M9961-H11100

YANMAR

SERVICE MANUAL

INDUSTRIAL DIESEL ENGINE

MODEL TF(-M) series

YANMAR DIESEL ENGINE CO.,LTD.

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FOREWORD

This manual describes the service procedures for the TF (-M) series industrial diesel engine.

Please use this manual for accurate, quick and safe servicing of the respective engine. Since the explanation herein assumes the standard type engine, the specifications and components may partially be different from the engine installed on each machinery. Please also refer to the service manual for each machinery for details.

The specifications and components are subject to change for improvement of the engine quality. If any modification of the contents described in this manual becomes necessary, it will be notified in the form of a correction notice each time.

CONTENTS

1. For Safe Operation

1.1 Warning Symbols

- Most accidents are caused by negligence of basic safety rules and precautions.
  For accident prevention, it is important to avoid such causes before development to accidents.
  Please read this manual carefully before starting repair or maintenance to fully understand safety precautions and appropriate inspection and maintenance procedures.
  Attempting a repair of maintenance job without sufficient knowledge may cause an unexpected accident.

- It is impossible to cover every possible danger in repair or maintenance in the manual.
  Sufficient consideration for safety is required in addition to the matters marked Ⓒ CAUTION.
  Especially for safety precautions in a repair or maintenance job not described in this manual, receive instructions from a knowledgeable leader.

- Warning Symbols used in this manual and their meanings are as follows:

⚠ DANGER — ***DANGER - Indicates an imminently hazardous situation which, if not avoided, WILL result in death or serious injury.***

⚠ WARNING — ***WARNING - Indicates a potentially hazardous situation which, if not avoided, COULD result in death or serious injury.***

⚠ CAUTION — ***CAUTION - Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.***

- Any matter marked **[NOTICE]** in this manual is especially important in serving. If not observed, the product performance and quality may not be guaranteed.

1.2 Precautions for Safe Servicing

(1) Service Shop (Place)

⚠ CAUTION

● **Place allowing sufficient ventilation**

Jobs such as engine running, part welding and polishing the paint with sandpaper shoule be done in a well-ventilated place.

[Otherwise]

Very dangerous for human body due to the possibility of poisonous gas or dust inhalation.

⚠ CAUTION

● **Sufficiently wide and flat place**

The floor space of the service shop for inspection and maintenance shall be sufficiently wide and flat without any hole.

[Otherwise]

An accident such as a violent fall may be caused.

⚠ CAUTION

● **Clean, orderly arranged place**

No dust, mud, oil or parts shall be left on the floor surface.

[Otherwise]

An unexpected accident may be caused.

⚠ CAUTION

● **Bright, safety illuminated place**

The working place should be illuminated sufficiently and safely. For a job in a dark position involving difficulty in observation, use a portable safety lamp. The bulb shall be covered with a wire cage.

[Otherwise]

The bulb may be broken accidentally to cause ignition of leaking oil.

⚠ CAUTION

● **Place equipped with a fire extinguisher**

Keep a first aid kit and fire extinguisher close at hand in preparation for an emergency of fire.

(2) Working Wear

⚠ WARNING

● **Wears for safe operation**

Wear a helmet, working clothes, safety shoes and other safety protectors matching each job. Especially, wear wellfitting working clothes.

[Otherwise]

A serious accident such as trapping by a machine may arise.

(3) Tools to Be Used

⚠ WARNING

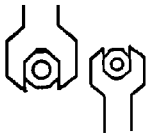
● **Appropriate holding and lifting**

Never operate when the engine is supported with blocks or wooden pieces or only with a jack. To lift and hold the engine, always use a crane with a sufficient allowance in limit load or a rigid jack.

[Otherwise]

A serious accident may arise.

⚠ WARNING



● **Use of appropriate tools**

Use tools matching the jobs to be done. Use a correctly sized tool for loosening or tightening a machine part.

[Otherwise]

A serious injury or engine damage may arise.

(4) Use of Genuine parts, Oil and Grease

⚠ CAUTION

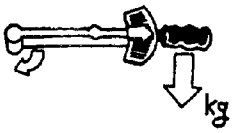
● **Always use genuine product**

[Otherwise]

Shortening of engine life or an unexpected accident may arise.

(5) Bolt and Nut Tightening Torques

⚠ WARNING



Always tighten to the specified torque if designated in the manual

[Otherwise]

Loosening or falling may cause parts damage or an injury.

(6) andling Of Product

⚠ WARNING

● **Pay attention to hot portions**

Do not touch the engine during running or immediately after it is stopped.

[Otherwise]

Scalding may be caused by a high temperature.

⚠ WARNING

● **Pay attention to the rotating part**

Never bring clothes or a tool close to the rotating part during engine running.

[Otherwise]

Injury may be caused by entrapping.

⚠ WARNING

● **Harness short-circuit**

Disconnect the battery negative(-) terminal before starting the service job.

[Otherwise]

Shorting of a harness may occur to start a fire.

⚠ WARNING

● **Battery charging**

Since flammable gas is generated during battery charging, keep any fire source away.

[Otherwise]

Explosion may arise.

⚠ WARNING

● **Battery electrolyte**

Since the electrolyte is diluted sulfuric acid, do not let it be splashed onto clothes or skin.

[Otherwise]

The clothes or skin may be burnt.

⚠ WARNING

● **Supplying the Fuel**

When supplying the fuel, always keep any fire source like a cigarette or match away.

[Otherwise]

A fire or explosion may arise.

(7) Waste Disposal

⚠ CAUTION

Observe the following instructions with regard to waste disposal.
Negligence of each instruction will cause environmental pollution.

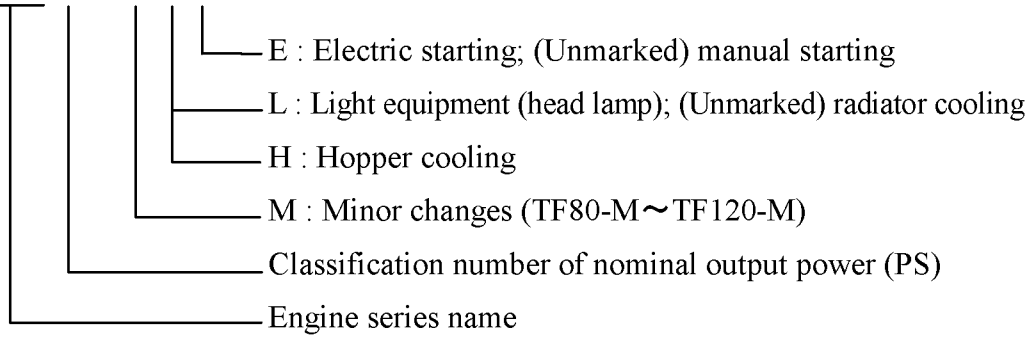
- Waste fluids such as engine oil and cooling water shall be discharged into a container without spillage onto the ground.
- Do not let waste fluids be discharged into the sewerage, a river or the sea.
- Harmful wastes such as oil, fuel, coolants, solvents, filter elements and battery shall be disposed according to the relevant laws and regulations. Ask a qualified disposal company for example.

2. General

2.1 Engine Nomenclature

The use and specifications of the TF series are explained below.

