

エア軸受タービンスピンドル / Air Bearing Turbine Spindle

ABT - 1600 - BT40

取扱説明書 / OPERATION MANUAL

日本語 : P1 - P23 / English : P25 - P50

OM-K0695






Thank you for purchasing the ABT-1600-BT40 Air Bearing Turbine Spindle. This Air Bearing Turbine Spindle is designed for use on machining center's without rotating the machine's main spindle. The Air Line Kit, Piping Connection Hose, Compressor and Control Unit for Rotation Speed Detection Sensor are required to drive this Air Bearing Turbine Spindle. Read this and all the associated component Operation Manuals carefully before use. Always keep this Operation Manual in a place where a user can referred to for reference at any time.

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1. CAUTIONS FOR HANDLING AND OPERATION

- Read these warnings and cautions carefully and only use in the manner intended.
- These warnings and cautions are intended to avoid potential hazards that could result in personal injury to the operator or damage to the device. These are classified as follows in accordance with the seriousness of the risk.

| Class | Degree of Risk |
|---|---|
|  DANGER | Existence of a hazard that could result in personal death or serious injury, if the safety precautions are not followed. |
|  WARNING | A safety hazard could result in bodily injury or damage to the device if the safety instructions are not properly followed. |
|  CAUTION | A hazard that could result in light or moderate bodily injury or damage to the device if the safety instructions are not followed. |
| INFORMATION | Be sure to keep the usage for your safety. |

DANGER

Do not rotate the machining center's main spindle with the Air Turbine Spindle installed. Rotating the machining center's main spindle with the Air Turbine Spindle installed can cause the supply air / oil hose to become tangling will lead to a big accident.

WARNING

- ① This Air Bearing Turbine Spindle is not a hand tool. It is designed to be used install this Air Turbine Spindle to the machining center's machines or milling machines.
- ② Do not touch the cutting tool while it is running. It is very dangerous.
- ③ Wear safety glasses, dust mask and use a protective cover around the Air Bearing Turbine Spindle whenever the Air Bearing Turbine Spindle is rotating.
- ④ Never operate or handle the Air Bearing Turbine Spindle until you have thoroughly read the Operation Manuals and safe operation has been confirmed.
 - 1) To prevent injuries / damages, check the Air Bearing Turbine Spindle and cutting tool for proper installation, before operating the Air Bearing Turbine Spindle.
 - 2) Before disconnecting the Air Bearing Turbine Spindle, always turn the compressed air supply OFF to the Air Line Kit. Then it is safe to remove the Air Bearing Turbine Spindle.
- ⑤ Whenever installing an Air Bearing Turbine Spindle to a metal fixed base, ensure that the fixed base is grounded in order to avoid risk of an electric shock.
- ⑥ When installing a tool, tighten the collet correctly and check again the collet and collet nut before use. Do not over-tighten the collet. This may cause damage to the spindle.
- ⑦ Do not use bent, broken, chipped, out of round or sub-standard tools, as this may cause them to shatter or explode. Tools with fractures or a bent shank will cause injury to the operator. When using a new tool, rotate it in a low speed and increase speed gradually for safety.
- ⑧ Do not exceed the recommended maximum allowable speed of the tool. For your safety, use speeds below the maximum allowable speed.
- ⑨ Do not apply excessive force. This may cause injury to the operator by slippage or damage of the tool, or loss of concentricity and precision of the Air Bearing Turbine Spindle.

CAUTION

- ① Do not drop or hit this Air Bearing Turbine Spindle, as shock can damage to the internal components.
- ② Use the our recommended Air Line Kit (AL - A0611 / AL - A1205) or oil mist filter-equipped similar product when operating the Air Bearing Turbine Spindle.
- ③ Before use, carefully read " Air Line Kit Operation Manual " regarding the correct connection, operation and cautions when using the Air Line Kit.
- ④ Be sure to clean the collet and collet nut, the inside of the spindle before replacing the tool. If ground particles or metal chips stick to the inside of spindle or the collet, damage to the collet or spindle can occur due to the loss of precision.

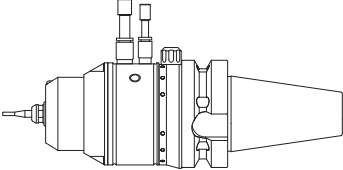


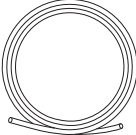
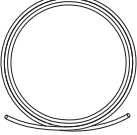


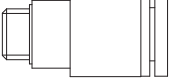
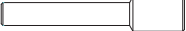

⚠ CAUTION

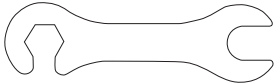
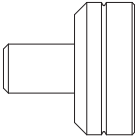


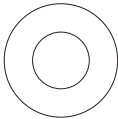

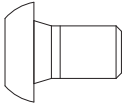
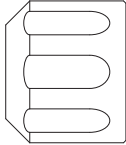

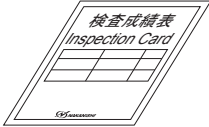

- ⑤ When cleaning a Air Bearing Turbine Spindle, stop the Air Bearing Turbine Spindle and remove debris with a soft brush or a cloth. Do not blow compressed air into the end of spindle area (refer to section " 6 - 2 Outside View ") as foreign particles or cutting debris may get into the Air Bearing.
- ⑥ Always clean the tool shank before installing the tool in the spindle.
- ⑦ When sizing the correct collet size to the tool shank diameter, a tolerance of $+0 \sim -0.01\text{mm}$ is strongly recommended.
A tool shank within the $+0 \sim -0.1\text{mm}$ range is mountable, however, this may cause poor concentricity and or insufficient tool shank gripping force.
- ⑧ Be sure to drain moisture and condensation from the Air Line Kit (oi mist filter or mist separator and micro mist separator) regularly to avoid moisture being carried to the Air Bearing Turbine Spindle. This may cause damage to the Air Bearing Turbine Spindle.
- ⑨ Select suitable products or tools for all applications. Do not exceed the capabilities of the Air Bearing Turbine Spindle or cutting tools.
- ⑩ Do not stop the supplied cooling air to the Air Bearing Turbine Spindle while it is rotating. Removing the air pressure from the Air Bearing Turbine Spindle will cause a loss of purging, allowing the Air Bearing Turbine Spindle to ingest coolant and debris. This will cause damage to the Air Bearing Turbine Spindle.
- ⑪ Carefully direct coolant spray directly on the tool. Do not spray directly on the Air Bearing Turbine Spindle and collet nut. Large amounts of coolant sprayed directly on the Air Bearing Turbine Spindle may cause excess load of the Air Bearing Turbine Spindle causing a loss of durability and longevity of the Air Bearing Turbine Spindle.
- ⑫ Stop working immediately when abnormal rotation or unusual vibration are observed. Immediately, please check the content of section " 15. TROUBLESHOOTING ".
- ⑬ Always check if the tool, collet, collet nut, connection hose and supply air hose for signs of wear or damage before and after operating.
- ⑭ If the collet or collet nut show signs of wear or damage, replace them before a malfunction or additional damage occurs.
- ⑮ After installation, repair, initial operation, or long periods of non operation, please refer to section " 10 - 1 Break-in Procedure ". When checking the Air Bearing Turbine Spindle, no vibration or unusual sound should be observed during rotation.
- ⑯ Do not disassemble, modify or attempt to repair this Air Bearing / Air Turbine Spindle. Additional damage will occur to the internal components. Service must be performed by NSK NAKANISHI or an authorized service center.
- ⑰ When using this Air Bearing Turbine Spindle for mass production, please consider the purchase of an additional Air Bearing Turbine Spindle to be used as a back-up in case of emergency.
- ⑱ Securely connect the compressor supply connection hose to the Air Line Kit. Then connect the supply air hoses from the Air Line Kit to the Air Bearing and Air Turbine Spindle to avoid accidental disconnection during operation.

