15. Bearing handling

15.1 General information

Bearings are precision parts and in order to preserve their accuracy and reliability, care must be exercised in their handling. In particular, bearing cleanliness must be maintained, sharp impacts avoided, and rust prevented.

Bearings are vulnerable to impact. Do not hit them with a hammer directly or drop them on the floor (see **Fig. 15.1**).

In addition, bearings are sensitive to foreign particle contamination. When foreign particles enters the bearing during rotation, denting and/or scratches may occur, resulting in objectionable noise and vibration levels and rough bearing rotation (see **Fig. 15.2**). Therefore, when handling bearings, it is necessary to keep the periphery clean.

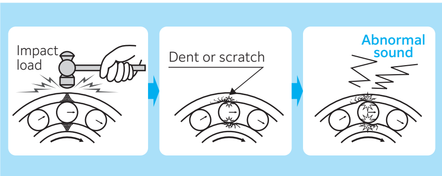

Fig. 15.1 Damage caused by impact

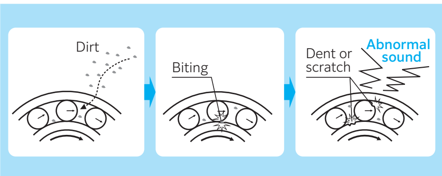

Fig. 15.2 Damage caused by foreign particle contamination

For optimal bearing performance, proper bearing handling methods must be used. The handling methods described herein are general guidelines. Depending on the type and size of bearing needed, special handling "methods" may be necessary. For more detailed information, please consult **NTN** Engineering.

Using proper protective equipment and tools are also essential when installing or removing bearings, to avoid damage to the machinery and ensure the safety of the technician. Further information on proper installation and removal procedures is detailed in the following sections.

15.2 Bearing storage

Most rolling bearings are coated with a rust preventive oil before being packed and shipped. Please observe the following guidelines when storing bearings.

1. Ideally, bearings should be stored indoors at room temperature with a relative humidity of less than 60 %. Avoid places in direct sunlight or in contact with outer walls because excessive temperature fluctuation or humidity rise may cause condensation.
2. Bearings should not be stored directly on the ground. Instead, they should be placed on a shelf or pallet at least 20 cm above the ground. The maximum number of shipping boxes to be stacked for storage should limited to four whenever possible (see **Fig. 15.3**).
3. Precision rolling bearings, large rolling bearings and thin ring or race rolling bearings must be laid down horizontally for storage (see **Fig. 15.4**). Storing them standing vertically may cause raceway deformation.

   To avoid damage during transportation such as fretting or false brinelling, ensure that the individual bearing boxes are packed laying down horizontally within the shipping box. Fill remaining space with dunnage (see **Fig. 15.5**).

   Some products have a ↑ symbol on the shipping box to prevent improper storage placement. Follow the indication on the box in this case (see **Fig. 15.6**).

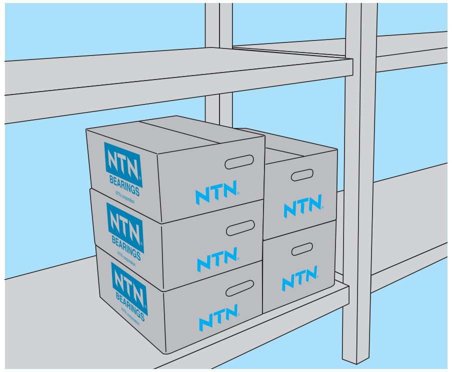

Fig. 15.3 Storing bearings on a shelf

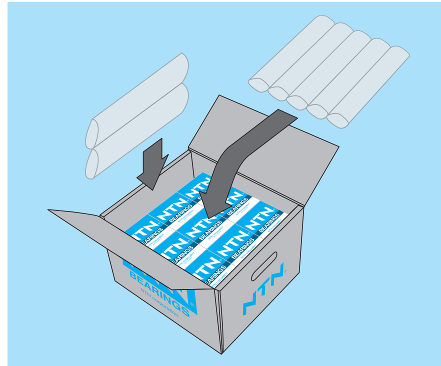

Fig. 15.5 Transportation and storage by shipping box

Fig. 15.4 Storing one-bearing boxes on a shelf

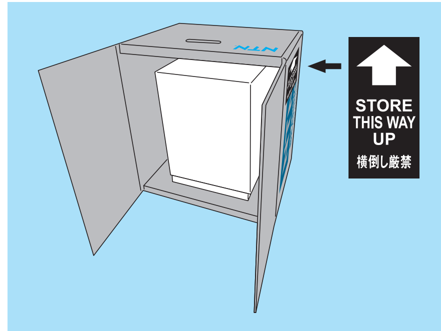

Fig. 15.6 Horizontally placing box prohibited

15.3 Bearing installation

A jig, a measuring instrument, a lubricant, and a clean and dry workshop will be needed for bearing installation. Further, if possible, it is desirable to install miniature/small ball bearings and precision rolling bearings in a clean room because intrusion of dirt and foreign matter significantly affects bearing performance.

Improper installation of bearings may cause marks from the rolling elements on the raceways, adversely affecting the bearing life. For the recommendations on machining accuracy and mounting accuracy of bearings, shafts, and housings, see section "14. Shaft and housing design".

15.3.1 Installation preparations

(1) Fitting surface of shafts and housings

When a bearing is installed on a shaft or in a housing with surfaces containing burrs or dents, the bearing may not seat properly, causing vibration and noise during operation (see **Fig. 15.7** and **Fig. 15.8**).

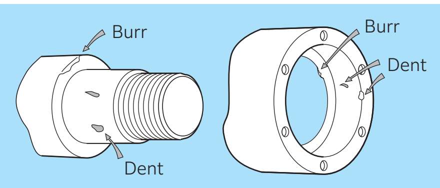

Fig. 15.7 Burrs and dents

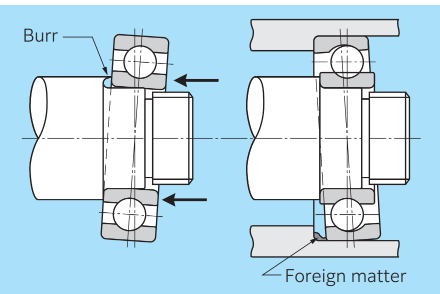

Fig. 15.8 Example of improper bearing installation

Therefore, before mounting bearings, remove any burrs, raised material near dents, rust, or dirt on the shaft, housing, or accessories (see **Fig. 15.9**).