(Example) **T F 8 0 - M L E**

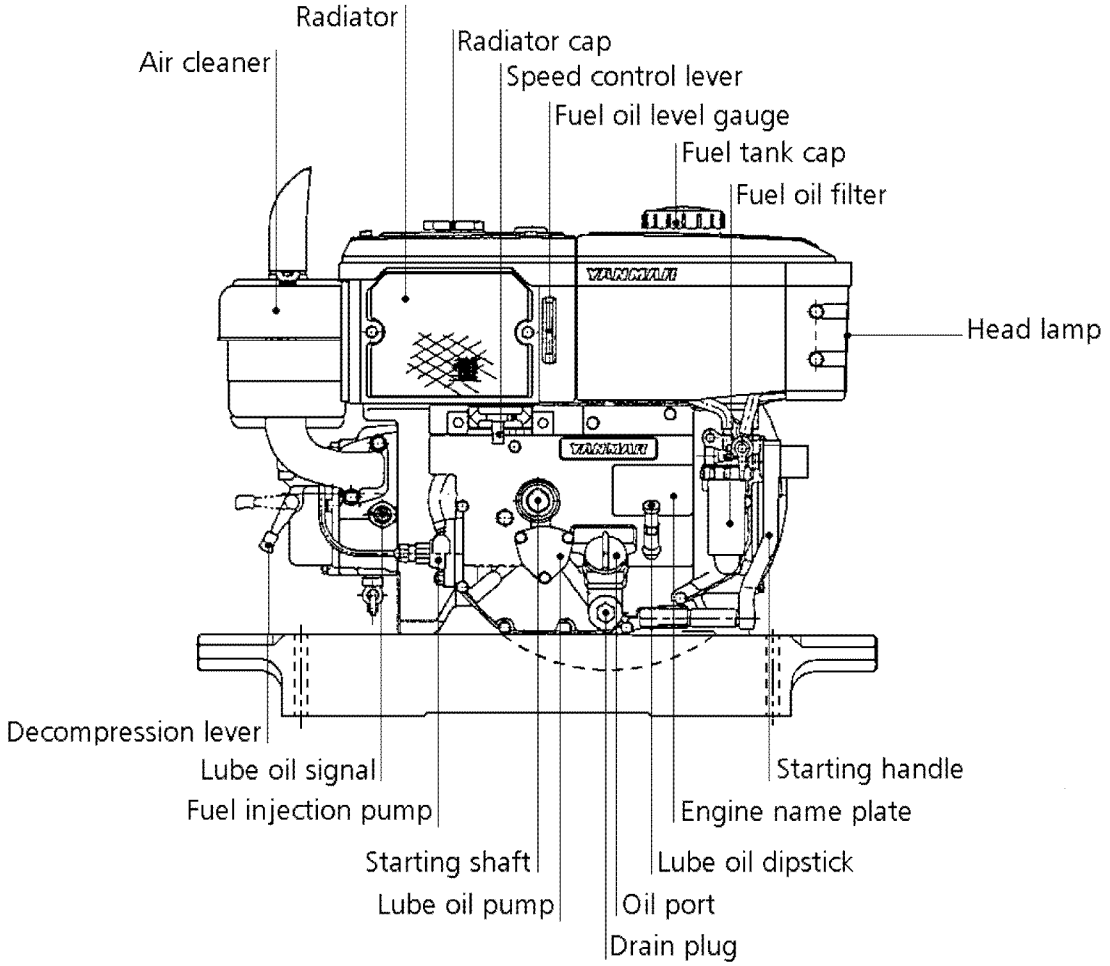


2.2 Specifications

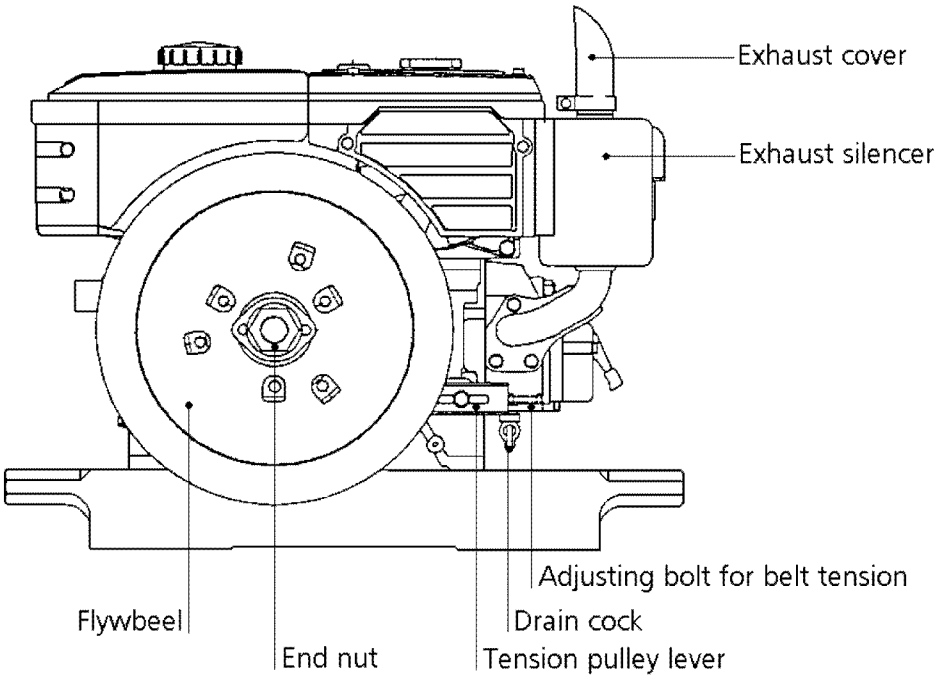
Engine model		TF50 (-H)(-E)	TF60 (-H)(-L)(-E)	TF70 (-H)(-L)(-E)	TF80-M (H)(L)(E)	TF90-M (H)(L)(E)	TF110-M (H)(L)(E)	TF120-M (H)(L)(E)	TF140 (-H)(-E)	TF160 (-H)(-E)
Type		1-cylinder, Horizontal, water-cooled, 4-cycle diesel engine								
combustion system		Direct injection								
Aspiration		Natural aspiration								
Cylinder bore × stroke	mm	74 × 72	75 × 80	78 × 80	80 × 87	85 × 87	88 × 96	92 × 96	96 × 105	102 × 105
Displacement	ⓤ	0.309	0.353	0.382	0.437	0.493	0.583	0.638	0.760	0.857
Continuous rating	rpm	2400	2400	2400	2400	2400	2400	2400	2400	2400
	kw {PS}	3.3 {4.5}	3.7 {5.0}	4.4 {6.0}	5.5 {7.5}	6.3 {8.5}	7.4 {10.0}	7.7 {10.5}	9.2 {12.5}	10.3 {14.0}
1hour rating	rpm	2400	2400	2400	2400	2400	2400	2400	2400	2400
	kw {PS}	3.7 {5.0}	4.4 {6.0}	5.1 {7.0}	6.3 {8.5}	7.0 {9.5}	8.1 {11.0}	8.8 {12.0}	10.3 {14.0}	11.8 {16.0}
Power take-off position		Flywheel side								
Direction of PTO rotation		Counterclockwise viewed from flywheel								
Starting system		Manual starting,Electric starting with manual starting (E)								
Cooling system		Radiator cooling,Hopper (H)								
Lubrication system		Forced lubrication system with trochoidal gear pump								
Electric system	Altemator	12V-6A (For Charging) (E)								
		12V-25W (L)			12V-45W (L)					
	Starting motor	12V-1.2kw (E)								
Fuel tank capacity	ⓤ	5.6	7.1	7.1	10.5	10.5	11.0	11.0	14.3	14.3
Engine oil capacity	ⓤ	1.2	1.8	1.8	2.2	2.2	2.8	2.8	3.0	3.0
Cooling water capacity	ⓤ	1.2 5.0(H)	1.25 8.1(H)	1.25 8.1(H)	1.65 8.9(H)	1.65 8.9(H)	2.3 12.0(H)	2.3 12.0(H)	3.0 13.0(H)	3.0 13.0(H)
Engine dimensions (mm)	Overall Length	557 601(E)	601.5 630.5(L) 630.5(E)	601.5 630.5(L) 630.5(E)	672 688(L) 688(E)	672 688(L) 688(E)	695.5 731(L) 731(E)	695.5 731(L) 731(E)	776 789(E)	776 789(E)
	Overall Width	311	311	311	334.5	334.5	348.5	348.5	379.5	379.5
	Overall Height	463	469	469	496	496	530	530	621	621
Engine dry mass (kg)		47.5 46.0(H) 54.0(E)	67.5 65.0(H) 69.0(L) 74.0(E)	67.5 65.0(H) 69.0(L) 74.0(E)	88.5 87.0(H) 89.5(L) 95.0(E)	88.5 87.0(H) 89.5(L) 95.0(E)	101.5 99.5(H) 102.5(L) 100.5(E)	101.5 99.5(H) 102.5(L) 100.5(E)	140 133.5(H) 148.0(E)	140 133.5(H) 148.0(E)
Battery recommended for electric starting		12V - 45Ah or larger			12V - 70Ah or larger		12V - 100Ah or larger		12V - 120Ah or larger	

2.3 External Views

Operation Side



Non-Operation Side



[NOTE] This illustration shows the model TF-(M)L.

