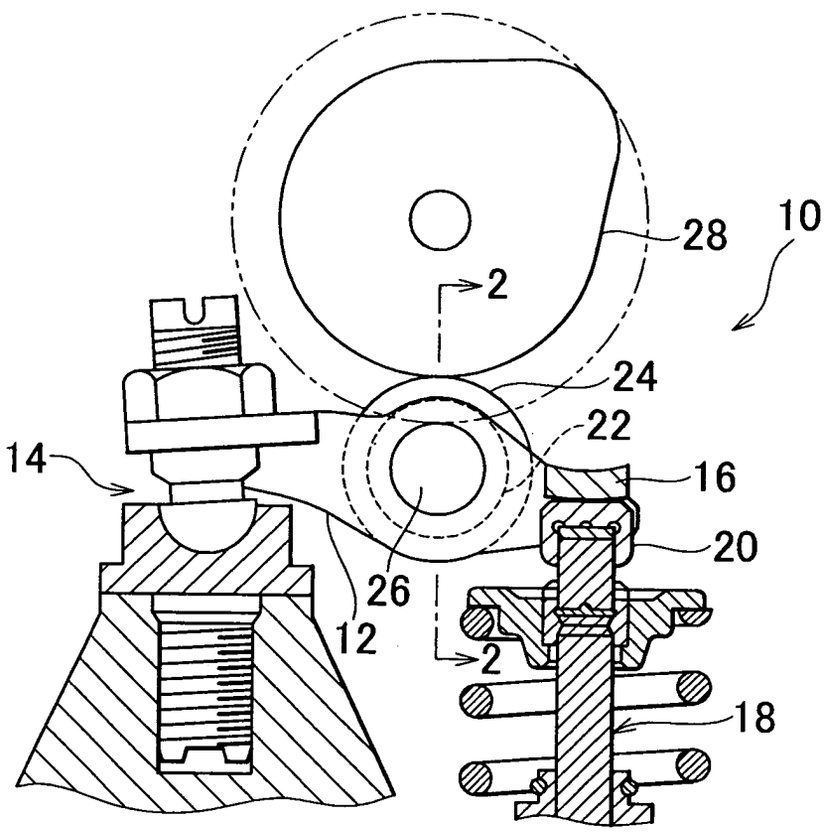


FIG. 2

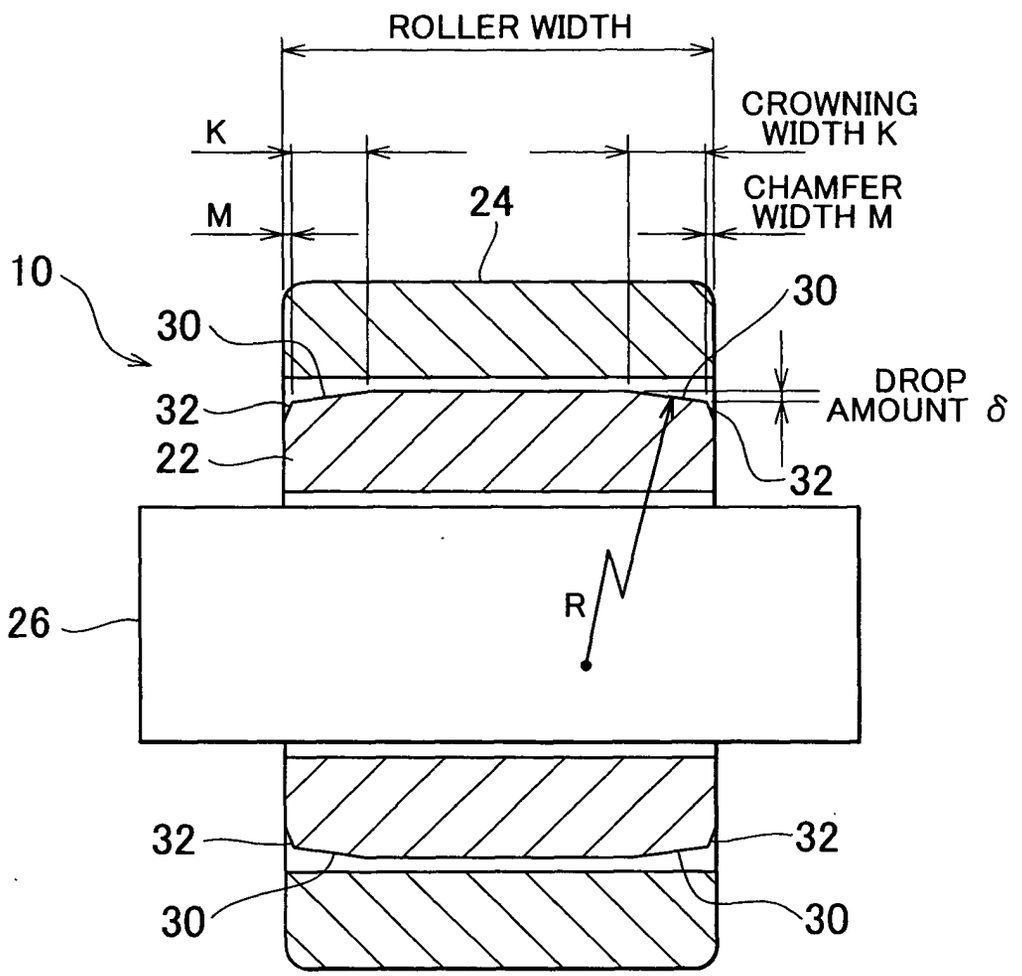

ROLLER WIDTH
K
CROWNING WIDTH K
M
CHAMFER WIDTH M
24
10
30
30
DROP AMOUNT δ
32
22
32
R
26
32
32
30
30

