

傾斜 N C 円テーブル

NC TILTING ROTARY TABLE

取扱説明書

INSTRUCTION MANUAL

Model TT (M) 181, 251, 321

重要

IMPORTANT

取扱説明書本文に記載してある危険・警告事項の部分は、製品を使用する前に注意深く読み、理解すること。

Please read and understand DANGER / WARNING items in this manual before operating your NC Rotary Table.

将来いつでも使用できるように大切に保管すること。

Please keep this manual by your side for answers to any questions you may have and to check.

You selected KITAGAWA brand NC tilting rotary table because it has the feature and benefits. All of its specialized features and their operations are described in this manual. Make sure that you are completely familiar with all its features of the table.

Preface

! SAFETY ALERT SYMBOLS

These are the industry "Safety Alert Symbol". Their symbols are used to call your attention to items or operations that could be dangerous to you or other persons using this equipment. Please read these messages and follow these instructions carefully.

Warning terminology



Indicates an imminently hazardous situation which will result in death or serious injury if proper safety procedures and instructions are not adhered to.



Indicates a potentially hazardous situation which could result in death or serious injury if proper safety procedures and instructions are not adhered to.



Indicates a potentially hazardous situation which may result in minor or moderate injury if proper safety procedures and instructions are not adhered to.



Instructions for table performance and avoiding errors or mistakes.

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Related drawing

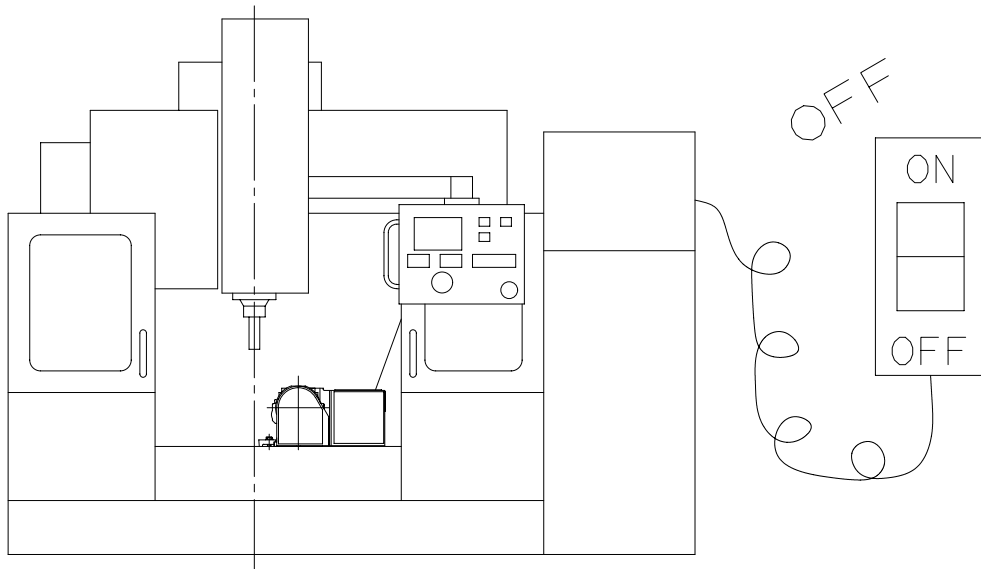
1 For Safety Operation

Please read this manual and follow instructions carefully.

We cannot assume responsibility for damage or accidents caused by misuse of the NC Rotary indexing tables, through non-compliance with the safety instructions.



Turn off the main power of the machine prior to maintenance, check, or repair of the unit. Failure to do so may cause severe injury and/or accident.

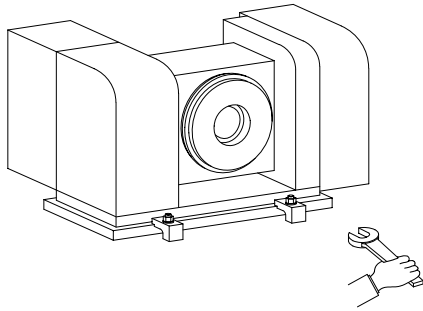


There is danger in which fingers or clothes may be caught in the table.

 **WARNING**



Secure clamp bolts to correct torque.



There is a danger of scattering the work because the table overturns.

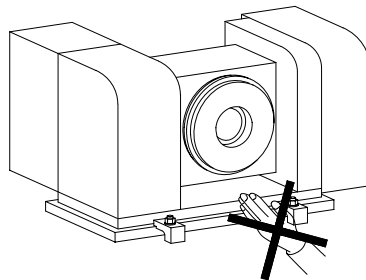
Tighten to correct torque.

Hex.bolt sizes	Tight.trq.(N·m)
M10	33.8
M12	58.9
M16	146.3
M20	294.3



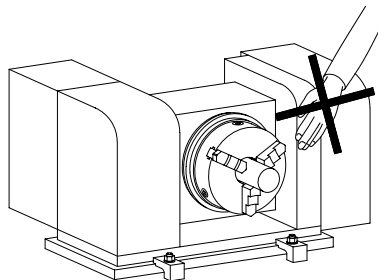
When rotation the table, ensure your hand is out of the space of tilting area.

There is a danger in which fingers may be caught in rotary member.



When rotating the table, ensure your hand out of rotating area.

There is a danger in which fingers may be caught in rotary member.



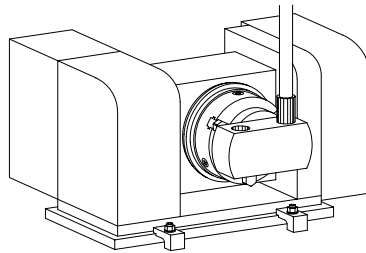


WARNING



Never apply excessive cutting force.

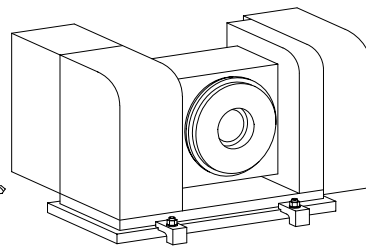
There is danger in which
NC rotary table damages
and work scatters.



Do not attempt to modify the NC
rotary indexing table.

There is danger in which
NC rotary table damages
and work scatters.

NO!



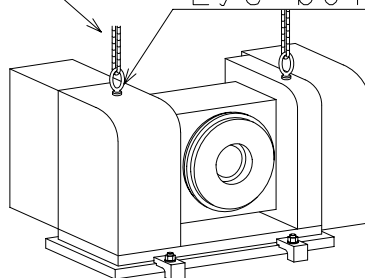
When lifting the NC rotary table,
use eye bolts and wire ropes.

(See page 9.)

There is a danger of falling.

Wire rope

Eye bolt



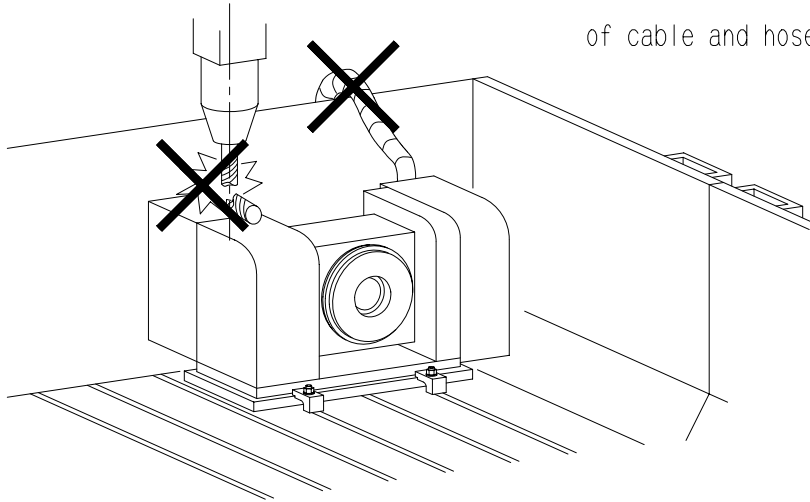
 **WARNING**



Maintain adequate clearance between the unit and any part of the machine.

Danger of scattering because of work damage.

Interference and extreme bending of cable and hose should be avoided.

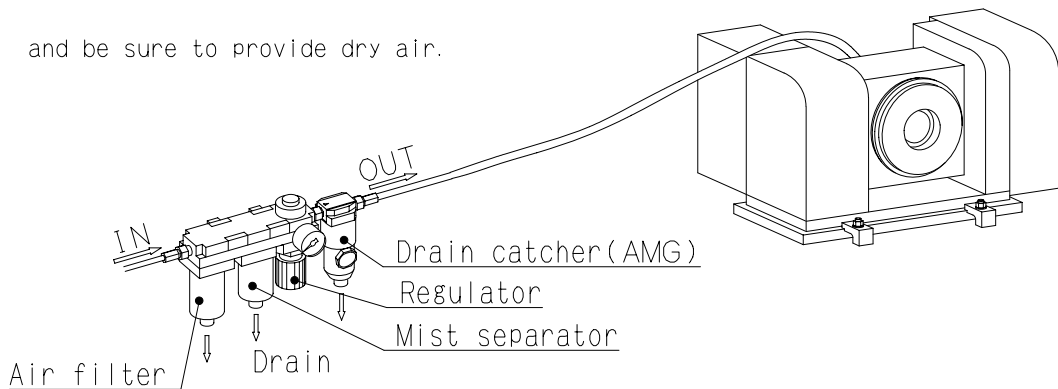


There is the possibility of electric shock if the cable is damaged.



Supply air through Air Combination (Air filter, Mist separator, Regulator) + Drain catcher. (See page 13)

Apply air purge inside the motor case and be sure to provide dry air.



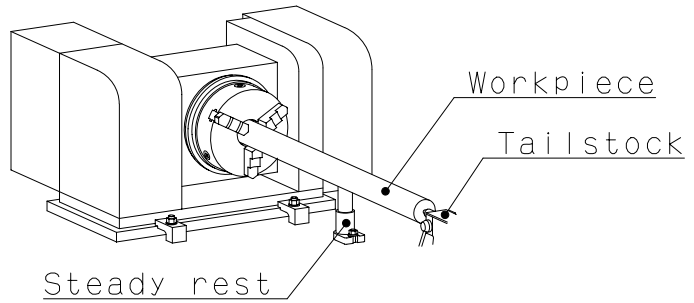
Drain the water for air filter constantly. (Auto drain system recommended.)

 **CAUTION**

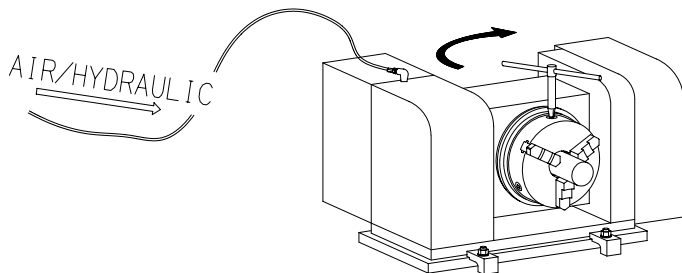


When machining a long or heavy workpiece, support with a tailstock or steady rest.
(See page 7.)