2.4 Fuel Oil

(1) Selection of Fuel Oil

Use the following diesel fuels and select fuels of a higher quality for the best engine per-formance.

[Diesel fuel standard for various countries]

- ISO8217 DMA
- ASTM D975 Grade No.1-D or No.2-D
- JIS K2204 Grade No.2, No.3 or special No.3
- BS 2869 Part-1 class-A1 or A2

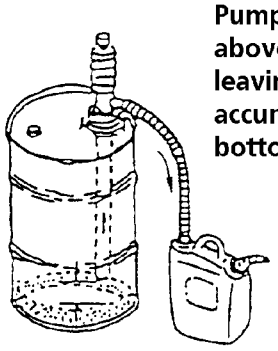
At low temperatures, fuel oil becomes difficult to ignite and will not flow easily, making starting difficult. Select fuel oil of a cetane number of 45 or greater to insure ignitability, and use the out-side temperature as a guide for selecting the proper grade to insure fluidity.

When other than the specified fuel oil is used,the engine will not perform to full capacity and parts may be damaged.

Sample for recommended fuel oil		
Standard for fuel oil	JIS K2204	ASTM D975
Pour point (Temperature)		
-7.5℃ or greater	Grade No.2	Grade No.2-D
-20℃ or greater	Grade No.3	Grade No.1-D
-30℃ or greater	Grade No.3-Sp.	
Cetane fuel number	45 or greater	40 or greater

(2) Handling of Fuel Oil

- Keep the fuel oil in a clean container. Store the container in a place away from rain and dirt as water and dust mixed in with the fuel cause engine failure.
- Keep the fuel container stationary for several hours to allow any dirt or water to settle to the bottom. Use a pump to extract the clear, filtered fuel from the top of the container for use.



Pump up only fuel above the down half, leaving dreg accumulated on the bottom.

2.5 Lube Oil

(1) Selection of Engine Lube Oil

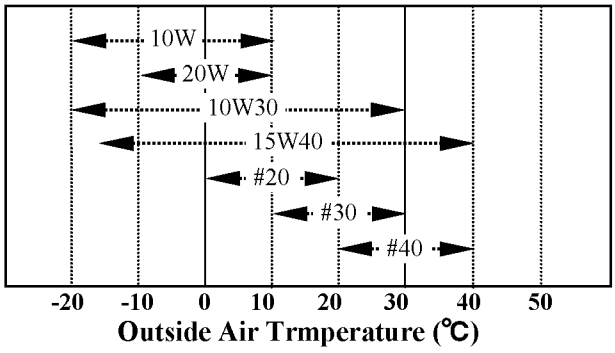
Use the following lube oil:

*API Classification · · · · · · · CC or better
(Standards of America Petroleum Institute)
*SAE Viscosity · · · · · · · · · · 15W40 or 10W30
(Standards of Society of Automotive Engineering)

[NOTICE]

Using other than the specified lube oil will lead to seizure of parts inside the engine and gear device, ab-normal Wear, and shorten engine life. It will also affect the starting ability and power output.

Selection of Viscosity
(Service Grade of SAE-STD.)



(2) Handling the Lube Oil

- When handling and storing lube oil, be careful not to allow dust and water to enter the lube oil. Clean around the filler port before refilling.
- Do not mix lube oils of different types or brands.
  Mixing may reduce the lubricating performance.
  Be careful to use the correct oil for each one and store in separate clearly labeled containers.

2.6 Cooling Water

- Always use soft water (tap water) for the fresh water. Never use dirty water or hard water. Impurities in the cooling water cause scale and rust to build up in the cooling system reducing cooling effciency and causing the engine to overheat.
- During the cold season, add antifreeze to the cooling water to prevent freezing.
  Failure to add antifreeze will result in damage to various parts in the cooling water system.
- Consult your Yanmar dealer or distributor on the use of anitifreeze, anti-rust, and detergents.

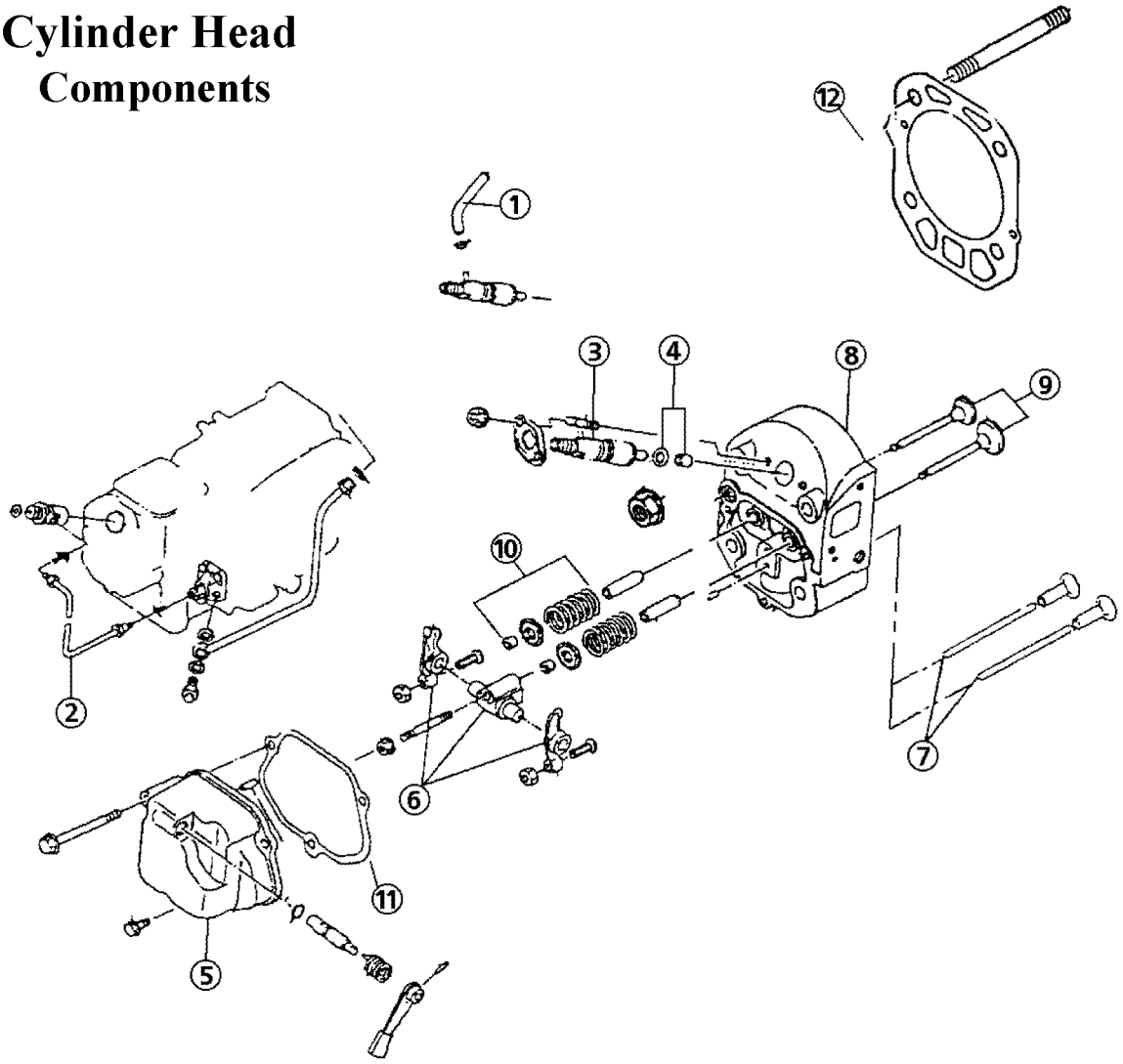
[NOTICE]

- ***Refer to the instructions accompanying the antifreeze for the proper mixing ratio.***
  Select the ratio for the lowest temperature of the cold season. If the mixture is too thick, the cooling efficiency will be reduced.
  Do not mix different brands of antifreeze or anti-rust. Mixing reduces cooling efficiency and leads to parts damage.
- ***When the amount of cooling water is too low, refill with fresh water only.***

3. Engine Overhaul

3.1 Cylinder Head

3.1.1 Components



No.	Part name
①	Fuel return pipe
②	Fuel injection pipe
③	Fuel injection nozzle
◆ ④	Nozzle seat · Nozzle protector
⑤	Bonnet
⑥	Rocker arm (intake, exhaust) · Rocker arm support
⑦	Push rod
⑧	Cylinder head
⑨	Intake valve · Exhaust valve
⑩	Valve spring · Valve spring retainer · Cotter
◆ ⑪	Gasket
◆ ⑫	Head Gasket

◆ Non-reusable part.

