

# CHAPTER 4

# INTAKE AND EXHAUST SYSTEM

<u>1</u>	<u>Intake and Exhaust System</u>	<u>4-1</u>
<u>2</u>	<u>Intake Silencer</u>	<u>4-4</u>
<u>3</u>	<u>Intake Manifold</u>	<u>4-5</u>
<u>4</u>	<u>Turbocharger</u>	<u>4-6</u>
<u>5</u>	<u>Mixing Elbow</u>	<u>4-21</u>
<u>6</u>	<u>Breather</u>	<u>4-22</u>

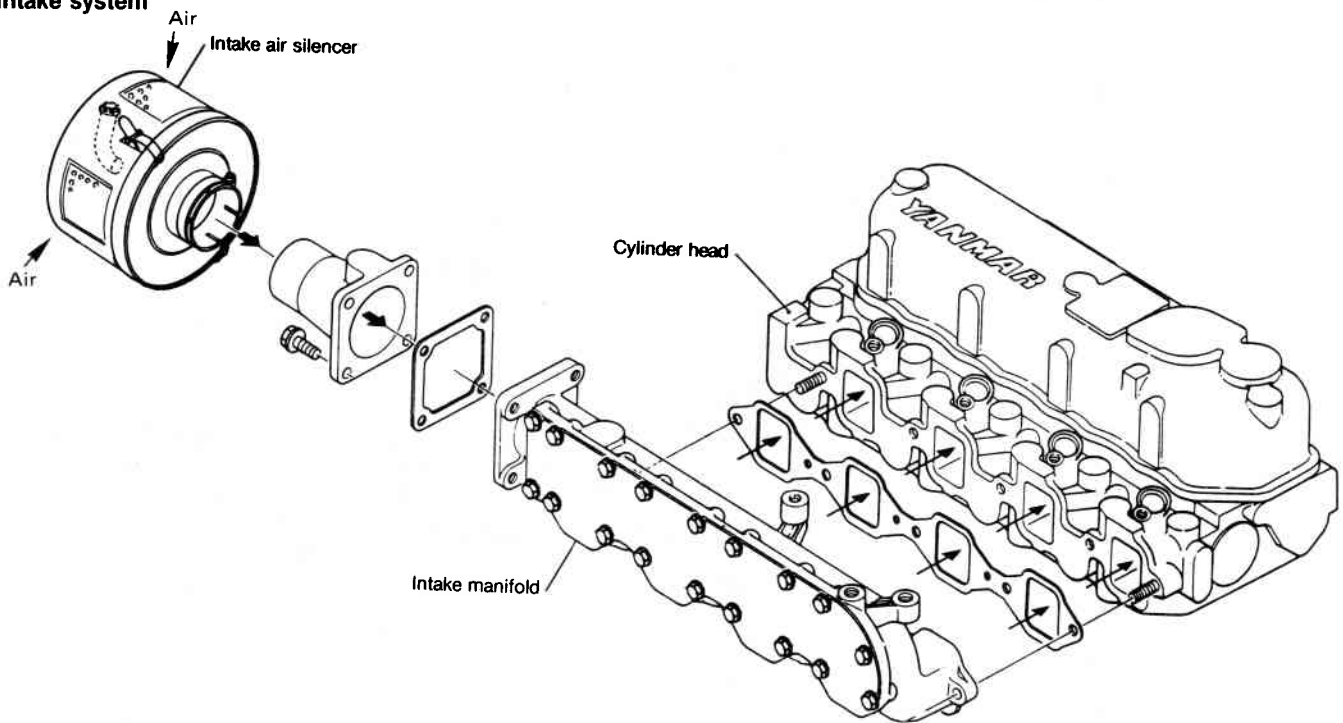
# 1. Intake and Exhaust System

## 1-1 4JHE engine

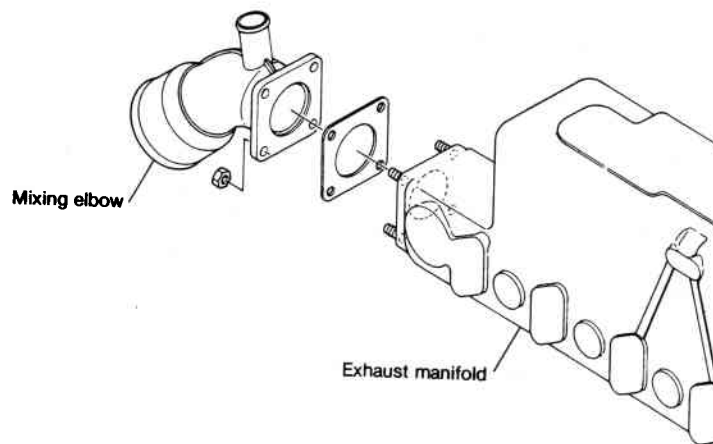
Air enters in the intake silencer mounted at the end of the intake manifold, is fed to the intake manifold and then on to each cylinder.

Exhaust gas goes into the exhaust manifold (in the fresh water tank) mounted on the cylinder head discharge. After cooling it enters the mixing elbow which is directly connected with the exhaust manifold, and is discharged from the ship along with waste cooling water.

### Intake system



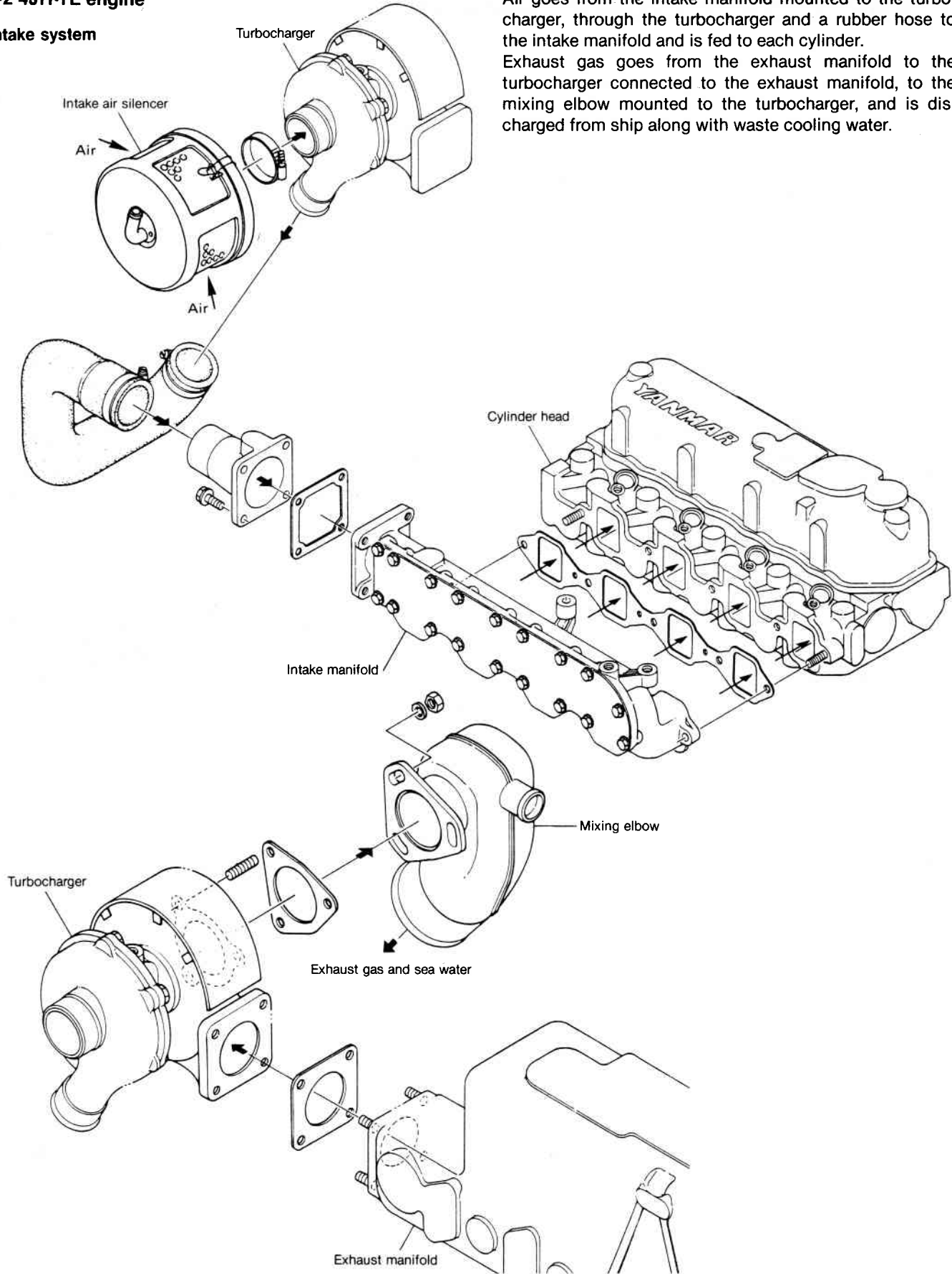
### Exhaust system



1-2 4JH-TE engine

Intake system

Air goes from the intake manifold mounted to the turbo-charger, through the turbocharger and a rubber hose to the intake manifold and is fed to each cylinder.  
Exhaust gas goes from the exhaust manifold to the turbocharger connected to the exhaust manifold, to the mixing elbow mounted to the turbocharger, and is discharged from ship along with waste cooling water.

