

ISO 1132-2:2001(E)

ICS 21.100.20

Price based on 48 pages

© ISO 2001 – All rights reserved

Rolling bearings — Tolerances —

Part 2:

**Measuring and gauging principles
and methods**

Roulements — Tolérances —

Partie 2: Principes et méthodes de mesurage et de vérification par calibre



PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

© ISO 2001

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

Contents

Page

Foreword	iv
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
4 Symbols	2
5 General conditions	4
6 Measuring and gauging principles and methods	7
7 Principles of measuring bore diameter	8
8 Principles of measuring outside diameter	14
9 Principles of measuring width and height	17
10 Principles of measuring ring and washer chamfer dimension	24
11 Principles of measuring raceway parallelism	26
12 Principles of measuring surface perpendicularity	28
13 Principles of measuring thickness variation	32
14 Principles of measuring radial runout	37
15 Principles of measuring axial runout	42
16 Principles of measuring radial clearance	45
Annex A (normative) Cross-reference to clauses in ISO 1132-1	47

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 1132 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 1132-2 was prepared by Technical Committee ISO/TC 4, *Rolling bearings*.

This first edition of ISO 1132-2 cancels and replaces ISO/TR 9274:1991, in the form of a technical revision thereof.

ISO 1132 consists of the following parts, under the general title *Rolling bearings — Tolerances*:

- *Part 1: Terms and definitions*
- *Part 2: Measuring and gauging principles and methods*

Annex A forms a normative part of this part of ISO 1132.

Rolling bearings — Tolerances —

Part 2:

Measuring and gauging principles and methods

1 Scope

This part of ISO 1132 establishes guidelines for measurement of dimensions, running accuracy and internal clearance of rolling bearings. The purpose is to outline the fundamentals of various measuring and gauging principles which may be used in order to clarify and comply with the definitions of ISO 1132-1 and ISO 5593.

The measuring and gauging methods described in this part of ISO 1132 may differ amongst themselves and do not provide for a unique interpretation. It is recognized that there are other adequate measuring and gauging methods and that technical development may result in even more convenient methods. Therefore, this part of ISO 1132 does not imply any obligation to apply any particular method. However, the methods specified may be referred to in cases of dispute.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 1132. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 1132 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 1:1975, *Standard reference temperature for industrial length measurements.*

ISO 76:1987, *Rolling bearings — Static load ratings.*

ISO 104:—¹⁾, *Rolling bearings — Thrust bearings — Boundary dimensions, general plan.*

ISO 286-2:1988, *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts.*

ISO 1132-1:2000, *Rolling bearings — Tolerances — Part 1: Terms and definitions.*

ISO 3030:1996, *Rolling bearings — Radial needle roller and cage assemblies — Dimensions and tolerances.*

ISO 3031:2000, *Rolling bearings — Thrust needle roller and cage assemblies, thrust washers — Boundary dimensions and tolerances.*

ISO 3245:1997, *Rolling bearings — Needle roller bearings, drawn cup without inner rings — Boundary dimensions and tolerances.*

1) To be published. (Revision of ISO 104:1994)

ISO 4291:1985, *Methods for the assessment of departure from roundness — Measurement of variations in radius.*

ISO 5593:1997, *Rolling bearings — Vocabulary.*

ISO 15241:2001, *Rolling bearings — Symbols for quantities.*

3 Terms and definitions

For the purpose of this part of ISO 1132, the terms and definitions given in ISO 1132-1 and ISO 5593 apply. The following additional terms and definitions are used throughout this part of ISO 1132. An index of methods with their respective symbols, as specified in ISO 1132-1, is included in annex A.

3.1

measurement

set of operations having the object of determining the dimension(s) or variation of a feature

3.2

gauge

device of defined geometric form and size used to assess the conformance of a feature of a work piece to a dimensional specification.

NOTE The device could give only “GO” and/or “NOT GO” information (e.g. plug gauge).

3.3

gauging

inspection of size and/or form by means of a gauge

3.4

measuring and gauging principle

fundamental geometric basis for the measurement or gauging of the considered geometric characteristic

3.5

measuring and gauging method

practical application of a principle by the use of different types of measuring and gauging equipment and operations

3.6

measuring and gauging equipment

technical device used to perform a specific method of measuring (e.g. calibrated indicator)

3.7

measuring force

force applied by the stylus of an indicator or a recorder to the feature being measured

3.8

measuring load

external force applied to the specimen being measured in order to accomplish the measurement

4 Symbols

For the purposes of this part of ISO 1132, the symbols given in ISO 15241 and the following apply.

The symbols (except those for tolerances) shown in the figures and the values given in the tables denote nominal dimensions unless specified otherwise. Additionally, the drawing symbols given in Table 1 are applied throughout this part of ISO 1132.

Table 1 — Drawing symbols

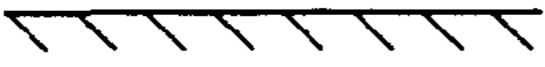

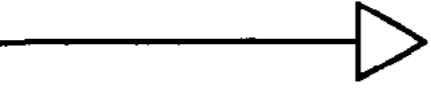
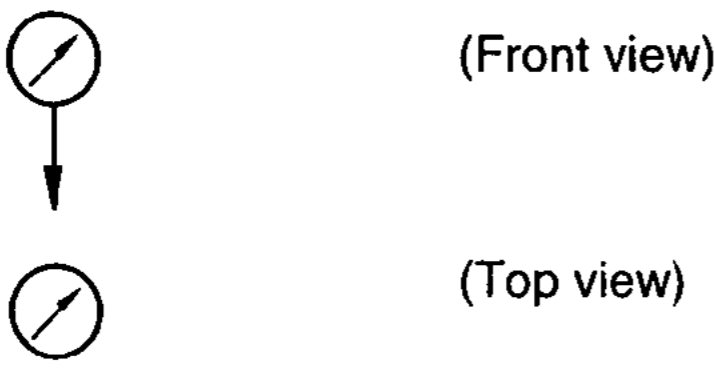
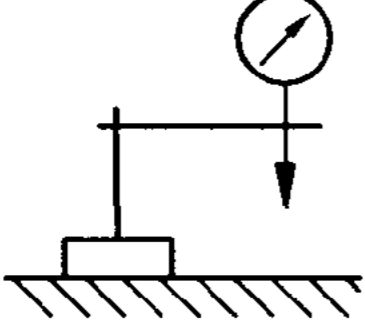
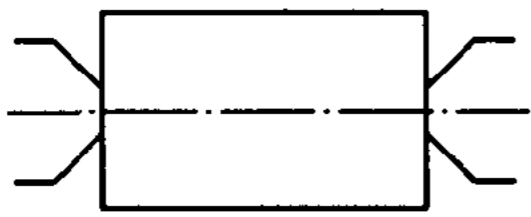
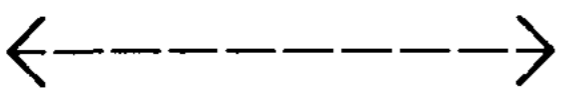
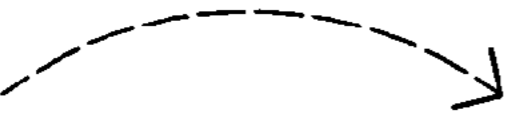
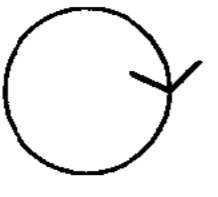

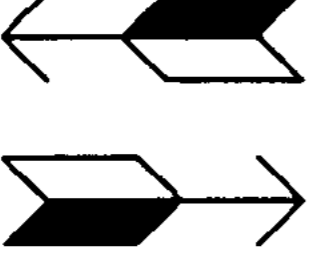
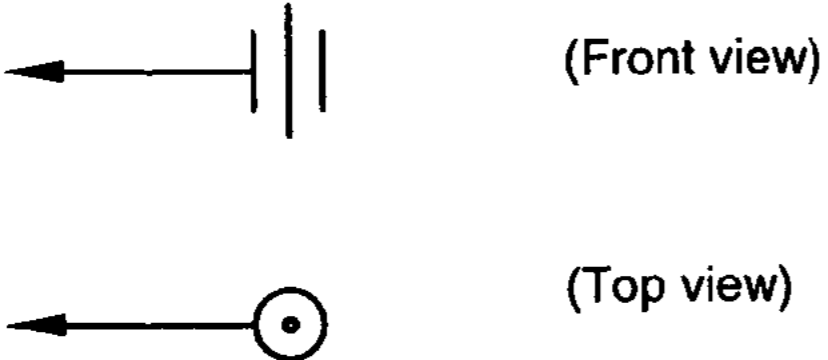
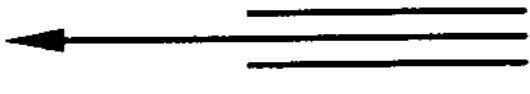
Symbol	Interpretation
	Surface plate (measuring plane)
	Fixed support
	Fixed gauge support
	Indicator or recorder
	Measuring stand with indicator or recorder Symbols for measuring stands can be drawn in different ways in accordance with the measuring equipment used.
	Centred arbor
	Intermittent linear traverse
	Turning against fixed support(s)
	Rotation about centre
	Loading, direction of loading
	Loading alternately in opposite directions

Table 1 — Drawing symbols (continued)

Symbol	Interpretation
 <p>(Front view)</p> <p>(Top view)</p>	Movable support for indicator moving perpendicular to the measured surface
	Movable support for indicator moving parallel to (along) the measured surface

5 General conditions

5.1 Measuring equipment

Measurements of the various dimensions, runouts and clearances can be performed on different types of measuring equipment and with differing degrees of accuracy. The principles described are commonly used by bearing manufacturers and users and generally they provide an accuracy sufficient for practical purposes. It is recommended that the total measuring inaccuracy should not exceed 10 % of the actual tolerance zone. However, the measuring and gauging methods may not always fully check the indicated requirements. Whether or not such methods are sufficient and acceptable depends on the magnitude of the actual deviations from the ideal dimension or form and the inspection circumstances.

Bearing manufacturers frequently use specially designed measuring equipment for individual components, as well as for assemblies, to increase speed and accuracy of measurement. Should the dimensional or geometrical errors appear to exceed those in the relevant specifications, when using equipment as indicated in any of the methods in this part of ISO 1132, the matter should be referred to the bearing manufacturer.

5.2 Masters and indicators

Dimensions are determined by comparing the actual component with appropriate gauge blocks or masters whose calibration is traceable through national standards organizations to the length of the international prototype as defined in ISO 1. For such comparison, a calibrated indicator of appropriate sensitivity is used.

5.3 Arbors

In all cases when the arbor method of measuring runout is used, the rotational accuracy of the arbor shall be determined so that subsequent bearing measurements may be suitably corrected for any appreciable arbor inaccuracy. A precision arbor having a taper of approximately 0,000 2:1 on diameter shall be used.

In cases when an arbor is used to measure the bore diameter of a roller complement, a precision arbor having a taper of approximately 0,000 5:1 on diameter shall be used.

5.4 Temperature

Before any measurements are made, the part to be measured, the measuring equipment and master shall be brought to the temperature of the room in which the measurements are to be made. The recommended room temperature is 20 °C, see ISO 1. Care shall be taken to avoid heat transfer to the component or assembled bearing during measurement.

5.5 Measuring force and radius of measuring stylus

To avoid undue deflection of thin rings, the measuring force shall be minimized. If significant distortion is present, a load deflection factor shall be introduced to correct the measured value to the free unloaded value. The maximum measuring force and minimum radius of the measuring stylus are given in Table 2.

Table 2 — Maximum measuring forces and minimum radii of measuring stylus

Bearing feature	Nominal size range mm		Measuring force ^a N max.	Stylus radius ^b mm min.
	>	≤		
Bore diameter <i>d</i>	—	10	2	0,8
	10	30	2	2,5
	30	—	2	2,5
Outside diameter <i>D</i>	—	30	2	2,5
	30	—	2	2,5

^a The maximum measuring force is intended to give repeatable measurements without distortion of the specimen. Where distortion occurs, a lower measuring force may be used.

^b Smaller radii may be used with an appropriate reduction in the measuring force applied.

5.6 Coaxial measuring load

To maintain bearing assemblies in their proper relative positions, the coaxial measuring load given in Tables 3 and 4 should be applied for the methods where specified.

Table 3 — Coaxial measuring loads for radial ball bearings and angular contact ball bearings with contact angles ≤ 30°

Outside diameter mm		Coaxial load on the bearing N min.
>	≤	
—	30	5
30	50	10
50	80	20
80	120	35
120	180	70
180	—	140

Table 4 — Coaxial measuring loads for tapered roller bearings, angular contact ball bearings with contact angles $> 30^\circ$ and thrust bearings

Outside diameter mm		Coaxial load on the bearing N
>	\leq	min.
—	30	40
30	50	80
50	80	120
80	120	150
120	—	150

5.7 Measurement zone

The limits for deviations of a bore or an outside diameter are applicable to measurements in radial planes situated at a distance greater than “ a ” from the side face or flange face of the ring. The values of “ a ” are given in Table 5.

Only the maximum material size applies outside the measurement zone.

Table 5 — Measurement zone limits

Dimensions in millimetres

$r_{s \text{ min}}$		a
>	\leq	
—	0,6	$r_{s \text{ max}} + 0,5$
0,6	—	$1,2 \times r_{s \text{ max}}$

5.8 Preparation before measuring

Any grease or corrosion inhibitor adhering to the bearing shall be removed if it is likely to affect the measured results. Before measuring, the bearing should be lubricated with a low viscosity oil.

The accuracy of measurements may be adversely affected for pre-lubricated bearings and some designs of sealed and shielded bearings. To eliminate any discrepancy, the measurements shall be made with open bearings, i.e. after removing the seals/shields and/or lubricant.

NOTE Immediately after completion of the measurements, the bearing should be protected with a corrosion inhibitor.

5.9 Reference face for measurements

The reference face is designated by the bearing manufacturer and is usually the datum for measurements.

NOTE The reference face for the measurement of a ring is generally taken as the unmarked face. In the case of symmetrical rings when it is not possible to identify the reference face, the tolerances are deemed to apply relative to either face.

The reference face of a shaft washer and housing washer of a thrust bearing is that face intended to support axial load and is generally opposite the raceway.

In the case of single-row angular contact ball bearing rings and tapered roller bearing rings, the reference face is the "back face" which is intended to support axial load.

For bearings with flanged outer rings, the reference face is the flange face intended to support axial load.

6 Measuring and gauging principles and methods

6.1 General

Principles for measuring and gauging are shown for the applicable definitions in ISO 1132-1. Methods are described as they apply to various bearing types in clauses 7 to 16 of this part of ISO 1132. Where more than one method is shown, a primary method is identified. Many terms in ISO 1132-1 are derivatives of measured features and they are so identified in the comments.

Measurements of geometrical accuracy (e.g. deviation from circular, cylindrical and spherical form) are as specified in ISO 4291.

6.2 Format of clauses

The format of clauses 7 to 16 is arranged in three parts.

- a) The title identifying the principle and method including the clause numbering.
- b) The left hand column entitled "Method" shows:
 - a figure illustrating the method;
 - essential characteristics of the method;
 - the readings to be taken;
 - required repetitions.
- c) The right hand column entitled "Comments" is used for supplementary information, e.g.:
 - a particular application;
 - any restrictions in application;
 - any particular sources of error;
 - any particular requirements as to equipment;
 - examples of equipment;
 - treatment of readings obtained.

6.3 Caution

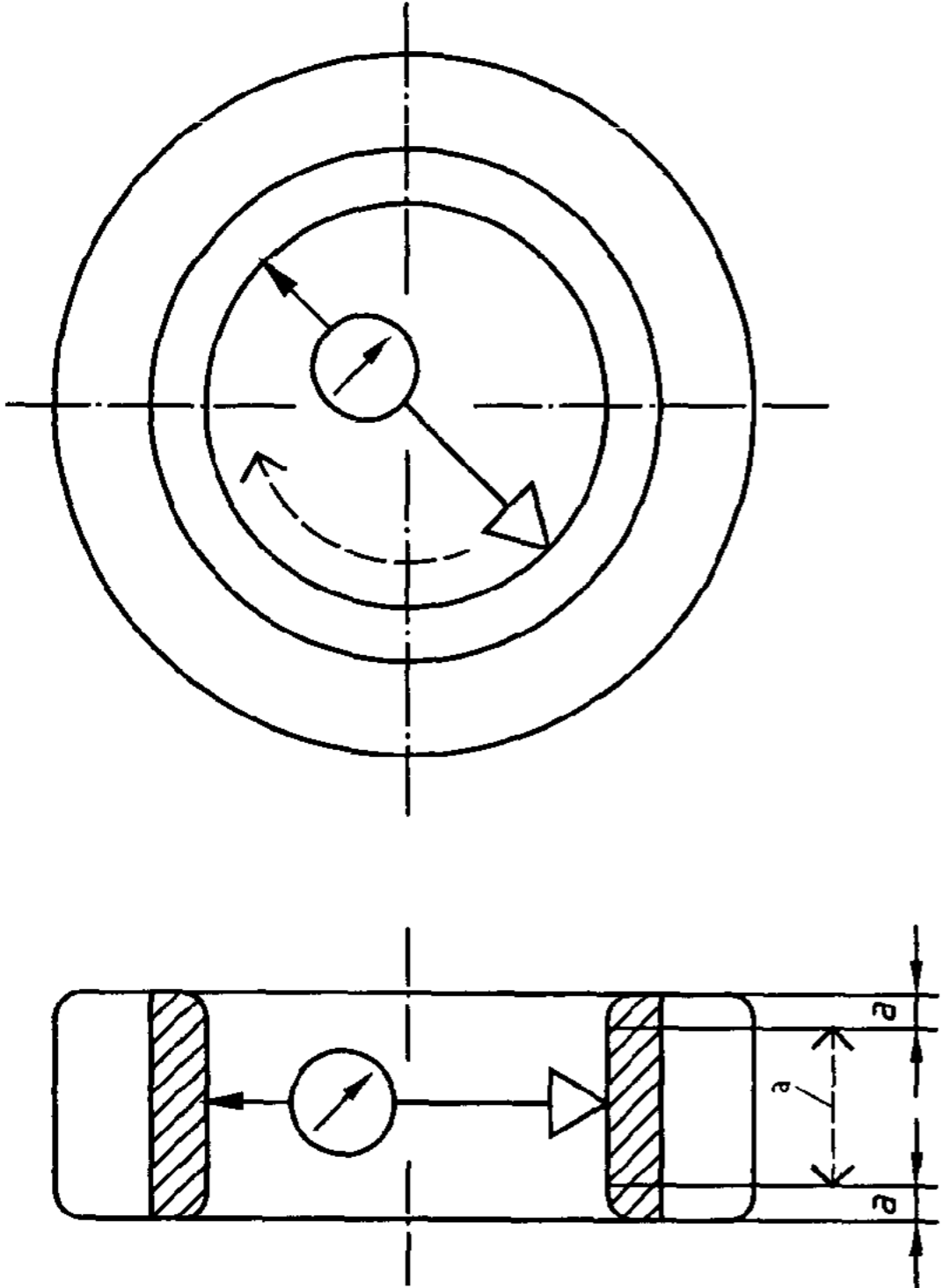
Consideration has not been given to the influence of the accuracy and design of the measuring equipment or to the skill of the operator. These factors sometimes have a significant influence on the resulting measurement or gauged assessment.

The measuring and gauging principles and methods are not illustrated in detail and are not intended for application on end-product drawings.

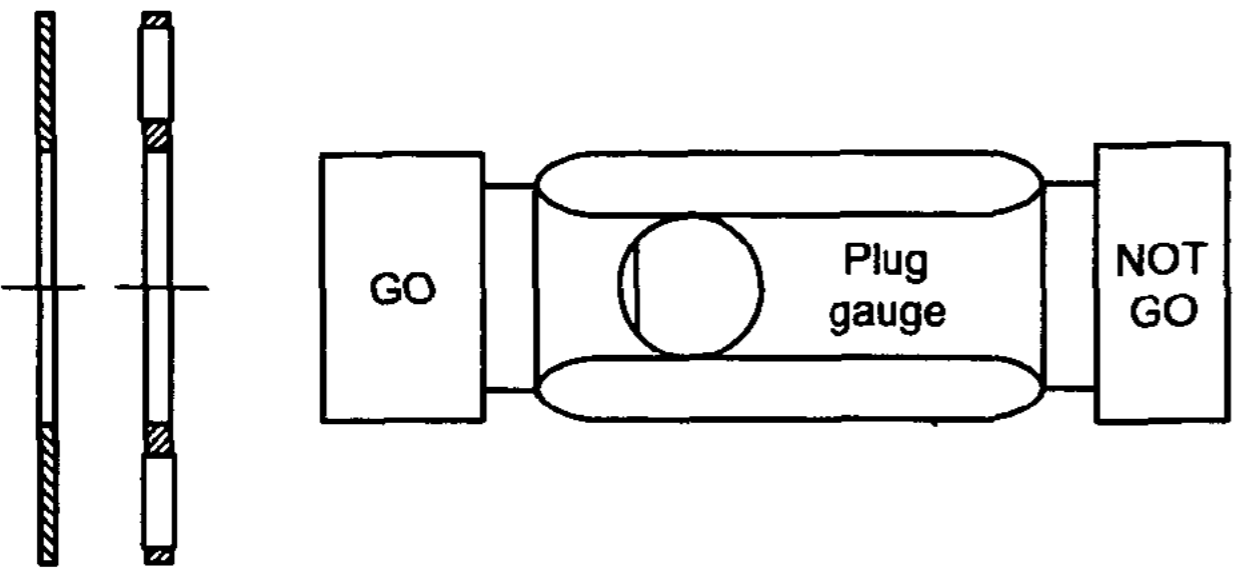
The order of presentation of measuring and gauging principles and methods shall not be regarded as a classification of priority within the prescribed type of measurements.

7 Principles of measuring bore diameter

7.1 Measurement of single bore diameter

Method	Comments
<div style="text-align: center;">  </div> <p>a Measuring zone</p> <p>Zero the gauge indicator to the appropriate size using gauge blocks or a master ring.</p> <p>In several angular directions and in a single radial plane, measure and record the largest and the smallest single bore diameters, $d_{sp\ max}$ and $d_{sp\ min}$, within the measuring zone as specified in 5.7.</p> <p>Repeat angular measurements and recordings in several radial planes to determine the largest and the smallest single bore diameter of an individual ring, $d_{s\ max}$ and $d_{s\ min}$.</p>	<p>This method is applicable to all types of rolling bearing rings, shaft washers and central washers.</p> <p>The single bore diameter, d_{sp} or d_s, is measured directly from the indicator.</p> <p>This method is also applicable in measuring a separable cylindrical or needle roller bearing outer ring bore diameter, providing the gauge point clear the raceway lead-in chamfers.</p> <p>The bearing ring or washer shall be placed with the axis in a vertical position in order to avoid the influences of gravity.</p> <p>The following are arithmetically based on the measurements of $d_{sp\ max}$ and $d_{sp\ min}$:</p> <ul style="list-style-type: none"> d_{mp} mean bore diameter in a single plane; Δ_{dmp} deviation of mean bore diameter in a single plane; V_{dsp} variation of bore diameter in a single plane; V_{dmp} variation of mean bore diameter. <p>The following are arithmetically based on the measurements of d_s, $d_{s\ max}$ and $d_{s\ min}$:</p> <ul style="list-style-type: none"> d_m mean bore diameter; Δ_{dm} deviation of mean bore diameter; Δ_{ds} deviation of a single bore diameter; V_{ds} variation of bore diameter.

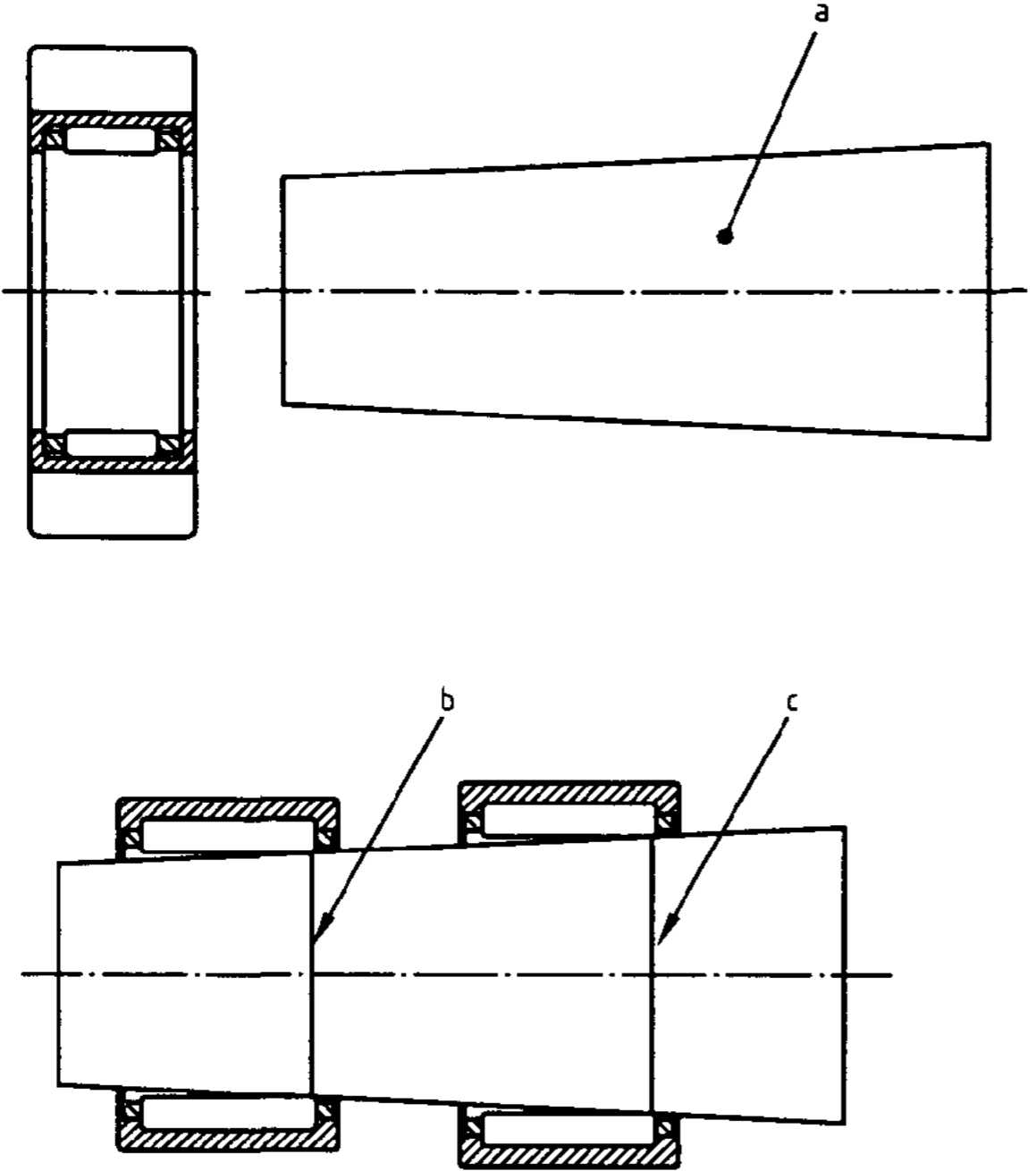
7.2 Functional gauging of smallest single bore diameter of thrust needle roller and cage assembly and thrust washer