Danger of scattering if work is lengthily protruded or heavy.



Clamp the table before mounting or removing the work.

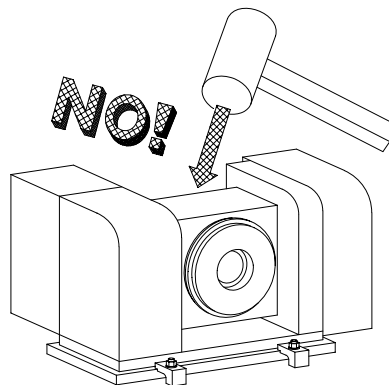


Danger because not only machining accuracy drops but also NC rotary table damages or work scatters.



Don't apply a shock to each component of NC rotary table.

Danger because NC rotary table damages and air work scatters.



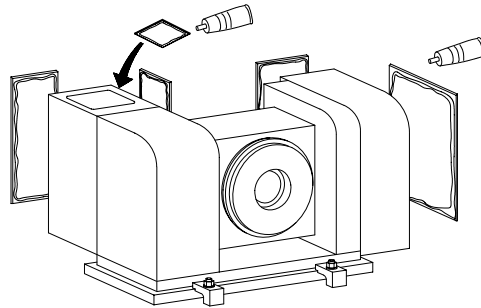


CAUTION



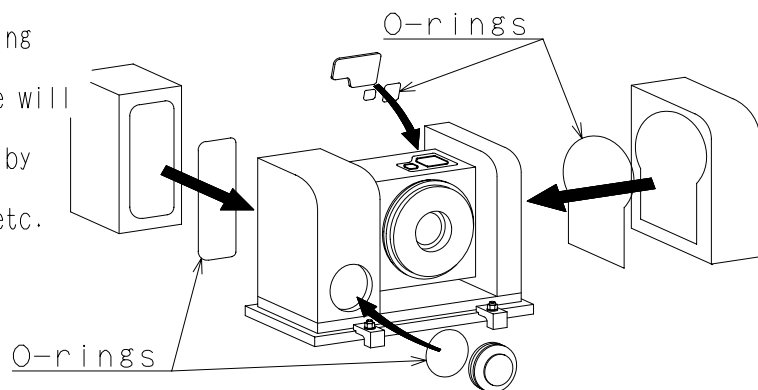
Coat solution packing on the cover mounting face.

Danger by work scattering because NC rotary table will result in misoperation by permeation of coolant, etc.



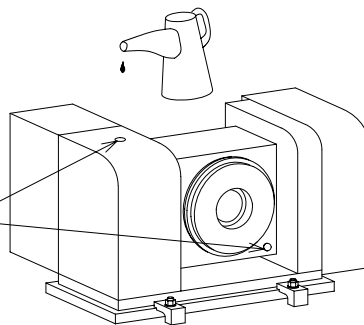
Mount all covers attached with O-rings.
(No damages on O-rings)

Danger by work scattering because NC rotary table will result in misoperation by permeation of coolant, etc.



Replace lubricating oil every 6 months (See page 9).

Lubrication port



2 Specifications

	NO.	Type	TT(M)181	TT(M)251	TT(M)321	
1	Table diameter	mm	φ180	φ250	φ320	
2	Table height at horizontal installation	mm	250	300	350	
3	Center height at vertical installation	mm	180	225	255	
4	Total height	mm	300	363	420	
5	Center hole diameter	mm	φ65	φ100	φ135	
6	Through hole diameter	mm	φ40	φ70	φ110	
7	Clamping torque [Pneumatic pressure (5.1kgf/cm ²)]	(Rotating axis) N·m(kgf·m)	150(15.3)			
		(Tilting axis) N·m(kgf·m)	200(20.4)			
	Clamping torque [Hydraulic pressure (35.7kgf/cm ²)]	(Rotating axis) N·m(kgf·m)	350(35.7)	900(91.8)	2600(265.2)	
		(Tilting axis) N·m(kgf·m)	400(40.8)	1200(122.4)	2600(265.2)	
8	Allowable work diameter	mm	φ180	φ250	φ320	
9	Allowable mass of workpiece	(In horizontal) kg	60	100	150	
		(In tilting) kg	40	60	100	
10	Allowable work inertia	Kg·m ² (kgf·cm·sec ²)	0.25(2.5)	0.78(8.0)	1.92(19.6)	
11	Total reduction ratio	(Rotating axis)	TT	1/90	1/90	1/120
			TTM	1/90	1/120	1/180
		(Tilting axis)	TT	1/180	1/180	1/360
			TTM	1/180	1/240	1/360
12	Max. rotation speed	(Rotating axis) min ⁻¹	TT	33.3	33.3	25
			TTM	33.3	25	16.6
		(Tilting axis) min ⁻¹	TT	16.6	16.6	8.3
			TTM	16.6	12.5	8.3
13	Mass of rotary table	kg	About 130	About 260	About 360	

IMPORTANT

The above list shows the values in standard specifications. Please refer to the outside view for details.

IMPORTANT

The maximum rotation speed is 3000 min⁻¹.

CAUTION

Be sure to observe the allowable work inertia even if the mass of work is within the allowable value.

CAUTION

There is a possibility to need the tailstock by the mass of work, shape, cutting condition, etc.

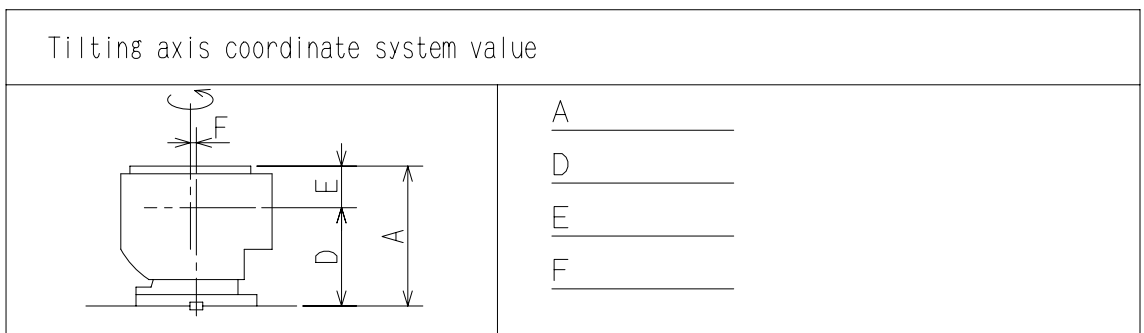
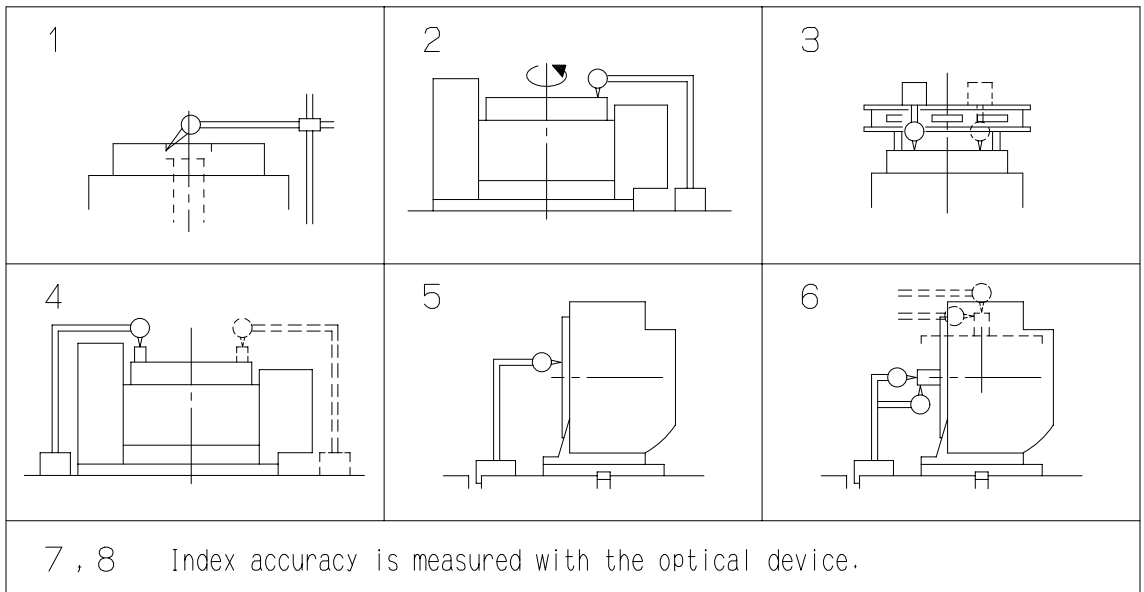
CAUTION

For conditions for using the table, refer to the above specifications and caution items. Set each cutting condition so as not to exceed the allowable value.

3 Accuracy Standard

(Unit : mm)

Inspection items		TT181	TT251	TT321		
1	Run out of center hole	0.010				
2	Run out of upper face during table rotation	0.015				
3	Straightness of upper face of table(center low)	Total length	0.010			
4	Parallelism of upper face of table and reference plane (tilting axis direction)	Total length	0.020			
5	Parallelism of upper face on table and center line of guide block (tilting angle 90°)	Total length	0.020			
6	Parallelism of tilting axis and reference plane	Total length	0.020			
7	Index accuracy	Rotating axis	Accumulation	20sec	20sec	20sec
		Tilting axis	Accumulation	60sec	45sec	45sec
8	Reproducibility	4 sec				



4 Preparation

Unpack the unit and remove the packing material.

4-1 Installation

- 1) When lifting the unit, securely screw in the eye bolts provided. Use wire loop which provided sufficient strength to lift the unit.
- 2) Clean the unit thoroughly with an adequate clean agent. When installing the unit on the machine table, make sure there is no foreign material nor damage such as nicks and burrs on the mating faces. Use an oil stone for correction if necessary.
- 3) Locate and set the unit at the most suitable location for the operation.
The guide blocks will fit into the slotted groove on the machine.
If there is any play between the guide block and the T-slot, place the unit against one side of the T-slot to eliminate the gap.
- 4) Firmly clamp down the unit to the machine with the furnished clamping fixtures.



When mounting the NC rotary table to the machine tool, check the mounting space. Especially, take care so that the NC rotary table, cable and air hose will not interfere with the splash guide, ATC device, spindle head, etc., of the machine tool when moving the machine tool table or spindle head, etc.