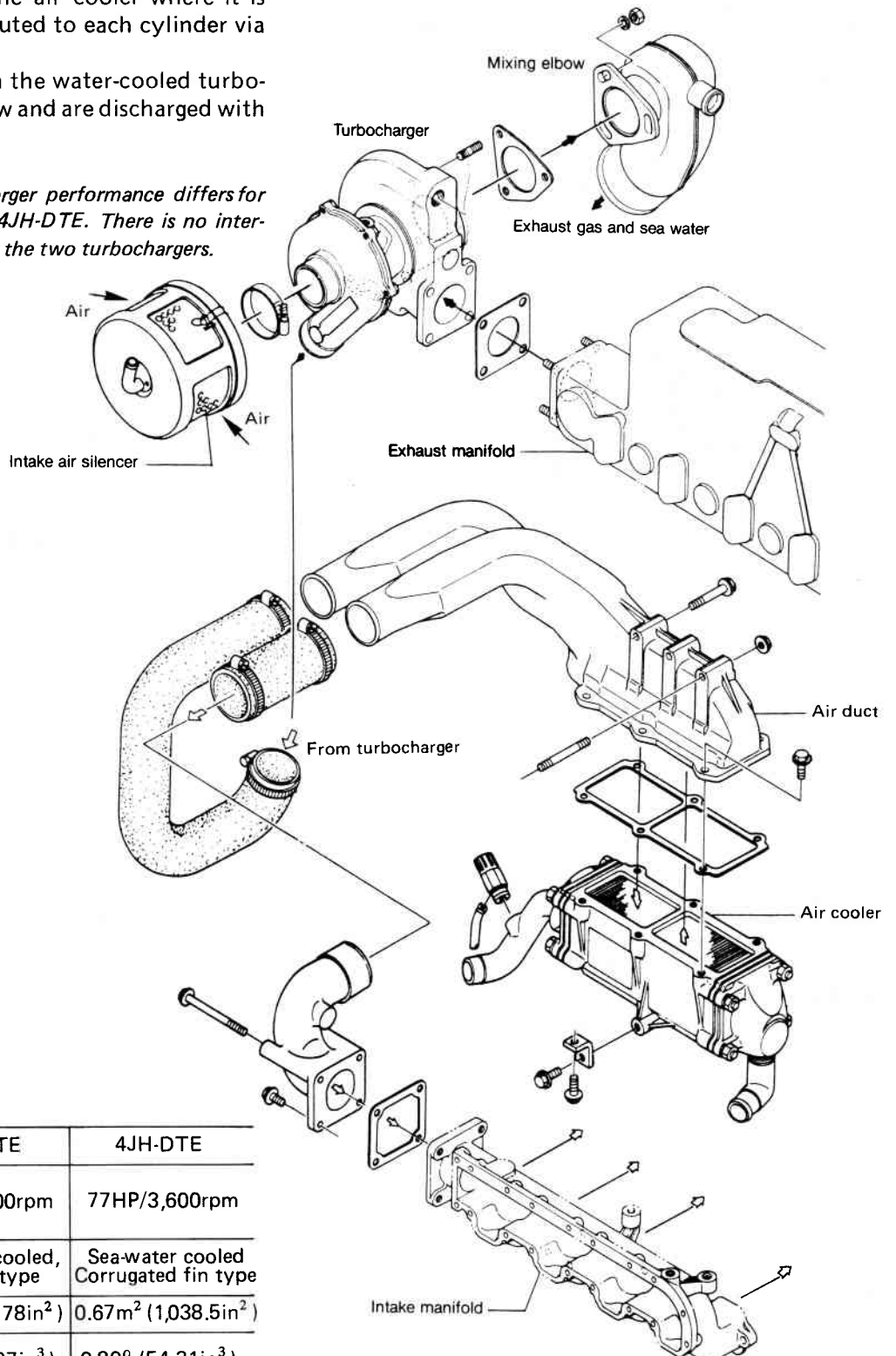


**Air Cooler for Models 4JH-HTE and 4JH-DTE**

Air introduced from the intake air silencer passes through the air duct to the air cooler where it is cooled, and is then distributed to each cylinder via the intake manifold.

Exhaust gases pass through the water-cooled turbocharger to the mixing elbow and are discharged with the sea water.

**NOTE:** *Water-cooled turbocharger performance differs for models 4JH-HTE and 4JH-DTE. There is no interchangeability between the two turbochargers.*



**Air Cooler Specifications**

Engine model	4JH-HTE	4JH-DTE
Output Din6270B Rating	66HP/3,600rpm	77HP/3,600rpm
Type	Sea-water cooled, Plate fin type	Sea-water cooled Corrugated fin type
Radiation area	0.76m <sup>2</sup> (1,178in <sup>2</sup> )	0.67m <sup>2</sup> (1,038.5in <sup>2</sup> )
Sea-water capacity	0.85ℓ (51.87in <sup>3</sup> )	0.89ℓ (54.31in <sup>3</sup> )

**NOTE:** ⇨ Charging Air  
 ⇨ Exhaust gas and Sea-water

# 2. Intake Silencer

## 2-1 Construction

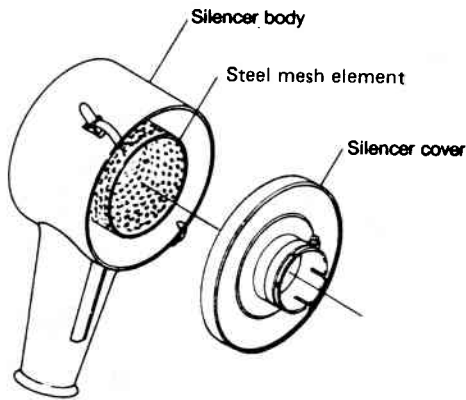
The intake silencer has a steel plate element with holes to reduce noise.

The silencer is provided with a mist breather pipe joint from which mist is taken in.

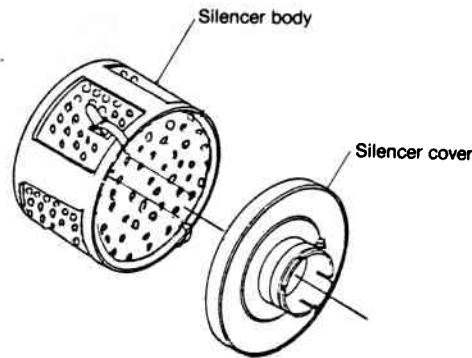
## 2-2 Intake silencer inspection

- (1) Sometimes disassemble the silencer and clean the inside. If welds are cracked or corroded, repair or replace as necessary.
- (2) Inspect the mist pipe joint, remove any dirt and thoroughly clean.

**Old type** (Part No. 129495-12500)



**New type** (Part No. 129470-12300)



			4JHE	4JH-TE	4JH-HTE	4JH-DTE
Rating air discharge volume		m <sup>3</sup> /min (ft <sup>3</sup> /min)	2.5 (88.27)	3.7 (130.64)	4.7 (165.96)	5.6 (197.74)
Ventilation resistance	Old type	mmAq (in.Aq)	120 (4.72)	150 (5.90)	—	—
	New type	mmAq (in.Aq)	35 (1.38)	70 (2.76)	100 (3.94)	125 (4.92)

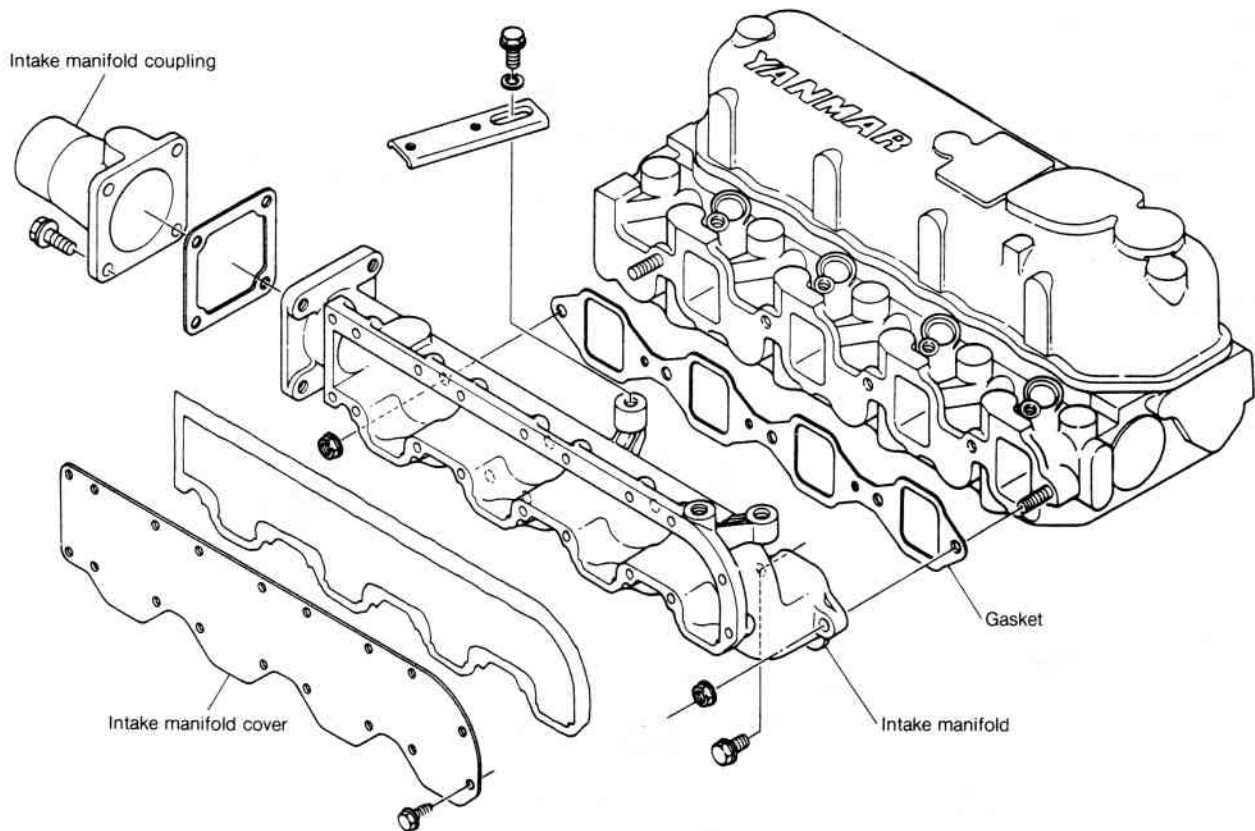
## 3. Intake Manifold

### 3-1 Construction

The intake manifold consists of the manifold and the cover, but the cover should not be disassembled without a special reason as it is coated with adhesive and bolted. If it is disassembled, recoat with adhesive and tighten to specified torque. (It can only be disassembled three times).