Method	Comments
 <p>The bore diameter of a free thrust needle roller and cage assembly or free thrust washer is gauged with GO and NOT GO plug gauges.</p> <p>The GO plug gauge size is the thrust needle roller and cage assembly or thrust washer minimum bore diameter, $d_{CS \text{ min}}$ or $d_{S \text{ min}}$, respectively, as specified in ISO 3031.</p> <p>The NOT GO plug gauge size is the thrust needle roller and cage assembly or thrust washer maximum bore diameter specified in ISO 3031.</p>	<p>This method is applicable to thrust needle roller and cage assemblies and thrust washers specified in ISO 3031.</p> <p>This method may also be used to gauge the smallest bore diameter of housing washers, $D_{1s \text{ min}}$, specified in ISO 104.</p> <p>The assembly or washer shall fall freely from the GO plug gauge under its own weight.</p> <p>The NOT GO plug gauge should not enter the bore of the assembly or washer. Where the NOT GO plug gauge can be forced through the bore, the assembly or washer shall not fall from the gauge under its own weight.</p> <p>Plug gauges are used to verify the limits of size and do not directly measure the bore diameter.</p> <p>NOTE The thrust needle roller and cage assembly and corresponding thrust washer require different plug gauges due to their respective tolerances.</p>

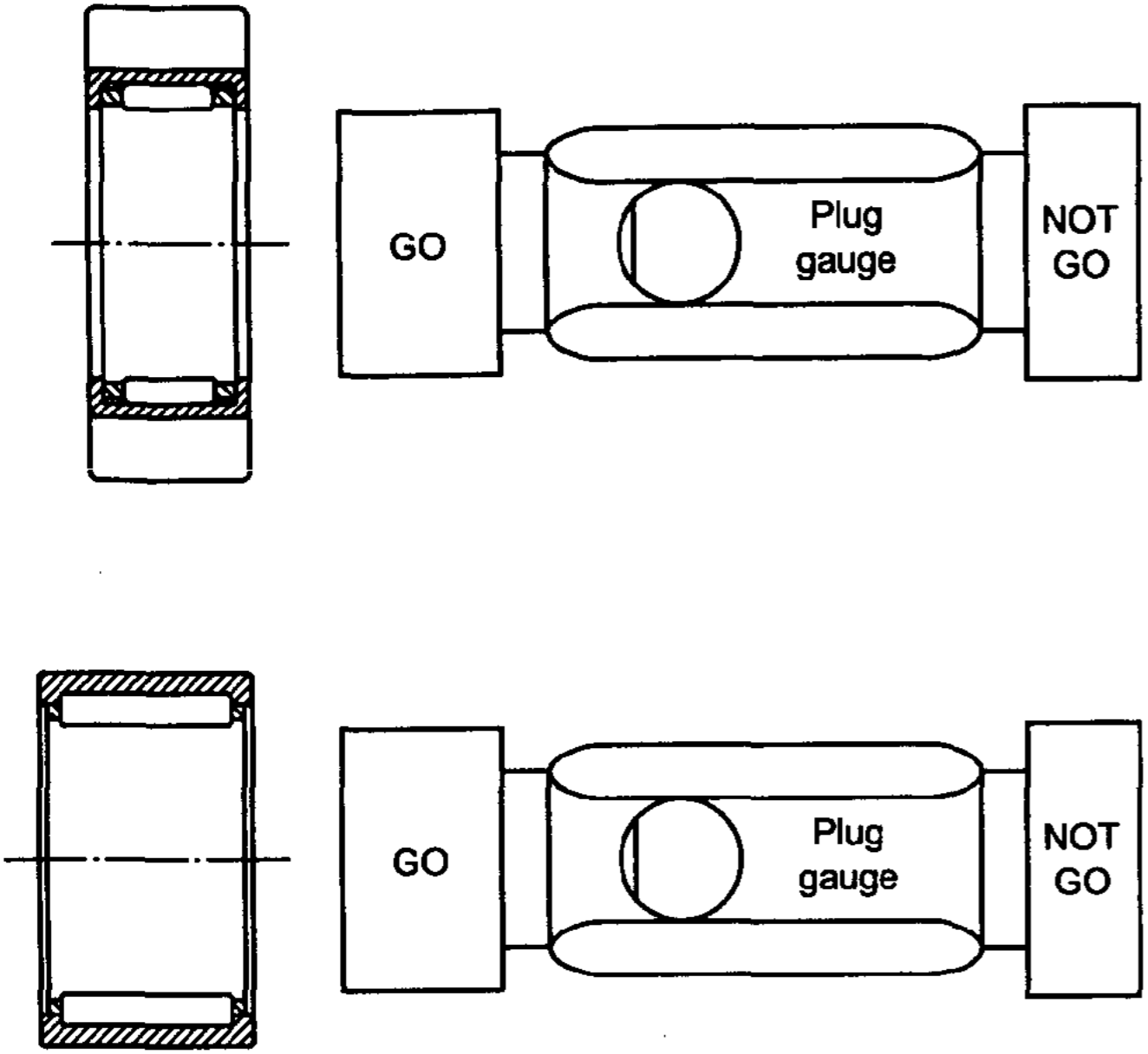
7.3 Measurement of single bore diameter of rolling element complement

Method	Comments																																																			
<div data-bbox="184 457 882 914" data-label="Image"> </div> <p data-bbox="107 967 779 1009">Fasten the master gauge to a surface plate.</p> <p data-bbox="107 1050 963 1124">Bearings with machined rings are measured in the free state.</p> <p data-bbox="107 1169 968 1362">For drawn cup needle roller bearings, first press the bearing into a hardened steel ring gauge of bore diameter specified in ISO 3245. The minimum radial cross-section of the ring gauge is shown in the adjacent table.</p> <p data-bbox="107 1406 968 1525">Position the bearing on the master gauge and apply the indicator in the radial direction to the approximate middle of the width on the ring outside surface.</p> <p data-bbox="107 1567 968 1762">Measure the amount of movement of the outer ring in the radial direction by applying sufficient load on the outer ring in the same radial direction as that of the indicator and in the opposite radial direction. The radial load to be applied is shown in the adjacent table.</p> <p data-bbox="107 1804 968 2000">Record indicator readings at the extreme radial positions of the outer ring. Rotate the bearing and repeat the measurement in several different angular positions to determine the largest and the smallest readings, $F_{ws \max}$ and $F_{ws \min}$.</p>	<p data-bbox="982 457 1837 575">This method is applicable to all radial cylindrical roller, needle roller and drawn cup needle roller bearings without inner ring.</p> <p data-bbox="982 617 1837 736">The single bore diameter of rolling element complement, F_{ws}, is equal to the measurement taken plus the master gauge diameter.</p> <p data-bbox="982 777 1837 851">The following are arithmetically based on $F_{ws \max}$ and $F_{ws \min}$:</p> <p data-bbox="1031 884 1837 958">F_{wm} mean bore diameter of rolling element complement;</p> <p data-bbox="1031 1000 1837 1074">Δ_{Fwm} deviation of mean bore diameter of rolling element complement.</p> <p data-bbox="1115 1115 1724 1234">Minimum radial cross-section of ring gauges for drawn cup needle roller bearings</p> <table border="1" data-bbox="1100 1249 1734 1822"> <thead> <tr> <th colspan="2">Nominal ring gauge bore diameter</th> <th>Ring gauge radial cross-section</th> </tr> <tr> <th colspan="2">mm</th> <th>mm</th> </tr> <tr> <th>></th> <th>≤</th> <th>min. ^a</th> </tr> </thead> <tbody> <tr> <td>6</td> <td>10</td> <td>10</td> </tr> <tr> <td>10</td> <td>18</td> <td>12</td> </tr> <tr> <td>18</td> <td>30</td> <td>15</td> </tr> <tr> <td>30</td> <td>50</td> <td>18</td> </tr> <tr> <td>50</td> <td>80</td> <td>20</td> </tr> <tr> <td>80</td> <td>120</td> <td>25</td> </tr> <tr> <td>120</td> <td>150</td> <td>30</td> </tr> </tbody> </table> <p data-bbox="1108 1843 1724 1917">^a Larger ring gauge radial cross-sections may be used to assure accurate measurement.</p> <p data-bbox="1226 2027 1612 2068">Radial measuring loads</p> <table border="1" data-bbox="1100 2080 1734 2472"> <thead> <tr> <th colspan="2">F_w</th> <th>Measuring load</th> </tr> <tr> <th colspan="2">mm</th> <th>N</th> </tr> <tr> <th>></th> <th>≤</th> <th>min.</th> </tr> </thead> <tbody> <tr> <td>—</td> <td>30</td> <td>50</td> </tr> <tr> <td>30</td> <td>50</td> <td>60</td> </tr> <tr> <td>50</td> <td>80</td> <td>70</td> </tr> <tr> <td>80</td> <td>—</td> <td>80</td> </tr> </tbody> </table>	Nominal ring gauge bore diameter		Ring gauge radial cross-section	mm		mm	>	≤	min. ^a	6	10	10	10	18	12	18	30	15	30	50	18	50	80	20	80	120	25	120	150	30	F_w		Measuring load	mm		N	>	≤	min.	—	30	50	30	50	60	50	80	70	80	—	80
Nominal ring gauge bore diameter		Ring gauge radial cross-section																																																		
mm		mm																																																		
>	≤	min. ^a																																																		
6	10	10																																																		
10	18	12																																																		
18	30	15																																																		
30	50	18																																																		
50	80	20																																																		
80	120	25																																																		
120	150	30																																																		
F_w		Measuring load																																																		
mm		N																																																		
>	≤	min.																																																		
—	30	50																																																		
30	50	60																																																		
50	80	70																																																		
80	—	80																																																		

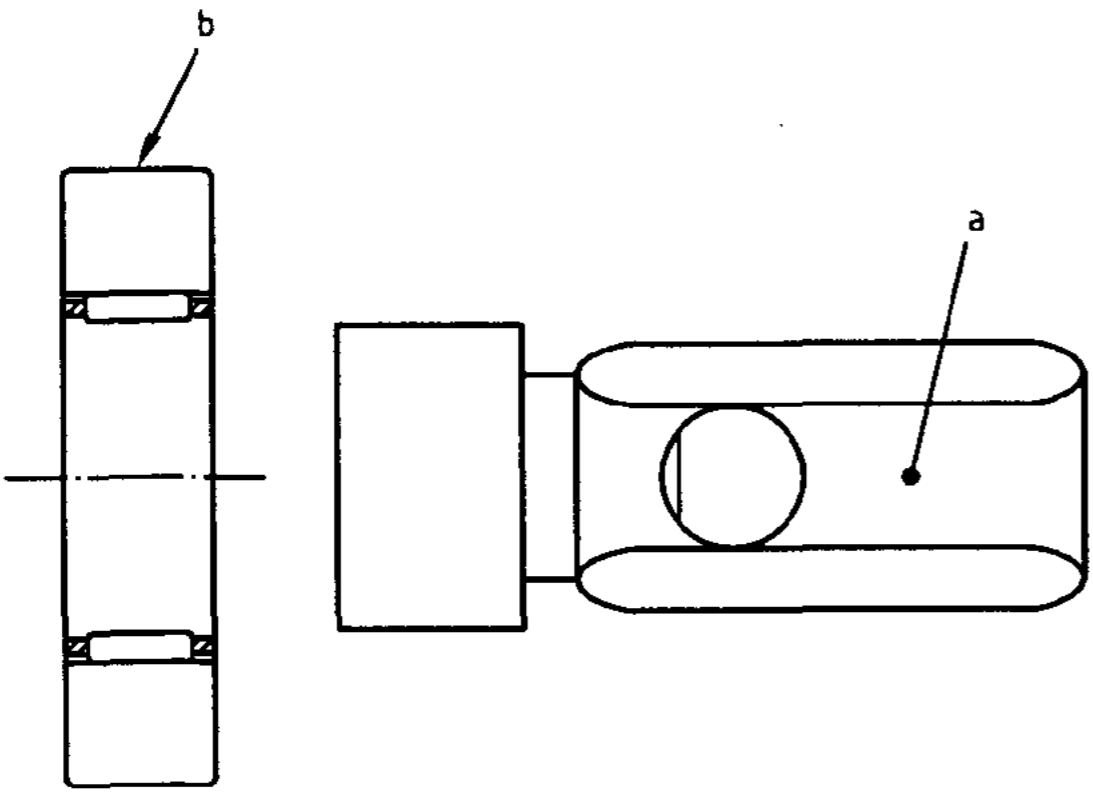
7.4 Measurement of smallest single bore diameter of rolling element complement

Method	Comments																																																			
 <p>a Tapered arbor b Calibrated minimum diameter c Calibrated maximum diameter</p> <p>The bore diameter of the rolling element complement is measured with a full circular, calibrated tapered arbor spanning the range of the bore size and having a taper of approximately 0,000 5:1.</p> <p>Bearings with machined rings are measured in the free state.</p> <p>For drawn cup needle roller bearings, first press the bearing into a hardened steel ring gauge of bore diameter specified in ISO 3245. The minimum radial cross-section of the ring gauge is shown in the adjacent table.</p> <p>Seat the tapered arbor in the bearing bore with a slight oscillating motion so as to remove the radial clearance and align the rollers while not expanding the bearing. An axial load for seating the arbor is shown in the adjacent table. Withdraw the arbor and measure its diameter at the location where the roller complement rested against the largest arbor diameter.</p> <p>NOTE A thin coating of preserving agent applied to the bearing before measurement will indicate the precise stopping point of the rolling elements on the arbor.</p>	<p>This method is applicable to all radial cylindrical roller, needle roller and drawn cup needle roller bearings without inner ring and with $F_w \leq 150$ mm.</p> <p>This method is used to measure the smallest single bore diameter of rolling element complement, $F_{ws \text{ min}}$. The single bore diameter of rolling element complement, F_{ws}, is not directly measured.</p> <p>This method may be used as a gauging technique. The arbor is marked on the diameter at the limits of the tolerance range of the bearing bore diameter. The tolerance limits of the bore diameter of a rolling element complement are met if the diameter of the arbor at the contact location of the roller complement exceeds the minimum diameter calibration marking and does not exceed the maximum diameter calibration marking.</p> <p>Minimum radial cross-section of ring gauges for drawn cup needle roller bearings</p> <table border="1" data-bbox="1123 1240 1759 1834"> <thead> <tr> <th colspan="2">Nominal ring gauge bore diameter</th> <th>Ring gauge radial cross-section</th> </tr> <tr> <th colspan="2">mm</th> <th>mm</th> </tr> <tr> <th>></th> <th>≤</th> <th>min. ^a</th> </tr> </thead> <tbody> <tr> <td>6</td> <td>10</td> <td>10</td> </tr> <tr> <td>10</td> <td>18</td> <td>12</td> </tr> <tr> <td>18</td> <td>30</td> <td>15</td> </tr> <tr> <td>30</td> <td>50</td> <td>18</td> </tr> <tr> <td>50</td> <td>80</td> <td>20</td> </tr> <tr> <td>80</td> <td>120</td> <td>25</td> </tr> <tr> <td>120</td> <td>150</td> <td>30</td> </tr> </tbody> </table> <p>^a Larger ring gauge radial cross-sections may be used to assure accurate measurement.</p> <p>Axial seating loads for measuring with tapered arbor</p> <table border="1" data-bbox="1123 2092 1759 2493"> <thead> <tr> <th colspan="2">F_w</th> <th>Axial load ^a</th> </tr> <tr> <th colspan="2">mm</th> <th>N</th> </tr> <tr> <th>></th> <th>≤</th> <th></th> </tr> </thead> <tbody> <tr> <td>8</td> <td>15</td> <td>10</td> </tr> <tr> <td>15</td> <td>30</td> <td>15</td> </tr> <tr> <td>30</td> <td>80</td> <td>30</td> </tr> <tr> <td>80</td> <td>150</td> <td>50</td> </tr> </tbody> </table> <p>^a Heavier loads may be used provided the measurement is not influenced.</p>	Nominal ring gauge bore diameter		Ring gauge radial cross-section	mm		mm	>	≤	min. ^a	6	10	10	10	18	12	18	30	15	30	50	18	50	80	20	80	120	25	120	150	30	F_w		Axial load ^a	mm		N	>	≤		8	15	10	15	30	15	30	80	30	80	150	50
Nominal ring gauge bore diameter		Ring gauge radial cross-section																																																		
mm		mm																																																		
>	≤	min. ^a																																																		
6	10	10																																																		
10	18	12																																																		
18	30	15																																																		
30	50	18																																																		
50	80	20																																																		
80	120	25																																																		
120	150	30																																																		
F_w		Axial load ^a																																																		
mm		N																																																		
>	≤																																																			
8	15	10																																																		
15	30	15																																																		
30	80	30																																																		
80	150	50																																																		

7.5 Functional gauging of smallest single bore diameter of rolling element complement

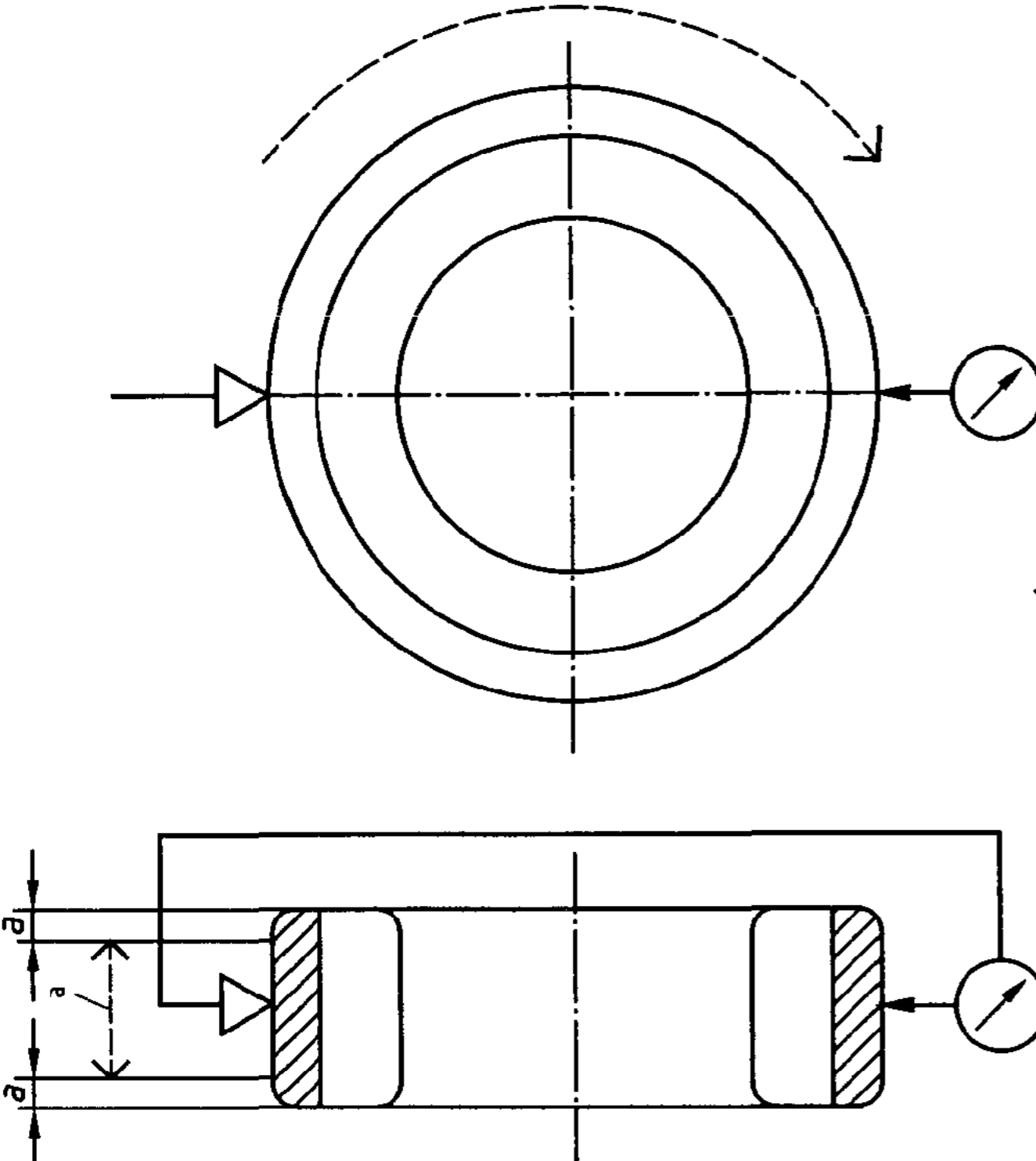
Method	Comments																														
 <p>The bore diameter of the rolling element complement, F_w, is gauged with GO and NOT GO plug gauges.</p> <p>Bearings with machined rings are measured in the free state.</p> <p>For drawn cup needle roller bearings, first press the bearing into a hardened steel ring gauge of bore diameter specified in ISO 3245. The minimum radial cross-section of the ring gauge is shown in the adjacent table.</p> <p>The bore diameter of the rolling element complement is then gauged with GO and NOT GO plug gauges.</p> <p>The GO plug gauge size is the minimum bore diameter of the rolling element complement.</p> <p>The NOT GO plug gauge size is larger than the maximum bore diameter of the rolling element complement by 0,002 mm.</p>	<p>This method is applicable to all radial cylindrical roller, needle roller and drawn cup needle roller bearings without inner ring and with $F_w \leq 150$ mm.</p> <p>The bearing, while under its own weight (and in the case of drawn cup bearings, while mounted in a ring gauge and under the combined weight of the ring and bearing), shall fall freely over the GO plug gauge and shall not fall freely over the NOT GO plug gauge.</p> <p>Plug gauges are used to verify limits of size and do not directly measure the single bore diameter of rolling element complement, F_{ws}. This method of gauging determines if the range of $F_{ws \min}$ is within the tolerance limits.</p> <p style="text-align: center;">Minimum radial cross-section of ring gauges for drawn cup needle roller bearings</p> <table border="1" data-bbox="1094 1320 1732 1872"> <thead> <tr> <th colspan="2" data-bbox="1094 1320 1413 1418">Nominal ring gauge bore diameter</th> <th data-bbox="1413 1320 1732 1418">Ring gauge radial cross-section</th> </tr> <tr> <th colspan="2" data-bbox="1094 1418 1413 1478">mm</th> <th data-bbox="1413 1418 1732 1478">mm</th> </tr> <tr> <th data-bbox="1094 1478 1260 1546">></th> <th data-bbox="1260 1478 1413 1546">≤</th> <th data-bbox="1413 1478 1732 1546">min. ^a</th> </tr> </thead> <tbody> <tr> <td data-bbox="1094 1546 1260 1596">6</td> <td data-bbox="1260 1546 1413 1596">10</td> <td data-bbox="1413 1546 1732 1596">10</td> </tr> <tr> <td data-bbox="1094 1596 1260 1647">10</td> <td data-bbox="1260 1596 1413 1647">18</td> <td data-bbox="1413 1596 1732 1647">12</td> </tr> <tr> <td data-bbox="1094 1647 1260 1697">18</td> <td data-bbox="1260 1647 1413 1697">30</td> <td data-bbox="1413 1647 1732 1697">15</td> </tr> <tr> <td data-bbox="1094 1697 1260 1748">30</td> <td data-bbox="1260 1697 1413 1748">50</td> <td data-bbox="1413 1697 1732 1748">18</td> </tr> <tr> <td data-bbox="1094 1748 1260 1798">50</td> <td data-bbox="1260 1748 1413 1798">80</td> <td data-bbox="1413 1748 1732 1798">20</td> </tr> <tr> <td data-bbox="1094 1798 1260 1849">80</td> <td data-bbox="1260 1798 1413 1849">120</td> <td data-bbox="1413 1798 1732 1849">25</td> </tr> <tr> <td data-bbox="1094 1849 1260 1872">120</td> <td data-bbox="1260 1849 1413 1872">150</td> <td data-bbox="1413 1849 1732 1872">30</td> </tr> </tbody> </table> <p>^a Larger ring gauge radial cross-sections may be used to assure accuracy.</p>	Nominal ring gauge bore diameter		Ring gauge radial cross-section	mm		mm	>	≤	min. ^a	6	10	10	10	18	12	18	30	15	30	50	18	50	80	20	80	120	25	120	150	30
Nominal ring gauge bore diameter		Ring gauge radial cross-section																													
mm		mm																													
>	≤	min. ^a																													
6	10	10																													
10	18	12																													
18	30	15																													
30	50	18																													
50	80	20																													
80	120	25																													
120	150	30																													

7.6 Functional gauging of smallest single bore diameter of rolling element complement (radial needle roller and cage assemblies)

Method	Comments
 <p data-bbox="142 1050 472 1145"> a Plug gauge b Housing ring gauge </p> <p data-bbox="142 1187 1003 1418"> Place the radial needle roller and cage assembly in a ring gauge having an outer raceway dimension as specified in ISO 3030. The ring gauge size is equal to the lower deviation of tolerance class G6 (see ISO 286-2) applied to the nominal outside diameter of the rolling element complement, E_w. </p> <p data-bbox="142 1469 1003 1581"> Insert a plug gauge having a dimension equal to the nominal bore diameter of the rolling element complement, F_w, as specified in ISO 3030. </p> <p data-bbox="142 1632 1003 1745"> The radial needle roller and cage assembly shall rotate freely when the ring and plug gauges are rotated relative to each other. </p>	<p data-bbox="1014 498 1879 578"> This method is applicable to radial needle roller and cage assemblies. </p> <p data-bbox="1014 617 1879 697"> The bore and outside diameters of the rolling element complement, F_{ws} and E_{ws}, are not directly measured. </p>

8 Principles of measuring outside diameter

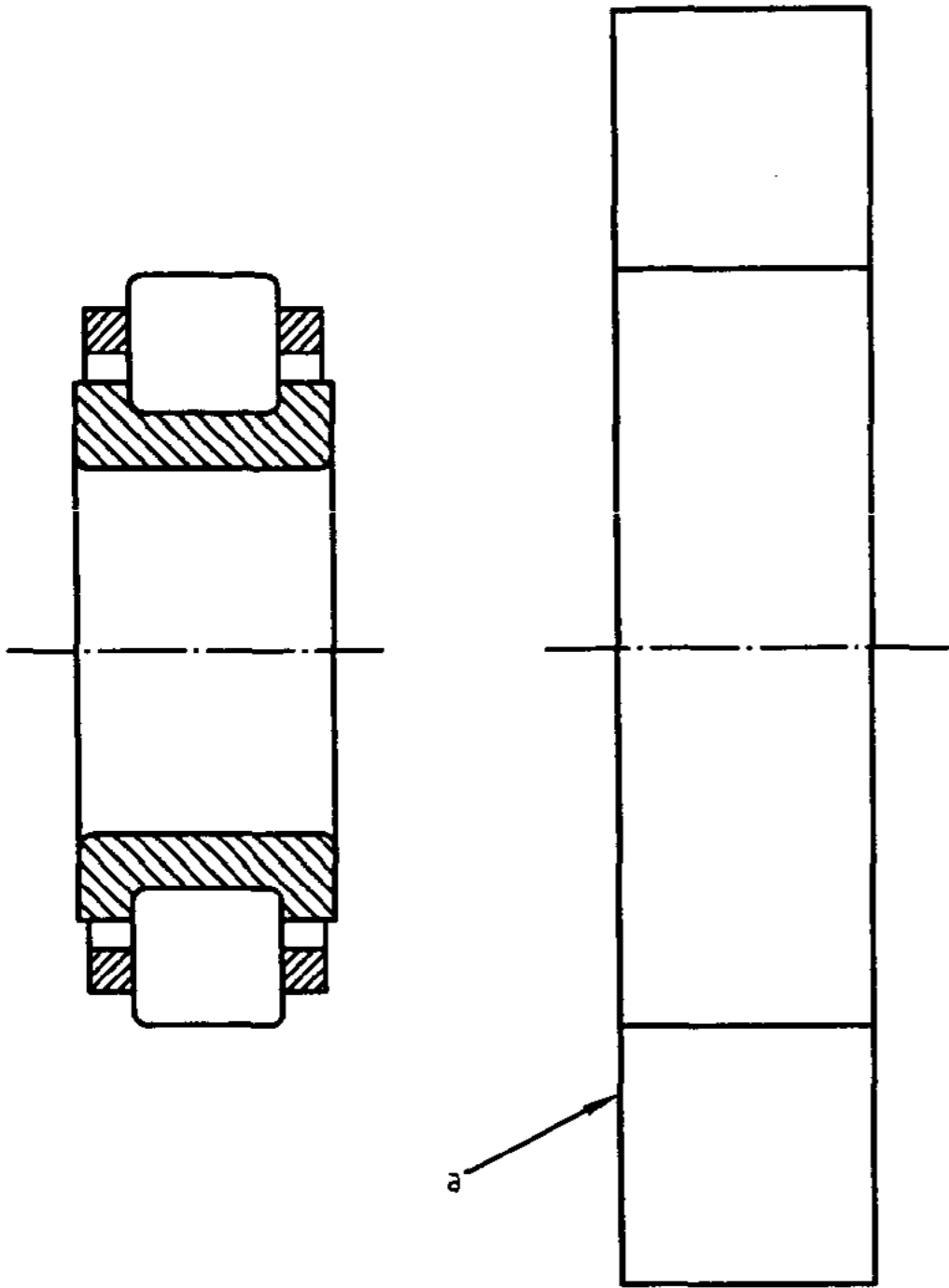
8.1 Measurement of single outside diameter