The shaft and housing fitting surfaces should also be checked for roughness, dimensional and design accuracy, and to ensure that they are within allowable tolerance limits. Further, when the bearing is to be press-fitted, using an anti-fretting agent on the fitting surface improves the ease of assembly.

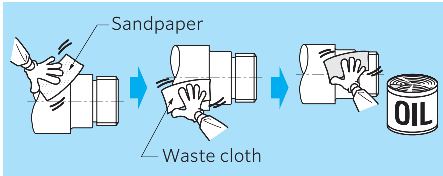

Fig. 15.9 Example of working procedure

(2) Mounting jig

The jig to be used for mounting must have a size suitable for the bearing and be free of dirt or damage.

(3) Opening of bearing

Bearings should be unpackaged directly before use to avoid introducing foreign particle contaminates or condensation which would lead to rust. Gloves should also be worn when handling bearings to avoid rust generation.

(4) Removal of rust preventative oil

In general, bearings with grease lubrication may be installed without cleaning the rust preventative oil.

However, for bearings using oil lubricant, or when lubrication efficiency would be compromised by mixing the grease and rust preventive oil, the rust preventive oil should be removed by washing with a cleaning solvent and dried before installation. **The shield type bearings and the seal type bearings** filled with grease **must not be cleaned.**

15.3.2 Installing cylindrical bore bearings

15.3.2.1 Press-fitting

Press-fitting is the most common mounting method and is widely used for small bearings. Bearings having a relatively small interference can be press-fitted by using a sleeve and applying force to the raceway at room temperature.

When press-fitting a bearing by applying impact with a hammer, use a resin or copper hammer rather than an iron one. To uniformly press the bearing onto the shaft or into the housing, use a sleeve (Use of a mounting tool kit as shown in **Fig. 15.40**, A-168 is recommended). Do not directly apply impact to bearing rings or press-fit them by using a punch because the bearings will not be press-fitted uniformly, causing bearing damage (see **Fig. 15.10**).

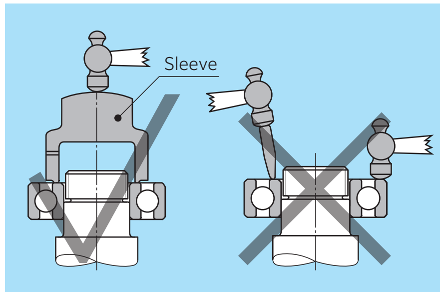

Fig. 15.10 Using hammer for press-fitting

When a large number of bearings are to be installed at one time, a dedicated jig or a hydraulic press may be used.

(1) Press-fitting bearing into shaft

Uniformly apply force by applying a sleeve to the inner ring width surface when press-fitting a bearing onto a shaft. Do not apply force to the outer ring as this will transfer the press force through the rolling elements which may cause dents or scratches on the raceway surface (see **Fig. 15.11**).

When press-fitting self-aligning bearings, using a ring-shaped block as shown in **Fig. 15.13** improves ease of installation.

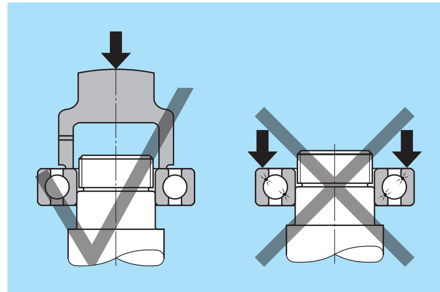

Fig. 15.11 Press-fitting bearing into shaft

(2) Press-fitting bearing into housing

Uniformly apply force by applying a sleeve to the outer ring width surface to press-fit a bearing into a housing. Do not apply force to the inner ring as this will transfer the press force through the rolling elements which may cause dents or scratches on the raceway surface (see **Fig. 15.12**).

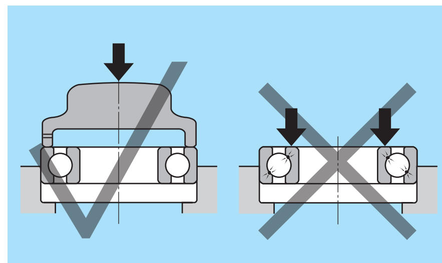

Fig. 15.12 Press-fitting bearing into housing

(3) Simultaneous press-fitting

When press-fitting a non-separable bearing such as a deep groove ball bearing onto the shaft and into the housing at the same time, use a ring-shaped block and uniformly apply force to inner and outer rings simultaneously. Do not apply force on either the inner or outer ring individually because it may cause dents or scratches on the raceway surface (see **Fig. 15.13**).

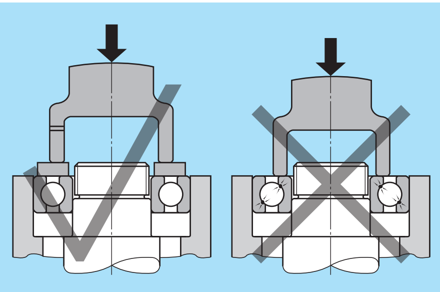

Fig. 15.13 Simultaneous press-fitting

[Caution]

- Excessive interference during installation may cause cracks and excessively small bearing internal clearance, resulting in seizure. For further detail, see section "7. Bearing fits".
- Excessive impact at the time of installation may cause dents and damage.
- No foreign matter should enter the fitting surface during installation.
- For large interference fits and medium/ large size bearings, consider other installation methods besides press-fitting at room temperature.

15.3.2.2 Heat fitting (shrink fitting)

When the inner ring interference is large or the bearing is large, press-fitting the inner ring onto the shaft at room temperature requires significant force. Heating the bearing and expanding the inner ring before installation makes the installation onto the shaft easier.

The inner ring expansion amount necessary for heat fitting can be obtained from the interference of the fitting surface between the inner ring and the shaft and the temperature difference before and after the bearing is heated (see **Fig. 15.14**).

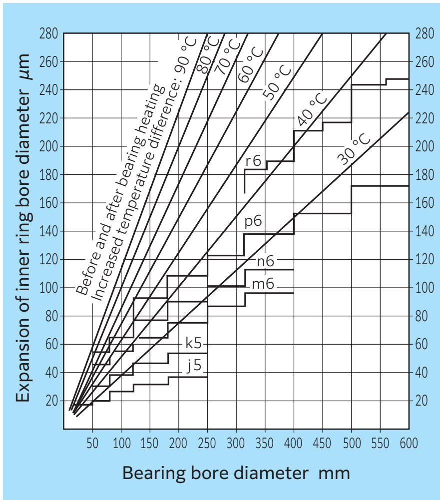

Fig. 15.14 Temperature required for heat-fitting inner ring

For heat fitting, any bearing that did not undergo dimension stabilization treatment **must not be heated above 120 °C** to avoid permanent bearing damaged and shortened operating life. For sealed bearings, the seal temperature rating must not be exceeded.

