GP22AE-1
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Tsubaki Troi Drive
TD series
Instruction Manual

Thank you for purchasing Worm power drive, Troi Drive, TD series.
Please read this instruction manual carefully and fully understand the reducer specifications for the products installation and inspection. An experienced worker should handle the products carefully with referring to instruction manual.

For model-to-order products, use this instruction manual with referring to drawings (specification drawings or approval drawings) for your reducer. If you have any points unclear on this instruction manual, please contact your supplier that you sourced the reducer, Tsubaki sales office, or customer service.

Please ensure that this instruction manual is delivered to the end user who will use the reducer.
Carefully keep this instruction manual to be referred at any time in need.

TSUBAKIMOTO CHAIN CO.

Contents

Safety precautions

In order to use this reducer safely, always be aware of the followings.

- An experienced worker should handle the reducer carefully. The content listed in this instruction manual must be carefully read and fully understood before using the reducer.
- Please ensure that this instruction manual is delivered to the end user who will use the reducer.
- Carefully keep this instruction manual to be referred at any time in need.
- The level of harm and damage while reducer mishandled is classified into "WARNING" and "CAUTION". These are indicated in the instruction manual. The definitions and indications are as follows.

⚠ WARNING	This indicates the possibility that a dangerous situation may occur, it causes the critical case of death or heavy injury when the reducer is mishandled.
⚠ CAUTION	This indicates the possibility that a dangerous situation may occur, it causes moderate injury or physical damage, when the reducer is mishandled.

Depending on the situation, even items listed under CAUTION may result in serious consequences.
Both indicate important content that must always be observed.

⚠ WARNING

(Overall)

- Work to transport, install, wiring, run/operate, and maintain/inspect the reducer must always be performed by a technician with specialized knowledge and skills. Otherwise, there is a risk of explosion, combustion, fire, electric shock, injury, and damage to equipment.
- When the reducer is installed in equipment to transport people, always install protective devices for safety on the equipment side. Otherwise, there is a risk of accidents due to run away or falling equipment and damage to equipment.
- When the reducer is used in lift equipment, always install safety devices to prevent drops on the equipment side. Otherwise, there is a risk of accidents due to the lift falling and damage to equipment.
- Do not work when the wires are live. Always turn off the power before working. Otherwise, there is a risk of electric shock.
- Special skills and experience are required when overhauling the reducer, so always return it to a dedicated Tsubakimoto Chain Co. factory for overhaul.

(Transport)

- When hoisting the reducer to transport it, do not enter the area underneath it. Otherwise, there is a risk of accidents due to the reducer falling.

(Operation)

- During operation, do not get near or touch any rotating bodies (shafts or other parts). Otherwise, there is a risk of being caught in those parts resulting in injury.

(Daily inspection and maintenance)

- In maintenance and inspection during operation, do not touch any rotating bodies (shafts or other parts). Otherwise, there is a risk of being caught in those parts resulting in accident.
- Do not remove the pressure vent during operation. High temperature lubrication oil will spray resulting in burns.
- When inspecting the condition of the gear teeth when stopped, ensure that the rotation of the motor and driven machine has stopped. Otherwise, there is a risk of being caught in the gear meshing sections resulting in accident.
- Loading the reducer above its rated capacity can affect the life of the motor and gears and result in damage.

⚠ CAUTION

(Overall)

- Do not use the reducer outside of the specifications listed on the nameplate or the specifications in the manufacturing specification document. Otherwise, there is a risk of injury and damage to equipment.
- Do not insert fingers or objects into the openings on the reducer. Otherwise, there is a risk of electric shock, injury, and damage to equipment.
- Do not use the reducer when damaged. There is a risk of injury and fire.
- Do not remove the nameplate.
- Alterations to the reducer by the customer are not covered by the warranty and Tsubakimoto Chain Co. assumes no responsibility for them.

(Upon receipt of your reducer)

- Check the orientation of the packaging and open it. Otherwise, there is a risk of injury.
- Make sure the model number of the unit delivered matches your order. If the wrong reducer is installed, there is a risk of injury and damage to equipment.

(Transport)

- Use caution when transporting the reducer as it is dangerous if it drops or falls over. If the reducer has lifting rings, always use those lifting rings. However, after the reducer is installed in the machinery, do not hoist the machinery itself with the lifting rings. Otherwise, there is a risk of damaging the lifting rings, injury from the reducer falling over, and damage to equipment. Before hoisting the reducer, check the weight on the nameplate, packaging, external diagram (specification diagram, final drawings), or catalog, and do not suspend a reducer that exceeds the weight rating of the lifting rings. Otherwise, there is a risk of damaging the bolts, injury from the reducer falling over, and damage to equipment.

(Installation)

- Do not place obstructions around the reducer that will interfere with ventilation. This will hinder cooling and may result in burns or a fire due to abnormal overheating.
- Do not get on the reducer or hang from it under any circumstances. Otherwise, there is a risk of injury.
- Do not touch the shaft ends or the bore section keyways on the reducer with bare hands. Otherwise, there is a risk of injury.
- For equipment that is averse to greasiness such as food machinery, take precautions for an accidental oil leak due to breakdown or service life and install damage prevention equipment such as an oil pan. Otherwise, there is a risk the reducer may become faulty due to an oil leak.

(Connection)

- When connecting the reducer to a motor and the driven machine, pay careful attention to centering, belt tension, and the parallelism of the pulleys. When directly connected, pay careful attention to the accuracy of the direct connection. When belt driven, correctly adjust the belt tension. Before operation, ensure that the tie bolts for the pulleys and couplings have been fully tightened. Otherwise, there is a risk of injury due to flying debris and damage to equipment.
- Install a cover so that rotating components will not be touched. Otherwise, there is a risk of injury.
- When the reducer will rotate independently, remove the key that is temporarily installed to the output shaft. Otherwise, there is a risk of injury.
- Check the direction of rotation before connecting the reducer to the driven machine. There is a risk of injury and damage to equipment by mistaking the direction of rotation.

(Operation)

- Do not insert your hand in the fan cover. Otherwise, there is a risk of being caught in those parts resulting in injury.
- During operation, the reducer reaches high temperatures. Use caution not to touch the reducer with your hands or body. Otherwise, there is a risk of burns.
- When a problem occurs, immediately stop operation. Otherwise, there is a risk of electric shock, injury, and fire.
- Do not use the reducer with a load that exceeds the rated load. Otherwise, there is a risk of injury and damage to equipment.
- Do not loosen the oil plugs during operation. Otherwise, lubrication oil may spray out resulting in burns.
- When running the reducer in reverse, first stop it, and then run it in reverse. Forward and reverse operation by plucking may damage the reducer and the driven machine.

(Disassembly/assembly)

- Repair, disassembly, and assembly should always be performed by a specialist. Otherwise, there is a risk of electric shock, injury, and fire.

(Daily inspection and maintenance)

- Change the lubrication oil and grease according to the instruction manual. Always use the type of oil recommended by the manufacturer. Otherwise, there is a risk of damage to equipment.
- The surface of the reducer reaches high temperatures, so do not touch it bare hands. Otherwise, there is a risk of burns.
- Do not change the lubrication oil during operation or immediately after stopping. Otherwise, there is a risk of burns.
- Diagnose problems that occur based on the instruction manual. Do not operate the reducer until the cause of the problem has been determined and action has been taken.

(Disposal)

- The reducer and its lubrication oil should be treated as general industrial waste.

1 When delivered

1-1. What to be checked at first

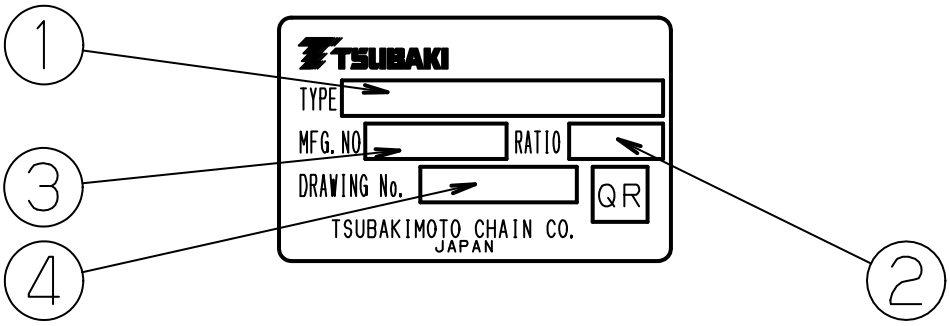
Check the following points upon receipt of your reducer.