Method	Comments
 <p>a Measuring zone</p> <p>Zero the gauge indicator to the appropriate size using gauge blocks or a master.</p> <p>In several angular directions and in a single radial plane, measure and record the largest and the smallest single outside diameters, $D_{sp\ max}$ and $D_{sp\ min}$, within the measuring zone as specified in 5.7.</p> <p>Repeat and record measurements in several radial planes to determine the largest and the smallest single outside diameter of an individual ring, $D_{s\ max}$ and $D_{s\ min}$.</p>	<p>This method is applicable to all types of rolling bearing rings, shaft washers and housing washers.</p> <p>The single outside diameter, D_{sp} or D_s, is measured directly from the indicator.</p> <p>The bearing ring or washer shall be placed with the axis in a vertical position to avoid the influences of gravity.</p> <p>The following are arithmetically based on the measurement of $D_{sp\ max}$ and $D_{sp\ min}$:</p> <p>D_{mp} mean outside diameter in a single plane;</p> <p>Δ_{Dmp} deviation of mean outside diameter in a single plane;</p> <p>V_{Dmp} variation of mean outside diameter.</p> <p>The following are arithmetically based on the measurement of D_s, $D_{s\ max}$ and $D_{s\ min}$:</p> <p>D_m mean outside diameter;</p> <p>Δ_{Dm} deviation of mean outside diameter;</p> <p>Δ_{Ds} deviation of a single outside diameter;</p> <p>V_{Ds} variation of outside diameter.</p>

8.2 Measurement of single outside diameter of rolling element complement

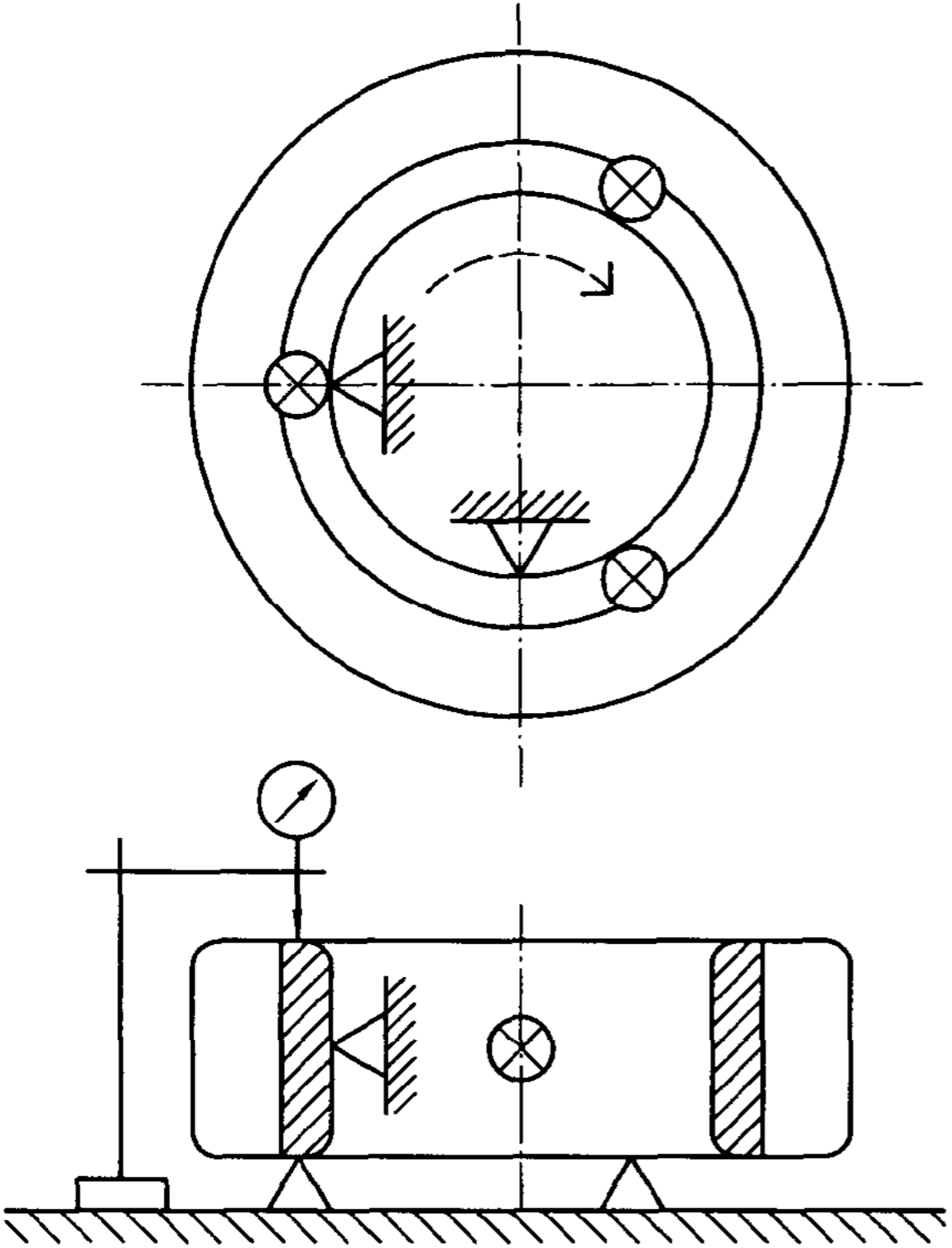
Method	Comments																					
<div data-bbox="157 460 966 934" data-label="Image"> </div> <p data-bbox="130 988 352 1026">a Ring gauge</p> <p data-bbox="130 1065 991 1264">Fasten the inner ring of the assembled bearing without outer ring on a surface plate. Mount a ring gauge over the outside diameter of the rolling element complement. Apply the indicator to the ring gauge outside diameter surface opposite the middle of the inner ring width.</p> <p data-bbox="130 1308 991 1507">Measure the amount of movement of the ring gauge in the radial direction by alternately applying sufficient load on the ring gauge in the same radial direction as that of the indicator and in the opposite radial direction. The radial load to be applied is shown in the adjacent table.</p> <p data-bbox="130 1552 991 1665">Take indicator readings at the extreme radial positions of the ring gauge. Repeat the measurement on the bearing in several different angular positions.</p> <p data-bbox="130 1709 991 1872">Take indicator readings at the extreme radial positions of the bearing. Repeat the measurement on the bearing in several different angular positions to determine the largest and the smallest readings, $E_{ws \max}$ and $E_{ws \min}$.</p>	<p data-bbox="1010 454 1871 575">This method is applicable to radial cylindrical roller bearings and radial needle roller bearings without outer ring.</p> <p data-bbox="1010 620 1871 736">The single outside diameter of rolling element complement, E_{ws}, will equal the ring gauge bore diameter minus measurements taken.</p> <p data-bbox="1010 780 1871 863">The following are arithmetically based on $E_{ws \max}$ and $E_{ws \min}$:</p> <p data-bbox="1058 908 1871 991">E_{wm} mean outside diameter of rolling element complement;</p> <p data-bbox="1058 1035 1871 1118">ΔE_{wm} deviation of mean outside diameter of rolling element complement.</p> <div data-bbox="1123 1205 1759 1706" data-label="Table"> <p data-bbox="1251 1205 1633 1243" style="text-align: center;">Radial measuring loads</p> <table border="1"> <thead> <tr> <th colspan="2" data-bbox="1129 1261 1440 1320">E_w</th> <th data-bbox="1440 1261 1759 1320">Measuring load</th> </tr> <tr> <th colspan="2" data-bbox="1129 1320 1440 1380">mm</th> <th data-bbox="1440 1320 1759 1380">N</th> </tr> <tr> <th data-bbox="1129 1380 1285 1457">></th> <th data-bbox="1285 1380 1440 1457">≤</th> <th data-bbox="1440 1380 1759 1457">min.</th> </tr> </thead> <tbody> <tr> <td data-bbox="1129 1457 1285 1534">—</td> <td data-bbox="1285 1457 1440 1534">30</td> <td data-bbox="1440 1457 1759 1534">50</td> </tr> <tr> <td data-bbox="1129 1534 1285 1611">30</td> <td data-bbox="1285 1534 1440 1611">50</td> <td data-bbox="1440 1534 1759 1611">60</td> </tr> <tr> <td data-bbox="1129 1611 1285 1688">50</td> <td data-bbox="1285 1611 1440 1688">80</td> <td data-bbox="1440 1611 1759 1688">70</td> </tr> <tr> <td data-bbox="1129 1688 1285 1765">80</td> <td data-bbox="1285 1688 1440 1765">—</td> <td data-bbox="1440 1688 1759 1765">80</td> </tr> </tbody> </table> </div>	E_w		Measuring load	mm		N	>	≤	min.	—	30	50	30	50	60	50	80	70	80	—	80
E_w		Measuring load																				
mm		N																				
>	≤	min.																				
—	30	50																				
30	50	60																				
50	80	70																				
80	—	80																				

8.3 Functional gauging of largest single outside diameter of rolling element complement

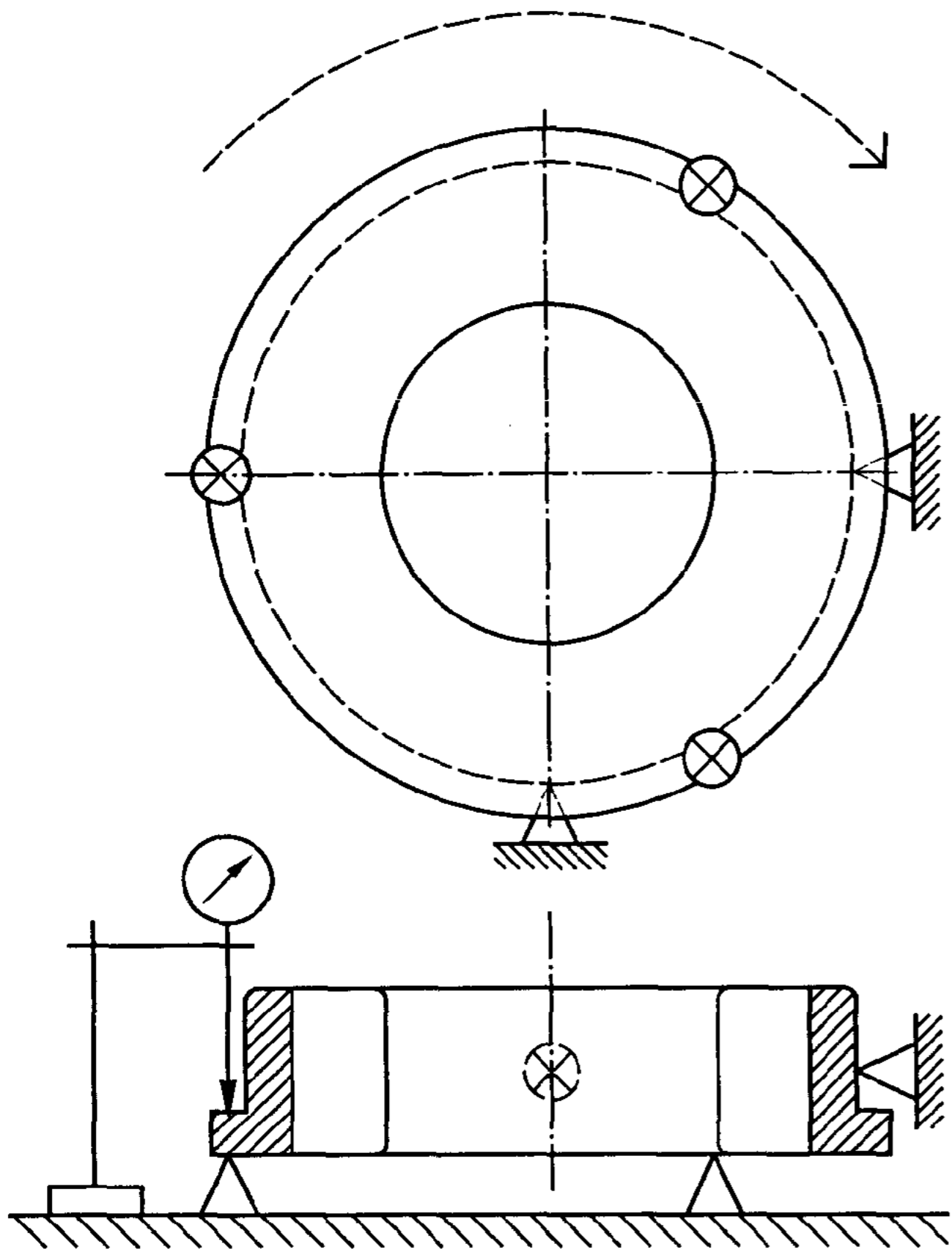
Method	Comments
 <p>a Ring gauge</p> <p>The outside diameter of the rolling element complement, E_w, is gauged with GO and NOT GO ring gauges.</p> <p>The GO ring gauge size is larger than the maximum outside diameter of the rolling element complement by 0,002 mm.</p> <p>The NOT GO ring gauge size is smaller than the minimum outside diameter of the rolling element complement by 0,002 mm.</p>	<p>This method is applicable to radial cylindrical roller bearings and radial needle roller bearings without outer ring.</p> <p>The GO gauge shall pass over the roller complement and the NOT GO gauge shall not pass over the roller complement.</p> <p>The ring gauge is used to verify the limits of size and does not directly measure the single outside diameter of the rolling element complement, E_{ws}. This method of gauging determines if the range of $E_{ws \max}$ is within the tolerance limits.</p>

9 Principles of measuring width and height

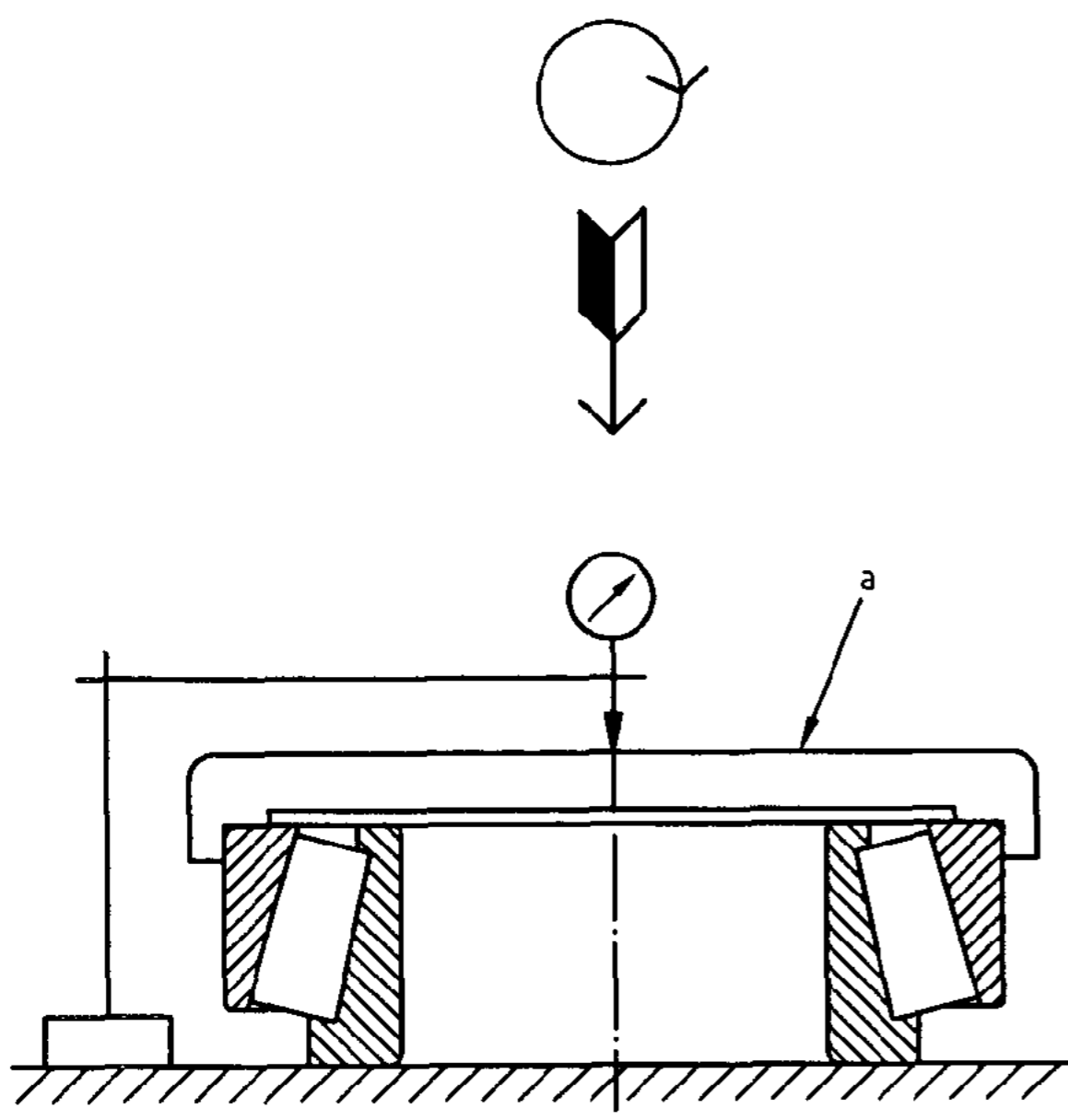
9.1 Measurement of single ring width

Method	Comments
 <p>Zero the gauge indicator to the appropriate height from the reference surface using gauge blocks or a master.</p> <p>Support one face of the ring on three equally spaced fixed supports of equal height and provide two suitable radial supports on the bore surface set at 90° to each other to centre the ring.</p> <p>Position the indicator against the other face of the ring opposite one fixed support.</p> <p>Rotate the ring one revolution and measure and record the largest and the smallest single ring width, $B_{S \max}$ and $B_{S \min}$, ($C_{S \max}$ and $C_{S \min}$).</p>	<p>This method is applicable to all types of inner and outer rings of rolling bearings.</p> <p>The single ring width, B_S or C_S, is the actual measurement made at any point on the ring.</p> <p>The following are arithmetically based on the single inner or outer ring width, B_S or C_S:</p> <p>Δ_{B_S} or Δ_{C_S} deviation of a single ring width;</p> <p>V_{B_S} or V_{C_S} variation of ring width;</p> <p>B_m or C_m mean ring width.</p>

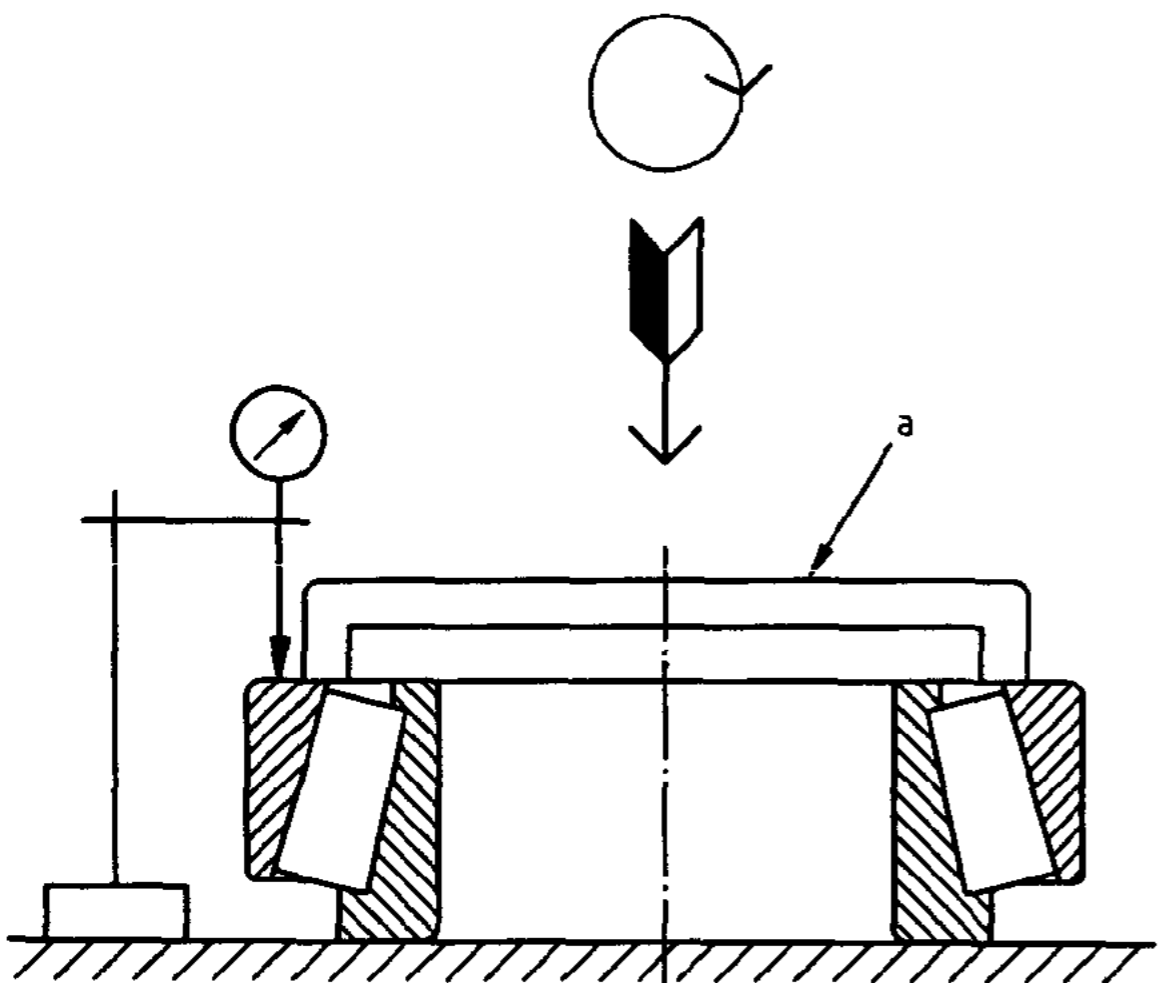
9.2 Measurement of single outer ring flange width

Method	Comments
 <p data-bbox="107 1596 961 1670">Zero the gauge indicator to an appropriate height from the fixed supports using gauge blocks or a master.</p> <p data-bbox="107 1715 961 1908">Support the flange front face of the outer ring on three equally spaced fixed supports of equal height and provide two suitable radial supports on the bearing outside surface set at 90° to each other to centre the outer ring.</p> <p data-bbox="107 1952 961 2027">Position the indicator against the flange back face opposite one fixed support.</p> <p data-bbox="107 2071 961 2190">Rotate the outer ring one revolution and measure and record the largest and the smallest single outer ring flange width, $C_{1s \max}$ and $C_{1s \min}$.</p>	<p data-bbox="978 460 1829 534">This method is applicable to all types of radial rolling bearings with flanges on their outer rings.</p> <p data-bbox="978 578 1829 697">The single outer ring flange width, C_{1s}, is the actual measurement made at any position on the flange back face.</p> <p data-bbox="978 742 1829 816">The following are arithmetically based on the single outer ring flange width, C_{1s}:</p> <p data-bbox="1024 875 1797 914">ΔC_{1s} deviation of a single outer ring flange width;</p> <p data-bbox="1024 958 1661 997">$V_{C_{1s}}$ variation of outer ring flange width.</p>

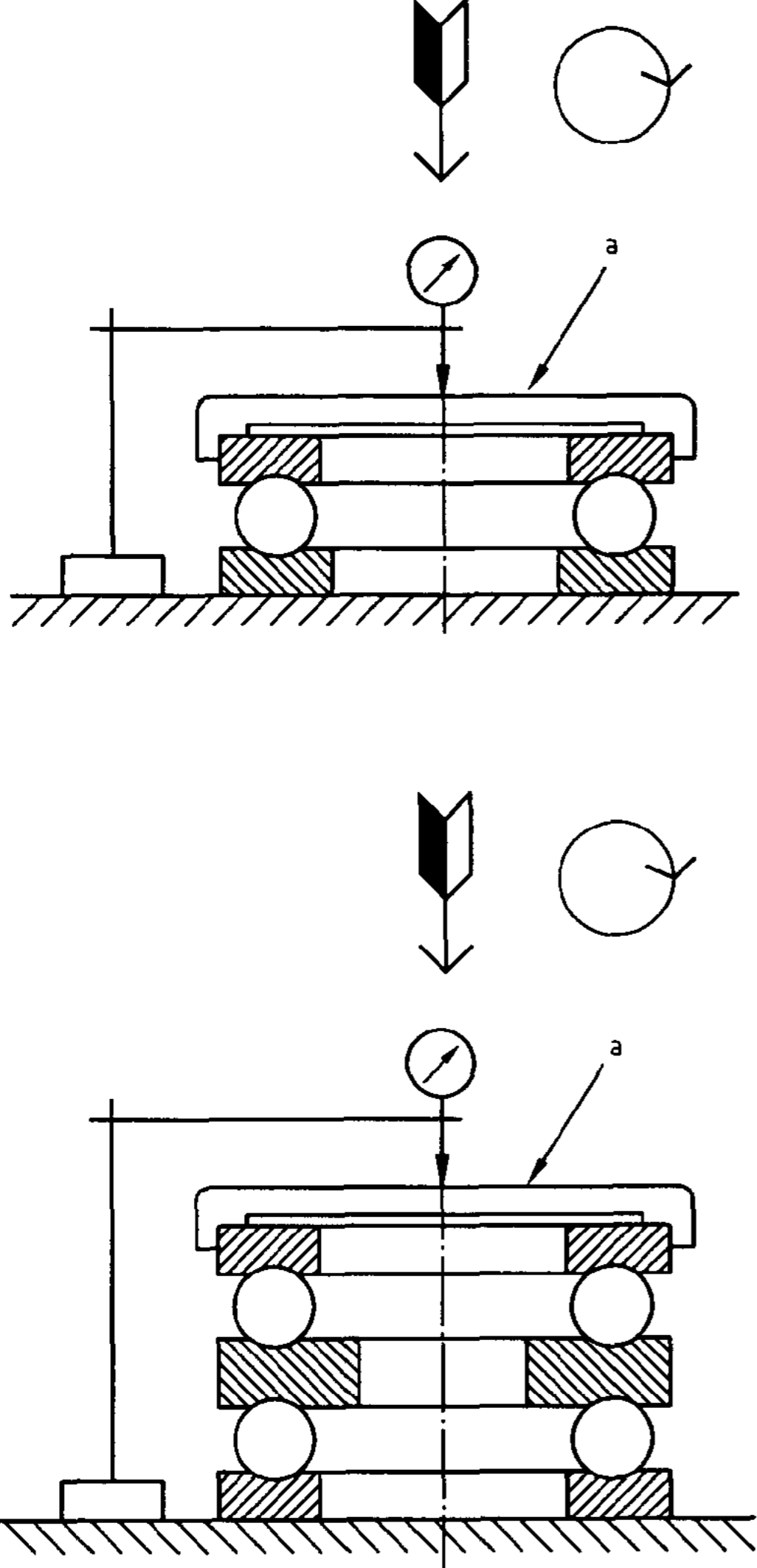
9.3 Measurement of actual bearing width (primary method)