In addition, **heat torches and heat guns should not be used for heating bearings** because the bearings may be heated non-uniformly and temperature control is difficult (see **Fig. 15.15**).

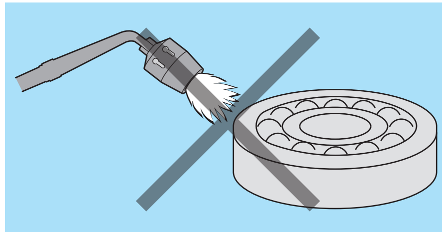

Fig. 15.15 Heating bearings by heat torch

The main methods used to heat bearings uniformly are (1) oil bath, (2) constant temperature oven, and (3) fast therm induction heater.

(1) Heating bearings in oil bath

One bearing heating method is immersing a bearing in a heated clean oil (see **Fig. 15.16**). **Foreign particles are often found on the bottom of the oil bath; therefore, do not directly place bearings on the bottom of the oil bath. Instead, place the bearings on a wire rack or suspend it in the oil and then heat it. Shielded bearings and sealed bearings filled with grease must not be heated in the oil bath** (see **Fig. 15.17**).

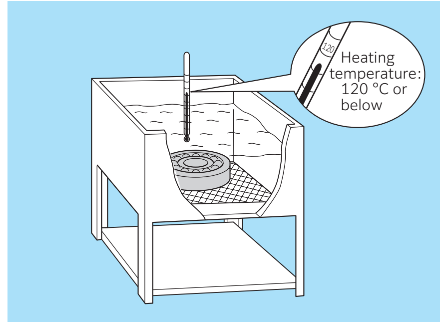

Fig. 15.16 Heating bearings in oil bath

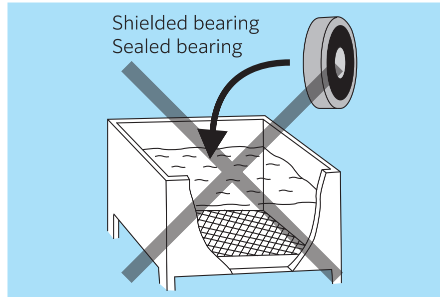

Fig. 15.17 Heating grease filled bearings in oil bath prohibited

(2) Heating bearings in constant temperature oven

With a constant temperature oven, bearings can be heated in a dry state (see **Fig. 15.18**).

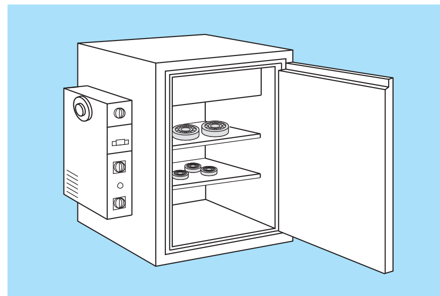

Fig. 15.18 Heating bearings in constant temperature oven

(3) Heating bearings with fast therm induction heater

With a fast therm induction heater, bearings can be heated safely, cleanly, and quickly in a dry state. **Heating bearings by induction heating makes the bearings magnetic; therefore, it is necessary to demagnetize bearings after heating.** The **NTN** fast therm induction heater (see **Fig. 15.42**, A-168) has an automatic demagnetization function.

[Caution]

- Use heat-resistant gloves for safety when handling a heated bearing. **NTN** heat-resistant gloves optimal for bearing handling are available (see **Fig. 15.43**, A-168).
- It is important to complete heat fitting quickly. If the bearing cannot be inserted onto the shaft during heat fitting, stop the process and consider removing the bearing.
- When heat fitting is performed, the inner ring contracts in the axial direction during cooling, creating a clearance between the bearing and the shaft shoulder (see **Fig. 15.19**).

  Therefore, **it is necessary to tighten the bearing with a nut until it is completely cooled or apply a force in the axial direction while the bearing cools, to bring the bearing into close contact with the shoulder of the shaft.**

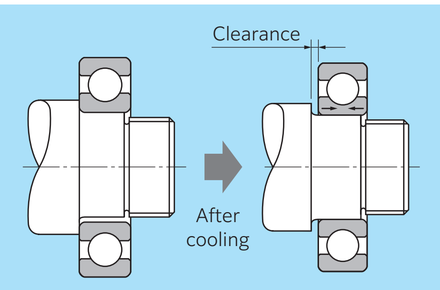

Fig. 15.19 Bearing contraction after heating

15.3.3 Installation of tapered bore bearing

Small tapered bore bearings are installed by inserting a bearing a predetermined amount with locknuts and by using a tapered bore or an adapter sleeve/withdrawal sleeve. Locknuts are tightened by a hook spanner wrench (see **Fig. 15.20**).

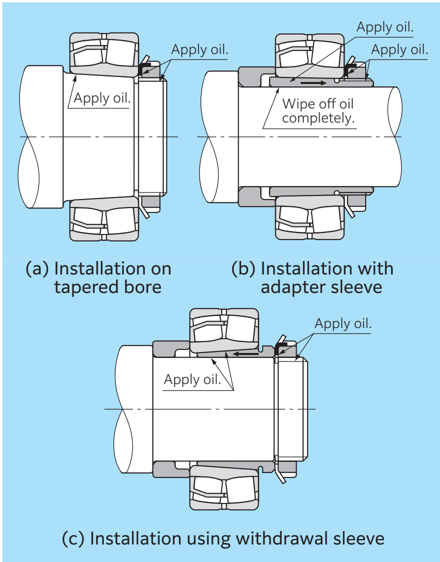

Fig. 15.20 Installation methods using locknuts

Large size bearings require considerable fitting force and must be installed hydraulically.

In **Fig. 15.21** the fitting surface friction and nut tightening torque needed to install bearings with tapered bores directly onto tapered shafts are decreased by injecting high pressure oil between the fitting surfaces.