2. BASIC PACKAGE

When opening the package, check if all items listed in " Table. 1 Packing List Contents " are included. In the event of any shortage, please contact either NAKANISHI (see the " 4. CONTACT US " section) or your local dealer.

Table. 1 Packing List Contents

| | |
|---|--|
| <p>Air Bearing Turbine Spindle · · 1pc.</p>  | <p>Collet $\phi 4.0\text{mm}$ (CHA - 4.0) · · 1pc.*</p>  |
| <p>Collet Nut (CHN - 3A) · · 1pc.*</p>  | <p>Supply Air Hose ($\phi 6\text{mm}$ x 1.5m) (TU0604BU [SMC]) · · 1pc.</p>  |
| <p>Supply Air Hose ($\phi 4\text{mm}$ x 1.5m) (TU0425C [SMC]) · · 1pc.</p>  | <p>Sensor Cable (XS3F - M421 - 405 - R [OMRON]) · · 1pc.</p>  |
| <p>Connection Joint (KQ2S04 - M5N [SMC]) · · 1pc.*</p>  | <p>Connection Joint (KQ2S06 - M6N [SMC]) · · 1pc.*</p>  |
| <p>Air Plug ($\phi 4$) · · 1pc.*</p>  | <p>Air Plug ($\phi 6$) · · 1pc.*</p>  |

| | |
|---|--|
| <p>Wrench (10 x 10) · · 1pc.</p>  | <p>Protective Cover · · 1pc.*</p>  |
| <p>Stepped Test Bur ($\phi 2\text{mm} \times \phi 4\text{mm} \times 34\text{L}$) · · 1pc.*</p>  | <p>Bur Wrench (K - 277) · · 1pc.</p>  |
| <p>Gasket (for M3 Screw) · · 1pc.</p>  | <p>Hexagon Wrench (2mm) · · 1pc.</p>  |
| <p>Hexagon Socket Button Head Bolt (M3 x 5L) · · 1pc.</p>  | <p>Cap (K1056035) · · 1pc.*</p>  |
| <p>THE ANTI-ROTATION BAR (K022154, K022155) · · 1set</p>  | <p>Inspection Card (KS - 212) · · 1pc.</p>  |
| <p>Operation Manual · · 1set</p>  | |

The Stepped Test Bur, Collet, Collet Nut, Connection Joint, Air Plug, Protective Cover and Cap are attached to the Air Bearing Turbine Spindle.

3. WARRANTY

We provide a limited warranty for our products. We will repair or replace the products if the cause of failure is due to the following manufactures defects. Please contact us or your local distributor for details.

- (1) Defect in manufacturing.
- (2) Any shortage of components in the package.
- (3) Where damaged components are found when initially opening the package.
(This shall not apply if the damage was caused by the negligence of a customer.)

4. CONTACT US


For your safety and convenience when purchasing our products, we welcome your questions. If you have any questions about operation, maintenance and repair of the product, please contact us.

Contact Us

● For U.S. Market

Company Name : **NSK America Corp**
Industrial Div.
Business Hours : 8:30am to 17:00pm (CST)
(closed Saturday, Sunday and Public Holidays)
U.S. Toll Free No. : 800-585-4675
Telephone No. : 847-843-7664
Fax No. : 847-843-7622
Web Address : www.nskamericacorp.com

● For Other Markets

Company Name : **NAKANISHI INC.** 
Business Hours : 8:00am to 17:00pm
(closed Saturday, Sunday and Public Holidays)
Telephone No. : +81 (0) 289-64-3520
e-mail Address : webmaster-ie@nsk-nakanishi.co.jp

5. FEATURES

- ① Usage of the air bearing / turbine drive is best suited for high speed mold cutting, small diameter drilling, and grinding of highly-detailed parts which require high precision machining.
- ② Optimal cutting conditions are achieved when mounted in a CNC Machine and by making use of high speed rotational performance of 160,000 min-1(rpm). The result will be an increased production performance and superior surface finish, and can expect to long life of the tool.
- ③ The air bearing is a rotating shaft that is floated without contact by supplying dry compressed air from which oil is removed from the bearing gap. This prevents the bearing from being worn and reduced energy consumption to a minimal level. Always use in as clean an environment as possible.
- ④ The Air Bearing section should never come in contact with the rotating shaft. In order to suppress any heat generation, due to air resistance during rotation, a highly-functional bearing material has been used in the bearing section to increase the anti-seizing properties and cooling effects.
- ⑤ There are no electronics used to operate this Air Bearing Turbine Spindle. Operation is performed through the air piping.

- ⑥ This Air Bearing Turbine Spindle is equipped with a Rotational Speed Detection Sensor. When in operation, a signal consistent with rotation speed can be output.
The rotation speed and load condition can be accurately monitored by using a high performance, commercially available meters.

6. SPECIFICATIONS AND DIMENSIONS

6 - 1 Specifications

| | |
|-------------------------------------|--|
| Model | ABT - 1600 - BT40 |
| Maximum Rotation Speed | 160,000 min ⁻¹ (rpm) |
| Taper Shank | BT40 |
| Drive Method | Air Turbine Drive |
| Bearing Type | Air Static Pressure Bearing |
| Rotation Direction | Right Hand Rotation (FWD). Viewed from the rear of the Air Bearing Turbine Spindle toward the cutting tool. |
| Air Bearing Required Air Pressure | 0.5MPa |
| Air Turbine Operating Air Pressure* | Less than 0.5MPa |
| Rotational Speed Detection Method | Magnetic Sensor Method (Output Signal 2 pulse / rev) |
| Spindle Accuracy | Less than 1μm |
| Weight | 1615g |

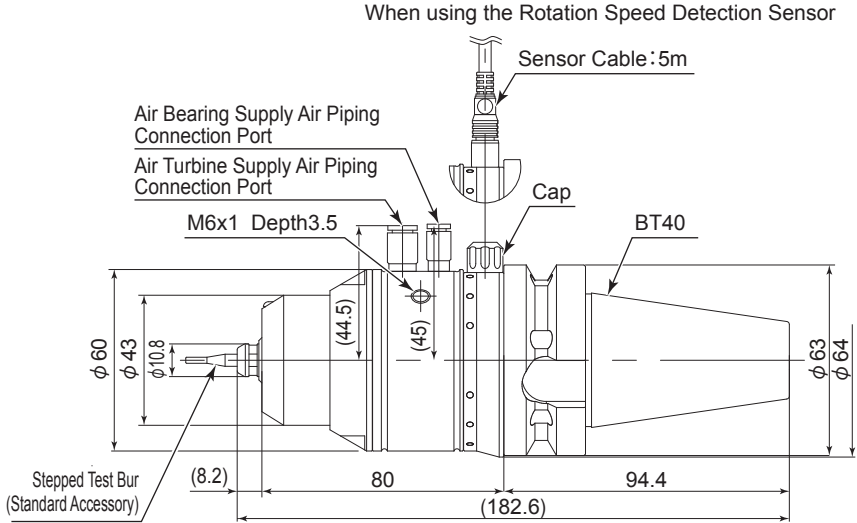
* For the proper air pressure setting for the Air Turbine, please refer to the Inspection Card.