Method	Comments
 <p>a Plate</p> <p>Zero the gauge indicator to an appropriate height from the surface plate using gauge blocks or a master.</p> <p>Support the bearing on the reference face of the inner ring and ensure that the rolling elements are in contact with the raceways. For tapered roller bearings, ensure the rolling elements are in contact with the inner ring back face rib and the raceways.</p> <p>Place a plate of known thickness on the reference face of the outer ring, apply a dynamically stable coaxial load, as specified in 5.6, and position the indicator over the centre of the plate.</p> <p>Rotate the outer ring several times, to be sure to reach the minimum width, and take indicator readings.</p>	<p>This method is the primary method for measuring actual bearing width in radial or angular contact bearings where one inner ring face and one outer ring face bound the bearing width. It is applicable to tapered roller bearings, single-row angular contact spherical roller bearings, single-row angular contact ball bearings and single-row thrust spherical roller bearings.</p> <p>This measurement method excludes the effects of ring face surface flatness.</p> <p>The actual bearing width, T_s, will equal the indicator reading minus the known plate thickness.</p> <p>The deviation of the actual bearing width, ΔT_s, is arithmetically based on the measurement of T_s.</p>

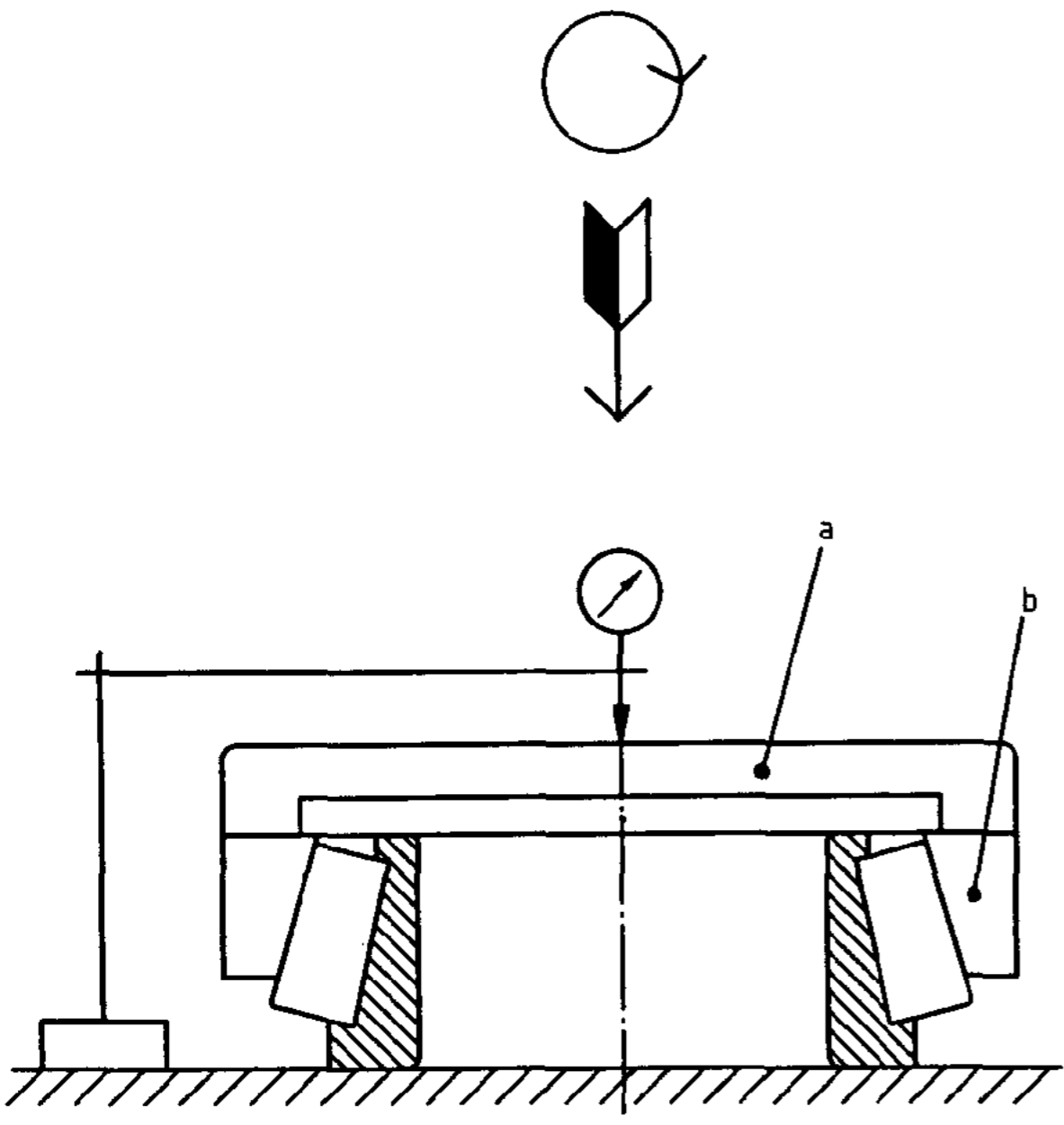
9.4 Measurement of actual bearing width (alternative method)

Method	Comments
 <p>a Stabilizing plate</p> <p>Zero the gauge indicator to an appropriate height from the surface plate using gauge blocks or a master.</p> <p>Support the bearing on the reference face of the inner ring and ensure that the rolling elements are in contact with the raceways. For tapered roller bearings, ensure the rolling elements are in contact with the inner ring back face rib and the raceways.</p> <p>Place a stabilizing plate or ring on the reference face of the outer ring and apply a dynamically stable coaxial load as specified in 5.6.</p> <p>Position the indicator on the reference face of the outer ring, rotate the outer ring, and take indicator readings.</p> <p>Repeat readings at several circumferential and radial positions on the outer ring back face to determine the value of the actual bearing width, T_S.</p>	<p>This method is applicable to bearings where one inner ring face and one outer ring face bound the bearing width. It is applicable to tapered roller bearings, single-row angular contact spherical roller bearings, single-row angular contact ball bearings and single-row thrust spherical roller bearings.</p> <p>The deviation of the actual bearing width, ΔT_S, is arithmetically based on the measurement of T_S.</p> <p>This method is an alternative method for measuring actual bearing width, T_S. The actual bearing width is the average of the measurements taken directly from the indicator.</p> <p>For large bearings, the stabilizing plate or ring may be unnecessary.</p> <p>This measurement method includes the effects of surface flatness on the reference face of the outer ring.</p>

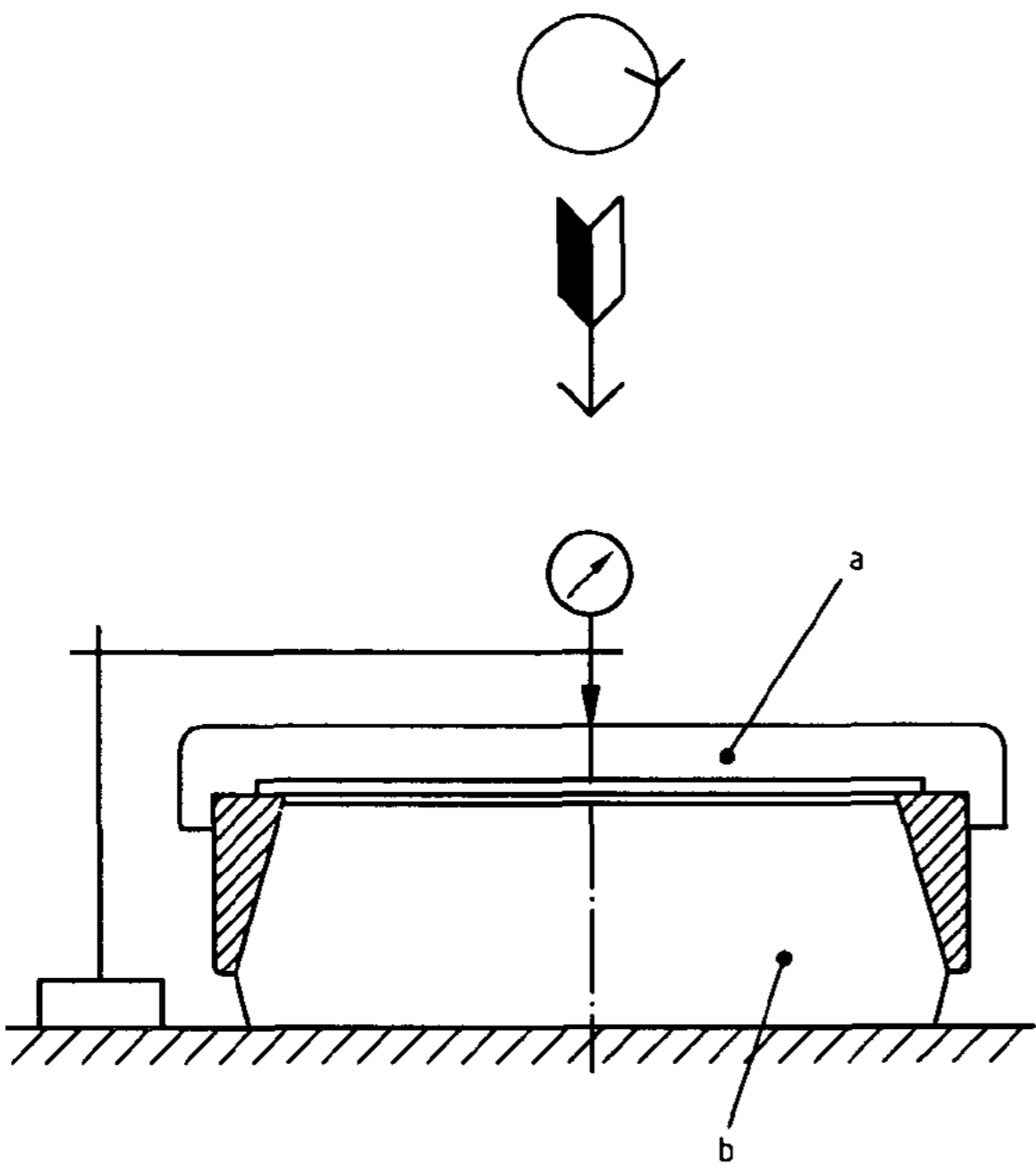
9.5 Measurement of actual bearing height (thrust bearings)

Method	Comments
 <p data-bbox="142 1881 277 1917">a Plate</p> <p data-bbox="142 1958 1003 2077">Support the bearing on a surface plate. Zero the gauge indicator to an appropriate height from the surface plate using gauge blocks or a master.</p> <p data-bbox="142 2119 1003 2279">Place a plate of known thickness on the bearing assembly, apply a dynamically stable coaxial load, as specified in 5.6, and position the indicator over the centre of the plate.</p> <p data-bbox="142 2320 1003 2410">Rotate the bearing several times, to be sure to reach the smallest height, and take indicator readings.</p>	<p data-bbox="1012 457 1873 587">This method is applicable to all types of thrust bearings including thrust ball, thrust cylindrical roller and thrust tapered roller bearings.</p> <p data-bbox="1012 629 1873 706">The actual bearing height, T_s, will equal the indicator reading minus the known plate thickness.</p> <p data-bbox="1012 747 1873 825">This measurement method excludes the effects of washer face surface flatness.</p> <p data-bbox="1012 866 1873 985">The determination of the deviation of the actual bearing height, ΔT_s, is arithmetically based on the measurement of T_s.</p>

9.6 Measurement of actual effective width of inner subunit (tapered roller bearings)

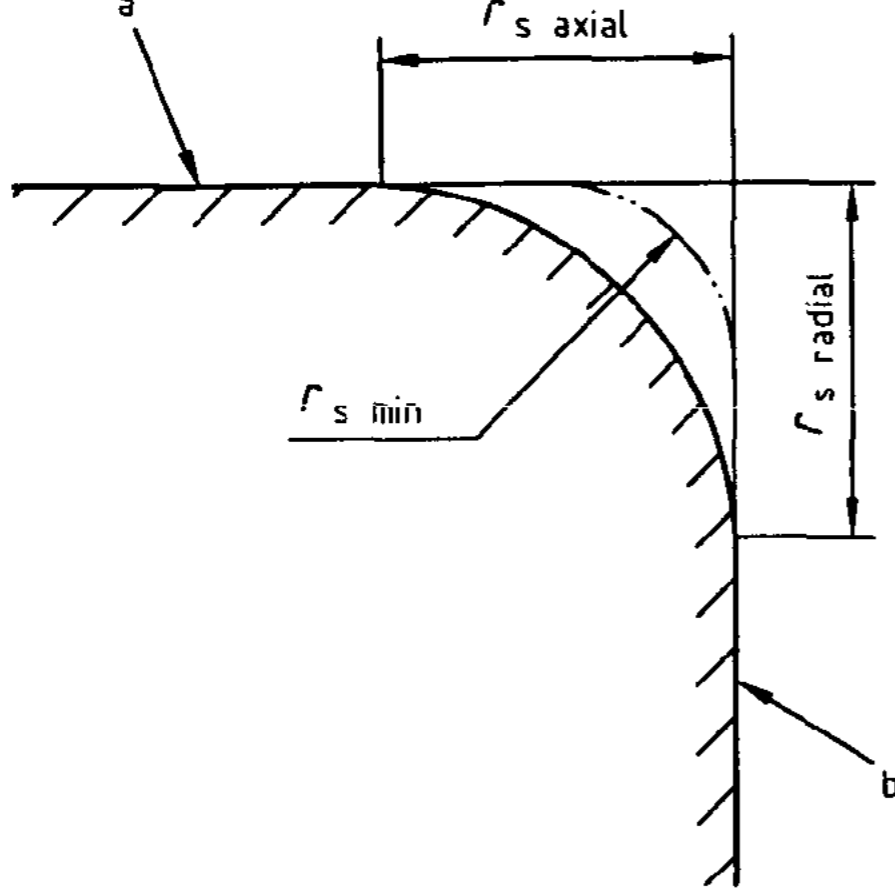
Method	Comments
<div style="text-align: center;">  </div> <p>a Plate</p> <p>b Master outer ring</p> <p>Zero the gauge indicator to an appropriate height from the surface plate using gauge blocks or a master.</p> <p>Support the inner subunit on the reference face of the inner ring and ensure the rollers are in contact with the inner ring back face rib and raceway.</p> <p>Place the master outer ring in position on the inner subunit.</p> <p>Place a plate of known thickness on the master outer ring back face, apply a dynamically stable coaxial load, as specified in 5.6, and position the indicator over the centre of the plate.</p> <p>Rotate the master outer ring several times, to be sure to reach the minimum width, and take indicator readings.</p>	<p>This method is applicable to tapered roller bearing inner subunits. It requires the use of a master outer ring.</p> <p>The actual effective width of the inner subunit, T_{1s}, is based on the height of the master outer ring and is equal to the indicator reading minus the known plate thickness.</p> <p>This measurement method excludes the effects of ring face surface flatness.</p>

9.7 Measurement of actual effective width of outer ring (tapered roller bearings)

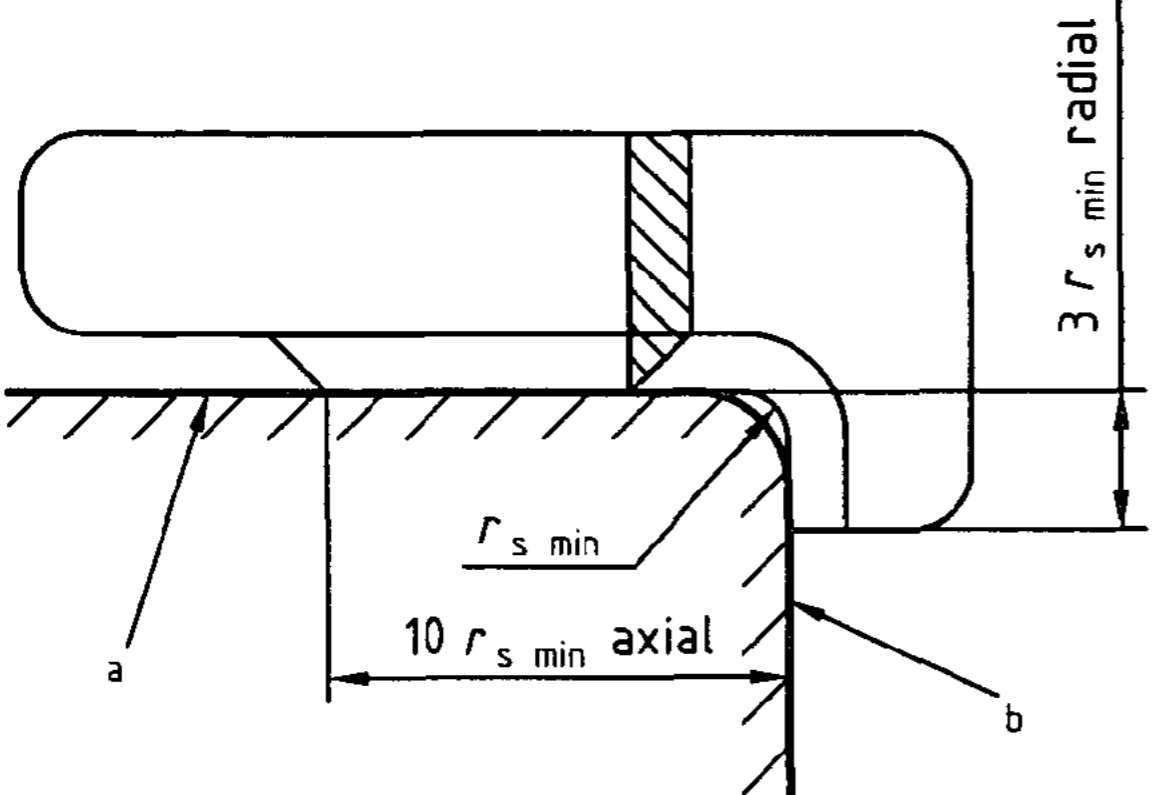
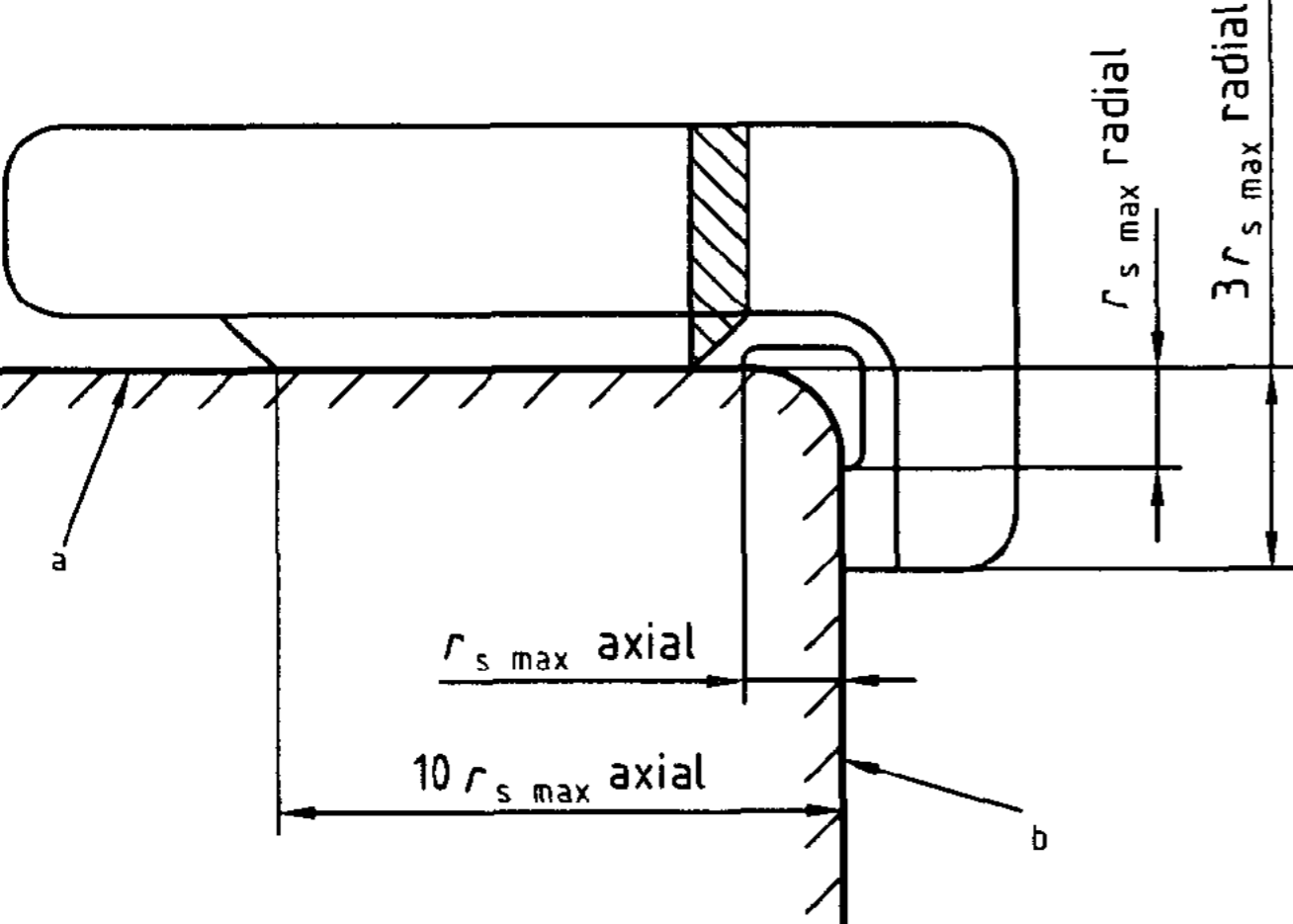
Method	Comments
 <p>a Plate</p> <p>b Inner master plug</p> <p>Zero the gauge indicator to an appropriate height from the surface plate using gauge blocks or a master.</p> <p>Support the back face of an inner master plug on the surface plate and place the outer ring in position on the plug.</p> <p>Place a plate of known thickness on the back face of the outer ring, apply a dynamically stable coaxial load, as specified in 5.6, and position the indicator over the centre of the plate.</p> <p>Reposition the outer ring several times, to be sure to reach the minimum width, and take indicator reading.</p>	<p>This method is applicable to tapered roller bearing outer rings. It requires the use of an inner master plug.</p> <p>The actual effective width of the outer ring, T_{2s}, is based on the height of the inner master plug and is equal to the indicator reading minus the known plate thickness.</p> <p>This measurement method excludes the effects of ring face surface flatness.</p> <p>Where necessary, a calibrated inner subunit (sub-assembly of inner ring, cage and rolling elements) may be used in place of an inner master plug.</p>

10 Principles of measuring ring and washer chamfer dimension

10.1 Measurement of single chamfer dimension (primary method)

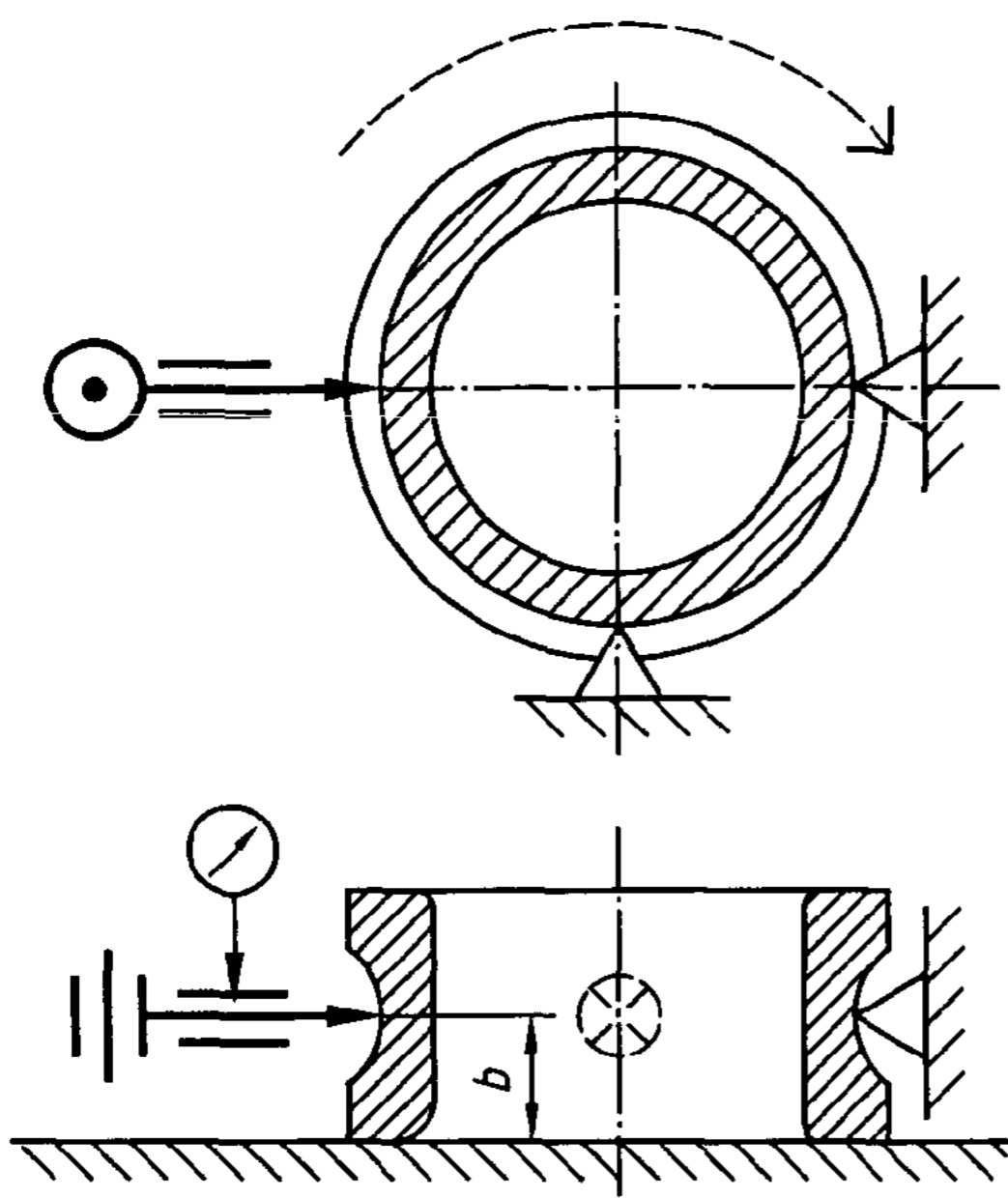
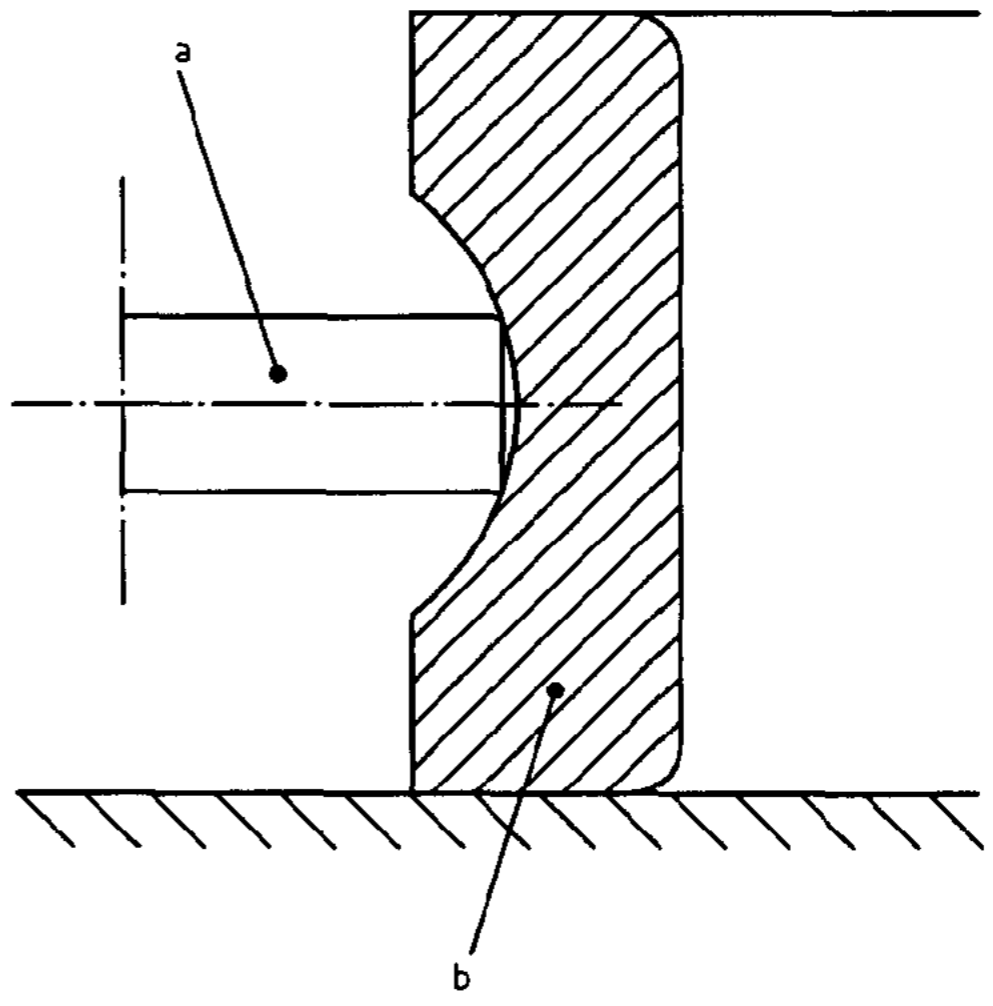
Method	Comments
 <p>a Bore or outside diameter surface b Face surface</p> <p>Draw the chamfer profile with a profile projector using a magnification of at least $\times 20$. Extend the profile generatrix of the diameter surface and the face surface up to the point of intersection. From the point of intersection, measure the horizontal and vertical distances to the beginning of the diameter and face surfaces.</p> <p>Draw in a circular arc with a radius equal to $r_{s \text{ min}}$. If the nominal radial and axial chamfer distances are different, use the smaller of the two chamfer distances.</p>	<p>This method of measuring the radii r_s is applicable to inner and outer rings and thrust washers for all types of rolling bearings.</p> <p>The ring chamfer shall not extend beyond the circular arc having the radius $r_{s \text{ min}}$.</p> <p>NOTE 1 The axial and radial limits of $r_{s \text{ max}}$ may differ.</p> <p>NOTE 2 The method is equally applicable to measurement of radii designated r_1, r_2, etc.</p>