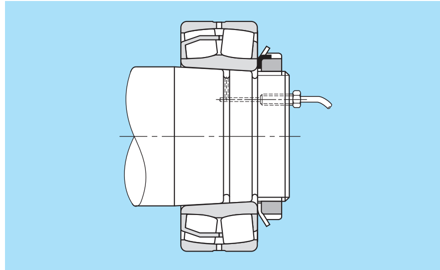

Fig. 15.21 Bearing installation using oil pressure

Fig. 15.22 (a) shows a method of installation where a hydraulic nut is used to drive the bearing onto a tapered shaft. **Fig. 15.22 (b)** and **(c)** show installation methods using a hydraulic nut with adapter sleeves and withdrawal sleeves.

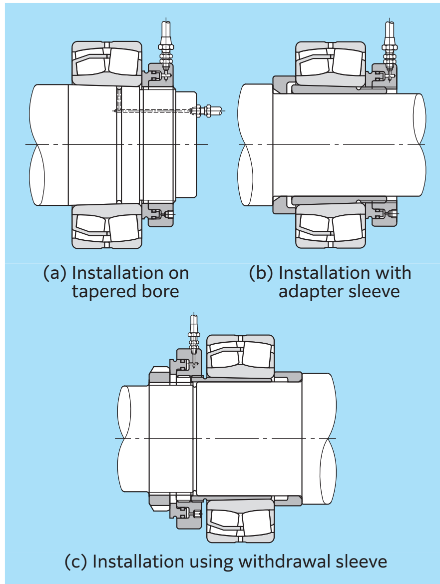

Fig. 15.22 Installation using hydraulic nut

Fig. 15.23 shows an installation method using a hydraulic withdrawal sleeve.

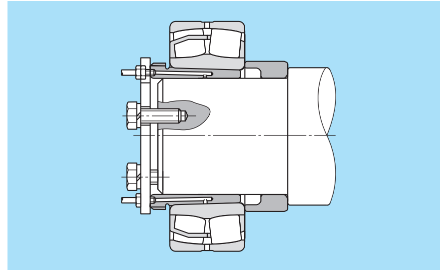

Fig. 15.23 Installation using hydraulic withdrawal sleeve

With tapered bore bearings, as the inner ring is driven axially onto the shaft, adapter or withdrawal sleeve, the interference increases so that the bearing radial internal clearance will decrease. Interference can be estimated by measuring the decrease in radial internal clearance. As shown in **Fig. 15.24**, the radial internal clearance between the rollers and outer ring of spherical roller bearings should be measured with a thickness gauge under no load while the rollers are held in the correct position. Measure the radial internal clearance on both rows, and check that the values are equivalent. Instead of using the decrease in amount of radial internal clearance to estimate the interference, it is possible to estimate the mounted radial internal clearance by measuring the distance the bearing has been driven onto the shaft.

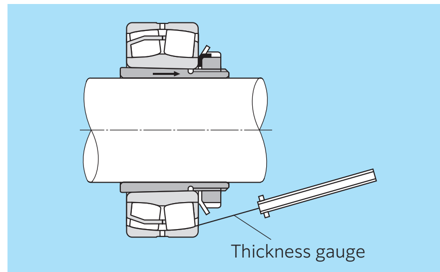

Fig. 15.24 Internal clearance measurement method for spherical roller bearings

For spherical roller bearings, **Table 15.1** (applied to ULTAGE™ series) and **Table 15.2** (applied to non-ULTAGE™ series) indicate the predetermined interference which will be achieved as a result of the radial internal clearance decrease, or the distance the bearing has been driven onto the shaft.

For conditions such as heavy loads, high speeds, or when there is a large temperature differential between inner and outer rings, etc. which require large interference fits, bearings with a minimum radial internal clearance of C3 or greater should be used. **Table 15.1** and **Table 15.2** list the maximum values for radial internal clearance decrease and axial displacement. The remaining clearance in mounted bearings with tapered bores must be greater than the minimum allowable residual clearance listed in **Table 15.1** or **Table 15.2**.

For self-aligning ball bearings, a predetermined interference can be obtained by tightening the nut until the radial internal clearance becomes about half the size before the fitting. After installation, check that the bearing lightly and smoothly rotates.

Table 15.1 Installing tapered bore spherical roller bearings (ULTAGE™ series) Unit: mm

Nominal bearing bore diameter *d*		Reduction of radial internal clearance		Axial displacement drive up				Nut rotation angle ° (approx.)				Minimum residual radial internal clearance		
				Taper, 1:12		Taper, 1:30		Taper, 1:12		Taper, 1:30				
Over	Incl.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	CN	C3	C4
24	30	0.010	0.015	0.15	0.20	—	—	36	48	—	—	0.015	0.025	0.040
30	40	0.015	0.020	0.25	0.30	—	—	60	72	—	—	0.015	0.030	0.045
40	50	0.020	0.025	0.35	0.40	—	—	84	96	—	—	0.020	0.035	0.055
50	65	0.025	0.030	0.40	0.45	—	—	72	81	—	—	0.025	0.045	0.065
65	80	0.035	0.040	0.50	0.60	—	—	90	108	—	—	0.030	0.055	0.080
80	100	0.040	0.050	0.60	0.70	—	—	108	126	—	—	0.030	0.060	0.090
100	120	0.055	0.065	0.80	0.90	1.80	2.30	144	162	324	414	0.035	0.070	0.105
120	140	0.065	0.075	0.90	1.00	1.95	2.70	162	180	351	486	0.045	0.085	0.125
140	150	0.075	0.090	1.00	1.20	2.35	3.10	180	216	423	558	0.040	0.090	0.140
150	160	0.075	0.090	1.00	1.20	2.35	3.10	120	144	282	372	0.040	0.090	0.140
160	180	0.080	0.100	1.10	1.40	2.80	3.55	132	168	336	426	0.040	0.100	0.160
180	200	0.090	0.110	1.20	1.50	3.20	3.95	144	180	384	474	0.050	0.110	0.180
200	225	0.110	0.130	1.50	1.80	3.85	4.60	135	162	347	414	0.050	0.120	0.190
225	250	0.120	0.140	1.60	1.90	4.20	4.95	144	171	378	446	0.060	0.130	0.210
250	280	0.130	0.160	1.60	2.10	4.25	5.40	144	189	383	486	0.060	0.140	0.230
280	305	0.150	0.180	1.90	2.40	4.45	5.70	171	216	401	513	0.060	0.150	0.250
305	315	0.150	0.180	1.90	2.40	4.45	5.70	137	173	320	410	0.060	0.150	0.250
315	355	0.160	0.190	2.10	2.50	5.10	6.10	151	180	367	439	0.080	0.170	0.280
355	400	0.180	0.220	2.30	3.00	5.75	7.50	166	216	414	540	0.080	0.180	0.300
400	450	0.210	0.250	3.00	3.60	—	—	216	259	—	—	0.080	0.190	0.320

Note: The nut rotation angle may only be applied when a nut having the same bore diameter code as the bearing is used.