Don't damage the cable by applying unreasonable stress, placing a heavy thing or pinching it. If damaged, there is a danger of electric shock.



Effectively use mounting seats and tighten clamping bolts at the specified torque. (See page 2.)

4-2 Lubrication

Lubricant has been already filled in the NC rotary table body before shipping. Check the lubricant is filled to the center line of the gauge before operating the machine.

(See Fig.2.)



Replace all lubricant with new one every 6 months. Completely drain before replacing the oil. When filling the oil, wipe the oil filler so that chips and foreign matter are not entered into the tank. If the chips or foreign matter are entered, the important part such as bearings, etc., are seized or machining accuracy drops. Use recommended oil in the following table.

Recommended Lubricant
TT(M)181(Viscosity grade ISO VG32)

Maker	Oil Name	Maker	Oil Name
Mobil	Vactra Oil No.1	Cosmo	Dynaway 32
Nippon Oil	Uniway 32	Idemitsu	Daphne Multiway 32MT
Jomo	Slidus HS32	Esso	Unipower MP32
Shell	Shell Tonna Oil S32		

Recommended Lubricant
TT(M)251.TT(M)321(Viscosity grade ISO VG68)

Maker	Oil Name	Maker	Oil Name
Mobil	Vactra Oil No.2	Cosmo	Dynaway 68
Nippon Oil	Uniway 68	Idemitsu	Daphne Multiway 68MT
Jomo	Slidus HS68	Esso	Fabis K68
Shell	Shell Tonna Oil S68		

☆ Required oil (Liter)

Part \ Type	Type		
	TT181	TT251	TT321
Tilting axis body	0.3	0.5	1.0
Gear case of tilting table	0.2	0.2	0.5
Rotary table body	0.7	0.7	0.9
Gear case of rotary table	—	0.1	0.2

☆ TT(M)181...Daphne multiway 32MT has already been filled before shipping.
TT(M)251.TT(M)321...Daphne multiway 68MT has already been filled before shipping.

4-3 Air/Hydraulic pressure supply for clamp

4-3-1 Specification for air pressure clamping

1) Supply air through 4-point unit(air filter.mist separator.regulator.drain catcher)
(See page 4).

2) Connect the air pressure hose to the connection(Rc 1/4)shown in outside view.

3) Use the air pressure at the range of 0.4~0.5MPa(4.1~5.1kgf/cm²).

4) In the case of air pressure specification,the solenoid valves are incorporated.
The piping is as follows with the standard specification. Take care when the electric wires are routed.

Refer to outside view and winning diagram.

【Excitation Unclamp Spec.】

Solenoid:ON ... Table UNCLAMP

Solenoid:OFF ... Table CLAMP

【Excitation Clamp Spec.】

Solenoid:ON ... Table CLAMP

Solenoid:OFF ... Table UNCLAMP

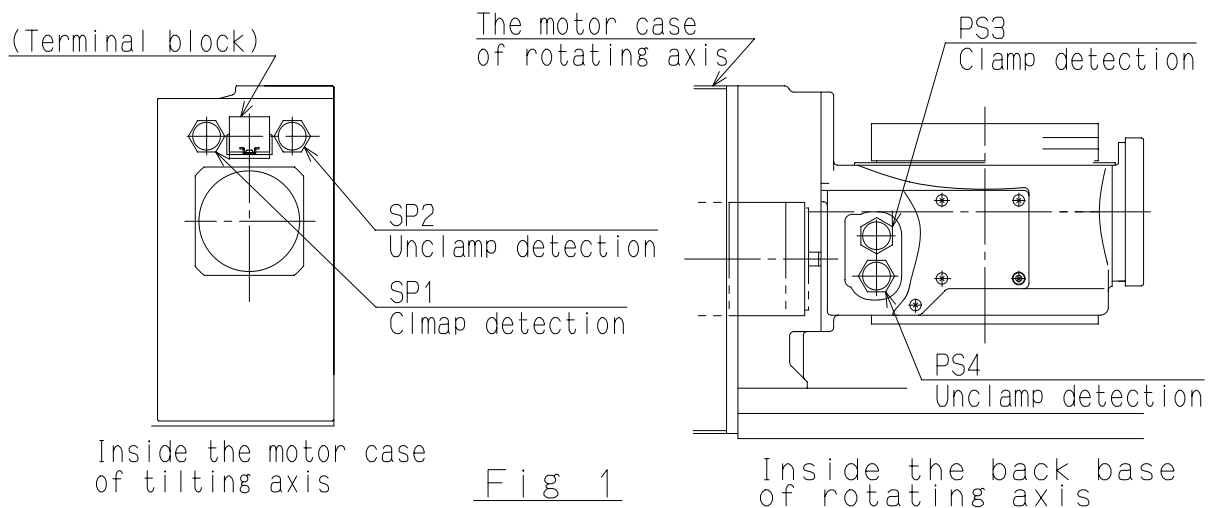
4-3-2 Specifications for hydraulic pressure clamping

- 1) Connect the hydraulic pressure hose to the connection(Rc 1/4)shown in outside view.
Use the hydraulic pressure at the range of 3.5~3.7 MPa(35.7~37.7kgf/cm²).
- 2) In the case of hydraulic pressure specifications, since the solenoid valve is not incorporated, provide the solenoid valves on the external portion and route the same wiring as the air pressure specifications.

4-3-3 Clamp - Unclamp check

The set up pressures of the switches for both pneumatic and hydraulic systems are as follows:

	Clamp Signal (SP1.SP3)	Unclamp Signal (SP2.SP4)
Pneumatic	0.25 MPa (2.55kgf/cm ²)	0.055 MPa (0.56kgf/cm ²)
Hydraulic	2.75 MPa (28.0kgf/cm ²)	0.2 MPa (2.0kgf/cm ²)



4-3-4 Clamp - Unclamp caution



Rotate the table and move the tilting axis with the chuck unclamped. After positioning, machine the work with the chuck clamped. Take care because the worm wheel will be damaged by misuse.



Avoid the machining more than the clamping force shown in the specification table. The clamped part is worm and the worm wheel is damaged.



Completely escape pressure when the unit is unclamped. If remained, the worm gear and clamber will be seized and damaged. Therefore, take care of back pressure.

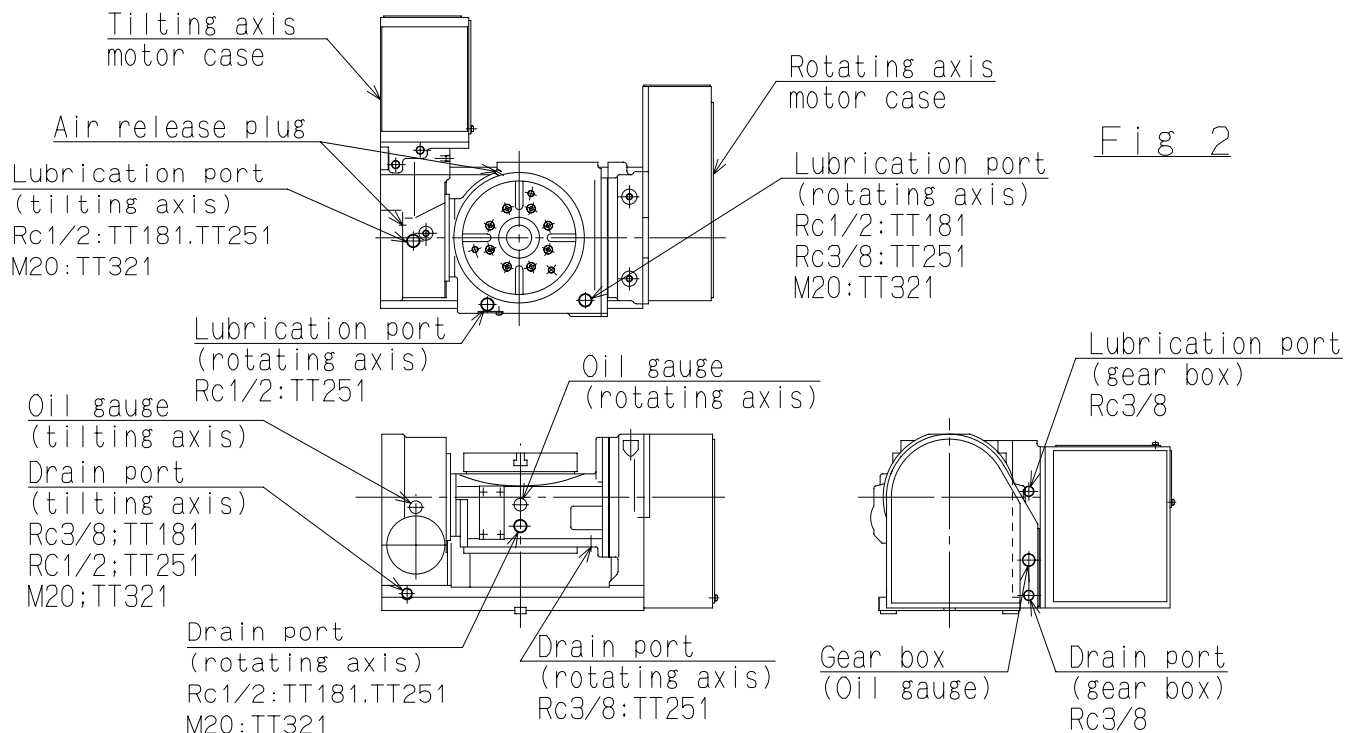


Fig 2

4-4 Trial run, accuracy check

- 1) Perform the trial run under no load in which no work is mounted on the table.
- 2) Check there is no noise and vibration during the operation of axis LOW, HIGH, FORWARD and REVERSE. Perform the running-in of rotary axis by two slowly increase the forward and reverse directions at 1 rpm st first. After that,slowly increase the speed in high speed.
- 3) Perform the running-in of the tilting axis by two strokes at the feed of 1 RPM, paying attention so as not to enter in the over travel area and slowly increase the speed.(Pneumatic specification)
- 4) Check accuracy, referring to the inspection result table and the accuracy standard in the manual.

 The contents of this item are unnecessary for the NC rotary table of Kitagawa's controller spec. and 4th axis spec. which don't have a Proximity switch for ZRN deceleration.

4-5 Setting of ZRN and shift value to machine datum

- 1) After checking the above operation,when there is no alarm, return each axis to machine datum,for the ZRN of each axis, the axis rotates at high speed in the fixed direction and decelerates with the sensor (proximity switch) of the incorporated ZRN decelerating dog before stopping by receiving the standard signal of motor detector.
- 2) The tilting axis datum (0°) is where the table face is horizontal and +90°where the table face is vertical. The standard ZRN direction of tilting axis is set from - (minus) direction to 0°.
- 3) The ZRN direction of rotary table is right.
- 4) Individually perform ZRN for the tilting axis and the rotating axis to find the angle difference between the actual stopping position and the machine datum. To compensate this angle difference, set the parameter value of datum shift volume of control unit. If the compensating value exceeds the setting range, it is necessary to adjust the ZRN deceleration dog position (See item 6-3).