| | Temperature | Humidity | Atmospheric Pressure |
|--|-------------|------------------------------|----------------------|
| Operation Environment | 0 - 40°C | MAX.75% (No condensation) | 800 - 1,060hPa |
| Transportation and Storage Environment | -10 - 50°C | 10 - 85% | 500 - 1,060hPa |

<Option>

| | |
|--------------------|---|
| Collet (CHA - □□) | φ0.5mm - φ4.0mm in 0.1mm increments and φ2.35mm, φ3.175mm |
| Collet Nut | CHN - 3A |

6 - 2 Outside View



[Magnetic Sensor Wiring Connections]

| Sensor Cable (Color) | Rotation Speed Detection Sensor |
|-------------------------------|---|
| XS3F - M421 - 405 - R [OMRON] | |
| Brown | VCC (Power Supply Voltage : DC+4V - DC+24V) |
| Black | VOUT (Signal Output) |
| Blue | GND (Ground) |

Fig. 1

6 - 3 Torque Characteristics

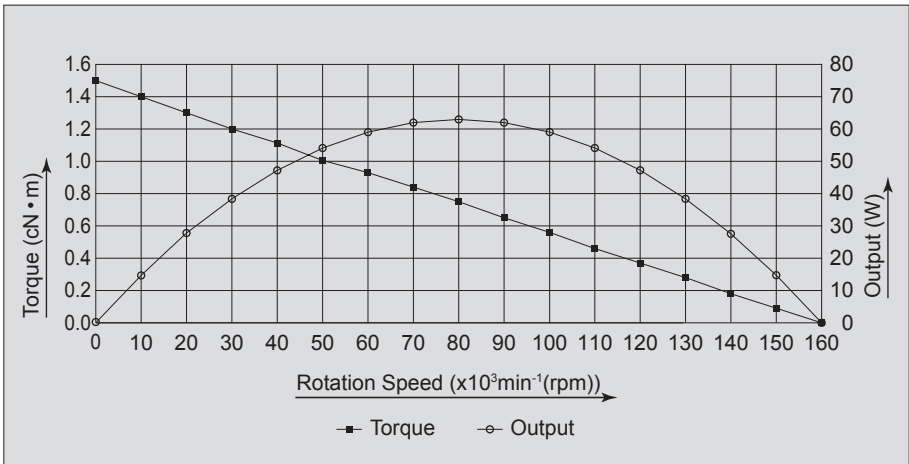


Fig. 2

7. ATTACHING TO A MACHINING CENTERS MAIN SPINDLE

DANGER

Do not rotate the machining center's main spindle with the Air Turbine Spindle installed. Rotating the machining center's main spindle with the Air Turbine Spindle installed can cause the supply air hose to become tangling will lead to a big accident.

WARNING

- **If the main spindle of the machining center is rotate by mistake, stop the main spindle immediately. Make sure the not damaged to the machine, unit and supply air / oil hose. Afterward, please carry out break-in as follow. Start rotating slowly and over a short period of 15 - 20 minutes, increase speed gradually until allowable maximum speed.**
- **Confirm there is not a heat near aupply air / oil hose, as supply air / oil hose might melt by heat.**

- (1) Insert and Clamp the Air Turbine Spindle to the main spindle of the machining center.
- (2) Allow an ample length of supply air / oil hose to allow for axis movement of the machining center.
- (3) Secure the supply air / oil hose to the machine. Do not allow damage to the supply air / oil hose.

8. AIR PIPING, SENSOR CABLE CONNECTION AND AIR SUPPLY TO THE AIR BEARING

WARNING

- Use the supply air hose (Standard Accessory) and supply pressure no higher than 0.8MPa (116psi). If the supplied air is more than 0.8MPa (116psi), the supply air hose may rupture and cause injury to the operator.
- Be sure to use the provided Sensor Cable (XS3F - M421 - 405 - R) or the cable that adapts to the connector plug for sensor assembly (XS3M - K421 - 2 [OMRON]) when using the Rotational Speed Detection Sensor.
Using the incorrect cable or adapter will cause damage to the Rotation Speed Detection Sensor or the connector plug for sensor assembly (XS3M - K421 - 2 [OMRON]).

CAUTION

- Securely connect the compressor supply connection hose to the Air Line Kit. Then connect the supply air hoses from the Air Line Kit to the Air Bearing and Air Turbine Spindle to avoid accidental disconnection during operation.
- Ensure that all parts and tools used for the connection of the Air Line Kit and Air Bearing / Turbine Spindle are clean, as contaminants, water and oil entering the components will cause damage to the system.
- Ensure the air piping connections are correctly connected as instructed in this manual (Refer to Fig. 3).
If connections are incorrectly made, abnormal operation and damage to the Air Bearing Turbine Spindle will occur.
- Be sure to install a proper piping system (refer to Fig. 3, 4 and Fig. 5) for a clean and dry air supply to the Air Turbine Spindle.
If contaminants, water or oil enter the Air Bearing Turbine Spindle, damage to the Air Bearing Turbine Spindle will occur.

8 - 1 Connection of the Air Piping and Sensor Cable

- (1) Connection to the Air Bearing Turbine Spindle, consists of air piping and a Rotation Speed Detection Sensor Cable.
Securely connect the air supply piping, referring to " Fig. 3 Marking of the Piping Connection Section " section.
- (2) Rotation Speed Detection Sensor Cable (length : 5m) connects to the side of the Air Bearing Turbine Spindle. Securely connect the Rotation Speed Detection Sensor Cable to the Wiring Connector.