3.1.2 Removal of Cylinder Head

3.1.2.1 Drain the engine cooling water, lube oil and make sure the fuel oil cock is closed

3.1.2.2 Remove the air cleaner from the intake pipe. After that, remove the intake pipe

[NOTICE]

Keep the air cleaner not to spill out the oil from the oil bath of air cleaner.

3.1.2.3 Remove the exhaust silencer

3.1.2.4 Remove the fuel return hose from the fuel injection nozzle

Check the fuel return hose for deformation or crack.
If any, replace the new one.

3.1.2.5 Remove the fuel injection pipe

[NOTICE]

Keep away the fuel injection pipe from dust.

3.1.2.6 Remove the fuel injection nozzle

[NOTICE]

Remove the carbon deposits adhering on the fuel injection nozzle hole of the cylinder head.

3.1.2.7 Remove the nozzle seat and nozzle protector in the injection nozzle hole of the cylinder head

3.1.2.8 Remove the bonnet

3.1.2.9 Remove the rocker arms and rocker arm support

3.1.2.10 Remove the push rods

Mark to distinguish the push rod to the exhaust and intake side, tappet side and rocker arm side so that they will be reassembled in the original positions.

3.1.2.11 Remove the cylinder head assy.

(1) Uniformly loosen cylinder head nuts and bolts at two times in the cross direction.

[NOTICE]

If nuts are removed at randum, the head may be warped.

[NOTICE]

Pay attention so as not to damage the contact surfaces of the cylinder head and cylinder block.

3.1.3 Disassembly of Cylinder Head

3.1.3.1 Remove the intake and exhaust valves

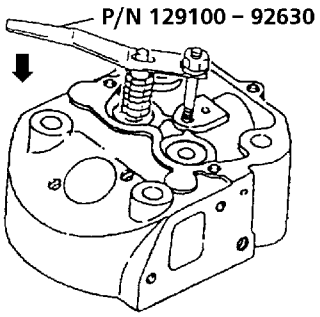
(1) Compress the valve spring using the valve spring compressor and remove the cotters.

(2) Remove the spring retainer, valve spring and valve.

[NOTICE]

Keep the valve spring, spring retainer distinguishing the intake and exhaust side so that they will be reassembled in the original position.

(Removing the cottler)

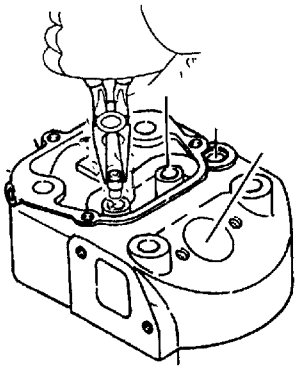


(3) Remove the stem seal using nose pliers.

(TF80-M, TF90-M, TF110-M, TF120-M series only)

(Stem seals are non-reusable)

(Removing the stem seal)



3.1.4 Inspection and Servicing of Cylinder Head Components

3.1.4.1 Clean the piston and cylinder block top surfaces

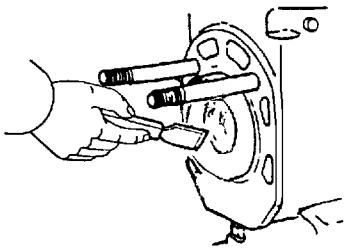
(1) Turn the crankshaft to bring the piston to the top dead center. Remove carbon deposits completely from the piston top surface using a scraper.

(2) Completely remove the gasket materials re-maining on the top surface of cylinder block.

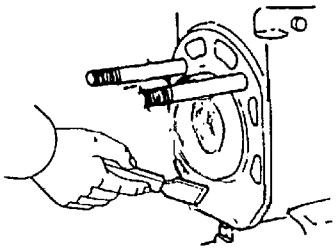
[NOTICE]

Pay attention so as not to damage the cylinder block top surface.

(Cleaning the piston top)



(Cleaning the cylinder block top surface)



3.1.4.2 Clean the cylinder head

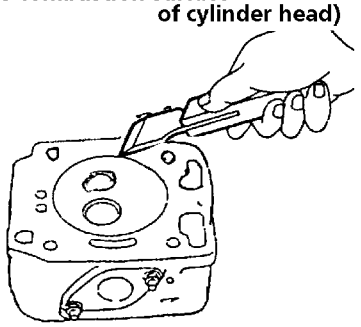
(1) Remove the gasket materials

Completely remove gasket materials rema-ining on the cylinder block contacting surface, using a scraper.

[NOTICE]

Pay attention so as not to damage the cylinder head surface.

(Cleaning the combustion surface of cylinder head)



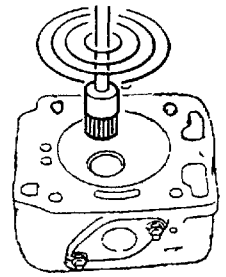
(2) Clean the intake and exhaust valve seats

Completely remove carbon deposits from the intake and exhaust valve seats, using a wire brush.

[NOTICE]

Pay attention so as not to damage the valve contacting surfaces.

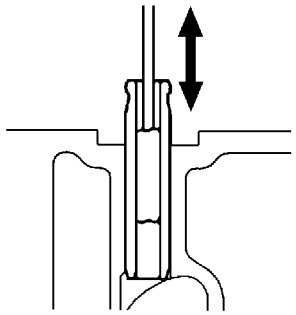
(Cleaning the intake and exhaust valve seats)



(3) Clean the valve guide

Clean the entire valve guide intemal surfaces using a brush and solvent.

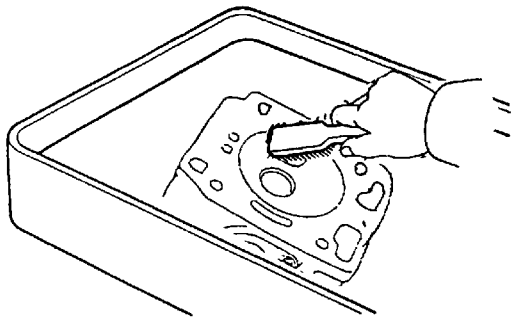
(Cleaning the internal surface of valve guide)



(4) Clean the cylinder head

Thoroughly clean the cylinder block contating surface of cylinder head using a soft brush and solvent.

(Cleaning the cylinder head)



3.1.4.3 Inspect the cylinder head

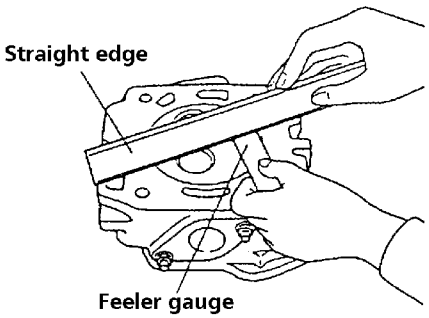
(1) Inspect the flatness

Measure the cylinder block contacting surface using a straight edge and feeler gauge in order to check warpage of the surface.

Limit warpage: 0.10 mm

If the measured warpage exceeds the spe-cified limit, replace the cyinder head.

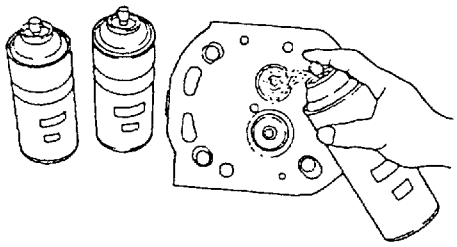
(Measuring warpage of cylinder head)



(2) Inspect for cracks

Check the intake and exhaust ports and cylinder block contacting surfaces for cracks, using the color check agent. If any cracks are discovered, replace the cylinder head.