Table 15.2 Installing tapered bore spherical roller bearings (non-ULTAGE™ series) Unit: mm

Nominal bearing bore diameter *d*		Reduction of radial internal clearance		Axial displacement drive up				Nut rotation angle ° (approx.)				Minimum residual radial internal clearance		
				Taper, 1:12		Taper, 1:30		Taper, 1:12		Taper, 1:30				
Over	Incl.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	CN	C3	C4
30	40	0.020	0.025	0.35	0.40	—	—	84	96	—	—	0.010	0.025	0.040
40	50	0.025	0.030	0.40	0.45	—	—	96	108	—	—	0.015	0.030	0.050
50	65	0.030	0.035	0.45	0.60	—	—	81	108	—	—	0.020	0.040	0.060
65	80	0.040	0.045	0.60	0.70	—	—	108	126	—	—	0.025	0.050	0.075
80	100	0.045	0.055	0.70	0.80	1.75	2.25	126	144	315	405	0.025	0.055	0.085
100	120	0.050	0.060	0.75	0.90	1.90	2.25	135	162	342	405	0.040	0.075	0.110
120	140	0.065	0.075	1.10	1.20	2.75	3.00	198	216	495	540	0.045	0.085	0.130
140	150	0.075	0.090	1.20	1.40	3.00	3.75	216	252	540	675	0.040	0.090	0.140
150	160	0.075	0.090	1.20	1.40	3.00	3.75	144	168	360	450	0.040	0.090	0.140
160	180	0.080	0.100	1.30	1.60	3.25	4.00	156	192	390	480	0.040	0.100	0.160
180	200	0.090	0.110	1.40	1.70	3.50	4.25	168	204	420	510	0.050	0.110	0.180
200	225	0.100	0.120	1.60	1.90	4.00	4.75	144	171	360	428	0.060	0.130	0.200
225	250	0.110	0.130	1.70	2.00	4.25	5.00	153	180	383	450	0.070	0.140	0.220
250	280	0.120	0.150	1.90	2.40	4.75	6.00	171	216	428	540	0.070	0.150	0.240
280	305	0.130	0.160	2.00	2.50	5.00	6.25	180	225	450	563	0.080	0.170	0.270
305	315	0.130	0.160	2.00	2.50	5.00	6.25	144	180	360	450	0.080	0.170	0.270
315	355	0.150	0.180	2.40	2.80	6.00	7.00	173	202	432	504	0.090	0.180	0.290
355	400	0.170	0.210	2.60	3.30	6.50	8.25	187	238	468	594	0.090	0.190	0.310
400	450	0.200	0.240	3.10	3.70	7.75	9.25	223	266	558	666	0.090	0.200	0.330
450	500	0.210	0.260	3.30	4.00	8.25	10.0	238	288	594	720	0.110	0.230	0.370
500	560	0.240	0.300	3.70	4.60	9.25	11.5	222	276	555	690	0.110	0.240	0.380
560	630	0.260	0.330	4.00	5.10	10.0	12.5	240	306	600	750	0.130	0.270	0.430
630	670	0.300	0.370	4.60	5.70	11.5	14.5	276	342	690	870	0.140	0.300	0.480
670	710	0.300	0.370	4.60	5.70	11.5	14.5	237	293	591	746	0.140	0.300	0.480
710	800	0.340	0.430	5.30	6.70	13.3	16.5	273	345	684	849	0.140	0.320	0.530
800	900	0.370	0.470	5.70	7.30	14.3	18.5	293	375	735	951	0.170	0.370	0.600
900	1 000	0.410	0.530	6.30	8.20	15.8	20.5	284	369	711	923	0.180	0.400	0.660
1 000	1 120	0.450	0.580	6.80	8.70	17.0	22.5	306	392	765	1 013	0.190	0.450	0.720
1 120	1 250	0.490	0.630	7.40	9.40	18.5	24.5	—	—	—	—	0.200	0.490	0.790

Note: The nut rotation angle may only be applied when a nut having the same bore diameter code as the bearing is used.

15.3.4 Installation of outer ring

With tight interference fits, the outer rings of small type bearings can be installed with a hydraulic press at room temperature. Alternately, the housing can be heated and expanded before installing the outer ring, or the outer ring can be cooled with a freezer, etc. before installing. If a freezer or another cooling agent is used, moisture will condense on bearing surfaces. Therefore appropriate rust preventative measures are necessary before cooling the bearing.

15.3.5 Internal clearance adjustment

As shown in **Fig. 15.25**, for angular contact ball bearings and tapered roller bearings the required amount of axial internal clearance can be set at the time of installation by tightening or loosening the adjustment nut.

To adjust the suitable axial internal clearance or amount of bearing preload, the internal clearance can be measured while tightening the adjusting nut as shown in **Fig. 15.26**. Another method is to check rotational torque by rotating the shaft or housing while adjusting the nut.

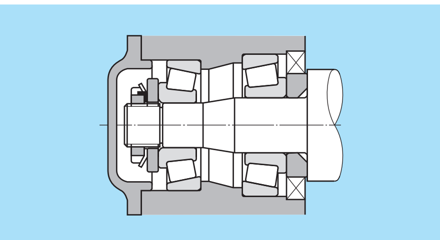

Fig. 15.25 Axial internal clearance adjustment

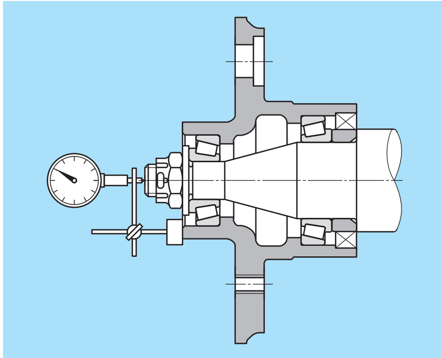

Fig. 15.26 Axial internal clearance measurement

A shim with appropriate thickness may also be used for adjusting the bearing internal clearance. **Fig. 15.27** shows the case in which angular contact ball bearings are used in a face-to-face arrangement on the fixed side. A shim is inserted between the housing front cover and the housing shown by an arrow to change the fixed position of the outer ring.