### 3-2 Inspection

- (1) Make sure that air flows through smoothly and clean out any dirt. Replace if it is excessively corroded, cracked or otherwise damaged.
- (2) Inspect the gasket packings and replace if damaged.
- (3) On models equipped with an air heater between the manifold and coupling, inspect the nickel-chrome wires for breakage, damaged contacts, etc.,



Intake manifold cover set bolts tightening torque	0.7 kg-m (5.06 ft-lb)
--	-----------------------

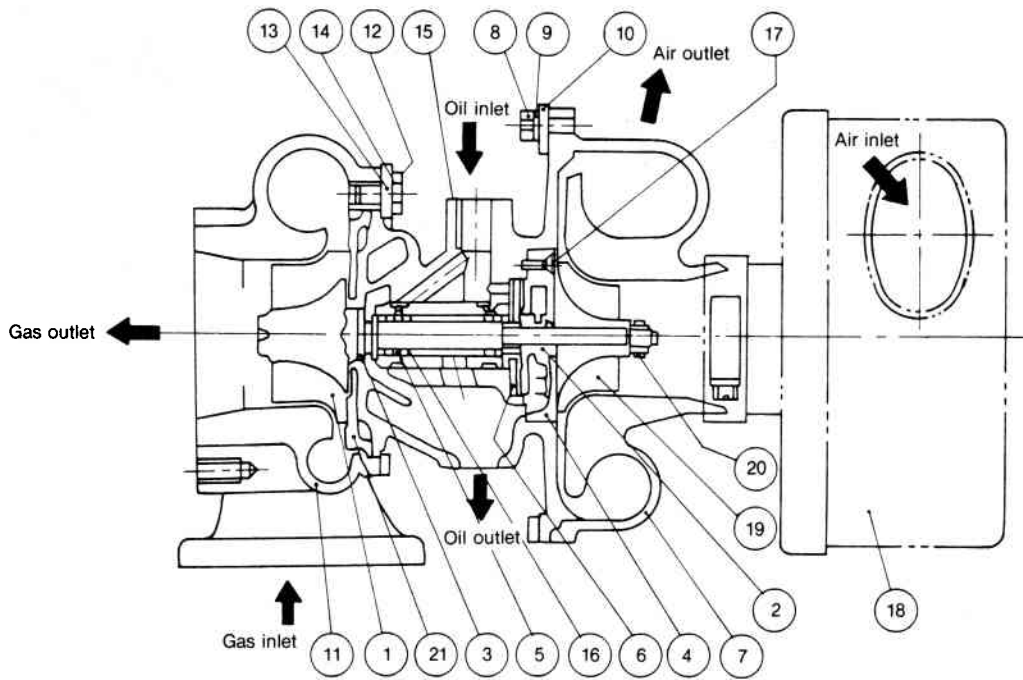
# 4. Turbocharger

## 4-1 Specifications

Turbocharger maker	ISHIKAWAJIMA-HARIMA HEAVY INDUSTRIAL CO.,LTD. ( I H I )		
Turbine type	Radial flow		
Blower type	Centrifugal		
Bearing type	Full floating		
Lubrication method	Outer lubrication		
Cooling method	Air cooled	Water cooled	
Continuous rated rpm	140,000	160,000	170,000
Max. gas inlet temp. (continuous allowable)	700°C		
Dry weight, approx.	4.2kg (9.26 lb.)		
Turbocharger model	MY20	*MY29	MY31 MY34
Applicable engine model	4JH-TE		4JH-HTE 4JH-DTE

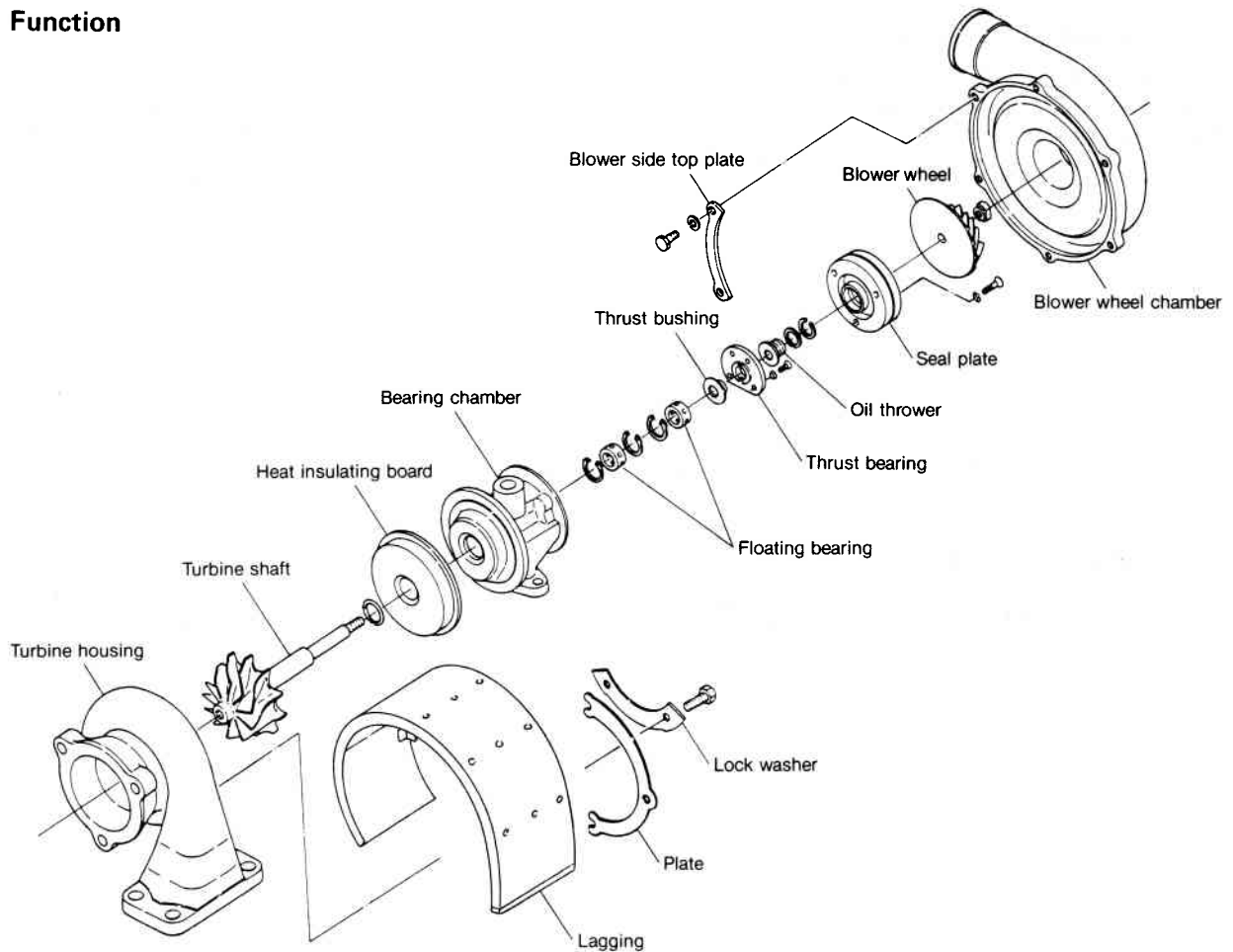
NOTE: \*MY29 is equipped on models 4JH-TE produced at Yanmar plants since Nov., 21.1984

## 4-2 Construction



- |                           |                                |
|---------------------------|--------------------------------|
| 1. Turbine shaft          | 11. Turbine wheel chamber      |
| 2. Oil thrower            | 12. M6 hexagonal bolt          |
| 3. Turbine side seal ring | 13. Turbine side locking plate |
| 4. Seal plate             | 14. Lock washer                |
| 5. Floating bearing       | 15. Bearing chamber            |
| 6. Thrust bearing         | 16. Stop ring                  |
| 7. Blower wheel chamber   | 17. Screw M3                   |
| 8. M5 hexagonal bolt      | 18. Intake silencer            |
| 9. M5 lock washer         | 19. Blower wheel fixing nut    |
| 10. Blower side top plate | 20. Blower wheel               |
|                           | 21. Heat insulating board      |

4-3 Function



(1) Turbine

Exhaust air from the engine is accelerated by the nozzle of the turbine chamber and is blown onto the turbine (blade) to drive the turbine shaft.

This mechanism is called the turbine, and is provided with a seal ring(s) and heat shield to prevent the gas from adversely affecting the bearings.

(2) Blower

The turbine shaft drives the blower blade mounted on the shaft. This sucks in and compresses the air and feeds it to the supply pipe.

This mechanism is called the blower.

(3) Bearings

1) Thrust bushings

The thrust bushings prevent the turbine shaft from rotating due to the constant centrifugal force.

2) Radial bushings

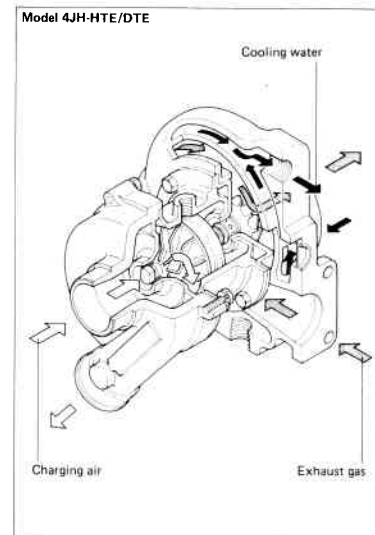
Floating type radial bushings are used. When compared with the normal fixed type, this kind of bushing provides for an inner/outer double oil film, and as the bushings rotate with the shaft, the bushing surface sliding speed is less than the turbine shaft rotating speed. This in turn facilitates increased dynamic stability.

(4) Blower side seal mechanism

A double-walled sealing plate is provided at the back of the blower blade to prevent air or oil leakage.

(5) Water-cooled type

Turbocharger with fresh water cooling piping in the turbine housing. Used for models 4JH-HTE and 4JH-DTE.