(Color check of cylinder head)

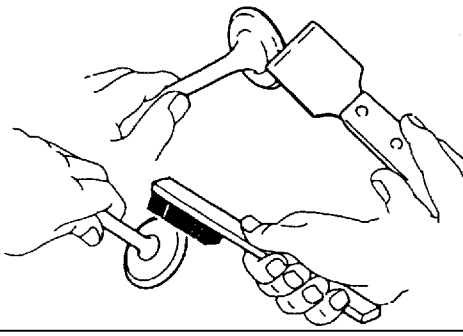


3.1.4.4 Clean the intake and exhaust valves

(1) Remove the carbon deposits adhering on the valve head, using a scraper.

(2) Thoroughly clean the valve using a wire brush.

(Cleaning the intake and exhaust valves)



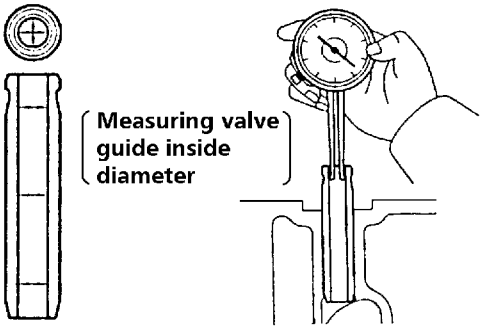
3.1.4.5 Inspect the valve stem and valve guide

(1) Measure the inside diameter of valve guide using a caliper gauge.

Valve guide inside diameter:

Model	Standard (mm)	Limit (mm)
TF50, 60, 70 TF80-M, 90-M series	7.005 to 7.020	7.090
TF110-M, 120-M series	8.005 to 8.020	8.090
TF140, 160 series	9.005 to 9.020	9.090

Remark: TF50series do not insert the valve guides.

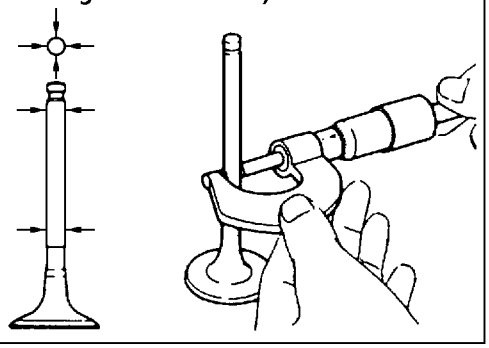


(2) Measure the diameter of the valve stem using a micrometer.

Valve stem diameter:

Model	----	Standard (mm)	Limit (mm)
TF50 series	Intake	6.960 to 6.975	6.900
	Exh.	6.945 to 6.960	6.900
TF60, 70, TF80-M, 90-M series	Intake	6.945 to 6.960	6.850
	Exh.		
TF110-M, 120-M series	Intake	7.945 to 7.960	7.850
	Exh.		
TF140, 160	Intake	8.945 to 8.960	8.850
	Exh.		

(Measuring the valve stem)



(3) Subtract the valve stem diameter from the measured valve guide inside diameter.

Oil Clearence:

Model	----	Standard (mm)	Limit (mm)
TF50 series	Intake	0.030 to 0.060	0.150
	Exh.	0.045 to 0.075	
TF60, 70, TF80-M, 90-M series	Intake	0.045 to 0.075	
	Exh.		
TF110-M, 120-M series	Intake		
	Exh.		
TF140, 160 series	Intake		
	Exh.		

If the measured oil clearance exceeds the specified limit, replace the valve and valve guide or cylinder head (TF50 series).

• Replacing the valve guide.

① Pull out the valve guide from the cylinder head using a removing tool.

② Put dry ice in a container filled with ether or alcohol. Put the valve guide in the container to cool it. Tap the valve guide in to the cy-linder head using a valve guide inserting tool.

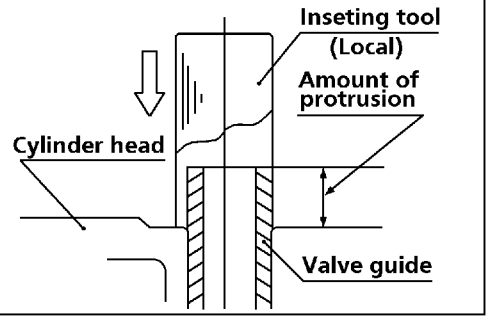
③ Check the inside diameter. Finish it to the standard.
Inside diameter as necessary using a reamer.

④ Check the amount of protrusion from the cylinder head.

⚠ CAUTION

Do not touch a cooled valve guide withbare hands. Damage to the skin may result.

(Replacing the valve guide)



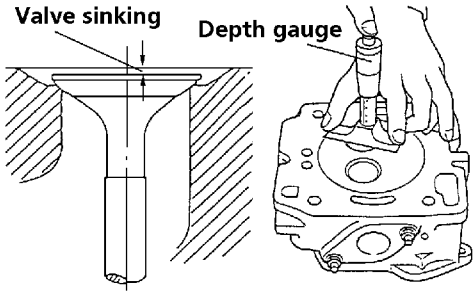
Model	Protrusion (mm)
TF60, 70, TF110-M, TF120-M series	13.2 to 13.5
TF80-M, 90-M series	9.2 to 9.5
TF140, 160 series	14.7 to 15.0

(4) Mesure the valve sinking using a depth gauge.

Valve sinking:

Model	----	Standard (mm)	Limit (mm)
TF50 series	Intake	0.35	0.6
	Exh.	0.75	1.0
TF60, 70 series	Intake	0.41 to 0.76	0.8
	Exh.	0.75 to 1.05	1.2
TF80-M, 90-M series	Intake	0.15 to 0.45	0.6
	Exh.	0.55 to 0.85	1.0
TF110-M, 120-M series	Intake	0.25 to 0.55	0.7
	Exh.	0.65 to 0.95	1.1
TF140, 160 series	Intake	0.35	0.7
	Exh.	1.00	1.2

(Measuring the valve sinking)



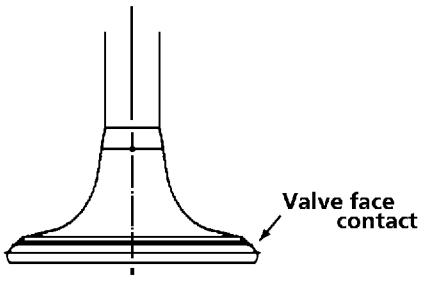
3.1.4.6 Inspect the valve seat

(1) Check the valve seat for poor contact. Apply a light coat of prussian blue (or white lead) on the valve face. Lightly press the valve onto the seat, without rotating the valve.

(2) Check the valve face and seat as follows:

- If the blue color adheres around 360° of the valve seat, the valve is concentric. If not concentric, replace the valve.
- If the blue color adheres around 360° of the valve seat, the guide and face are con-centric. If the color fails to adhere around 360°, carry out the surface finishing of the seat.

(Check the valve contact to seat)



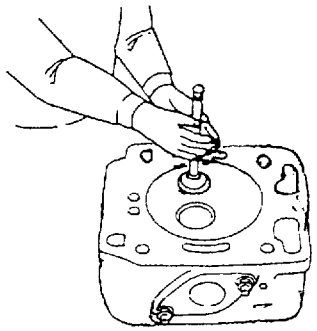
[NOTICE]

If correcting the valve seat is needed, be sure to check the clearance between the valve stem and valve guide. If the cleara-nce exceeds the limit, replace the valve or valve guide or cylinder head (TF50series) first and then correct the seat.

(3) Correcting the valve seat:

- If the seat surface is slightly rough, hand-lap the valve and valve seat using the abrasive compound, and after lapping, clean the valve and valve seat.