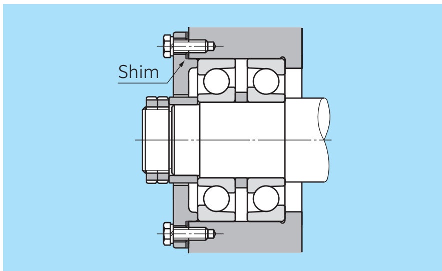

Fig. 15.27 Internal clearance adjustment using shims

15.4 Lubricant enclosure

An appropriate amount of lubricant that is suitable for the use condition of the bearing should be applied if the bearings are not pre-filled with grease. For details, see section "11. Lubrication".

15.5 Post installation running test

To check that the bearing has been properly installed, a running test is performed after installation is completed. The shaft or housing is first rotated by hand and if no problems are observed at low speed, a no-load power test should then be performed. **If no abnormalities are observed, the load and speed are gradually increased to operating conditions. During the test if any unusual noise, vibration, or temperature rise is observed, the test should be stopped and the equipment should be examined. If necessary, the bearing should be disassembled for inspection.**

15.6 Bearing disassembly

Bearings are often removed as part of periodic inspection procedures or during the replacement of other parts. However, the shaft and housing are almost always reinstalled, and in more than a few cases the bearings themselves are reused. These bearings, shafts, housings, and other related parts must be designed to prevent damage during disassembly procedures, and the proper disassembly tools must be employed. When removing bearing rings with interference, pulling force should be applied to the press fit bearing ring only. Do not remove the raceway through the rolling elements.

[Caution]

Bearings and jigs used for disassembly may fall off when the bearing is removed from the shaft or the housing.

15.6.1 Disassembly of bearings with cylindrical bores

For small sized bearings, pullers shown in **Fig. 15.28 (a)** and **(b)** or the press method shown in **Fig. 15.29** can be used for disassembly. When used properly, these methods can improve disassembly efficiency and prevent damage to bearings.

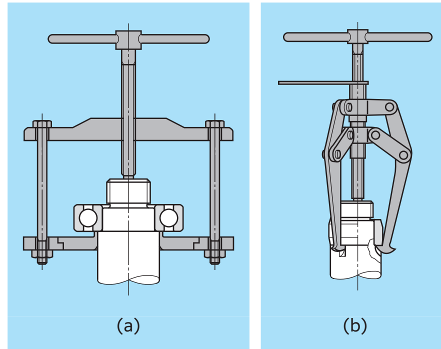

Fig. 15.28 Puller disassembly

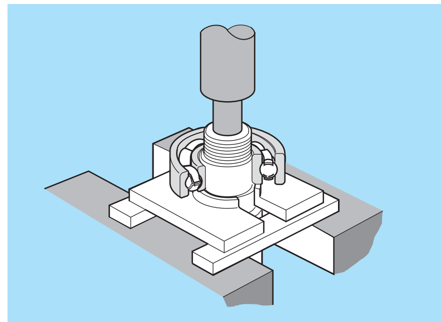

Fig. 15.29 Press disassembly

To facilitate disassembly procedures, attention should be given to planning the designs of shafts and housings, such as providing extraction grooves on the shaft and housing for puller claws as shown in **Fig. 15.30** and **Fig. 15.31**. Threaded bolt holes could also be provided in housings to facilitate the pressing out of outer rings as shown in **Fig. 15.32**.

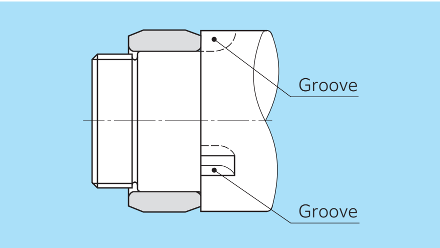

Fig. 15.30 Extracting grooves (example of three positions in circumferential direction)

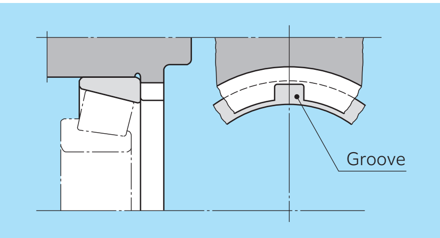

Fig. 15.31 Extraction groove for outer ring disassembly

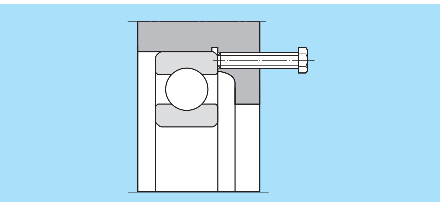

Fig. 15.32 Outer ring disassembly bolt

Large bearings, installed with tight fits, that have been in service for a long period of time, will likely have developed fretting on fitting surfaces and will require considerable dismounting force. In such instances, dismounting friction can be reduced by injecting oil under high pressure between the shaft and inner ring surfaces as shown in **Fig. 15.33**.

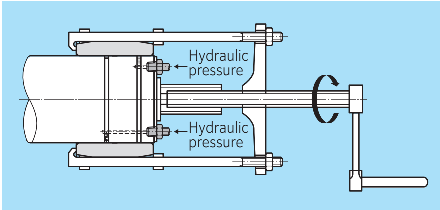

Fig. 15.33 Removal of bearing by hydraulic pressure

Induction heating can be used for removing the inner ring of cylindrical roller bearings having no rib on the inner ring such as NU type and NJ type bearings. With this method, the inner ring is heated until it expands, and can be removed (see **Fig. 15.34**).

The bearing becomes magnetized by induction heating; therefore, it is necessary to demagnetize the bearing after heating.

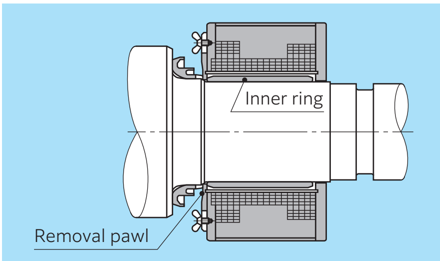

Fig. 15.34 Removal by induction heating

Commentary
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15.6.2 Disassembly of bearings with tapered bores

Small bearings installed using an adapter are removed by loosening the locknut, placing a block on the edge of the inner ring as shown in **Fig. 15.35 (a)** or the edge of the lock nut as shown in **Fig. 15.35 (b)**, and tapping it with a hammer. In such a case, use a resin or copper hammer instead of an iron one. Bearings which have been installed with withdrawal sleeves can be disassembled by tightening down the lock nut as shown in **Fig. 15.36**.