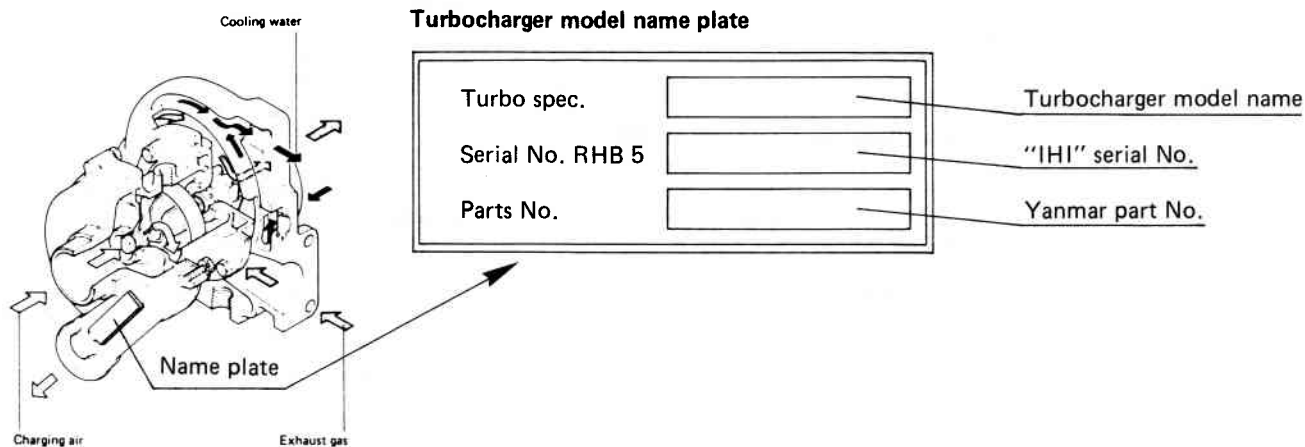




#### 4-4 Interchangeability of turbochargers

The IHI-make turbocharger used for the 4JH serieses differ according to the engine model. Care should therefore be taken to assemble only components for the turbocharger used in

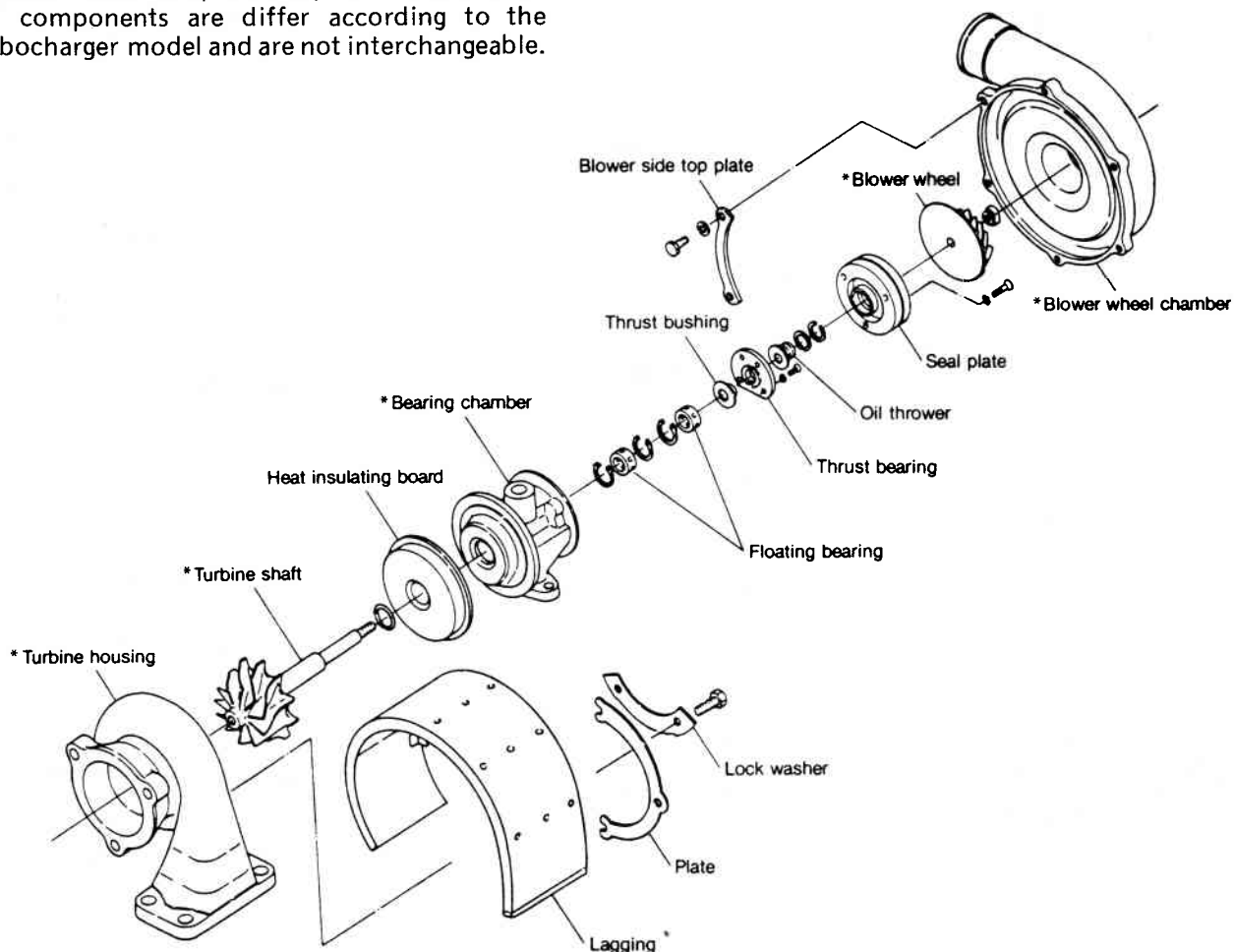
your engine when replacing parts. The use of incorrect turbocharger components will detract from the performance of the engine. Turbocharger models can be distinguished by their name plates.



Engine model	Turbocharger model (spec.)	Yanmar parts No.	Note.
4JH - TE	MY20	129492 - 18000	Design changed from MY29
	MY29	129497 - 18000	Yanmar production start Nov., 21. 1984
4JH - HTE	MY31	129474 - 18000	
4JH - HTE	MY34	129473 - 18000	

4-5 Interchangeability of turbocharger components

The inspection procedures and adjustment standard are identical for all turbocharger models. Please note, however, that the asterisked (\*) components are differ according to the turbocharger model and are not interchangeable.

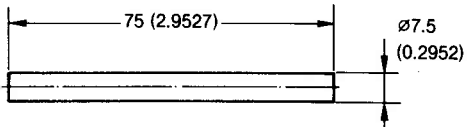
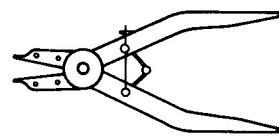
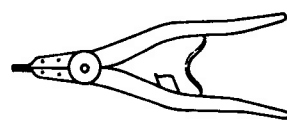
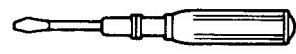
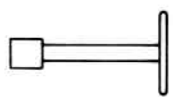
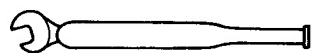
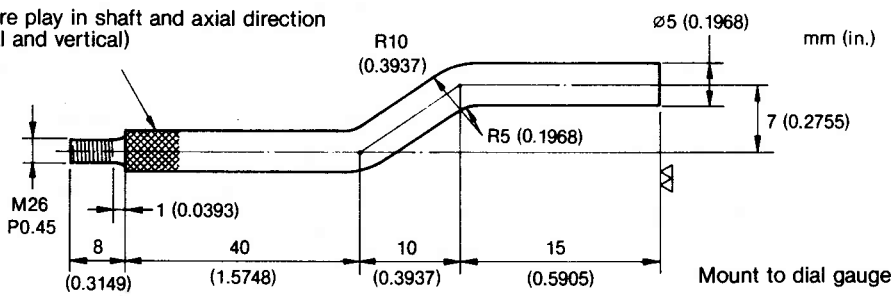


Part name	Part No.	Turbocharger model	Engine model
Turbine houaing	X-N138892	MY20	4JH-TE
	X-N138872	MY29	
	X-N139452	MY31	4JH-HTE
	X-N139402	MY34	4JH-DTE
Bearing chamber	X-N133422	MY20	4JH-TE
	X-N133432	MY29, MY31	4JH-TE, 4JH-HTE
	X-N133442	MY34	4JH-DTE
Turbine shaft	X-N131502	MY20, MY29, MY34	4JH-TE, 4JH-DTE
	X-N131572	MY31	4JH-HTE
Blower sheel	X-N136504	MY20, MY29, MY31	4JH-TE, 4JH-HTE
	X-N136606	MY34	4JH-DTE
Blower wheel chamber	X-N134072	MY20, MY29, MY31,	4JH-TE, 4JH-HTE
	X-N134092	MY34	4JH-DTE

4-6 Disassembly, assembly

4-6.1 Preparations for disassembly

The following special tools are required for disassembly of the turbocharger, in addition to the standard tools.

Name of tool	Use	Illustration
Bar	To remove thrust metal and thrust bushings	 <p>mm (in.) 75 (2.9527) ø7.5 (0.2952)</p> <p>Material: Copper or brass</p>
Pliers	To remove floating bushing stop ring	
Pliers	To remove seal ring	
Torque driver (Phillips) 5 ~ 50kg/cm <sup>2</sup> (71.11 ~ 711.16 lb/in. <sup>2</sup> )	To mount thrust metal and seal plate (+)	 <p>Standard Model</p>
Box wrench	To tighten turbine shaft 10mm (0.3937 in.) × 12 square	 <p>Box only may be used</p>
Torque wrench	For following bolts M6: 10mm (0.3937 in.) 110kg/cm <sup>2</sup> (1564.56 lb/in. <sup>2</sup> ) M5: 8mm (0.3149 in.) 45 kg/cm <sup>2</sup> (64.005 lb/in. <sup>2</sup> ) M5: 8mm (0.3149 in.) 20 kg/cm <sup>2</sup> (284.46 lb/in. <sup>2</sup> )	
Gauge wire	To measure play in shaft and axial direction (horizontal and vertical)	 <p>mm (in.) ø5 (0.1968) 7 (0.2755) R10 (0.3937) R5 (0.1968) 15 (0.5905) 10 (0.3937) 40 (1.5748) 8 (0.3149) M26 P0.45 1 (0.0393) Mount to dial gauge</p>

## 4-6.2 Inspection prior to disassembly

- (1) Make sure that the turbine and blower blades are not in contact and that the rotor rotates smoothly.
- (2) Measuring rotor play.

	mm (in.)	
	Standard	Wear limit
Rotor play in direction of shaft	0.03 ~ 0.06 (0.0011 ~ 0.0023)	0.09 (0.0035)
Rotor play in axial direction	0.08 ~ 0.13 (0.0031 ~ 0.0051)	0.17 (0.0066)

## 4-6.3 Disassembly

Make match marks before disassembling the turbocharger to show how the super charger is mounted on the engine. This determines the angle at which the turbine chamber, bearing chamber and blower chamber are mounted.