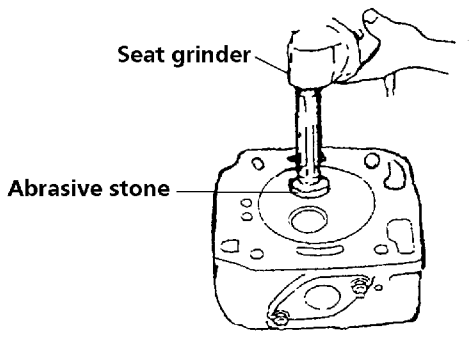
(Valve and valve seat hand-lapping)



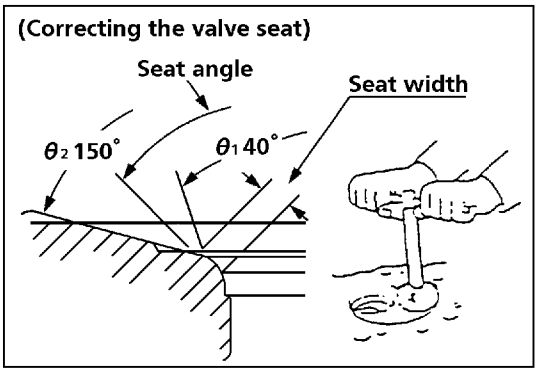
- If the seat surface is considerably rough, correct the seat surface using seat grinder or seat cutter. After that, hand-lap and clean the seat surface.

Cutter angle (Seat angle)	Intake	Exhaust
	120°	90°

(Correcting the seat surface)



- If the valve seat is wider than standard, grind seat surface using a cutter having angle 40° (θ_1) first and then finish the seat width to the specified size (listed below) using a cutter having angle 150°(θ_2).

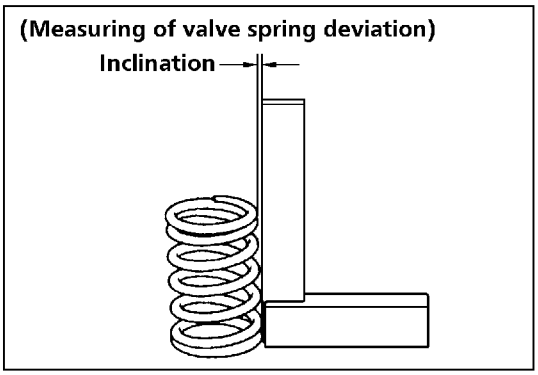


Model	Seat width (mm)		
	----	Standard	Limit
TF50, 60, 70 TF80-M, 90-M series	Intake	1.15	1.45
	Exhaust	1.41	1.71
TF110-M, 120-M TF140, 160 series	Intake	1.44	1.74
	Exhaust	1.77	2.07

3.1.4.7 Check the valve spring

(1) Visually check the valve spring for flaw or corrosion.

(2) Measure the deviation of the valve spring using a square.

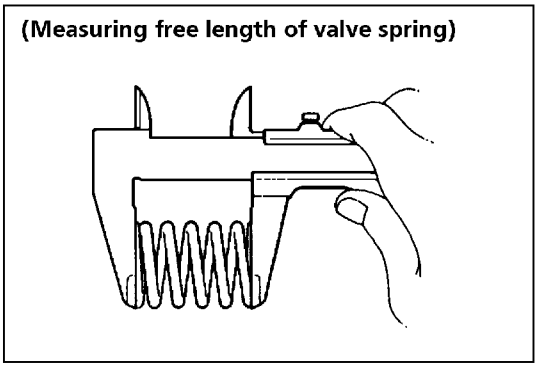


Deviation:

Model	Limit (mm)
TF50, 60, 70, TF80-M, 90-M, series	1.2
TF110-M, 120-M TF140, 160series	1.4

If the measured deviation exceeds the spe-cified limit, replace the valve spring.

(3) Measure free length of the valve spring using calipers.



Free length:

Model	Free length (mm)
TF50, 60, 70 TF80-M, 90-M series	35.5
TF110-M, 120-M series	42.0
TF140, 160 series	43.5

If the measured free length is out of the specification, replace the valve spring.

3.1.4.8 Check the rocker arm and shaft (Rocker arm support)

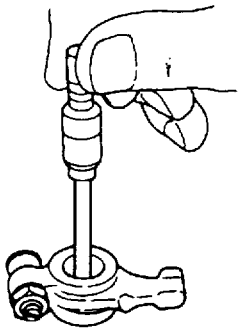
- Blow the oil hole of rocker arm and confirm the oil hole without any clogged.

(1) Measure the inside diameter of rocker arm using a cylinder bore gauge or a caliper gauge.

Inside diameter of rocker arm:

Model	Standard (mm)	Limit (mm)
TF50, 60, 70, TF80-M, 90-M series	14.016 to 14.034	14.100
TF110-M, 120M TF140, 160 series	16.016 to 16.034	16.100

(Measuring rocker arm inside diameter)

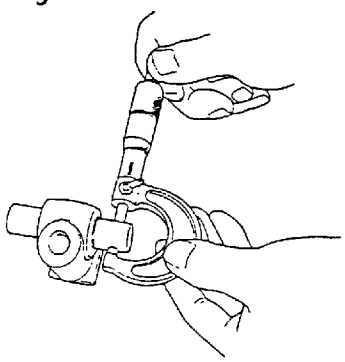


(2) Measure the rocker arm shaft (Rocker arm support) outside diameter.

Outside diameter of rocker arm shaft:

Model	Standard (mm)	Limit (mm)
TF50, 60, 70, TF80-M, 90-M series	13.982 to 14.000	13.900
TF110-M, 120M TF140, 160 series	15.982 to 16.000	15.900

(Measuring outside diameter of rocker shaft)



(3) Subtract the rocker arm shaft diameter from the inside diameter of the rocker arm.

Oil clearance:

Model	Standard (mm)	Limit (mm)
All	0.016 to 0.052	0.150

If the measured oil clearance exceeds the specified limit, replace the rocker arm support and rocker arm.

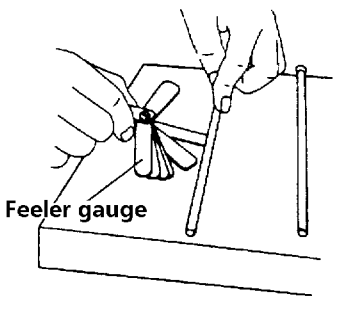
3.1.4.9 Check the push rod for damage or bending

- Visually check for the each side of push rod tip. If any roughness, slightly lap using oil stone.
- Mesure the push rod bending.

Bending:

Model	Standard (mm)	Limit (mm)
All	TIR0.03	0.06

(Measuring the push rod bending)



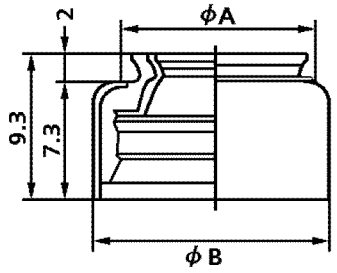
3.1.5 Assembly of Cylinder Head

[NOTICE]

Clean all parts to be assembled. Apply new engine oil to all sliding and rotating surfaces before assemble parts.

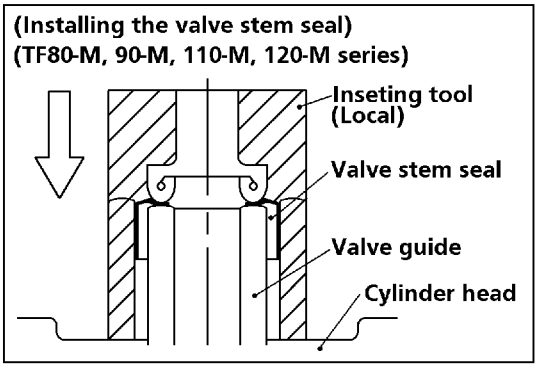
3.1.5.1 Install the intake and exhaust valves

(1) Press in the new stem seal into the valve guide. (TF80-M, 90-M, 110-M, 120-M series only)



(mm)

Model	A	B
TF80-M, 90-M series	12.5	14.6
TF110-M, 120-M series	13.5	15.6

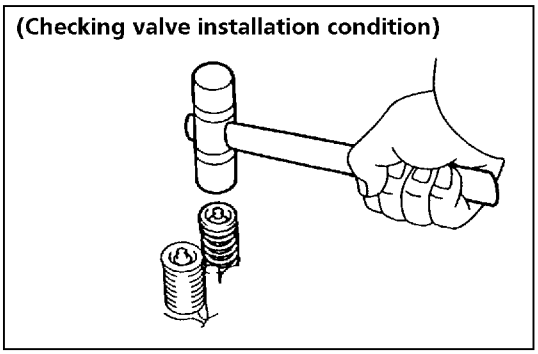


(2) Install the following parts:

1) Valve
2) Valve spring
3) Spring retainer

(3) Compress the valve spring and install the spring retainer using the valve spring compressor. (See 3.1.3.1 Remove the intake and exhaust valves)

(4) Tap the top of the valve stem using a plastic hammer to check that it is fit in position.