10.2 Functional gauging of single chamfer dimension (alternative method)

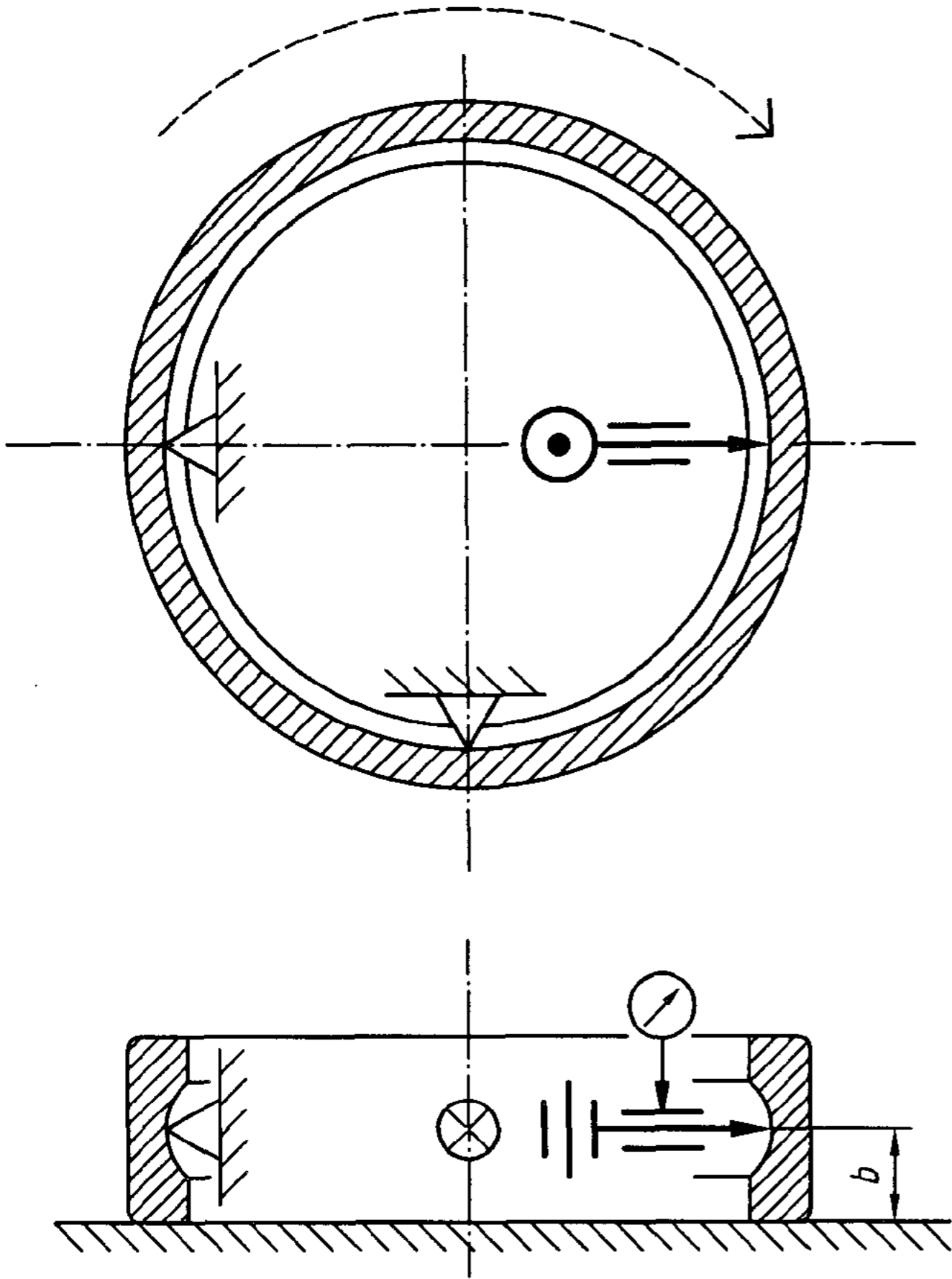
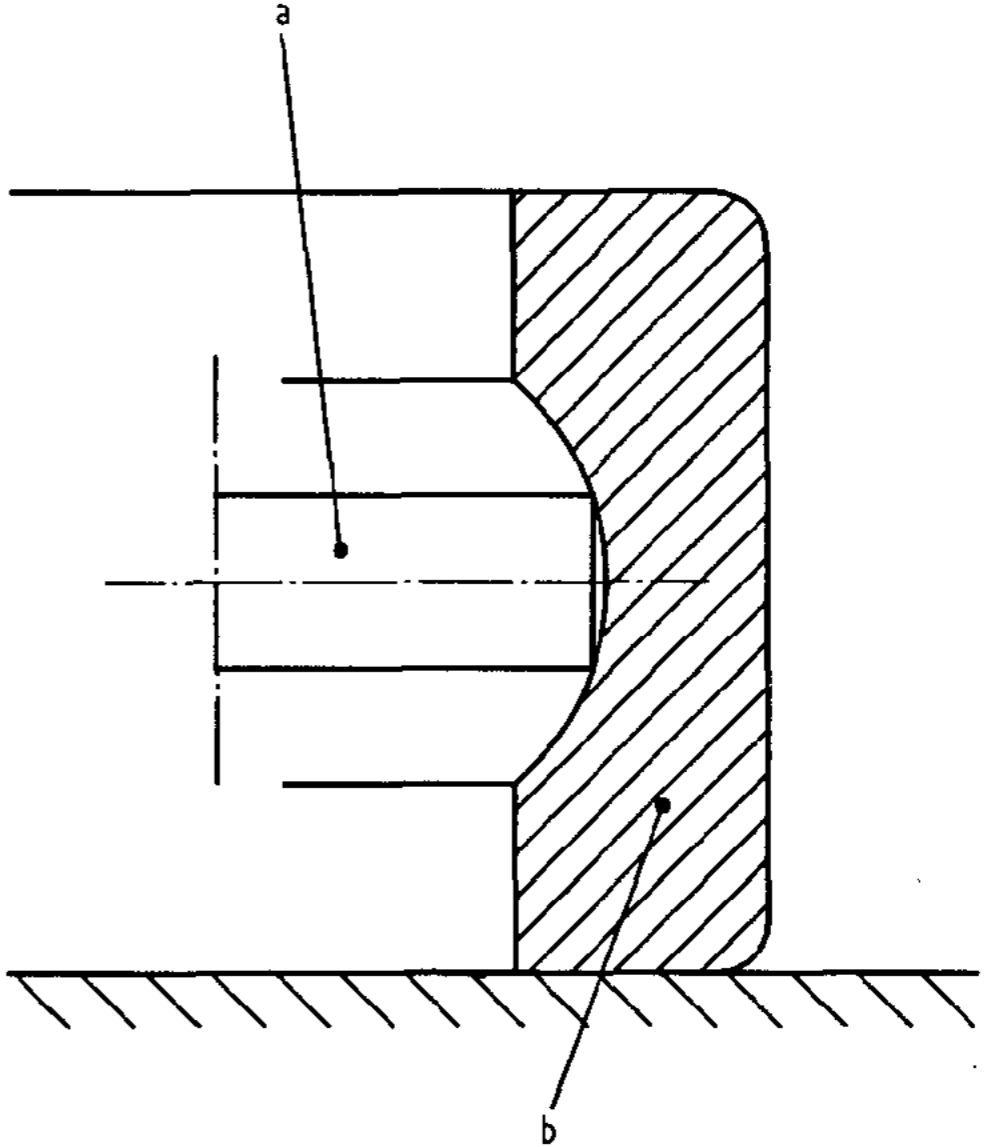
Method	Comments
 <p>The diagram shows a cylindrical part with a chamfered end. A template with a radius $r_{s \text{ min}}$ is placed against the diameter surface (a) and the face surface (b). The template's axial extent is $10 r_{s \text{ min}}$ and its radial extent is $3 r_{s \text{ min}}$.</p> <p>a Bore or outside diameter surface b Face surface</p> <p>Place the minimum chamfer template against the ring or washer. The template should rest on both the diameter surface and the face surface. Compare the ring or washer chamfer with the profile of the template.</p>  <p>The diagram shows a cylindrical part with a chamfered end. A template with a radius $r_{s \text{ max}}$ is placed against the diameter surface (a) and the face surface (b). The template's axial extent is $10 r_{s \text{ max}}$ and its radial extent is $3 r_{s \text{ max}}$.</p> <p>a Bore or outside diameter surface b Face surface</p> <p>Place the maximum chamfer template against the ring or washer. The template should rest on both the diameter surface and the face surface. Compare the ring or washer chamfer with the markings of the template.</p>	<p>This method of gauging the radii r_s is applicable to inner and outer rings and thrust washers for all types of rolling bearings.</p> <p>The ring or washer chamfer shall not interfere with the minimum chamfer ($r_{s \text{ min}}$) template.</p> <p>The ring or washer chamfer shall not extend beyond the markings on the maximum chamfer ($r_{s \text{ max}}$) template.</p> <p>NOTE 1 The axial and radial limits of $r_{s \text{ max}}$ may differ.</p> <p>NOTE 2 The method is equally applicable to gauging of radii designated r_1, r_2, etc.</p>

11 Principles of measuring raceway parallelism

11.1 Measurement of parallelism of inner ring raceway with respect to the face

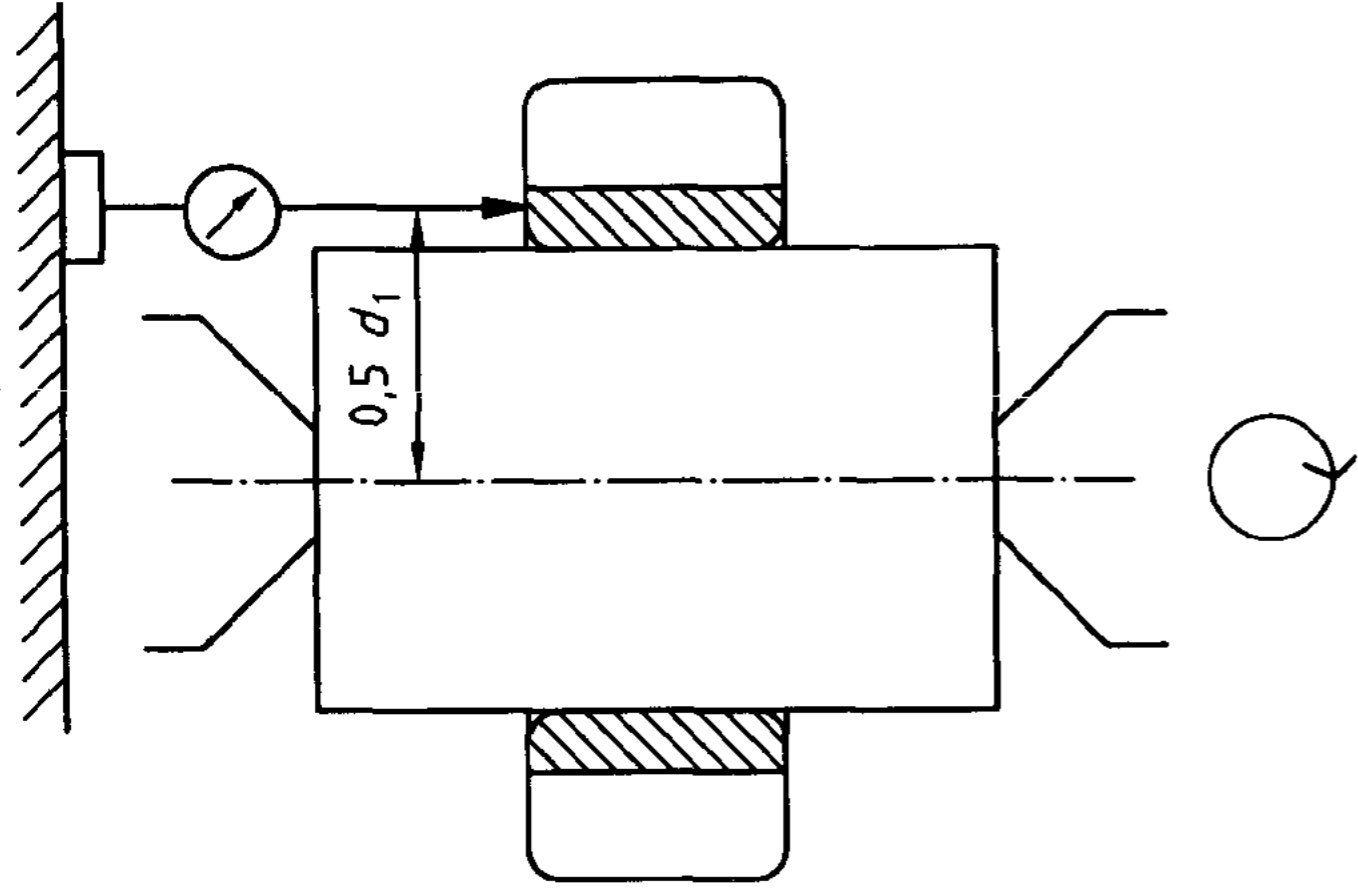
Method	Comments
 <p>Support the reference face of the inner ring on a surface plate, and provide two supports on the raceway surface, set at 90° to each other at the middle of the raceway, to centre the inner ring.</p> <p>Position the gauge head opposite one of the fixed supports and ensure constant pressure of the gauge head against the raceway and in a direction parallel with the ring axis.</p> <p>Take indicator readings while rotating the inner ring one revolution.</p>	<p>This method is applicable to all radial groove ball bearings.</p> <p>The parallelism of inner ring raceway with respect to the face, S_i, is the difference between the largest and the smallest indicator readings.</p> <p>The height of the gauge head, b, is located at the raceway contact diameter.</p> <p>In practice, the axial movement of the gauge head is improved by using a head that spans the curvature of the raceway (see diagram below).</p>  <p>a Gauge head b Inner ring</p>

11.2 Measurement of parallelism of outer ring raceway with respect to the face

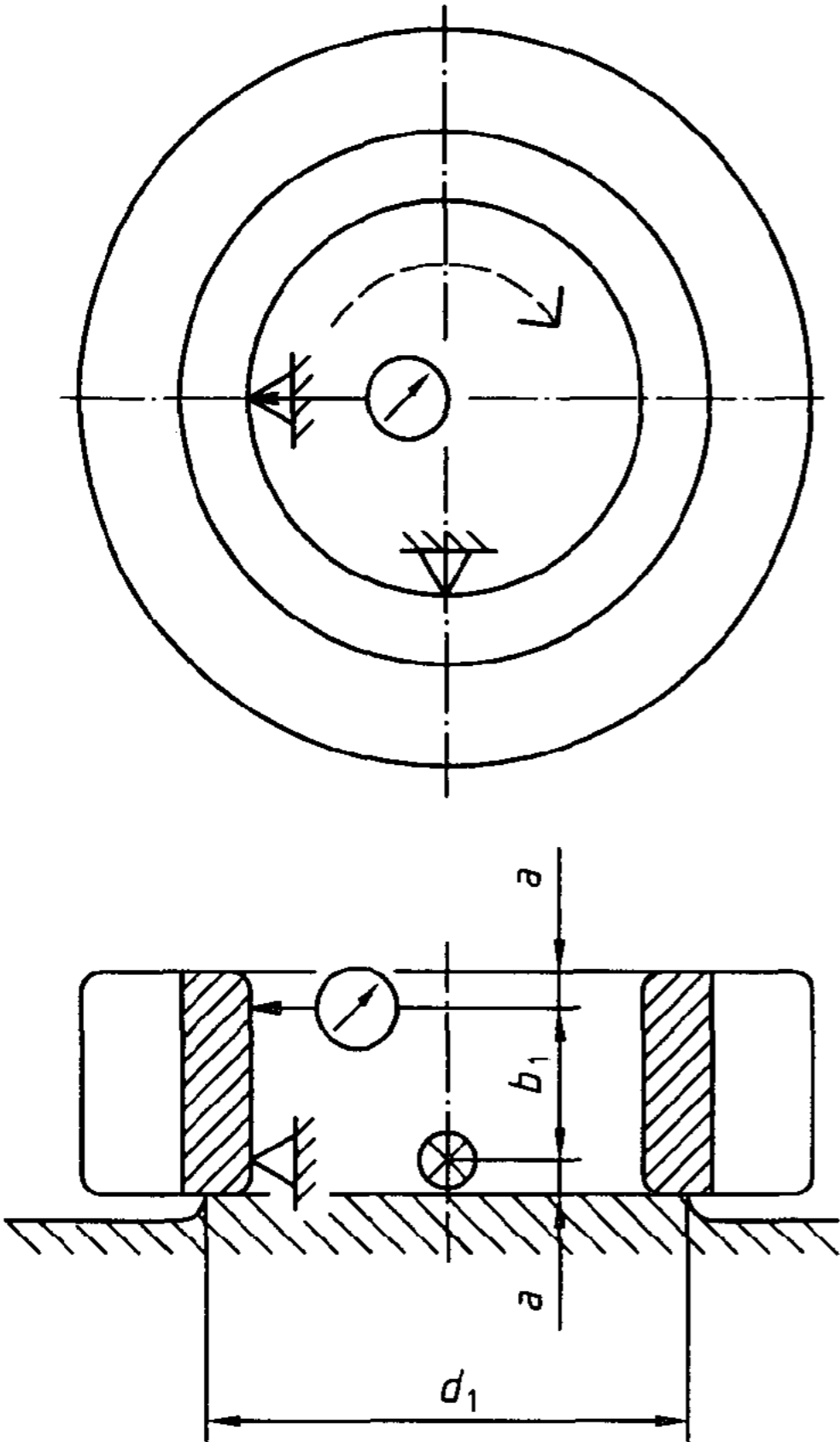
Method	Comments
 <p>Support the reference face of the outer ring on a surface plate, and provide two supports on the raceway surface, set at 90° to each other at the middle of the raceway, to centre the outer ring.</p> <p>Position the gauge head opposite one of the fixed supports and ensure constant pressure of the gauge head against the raceway and in a direction parallel with the ring axis.</p> <p>Take indicator readings while rotating the outer ring one revolution.</p>	<p>This method is applicable to all radial groove ball bearings.</p> <p>The parallelism of outer ring raceway with respect to the reference face, S_e, is the difference between the largest and the smallest indicator readings.</p> <p>The height of the gauge head, b, is located at the raceway contact diameter.</p> <p>In practice, the axial movement of the gauge head is improved by using a head that spans the curvature of the raceway (see diagram below).</p>  <p>a Gauge head b Outer ring</p>

12 Principles of measuring surface perpendicularity

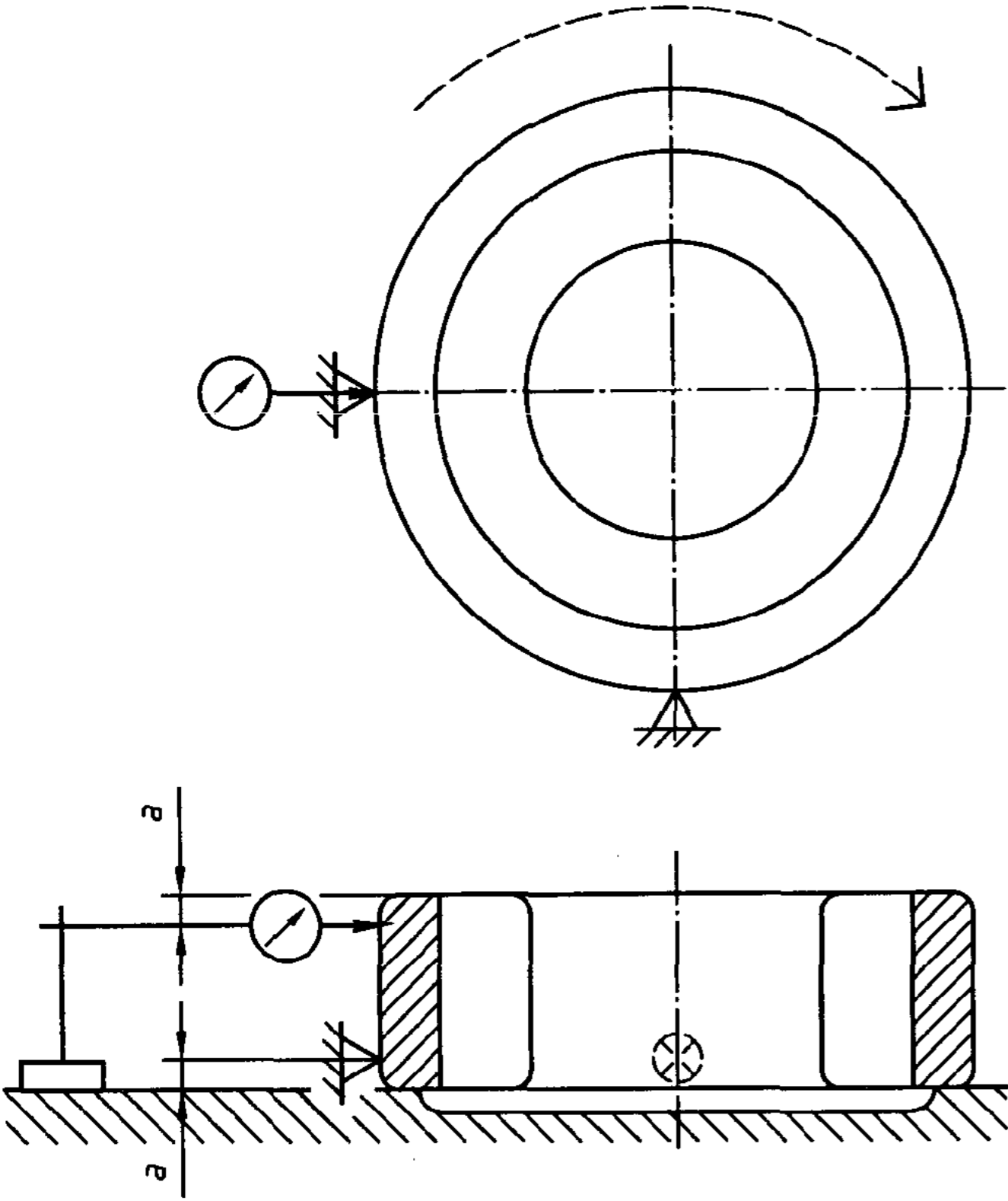
12.1 Measurement of perpendicularity of inner ring face with respect to the bore (method A)

Method	Comments
 <p data-bbox="100 1169 970 1246">Use a precision arbor having a taper of approximately 0,000 2:1 on diameter.</p> <p data-bbox="100 1288 970 1484">Mount the bearing assembly on the tapered arbor and place the arbor between two centres so that it can be accurately rotated. Position the indicator against the reference face of the inner ring at a radial distance from the arbor axis of half the mean diameter of the face.</p> <p data-bbox="100 1525 970 1602">Take indicator readings while rotating the inner ring one revolution.</p>	<p data-bbox="982 557 1839 712">This method is applicable to radial rolling bearings and their inner rings. It is most applicable to inner rings with an inner ring bore diameter-to-width ratio of less than four.</p> <p data-bbox="982 753 1839 878">The perpendicularity of the inner ring face with respect to the bore, S_d, is the difference between the largest and the smallest indicator readings.</p> <p data-bbox="982 920 1839 1026">NOTE Care must be taken when mounting the bearing on the arbor that the inner ring bore axis is coaxial with the arbor axis.</p> <p data-bbox="1033 1068 1591 1110">d_1 mean diameter of inner ring face</p>