4-6 Work mounting

Securely mount the work for a high accuracy machining.



If the work is not securely mounted, not only accuracy is wrong but also the machine and tool are damaged. In the worst case, it will result in serious injury.



If the work which is not flatness and straightness is mounted as is, the work or rotary table is distorted, thus causing accuracy drop or unevenness rotation. In this case, insert shim in the gap between the work and the rotary table.



Clamp the work in equipartition on the rotary table as much as possible.

4-7 Air purge



(Pneumatic Clamping)

According to the circumstance of use, the dew may be occurred in the motor case.

Air is exhausted from the portion of the air exhaust so that it causes the obstacle of electric parts or each part.

The air purge is performed by air branched inside of NC table that uses air for clamp.

Be sure to use the clean air (passing through air filter, mist separator, regulator and drain catcher) passing through the filter. If the air contains water content (moisture), oil content, etc., it is entered in the motor case, thus causing in equipment damage. The air inside of motor case is exhausted from the air exhaust port.

In case that the portion of the air closed, motor case or motor etc. may be damaged so that the dew cannot be exhausted and that pneumatic is kept in the motor case. Therefore, the portion of exhaust should not be closed.

When exhausting, though exhaust sound occurs, there is no trouble.

(Hydraulic Clamping)

In the hydraulic pressure specification, since the exclusive air supply port for air purge is provided, be sure to supply the clean air as well as air specification (Service air pressure: 5kgf/cm²). If the air purge is not performed because there is no air source, be sure to replace the silencer mounted to the exhaust port for air purge as shown in the outside view with the plug 1/4 or M5.

5 Daily Inspection

Daily Inspection

- 1) Confirm that the NC rotary tables (including jigs, if attached) are securely fixed.
- 2) Confirm that the electric connection cables and hoses are not damaged and the hydraulic pressure is appropriate.
- 3) Confirmation of the machine-zero operation, indexing operation, and position.
- 4) Confirm that there is no abnormal vibration or noise. (Body and motor)
- 5) Confirm that there is no abnormal heating.(Body and motor)

Periodic inspection

(Inspect the following items every six months.)

- 1) Muddiness of the lubricating oil.(in the body and gear case)
- 2) Confirm that the connectors are securely attached and there is no damage on the cables.
- 3) Corrosion and breaking of the wiring in the motor case.

6 Each Component and Maintenance, Adjustment

This chapter explains the structure and maintenance, adjustment about worm gear, spur gear drive mechanism, ZRN device, tilting axis emergency stop device and motor case.

6-1 Back-lash adjustment of worm gear

The worm and worm wheel are made of the special material and accurately machined. Though the back-lash of the worm gear has already been adequately adjusted before shipping, it may be necessary to adjust it after using for a long period of time. The adequate values of backlash are as follows. These values were measured when the machine is cooled. Thus, values are measured after interrupting for a long period of time. Consequently, when operating the machine for a long period of time, the back-lash values become smaller than the following table due to thermal expansion.



If backlash is too small, the worm gear will be seized.

Adequate backlash

	Circular arc length at peripheral table position(μm) Angle(sec.)in []		
Type	TT181	TT251	TT321
Rotary axis	13~38 [28~86]	14~42 [23~69]	15~45 [19~58]
Tilting axis	6~10 [14~24]	6~10 [9~16]	6~11 [8~14]

When adjusting the back-lash, measure the current backlash with the following method before adjusting it.

6-1-1 Measuring method of back-lash of worm gear on table
(See Fig.3)

- 1) Set the dial gauge to the peripheral part of the T-groove on the upper face of table.
- 2) Slowly turn the table with the flat steel or round bar inserted in the T-groove on the upper face of table and release your hand when the worm wheel tooth is touched before reading the value of dial gauge. Next, turn the table at the same condition in the reverse direction and read the value of dial gauge. At this time, the difference of measuring values is the back-lash.
- 3) Perform the above measurement at 8 equipartition of outer periphery by turning the table and compare them with the above adequate values.

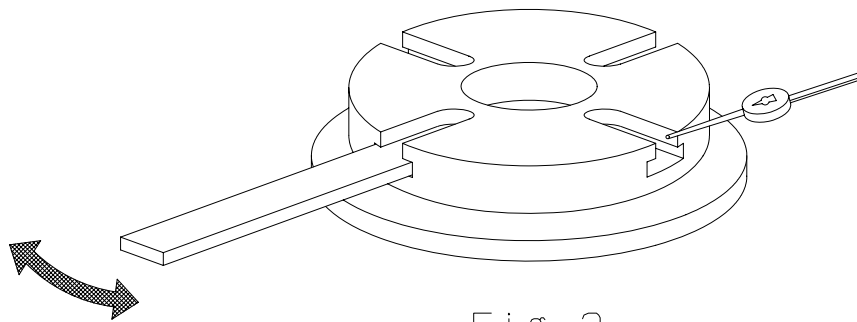


Fig 3

6-1-2 Back-lash measuring method of tilting worm gear
(See Fig.4)

- 1) Set the dial gauge around the outer periphery on the upper face of table.
- 2) After turning the tilting body at about 10kg in the minus direction, loosen force and read the value of dial gauge with the body maintained at the force of 2~3kg in the same direction. Similarly turn the body in the reverse direction and read the value of dial gauge. This difference of measuring values is the back-lash.

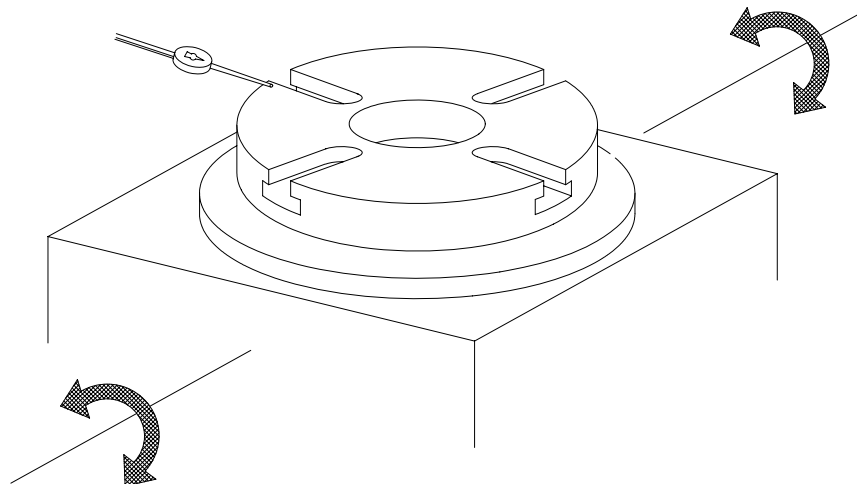


Fig.4

6-1-3 Back-lash measuring method of rotary worm gear
 [TT181: Fig.5.1]

- 1) Drain lubricating oil from the drain port of rotary axis.
- 2) Remove the cover ① . ② .
- 3) Remove the hexagon socket set bolt ③ which fixes the lock nut ⑥ and loosen ④.
- 4) The lock-nut ⑥ and the bearing-case ⑤ is set up with M45×P1.5 thread.
 When you loosen the lock-nut ⑥, you lock the bearing-case ⑤ by using the bar.
 (You can lock it by plugging in the hole of $\phi 5-8$)
- 5) The degree of back-lash becomes to be small by the direction of clockwise.
- 6) Confirm the degree of back-lash after setting up the bearing-case ⑤ and tightening the lock-nut tightly.
- 7) Lock-nut ⑥, set screw ③ and ④ to be put back on as they were.

IMPORTANT

The pitch of bearing-case's outside hole $\phi 5-8$ is 45 degrees. The bearing-case is turned for 45 degrees moving, back-lash becomes to be about $7\mu\text{m}$ smaller at circular arc length on the outer position of the table.

CAUTION

Don't adjust the back-lash once. Slowly and carefully adjust it.

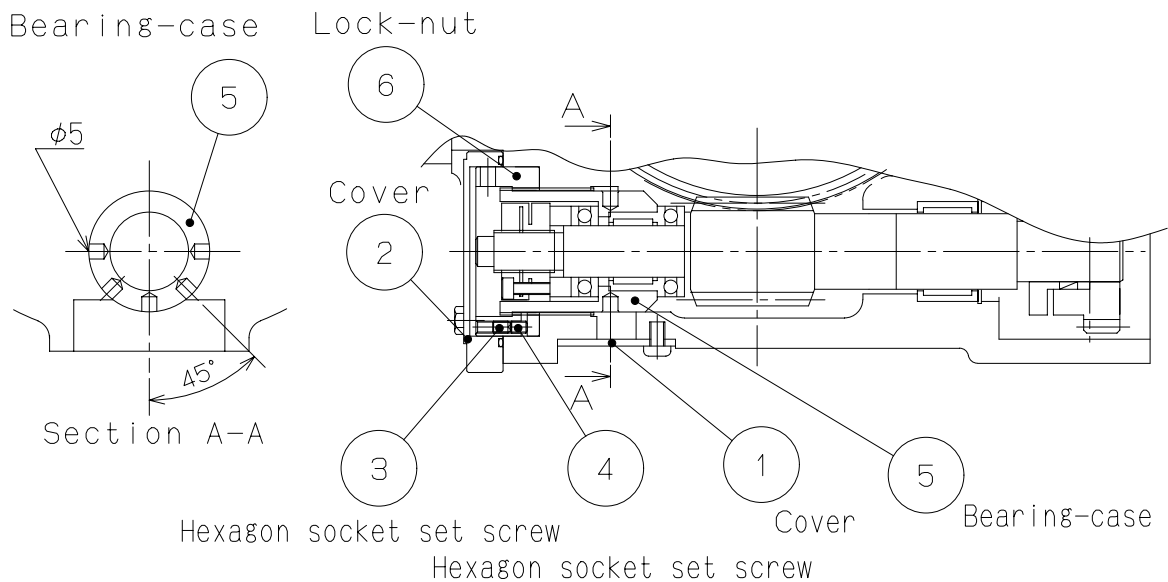


Fig 5.1

6-1-5 Back-lash adjusting method of rotary worm gear [TT321; Fig.5.3]

- 1) Drain lubricating oil from the drain port of rotary axis.
- 2) Remove the cover ① .
- 3) Loose hexagon socket head cap screws ③ which fix the bearing case ② a little. Next, loosen eight adjusting screws ④ uniformly a little. When tightening hexagon socket head cap screws ③ again, the bearing case ② advances, thus reducing the backlash of worm gears.