- (1) Removing blower chamber
  - 1) Remove the M5 mounting bolts, spring washers and blower side retaining plate.
  - 2) Remove the blower chamber.

**NOTE:** 1. The blower chamber and bearing chamber mounting surfaces are coated with a liquid gasket.

2. Be careful not to scratch the blower blade when disassembling the blower chamber.

- (2) Removing blower blade
  - 1) Fit a box wrench (10mm (0.3937in.)) to the end of the turbine side of the turbine shaft and remove the shaft end nut.

**NOTE:** The box end nut has left handed threads.

- 2) Remove the blower blade.
- (3) Removing turbine chamber, lagging.
  - 1) Remove the turbine chamber mounting bolts and the turbine side retaining plate for lagging.
  - 2) Remove the lagging and turbine chamber.

- (4) Pulling the turbine shaft
  - 1) Lightly hold the heat shield by the hand and pull out the turbine shaft.

**NOTE:** If the turbine shaft is hard to pull out, lightly tap the blower side end of the shaft with a wood mallet.

- 2) Remove the heat shield.

**NOTE:** If the heat shield is hard to remove, tap it lightly with a caulking chisel.

- (5) Removing the seal plate
  - 1) Loosen the M3 flat seal plate mounting screws with a plus screwdriver and remove them along with double grip (tooth) washers.
  - 2) Remove the seal plate.

**NOTE:** The seal plate and bearing chamber mounting surfaces are coated with a liquid gasket.

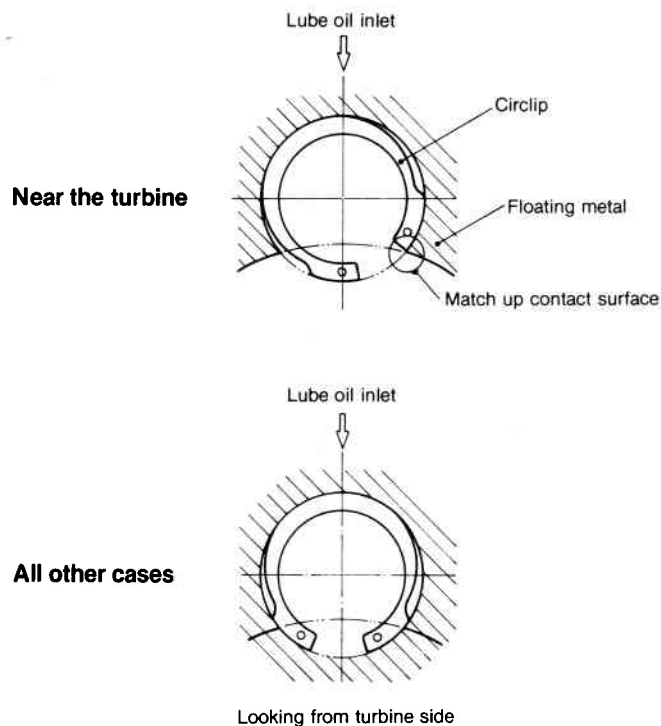
- 3) Remove the oil ring seal from the seal plate.
- (6) Removing the thrust metal and thrust bushing.
  - 1) Loosen the M3 flat seal plate mounting screws with a plus screwdriver and remove them along with the double grip washers.
  - 2) Use a copper rod to remove the thrust metal and thrust bushing.

- (7) Removing the floating metal (bushing)
  - 1) Remove the round R stop ring from the bearing chamber with stop ring pliers.
  - 2) Remove the floating metal from the bearing chamber.
- (8) Removing seal ring
  - 1) Remove the turbine side seal ring from the turbine shaft.
  - 2) Remove the large and small blower side seal rings from the oil seal.

## 4-6.4 Preparations for reassembly

- (1) When the turbocharger is reassembled, special tools, liquid gasket (Three Bond No.1207S or Three Bond No.1215) and burning preventative agent are needed in addition to the standard tools.
- (2) Always replace the following with new parts when reassembling the turbocharger:

Turbine side seal rings  
Blower side seal rings (large)  
Blower side seal rings (small)  
M3 flat screws  
Bent washers  
Double grip washers



4-6.5 Reassembly

- (1) Reassembly of floating metal
  - 1) Mount the inside round R stop ring in the bearing chamber with stop ring pliers.
  - 2) Fit the floating metal in the bearing chamber.
  - 3) Mount the outside round R stop ring in the bearing chamber.

**NOTE:** 1. The round R stop ring opening should be mounted as shown in the illustration. The round part of the stop ring should be mounted on the metal.

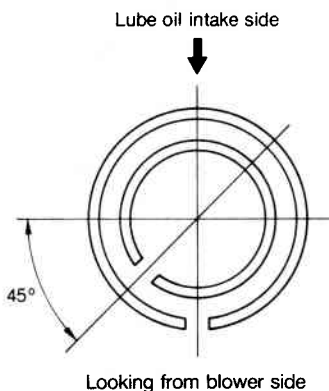
2. When mounting, coat the floating metal with engine oil.

- (2) Reassembly of the turbine shaft
  - 1) Insert the seal ring in the turbine shaft.
  - 2) Mount the heat shield on the turbine side bearing chamber.
  - 3) Coat the journal of the turbine shaft with engine oil and insert from the turbine side of the bearing chamber.

**NOTE:** Take adequate care not to scratch the floating metal with the turbine shaft.

The seal ring opening should face the oil intake and be inserted aligned with the turbine shaft center.

- (3) Reassembly of the thrust metal
  - 1) Insert the thrust bushing in the turbine shaft.
  - 2) Coat the thrust metal with engine oil and mount it in the bearing chamber.
  - 3) Put the double grip washers on the thrust metal mounting M3 flat screws and tighten with the torque driver.

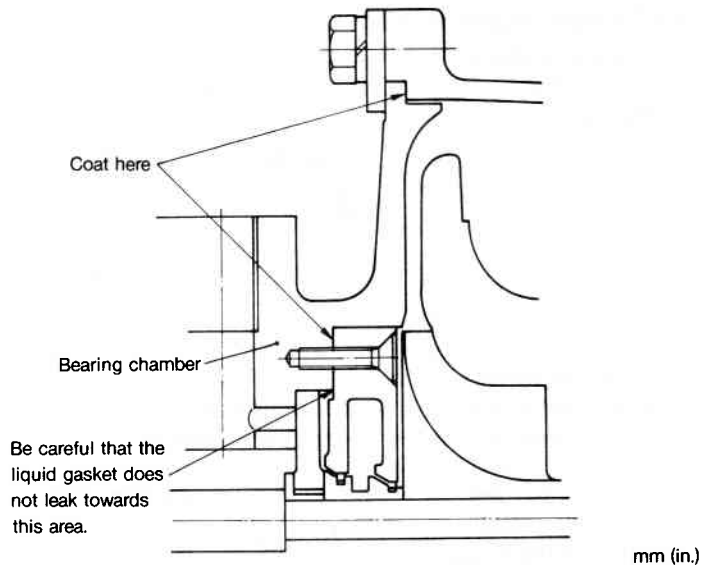


kg-cm (ft-lb)	
Tightening torque	12 ~ 14 (0.86 ~ 1.01)

- (4) Mounting seal plate
  - 1) Insert the seal ring in the oil drain.
  - 2) Insert the seal plate in the oil drain.

**NOTE:** The seal ring opening should face the direction indicated in the upper right illustration.

- 3) Coat the blower side seal plate mounting surface of the bearing chamber (20) with the liquid gasket (Three Bond No.1207S or Three Bond No.1215).



mm (in.)	
Coating thickness	0.1 ~ 0.2 (0.0039 ~ 0.0078)

**NOTE:** See the illustration for where to coat it.

- 4) Mount the sealing plate on the bearing chamber.
- 5) Put the double grip washers on the sealing plate mounting M3 flat screws and tighten with the torque driver.

kg-cm (ft-lb)	
Tightening torque	12 ~ 14 (0.86 ~ 1.01)

- (5) Mounting blower blade
  - 1) Put the blower blade on the turbine shaft.
  - 2) Tighten the turbine side shaft end nut of the turbine shaft with a box wrench (10mm (0.3937in.)).

**NOTE:** The shaft end nut has a left handed thread.

kg-cm (ft-lb)	
Tightening torque	18 ~ 22 (1.30 ~ 1.59)

- (6) Mounting turbine chamber
  - 1) Mount the turbine chamber, aligned with the match marks made before disassembly.

**NOTE:** When replacing parts, mount after checking the oil intake/discharge and exhaust gas intake positions.

- 2) Lugging
 

Put on the turbine side retainer plate for lugging and the bent washer, and tighten with the M6 hex bolt. Make sure to bend the washer after tightening the M6 hex bolt.

kg-cm (ft-lb)	
Tightening torque	105 ~ 115 (7.59 ~ 8.31)

- (7) Mounting blower chamber
  - 1) Coat the blower side flange surface of the seal plate with the liquid gasket (Three Bond No.1207S or Three Bond No.1215).

**NOTE:** Refer to page (21) for where to coat.

mm (in.)	
Coating thickness	0.1 ~ 0.2 (0.0039 ~ 0.0078)

- 2) Align the match marks made before disassembly and mount the seal plate in the blower chamber.

NOTE: When replacing parts, mount only after checking oil intake/discharge and air discharge positions.

- 3) Replace on the blower side retaining plate and spring washer and tighten with the M5 hex bolt.

	kg-cm (ft-lb)
Tightening torque	40 ~ 50 (2.89 ~ 3.61)

(8) Measuring rotor play

See item 3-2 on inspection procedure—the measuring procedure is the same.