3.1.6 Installation of Cylinder Head

3.1.6.1 Install the cylinder head

(1) Install the cylinder head to the cylinder block

1) Install a new cylinder head gasket in position to the cylinder block.

[NOTICE]

Install the gasket in the right way round.

2) Install the cylinder head correctly on the cylinder head gasket.

(2) Install the cylinder head nut

[NOTICE]

- ***Gradually tighten the cylinder head nut or bolt in 2 steps.***
- ***If the nut or bolt is damaged or deformed, replace with a new one.***

1) Lightly apply the engine oil to the thread and cylinder head nut seat and cylinder head bolt as well.
2) Uniformly tighten the cylinder head nuts and cylinder head bolts at two times in the cross direction.

Cylinder head nut and bolt tightening torque:

Model	Tightening torque N·m (kgf·m)	Note
TF50, 60, 70 TF80-M, 90-M series	95.2 to 101.0 (9.7 to 10.3)	4nuts: TS50 series 2nuts, 2bolts: except TF50 series
TF110-M, 120-M series	128.5 to 138.2 (13.1 to 14.1)	2nots, 2bolt
TF140, 160 series	186.4 to 205.9 (19.0 to 21.0)	4nuts and 4plane washers

3.1.6.2 Install the push rod

- Install the push rods in the original position that they had installed befor disassembled.

3.1.6.3 Install the rocker arm support and rocker arms

(1) Install the rocker arm support to the cylinder head using the positioning pin and nut.

(2) Install the rocker arms to the rocker arm support.

[NOTICE]

Make sure exhahust side rocker arm is machined on the opposite side of the valve stem side.

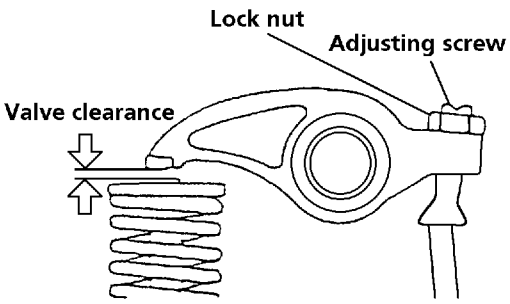
Model	Tightening torque N·m(kgf·m)
TF50, 60, 70 TF80-M, 90-M TF110-M, 120-M series	22.6 to 28.4 (2.3 to 2.9)
TF140, 160 series	44.1 to 53.9 (4.5 to 5.5)

3.1.6.4 Adjust the valve clearance

(1) Turn the crankshaft clockwise to locate the piston to the compression top.

(2) Loosen the lock nut on the rocker arm and then adjust the adjusting screw.

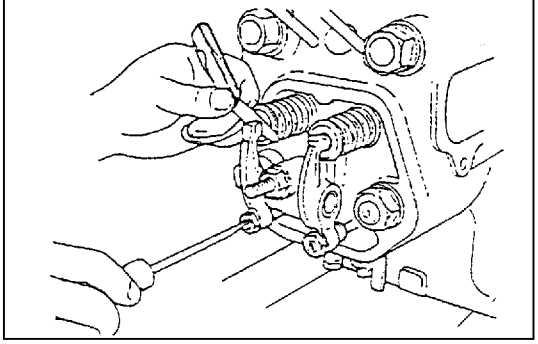
(Adjusting screw for valve clearance)



(3) Insert the feeler gauge of the specified valve clearance as shown below.

(4) Turn the adjusting screw, slightly slide the feeler gauge, and lock the adjusting screw by the lock nut.

(Adjusting valve clearance)



Valve clearance:

Model	Valve clearance (mm)
TF50, 60, 70 series	0.15
TF80-M, 90-M TF110-M, 120-M 140, 160 series	0.20

3.1.6.5 Install the bonnet

(1) Completely remove the adhering packing material.

(2) Install new gasket to the bonnet.

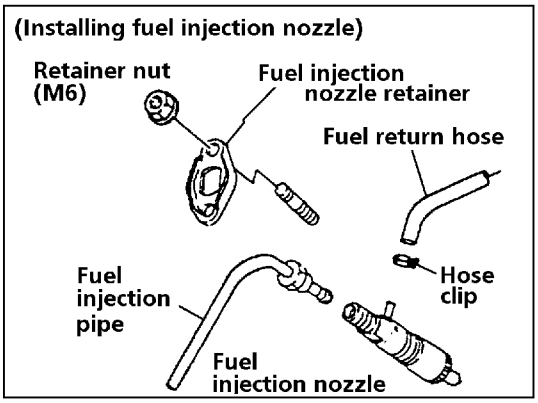
(3) Install the bonnet to the cylinder head with 3 bolts.

3.1.6.6 Install the fuel injection nozzle

(1) Install new nozzle protector and new nozzle seat to the fuel injection nozzle.

(2) Install the fuel injection nozzle to the cylinder head with the fuel injection nozzle retainer.

(Installing fuel injection nozzle)



Retainer nut tightening torque:

Model	Tightening torque N·m(kgf·m)
All	6.86 to 8.82 (0.7 to 0.9)

3.1.6.7 Install the fuel injection pipe

3.1.6.8 Install the fuel return hose to the fuel injection nozzle

3.1.6.9 Install the exhaust silencer to the cylinder head with gasket

3.1.6.10 Install the intake pipe to the cylinder head with gasket, and then install the air cleaner

3.1.6.11 Fill with enine coolant

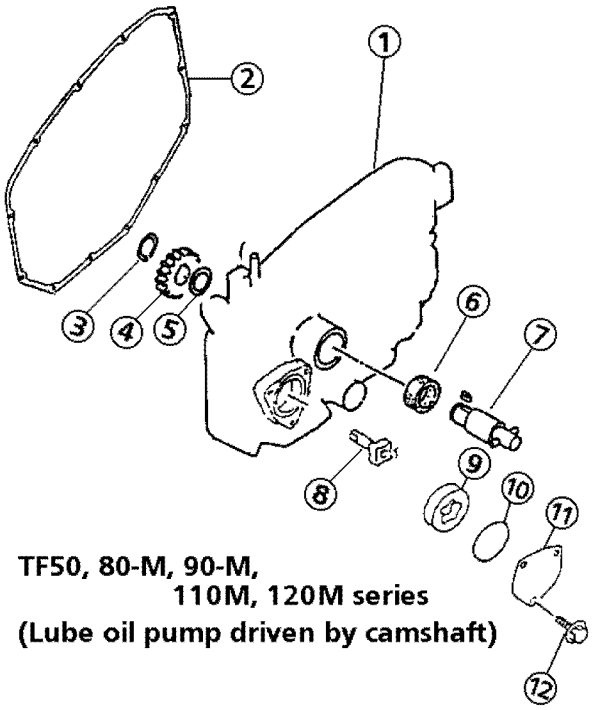
3.1.6.12 Fill up lube oil to the upper limit of the oil dipstick

3.1.6.13 Start the engine and check for oil leakage

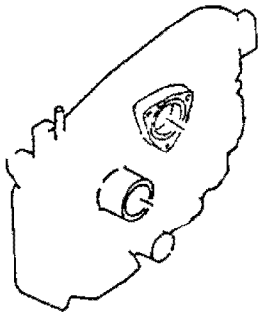
3.1.6.14 Check the lube oil level again and, if need, replenish up to the upper limit of the oil dipstick

3.2 Gear Case

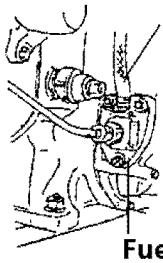
3.2.1 Components



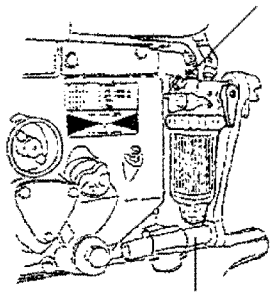
TF50, 80-M, 90-M,
110M, 120M series
(Lube oil pump driven by camshaft)



TF60, 70, 140, 160 series
(Lube oil pump driven by crankshaft)



Fuel injection pump



Starting handle

No.	Part name
①	Gear case
◆ ②	Gasket
③	Circlip
④	Starting gear
⑤	Coller
⑥	Oil seal
⑦	Starting shaft
⑧	Inner rotor
⑨	Outer rotor
◆ ⑩	O-ring
⑪	Lube oil pump cover
⑫	Bolt M6 × 12 ⓤ

◆ Non-reusable part.