If it has any problem, please contact the supplier where the reducer was sourced or Tsubakimoto Chain Co. customer service.

⚠ CAUTION
● Make sure the model of the unit delivered matches your order. If the wrong reducer is installed, there is a risk of injury and damage to equipment. ● Check the orientation of the packaging and open it. Otherwise, there is a risk of injury.

(1) Verify the specifications on the nameplate that correspond to your order. Pay special attention to the shaft arrangement and rotational direction, the position of the input and output shafts, oil gauge and plugs.
(2) Make sure all accessories, such as pressure vents, are attached.
(3) Visual inspection if it has any damage on the reducer during transportation.
(4) Make sure there are no loose on any screws or nuts.

Nameplate



(1) Type, models (2) Gear ratio (3) Manufacturing number (4) Drawing number.

1-2. When inquiring

If the content on the nameplate does not match the reducer that you ordered, or when ordering the replacement reducer and spare parts, please inform us the following information.

(1) Type
(2) Ratio
(3) Manufacturing number
(4) Drawing number

1-3. Models

The symbols the models are described on the following page. Make sure the models of the reducer are matched with delivered product.

1-3-1. Models, TD series

Single reduction

(1) Solid output shaft type

TD	280	S	30	B	R
Product series	Size 125 150 175 200 225 250 280 315	Output shaft S: Solid shaft	Nominal reduction ratio 10: 1/10 20: 1/20 30: 1/30 40: 1/40 50: 1/50 60: 1/60	Mounting position T: T type B: B type V: V type	Shaft arrangement Refer to page 8

(2) Hollow output shaft type

TD	250	H	60	T	LF
Product series	Size 125 150 175 200 225 250 280 315	Output shaft H: Hollow shaft	Nominal reduction ratio 10: 1/10 20: 1/20 30: 1/30 40: 1/40 50: 1/50 60: 1/60	Mounting position T: T type B: B type V: V type	Shaft arrangement Refer to page 8

Double reduction

(1) Solid output shaft type

TD	200	S	100	B	L-R
Product series	Size	Output shaft S: Solid shaft	Nominal reduction ratio	Input shaft position	Shaft arrangement
	125 150 175 200 225 250 280 315		100: 1/100 150: 1/150 200: 1/200 250: 1/250 300: 1/300 450: 1/450 600: 1/600 750: 1/750 900: 1/900 1200: 1/1200 1500: 1/1500 1800: 1/1800 2400: 1/2400 3000: 1/3000	B: B type V: V type	Refer to page 9.

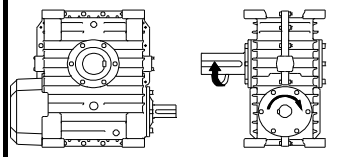
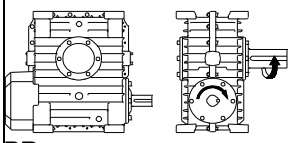
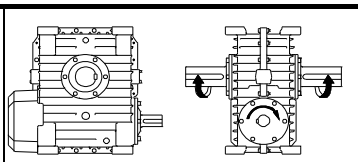
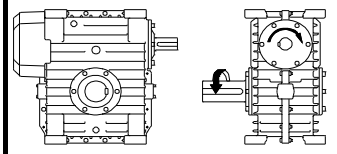
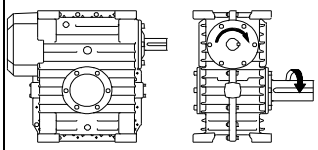
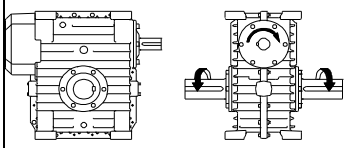
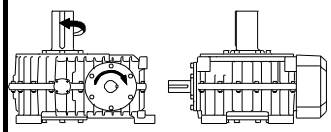
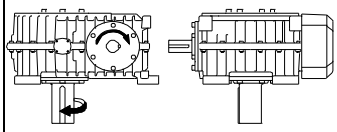
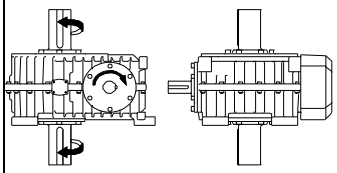
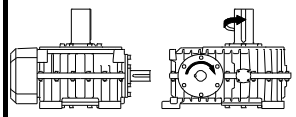
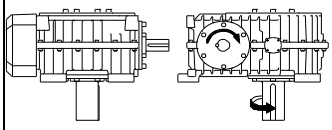
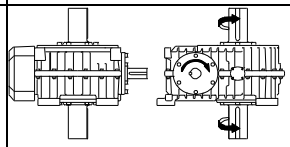
(2) Hollow output shaft type

TD	250	H	300	B	R-LF
Product name	Size	Output shaft	Nominal reduction ratio	Input shaft position	Shaft arrangement
	125 150 175 200 225 250 280 315	H: Hollow shaft	100: 1/100 150: 1/150 200: 1/200 250: 1/250 300: 1/300 450: 1/450 600: 1/600 750: 1/750 900: 1/900 1200: 1/1200 1500: 1/1500 1800: 1/1800 2400: 1/2400 3000: 1/3000	B: B type V: V type	Refer to page 9.

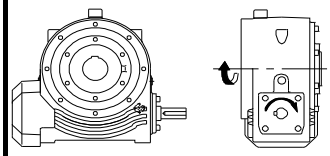
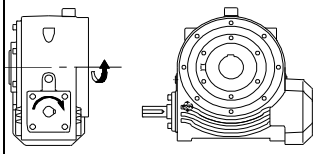
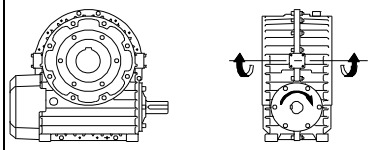
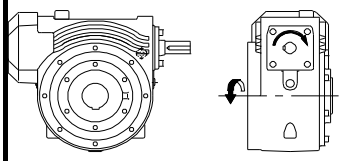
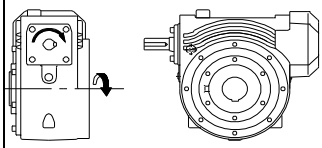
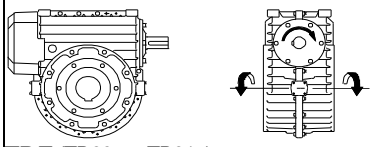
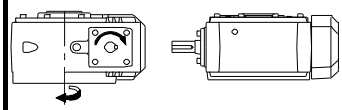
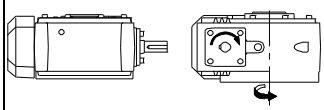
1-3-2. Shaft arrangements

Single reduction

(1) Solid output shaft type (S) (common to all sizes)