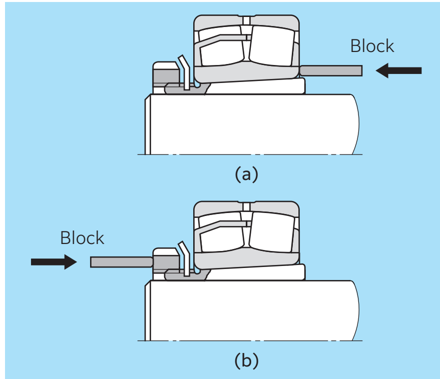


Fig. 15.35 Removal of bearing with adapter

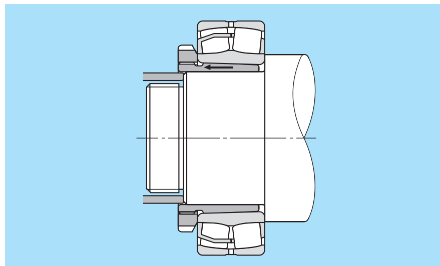


Fig. 15.36 Disassembly of bearing with withdrawal sleeve

For large type bearings on tapered shafts, adapters, or withdrawal sleeves, disassembly is greatly facilitated by hydraulic methods. **Fig. 15.37** shows the case where the bearing is removed by applying hydraulic pressure on the fitting surface of a bearing installed on a tapered shaft.

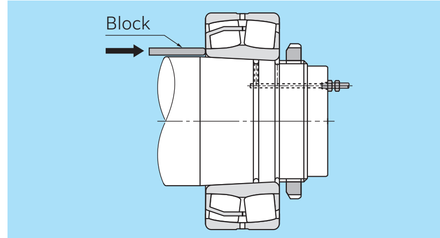


Fig. 15.37 Bearing disassembly using oil pressure

Fig. 15.38 shows two methods of disassembling bearings with adapters or withdrawal sleeves using a hydraulic nut. **Fig. 15.39** shows a disassembly method using a hydraulic withdrawal sleeve where high pressure oil is injected between fitting surfaces and a lock nut is then employed to remove the sleeve.

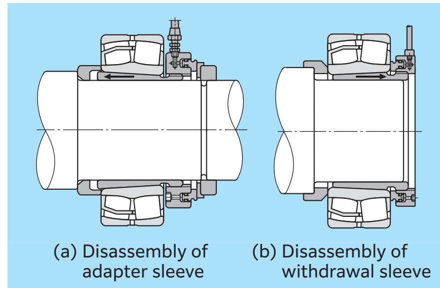


Fig. 15.38 Disassembly using hydraulic nut

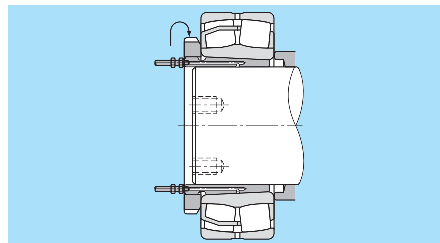


Fig. 15.39 Disassembly using hydraulic withdrawal sleeve

15.7 Bearing maintenance and inspection

Managing the condition of the machine during operation is important for preventing bearing failure. The following items are the general maintenance management methods.

(1) Inspection of machine while running
The interval for replenishing and replacing lubricant is determined by a study of lubricant properties and checking the bearing temperature, noise and vibration.

(2) Observation of bearing after use
Take note of any problem that may appear after the bearing is used or when performing routine inspections, and take measures for preventing reoccurrence of any damage discovered.

Maintenance management requires that the frequency for performing routine inspections be determined according to the importance of the device or machine.

15.7.1 Inspection of machine while running

15.7.1.1 Bearing temperature

In general, the bearing temperature increases after the start of operation and becomes steady at a slightly lower temperature after a certain time elapses (usually 10 to 40 °C higher than the room temperature). The time until the temperature becomes steady differs depending on the bearing size, type, rotational speed, lubrication method, and heat dissipation condition of the bearing surroundings. It varies from 20 minutes to several hours.

When the bearing temperature does not become steady and rises excessively, the following may be the cause. Stop the operation and take measures.

<Main causes of abnormal temperature rise>
- Amount of lubricant too small or large
- Improper bearing installation
- Bearing internal clearance too small, or load too large
- Friction of sealing mechanism too large
- Unsuitable lubricant
- Creeping of fitting surface

The bearing temperature should not be too high to maintain suitable bearing operation and prevent the deterioration of lubricant. In general, it is best to use bearings at 100 °C or below.

15.7.1.2 Bearing noise

To check bearing running noise, the sound can be checked and the type of noise can be ascertained with a listening instrument placed against the housing. A clear, smooth and continuous running sound is normal; however, determining the exact noise requires significant experience. Although it is difficult to express noise with words and it is different depending on the person, **Table 15.3** shows the characteristics and cause of the typical abnormal noises of bearings.