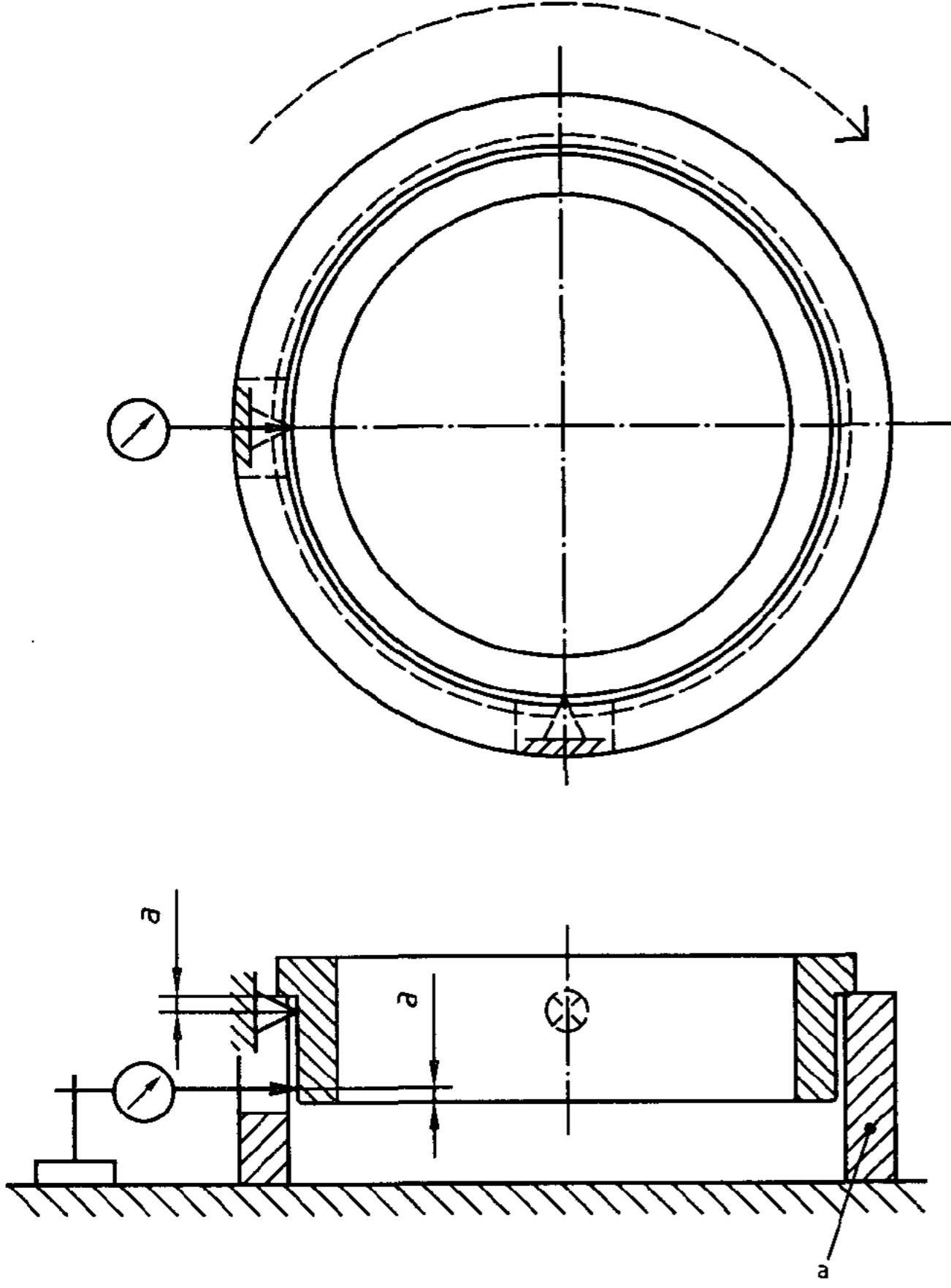
12.2 Measurement of perpendicularity of inner ring face with respect to the bore (method B)

Method	Comments
 <p>Support the reference face of the inner ring on a surface plate, leaving the outer ring, if an assembled bearing, free and locate the inner ring bore surface against two supports set at 90° to each other to centre the inner ring.</p> <p>Position the indicator directly above one support. The indicator and the two supports are axially located at the extremes of the measurement zone based on the chamfer size as specified in 5.7.</p> <p>Take indicator readings while rotating the inner ring one revolution.</p>	<p>This method is applicable to all types of radial rolling bearings and their inner rings. It is primarily applicable to large rings, where measurements are affected by bearing weight, or inner rings with a bore diameter-to-width ratio equal to or greater than four.</p> <p>This method of measurement defines the deviation of the bore with respect to the face and is converted to deviation of the face with respect to the bore, S_d, by calculation thus:</p> $S_d = \frac{S_{dr} \times d_1}{2 \times b_1}$ <p>S_d perpendicularity of inner ring face with respect to the bore</p> <p>S_{dr} difference between maximum indicator reading and minimum indicator reading</p> <p>d_1 mean diameter of inner ring face</p> <p>b_1 axial distance between the indicator and the fixed support directly below it</p>

12.3 Measurement of perpendicularity of outer ring outside surface with respect to the face

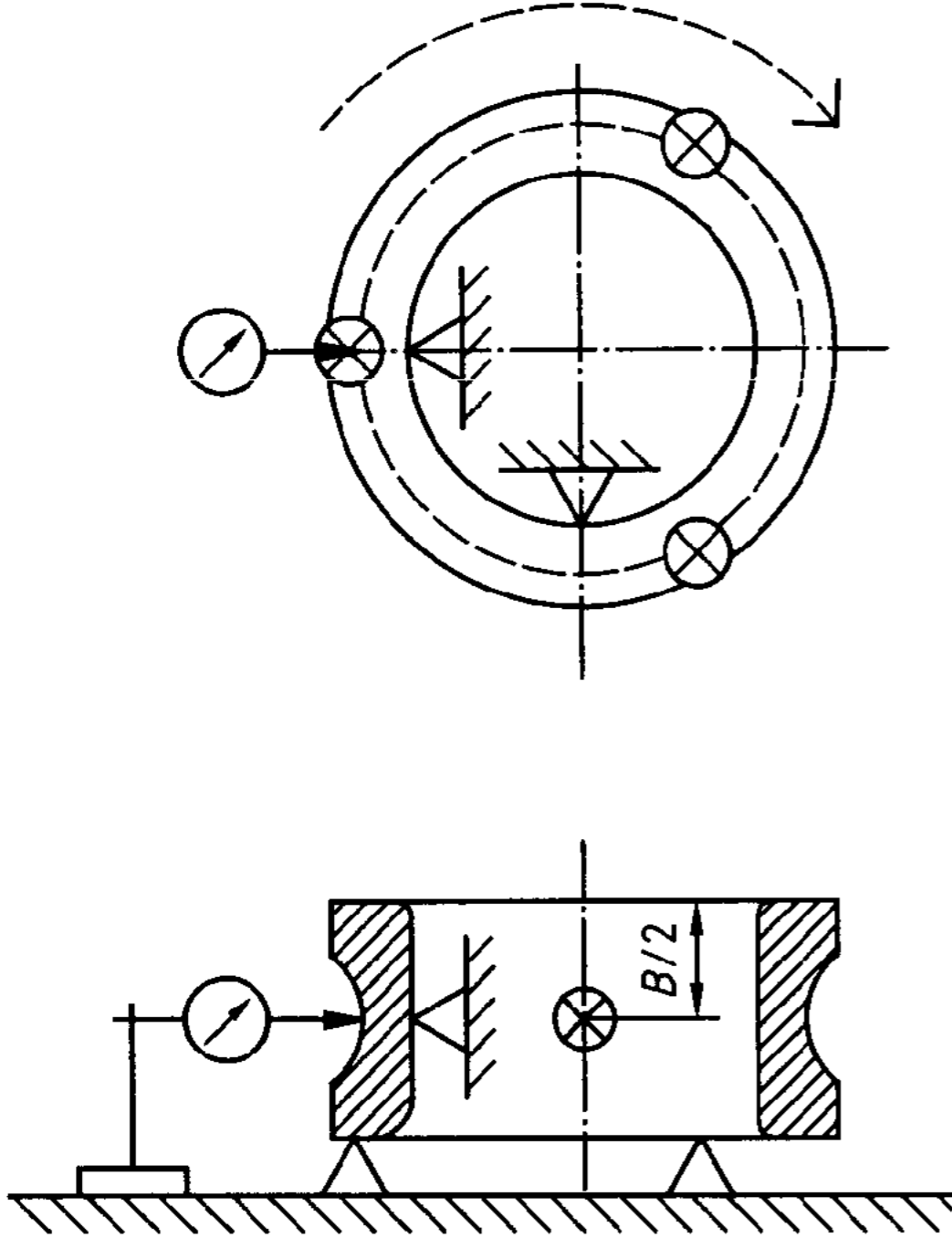
Method	Comments
 <p data-bbox="111 1516 968 1715">Support the reference face of the outer ring on a surface plate leaving the inner ring, if an assembled bearing, free. Locate the outer ring cylindrical outside surface against two supports set at 90° to each other to centre the outer ring.</p> <p data-bbox="111 1760 968 1914">Position the indicator directly above one support. The indicator and the two supports are axially located at the extremes of the measurement zone based on the chamfer size as specified in 5.7.</p> <p data-bbox="111 1955 968 2033">Take indicator readings while rotating the outer ring one revolution.</p>	<p data-bbox="978 460 1839 658">This method is applicable to all types of radial rolling bearings and their outer rings. It is particularly applicable to large rings, where measurements are affected by bearing weight, or rings with a diameter-to-width ratio equal to or greater than four.</p> <p data-bbox="978 700 1839 822">The perpendicularity of outer ring outside surface with respect to the face, S_D, is the difference between the largest and the smallest indicator readings.</p>

12.4 Measurement of perpendicularity of outer ring outside surface with respect to the flange back face

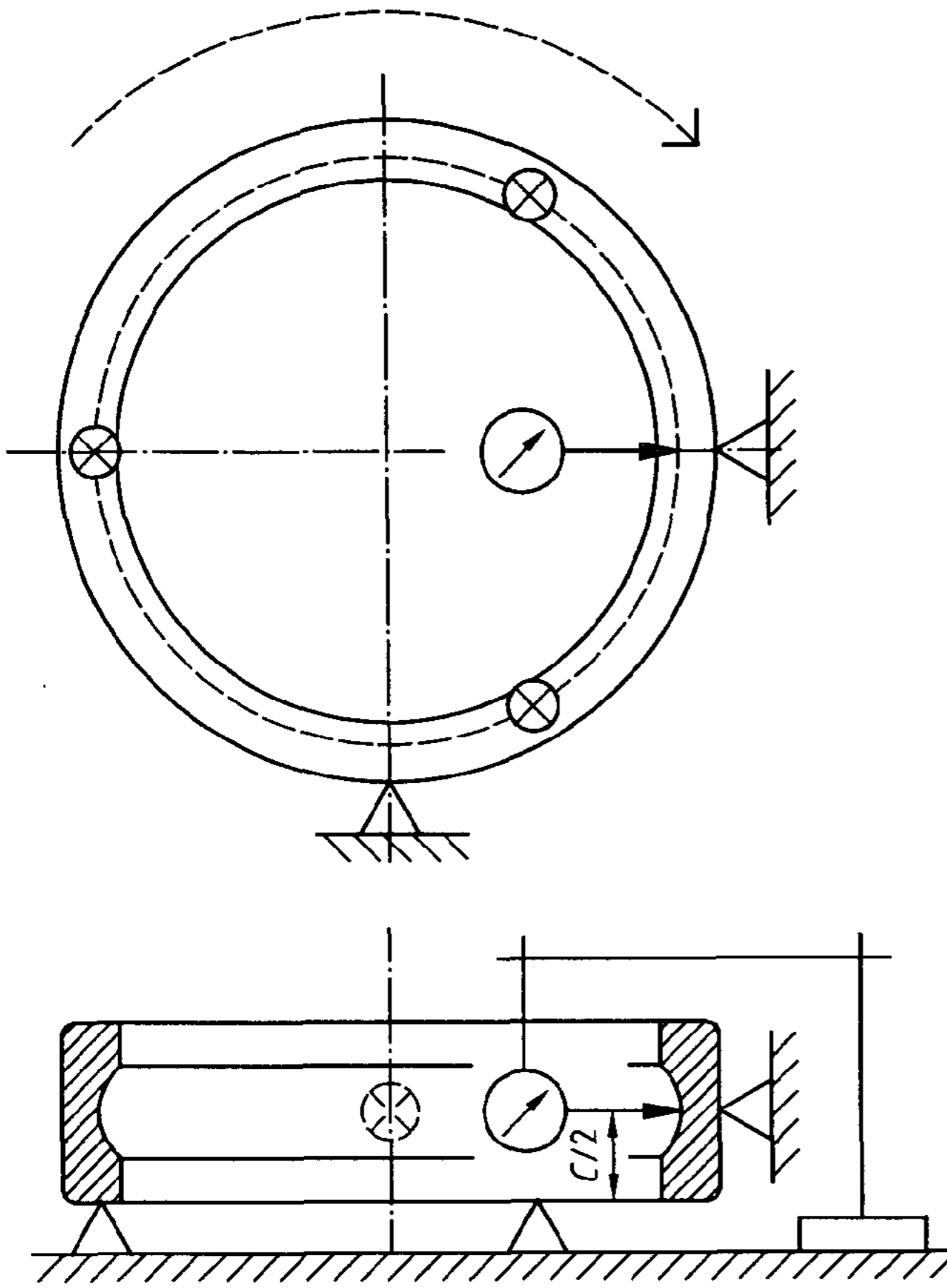
Method	Comments
 <p>a Cylindrical support ring</p> <p>Support the flange back face of the outer ring on the face of a cylindrical support ring, leaving the inner ring, if an assembled bearing, free. The bore diameter of the supporting ring should equal the mean diameter of the flange. Locate the outer ring outside diameter surface against two supports set at 90° to each other to centre the outer ring.</p> <p>NOTE Slots in the support ring permit access for side supports.</p> <p>Position the indicator directly below one support. The indicator and the two supports are axially located at the extremes of the measuring zone based on the chamfer size as specified in 5.7.</p> <p>Take indicator readings while rotating the outer ring one revolution.</p>	<p>This method is applicable to all types of radial rolling bearings with flanged outer rings.</p> <p>The perpendicularity of outer ring outside surface with respect to the flange back face, S_{D1}, is the difference between the largest and the smallest indicator readings.</p>

13 Principles of measuring thickness variation

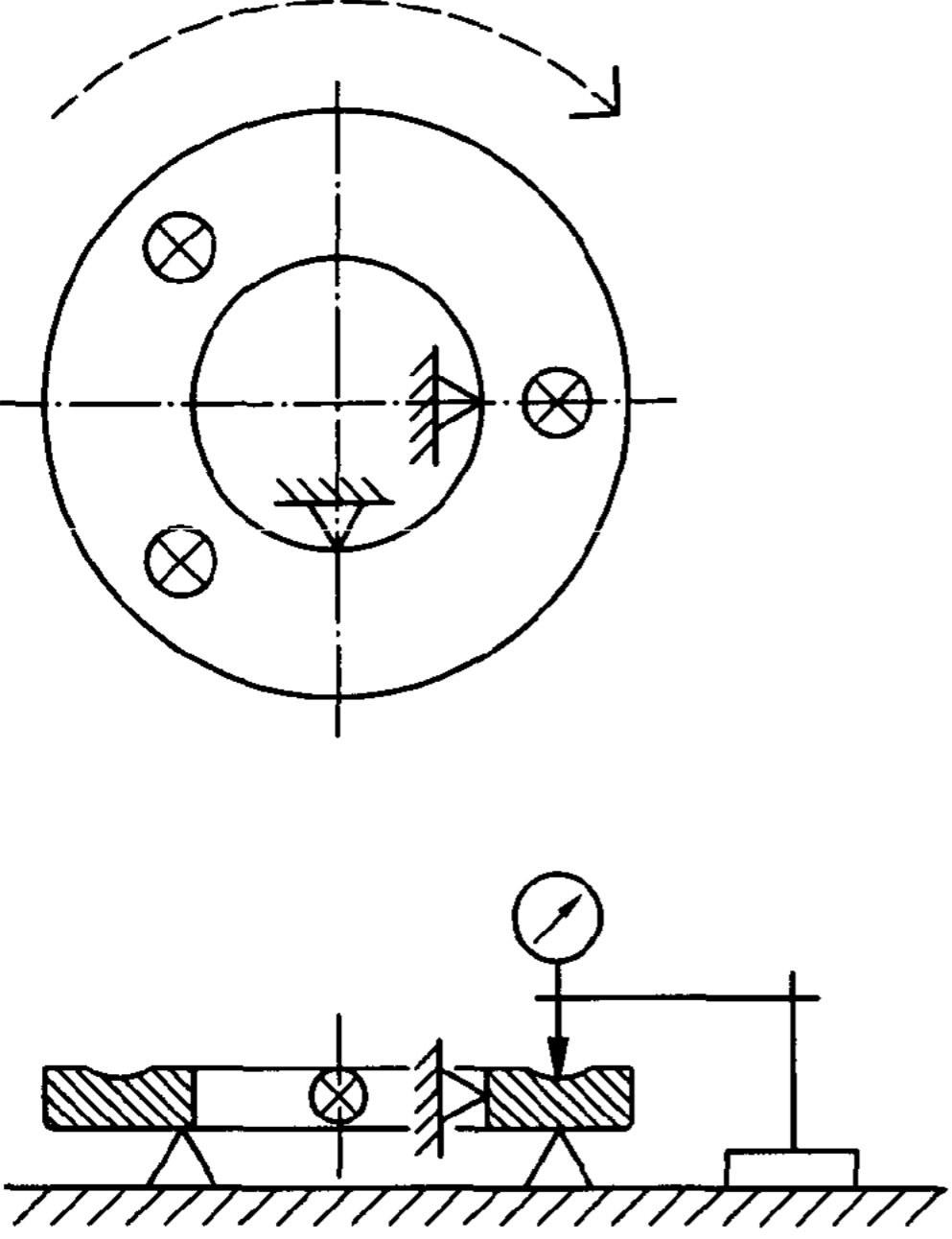
13.1 Measurement of variation in thickness between inner ring raceway and bore

Method	Comments
 <p>Support one face of the inner ring on three equally spaced fixed supports of equal height. Provide two suitable radial supports on the bore surface set at 90° to each other, at an axial distance of $B/2$, or opposite the middle of the raceway, to centre the inner ring.</p> <p>Position the indicator opposite one bore support.</p> <p>Take indicator readings while rotating the inner ring one revolution.</p>	<p>This method is applicable to all types of radial and angular contact rolling bearing inner rings.</p> <p>The variation in thickness between inner ring raceway and bore, K_i, is the difference between the largest and the smallest indicator readings.</p>

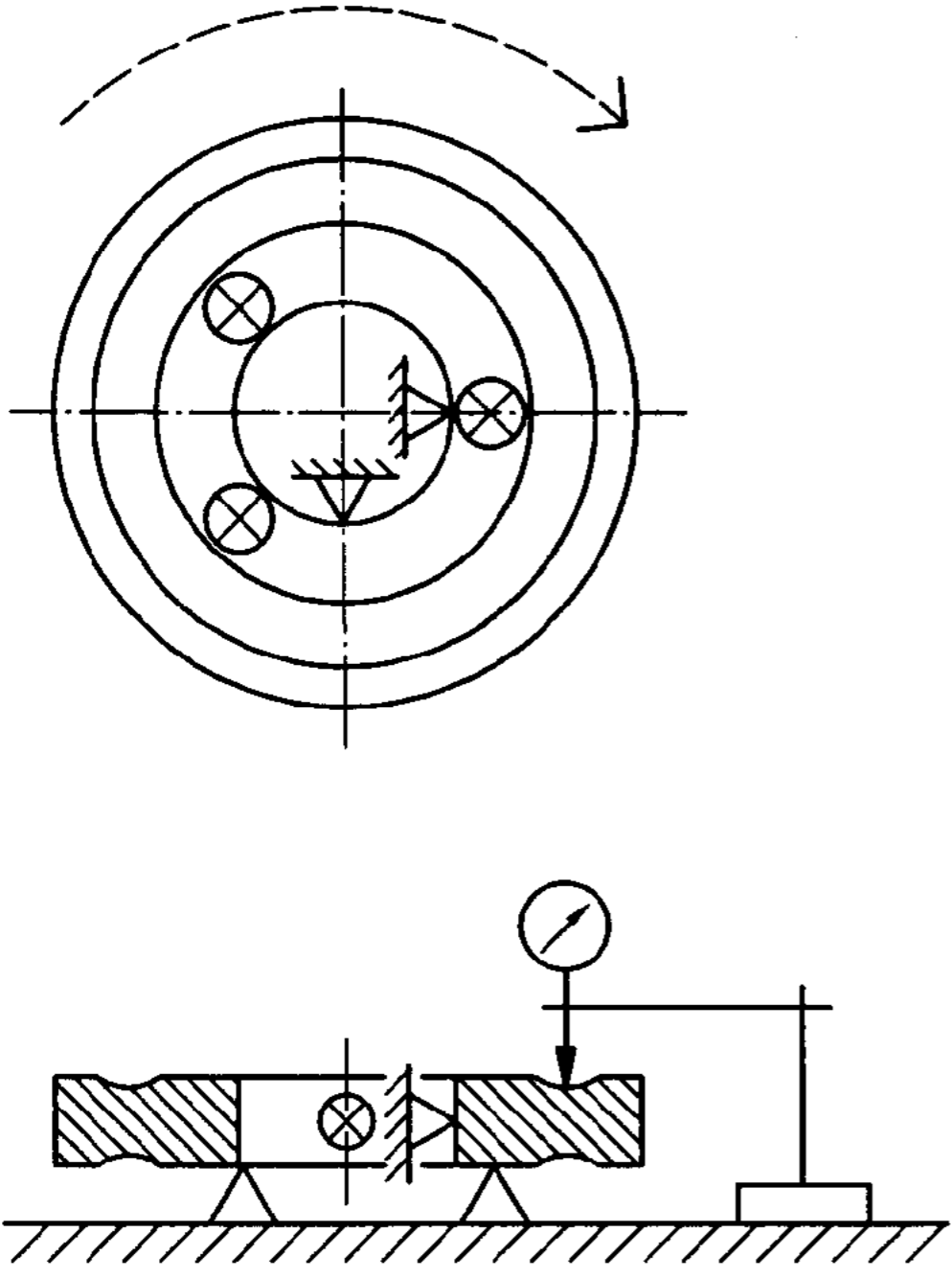
13.2 Measurement of variation in thickness between outer ring raceway and outside surface

Method	Comments
 <p data-bbox="126 1647 966 1884">Support one face of the outer ring on three equally spaced fixed supports of equal height. Provide two suitable radial supports on the outside surface set at 90° to each other, at an axial distance of $C/2$, or opposite the middle of the raceway, to centre the inner ring.</p> <p data-bbox="126 1914 966 2003">Position the indicator opposite one outside diameter support.</p> <p data-bbox="126 2033 966 2122">Take indicator readings while rotating the outer ring one revolution.</p>	<p data-bbox="997 460 1848 549">This method is applicable to all types of radial and angular contact rolling bearing outer rings.</p> <p data-bbox="997 578 1848 697">The variation in thickness between outer ring raceway and outside surface, K_e, is the difference between the largest and the smallest indicator readings.</p>

13.3 Measurement of variation in thickness between shaft washer raceway and back face

Method	Comments
 <p>Support the flat back face of the shaft washer on three equally spaced fixed supports of equal height. Provide two suitable radial supports on the bore surface, set at 90° to each other, to centre the shaft washer.</p> <p>Position the indicator against the middle of the raceway directly opposite one fixed support.</p> <p>With the washer in contact with the supports, take indicator readings while rotating the washer one revolution.</p>	<p>This method is applicable to shaft washers with a flat raceway or profiled raceway and flat back face.</p> <p>The variation in thickness between shaft washer raceway and back face, S_i, is the difference between the largest and the smallest indicator readings.</p>

13.4 Measurement of variation in thickness between raceway and back face of central shaft washer

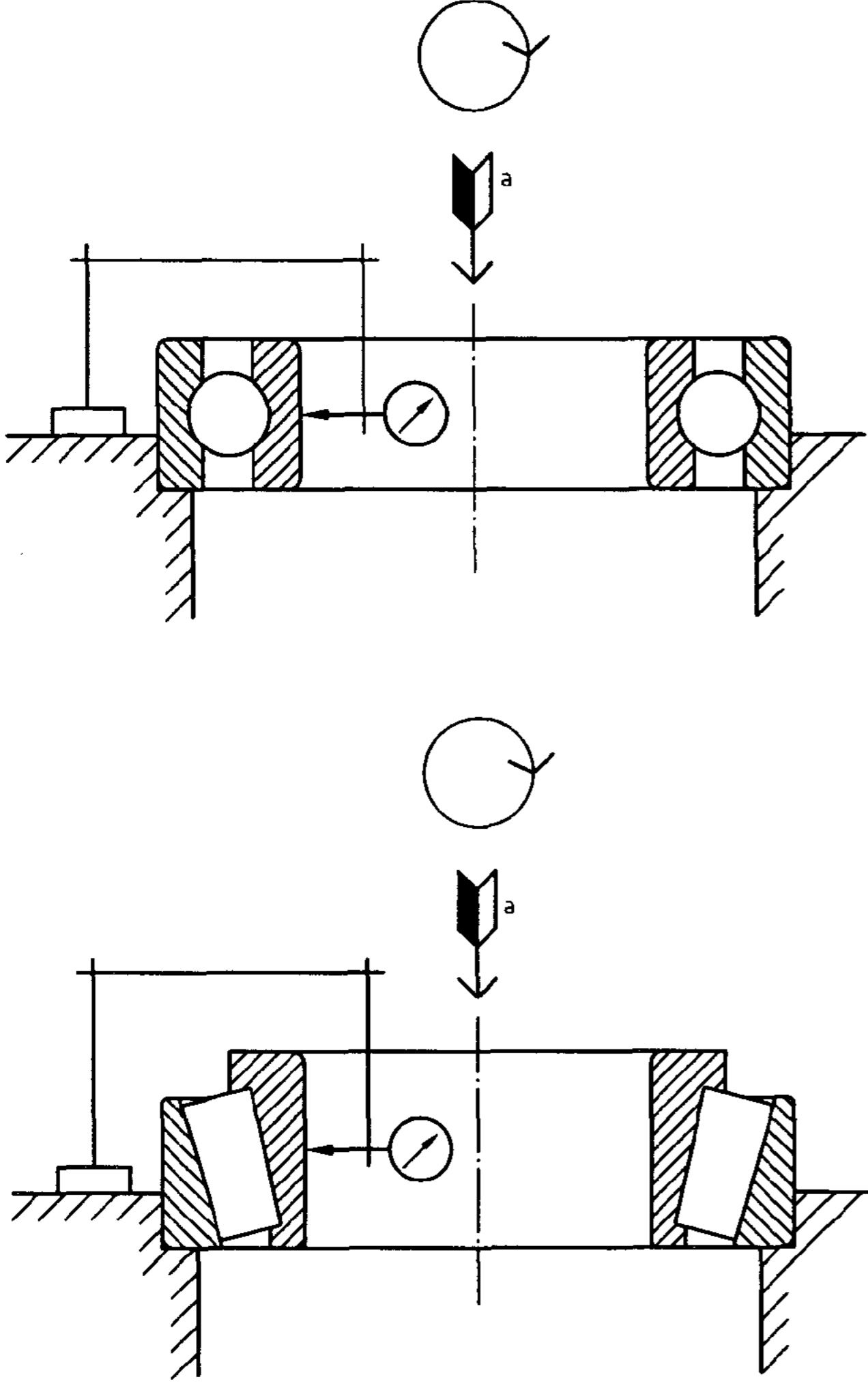
Method	Comments
 <p>Support a face of the central shaft washer on three equally spaced fixed supports of equal height. Provide two suitable radial supports on the bore surface, set at 90° to each other, to centre the shaft washer.</p> <p>Position the indicator against the middle of the raceway adjacent to one fixed support.</p> <p>With the washer in contact with the supports, take indicator readings while rotating the washer one revolution.</p> <p>Repeat the measurement for the opposite raceway.</p>	<p>This method is applicable to central shaft washers with a profiled raceway on each face.</p> <p>The variation in thickness between shaft washer raceway and back face, S_i, is the difference between the largest and the smallest indicator readings.</p> <p>Each variation of thickness of the back face to raceway is an independent measurement.</p>