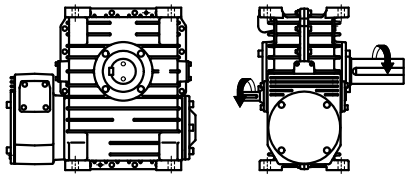
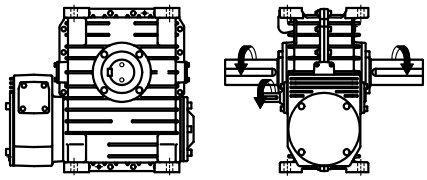
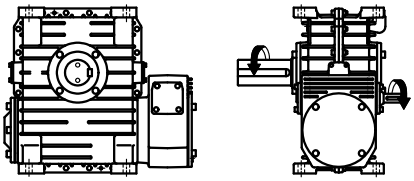
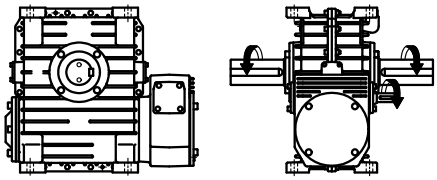
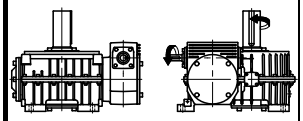
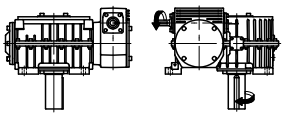
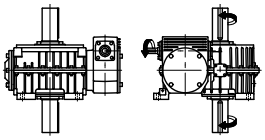
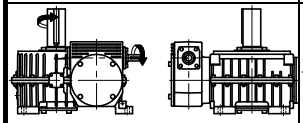
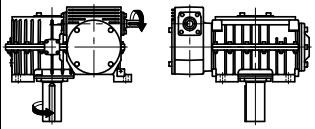
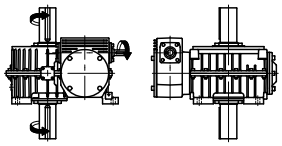
B type	 BL	 BR	 BLR
T type	 TL	 TR	 TLR
V type	 VLU	 VLD	 VLUD
	 VRU	 VRD	 VRUD

(2) Hollow output shaft type (H)

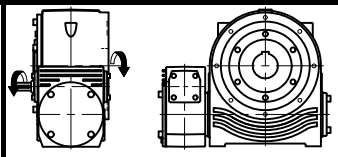
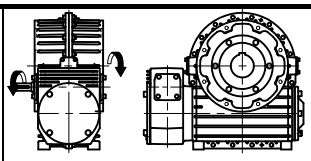
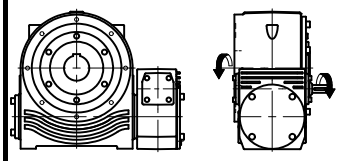
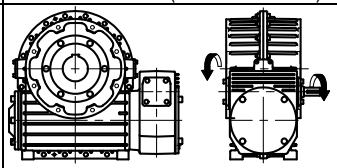
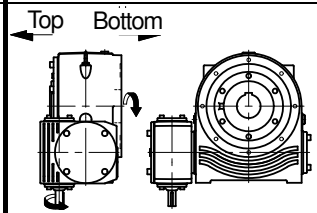
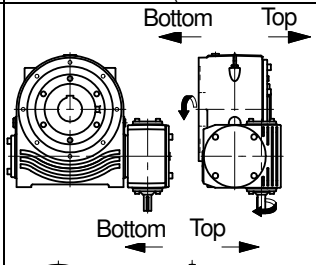
B type	 BLF (TD125 to TD200)	 BRF (TD125 to TD200)	 BDF (TD225 to TD315)
T type	 TLF (TD125 to TD200)	 TRF (TD125 to TD200)	 TDF (TD225 to TD315)
V type	 VLF (TD125 to TD315)	 VRF (TD125 to TD315)	

Double reduction

(1) Solid output shaft type (S) (common to all sizes)

B type	 B L-R	 B L-LR
T type	 B R-L	 B R-LR
V type	 V L-RU	 V L-RD
	 V L-RUD	
	 V R-LU	 V R-LD
	 V R-LUD	

(2) Hollow output shaft type (H)

B type	 B L-RF (TD125 to TD200)	 B L-DF (TD225 to TD315)
	 B R-LF (TD125 to TD200)	 B R-DF (TD225 to TD315)
V type	 V L-RF (TD125 to TD315)	 V R-LF (TD125 to TD315)

2 Transportation

⚠ WARNING

- When hoisting the reducer to transport it, do not enter the area underneath it. Otherwise, there is a risk of accidents due to the reducer falling.

⚠ CAUTION

(Transport)

- Use caution when transporting the reducer as it is dangerous if it drops or falls over. If the reducer has lifting rings, always use those lifting rings. However, after the reducer is installed in the machinery, do not hoist the machinery itself with the lifting rings. Otherwise, there is a risk of damaging the lifting rings, injury from the reducer falling over, and damage to equipment. Before hoisting the reducer, check the weight on the nameplate, packaging, external diagram (specification diagram, final drawings), or catalog, and do not suspend a reducer that exceeds the weight rating of the lifting rings. Otherwise, there is a risk of damaging the bolts, injury from the reducer falling over, and damage to equipment.

Be sure to use the eye-nut on the top surface of the housing (fastened with a hex bolt in the drilled hole) when transporting the reducer. Never hook wires or slings to the input/output shafts. Doing so may cause unexpected load to the shaft/bearing and shorten the life of the reducer or cause a malfunction.

3 Installation

⚠ CAUTION

- Do not place obstructions around the reducer that will interfere with ventilation. This will hinder cooling and may result in burns or a fire due to abnormal overheating.
- Do not get on the reducer or hang from it under any circumstances. Otherwise, there is a risk of injury.
- Do not touch the shaft ends, the bore section keyways, or the cooling fin edges on the reducer with bare hands. Otherwise, there is a risk of injury.
- For equipment that is averse to greasiness such as food machinery, take precautions for an accidental oil leak due to breakdown or service life and install damage prevention equipment such as an oil pan. Otherwise, there is a risk the reducer may become faulty due to an oil leak.

The area of installation should be an ambient temperature between 0 to 40°C, well-ventilated, low in humidity, and have a little or no dust. Do not use the reducer in locations with corrosive liquids or gases, or in flammable or explosive conditions.

If the reducer is to be used outdoors, cover the reducer or have some protection to avoid direct exposure to rain.

(1) When installing or removing the reducer from the driven shaft, make sure to shut off the power source before working.

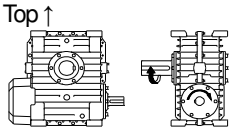
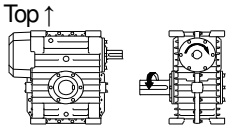
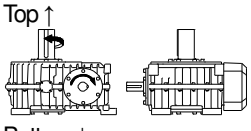
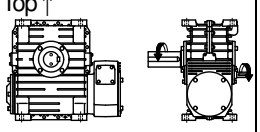
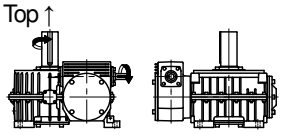
(2) Always use the lifting bolt on the top surface of the reducer housing when installing or removing it from the driven shaft. Never hook wires or slings to the input/output shafts.

(3) Make sure the reducer is balanced and stable when installing or removing it from the driven shaft. Working with the reducer in an unbalanced position is extremely dangerous as it may turn over. Always maintain the reducer in a stable position.

3-1. Solid output shaft type

The solid output shaft type is foot-mounted type.

- Refer to the following installation as standard.

	B type (input shaft is bottom)	T type (input shaft is top)	V type (output shaft is vertical)
Single reduction			
Double reduction		-----	

- If the installation is not as standard and made-to-order products, refer to the outline drawing or contact Tsubaki representative for the volume and type of lubrication.
- Install on firm and flat installation surface that has enough strength and the installation mounting flatness should be within ±1°.
- Use bolts of JIS strength class 10.9T for installation.

Recommended bolts size and length for mounting

Reducer size	125	150	175	200	225	250	280	315
Recommended bolts	M16 x 55	M20 x 60	M20 x 70	M24 x 80	M24 x 80	M30 x 100	M30 x 100	M30 x 110

- Avoid the deformation while installing reducer.

3-2. Hollow output shaft type

It has three options to install reducer against rotating: torque arm mount, flange mount, foot mount (EW-hollow shaft only).

(1) Before inserting the driven shaft into the output hollow shaft, make sure the outside of the driven shaft and the inside of the hollow shaft are free from scratches or any dust.

(2) Apply grease or molybdenum disulfide on the driven shaft, it makes easier to install.

(3) If the shafts fit very tight, tapping its opposite side of hollow shaft by a plastic hammer. It has to be done carefully not to damage the oil seal at output shaft.

(4) The hollow shaft keyway is finished with New JIS standards for normal grade keyways. As for key length, refer to the following table.