IMPORTANT

Since the pitch of adjusting screw is 1.25mm, when returning one revolution, the backlash becomes small as shown in the following list.

Table model	TT321
Circular arc length on the outer position of the table (μm)	About 41

When finishing the adjustment, reassemble the table in reverse steps as the above and tighten bolts securely.

After reassembling, measure the backlash at table periphery again at the same positions before adjusting and check the backlash is adequate.

IMPORTANT

Adjust the backlash gradually and carefully.

CAUTION

When reassembling the cover ①, take care so as not to damage the O-ring ⑥

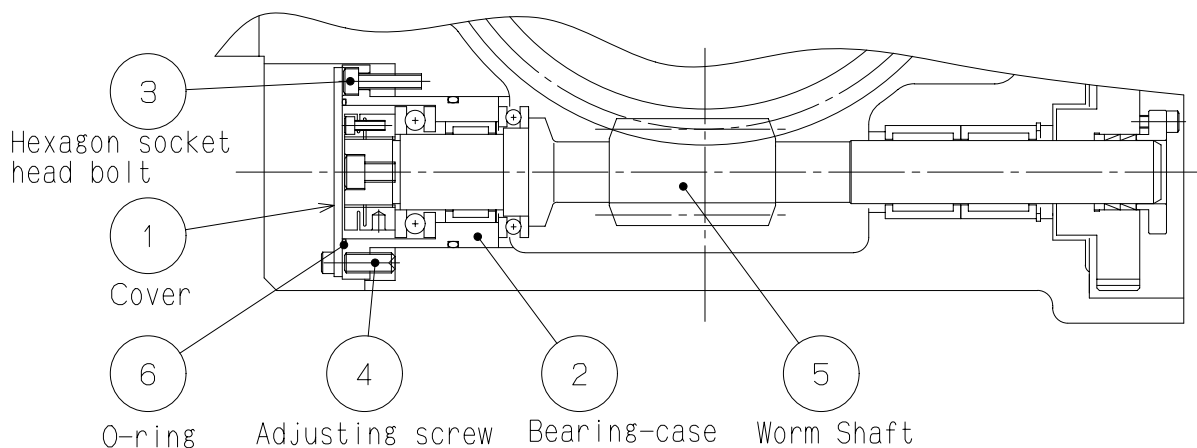


Fig 5.3

6-1-6 Back-lash adjusting method of tilting axis worm gear (Fig.6)

- 1) Remove the work, jig, etc..on the table before adjusting and level the table.
- 2) Drain lubricating oil from the drain port.
- 3) Remove the cover ①.
- 4) The bearing-case ④ is fixed on the hexagon socket head cap screw ③ and the adjusting screw ②.
- 5) Slightly loosen four pieces of bolts ③.
- 6) Back-lash becomes smaller by forwarding Bearing case ④, when 8 pieces of adjusting screws ② are loosen equally and 4 pieces of Hexagon socket cap screw ③ are tighten.

IMPORTANT

The Angle for adjusting screws ② to be turned in CCW due to reduce the back-lash amount by 0.01mm as follows.

Type	TT181	TT251	TT321
Angle in CCW	90°	134°	132°

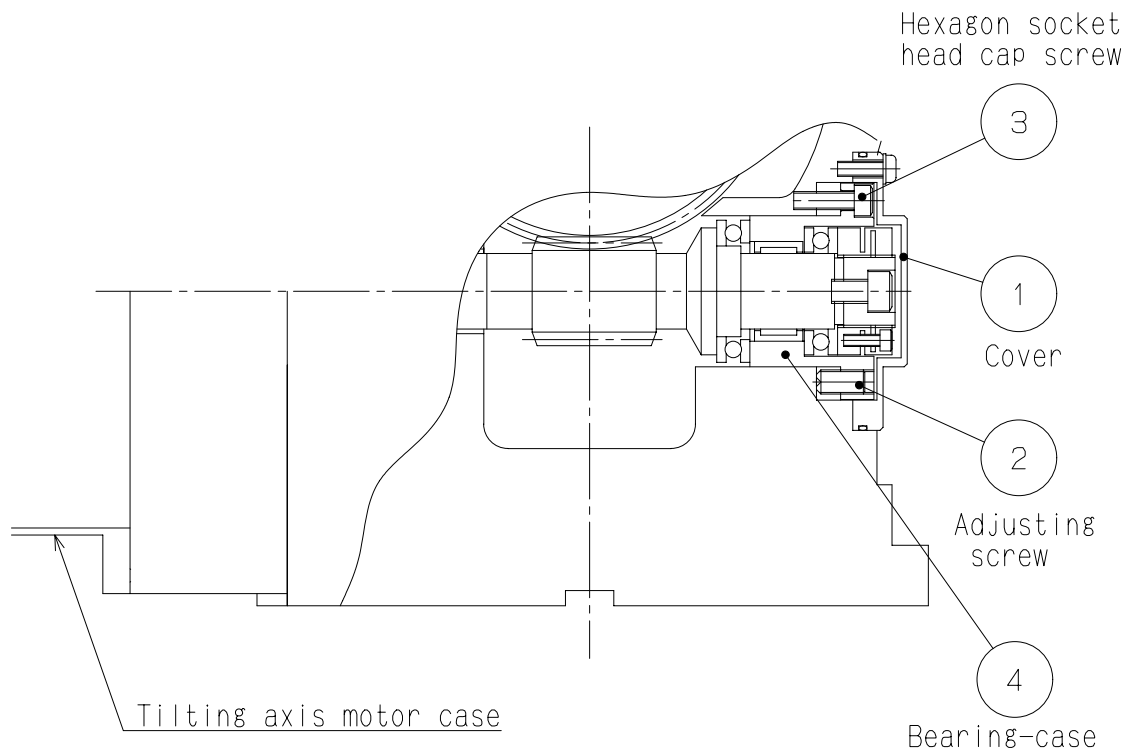


Fig.6

6-2 Back-lash adjustment of spur gear

6-2-1 Back-lash adjusting method of table drive spur gear(See Fig.7)

The back-lash between spur gears of Z1 and Z2 is adjusted by touching the hex. head bolt ① for stopper to the side face of the servo motor and by varying the distance between axis after adjusting the motor position.

- 1) When you adjust the back-lash, it is necessary to keep tilting axis in the horizontal position(0 degree).
- 2) Drain the lubrication oil from the drain port.
- 3) Remove the cover ④.
- 4) Slightly loosen four bolts ③ which fix the Servo Motor.
- 5) Move motor up to the back-lash of two gears Z1 and Z2 becomes nearly Zero position using Hex. head bolts ① and ② for stopper.
- 6) Firstly turn Hex. head bolt ② in CW and secondly do Hex. head bolt ① in CCW to get the back-lash nearly Zero position.
- 7) The proper back-lash amount of two gears Z1 and Z2 is 0.02~0.04mm.

The back-lash changes 0.02mm smaller by turning Hex. head bolts ① and ② by 10 degree (1/36turn) each. Because of the thread pitch of bolts is 1.0mm.

Motor movement to be checked by Dial indicator on the Motor at this time.

- 8) Fasten the four bolts ③ with putting the motor on the hexagon bolt ①, ② for motor's stopper.
- 9) After adjusting, rotate the motor from slow speed to high speed to check no noise occurs.



When Servo Motor is mounted, please take care of O-ring not to damage.

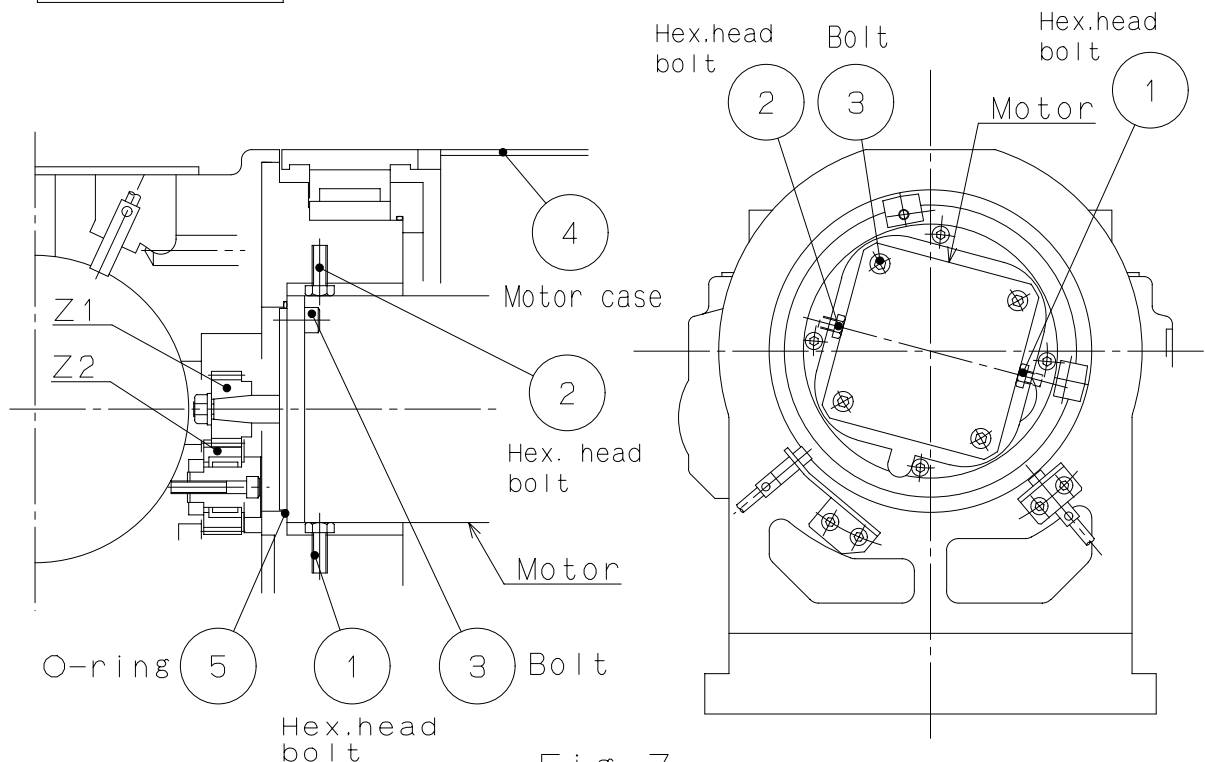


Fig. 7

6-2-2 Back-lash adjusting method of tilting axis drive spur gear

[TT181.TT251: Fig.8]

- 1) Drain the lubrication oil from the drain port.
- 2) Remove the motor case ①.
- 3) Slightly loosen four bolts ③ which fix the Servo Motor.
- 4) Move Motor position down up to the back-lash becomes nearly Zero position by using Hex. head bolts ② and ⑤ for stopper.
- 5) Loosen Hex. head bolt ② and tighten Hex. head bolt ⑤ slowly in order to make the back-lash Zero position.
- 6) The proper back-lash amount of two gears is 0.02~0.04mm.
The back-lash changes 0.02mm smaller by turning Hex. head bolts ② and ⑤ by 10 degree (1/36turn) each. Because of the thread pitch of bolts is 1.0mm.
Motor movement to be checked by Dial indicator on the Motor at this time.
- 7) Tighten 4 pieces of bolts which were loosened condition slightly in the condition of holding motor by 2 pieces of Hex. head bolts for stopper ② and ⑤.
- 8) After adjusting, rotate the motor from slow speed to high speed to check no noise occurs.