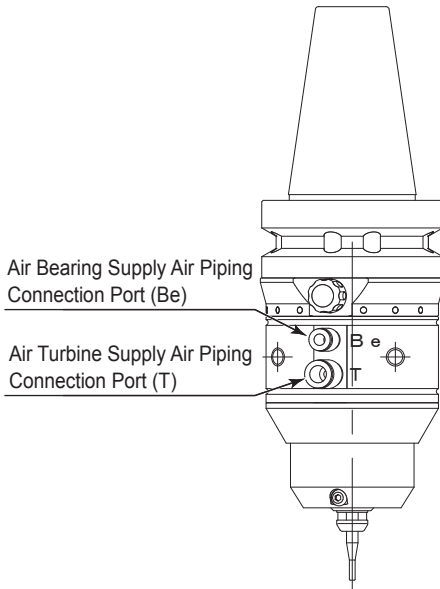


Fig. 3 Marking of the Piping Connection Section

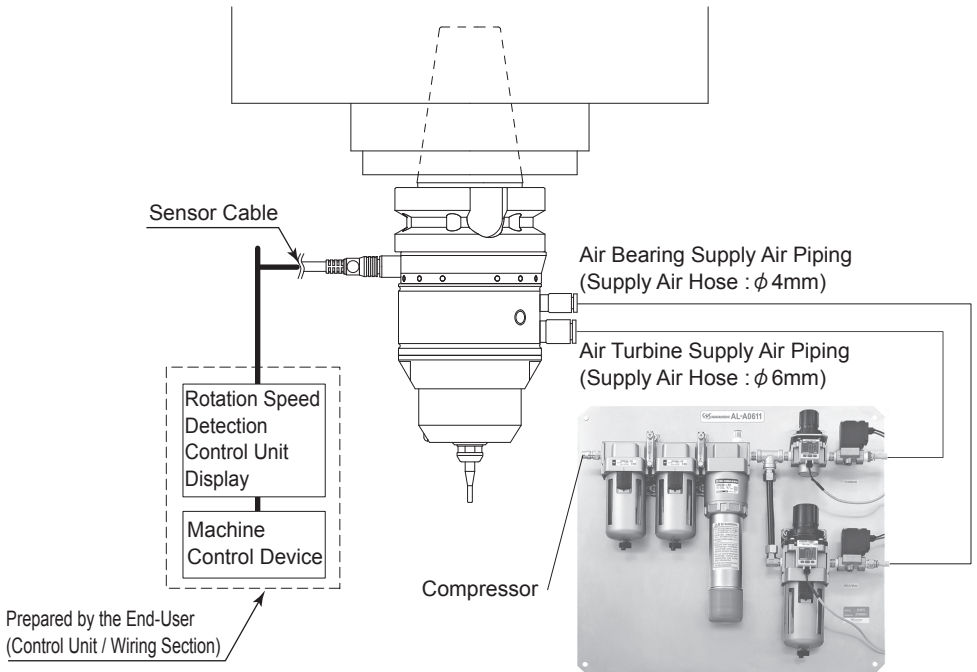
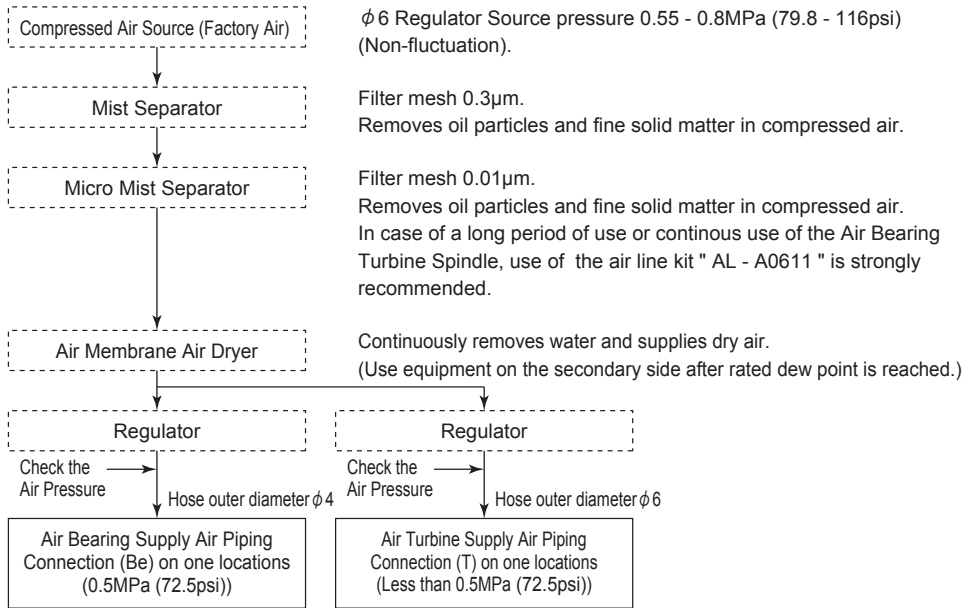


Fig. 4



- * Note 1 : Devices in the broken lined frame are not included with Air Bearing Turbine Spindle, therefore, these items should be prepared by the customer.
- * Note 2 : For details and precautions of each air device, refer to the Operation Manual of the manufacturer from which you purchased the each product.
- * Note 3 : Make sure the set air pressure at the Air Bearing Turbine Spindle piping connection port.

Fig. 5

8 - 2 Procedures to Supply Air to Air Bearing

⚠ WARNING

Do not supply air to the turbine air supply piping before supplying air to the Air Bearing. Failure to do so will cause damage to the spindle shaft.

⚠ CAUTION

- **Be sure to correctly connect the piping and wiring to the Air Bearing Turbine Spindle. If incorrectly wired and plumbed, to the Air Bearing Turbine Spindle, major damage will occur to the air bearing and spindle shaft.**
- **Be sure the set the correct air pressure to the Air Bearing Turbine Spindle connection port. If the piping connection port is separated from the pressure detecting section, the correct air pressure cannot measured.**

- (1) Adjust the set pressure in each piping to 0MPa (0psi).
- (2) Perform a flushing of supply connection hose and the air hoses to be connected to the Air Turbine and Air Bearing for a few minutes to completely remove any contaminants such as water, oil and dust that may be in the piping before use.
- (3) After the air has been dehumidified to the rated dew point with an air dryer, supply the air to the Air Bearing Supply Air Piping Connection Port (Be).
- (4) Adjust the Air Bearing pressure to 0.5MPa (72.5psi) at the piping connection port of the Air Bearing Turbine Spindle.
- (5) Slowly rotate the rotating shaft by hand to check that the shaft rotates smoothly without any abnormal or sticking feeling.
- (6) Leave this Air Bearing Turbine Spindle as it is without operating for approximately 15 minutes after supplying air to the air bearing supply piping. Wait until the inside of the spindle has been sufficiently cleaned and dehumidified.

9. USING THE ANTI-ROTATION BAR

⚠ CAUTION

Use the Anti-Rotation Bar (Included) and Block (Not Included) for your safety. If the main spindle is rotated by mistake, the Anti-Rotation System will prevent the tangling of supply air / oil hose.

Screw in the Anti-Rotation Bar into the Outward Rotation Ring before use. Refer to Fig. 6.

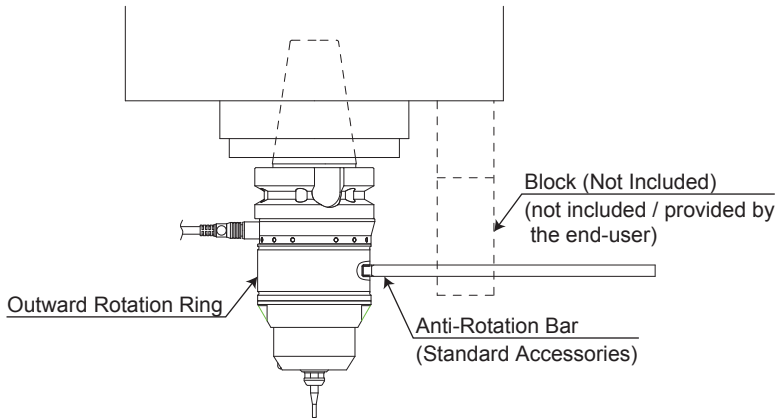


Fig. 6

10. CHANGING THE TOOL AND REPLACING THE COLLET

WARNING

Ensure that the supply air to the turbine spindle has been shut off and the Air Turbine has stopped rotating before attempting to change the tool or replace the collet. If accidentally trying to changing the tool or replace the collet while the turbine is rotating, major personnel injury will occur.