Recommended driven shaft lengths

Reducer size	125	150	175	200	225	250	280	315
Output shaft length: A	200	250	270	290	320	356	404	454
Recommended driven shaft lengths: L	170	220	238	258	272	303	344	386

3-2-1. Installation/removal of torque arm

1. Installation procedures

(1) Fix the torque arm to the reducer with bolts.

Note) If the torque arm is purchased from Tsubakimoto Chain Co., use the attached bolts. When the torque arm is prepared by customer, use a bolt strength class of 10.9 or equivalent.

(2) Insert the reducer onto the driven shaft.

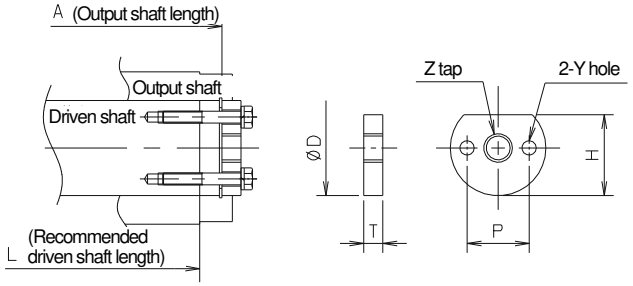
(3) Fix the reducer to the driven shaft in the axial direction.

⊙ Tsubakimoto Chain Co. recommends using the stop ring groove on the hollow output shaft as shown in the figure below and fixing the driven shaft with the stop ring and end plate.
(Refer to technical data on catalogue "Detailed dimensions of hollow output shaft")

(4) Once fix the position of the reducer, install the torque arm to prevent the reducer and driven shaft from rotating.

Keep sufficient space for the torque arm is free to move in the axial direction.

Note) Do not fix the torque arm position before fixing it to the reducer. Doing so may damage the reducer. Follow the work procedure as outlined here.



(Table 1) The dimensions and configurations given in the following table are recommended for the end plate preparation, which also serves as a draw plate.

	Output shaft bore diameter	Recommended plate dimensions						Bolt for plate (with spring washer)	Stop ring size
		ΦD	T	H	Z	Y hole	P		
125	Φ70	69.5	14	62	M24	2-14	44	2-M12 × 60	C70
150	Φ80	79.5	17	70	M24	2-14	52	2-M12 × 65	C80
175	Φ90	89.5	17	80	M30	2-14	60	2-M12 × 65	C90
200	Φ100	99.5	17	89	M30	2-18	65	2-M16 x 75	C100
225	Φ110	109.6	20	99	M30	2-18	65	2-M16 x 85	C110
250	Φ125	124.4	20	113	M30	2-18	70	2-M16 x 85	C125
280	Φ130	129.4	24	118	M36	2-22	80	2-M20 x 100	C130
315	Φ160	159.4	24	146	M36	2-22	85	2-M20 x 100	C160

2. Removal procedures

(1) Lift the reducer using the lifting bolts.

(2) Loosen the end plate bolt which fixes (axial direction) the reducer to the driven shaft.

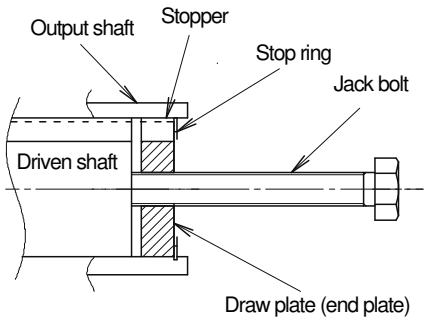
(3) Remove any attachments on the tip of the torque arm, which stops the shaft from rotating, so that it moves freely.

(4) Remove the hollow output shaft from the driven shaft so as to prevent the application of excessive force between it and the housing. Prepare a draw plate (Table 1) and jack bolt (Table 2). Removal is much easier when the jack bolt is attached as shown in Figure 3.

Table 2 Jack bolt dimensions

Size	Output shaft bore diameter	Jack bolt (fully threaded)
125	φ70	M24 x 150
150	φ80	M24 x 150
175	φ90	M30 x 180
200	φ100	M30 x 180
225	φ110	M30 x 180
250	φ125	M30 x 180
280	φ130	M36 x 250
315	φ160	M36 x 250

Figure 3



3-2-2. Installation/removal for flange mounting

1. Installation procedures

☆ Mounting the reducer to the driven machine (mounting without radial load onto the reducer)

(1) Insert the reducer onto the driven shaft.

(2) Use the screw taps on the flange surface of the housing for mounting.

⊙ Use bolts as JIS strength class 10.9T or equivalent for installation. The recommended bolt and mounting dimensions are as in the following table.

(Bolt sizes in table: depths are tapping depths.)

Recommended bolt sizes for flange surface

Reducer size	125	150	175	200	225	250	280	315
Bolt size	M12 25 deep	M12 25 deep	M14 30 deep	M16 30 deep	M16 28 deep	M20 35 deep	M20 35 deep	M20 35 deep
Mounting PCD	255	300	350	380	390	430	490	550
Number used	6 evenly spaced	8 evenly spaced	8 evenly spaced	8 evenly spaced	8 evenly spaced	8 evenly spaced	8 evenly spaced	8 evenly spaced
Bolt strength class	10.9 or greater	10.9 or greater	10.9 or greater	10.9 or greater	10.9 or greater	10.9 or greater	10.9 or greater	10.9 or greater
Tightening torque N·m (kgf·m)	84 to 118 (8.6 to 12)	84 to 118 (8.6 to 12)	137 to 186 (14 to 19)	206 to 294 (21 to 30)	206 to 294 (21 to 30)	402 to 559 (41 to 57)	402 to 559 (41 to 57)	402 to 559 (41 to 57)

(3) Use the step on the housing for positioning.

Note) The end plate is not necessary for flange mounting. If the shaft is fixed by end plate, it causes the additional thrust load on the bearing and it gives damage to the bearing at hollow shaft.

☆ Mounting the reducer by its flange to the driven machine (mounting with radial load onto the reducer)

(1) Insert the reducer onto the driven shaft.

(2) Adjust the radial alignment with the driven shaft and install the reducer without load and have some play in the thrust direction.

(3) Use the taps on the flange side of the reducer housing while using the spigot facing on the housing for positioning.

(4) After fixing the reducer, fix the driven shaft in the thrust direction.

Note) If the driven shaft is fixed in the thrust direction first, the bearing may be damaged due to the thrust to the bearing on the hollow output shaft.

2. Removal procedures

☆ The reducer is mounted to the driven machine (mounting without radial load onto the reducer)

(1) Loosen the flange bolts which fix the reducer to the driven machine.

(2) Remove the hollow output shaft from the driven shaft without any load between housing and output shaft. Prepare a draw plate (Table 1) and jack bolt (Table 2). Removal with the jack bolt makes easier process as shown in Figure 3.

☆ The reducer is mounted by its output flange direct to the machine (mounting with radial load onto the reducer)

(1) Hold the driven shaft steady and balanced.

(2) Loosen the flange which fixes the reducer to the machine.

(3) Remove the hollow output shaft from the driven shaft without any load between housing and output shaft. Prepare a draw plate (Table 1) and jack bolt (Table 2). Removal with the jack bolt makes easier process as shown in Figure 3.

4 Connection

⚠ CAUTION
● When connecting the reducer to a motor and the driven machine, pay careful attention to centering, belt tension, and the parallelism of the pulleys. When directly connected, pay careful attention to the accuracy of the direct connection. When belt driven, correctly adjust the belt tension. Before operation, ensure that the tie bolts for the pulleys and couplings have been fully tightened. Otherwise, there is a risk of injury due to flying debris and damage to equipment. ● Install a cover so that rotating components will not be touched. Otherwise, there is a risk of injury. ● When the reducer will rotate independently, remove the key that is temporarily installed to the output shaft. Otherwise, there is a risk of injury. ● Check the direction of rotation before connecting the reducer to the driven machine. There is a risk of injury and damage to equipment by mistaking the direction of rotation.

4-1. Verifying the direction of rotation

Worms are always a right-handed helix. Verify the rotational direction of the input and output shafts.