13.5 Measurement of variation in thickness between housing washer raceway and back face

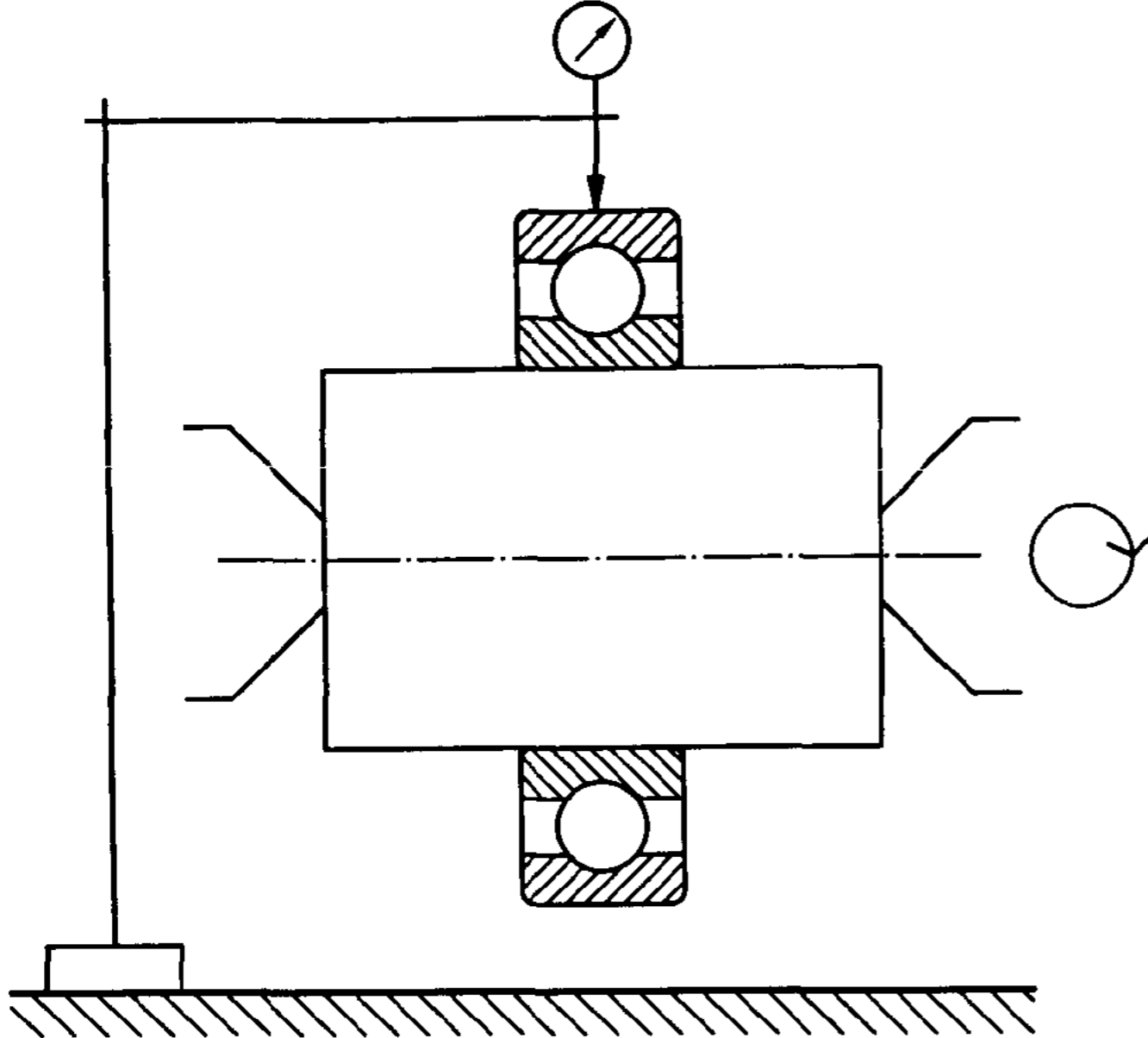
Method	Comments
<div data-bbox="220 468 861 1291" data-label="Image"> </div> <p data-bbox="115 1335 976 1528">Support the flat back face of the housing washer on three equally spaced fixed supports of equal height. Provide two suitable radial supports on the outside surface, set at 90° to each other, to centre the housing washer.</p> <p data-bbox="115 1573 976 1647">Position the indicator against the middle of the raceway directly opposite one fixed support.</p> <p data-bbox="115 1691 976 1810">With the washer in contact with the supports, take indicator readings while rotating the washer one revolution.</p>	<p data-bbox="987 460 1848 549">This method is applicable to housing washers with a flat raceway or profiled raceway and flat back face.</p> <p data-bbox="987 578 1848 697">The variation in thickness between housing washer raceway and back face, S_e, is the difference between the largest and the smallest indicator readings.</p>

14 Principles of measuring radial runout

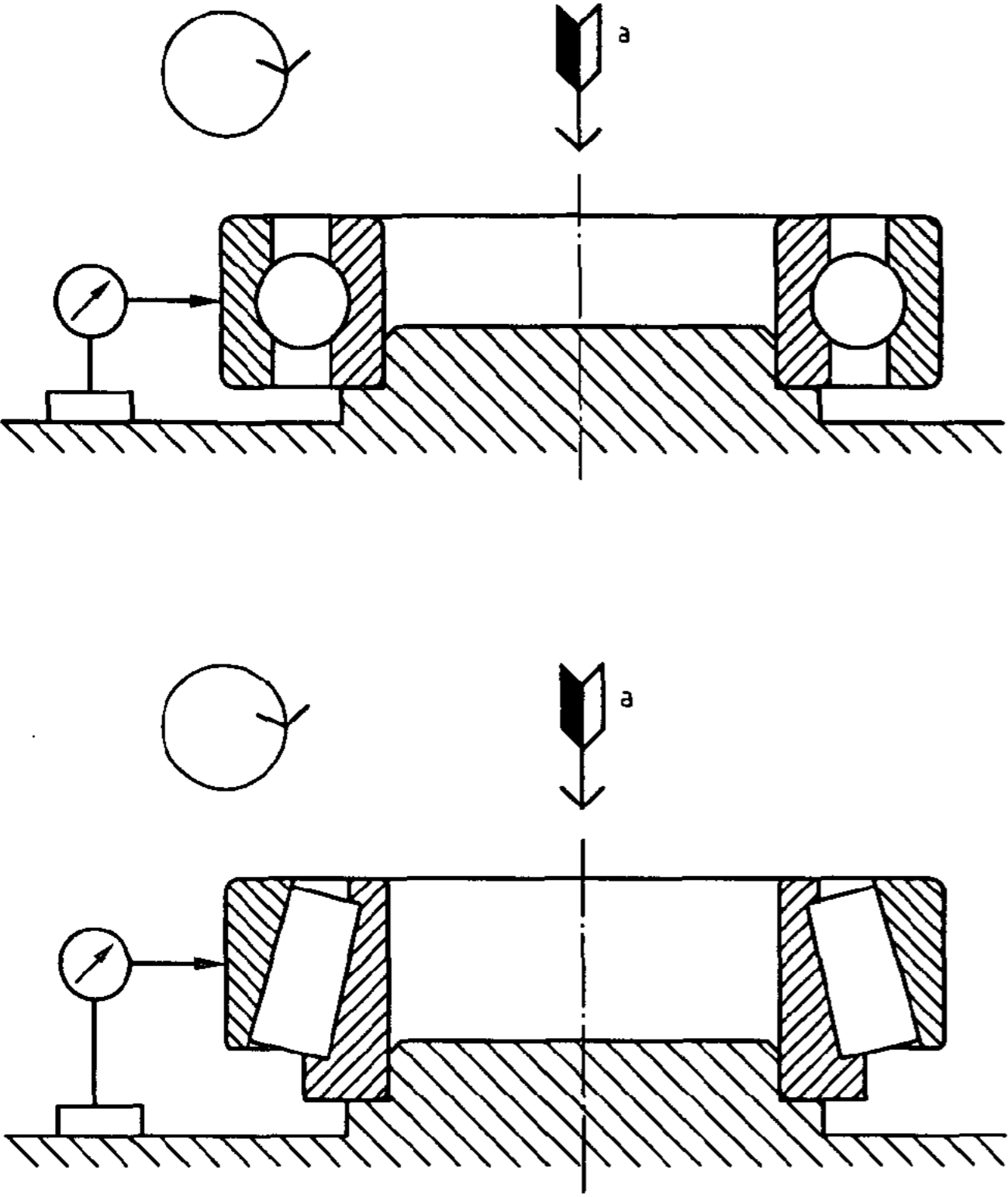
14.1 Measurement of radial runout of inner ring of assembled bearing (primary method)

Method	Comments
 <p data-bbox="121 1893 436 1932">a Load on inner ring</p> <p data-bbox="121 1970 982 2288">Support the reference face of the outer ring on a surface plate with a pilot for centering the outside diameter of the ring. Apply a dynamically stable coaxial load, as specified in 5.6, to the reference face of the inner ring in order to ensure contact between rolling elements and raceways. For tapered roller bearings, ensure the rolling elements are in contact with the inner ring back face rib and the raceways.</p> <p data-bbox="121 2332 982 2487">Position the indicator against the bore surface of the inner ring as close as possible to the middle of the inner ring raceway. Take indicator readings while rotating the inner ring one revolution.</p>	<p data-bbox="995 543 1858 697">This method is applicable to radial groove ball bearings (including single-row angular contact ball bearings), 4-point-contact ball bearings and tapered roller bearings.</p> <p data-bbox="995 742 1858 863">The radial runout of inner ring of assembled bearing, K_{ia}, is the difference between the largest and the smallest indicator readings.</p> <p data-bbox="995 908 1858 1338">Radial runout of the inner ring of an assembled bearing is the result of several factors (e.g. variation of rolling element diameter, raceway imperfections and waviness, variation of contact angle, reference face/surface flatness and lubricant contaminant). Accurate measurement is difficult, particularly in higher precision classes of bearings. In cases of dispute, the producer and the user may agree on a more specific method, which may include the measurement of individual components as specified in 11.1, 11.2, 13.1 and 13.2.</p>

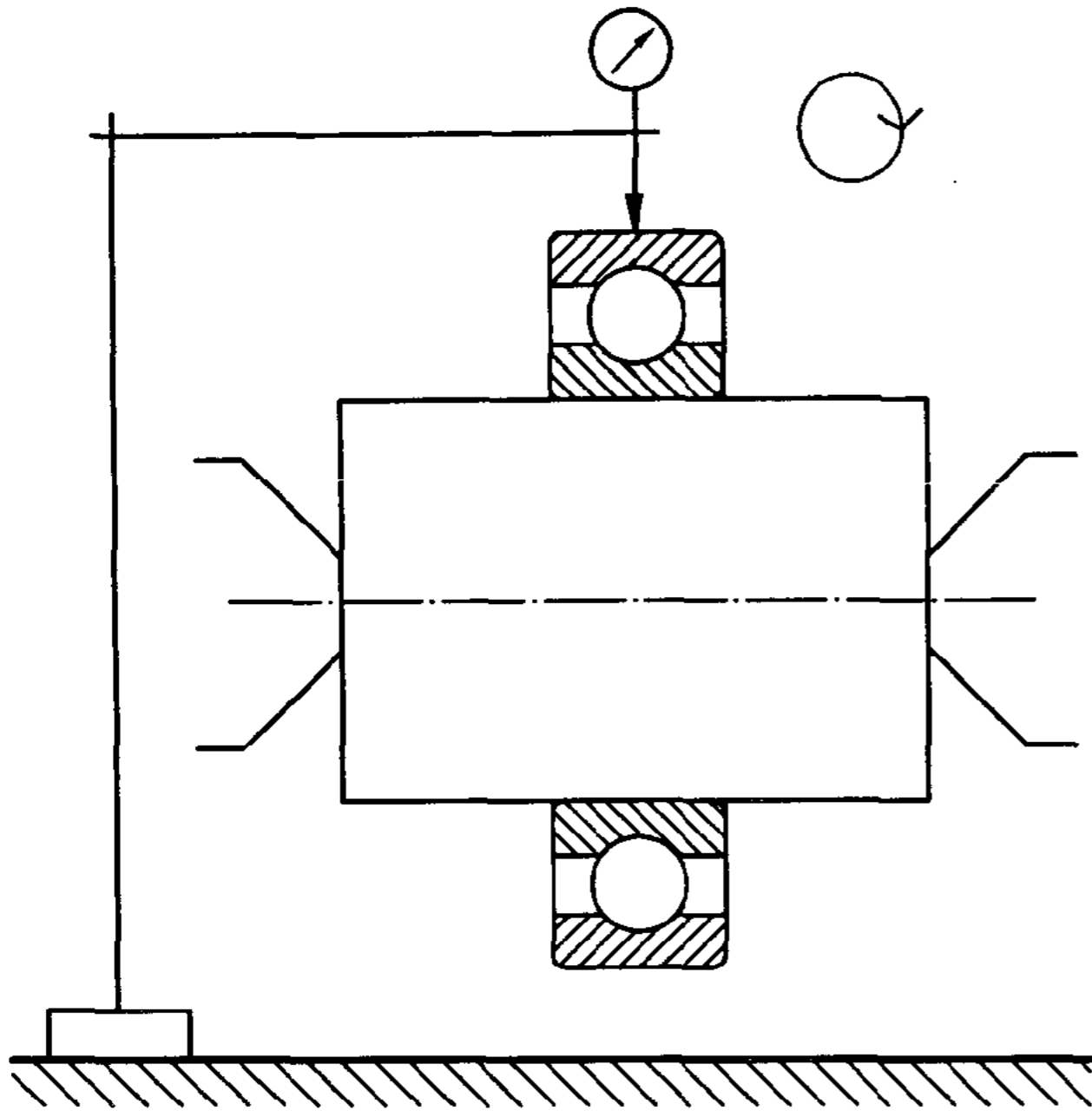
14.2 Measurement of radial runout of inner ring of assembled bearing (alternative method)

Method	Comments
 <p>Use a precision arbor having a taper of approximately 0,000 2:1 on diameter.</p> <p>Mount the bearing assembly on the tapered arbor and place the arbor between two centres so that it can be accurately rotated.</p> <p>Position the indicator against the outside surface of the outer ring as close as possible to the middle of the outer ring raceway.</p> <p>Hold the outer ring to prevent rotation but ensure its weight is supported by the rolling elements. Take indicator readings while rotating the arbor one revolution.</p>	<p>This method is applicable to radial groove ball bearings (except single-row angular contact ball bearings), radial cylindrical roller, spherical roller and needle roller bearings.</p> <p>The radial runout of inner ring of assembled bearing, K_{ia}, is the difference between the largest and the smallest indicator readings.</p> <p>Radial runout of the inner ring of an assembled bearing is the result of several factors (e.g. variation of rolling element diameter, raceway imperfections and waviness, variation of contact angle, reference face/surface flatness and lubricant contaminant). Accurate measurement is difficult, particularly in higher precision classes of bearings. In cases of dispute, the producer and the user may agree on a more specific method, which may include the measurement of individual components as specified in 11.1, 11.2, 13.1 and 13.2.</p>

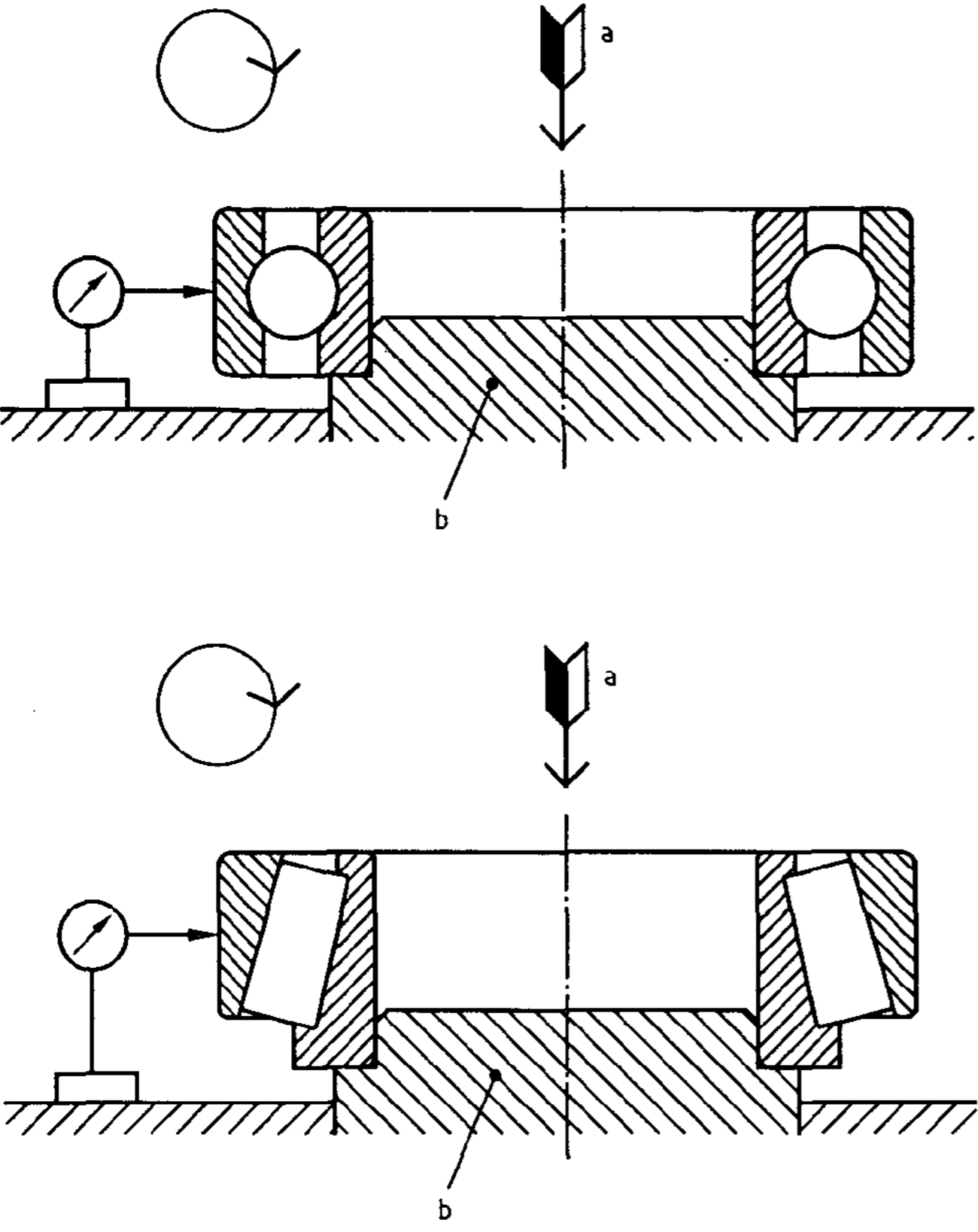
14.3 Measurement of radial runout of outer ring of assembled bearing (primary method)

Method	Comments
 <p data-bbox="121 1498 436 1537">a Load on outer ring</p> <p data-bbox="121 1578 982 1893">Support the reference face of the inner ring on a surface plate with a pilot for centering the bore of the ring. Apply a dynamically stable coaxial load, as specified in 5.6, to the reference face of the outer ring in order to ensure contact between rolling elements and raceways. For tapered roller bearings, ensure the rolling elements are in contact with the inner ring back face rib and the raceways.</p> <p data-bbox="121 1935 982 2092">Position the indicator against the outside surface of the outer ring as close as possible to the middle of the outer ring raceway and take indicator readings while rotating the outer ring one revolution.</p>	<p data-bbox="997 460 1852 617">This method is applicable to radial groove ball bearings (including single-row angular contact ball bearings), 4-point-contact ball bearings and tapered roller bearings.</p> <p data-bbox="997 658 1852 777">The radial runout of outer ring of assembled bearing, K_{ea}, is the difference between the largest and the smallest indicator readings.</p> <p data-bbox="997 819 1852 1210">Radial runout of the outer ring of an assembled bearing is the result of several factors (e.g. variation of rolling element size, raceway imperfections and waviness, variation of contact angle, reference face/surface flatness and lubricant contaminant). Accurate measurement is difficult, particularly in higher precision classes of bearings. In cases of dispute, the producer and the user may agree on a more specific method, which may include the measurement of individual components as specified in 11.1, 11.2, 13.1 and 13.2.</p>

14.4 Measurement of radial runout of outer ring of assembled bearing (alternative method)

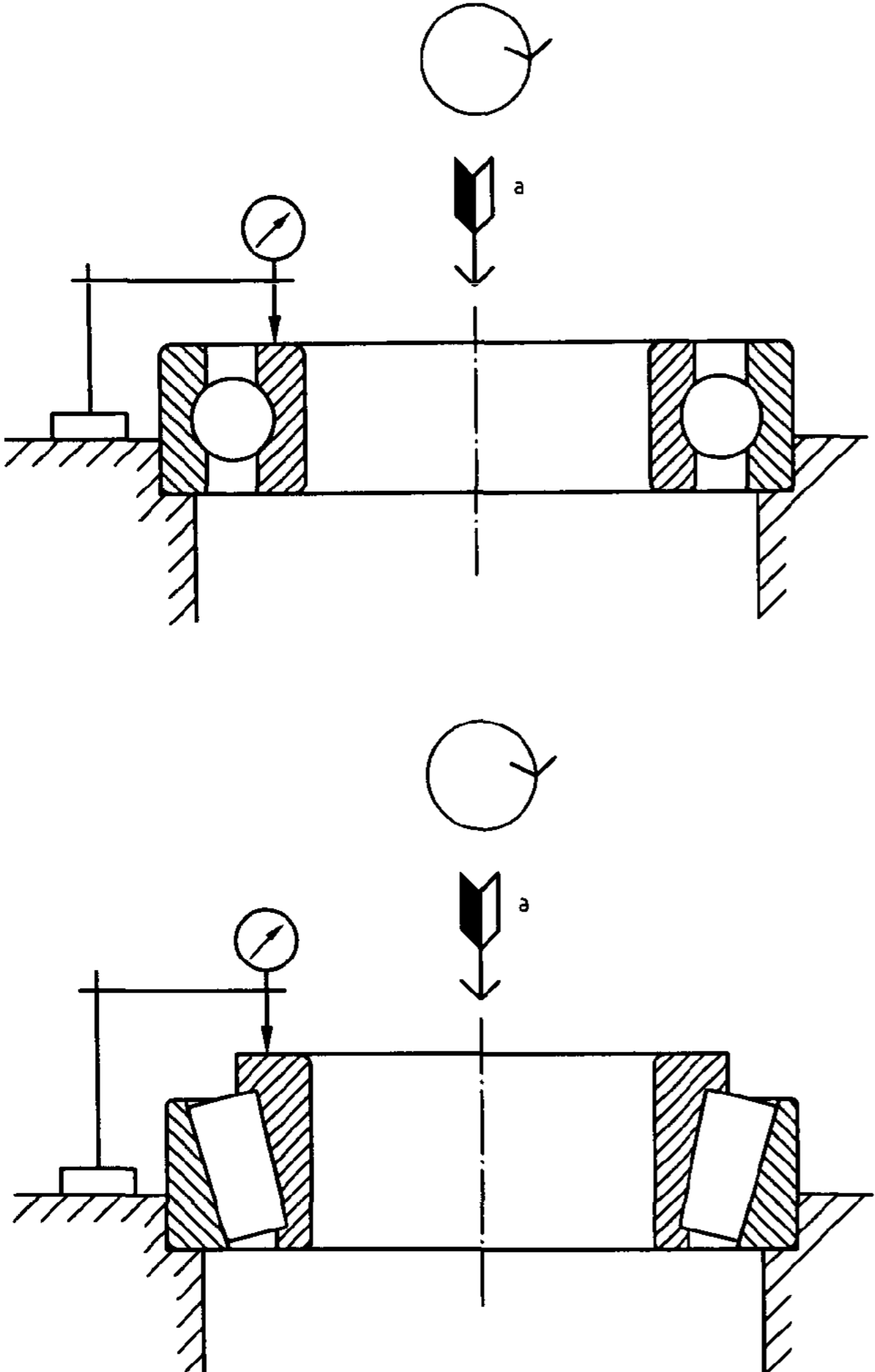
Method	Comments
 <p>Use a precision arbor having a taper of approximately 0,000 2:1 on diameter.</p> <p>Mount the bearing assembly on the tapered arbor and place the arbor between two centres so that it can be accurately rotated.</p> <p>Position the indicator against the outside surface of the outer ring as close as possible to the middle of the outer ring raceway.</p> <p>Hold the inner ring stationary. Take indicator readings while rotating the outer ring one revolution.</p>	<p>This method is applicable to radial groove ball bearings (except single-row angular contact ball bearings), radial cylindrical roller, spherical roller and needle roller bearings.</p> <p>The radial runout of outer ring of assembled bearing, K_{ea}, is the difference between the largest and the smallest indicator readings.</p> <p>Radial runout of the outer ring of an assembled bearing is the result of several factors (e.g. variation of rolling element diameter, raceway imperfections and waviness, variation of contact angle, reference face/surface flatness and lubricant contaminant). Accurate measurement is difficult, particularly in higher precision classes of bearings. In cases of dispute, the producer and the user may agree on a more specific method, which may include the measurement of individual components as specified in 11.1, 11.2, 13.1 and 13.2.</p>

14.5 Measurement of asynchronous radial runout of inner ring of assembled bearing

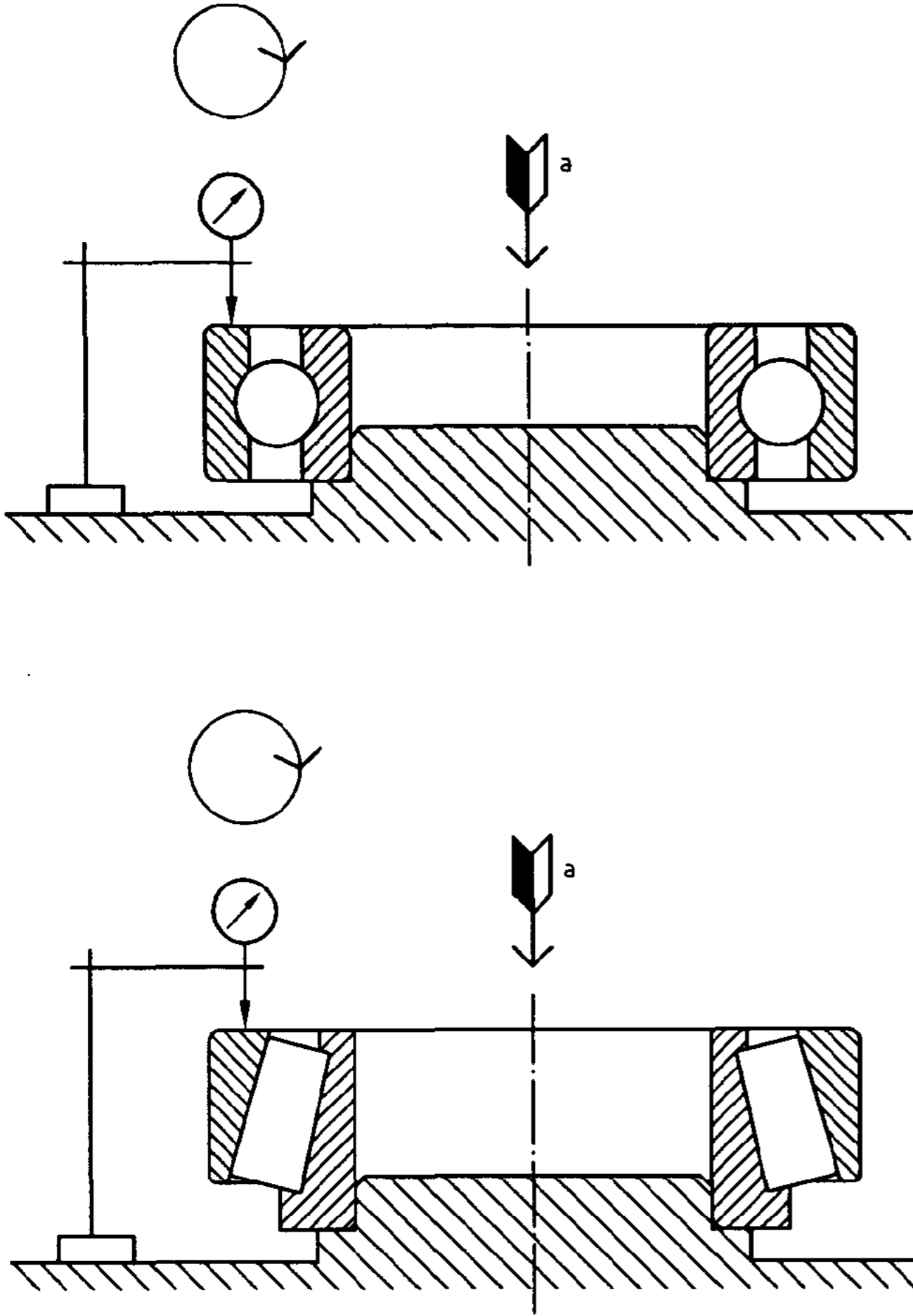
Method	Comments
 <p>a Load on outer ring b Rotatable surface plate</p> <p>Support the reference face of the inner ring on a rotatable surface plate with a pilot for centering in the bore of the ring. Prevent relative rotation between the bearing inner ring and the surface plate. Apply a dynamically stable coaxial load, as specified in 5.6, to the reference face of the outer ring in order to ensure contact between rolling elements and raceways. For tapered roller bearings, ensure the rolling elements are in contact with the inner ring back face rib and the raceways.</p> <p>Position the indicator against the outside surface of the stationary outer ring as close as possible to the middle of the outer ring raceway. While rotating the inner ring (with surface plate) through multiple revolutions in both directions, record the largest indicator readings for each revolution.</p> <p>Reposition the indicator against another radial location on the outside surface of the outer ring and repeat the measurements with multiple revolutions of the inner ring in both directions. Repeat measurements with the indicator repositioned to different radial locations on the outer ring outside surface.</p>	<p>This method is applicable to radial groove ball bearings (including single-row angular contact ball bearings), 4-point-contact ball bearings and tapered roller bearings.</p> <p>The asynchronous radial runout of inner ring of assembled bearing, K_{iaa}, is the range of the largest indicator readings when measured with multiple revolutions of the inner ring and with different fixed points on the outer ring.</p> <p>Measurements should be made with the inner ring rotated through many revolutions in both directions.</p> <p>Asynchronous radial runout of an assembled bearing is the result of several factors (e.g. variation of rolling element diameter, raceway imperfections and waviness, variation of contact angle, reference face/surface flatness and lubricant contaminant). Accurate measurement is difficult, particularly in higher precision classes of bearings. In cases of dispute, the producer and the user may agree on a more specific method, which may include the measurement of individual components as specified in 11.1, 11.2, 13.1 and 13.2.</p>