Rotor play above the standard is usually due to improper assembly or use of the wrong part—reassemble.

	mm (in.)
	Standard
Rotor play in direction of shaft	0.03 ~ 0.06 (0.0011 ~ 0.0023)
Rotor play in axial direction	0.08 ~ 0.13 (0.0031 ~ 0.0051)

#### 4-6.6 Disassembly/reassembly precautions

Observe the following during and after mounting the turbocharger on the engine.

Be especially careful to prevent the entrance of foreign matter into the turbocharger.

- (1) Precautions on mounting the turbocharger.

#### Lube oil system

- 1) Run new engine oil through the oil intake holes before mounting on the engine, turn the turbine shaft by hand and lubricate the journal metal (bushings) and thrust metal.
- 2) Wash the engine oil intake pipe and oil discharge pipe, check for damage and make sure it is not clogged up with dirt or other foreign matter.
- 3) Make sure that there is no oil leakage from the oil pipes and joints after assembly.

#### Intake system

- 1) Make sure that there is no dirt or other foreign matter in the air intake system.
- 2) Make sure that there is no air leakage from the air supply duct/air cleaner connections.

#### Exhaust system

- 1) Make sure that there is no dirt or other foreign matter in the exhaust gas system.
- 2) Make sure not to mix up the special heat resistant bolts and nuts with the regular bolts when mounting the parts. Coat the bolts, nuts, etc. with burning preventive agent.  
(Heat resistant hex bolts are used for the turbine chamber.)
- 3) Make sure that there is no gas leakage from exhaust piping/connections.

## 4-7 Inspection and maintenance

### 4-7.1 Washing

- (1) Inspection prior to washing

Make a visual inspection of disassembled parts before washing to check for burning, wear, foreign matter and carbon build-up. Make an especially thorough inspection in case of breakdowns as a step towards determining the cause of the breakdown.

#### Major items

Inspection	Location
Carbon build-up	<ol style="list-style-type: none"> <li>1) Turbine shaft turbine side seal ring and back of blade.</li> <li>2) Around the heat shield mounting of the bearing chamber and the inside wall of the bearing chamber.</li> </ol>
Lubrication (wear, burning, discoloration)	<ol style="list-style-type: none"> <li>1) Turbine shaft journal, thrust bushing, oil drain.</li> <li>2) Floating metal and thrust metal.</li> <li>3) Around the inner bearing race of the bearing chamber.</li> </ol>
Oil leakage	<ol style="list-style-type: none"> <li>1) Inside wall of the turbine chamber.</li> <li>2) Outer circumference of the bearing chamber and around the heat shield mounting.</li> <li>3) Turbine side seal ring of the turbine shaft and the back of the blade.</li> <li>4) Inside wall of the blower chamber.</li> <li>5) Back of the blower blade.</li> <li>6) Back of the seal plate and portion where the seal ring is inserted.</li> </ol>

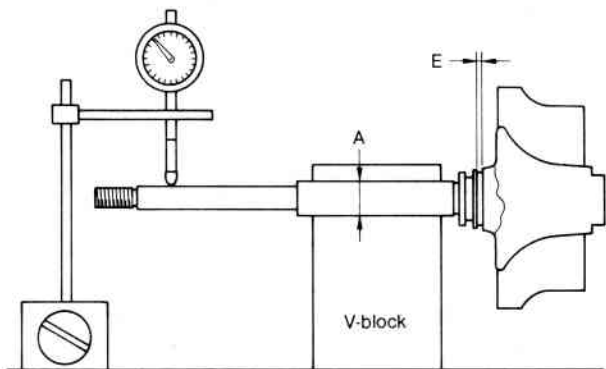
## (2) Washing procedure

Keep the following in mind when washing the parts.

Item	Tools/Cleaning Agent	Procedure
(1) Turbine shaft	1. Tools (1) Bucket (500 × 500) (2) Heat source steam or gas burner (3) Brush  2. Cleaning agent Standard carbon removing agent	(1) Boil the turbine shaft in the washing bucket. Do not hit the blade to remove the carbon.  (2) Soak in the cleaning agent until the carbon and other materials adhering to the surface become soft.  (3) Use a plastic scrubber or hard hair brush to remove the softened foreign matter.  (4) Be very careful not to scratch the turbine shaft bearing surface or the seal ring grooves.  (5) Any foreign matter will unbalance the turbine shaft, so be sure to clean it well. Do not use a wire brush.
(2) Turbine chamber	1. Tools same as for turbine shaft  2. Cleaning agent same as for turbine shaft	(1) Boil the turbine chamber in the washing bucket.  (2) Soak in the cleaning agent until all the material adhering to the surface becomes soft.  (3) Use a plastic scrubber or hard hair brush to remove the foreign matter.
(3) Blower blade, blower chamber	1. Tools (1) Bucket (500 × 500) (2) Brush  2. Cleaning agent	(1) Soak in the cleaning agent until the foreign matter adhering to the surface becomes soft.  (2) Use a plastic scrubber or hard hair brush to remove the softened foreign matter. Do not use a wire brush.
(4) Other parts	(1) Wash all other parts with diesel oil. (2) Clean all lube oil lines with compressed air. (3) Be careful not to scratch parts or allow them to rust.	

4-7.2 Inspection procedure

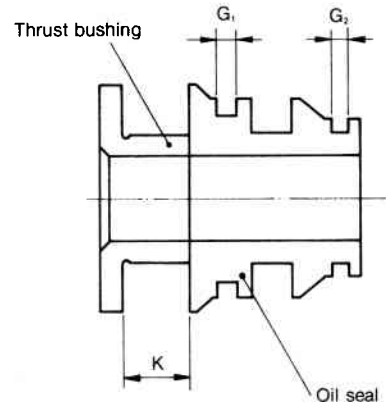
- (1) Blower chamber  
Inspect for scratches caused by contact with the blower blade, scratches in the mounting surface, any galling or cracks.  
Replace if necessary.
- (2) Turbine chamber  
Inspect for scratches caused by contact with the turbine blade, flaking due to oxidation of the skin, and deformation due to heat or cracks.  
Replace if necessary.
- (3) Blower blade  
Inspect for scratches caused by contact, and for breakage, corrosion or deformation.  
Replace if necessary.
- (4) Turbine shaft
  - 1) Inspect the portion around the turbine blade for scratches, breakage, discoloration or deformation, and inspect the shaft for bending, discoloration of journal, abnormal wear, seal ring groove scratches or wear.  
Replace if necessary.
  - 2) Measure the outer diameter of turbine shaft journal (A) and seal ring groove width (E), and replace if beyond the wear limit.



		mm (in.)
		Wear limit
Journal outer dia.	A	7.98 (0.3141)
Seal ring groove width	B	1.29 (0.0507)

- 3) Measure turbine shaft undulation and replace if it exceeds 0.011mm (0.0004in.).
- (5) Head shield  
Inspect for scratches due to contact, deformation due to heat, and corrosion.  
Replace if necessary.

- (6) Thrust bushing, oil seal and thrust metal. Inspect for wear, scratches, discoloration, etc., and replace if necessary, even if they remain within the wear limit.



- 1) Thrust bush  
Measure the thrust bush groove clearance (K), and replace if it exceeds the wear limit.

		mm (in.)
		Wear limit
Thrust bush groove clearance	K	4.07 (0.1602)

- 2) Oil ring  
Measure the seal ring groove width (G<sub>1</sub>), (G<sub>2</sub>) and replace if it exceeds the wear limit.

		mm (in.)
		Wear limit
Seal ring groove width	G <sub>1</sub>	1.31 (0.0515)
	G <sub>2</sub>	1.11 (0.0437)

- 3) Thrust metal  
Measure the thrust metal width (J), and replace if it exceeds the wear limit.

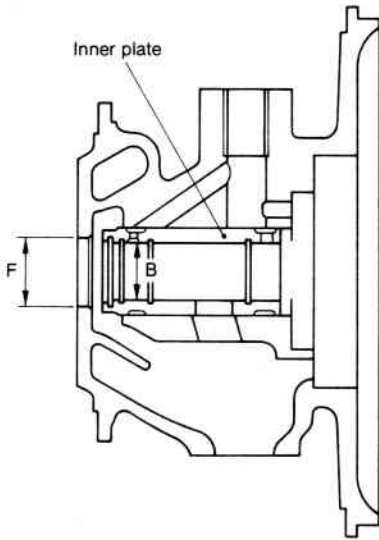
		mm (in.)
		Wear limit
Thrust metal width	J	3.98 (0.1566)

- (7) Floating metal
  - 1) Inspect for abnormal wear, discoloration, scratches, etc., and replace if necessary.
  - 2) Measure the inner diameter (C) and outer diameter (D) of the metal, and replace if either exceeds the wear limit.

		mm (in.)
		Wear limit
Floating metal outer dia.	C	12.31 (0.4846)
Floating metal inner dia.	D	8.04 (0.3165)

- (8) Bearing chamber
  - 1) Inspect for flaking due to oxidation of the skin, galling and scratches, and replace if necessary.
  - 2) Inspect the round R stop ring for breakage or cracks and replace if necessary.
  - 3) Measure the (B) and (F) dimensions of the bearing chamber as shown in the illustration on the right, and replace if either exceeds the wear limit.

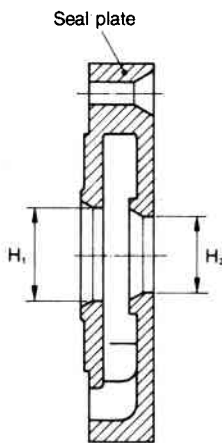




		mm (in.)
		Wear limit
Bearing chamber inner dia.	B	12.42 (0.4889)
Turbine side seal ring area inner dia.	F	15.05 (0.5925)

(9) Seal plate

- 1) Inspect for scratches due to contact, scratches in mounting surface, galling and cracks and replace if necessary.
- 2) Measure the blower side seal ring area ( $H_1$ ,  $H_2$ ) and replace if either exceeds the wear limit.



		mm (in.)
		Wear limit
Blower side seal ring area inner dia.	$H_1$	12.45 (0.4901)
	$H_2$	10.05 (0.3956)

(10) Seal ring

Inspect for wear or deformation and replace if necessary.