4-2. Connection

Connecting the reducer's input and output shafts

- Do not apply impacts or excessive thrust loads to the shaft when installing pulleys, sprockets, or couplings to the reducer input/output shafts.
- Align accurately. Refer to catalogs/manuals of those pulley, sprocket, or coupling, and keep alignment accuracy.
- Shaft eccentricity, and radial and axial loads that exceed allowable values may cause vibration or noise, possibly shortening gear, bearing, and shaft life.

5 Lubrication

The worm reducer has been filled with lubrication oil when shipped from the factory. The reducer does not need to oil to be filled, it can be used as shipped.

5-1. Recommended lubrication oil (standard):

Single reduction: Idemitsu Daphne Alpha Oil TE260

Double reduction: Idemitsu Daphne Alpha Oil TE380

- Lubrication oil is the one of the most important factors for reducer performance, life, and efficiency. Use only lubrication oil recommended by Tsubakimoto Chain Co. Do not mix the oil with other brands.
- In case using other brands, Exxon Mobile oil,
  Single reduction: Mobile SHC632
  Double reduction: Mobile SHC634.
- Do not mix and use other lubrication oils. Gear box performance and operation life may decrease significantly.
- Single reduction reducers running at an input speed of 500 r/min or slower, change the lubrication to Daphne Alpha Oil TE380, it gives longer operation life.
- Do not change the brand of lubrication oil. Please contact to supplier where the product was purchased or contact to Tsubaki.
- For Daphne Alpha Oil TE, please contact to supplier where the product was purchased or contact to Tsubaki.
  Note) Contact Tsubaki if the ambient temperature is below -10°C or above 50°C.

5-2 Approximate oil quantity

- Even with the same size reducer, oil quantity varies depending on the reduction ratio. Refer to the quantity in the following tables as a guideline, and always check the oil level with the oil gauge. (The oil quantity should be checked through the oil gauge while the reducer is not working, and oil level is still. Note) Do not mix the brand of oil used for the single and double reduction.

- Single reduction

(1) Solid output shaft type (S) Unit: L

Size / Type	125	150	175	200	225	250	280	315
Type B	3.1	5.1	8.4	13.0	9.0	13.0	18.0	29.0
Type T	6.5	11.0	16.0	25.0	24.0	35.0	49.0	75.0
Type V	4.8	8.2	12.0	19.0	16.0	22.0	31.0	46.0

(2) Hollow output shaft type (H) Unit: L

Size	125	150	175	200	225	250	280	315
Type B	2.2	4.2	6.5	8.5	9.0	13.0	18.0	29.0
Type T	5.1	8.0	13.0	15.0	20.0	27.0	38.0	58.0
Type V	3.7	5.9	9.6	12.0	15.0	20.0	28.0	44.0

- Double reduction

(1) Solid output shaft type (S) Unit: L

Size	125	150	175	200	225	250	280	315
Type B	4.1	7.0	11.0	17.0	13.0	19.0	28.0	39.0
Type V	5.8	10.0	13.0	22.0	20.0	28.0	41.0	56.0

(2) Hollow output shaft type (H) Unit: L

Size	125	150	175	200	225	250	280	315
Type B	3.2	6.0	9.0	13.0	13.0	19.0	28.0	39.0
Type V	4.7	8.0	12.0	16.0	19.0	26.0	38.0	54.0

5-3. Lubrication oil replacement, period and notes

(1) Lubrication oil is the one of the most important factors for the reducer performance, life, and efficiency. Use only lubrication oil recommended by Tsubaki.

(2) Procedures of the lubrication oil replacement

- First replacement: 1000 hours or three months after operation, whichever comes first.
- Regular maintenance: oil replacement every 5000 hours or one year of whichever comes first.
- While in the replacement, if the drastic spoil of oil performance (viscosity, color or any) is found, plan the maintenance interval more frequently and replace the oil earlier.
- It is easier to drain oil while it is warm just after operation. However, hot oil may injure like burns and is extremely dangerous. Keep the housing surface temperature at cooler around 40 to 50°C before draining the oil.
- Tsubaki recommends flushing the inside of the housing with the new oil when replacing the oil.

Note) Do not mix the oil with other brands.

(3) Please check and keep the oil level higher position than center of oil gauge.
When the oil level is or comes lower below the oil gauge window, but some case it shows the oil at oil gauge due to the oil surface tension or remaining oil in the oil gauges.

5-4. Greasing (made to order specification)

- When the mounting direction of the reducer causes shafts to be vertical (where the bearing is located above the oil level), the bearing must be greased periodically.
- Models that must be greased are provided with a tapped hole for mounting a grease port.
(This is indicated on the drawings as the grease nipple. Refer to the outside drawing such as specification drawing or final drawings).
- A stopper plug (M6 fine threaded hex bolt) is mounted before shipment to prevent oil leakage during transport. Replace it with the grease nipple supplied with the reducer during installation and before operation. Note, the bearings are greased before shipment.
- Follow the procedures every 1000 hours of operation, before initial use and after operations.

Step	Greasing procedures
1	Add grease while the machine is all stopped and not in the operation.
2	Greasing by the grease gun through grease port or grease nipple that located on the top of the housing. Use only the recommended grease. Note) Do not apply over grease. Doing so may cause the reducer to heat up and cause the lubrication oil to deteriorate prematurely.

Grease nipple size: A-M6F

5-4-1. Recommended grease (standard specification, ambient temperature: -10°C to 40°C)

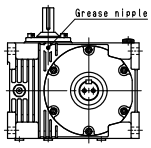
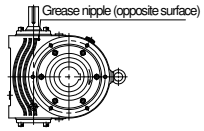
Manufacturer	Brand (industrial all-purpose grease JIS grade 2)
EMG Lubricants	Mobilux EP2 (factory filled)
Idemitsu	Daphne Eponex No. 2

Note) A different brand of grease may be used for special specifications (high temperature, freezing, etc.) Always supply with the type of lubricant appropriate for the specifications. Also take note of any precautions documented on the external diagrams (specification diagrams, final drawings).

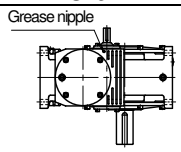
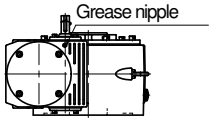
5-4-2. Approximate greasing volume (* Grease input shaft on top side.)

(1) Input shaft on top

・ Reduction ratio 1/10 to 1/60 Unit: g

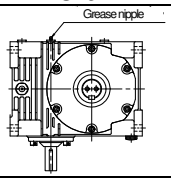
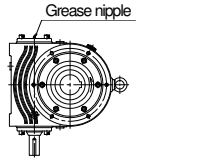
Solid type (S type)										Hollow type (H type)							
Size	125	150	175	200	225	250	280	315	Size	125	150	175	200	225	250	280	315
	19	28	36	46	44	64	96	127		19	28	36	46	44	69	99	127

・ Double reduction ratio 1/100 to 1/3600 Unit: g

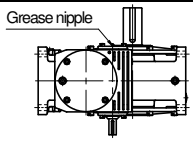
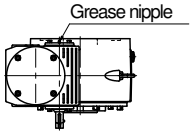
Solid type (S type)										Hollow type (H type)							
Size	125	150	175	200	225	250	280	315	Size	125	150	175	200	225	250	280	315
	-	20	25	25	25	25	30	30		-	20	25	25	25	25	30	30

(2) Input shaft at bottom

・ Reduction ratio 1/10 to 1/60 Unit: g

Solid type (S type)										Hollow type (H type)							
Size	125	150	175	200	225	250	280	315	Size	125	150	175	200	225	250	280	315
	17	45	60	72	47	67	98	127		28	40	47	74	47	67	98	127

・ Double reduction ratio 1/100 to 1/3600 Unit: g

Solid type (S type)										Hollow type (H type)							
Size	125	150	175	200	225	250	280	315	Size	125	150	175	200	225	250	280	315
	-	15	21.5	37	37	56	79	79		-	15	21.5	37	37	56	79	79

6 Operation

⚠ WARNING
(Operation) ● During operation, do not get near or touch any rotating bodies (shafts or other parts). Otherwise, there is a risk of being caught in those parts resulting in injury.
⚠ CAUTION
(Operation) ● Do not insert your hand in the fan cover. Otherwise, there is a risk of being caught in those parts resulting in injury. ● During operation, the reducer reaches high temperatures. Use caution not to touch the reducer with your hands or body. Otherwise, there is a risk of burns. ● When a problem occurs, immediately stop operation. Otherwise, there is a risk of electric shock, injury, and fire. ● Do not use the reducer with a load that exceeds the rated load. Otherwise, there is a risk of injury and damage to equipment. ● Do not loosen the oil plugs during operation. Otherwise, lubrication oil may spray out resulting in burns. ● When running the reducer in reverse, first stop it, and then run it in reverse. Forward and reverse operation by plucking may damage the reducer and the driven machine.