When Servo Motor is mounted, please take care of O-ring not to damage.

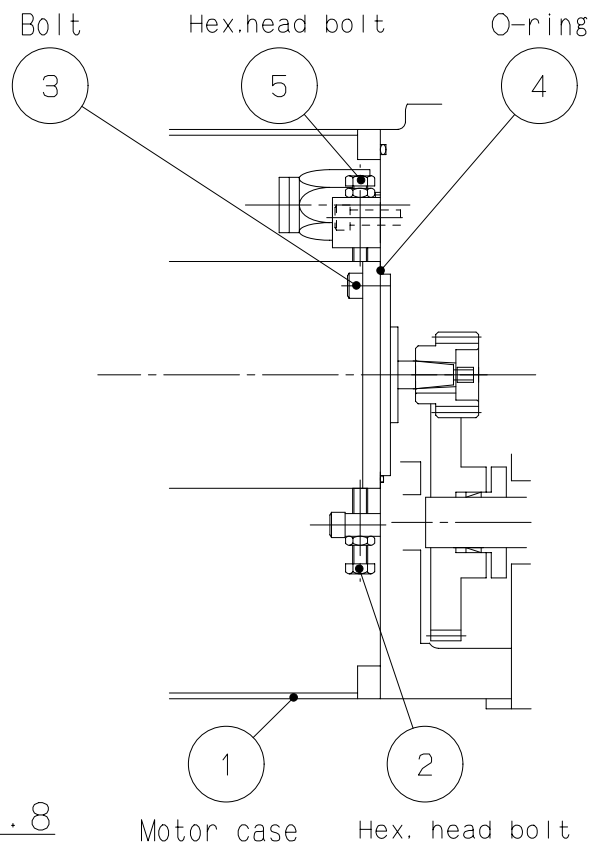


Fig. 8

6-2-3 Back-lash adjusting method of tilting axis drive spur gear [TT321: Fig.9]

A) Spur gear Z1 and spur gear Z2.

The backlash between spur gears of Z1 (11) and Z2 (12) is adjusted by turning the eccentric shaft and by varying the distance between axes.

- 1) Drain the lubricant from the drain port.
- 2) Remove the gear box (1).
- 3) Fix the spur gear Z2 and touch the dial gauge to the tooth face of the spur gear Z1 to measure the backlash.
- 4) Since the eccentric shaft (7) is fixed with the hexagon socket head set bolt (8), loosen this bolt and turn the eccentric shaft to adjust the center distance between the spur gear Z1 and the spur gear Z2 checking the backlash with the dial gauge.

B) Spur gear Z3 and spur gear Z4

The backlash between spur gears of Z3 (13) and Z4 (14) is adjusted by touching the set screw (5), (6) for stopper to the side face of the servo motor (4) and by varying the distance between axes after adjusting the motor position.

- 1) Fix the spur gear Z3 and touch the dial gauge to the tooth face of the spur gear Z4 to measure the backlash.
- 2) Remove the motor case (3).
- 3) Slightly loosen four bolts (2) which fix the servo motor.
- 4) Slowly shift the servo motor by turning the set screw for stopper.
- 5) Since the screw pitch of the set screw for stopper is 1.0mm, when turning the set screw $10^\circ(1/36\text{turn})$, the backlash varies 0.02mm.
- 6) After securely tightening four hexagon head bolts with the servo motor certainly touched to the set screw for stopper, check the backlash with the dial gauge again.

The adequate backlash of the spur gear is 0.02~0.04mm. If it is far removed from the adequate value, it is necessary to adjust the backlash.



Take care so that the tool faces of the spur gear are not damaged when the backlash is measured and adjusted. If damaged, the spur gear is not smoothly rotated, noise occurs in rotation and an index accuracy drops.



When remounting the servo motor, take care so as not to lose O-ring (9).

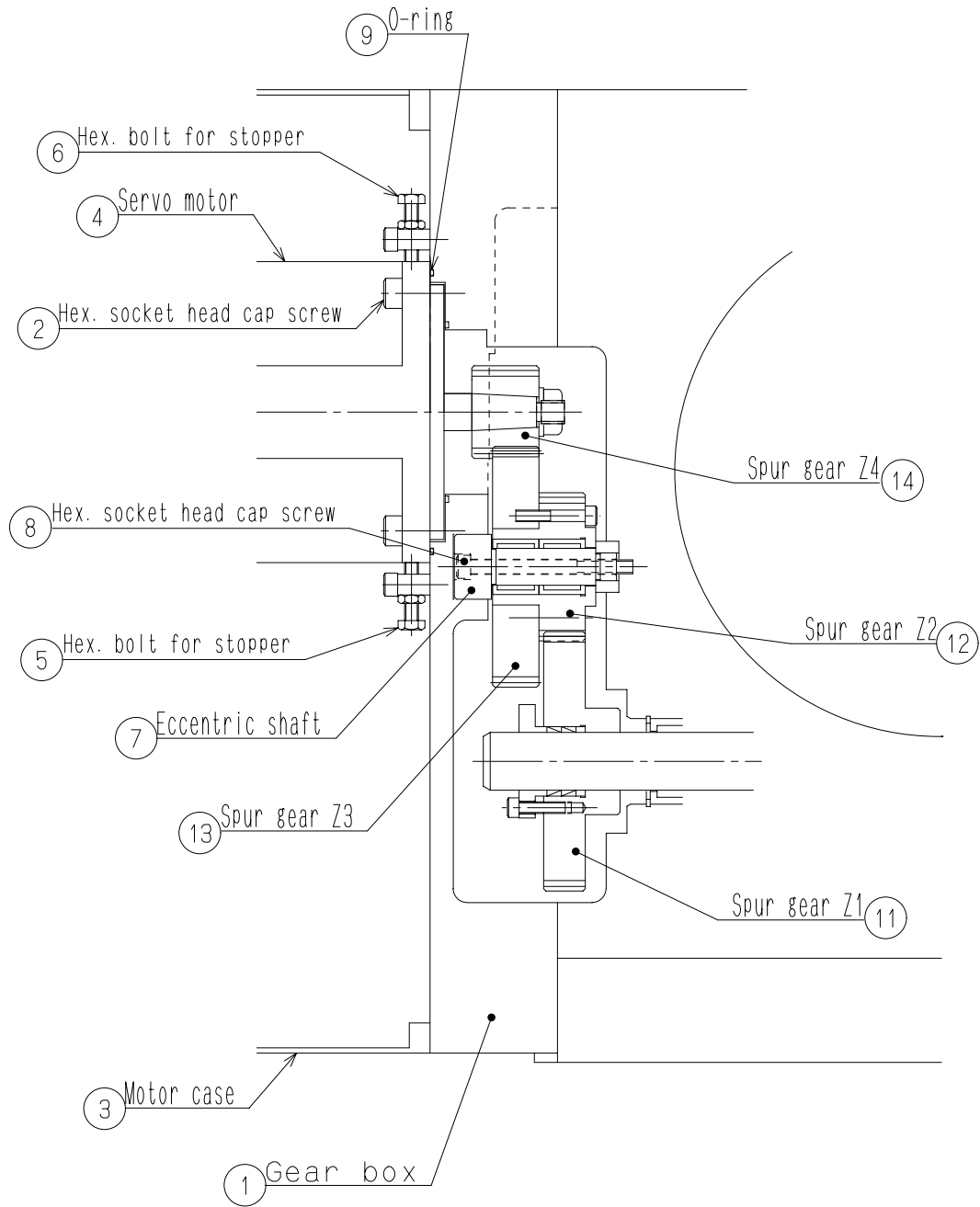


Fig 9

6-3 ZRN device

The contents of this item are unnecessary for the NC rotary table of Kitagawa's controller spec. and 4th axis spec. which don't have a proximity switch for ZRN deceleration.

6-3-1 Rotating axis ZRN device (Fig.10)

The ZRN device rotates clockwise (CW) on the standard specification. The ZRN deceleration dog is mounted in the table and it can be mounted on the optional position of outer periphery. When changing the ZRN position or ZRN rotary direction to counterclockwise, the dog position can be changed by the following procedure.

- 1) Drain the lubricating oil from the drain port.
- 2) Remove the cover ①.
- 3) Loosen the set screws ③ which fix the dog ②.
- 4) Shift the dog to the proper position.
- 5) After adjusting the position, securely tighten the set screws.

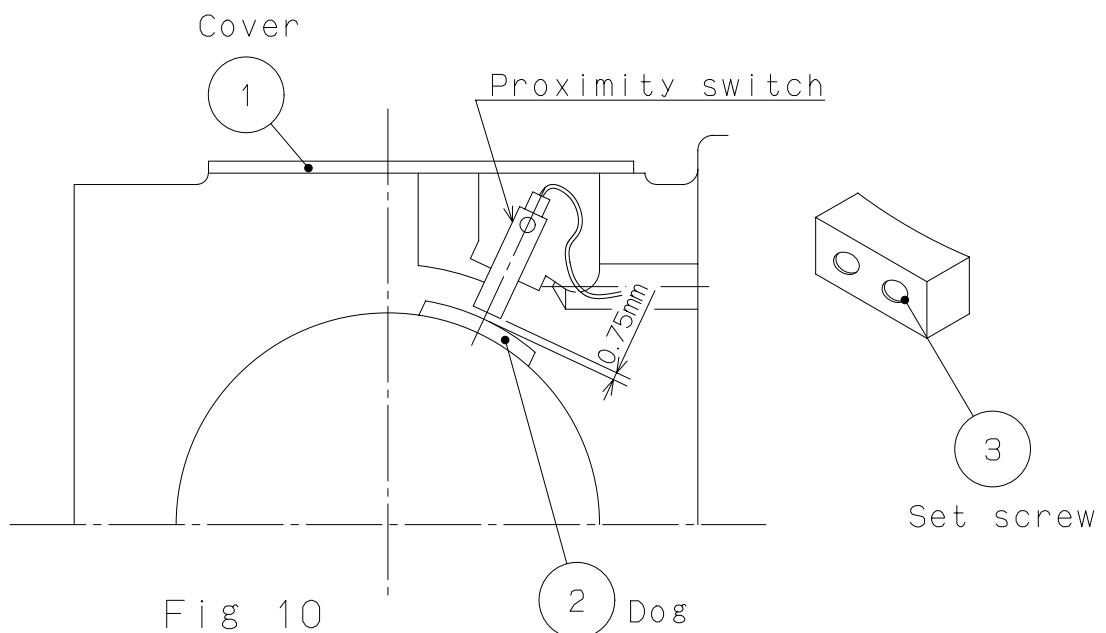


When the cover is re-installed, be careful not to damage the O-ring.
The damaged O-ring may allow the cutting water to enter the body.