- (11) Inspect retaining plates, bolts and spring washers for deformation and replace if necessary. Always replace the M3 flat screw bend washer and grip washer.

4-7.3 Periodic inspection

- (1) Periodically inspect the overall condition of supercharger and the amount of dirt build-up. Inspect at the intervals specified in the following chart.

Item	Interval		
	3 months or 1500 hours	6 months or 3000 hours	12 months or 6000 hours
Rotation of rotor	○		
Rotor play		○	
Disassembly, cleaning and inspection of entire unit			○
Cleaning and inspection of air filter	Every 300 hours		

(2) Inspection Procedure

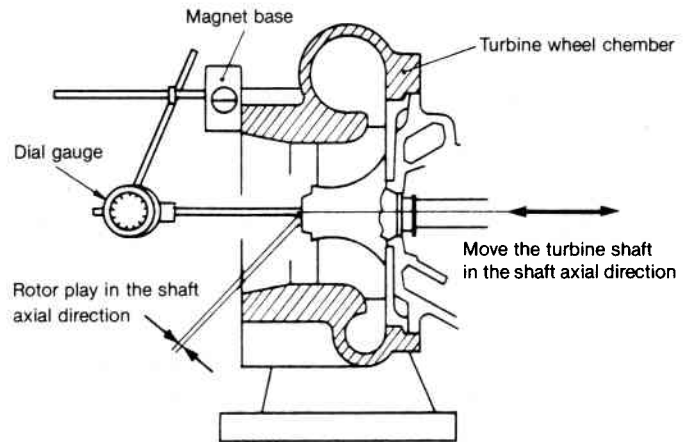
1) Rotation of rotor

The rotation of the rotor is checked by listening for any abnormal noise when it is rotating. Use a listening bar, placing the tip of the bar firmly against the turbocharger and gradually increasing engine rpm. If a loud noise is emitted every 2 or 3 seconds, rotation is abnormal. The turbocharger should be replaced or repaired as something may be wrong with the metal or rotor.

2) Rotor play

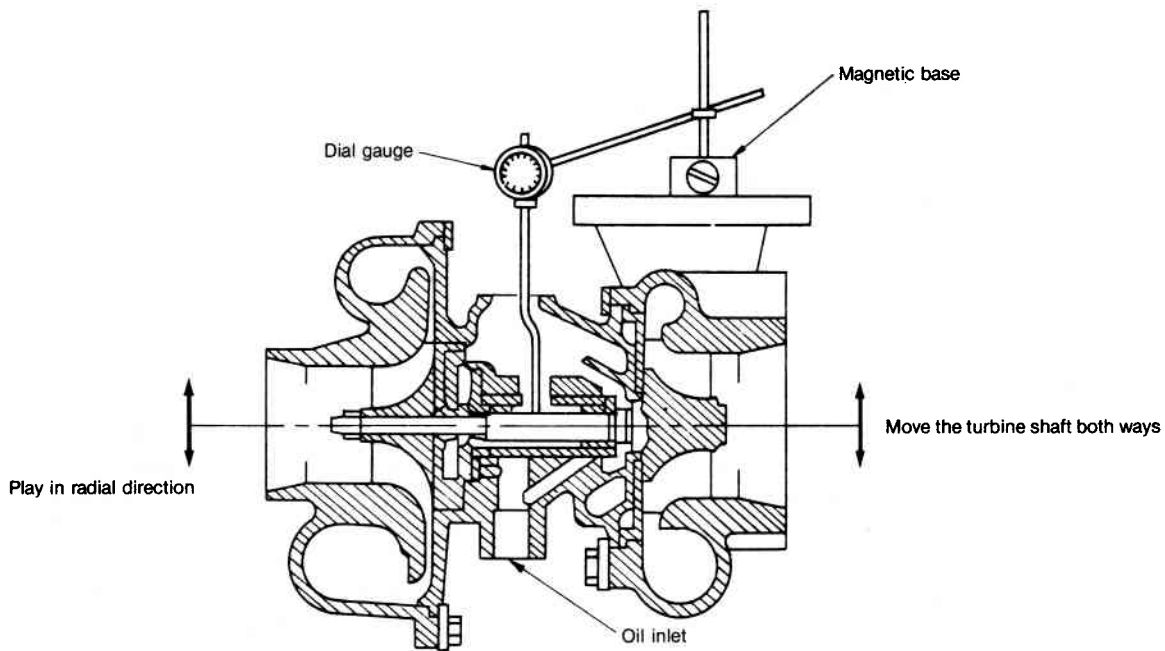
Remove the turbocharger from the engine and check the play in the shaft axial and radial directions as shown below.

3) Rotor play in the shaft axial direction.

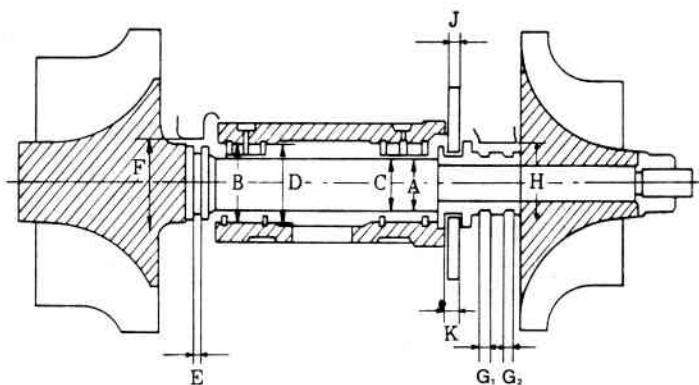


		mm (in.)
		Standard
		Wear limit
Rotor play in shaft axial direction		0.03 ~ 0.06 (0.0018 ~ 0.0023)
		0.09 (0.0035)

4) Rotor play in shaft radial direction.



	mm (in.)	
	Standard	Wear limit
Rotor play in the shaft radial direction	0.08 ~ 0.13 (0.0031 ~ 0.0051)	0.17 (0.0066)



mm (in.)

	Items to check	Standard	Wear limit
Turbine shaft	Turbine shaft journal outer dia. (A)	7.99 ~ 8.00 (0.3145 ~ 0.3149)	7.980 (0.3141)
	Turbine side seal ring groove width (E)	1.25 ~ 1.28 (0.0492 ~ 0.0503)	1.210 (0.0476)
	Blower side seal ring groove width (G <sub>1</sub> )	1.22 ~ 1.23 (0.0480 ~ 0.0484)	1.310 (0.0515)
	Blower side seal ring groove width (G <sub>2</sub> )	1.02 ~ 1.03 (0.0401 ~ 0.0405)	1.110 (0.0437)
	Turbine shaft play	0.01 (0.0003)	0.011 (0.0004)
Bearing	Floating bearing inner dia. (C)	8.01 ~ 8.03 (0.3153 ~ 0.3161)	8.040 (0.3165)
	Floating bearing inner dia. (D)	12.32 ~ 12.33 (0.4850 ~ 0.4854)	12.310 (0.4846)
	Bearing set ring inner dia. (B)	12.40 ~ 12.41 (0.4881 ~ 0.4885)	12.420 (0.4889)
Thrust bearing	Thrust bearing width (J)	3.99 ~ 4.01 (0.1570 ~ 0.1578)	3.980 (0.1566)
	Thrust bushing groove dimension (K)	4.04 ~ 4.05 (0.1590 ~ 0.1594)	4.070 (0.1602)
Seal ring fixing area	Turbine side (bearing wheel chamber) (F)	15.00 ~ 15.02 (0.5905 ~ 0.5913)	15.050 (0.5925)
	Blower side (seal plate) (H <sub>1</sub> )	12.40 ~ 12.42 (0.4881 ~ 0.4889)	12.450 (0.4901)
	Blower side (seal plate) (H <sub>2</sub> )	10.00 ~ 10.02 (0.3937 ~ 0.3944)	10.050 (0.3956)
Play of rotor in shaft axial direction		0.03 ~ 0.06 (0.0011 ~ 0.0023)	0.090 (0.0035)
Play of rotor in radial direction		0.08 ~ 0.13 (0.0031 ~ 0.0051)	0.170 (0.0066)

Tightening torque

	Screw dia. mm	Tightening torque kg-cm (ft-lb)
Turbine chamber set bolt	M6	105 ~ 115 (7.59 ~ 8.31)
Blower chamber set bolt	M5	40 ~ 45 (2.89 ~ 3.25)
Thrust metal set screw	M3	12 ~ 14 (0.86 ~ 1.01)
Seal plate set screw	M3	12 ~ 14 (0.86 ~ 1.01)
Blower blade nut	left hand screw M5	18 ~ 22 (1.30 ~ 1.59)

**4-8 Troubleshooting**

The engine will not produce the required output if the turbocharger breaks down. If the engine output drops, first check the engine to see if anything is wrong, and then check the turbocharger according to the following procedure if there is nothing wrong with the engine.