The reducer is filled with lubrication oil and plugged before shipment. Replace the plug with the supplied pressure vent before use.

Note 1) If the reducer is operated without replacing the plug, oil may leak due to high internal pressure.

6-1. Double checking before operation

6-1-1. Checking the reducer

Upon completing the installation, check the following prior to operation:

(1) Is the reducer filled with the correct amount of lubrication oil? (The amount of lubrication oil is correct if it can be seen in the oil gauge.)
(2) Has the pressure vent been installed? (If the reducer mounting direction is a special design and comes with a grease nipple, install it as well.)
(3) Is the reducer properly connected properly to the driven machine?
(4) Are the mounting bolts fully tightened?
(5) Is the direction of rotation being correct?

Make sure the equipment incorporates failsafe measures due to the use of the reducer, or in the event the reducer malfunctions.

6-2. Trial run

No trial run is made prior to shipment. For best results, operate the reducer for roughly one day under 1/2 to 1/3 load.

6-3. Load

Loading the reducer above its rated capacity can affect its life and result in damage.

Do not load the reducer above its rated capacity.

6-4. Verification after operation starts

Verify the following after starting production:

a) There is no abnormal vibration, noise, heat, etc.
b) The reducer is not subject to shock or overloads.
c) The temperature is not unusually high.

Note) The reducer may generate heat during the first two or three days of operation. This is expected and does indicate a problem. However, if the housing temperature exceeds 100°C, it could indicate insufficient capacity, incorrect oil level, or improper installation. Check each location. Note, do not touch the reducer with your bare hands when checking. Doing so may cause burns.

7 Maintenance

⚠ WARNING
● In maintenance and inspection during operation, do not touch any rotating bodies (shafts or other parts). Otherwise, there is a risk of being caught in those parts resulting in accident. ● When entering the inside of the product to inspect it while stopped, first confirm that the rotation of the motor and the driven machine has stopped, and sufficiently cool the inside of the product, and then you must work while ventilating the interior. While performing the inspection work, arrange personnel for confirming safe working conditions on the exterior, and always confirm safety with the worker. Be aware that the product interior is slippery from lubrication oil and take sufficient safety precautions. Otherwise, there is a risk accident.
⚠ CAUTION
(Daily inspection and maintenance) ● Change the lubrication oil and grease according to the instruction manual. Always use the type of oil recommended by the manufacturer. Otherwise, there is a risk of damage to equipment. ● The surface of the reducer reaches high temperatures, so do not touch it bare hands. Otherwise, there is a risk of burns. ● Do not change the lubrication oil during operation or immediately after stopping. Otherwise, there is a risk of burns. ● Diagnose problems that occur based on the instruction manual. Do not operate the reducer until the cause of the problem has been determined and action has been taken.

7-1. Maintenance

- When performing maintenance, wear suitable clothing and use protection including safety glasses, gloves, safety shoes, etc.
- To prevent secondary accidents, keep the surrounding area safe and tidy.
- Always turn the power off and wait for the machine to come to a full stop. Also, use lock-outs to prevent unintentional power supply.
- The reducer reaches extremely high temperatures during operation. Do not touch with your bare hands.
- Read and follow labor safety codes and standards.

7-2. Daily inspection

Make daily inspections using appropriate measuring instruments with the following procedures and take note of operating conditions. Failure to do so may result in problems.

Inspection items	Inspection details
Noise	Is the noise louder than usual? Are there any unusual noises?
Vibration	Are there any unusual vibrations? Any rapid changes in vibration?
Temperature	Is the surface temperature of the reducer higher than usual? Any rapid temperature rises?
Oil level	Is the oil level correct when the machine is stopped?
Mounting bolts	Are any of the bolts loose?
Chain/belt	Are the chains/belts loose?
Lubricant condition	Has the lubricant blackened due to abrasion powder?
Oil leakage	Are there any leakages from the connection points on the reducer, oil seals, caps?
Pressure vent	Are the holes for air bleeding clogged?

Note) When a problem occurs, immediately stop operation and perform a detailed inspection.
Note) If the cause is unclear or repair is not possible, please contact the dealer where the reducer was purchased or Tsubakimoto Chain Co. customer service.

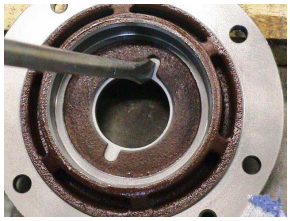
7-3. Inspection and replacement of the oil seals

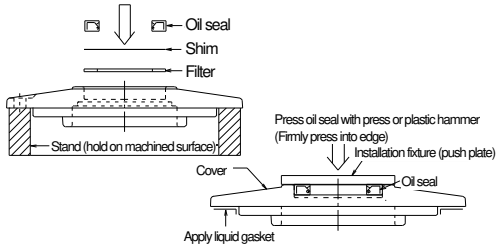
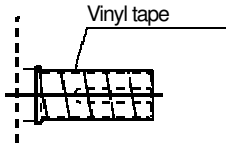
- Oil seals wear and have a service life which may eventually lead to oil leakage. The service life may be shorter when used at high temperatures, high rotating speeds, outdoors, or otherwise harsh conditions. Inspect the oil seals at regular intervals and replace immediately if oil leaks exist. Always replace the oil seals with the same model number and material. (Do not use oil seals made of different materials as this can cause oil leakage.) Refer to the oil seal manufacturer's catalog when replacing. The procedures for replacing oil seals and filters are listed on the next page. (TD225 to TD315 do not have a filter construction.)
- Occasionally, during the first few hours of operation, grease filled during the assembly process may seep out of the oil seal lip. This is normal and does not affect the performance of the reducer.

• Oil seal and filter replacement procedures

Replace the oil seals and filters attached to the various covers such as the housing, input seal support, output seal support, output bearing support, and the motor flange with the following procedure. Check the model and dimensions in the catalog and instruction manual to confirm that the oil seals and filters to replace are correct. They cannot be replaced if the model and dimensions are different. For the filters, please consult with Tsubakimoto Chain Co.

Note) Failures that are caused by the customer replacing the oil seals are not covered by the Tsubakimoto Chain Co. warranty.

Item	Details
Remove reducer equipment	Remove the reducer from the equipment. Remove all parts incorporated on the input and output shafts of the reducer. Prepare a sufficient maintenance space so that the work can be safely done. Perform the maintenance work with the reducer in a stable position. When the covers (seal support, output bearing support, motor flange) are removed when they are mounted on the equipment, there is a risk that internal components such as the shaft may drop or fly off due to the mounting position.
Check before removal	● Before removing the housing and covers (seal support, output bearing support, motor flange), check that the lubrication oil in the reducer has been drained. ● Check that no load is applied to the shafts as they may start moving by removing the covers (seal support, output bearing support, motor flange) when there is a load applied to them, which may result in injury.
Remove the oil seals, filters	● Remove the covers (seal support, output bearing support, motor flange). ● Remove the old oil seal using the groove for oil seal remove on the inside of the cover. The filter and shim can also be removed at this time.  ● Clean off the liquid gasket that is attached to the cover, reducer housing, and polyester shim. ● For the housing, remove in the same order as the covers.
How to attach the oil seals, filters	● Before pressing the oil seal into the covers (seal support, output bearing support, motor flange), insert the filter and shim into the oil seal press section in that order. (For the housing, insert in the same order.) ● Before pressing the oil seal, always fill the oil seal lip groove with a mineral-based lithium grease. (Approximately 50% of the lip space) ● Apply a liquid gasket to the circumference of the oil seal. (Not necessary when the circumference of the oil seal is rubber) ● When pressing the oil seal, use a flat press fixture to press in the oil seal so that it is not slanted, as shown in the figure below. * For attaching the oil seal, also refer to the oil seal manufacture's catalog.