CAUTION

Keep the air supply to the air bearing ON when changing a tool or replacing the collet. Replacing the tool without supplying air to the air bearing will cause damage or malfunction to the spindle shaft and as well as to internal surface areas.

10 - 1 Changing the Tool

CAUTION

- Do not tighten the collet without inserting the Stepped Test Bur or the tool shank into the collet, as this will damage the collet, spindle or collet nut, causing difficulty removing the collet.
- When installing a tool, tighten the collet correctly and check again the collet and collet nut before use. Do not over-tighten the collet. This may cause damage to the spindle.
- After changing the tool, measure the run-out accuracy of the outside diameter of the tool shank.
- After replacing a cutting tool, make sure to replace the Hexagon socket head / Button head bolt (Standard Accessories : M3 X 5L) into the provided threaded hole of the Dust Proof Cover (Be careful not to overtighten the bolts. This may cause damage to the Air Bearing Turbine Spindle.). Failure to do so will allow contaminants such as water, oil and dust to enter into the Air Bearing Turbine Spindle. This will cause damage to the Air Bearing Turbine Spindle.

RECOMMENDATION

Please set the cutting tool to a maximum over hang of 17mm. This is the maximum amount of overhang to maintain high accuracy and safety.

- (1) Supply proper air pressure to the Air Bearing.
- (2) Remove the Hexagon Socket Button Head Bolt (with Gasket (M3 X 5L) (Standard Accessories) on the outside diameter section of Dust Proof Cover by using the Hexagon Wrench (Standard Accessories : 2mm) (Fig. 7).
- (3) Insert the Bur Wrench (Standard Accessories : K - 277) into the Screw Hole located on the O.D. of the Dust Proof Cover. Then insert and fix the end of Bur Wrench (Standard Accessories : K - 277) to the groove on the spindle shaft (Fig. 8).
- (4) Place the wrench (Standard Accessories : 10mm) on the collet nut and turn it counter-clockwise to loosen the collet and remove the tool. (The first turn will loosen the collet nut, but the tool will not release and turning will become stiff. Keep turning through the stiffness and the collet will open.)
- (5) Always clean the collet and collet nut, then insert the new tool and tighten the collet by turning clockwise. Do not over-tighten. (Specified Torque : 3 N · m) (Fig. 8).
- (6) Remove the provided Bur Wrench (Standard Accessories : K - 277) from the Screw Hole.
- (7) Attach the Hexagon Socket Button Head Bolt (with Gasket (M3 x 5L) (Standard Accessories) to the Screw Hole by using the Hexagon Wrench (Standard Accessories : 2mm) (Specified Torque : 30 cN · m) .

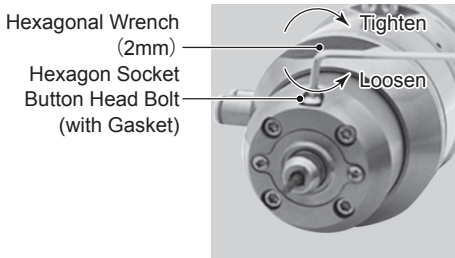
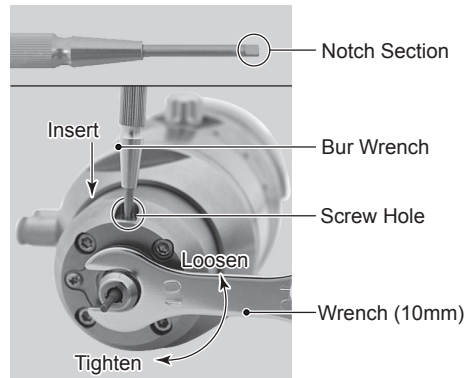


Fig. 7



*Insert the Bur Wrench (2mm) (located at tip notch of the Bur Wrench collet nut side.) to the screw hole, additionally insert the end of Bur Wrench (2mm) to the groove on the rotating shaft.

Fig. 8

10 - 2 Replacing the Collet

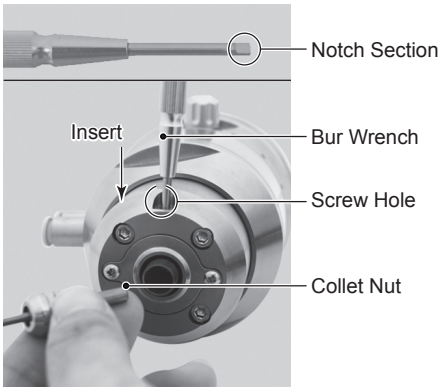
⚠ CAUTION

When installing the collet into the collet nut, be sure to fully engage the latch inside the collet nut to the groove on the collets outer diameter area. Do not set the collet into the spindle taper.

Precautions : If the collet is attached without being engaged into the latch of the collet nut :

- The collet will remain attached to the spindle shaft or cannot be removed.
- The tool cannot be properly gripped, resulting in a dangerous situation or injury due to the tool coming out of the spindle.
- The collet, collet nut or spindle shaft have be damaged and may cause the collet to be stuck in the taper of Air Bearing Turbine Spindle.

- (1) Supply proper air pressure to the Air Bearing.
- (2) Remove the tool according to the section " 10 - 1. Changing the Tool" procedure above and remove collet nut assembly. (Fig. 9)
- (3) The collet and collet nut are secured by a groove in the collet and a flange in the collet nut. To remove the collet hold the collet nut in one hand and push diagonally down on the collet. The collet should be released (Fig. 10).
- (4) To install the collet, hold the collet at a slight angle, and insert it into the collet nut (Fig. 11). Press the collet in the collet nut by positioning the collet in the collet nut and pressing down on flat surface (Fig. 10).
Be sure to fully engage the latch inside the collet nut into the groove on the collets outer circumference area (Fig. 12).



*Insert the Bur Wrench (2mm) (located at tip notch of the Bur Wrench collet nut side.) to the Screw Hole, additionally insert the end of Bur Wrench (2mm) to the groove on the rotating shaft.

Fig. 9

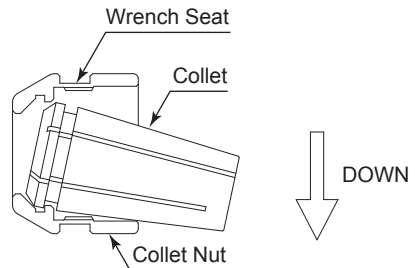


Fig. 10

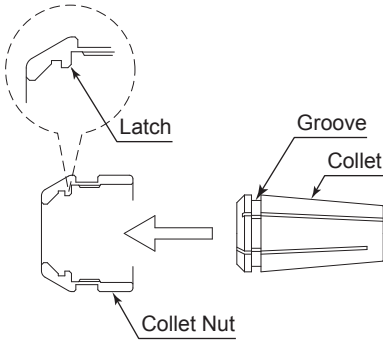


Fig. 11

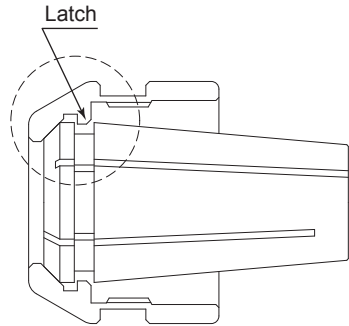


Fig. 12

11. START / STOP OPERATION

⚠ WARNING

- Make sure the completely removed the tool (spanner or wrench) from the Air Bearing Turbine Spindle. Always keep in mind that the tool will fly off, and this may cause injury and damage to property or operator if the shaft is rotated with the tools engaged.
- Wear safety glasses, dust mask, and use a protective cover around the Air Bearing Turbine Spindle whenever the Air Bearing Turbine Spindle is rotating.
- Do not exceed maximum rotation speed operation. This may cause damage to the Air Bearing Turbine Spindle.
- Make sure to correctly set air pressure to the Air Bearing Turbine Spindle piping connection ports. If the piping connection port is separated from the pressure measurement section, proper air pressure cannot be measured.
- Remember that rotation is not completely stopped when air flow to the air bearing is removed, even though air pressure to the turbine has been turned off. Do not touch the cutting tool until visual inspection shows the cutting tool has stopped rotating.