**4-8.1 Excessive smoke**

**(1) Insufficient air intake**

Cause	Remedy
1) Air cleaner is clogged up. 2) Air intake is closed. 3) Leakage from air intake system connections.	<ul style="list-style-type: none"> <li>• Replace or wash the element.</li> <li>• Open to proper position.</li> <li>• Inspect and repair</li> </ul>

**(2) Turbocharger does not rotate**

Cause	Remedy
1) Build-up of foreign matter in oil on seals inhibiting turbine shaft rotation. 2) Burned metal • Insufficient oil or clogging up of supply pipe. • Oil temperature too high. Rotating parts are out of balance. • Insufficient warming up or sharp stopping. 3) Turbine or blower blade knocking something or broken. • Excessive rpm • Excessive exhaust gas temperature rise. • Entrance of foreign matter. • Worn metal (bushings) • Improper reassembly	<ul style="list-style-type: none"> <li>• Disassemble and clean turbocharger and change engine oil.</li> <li>• Disassemble turbocharger and repair.</li> <li>• Inspect engine oil supply system, repair any parts as necessary and change the engine oil.</li> <li>• Wash or replace rotating parts.</li> <li>• Read operation manual and operate engine accordingly.</li> <li>• Inspect engine parts and adjust.</li> <li>• Disassemble and thoroughly remove any foreign matter, inspect the air cleaner, and engine parts, and repair as necessary.</li> <li>• Disassemble turbocharger and repair.</li> <li>• Reassemble</li> </ul>

**(3) Excessive exhaust gas drag (resistance)**

Cause	Remedy
1) Insufficient turbocharger rpm due to leakage of exhaust gas before entry into turbocharger. 2) Insufficient turbocharger rpm due to deformation of exhaust system piping.	<ul style="list-style-type: none"> <li>• Inspect fittings and repair.</li> <li>• Repair</li> </ul>

**4-8.2 White exhaust smoke**

Cause	Remedy
1) Oil leaking on blower side or turbine side due to clogging or deformation of return piping. 2) Seal ring excessively worn or broken due to excessive metal wear.	<ul style="list-style-type: none"> <li>• Repair or replace pipe.</li> <li>• Disassemble turbocharger and repair.</li> </ul>

**4-8.3 Excessive oil consumption**

Cause	Remedy
1) Seal ring excessively worn or broken due to excessive metal wear.	<ul style="list-style-type: none"> <li>• Disassemble turbocharger and repair.</li> </ul>

**4-8.4 Decrease in (engine) output**

Cause	Remedy
1) Gas leakage from exhaust gas system. 2) Air leakage from blower side discharge. 3) Air cleaner element clogged up. 4) Turbocharger dirty or damaged.	<ul style="list-style-type: none"> <li>• Inspect parts and repair.</li> <li>• Clean or replace element.</li> <li>• Disassemble turbocharger and repair, or replace.</li> </ul>

4-8.5 Poor (slow) turbocharger responsiveness (starting)

Cause	Remedy
1) Carbon build-up on turbine side (blade seal) inhibiting turbine shaft rotation.	• Disassemble and wash turbocharger and replace engine oil.
2) Incomplete combustion.	• Inspect engine fuel system and improve combustion efficiency.

4-8.6 Abnormal noise or vibration

(1) Abnormal noise

Cause	Remedy
1) Blower discharge air flows back (surges) when the gas line area is considerably reduced due to closing of the turbine chamber nozzle or during acceleration.	• Disassemble and clean turbocharger.
2) Rotating parts knocking something.	• Disassemble turbocharger and repair or replace.

(2) Vibration

Cause	Remedy
1) Fittings connecting turbocharger and exhaust gas piping/oil pipe have become loose.	• Inspect fittings and retighten/repair as necessary.
2) Rotating parts making contact with surrounding parts because of metal failure, or turbine blade or blower blade damaged due to entrance of foreign matter.	• Disassemble turbocharger and repair or replace. Thoroughly remove any foreign matter.
3) Rotating parts out of balance.	• Repair or replace rotating parts.

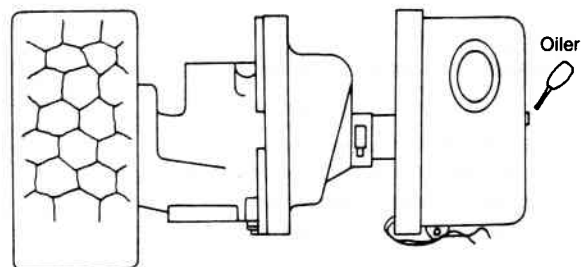
4-9 Turbocharger blower washing procedure

4-9.1 General

- Use "Blower Wash" and clean water to wash the blower.
- Make it a general practice to wash the turbocharger blower when the air supply pressure has decreased by about 10 percent. The frequency of this will differ greatly depending on working conditions, but about once a week is generally sufficient.
- This procedure cannot be used for cleaning the entire turbocharger. It must be periodically disassembled and cleaned.
- Only remove the inlet cap when washing the blower—it must not be removed under any other circumstances.

4-9.2 Procedure

- Run the engine at normal load (3/4 ~ 4/4 load) and apply Blower Wash for 4 ~ 5 seconds with a 20cc standard oiler.
- 3 ~ 5 minutes after application of the Blower Wash the dirt will be loosened up. Slowly put in 20cc of water (over about 4 ~ 10 seconds).
- Use a vinyl container to feed in the cleaning agent or water. If too much cleaning agent or water enters suddenly there might be a breakdown or breakage of the blower blade. Be sure to feed in the cleaning agent or water at the correct speed.
- If there is no change in the air supply pressure or exhaust gas temperature after washing, repeat the washing after about 10 minutes.  
No change after washing the blower 3 ~ 4 times indicates that either the blower is extremely dirty or something else is out of order. Disassemble and clean the washer, and take any other action as necessary.
- Run the engine under load to dry for at least 15 minutes after feeding in the agent or water.



Clean the blower: Every 150 hours

# 5. Mixing Elbow

## 5-1 Construction

There are two types of mixing elbows for the 4JHE engine: the L and U types. Both types are bolted to the exhaust manifold.

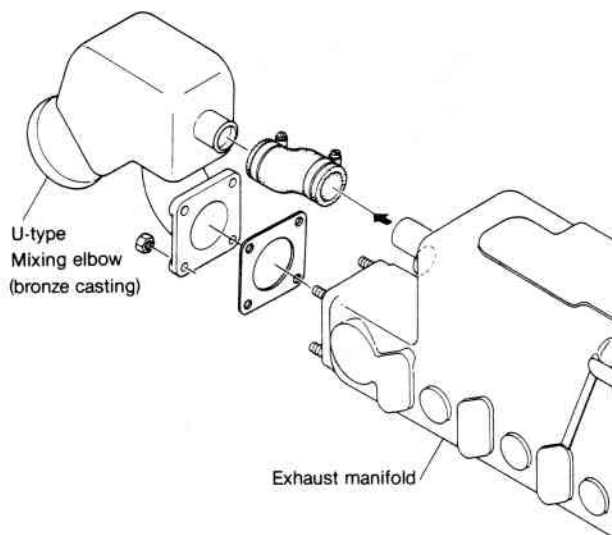
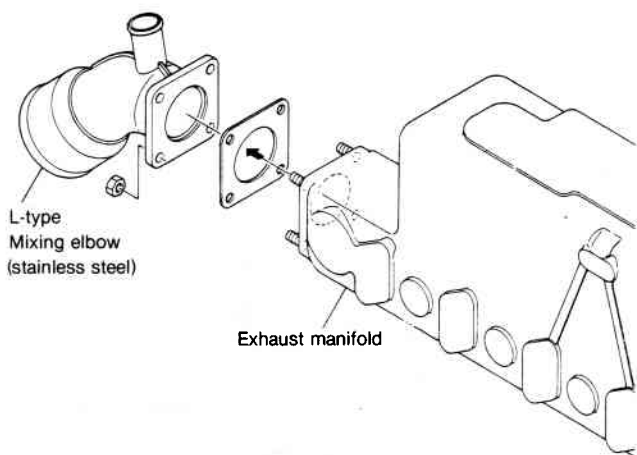
There are also L and U types for the 4JH-TE, 4JH-HTE and 4JH-DTE engines.

Both are mounted on the turbocharger discharge.

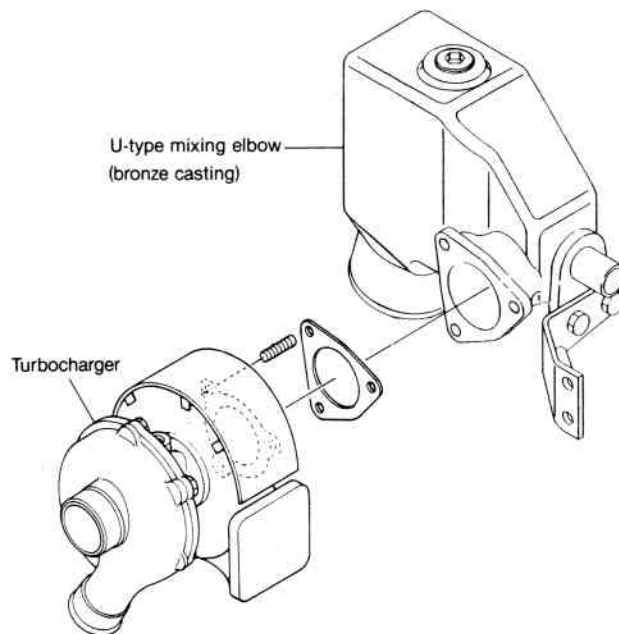
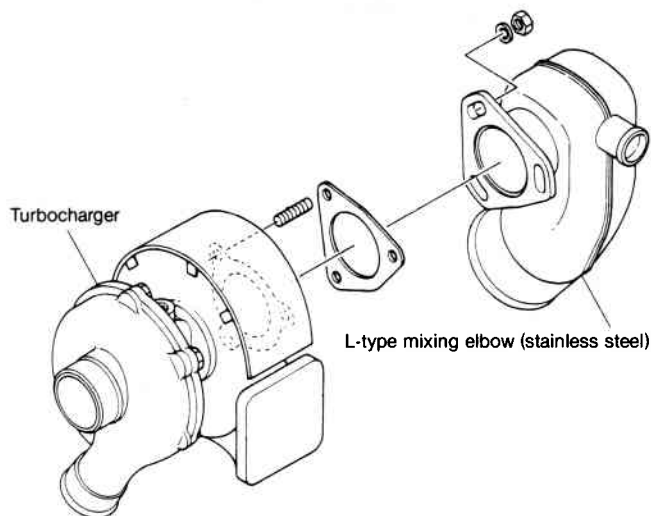
## 5-2 Mixing elbow inspection

- (1) Clean dirt and scale out of the air and cooling water lines.
- (2) Repair cracks or damage to welds, or replace.
- (3) Inspect the gasket packing and replace as necessary.

### For model 4JHE



### For models 4JH-TE, 4JH-HTE and 4JH-DTE



# 6. Breather

## 6-1 Construction

The mist in the crank chamber goes past the tappets in the cylinder block to the valve arm chamber, through the breather in the bonnet (head) cover, into the intake silencer through the mist (removal) pipe, and is sucked in together with the intake air.

## 6-2 Breather inspection

- (1) Remove the breather cover and clean the wire element.
- (2) Check to see whether the breather pipe is clogged up, and clean if necessary. Replace the pipe if damaged or cracked.
- (3) Inspect the O-ring(s) and replace as necessary.