Item	Details
How to attach the oil seals, filters	 ● Apply a liquid gasket to the mating portion of the covers (seal support, output bearing support, motor flange). (See the figure above)
Protection from the shaft	● When incorporating the covers (seal support, output bearing support, motor flange), the oil seal lip may be damaged by the shoulder edge of the shaft. Before incorporating them, wrap the shaft with vinyl tape, and after incorporating them, remove the vinyl tape. (Use caution as the shaft keyway may also damage the lip in the same manner.) The same procedure also applies for the housing. 
Attach the seal support	● Attach the covers (seal support, output bearing support, motor flange) to the reducer housing. When doing so, do not forget to attach the polyester shim. ● Bolt the bolts and tighten them to the correct torque.
Check seal performance	If the liquid gasket was not properly applied when attaching the covers (seal support, output bearing support, motor flange), oil may leak from the mated surface of the reducer housing and cover. Approximately 24 hours after changing the oil seal, check if any oil is leaking from the mated surface. If any oil is leaking, remove the covers once again, remove the liquid gasket, and re-apply it.

8 Disassembly/assembly

⚠ CAUTION
(Disassembly/assembly) ・Repair, disassembly, and assembly should always be performed by a specialist. Otherwise, there is a risk of electric shock, injury, and fire.

(1)Never disassemble the reducer except for repairs (replacing the oil seals, other components).

(2)Tooth contact and bearings have been adjusted for optimal performance.

(3)Contact us if the reducer needs to be disassembled.

9 Troubleshooting

If a problem occurs with the reducer, refer to the table below to troubleshoot the problem.

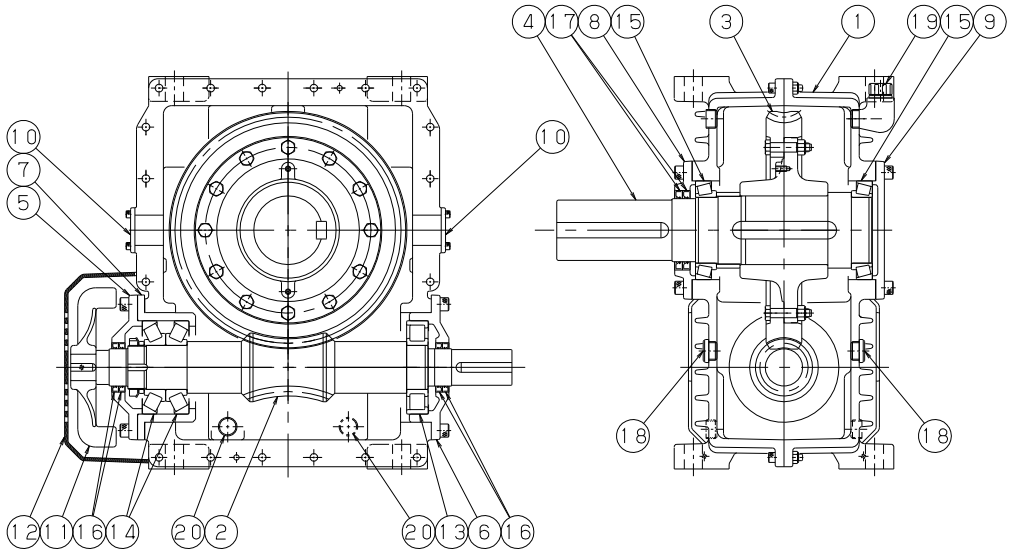
Problem	Possible cause	Action
Abnormal temperature rise	Overload operation	Check and apply the correct load.
	Insufficient or too much lubricant	Fill with the appropriate volume.
	Oil contamination or wrong oil	Replaced with new and correct oil.
	Bearings are overtightened	Contact Tsubakimoto Chain Co. for adjustment.
Loud noise Strong vibration	Damaged bearings	Contact Tsubakimoto Chain Co. for repair.
	Bad tooth contact	
	Bearings are overtightened	
	Damage to the teeth	
	Insufficient oil	Contact Tsubakimoto Chain Co.for repair and lubrication.
	Contaminated with foreign objects	Contact Tsubakimoto Chain Co.for repair and oil replacement.
Oil leak	Oil seal wear/damage	Replace the oil seal (including filter, depending on model)
	Damaged oil gauge	Replace the oil gauge
	Bolts/plugs have become loose	Retighten loose bolts/plugs.
Output shaft does not rotate	Worm wheel wear	Contact Tsubakimoto Chain Co. for repair.
	Breakage of worm shaft or worm wheel	
	Breakage of worm wheel hub and output shaft key	
Both input and output shafts do not rotate	Jammed with foreign objects	Contact Tsubakimoto Chain Co. for repair.
	Damaged or broken bearings	
	Seized gear teeth	

10 Internal construction and parts lists

10-1. Internal construction

This section lists representative examples. Please use it as a reference.

(1) Single reduction

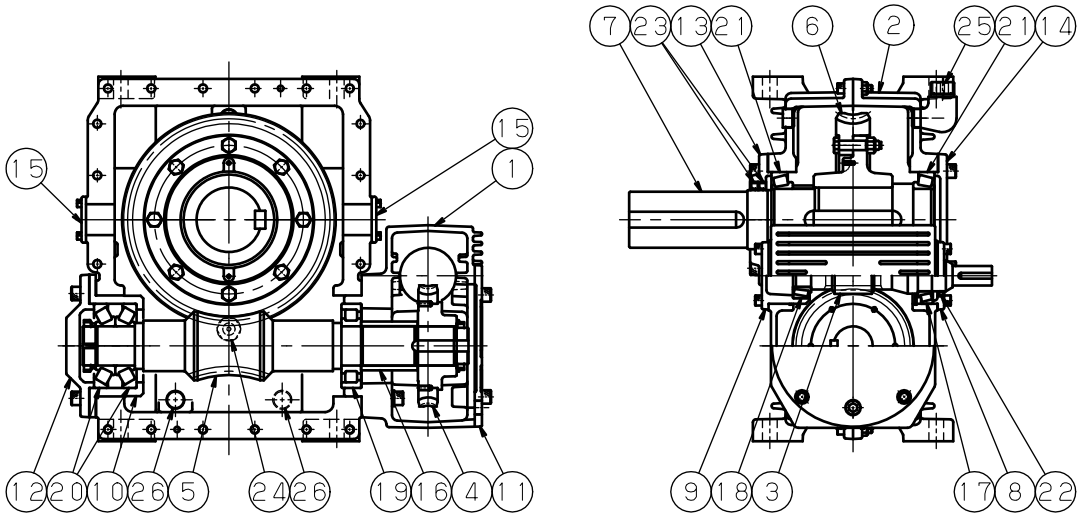


- This drawing shows the internal construction of the TD250 (single reduction).
- This drawing is representative and may differ slightly depending on the model and size.
  (The TD125 to TD200 have a filter construction.)

<Major parts table> For consumables by size (bearings/oil seals), see the parts lists.

No.	Part name	No.	Part name
1	Housing	11	Fan
2	Worm shaft	12	Fan cover
3	Worm wheel	13	Input shaft bearing
4	Output shaft	14	Input shaft bearing
5	Input seal support	15	Output shaft bearing
6	Input bearing support I	16	Input shaft oil seal
7	Input bearing support III	17	Output shaft oil seal
8	Output seal support	18	Oil gage
9	Output cap	19	Pressure vent
10	Inspection cap	20	Drain oil port

(2) Double reduction



- This drawing shows the internal construction of the TD225 (double reduction).
- This drawing is representative and may differ slightly depending on the model and size.
  (The TD125 to TD200 have a filter construction.)

<Major parts table> For consumables by size (bearings/oil seals), see the parts lists.