Table 15.3 Characteristics and cause of typical abnormal noise of bearings

Noise	Characteristics	Cause (probable)
Buzzing noise	—	• Entrance of foreign matter • Roughness of the surfaces of raceway, ball, roller • Scratches on the surfaces of raceway, ball, roller
Whoosh (small size bearings)	—	• Roughness of the surfaces of raceway, ball, roller
Short whoosh noise	• The noise is generated intermittently and regularly.	• Contact with labyrinth part • Contact of case and seal
Rubbing noise/ rumbling noise	• The noise magnitude and pitch change when the rotational speed is changed. The noise becomes loud at a certain rotational speed. The noise becomes loud and quiet. The noise sometimes resembles the sound of sirens and whistles (howling noise).	• Sympathetic vibration, fitting failure (shaft shape failure) • Deformation of raceway • Chattering noise of raceway, ball, roller (a little noise for large size bearings is normal)
Scraping noise/ crunchy noise	• Roughness felt when the bearing is rotated by hand	• Scratches on the raceway surface (regular) • Scratches on the ball or roller (irregular) • Dirt, deformation of raceway (partial negative clearance)
Grumbling noise	• Continuous noise in high speed rotation	• Scratches on the surfaces of raceway, ball, roller
Whirling noise	• The noise stops the moment the power is turned off.	• Electromagnetic sound of motor
Clinking noise (mainly with small size bearings)	• Irregular • The noise does not change when the rotational speed is changed.	• Entrance of foreign matter
Jingling noise (tapered roller bearings) Chattering noise (large size bearings) Flapping noise (small size bearings)	• The noise is regular and becomes continuous in high speed rotation. • Clear cage sound is normal.	• Unsuitable lubricant (use soft grease for low temperature) • Cage pocket abrasion, insufficient lubricant, insufficient bearing load operation
Ticking noise/ clacking noise/ clattering noise	• Conspicuous in low speed rotation • Continuous noise in high speed rotation	• Collision noise from cage pocket, insufficient lubrication. The noise stops by preloading or by making the internal clearance smaller. • Collision noise of rollers for the full component type
Clanging noise	• Loud metallic collision noise • Low-speed thin large size bearings	• Deformation of raceway
Sliding noise/ squeaky noise splashing sound	• Mainly with cylindrical roller bearings, the noise changes when the rotational speed is changed. Large noise sounds like metallic sound. The noise temporarily stops when grease is supplied.	• Lubricant (grease) consistency too high • Radial internal clearance too large • Insufficient lubricant
Squealing noise/ creaking noise/ whining noise	• Metal biting sound • High-pitched sound	• Biting between roller and rib surface of roller bearing • Internal clearance too small • Insufficient lubricant
Splashing noise	• Occurs irregularly with small size bearings	• Sound generated when bubbles in the grease are broken
Groaning noise/	• Irregular squeaky noise	• Slippage of fitting part • Squeakiness of mounting surface
Indistinguishable loud noise during operation.		• Roughness of the surfaces of raceway, ball, roller • Deformation of raceway surface, ball, and roller caused by abrasion • Too large internal clearance caused by abrasion

15.7.1.3 Bearing vibration

Measuring the machine vibration during operation with a vibration measuring instrument can reveal bearing damage at an early stage. The bearing damage degree can be estimated by quantitatively measuring and analyzing the vibration amplitude and frequency. However, measurement values differ depending on the measurement positions and bearing use conditions. Therefore, it is desirable to accumulate measurement data and set criteria for each machine.

When the bearing is damaged, vibration including specific frequencies that depend on the bearing internal specifications and rotational speed occurs. The bearing vibration frequency can be calculated with the bearing technique calculation tool on the **NTN** website (https://www.ntnglobal.com).

15.7.1.4 Leakage/abnormal deterioration of lubricant

The main causes of the leakage/abnormal deterioration of lubricant are as follows. It is necessary to take measures depending on the use conditions and environment.

- Too much lubricant
- Unsuitable lubricant
- Improper installation
- Unsuitable sealing mechanism
- Deterioration caused by use
- Unsuitable operating condition
- Abnormal deterioration

15.7.2 Observation of bearing after use

Carefully observe bearings after use and during periodic inspection, and take appropriate recurrence prevention measures if any damage was found. For details, see section “16. Bearing damage and corrective measures”.

15.8 Bearing maintenance tools

NTN offers maintenance tools for easily and safely installing/disassembling bearings. **NTN** also offers a portable abnormality detection device", a small vibration measurement device that has excellent portability and usability for measuring the vibration generated from the machine.

15.8.1 Maintenance tools

Fig. 15.40 through **Fig. 15.49** show some of the main maintenance tools that are convenient for installing/disassembling bearings.

The kit allows accurate, safe, and quick bearing installation.

Fig. 15.40 Cold mounting case

The five spanners allow tightening/loosening nuts of 30 different sizes.

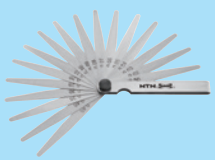
Fig. 15.41 Hook spanners

The device allows safe and secure heat fitting work and has an automatic demagnetization function, an overheat prevention function, and a temperature maintaining function.

Fig. 15.42 Induction heater

The protective gloves allow safe handling of high-temperature bearings up to 350 °C.

Fig. 15.43 Heat-resistant gloves



The tool allows simple and high precision measurement of bearing clearance.

Fig. 15.44 Set of calibrated feeler gauges

The jig allows quick and easy removal of bearings press-fitted into housings by a tight fit.

Fig. 15.45 Bore puller set

The jig allows safe and easy removal of bearings that are attached to shafts and difficult to remove.

Fig. 15.46 Back puller

The jig is a robust and simple tool for easily removing small and medium size bearings.

Fig. 15.47 Mechanical puller

The jig is efficient for easily and safely removing bearings press-fitted into shafts of large size bearings.

Fig. 15.48 Hydraulic puller

Removal can be done safely and efficiently by using the puller mechanically or hydraulically.

Fig. 15.49 Tri Section Pulling Plates

15.8.2 NTN PORTABLE VIBROSCOPE

NTN offers the "**NTN** PORTABLE VIBROSCOPE", a small vibration measurement device that has excellent portability and usability for performing FFT (Fast Fourier Transform) analysis and OA (Overall) measurement by wireless communication with tablets and smart devices with a dedicated application installed (see **Fig. 15.50**).

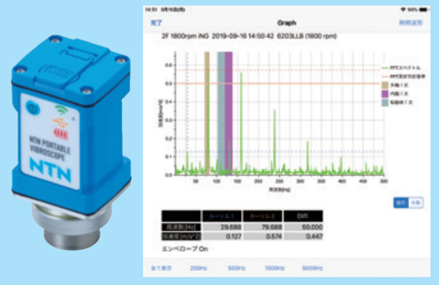


Fig. 15.50 NTN PORTABLE VIBROSCOPE

The FFT analysis clarifies the detailed operational state of the machine. By registering measurement conditions such as bearing part numbers and rotational speed, it is possible to detect the damage inside the bearing and estimate the damaged parts. In addition, selecting measurement conditions allows detecting abnormalities such as unbalance and misalignment of machines having rotating parts. In OA measurement, the acceleration, speed, and displacement can be displayed independently, and the measurement can be used as a general vibrometer.

The raw vibration data and the analysis results can be saved in smart devices for operation and can be downloaded in CSV format as necessary. In addition, the measurement device itself is dust-proof and drip-proof; therefore, the device is suitable for measuring vibration of machines used in various environments.

For the product details, please contact **NTN** Engineering.

For details, see the special catalog "**NTN PORTABLE VIBROSCOPE (CAT. No. 6601/E)**".