⚠ CAUTION

- Re-check for proper supply air pressure to the air bearing, piping connection and correct mounting.
- Remember that there is no air purge when air is not supplied to the Air Bearing and Air Turbine. Contaminants, water and oil may enter into the Air Bearing Turbine Spindle and cause air bearing and rotating shaft, causing seizing or galling.

When the air supply to the air bearing or air turbine is not present, please observe the following precautions (1) to (3).

- (1) Never rotate the spindle shaft unnecessarily.
- (2) Do not spray coolant directly on the Air Bearing Turbine Spindle body.
- (3) Do not blow air directly to the Air Bearing Turbine Spindle body.

CAUTION

- If the Air Bearing Turbine Spindle is going to remain in the machine, even though it is not being used, always supply air pressure to the air bearing. Ingress of the contaminants, oil or water into the Air Bearing Turbine Spindle, causing the air bearing or rotating shaft to seize or become galled.
- Immediately stop operation and shut off the supply air to the Air Turbine if abnormal rotation or unusual vibration are observed. Please check the content of P49 " 16. TROUBLESHOOTING " section.
- If the air pressure to the air bearing is low or air pressure to the air bearing is incorrectly shut off during operation by mistake, the air bearing will operate abnormally, causing the rotating shaft and the bearing come into contact with each other causing severe damage. Always observe the correct pressure.

INFORMATION

Adjust the rotating speed by adjusting the regulator to the correct values as described in the Inspection Card and Operation Manual.

Caution must always be observed when rotating the Air Bearing Turbine Spindle at high speeds to avoid any dangerous situations. Carefully read Section " 11 - 1 Break-in Procedure " and " 11 - 2 Running / Stop procedures ", to ensure safe operating conditions. Always be prepared to stop the Air Bearing Turbine Spindle if abnormal conditions are observed. For original factory specifications, refer to " Inspection Card (KS - 212) " included with the unit. After initial installation, repair, or extended periods of non operation, please follow the " 11 - 1 Break-in Procedure ".

11 - 1 Break-in Procedure

⚠ CAUTION

Check set air pressure (0.5MPa (72.5psi)) is always supplied into the Air Bearing before operation.

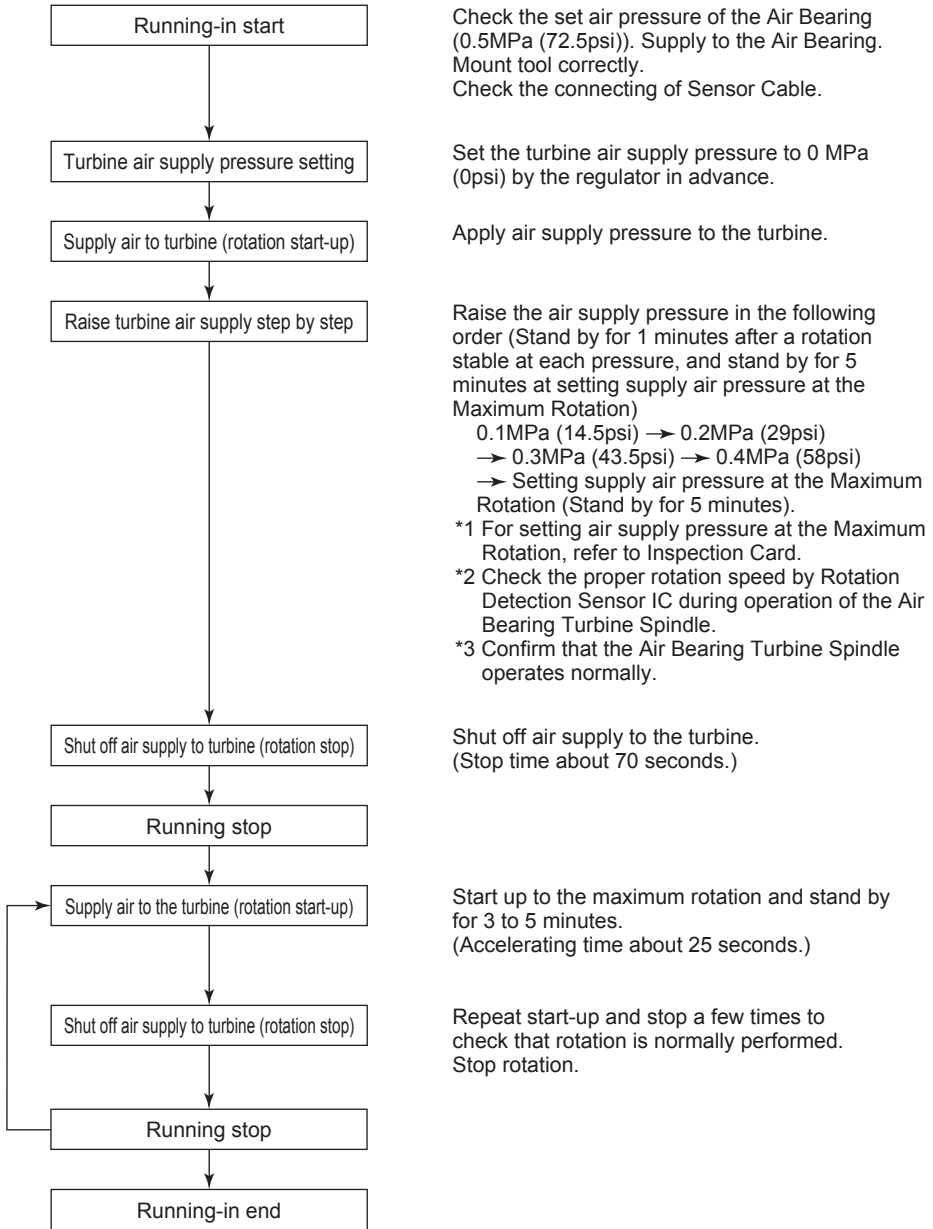
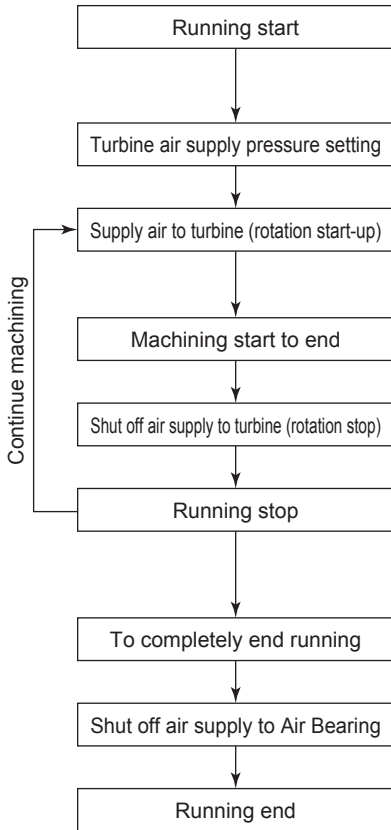


Fig. 13

11 - 2 Running / Stop Procedures

⚠ CAUTION

Check set air pressure (0.5MPa (72.5psi)) is always supplied into the Air Bearing before operation.