The proximity switch is provided as the sensor for detecting the dog. The gap between the dog and the switch is set to about 0.75mm. (The thread pitch for mounting the proximity switch is 1mm.) The proximity switch is equipped with the lamp.
Since the lamp goes out when the dog is detected, use it when the dog is adjusted.

6-3-2 Tilting axis ZRN device (Fig.11)

- 1) This is the proximity switch and the dog in the motor case.
- 2) The horizontal table face is the datum as the standard specification. The dog A ① in is detected with the proximity switch A ④.



6-4 The equipment for stopping the over-travel (Fig.11)

- 1) The dog for emergency stop of stroke limit of tilting axis and limit switch are inside the motor case.
- 2) The dog B ② of Fig.11 located on the stroke limit on the horizontal table face position is detected with the limit switch B ⑤.
- 3) The dog C ③ located on the stroke limit on the vertical table face position is detected with the limit switch C ⑥.
- 4) The angle of 35° is provided until the emergency stop is applied from the horizontal positions of table face.

The angle of 20° is provided until the emergency stop is applied from the vertical positions of table face.

When changing Dog B ② or Dog C ③ position because of Component Fixture condition, set Hexagon socket set screw of Dogs loosen and move them within the shaded positions. The interference between jig and rotary table must be checked when changing the dog position.

In case of moving Dogs out of the shaded position, NC rotary table might be damaged. There may be a case that position of Dog B ② and dog C ③ are changed from standard position in advance depend upon the using condition of customer.

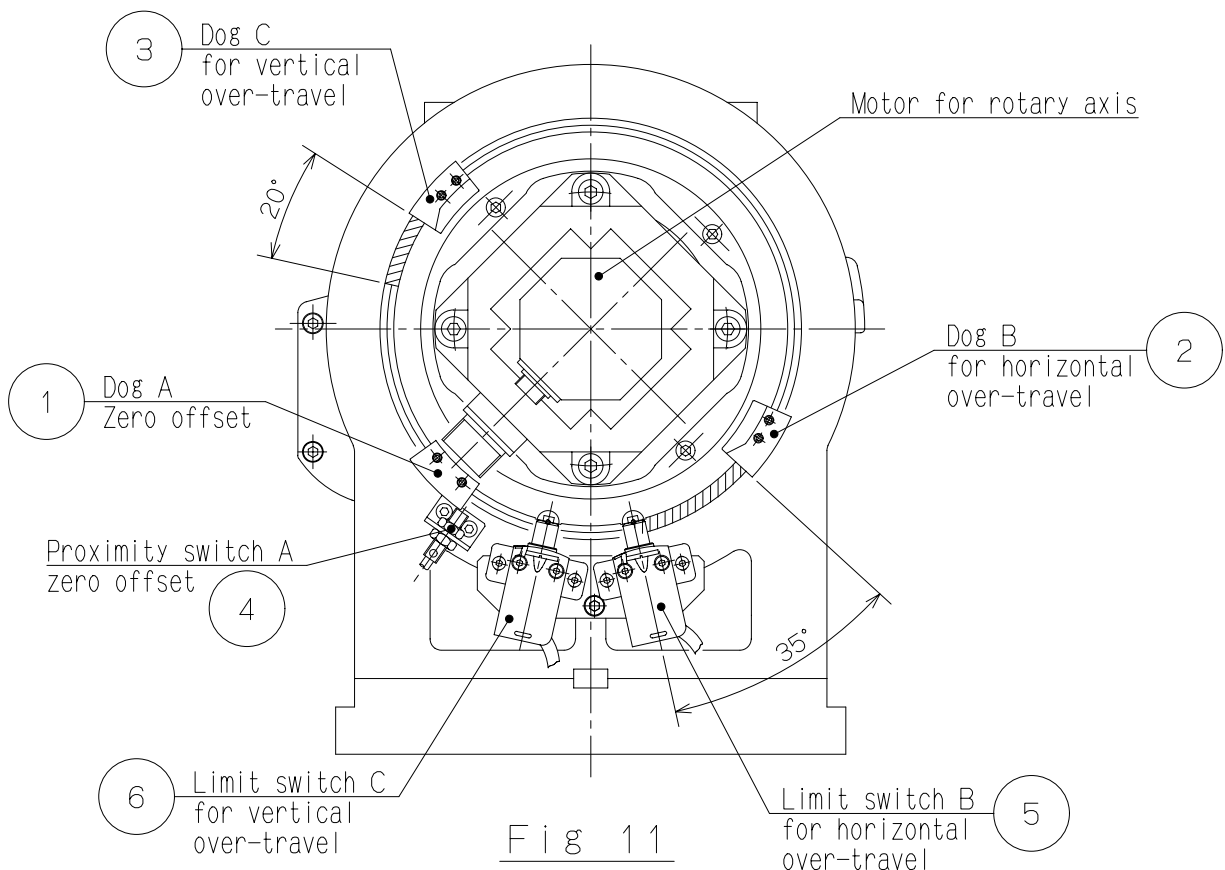


Fig 11

7 Storage

CAUTION

When storing the NC rotary table after removing it from the machine tool, place it on the stable wooden base for maintaining accuracy after removing chips or coolant, etc. Coat the table with rust prevention oil and case or lap it with the wooden cover or vinyl cover, etc. when using the wooden base and box, avoid the green wood. Since the green wood is not chemically neutral, use the wood moistened with paraffin.

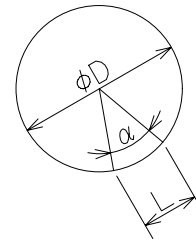
8 Reference Material

8-1 Conversion of peripheral length and angle

IMPORTANT

When understanding "How long at periphery is accumulation index accuracy 30 seconds?" or "How angle is the accumulation pitch error 0.05?", use the following formula from the relationship between the angle and the periphery length.

D : Work diameter (mm)
 α : Angle (sec)
 L : Periphery length (mm)



$$\frac{L}{\pi \times D} = \frac{\alpha}{360 \times 60 \times 60} \quad \text{----- (1)}$$

From (1)

$$\alpha = \frac{360 \times 60 \times 60 \times L}{\pi \times D} = \frac{4.125 \times L \times 10^5}{D} \quad \text{----- (2)}$$

$$\text{or } L = \frac{\alpha \times \pi \times D}{360 \times 60 \times 60} = 2.424 \times 10^{-6} \times \alpha \times D \quad \text{----- (3)}$$

(Example)

When the work diameter is regarded as 100mm, the following is formulated by "Accumulation accuracy of 30 sec. is indicated with periphery length." and formula (3).

$$L = 2.424 \times 30 \times 100 \times 10^{-6} = 0.007272 \text{mm} = 7.3 \mu\text{m}$$

Consequently, the periphery length is about 0.0073mm or 7.3 μ m.

The following is formulated by "Acculation pitch error is indicated with angle of 0.05." and formula (2).

$$\alpha = \frac{4.125 \times 0.05 \times 10^5}{100} = 206.25 \text{ (Sec.)}$$

Therefore, the angle is 206 seconds or 3 minutes and 26 seconds. As shown above, the periphery length and angle are converted by formulas of (2) and (3).

8-2 Coordinate calculation of table center for tilting angle

The calculation which finds the table center coordinate when tilted θ is shown as follows.
For values of E and F, use values entered in the inspection table.

$$X = F \cos \theta - E \sin \theta - F$$

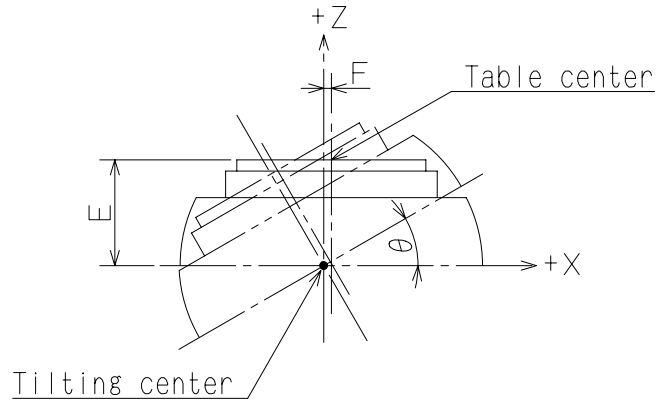
$$Z = E \cos \theta + F \sin \theta - E$$

(Example)

$E = 70, F = 0$ の場合

$$X = -70 \sin \theta$$

$$Z = 70 \cos \theta - 70$$



8-3 Work interference area

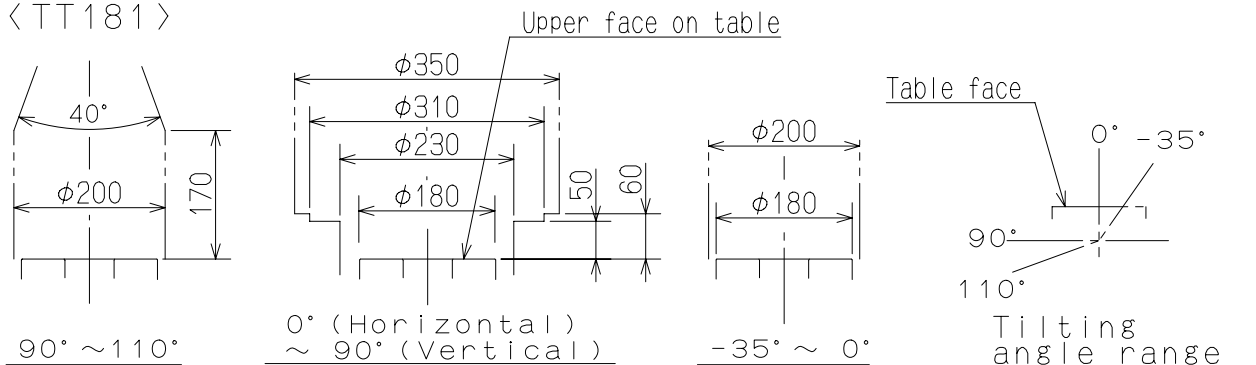
Since the following shows the standard specifications, take care in the case of special specifications. The interference with the clumper is not considered.

Tilting range may be reduced due to fit the Jig of Chuck onto Face plate.