FIG. 3

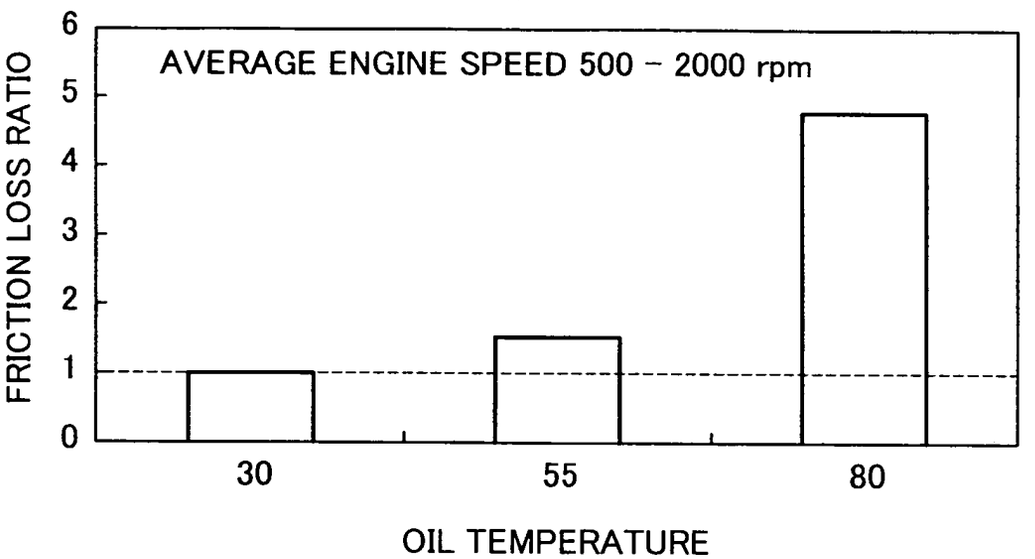

AVERAGE ENGINE SPEED 500 - 2000 rpm
FRICTION LOSS RATIO
0
1
2
3
4
5
6
30
55
80
OIL TEMPERATURE

FIG. 4

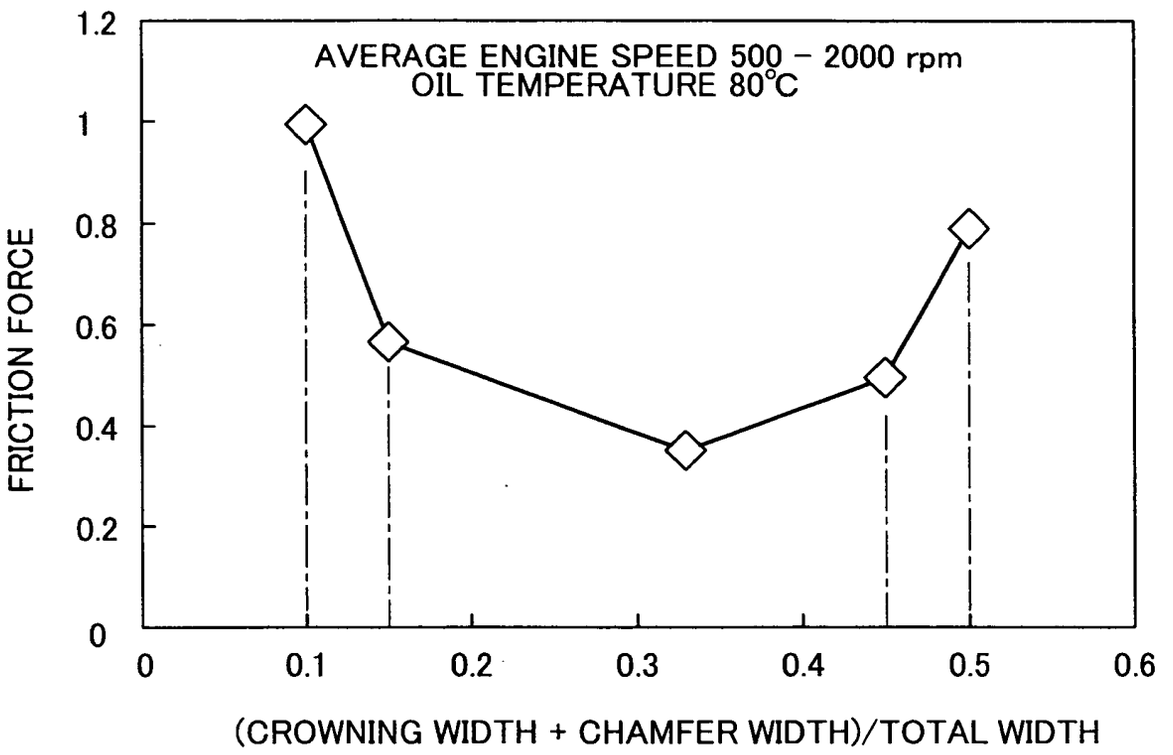

AVERAGE ENGINE SPEED 500 – 2000 rpm
OIL TEMPERATURE 80°C
FRICTION FORCE
1.2
1
0.8
0.6
0.4
0.2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
(CROWNING WIDTH + CHAMFER WIDTH)/TOTAL WIDTH