Check the set pressure for the air bearing (0.5MPa (72.5psi)) and supply air if it is insufficient.
Mount tool correctly.

Set the rotation speed necessary for running or machining in advance.
Set it not to exceed maximum rotation speed.

Apply air supply pressure to the turbine.
Stand by until a set rotation is reached from rotation start-up.
(Accelerating time about 25 seconds.)

Monitoring the rotation state of the Air Bearing Turbine Spindle by the Rotation Speed Detection Function.

Shut off air supply to the turbine.
(allowed to stop suddenly)
(Stop time about 70 seconds.)

Stop rotation and replace the tool if necessary.

(Normally, keep supplying air to the air bearing after the operation has ended.)
Keep the right state of the air bearing.)

Reconfirm the rotating stop state.

Completely stop rotation.
Then shut off air supply to the Air Bearing.

Fig. 14

12. DETECTION OF THE ROTATION SPEED

12 - 1 Connection of Sensor Cable

⚠ CAUTION

- Before connecting the Sensor Cable to the Machine Control Device, verify the Main Power Switch on the Machine Control Device is turned OFF. If the Main Power Switch on the Machine Control Device is ON while connecting the Sensor Cable, damage to the Machine Control Device is possible.

- (1) Loosen the Cap pull out the Sensor Cable from the Wiring Connector straight (Fig. 15).

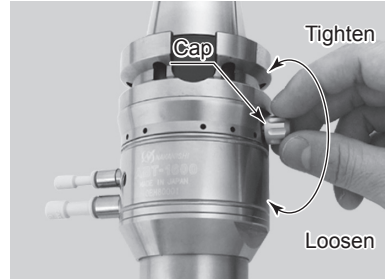


Fig. 15

- (2) Carefully insert the Holes (4 locations) on the Sensor Cable into the Pins (4 locations) on the Piping Connector, then push straight into the Piping Connector (Fig. 16).

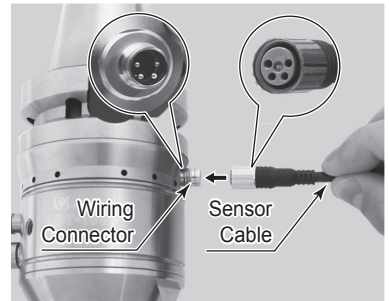


Fig. 16

- (3) Tighten the Connector Nut in a clockwise direction (Fig. 17).

- * Loosen the Connector Nut pull out the Sensor Cable from the Wiring Connector straight when removing the Sensor Cable.

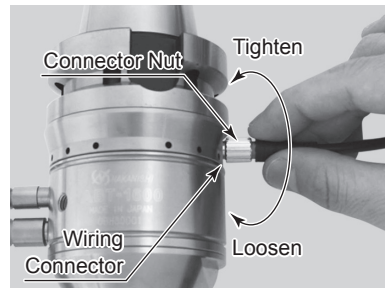


Fig. 17

12 - 2 Connecting the ABT-1600 Speed Sensor Unit to the Speed Meter Unit.

⚠ CAUTION

- Do not apply excess voltage or current to the Rotation Speed Detection Sensor.
- Incorrect wiring will cause damage to the Air Bearing Turbine Spindle.
- Connect the proper wiring leads to the Rotation Speed Detection Sensor.
- To minimize RF interference and noise, please minimize the length of the Wiring Cables to the Rotation Speed Detection Sensor.
- Do not disassemble any component that is not authorized in this Operation Manual.
- Tighten the Cap and Connector Nut of the Sensor Cable. Failure to do so may allow contamination of coolant spray or other debris to enter the the Air Bearing / Turbine Spindle, which will cause a malfunction or contact failure internally of the Air Bearing / Turbine Spindle.

[Checking and Adjusting the Rotation Speed of the Air Bearing / Air Turbine Spindle]

Rotational speed from zero to its maximum speed using a digital pulse signal from the the Rotation Speed Detection Sensor is performed by connecting using a commercial tachometer or speed measuring device to the Rotation Speed Detection Sensor built into the Air Bearing Turbine Spindle. The Rotation Speed Detection Sensor is designed to accurately detect a target located on the face of the Rotation Shaft. The rotational speed is adjusted by regulating the air pressure supplied from the Air Line Kit to the Air Turbine and Air Bearing.

Maximum Rotational Speed : $160,000\text{min}^{-1}$ (rpm)

(Rotational Frequency : Approx. 2,667Hz)

Signal Output : 2 pulses / rev

Circuit Diagram of Rotation Speed Detection Sensor, refer to Fig. 18.

[Control Output Circuit]

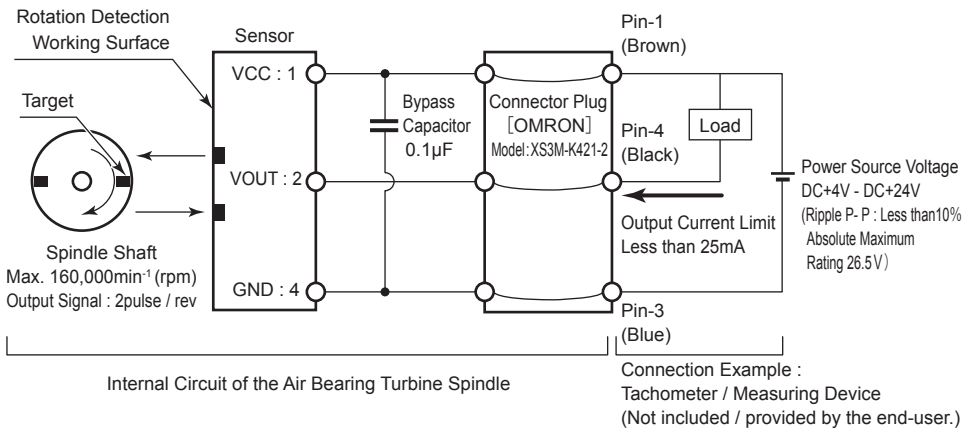


Fig. 18

12 - 3 When Not Using the Rotation Speed Detection Sensor

Install the provided Cap with O-ring to prevent damage or contamination to the Sensor Cable when not in use. Always confirm that the O-ring is properly seated in the Cap.
It is very important that the Cap and its O-ring are used for storage to prevent damage when not in use.