15 Principles of measuring axial runout

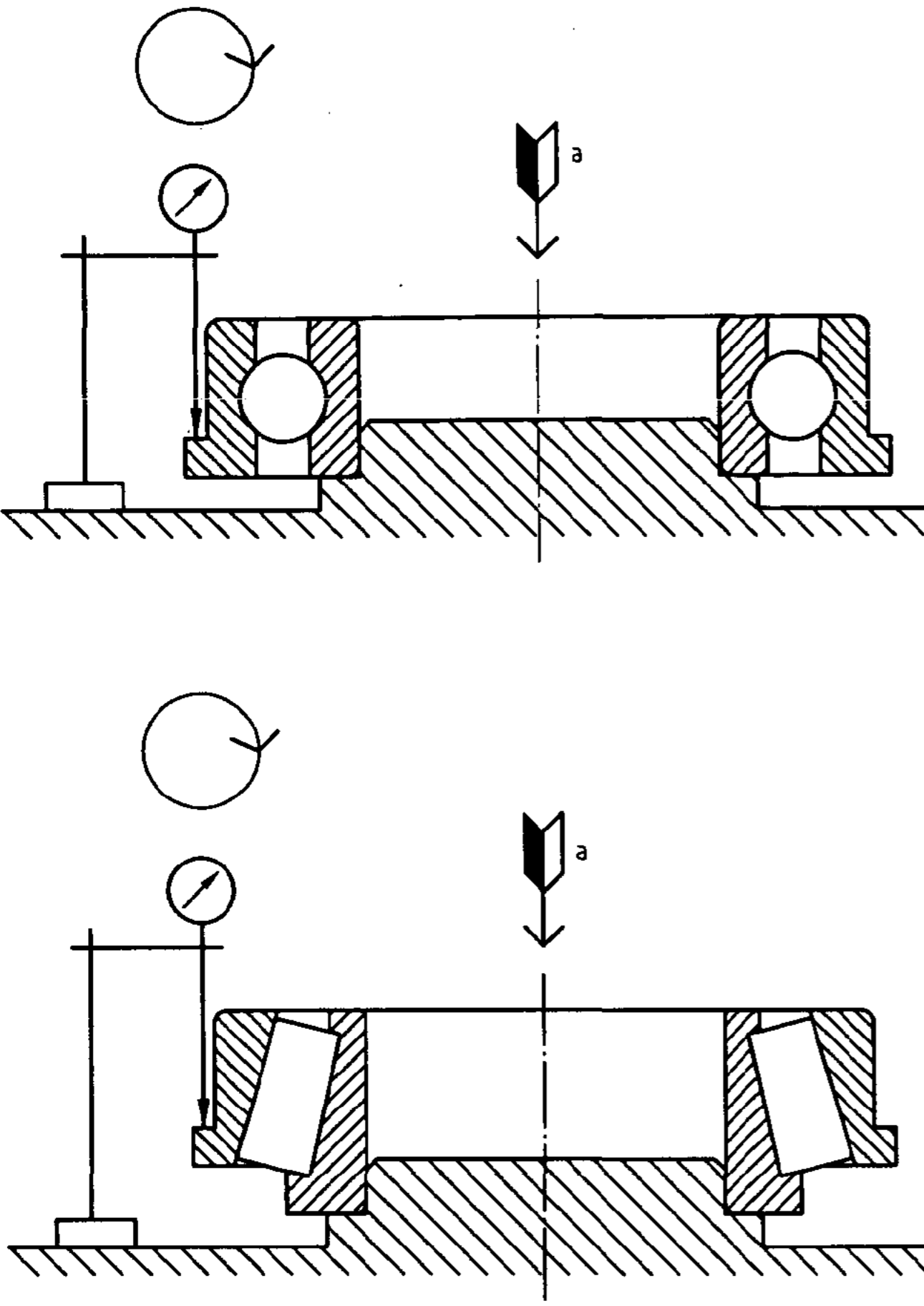
15.1 Measurement of axial runout of inner ring of assembled bearing

Method	Comments
 <p data-bbox="121 1884 441 1914">a Load on inner ring</p> <p data-bbox="121 1958 982 2270">Support the reference face of the outer ring on a surface plate with a pilot for centering the outside diameter of the ring. Apply a dynamically stable coaxial load, as specified in 5.6, to the reference face of the inner ring in order to ensure contact between rolling elements and raceways. For tapered roller bearings, ensure the rolling elements are in contact with the inner ring back face rib and the raceways.</p> <p data-bbox="121 2315 982 2433">Position the indicator against the reference face of the inner ring and take indicator readings while rotating the inner ring one revolution.</p>	<p data-bbox="997 549 1848 697">This method is applicable to radial groove ball bearings (including single-row angular contact ball bearings), 4-point-contact ball bearings and tapered roller bearings.</p> <p data-bbox="997 742 1848 860">The axial runout of inner ring of assembled bearing, S_{ia}, is the difference between the largest and the smallest indicator readings.</p> <p data-bbox="997 905 1848 1291">Axial runout of the inner ring of an assembled bearing is the result of several factors (e.g. variation of rolling element diameter, raceway imperfections and waviness, variation of contact angle, reference face/surface flatness and lubricant contaminant). Accurate measurement is difficult, particularly in higher precision classes of bearings. In cases of dispute, the producer and the user may agree on a more specific method, which may include the measurement of individual components as specified in 11.1, 11.2, 13.1 and 13.2.</p>

15.2 Measurement of axial runout of outer ring of assembled bearing

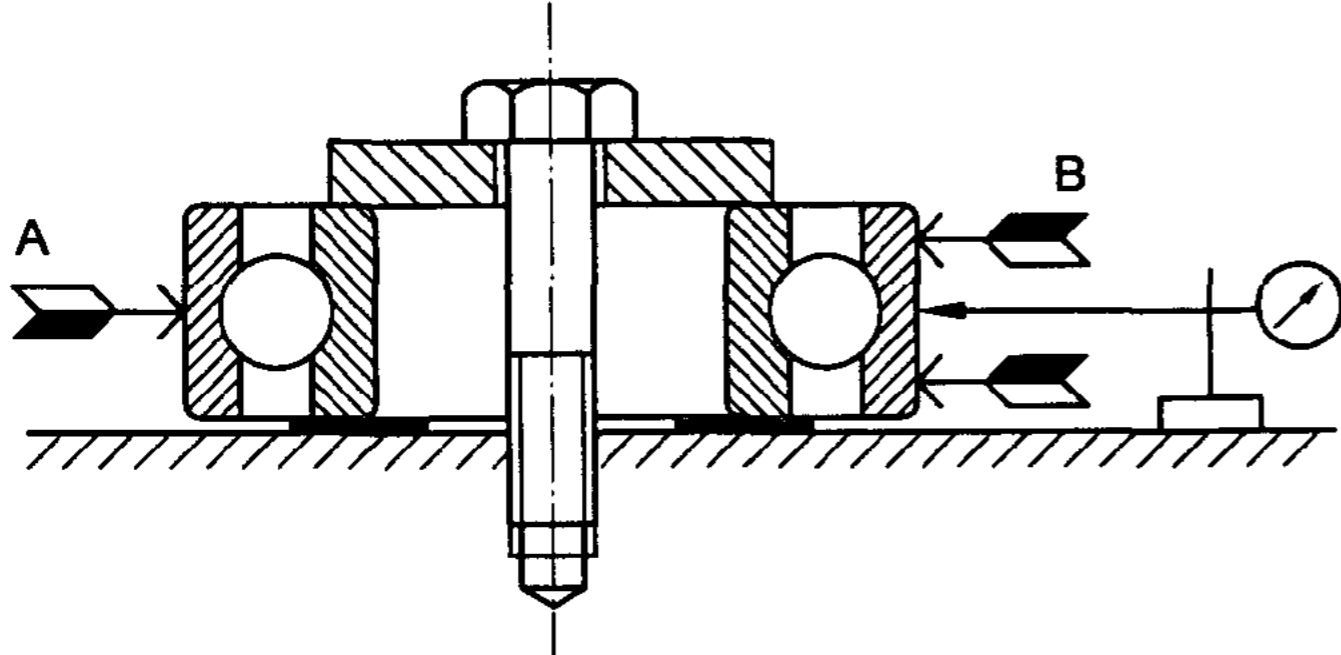
Method	Comments
 <p data-bbox="130 1697 443 1736">a Load on outer ring</p> <p data-bbox="130 1774 989 2092">Support the reference face of the inner ring on a surface plate with a pilot for centering in the bore of the inner ring. Apply a dynamically stable coaxial load, as specified in 5.6, to the reference face of the outer ring in order to ensure contact between rolling elements and raceways. For tapered roller bearings, ensure the rolling elements are in contact with the inner ring back face rib and the raceways.</p> <p data-bbox="130 2131 989 2249">Position the indicator against the reference face of the outer ring and take indicator readings while rotating the outer ring one revolution.</p>	<p data-bbox="999 460 1858 617">This method is applicable to groove ball bearings (including single-row angular contact ball bearings), 4-point-contact ball bearings and tapered roller bearings.</p> <p data-bbox="999 655 1858 774">The axial runout of outer ring of assembled bearing, S_{ea}, is the difference between the largest and the smallest indicator readings.</p> <p data-bbox="999 813 1858 1249">Axial runout of the outer ring of an assembled bearing is the result of several factors (e.g. variation of rolling element diameter, raceway imperfections and waviness, variation of contact angle, reference face/surface flatness and lubricant contaminant). Accurate measurement is difficult, particularly in higher precision classes of bearings. In cases of dispute, the producer and the user may agree on a more specific method, which may include the measurement of individual components as specified in 11.1, 11.2, 13.1 and 13.2.</p>

15.3 Measurement of axial runout of outer ring flange back face of assembled bearing

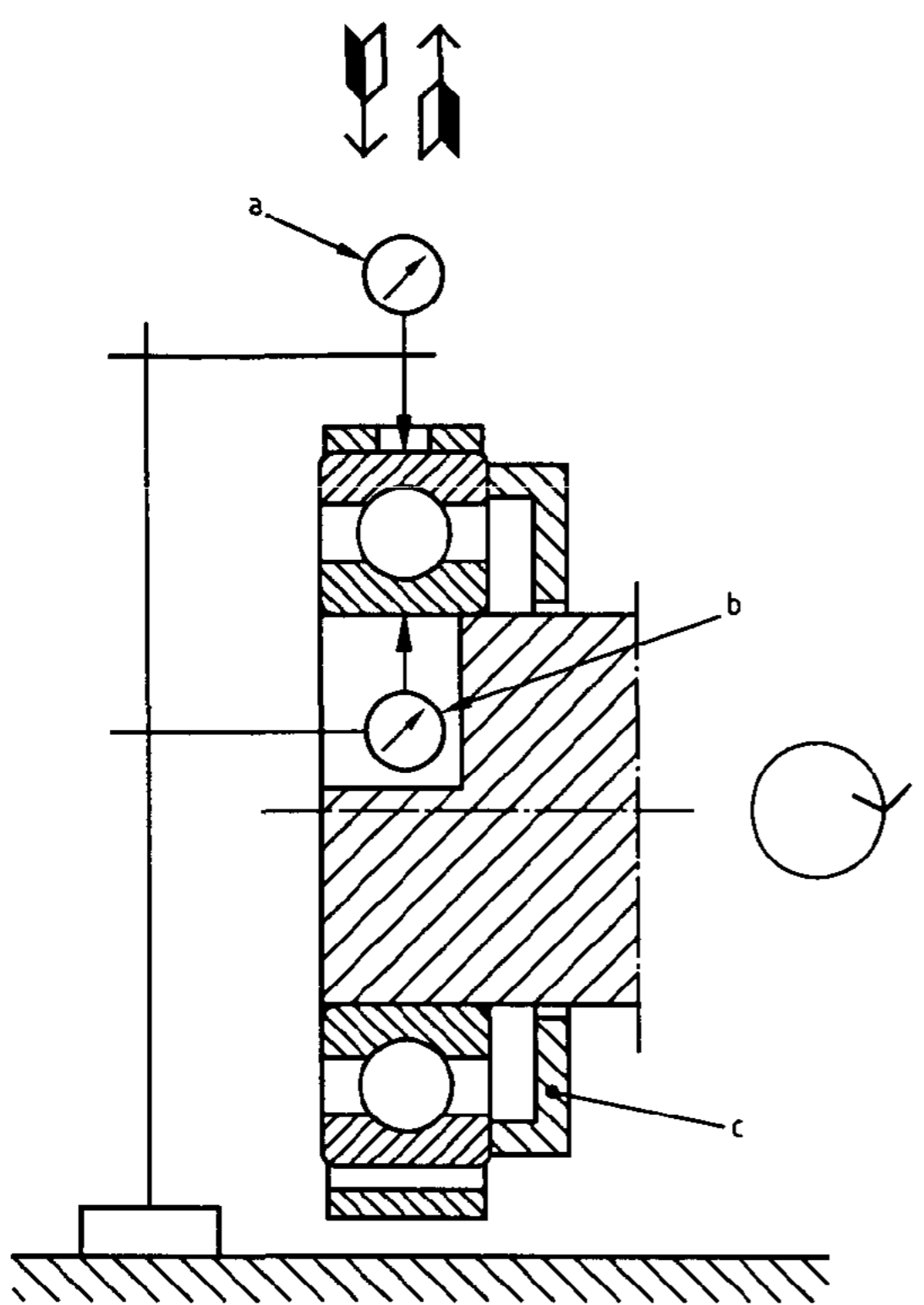
Method	Comments
 <p data-bbox="121 1656 441 1697">a Load on outer ring</p> <p data-bbox="121 1736 982 2062">Support the reference face of the inner ring on a surface plate with a pilot for centering in the bore of the inner ring. Apply a dynamically stable coaxial load, as specified in 5.6, to the reference face of the outer ring in order to ensure contact between rolling elements and raceways. For tapered roller bearings, ensure the rolling elements are in contact with the inner ring back face rib and the raceways.</p> <p data-bbox="121 2092 982 2211">Position the indicator against the outer ring flange back face in the middle of the flange and take indicator readings while rotating the outer ring one revolution.</p>	<p data-bbox="991 451 1856 617">This method is applicable to radial groove ball bearings (including single-row angular contact ball bearings), 4-point-contact ball bearings and tapered roller bearings with outer ring flanges.</p> <p data-bbox="991 652 1856 777">The axial runout of outer ring flange back face of assembled bearing, S_{ea1}, is the difference between the largest and the smallest indicator readings.</p> <p data-bbox="991 813 1856 1252">Axial runout of the outer ring flange back face of an assembled bearing is the result of several factors (e.g. variation of rolling element diameter, raceway imperfections and waviness, variation of contact angle, reference face/surface flatness and lubricant contaminant). Accurate measurement is difficult, particularly in higher precision classes of bearings. In cases of dispute, the producer and the user may agree on a more specific method, which may include the measurement of individual components as specified in 11.1, 11.2, 13.1 and 13.2.</p>

16 Principles of measuring radial clearance

16.1 Measurement of radial internal clearance (method A)

Method	Comments
 <p>Fasten the inner ring of the assembled bearing on a surface plate with a shim inserted between the inner ring face and the surface plate. For spherical roller bearings, the outer ring should be prevented from tilting.</p> <p>Position the indicator against the outer ring outside surface and in line with the middle of the raceway. Hold the outer ring in contact with the rest of the bearing in direction "A", taking care not to lift the opposite side. Axially move the outer ring repeatedly in one direction and then the other and oscillate the ring circumferentially (for the purpose of moving the rolling elements to the bottom of the raceway) until the indicator gives a consistent maximum reading.</p> <p>While continuing to hold the outer ring lightly in contact with the rest of the bearing in direction "A", axially move the outer ring in one direction and then the other without circumferential motion. When the rolling elements pass over the bottom of the raceways, the indicator will show a maximum reading, which is recorded.</p> <p>Without changing the general location of the outer ring, hold it in contact with the bearing in direction "B", taking care not to lift the opposite side. Axially move the outer ring repeatedly in one direction and then the other and oscillate circumferentially (for purpose of moving the rolling elements to the bottom of the raceway) until the indicator gives a consistent minimum reading.</p> <p>Then, while continuing to hold the outer ring lightly in contact with the rest of the bearing in direction "B", axially move the outer ring in one direction and then the other without circumferential motion. When the rolling elements pass over the bottom of the raceway, the indicator will show a minimum reading, which is recorded.</p> <p>Compensate for possible out-of-roundness of the outer ring and inner ring by repeating the same procedure several times at different angular positions.</p>	<p>This method is used for measuring radial internal clearance and is applicable to all radial bearings except single-row angular contact ball bearings and tapered roller bearings.</p> <p>This method is used for measuring the radial internal clearance directly using simple means and without the use of a master bearing.</p> <p>The difference between minimum and maximum measured readings is the measured radial internal clearance. The average of the several sets of measurements is the radial internal clearance, G_r, of the bearing.</p> <p>Since radial internal clearance is defined as being under no load, the measured values must be adjusted to compensate for deflections that may occur during measurement.</p> <p>NOTE If the indicator needle does not pass through a clearly largest and smallest reading, the shim is probably too thin.</p>

16.2 Measurement of radial internal clearance (method B)

Method	Comments																												
<div style="text-align: center;">  </div> <p>a Indicator A b Indicator B c Stop</p> <p>Mount the assembled bearing on a close-fitting rigid arbor. Position indicator "A" against the outer ring outside surface in line with the middle of the raceway. Position indicator "B" against the inner ring bore surface in line with the middle of the raceway. Rotate the inner ring and displace the outer ring radially under a radial measuring load as given in the adjacent table.</p> <p>Record mean readings A_{m1} and B_{m1} of indicators "A" and "B". Reverse the radial measuring load and record the mean readings A_{m2} and B_{m2} of indicators "A" and "B". Record the differences Δ_{Am} and Δ_{Bm} between the two sets of readings.</p> <p>Repeat the measurement in two more positions after turning the outer ring 120° each time (three measuring operations in all).</p>	<p>This method is used for measuring radial internal clearance and is applicable to deep groove ball bearings, radial cylindrical roller bearings, and radial spherical roller bearings.</p> <p>The bearing radial internal clearance, G_r, is the average of the three measurement values.</p> <p>Pre-lubricated bearings and some designs of bearings with seals or shields may adversely affect accuracy of measuring (see 5.8)</p> <p>Since radial internal clearance is defined as being under no load, the measured values must be adjusted to compensate for deflections that may occur during measurement.</p> <p style="text-align: center;">Radial measuring loads</p> <table border="1" data-bbox="1075 1216 1780 1795"> <thead> <tr> <th colspan="2" data-bbox="1075 1216 1430 1335">d mm</th> <th colspan="2" data-bbox="1430 1216 1780 1335">Measuring load, nominal ^a N</th> </tr> <tr> <th data-bbox="1075 1335 1255 1478">></th> <th data-bbox="1255 1335 1430 1478">\leq</th> <th data-bbox="1430 1335 1604 1478">Ball bearings</th> <th data-bbox="1604 1335 1780 1478">Roller bearings</th> </tr> </thead> <tbody> <tr> <td data-bbox="1075 1478 1255 1546">—</td> <td data-bbox="1255 1478 1430 1546">30</td> <td data-bbox="1430 1478 1604 1546">25</td> <td data-bbox="1604 1478 1780 1546">50</td> </tr> <tr> <td data-bbox="1075 1546 1255 1614">30</td> <td data-bbox="1255 1546 1430 1614">50</td> <td data-bbox="1430 1546 1604 1614">30</td> <td data-bbox="1604 1546 1780 1614">60</td> </tr> <tr> <td data-bbox="1075 1614 1255 1682">50</td> <td data-bbox="1255 1614 1430 1682">80</td> <td data-bbox="1430 1614 1604 1682">35</td> <td data-bbox="1604 1614 1780 1682">70</td> </tr> <tr> <td data-bbox="1075 1682 1255 1751">80</td> <td data-bbox="1255 1682 1430 1751">120</td> <td data-bbox="1430 1682 1604 1751">40</td> <td data-bbox="1604 1682 1780 1751">80</td> </tr> <tr> <td data-bbox="1075 1751 1255 1795">120</td> <td data-bbox="1255 1751 1430 1795">200</td> <td data-bbox="1430 1751 1604 1795">50</td> <td data-bbox="1604 1751 1780 1795">100</td> </tr> </tbody> </table> <p>^a The load must not exceed $0,005C_{0r}$, as defined in ISO 76.</p>	d mm		Measuring load, nominal ^a N		>	\leq	Ball bearings	Roller bearings	—	30	25	50	30	50	30	60	50	80	35	70	80	120	40	80	120	200	50	100
d mm		Measuring load, nominal ^a N																											
>	\leq	Ball bearings	Roller bearings																										
—	30	25	50																										
30	50	30	60																										
50	80	35	70																										
80	120	40	80																										
120	200	50	100																										

Annex A (normative)

Cross-reference to clauses in ISO 1132-1

Table A.1 — Cross-references and symbols

ISO 1132-2 Clause and method		Symbol	ISO 1132-1 reference
7	Principles of measuring bore diameter		
7.1	Measurement of single bore diameter (including single bore diameter in a single plane)	d_s, d_{sp}	5.1.2, 5.1.3
7.2	Functional gauging of smallest single bore diameter of thrust needle roller and cage assembly and thrust washer	$d_{cs\ min}, d_{s\ min}$ $D_{1s\ min}$	—
7.3	Measurement of single bore diameter of rolling element complement	F_{ws}	5.1.13
7.4	Measurement of smallest single bore diameter of rolling element complement	$F_{ws\ min}$	5.1.14
7.5	Functional gauging of smallest single bore diameter of rolling element complement	$F_{ws\ min}$	—
7.6	Functional gauging of smallest single bore diameter of rolling element complement (radial needle roller and cage assemblies)	$F_{ws\ min}$	—
8	Principles of measuring outside diameter		
8.1	Measurement of single outside diameter (including single outside diameter in a single plane)	D_s, D_{sp}	5.2.2, 5.2.3
8.2	Measurement of single outside diameter of rolling element complement	E_{ws}	5.2.13
8.3	Functional gauging of largest single outside diameter of rolling element complement	$E_{ws\ max}$	—
9	Principles of measuring width and height		
9.1	Measurement of single ring width	B_s, C_s	5.3.2
9.2	Measurement of single outer ring flange width	C_{1s}	5.3.7
9.3	Measurement of actual bearing width (primary method)	T_s	5.3.11
9.4	Measurement of actual bearing width (alternative method)	T_s	5.3.11
9.5	Measurement of actual bearing height (thrust bearings)	T_s	5.3.14
9.6	Measurement of actual effective width of inner subunit (tapered roller bearings)	T_{1s}	5.3.17
9.7	Measurement of actual effective width of outer ring (tapered roller bearings)	T_{2s}	5.3.20
10	Principles of measuring ring and washer chamfer dimension		
10.1	Measurement of single chamfer dimension (primary method)	r_s	5.4.2
10.2	Functional gauging of single chamfer dimension (alternative method)	$r_{s\ max}, r_{s\ min}$	—
11	Principles of measuring raceway parallelism		
11.1	Measurement of parallelism of inner ring raceway with respect to the face	S_i	6.2.1
11.2	Measurement of parallelism of outer ring raceway with respect to the face	S_e	6.2.2

Table A.1 — Cross-references and symbols (continued)

ISO 1132-2 Clause and method		Symbol	ISO 1132-1 reference
12	Principles of measuring surface perpendicularity		
12.1	Measurement of perpendicularity of inner ring face with respect to the bore (method A)	S_d	6.3.1
12.2	Measurement of perpendicularity of inner ring face with respect to the bore (method B)	S_d	6.3.1
12.3	Measurement of perpendicularity of outer ring outside surface with respect to the face	S_D	6.3.2
12.4	Measurement of perpendicularity of outer ring outside surface with respect to the flange back face	S_{D1}	6.3.3
13	Principles of measuring thickness variation		
13.1	Measurement of variation in thickness between inner ring raceway and bore	K_i	6.4.1
13.2	Measurement of variation in thickness between outer ring raceway and outside surface	K_e	6.4.2
13.3	Measurement of variation in thickness between shaft washer raceway and back face	S_i	6.4.3
13.4	Measurement of variation in thickness between raceway and back face of central shaft washer	S_i	6.4.3
13.5	Measurement of variation in thickness between housing washer raceway and back face	S_e	6.4.4
14	Principles of measuring radial runout		
14.1	Measurement of radial runout of inner ring of assembled bearing (primary method)	K_{ia}	7.1.1
14.2	Measurement of radial runout of inner ring of assembled bearing (alternative method)	K_{ia}	7.1.1
14.3	Measurement of radial runout of outer ring of assembled bearing (primary method)	K_{ea}	7.1.2
14.4	Measurement of radial runout of outer ring of assembled bearing (alternative method)	K_{ea}	7.1.2
14.5	Measurement of asynchronous radial runout of inner ring of assembled bearing	K_{iaa}	7.1.3
15	Principles of measuring axial runout		
15.1	Measurement of axial runout of inner ring of assembled bearing	S_{ia}	7.2.1, 7.2.2
15.2	Measurement of axial runout of outer ring of assembled bearing	S_{ea}	7.2.3, 7.2.4
15.3	Measurement of axial runout of outer ring flange back face of assembled bearing	S_{ea1}	7.2.5, 7.2.6
16	Principles of measuring radial clearance		
16.1	Measurement of radial internal clearance (method A)	G_r	8.1.1
16.2	Measurement of radial internal clearance (method B)	G_r	8.1.1