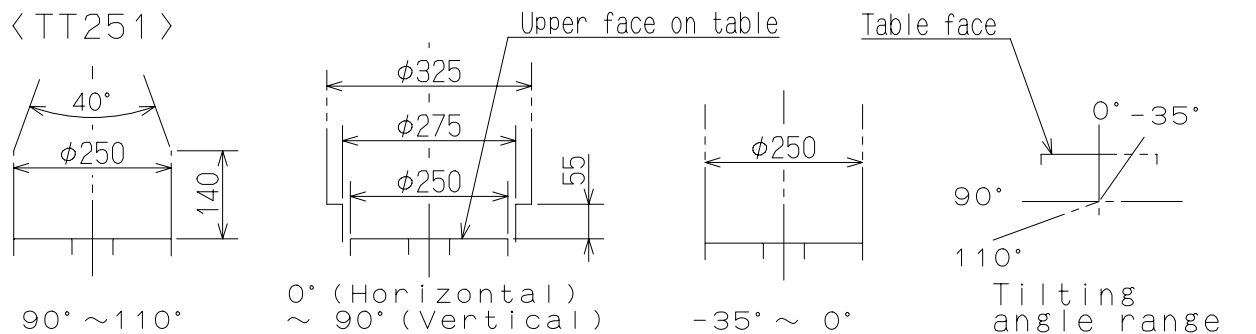
(Refer to the back of the Instruction Manual drawing and the outside view.)

Set a soft limit by the parameter to prevent interference at the customer.

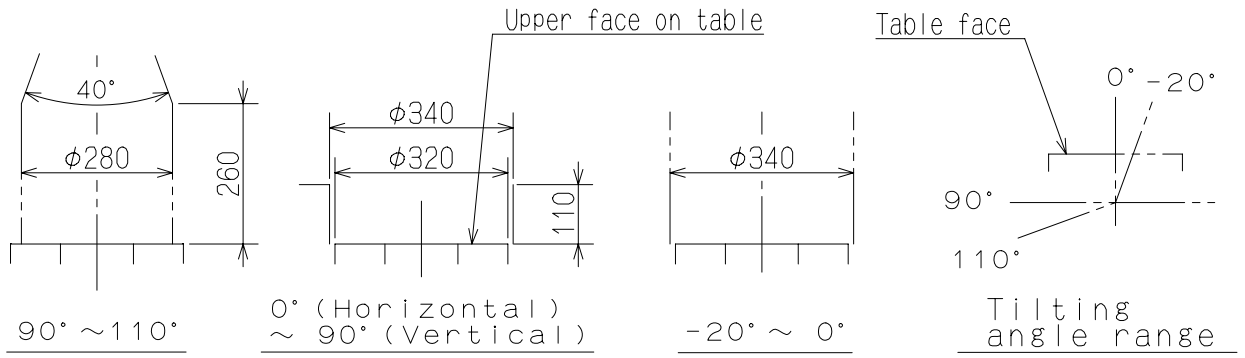
< TT181 >



< TT251 >



< TT321 >



○ Method and Attention Point of Air Relief (Hydraulic specification)

Be sure to perform air relief when lubrication oil is supplied after disassembling the table or alarm occurs. If air is not sufficiently exhausted, alarm occurs because of clamp failure.

- 1) Be applied hydraulic pressure to NC rotary table.
- 2) Loosen the air escape plug shown in figure a little to bleed the air.
- 3) When the air mixed into oil is not exhausted from the air relief plug, tighten the air relief plug as it was before. (If the plug is not tightened, exhausted air is breathed again.)



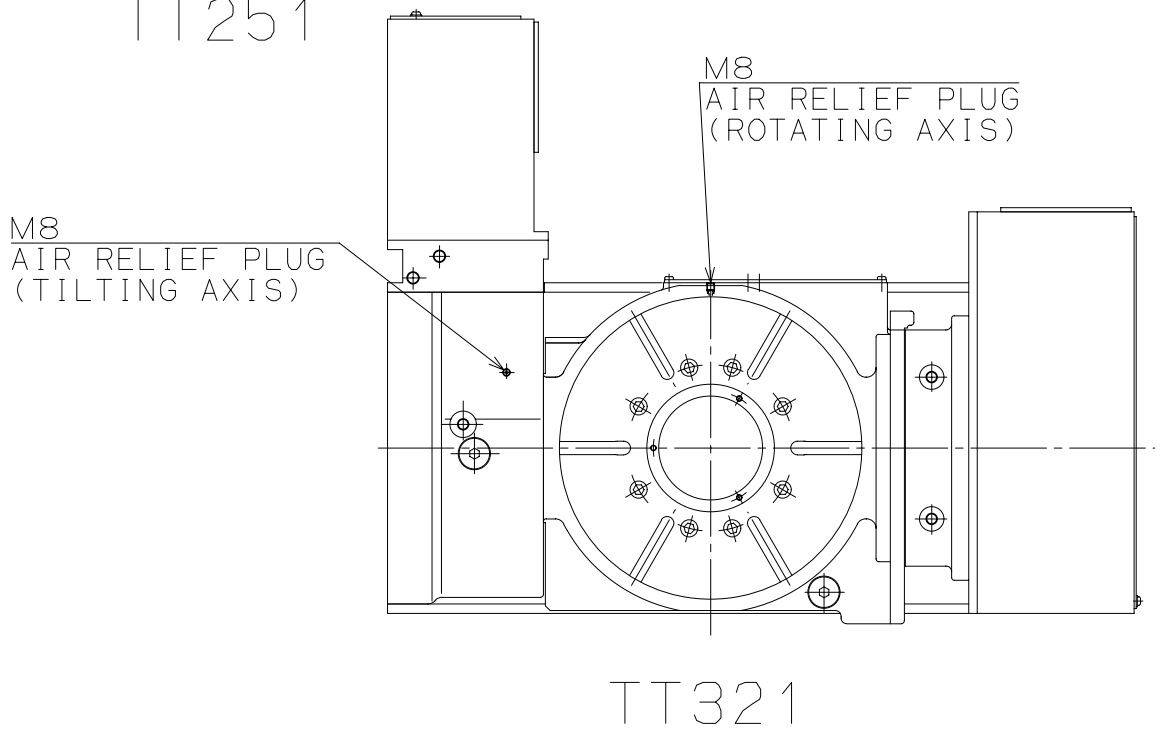
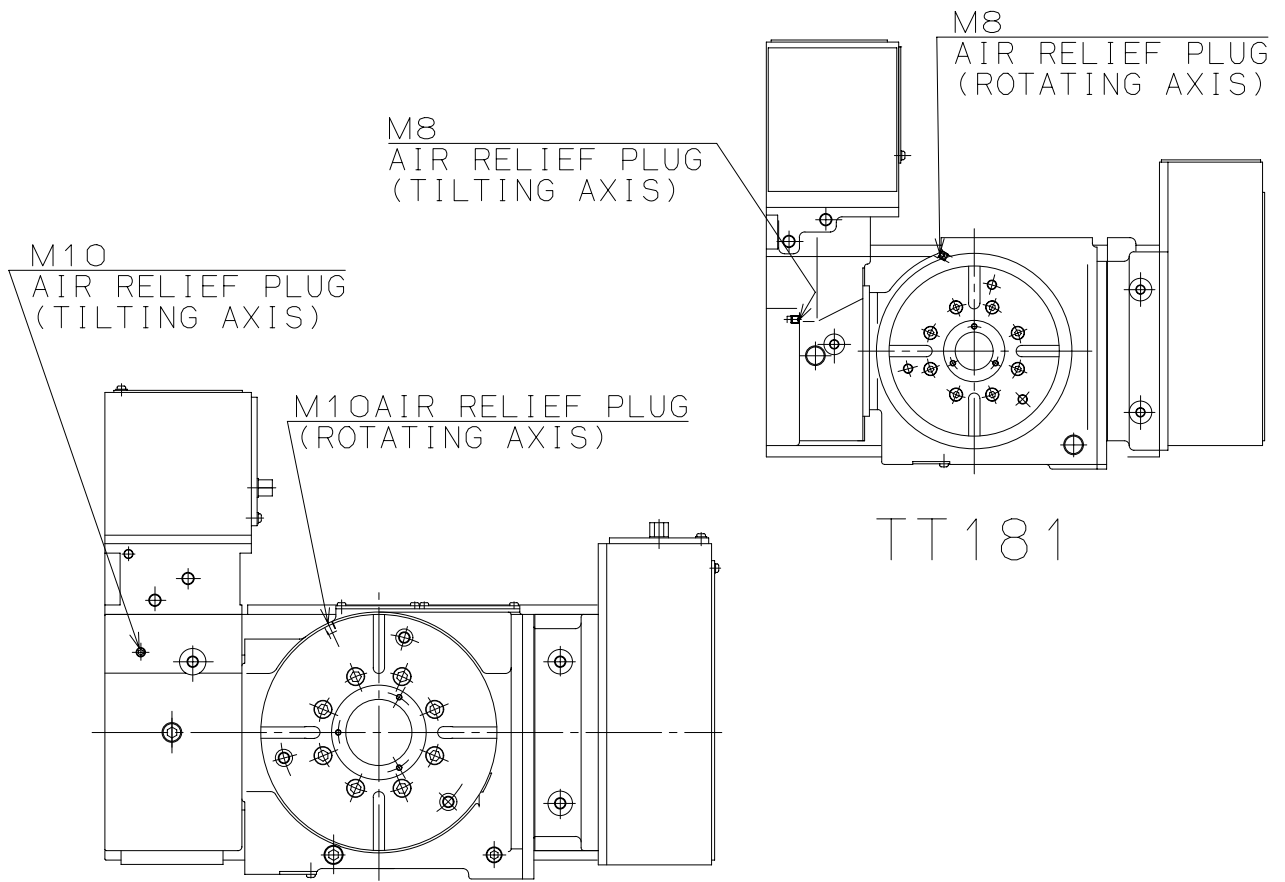
- 1) When the air relief plug is too loosened, there is a possibility that the air relief plug flies out. Slightly push the air relief plug with the hexagon bar spanner so as not to fly out.
- 2) For air relief, take enough time.
- 3) During air relief, since oil of pump unit becomes short, fill the oil into the pump unit.
- 4) After finishing the air relief, cleanly wipe oil spilled around the unit with a waste cloth.
- 5) During air relief, retain the hydraulic pressure.

Maintenance and Inspection

- 1) Air may infiltrate in oil during operation because the piping joint, each plug, etc., are loosened. At this time, relief the air according to the procedure of the above.
- 2) The hydraulic oil is deteriorated when it is used for a long period of time.
Replace the oil every year.
- 3) With the NC rotary table operated after ready for start-up, if a clamp failure occurs, check the air relief in order to make sure.



In case of air booster specification, refer to a instruction manual of it.



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