13. CAUTIONS WHEN USING GRINDSTONES AND TOOLS

⚠ CAUTION

The maximum surface speed or rpm is always specified for a grindstone. Do not exceed the maximum speed with reference to the calculating chart below. Always follow the grindstone manufacturer's recommendations.

$$\text{Surface Speed (m / s)} = \frac{3.14 \times \text{Diameter (mm)} \times \text{Rotation Speed (min}^{-1}) \text{ (rpm)}}{1,000 \times 60}$$

- (1) The proper surface speed for general grindstones is 10 - 30m / s.
- (2) Do not exceed 17mm of Tool the protrusion depth range at Depth for mounted grindstones and cutting tools when using at the Maximum Rotation Speed (160,000 min⁻¹) (rpm) (Fig. 19). If a total length of a grindstones and cutting tools are longer than 40mm, cut off a grindstones and cutting tools before use.
- (3) If the overhang must exceed 17mm, reduce the Air Turbine speed in accordance with Table. 2.
- (4) Dress the grindstone prior to use.
- (5) Do not use cutting tools with bent or broken shanks, cracks or excessive run-out.
- (6) For grinding, the maximum depth of cut should not exceed 0.01mm radially or axially. Reciprocate the tool several times after each pass to eliminate tool pressure.
- (7) Always operate cutting tools within the allowable recommended speed of the cutting tools. Use of a cutting tool outside of the allowable speed of the cutting tools could cause damage to the spindle and injury to the operator.
- (8) Keep the cutting tool shank, Collet Nut and Collet clean. If contaminants are allowed to remain in the collet or collet nut, excessive run-out will cause damage to the cutting tool and or spindle.
- (9) Do not strike or disassemble the Air Bearing Turbine Spindle.
- (10) Do not apply excessive cutting force as to cause more than a 5% decrease of the rotation speed.

RECOMMENDATION

It is recommend to perform a complete operational, rotation and shutdown procedure test to ensure there is no excessive force on the Rotation Speed Detection Sensor.

Table. 2 Use this Maximum Rotation Speed Table when exceeding the " Range of Overhang " recommendations (Refer to Fig. 19).

| Tool Sizes | Maximum Rotation Speed (min ⁻¹) (rpm) |
|------------|---|
| φ4 x 17L | Less than N x 1.0 |
| φ4 x 25L | Less than N x 0.9 |

" N " is the maximum rotation speed used in the formula for " Range of Overhang " (Refer to Fig. 19) (160,000min⁻¹) (rpm)).

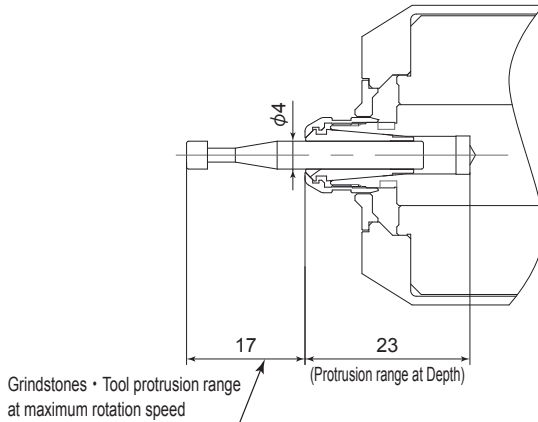


Fig. 19

14. MAINTENANCE AND INSPECTION

14 - 1 Routine Pre-operation Checks

- (1) Cleanliness of supplied air.
- (2) Check the air supply pressure to the Air Bearing and Air Turbine.
- (3) Check for damage to the Piping Joint and wiring of the Rotation Speed Detection Sensor and supply air hose.
- (4) Check for abnormal vibration, abnormal sound or heat generation during test or operation.

14 - 2 Cleaning

⚠ CAUTION

- Do not spray coolant and compressed air into the Air Bearing Turbine Spindle. This will cause contaminants, debris, oil and water to enter Air Bearing Turbine Spindle. Damage to the Air Bearing and Turbine Spindle will occur.
- Clean so as to prevent contaminants or foreign matter from entering into the piping, air lines or inside of the Air Bearing / Turbine Spindle.
- Do not apply rust inhibitor or rust preventive to the Air Bearing Turbine Spindle. Should any of these chemicals enter into the air bearing section or inside of the piping, loss of precision and damage to the Air Bearing Turbine Spindle will result.

- (1) Shut off the supply pressure to the Air Turbine first before shutting off the air to the Air Bearing.
- (2) Always keep air supplied to the Air Bearing. Wipe any debris off of the Air Bearing Turbine Spindle.

15. STORAGE

CAUTION

When attaching the Stepped Test Bur for storage of the spindle, attach the Protective Cover provided over the Stepped Test Bur to eliminate the chance of damaging the Stepped Test Bur.

Wrap the Air Bearing Turbine Spindle with the vapor phase corrosion inhibitor wrapping film in which the Air Bearing Turbine Spindle was originally packaged with at the factory. Wrap the Air Bearing Turbine Spindle in the quilting material and store in the original factory corrugated box.

Follow to the " STORAGE, INSTALLATION and OPERATION " (Refer to " 6 - 1 Specifications ") recommendations.

16. TROUBLESHOOTING

If a problem or concern occur, please check the following items prior to consulting your dealer.

| Trouble | Cause | Inspection / Corrective Action |
|---|--|--|
| Air Turbine Bearing Spindle does not rotate or increase rotation speed. | Low Air Pressure. | Check the Compressor, Air Circuit, and Regulator. |
| | Diameter of a hose used for air supply piping is too small. | Replace with the proper diameter hose. |
| | Contaminants, oil or water have entered into the air supply piping (to the Air Bearing or to Air Turbine inlets). | Repair is necessary . (Return to NAKANISHI dealer service.) |
| | When rotating the spindle shaft by hand, there is some abnormal or sticky feeling. | Return to NAKANISHI dealer service. |
| | Excess load or contact to the bearing have resulted in a constant reduction in the rotation speed or complete stopping of the spindle shaft. | Reduce the excessive load. If the spindle shaft is sticking or seized return to NAKANISHI dealer service immediately. |
| | There is continuity with air supplied. | Spindle shaft has been damaged. (Return to NAKANISHI dealer service.) |
| Abnormal vibration or noise during rotation. | Proper air pressure is not supplied to the Air Bearing. | Set the supply air pressure to the recommended air pressure. |
| | The tool shank is bent. | Replace the tool. |
| | Tool Mounting extension has been exceeded (refer to " Range of Tool Overhang "). | Be sure to mount the tool within the " Range of Tool Overhang " chart. |

| Trouble | Cause | Inspection / Corrective Action |
|--------------------------------------|--|---|
| Rotational Speed cannot be detected. | Incorrect connection of the Rotation Speed Detection Sensor Cable. | Check the wiring lead positions and wiring connections of the Rotation Speed Detection Sensor Cable. |
| | Sensor Cable Wiring Connector has been damaged. | Repair is necessary . (Return to NAKANISHI dealer service.) |
| High run-out. | The tool is bent. | Change the tool. |
| | Collet or collet nut is not correctly installed. | Secure the collet and the collet nut correctly. |
| | The collet and the collet nut are worn. | Replace the collet and the collet nut. |
| | Contaminants inside the collet and the collet nut or the spindle. | Clean the collet, collet nut and the inside of the taper and spindle. Use a soft cloth or cotton swab to clean inside of the spindle. |
| | Proper air pressure is not supplied to the Air Bearing. | Set the supply air pressure to the proper air pressure. |

17. DISPOSAL OF THE AIR BEARING TURBINE SPINDLE

When disposal of an Air Bearing Turbine Spindle is necessary, follow the instructions from your local government agency for proper disposal of industrial components.

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