No.	Part name	No.	Part name
1	Input housing	14	Output cap
2	Housing	15	Inspection cap
3	I Worm	16	Intermediate collar
4	I Wheel	17	Input shaft bearing
5	II Worm	18	Input shaft bearing
6	II Wheel	19	Intermediate shaft bearing
7	Output shaft	20	Intermediate shaft bearing
8	Input seal support	21	Output shaft bearing
9	Input bearing support II	22	Input shaft oil seal
10	Intermediate bearing support III	23	Output shaft oil seal
11	Intermediate cap	24	Oil gage
12	Intermediate seal support	25	Pressure vent
13	Output seal support	26	Drain oil port

10-2. Parts lists

(1) Single reduction

○TD125 to TD200

Part name	Quantity	TD125	TD150	TD175	TD200
Input shaft bearing	2	30309D	30311D	30312D	30314D
Output shaft bearing (solid)	2	32213	32214	32216	32218
Output shaft bearing (hollow)	2	32022	32024	32026	32030
Input shaft oil seal (load side)	1	D45.62.9	D55.72.9	D58.80.12	D68.90.12
Input shaft oil seal (fan side)	1	D32.52.8	D45.68.12	D45.68.12	D45.68.12
Output shaft oil seal (solid)	1 (2)	DM63.85.12	DM68.90.12	DM75.100.13	D85.110.13
Output shaft oil seal (hollow)	2	DM105.135.14	DM115.145.14	DM125.155.14	DM145.175.14

○TD225 to TD315

Part name	Quantity	TD225	TD250	TD280	TD315
Input shaft bearing (load side)	1	NF314	NF316	NF318	NF320
Input shaft bearing (fan side)	2	30314D	30316D	30318D	31320
Output shaft bearing (solid)	2	32022	32024	32026	32030
Output shaft bearing (hollow)	2	32030	32034	32040	32044
Input shaft oil seal (load side)	2	D58.80.12	D68.90.12	D80.100.13	D90.115.13
Input shaft oil seal (fan side)	2	D58.80.12	D68.90.12	D80.100.13	D90.115.13
Output shaft oil seal (solid)	2 (4)	DM105.135.14	DM115.145.14	D130.160.14	DM145.175.14
Output shaft oil seal (hollow)	4	DM150.180.14	D170.200.16	D200.235.18	D220.250.16

Note) Both the load-side and fan-side input shaft oil seals are acrylic rubber. The output shaft oil seals are nitrile rubber. Figures in ( ) are for double shaft types.
For the TD125 to TD200, the filter must also be replaced when replacing oil seals. Contact us for details.

(2) Double reduction

○TD125 to TD200

Part name	Quantity	TD125	TD150	TD175	TD200
Input shaft bearing (load side)	1	6208ZZ	32009	32011	32211
Input shaft bearing (opposite of load side)	1	6208ZZ	32206	32207	33208
Intermediate shaft bearing	2	30309D	30311D	30312D	30314D
Output shaft bearing (solid)	2	32213	32214	32216	32218
Output shaft bearing (hollow)	2	32022	32024	32026	32030
Input shaft oil seal	1	D40.72.9	DM45.68.12	[1] D54.72.9	[1] D54.72.9
Output shaft oil seal (solid)	1 (2)	DM63.85.12	DM68.90.12	DM75.100.13	D85.110.13
Output shaft oil seal (hollow)	2	DM105.135.14	DM115.145.14	DM125.155.14	DM145.175.14

○TD225 to TD315

Part name	Quantity	TD225	TD250	TD280	TD315
Input shaft bearing (load side)	1	32211	30311	30312	30312
Input shaft bearing (opposite of load side)	1	33208	32309	32310	32310
Intermediate shaft bearing (I wheel side)	1	NF314	NF316	NF318	NF320
Intermediate shaft bearing (opposite of I wheel side)	2	30314D	30316D	30318D	31320
Output shaft bearing (solid)	2	32022	32024	32026	32030
Output shaft bearing (hollow)	2	32030	32034	32040	32044
Input shaft oil seal (load side)	1	[1] D54.72.9	[1] D54.72.9	D58.80.12	D58.80.12
Output shaft oil seal (solid)	2 (4)	DM105.135.14	DM115.145.14	D130.160.14	DM145.175.14
Output shaft oil seal (hollow)	4	DM150.180.14	D170.200.16	D200.235.18	D220.250.16

Note) Both the load-side and fan-side input shaft oil seals are acrylic rubber. (TD100 & TD125 are nitrile rubber)
- The output shaft oil seals are nitrile rubber. Figures in ( ) are for double shaft types.

1) Made to order, and not available in general market. Contact Tsubaki representative for more information.

11 Storage

If you will not be using the reducer immediately upon delivery, store it by observing these precautions.

11-1. Storage location

Store in a clean and dry indoor environment.

Do not store outside where the reducer/motor may be exposed to humidity, dust, extreme temperature fluctuations, or corrosive gases.

11-2. Storage orientation

The reducer is packed and shipped suitable for installation. Store it as delivered, in the upright position. For reducers with special installation styles, if stored in the wrong position or direction, the bearing grease and lubrication may mix or even leak from the unit.

11-3. Storage period

(1) The maximum storage period is six months.

(2) Special anti-rust treatment is required for storage over six months. Contact us for details.

11-4. Operating the reducer after storage

(1) Non-metallic parts like oil seals, oil gauges, and oil plugs wear easily from environmental conditions such as extreme temperatures and ultraviolet rays. Make sure to inspect these parts and replace them if damaged, before operation.

(2) Make sure there is no abnormal noise, vibration, or overheating when starting operation. If there is a problem, immediately stop operation and contact the dealer where the reducer was purchased, Tsubakimoto Chain Co. sales office, or customer service.

12 Others

12-1. Disposal

The reducer and its lubrication oil should be treated as general industrial waste.

12-2. Paint

If you are going to paint your reducer, mask the oil seals to prevent contact with paint. Otherwise, oil leakages may occur.

12-3. Reducers with motors

Refer to the instruction manual for the motor for further disposal instructions.

12-4. Special specifications

For special specifications, use this instruction manual by checking the information for your reducer using the external diagrams (specification diagrams, final drawings). If any part of this instruction manual is unclear, please contact the dealer where the reducer was purchased, Tsubakimoto Chain Co. sales office, or customer service.

13 Limited Warranty

13-1. Warranty period without charge

18 months effective the date of shipment or 12 months effective the first use of Goods, including installation of Goods to Buyer's equipment or machine - whichever comes first. However, the warranty period may vary, depending on the usage conditions.

13-2. Warranty coverage

During the limited warranty period, a failure in a Tsubaki product installed, used, and maintained according to the catalog, instruction manual, or other appropriate documents can be returned to Tsubaki for replacement or repair free of charge.
However, please note that the limited warranty covers only Tsubaki products. The following expenses will not be covered by the warranty. (Instruction manuals and other appropriate documents include any documents specially submitted to the customer.)

(1) Any costs related to the removal or re-installation of Goods from the Buyer's equipment or machine to repair or replace parts.

(2) Cost to transport Buyer's equipment or machines to replace or repair.

(3) Costs to reimburse any profit loss due to any repair or damage and

13-3. Warranty with charge

Seller will charge for any investigation and repair of Goods (even during the warranty period without charge) caused by:

(1) Improper installation by failing to follow the instruction manual.
(2) Insufficient maintenance or improper operation by the Buyer.
(3) Incorrect installation of Goods onto other equipment or machines.
(4) Structure change of the Goods by any modifications or alterations by the Buyer.
(5) Any repair by engineers other than the Seller or those designated by the Seller.
(6) Operation in an inappropriate environment not specified in the manual.
(7) Force Majeure or forces beyond the Seller's control such as a natural disaster and injustices committed by a third party.
(8) Secondary damage or problems incurred by the Buyer's equipment or machines.
(9) Defective parts supplied or specified by the Buyer.
(10) Product failures due to wiring failures caused by the Buyer.
(11) The product reaching the end of its normal service life according to the operating conditions.
(12) Loss or damage not liable to the Seller.

13-4. Dispatching of Tsubaki engineers

Service expenses such as those incurred when dispatching engineers to perform an investigation, adjustment, or trial operation of a Tsubaki product will be charged separately.

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