FIG. 5

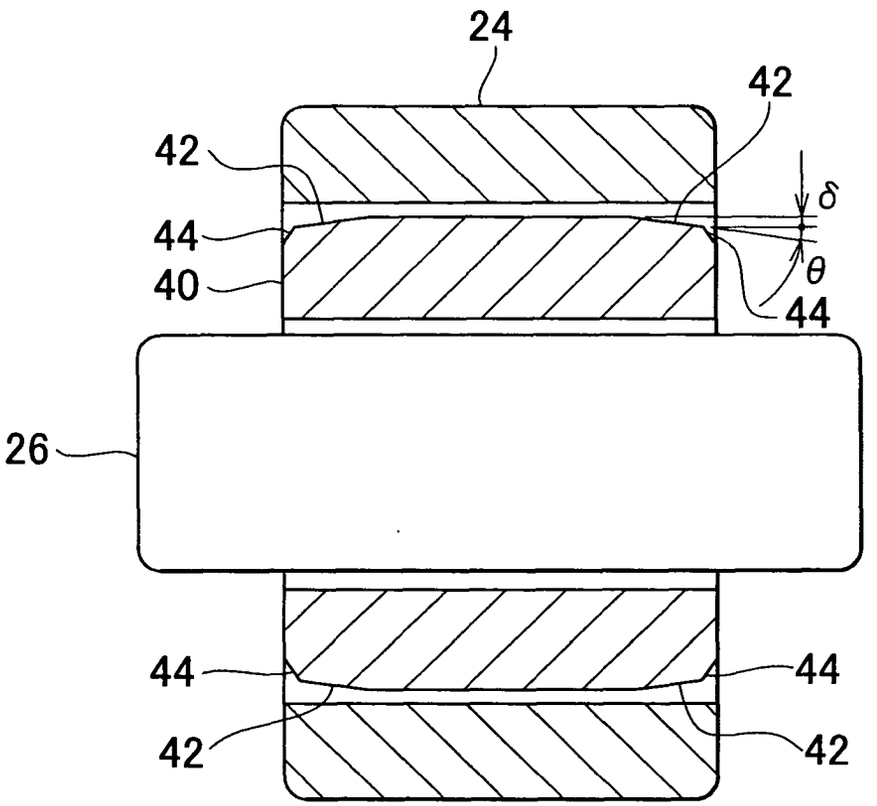
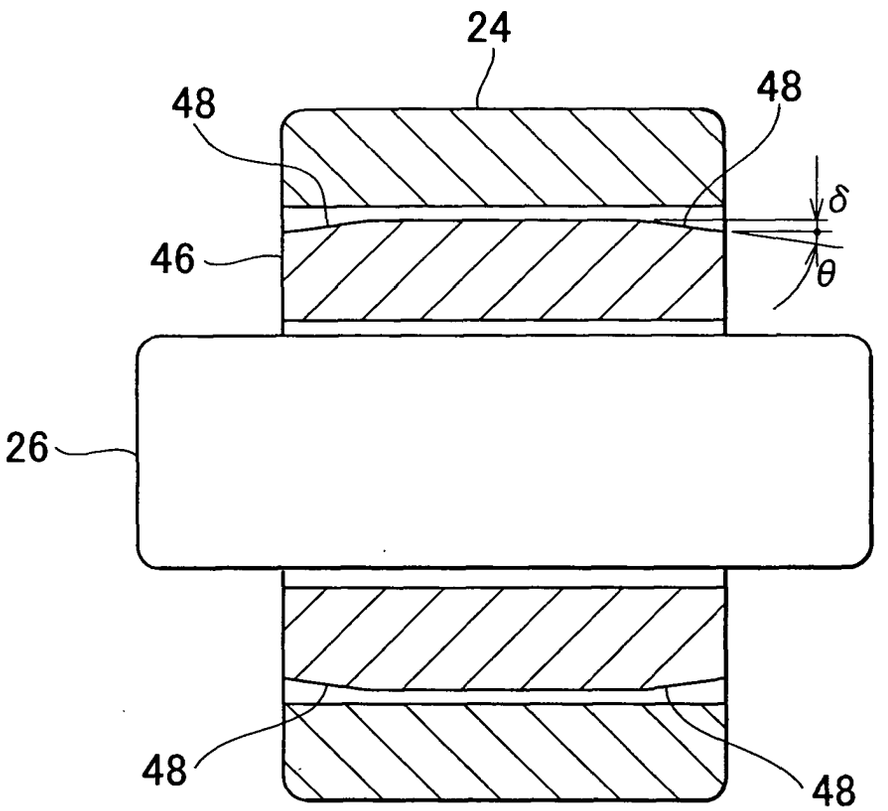


FIG. 6



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 00 4843

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	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 05, 14 September 2000 (2000-09-14) & JP 2000 034907 A (NIPPON SEIKO KK), 2 February 2000 (2000-02-02) * abstract * * figures *	1-3	F01L1/18
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A	US 5 259 346 A (MILLS ET AL) 9 November 1993 (1993-11-09) * figures 4,5 *	1-3	
A	EP 1 314 860 A (NTN CORPORATION) 28 May 2003 (2003-05-28) * figures 19b,29b *	1-3	
A	DE 195 49 223 A1 (ROBERT BOSCH GMBH, 70469 STUTTGART, DE) 3 July 1997 (1997-07-03) * figures 4,5 *	1-3	TECHNICAL FIELDS SEARCHED (Int.Cl.7) F01L
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	13 June 2005	Paulson, B

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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