3.2.2 Removal of Gear Case

3.2.2.1 Drain the lube oil

3.2.2.2. Make sure the fuel oil cock closed

3.2.2.3 Loosen the fuel oil filter installing bolt on the gear case and remove the starting handle

3.2.2.4 Remove the fuel oil pipe from the fuel injection pump

3.2.2.5 Remove the fuel injection pipe

3.2.2.6 Remove the fuel injection pump

(1) Loosen the 3 nuts on the fuel injection pump.

(2) Remove the fuel injection pump from the gear case.

(3) Keep the injection timing adjusting shim together with the fuel injection pump as they are installed.

[NOTICE]

Keep away the fuel oil pipe, fuel injection pipe and fuel injection pump from dust.

3.2.3 Disassembly of Gear Case

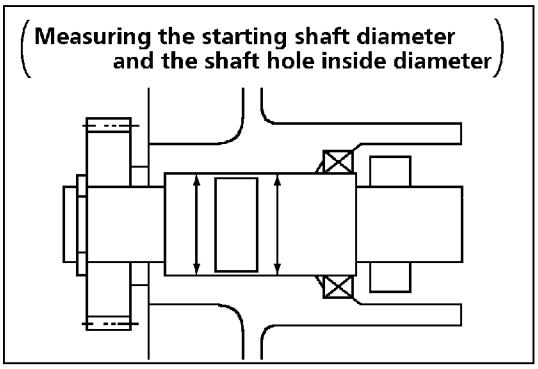
3.2.3.1 Remove the gear case Assy.

(1) Loosen the bolt on the gear case.

(2) Pull out the gear case slowly from the cylinder block.

3.2.3.2 Inspect the starling shaft and the shaft hole

- Visually check the oil seal for oil leakage. If oil leakage is found, replace the oil seal.
- Remove the circlip.
- Remove the starting gear, feather key and coller from the shaft.
- Remove the starting shaft from the gear case.



1) Measure the starling shaft diameter using a micrometer.
2) Measure the shaft hole inside diameter of the gear case using a caliper gauge.
3) Subtract the measured starting shaft diameter from the measured shaft hole inside diameter. If the measured oil clearance exceeds the specified limit, replace the starting shaft. When necessary, replace the gear case.

Model	Item	Standard (mm)	Limit (mm)
All	Shaft hole inside diameter of gear case	25.030 to 25.060	25.150
	Starting shaft diameter	24.972 to 24.993	24.950
	Oil clearance	0.037 to 0.088	0.200

3.2.3.3 Inspect the lube oil pump

- Turn the drive shaft(inner rotor) assembled in the gear case and check that the drive shaft(inner rotor) turns smoothly and the drive shaft(inner rotor) has no play.

(1) Remove the lube oil pump cover.

1) Loosen the 3 bolts.

2) Remove the lube oil pump cover.

- Check the lube oil pump cover surface for wear, if so, replace it.

(2) Check the clearance of the lube oil pump body(gear case).

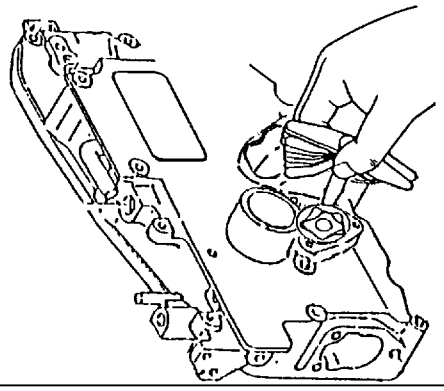
- Measure the clearance between the outer rotor and lube oil pump body(gear case) using a feeler gauge.

The pump body clearence:

Model	Standard (mm)	Limit (mm)
All	0.100 to 0.150	0.200

If the measured clearance exceeds the specified limit, replace the pump rotor ass-embly.

(Measuring the pump body Clearance)



(3) Check the clearance at the rotor tooth tip.

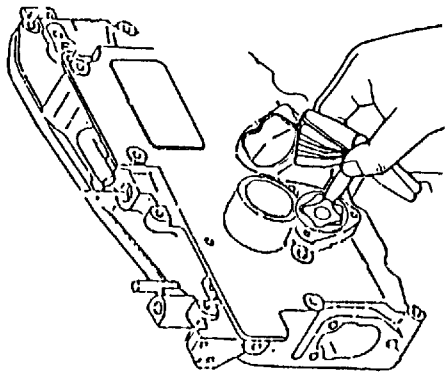
- Measure the clearance at the tip of the inner rotor and the outer rotor using a feeler gauge.

The rotor tip clearance:

Model	Standard (mm)	Limit (mm)
All	0.080 to 0.140	0.200

If the measured clearance exceeds the specified limit, replace the pump rotor assembly.

(Measuring clearance at the rotor tooth tip)



(4) Check the side clearance of the pump rotor assembly.

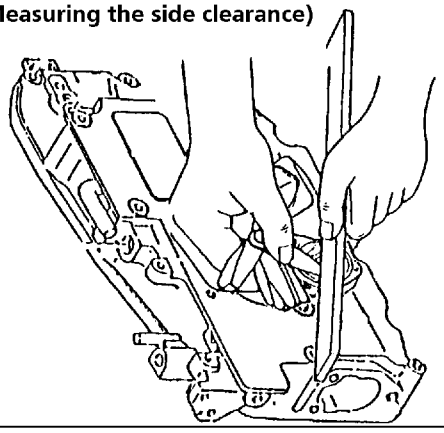
- Measure the clearance between the rotor and body end surface (gear case) using a feeler gauge and straight edge.

The side clearence:

Model	Standard (mm)	Limit (mm)
All	0.030 to 0.080	0.150

If the measured clearence exceeds the specified limit, replace the rotor assy.

(Measuring the side clearance)



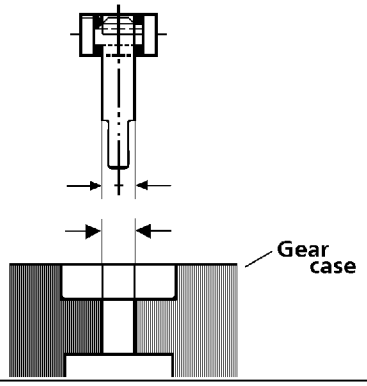
(5) Inspect the inner rotor shaft hole inside diameter and inner rotor shaft diameter.

1) Measure the diameter of the inner rotor shaft hole inside diameter using a caliper gauge.

Shaft hole inside diameter:

Model	Standard (mm)	Limit (mm)
TF50, 60, 70, 140, 160 series	8.010 to 8.050	8.080
TF80-M, 90-M 110-M, 120-M series	12.704 to 12.722	12.752

(Measuring the inner rotor shaft diameter and rotor shaft hole inside diameter)



2) Measure the diameter of the inner rotor shaft using a micrometer.

Model	Standard (mm)	Limit (mm)
TF50, 60, 70, 140, 160 series	7.985 to 8.000	7.955
TF80-M, 90-M 110-M, 120-M series	12.664 to 12.688	12.634

3) Subtract the measured inner rotor shaft diameter from the measured inner rotor shaft hole inside diameter.

Oil clearance:

Model	Standard (mm)	Limit (mm)
TF50, 60, 70, 140, 160 series	0.010 to 0.065	0.120
TF80-M, 90-M 110-M, 120-M series	0.016 to 0.058	

If the measured oil clearance exceeds the specified limit, replace the lube oil pump rotor assy. When necessary, replace the gear case.

3.2.4 Assembly of Gear Case

3.2.4.1 Install the starting shaft:

[NOTICE]

Clean all parts to be assembled. Apply new engine oil to all sliding and rotating surfaces before assembling parts.

(1) Install the starting shaft to the gear case not to damage the oil seal lip.

(2) Install the coller to the starting shaft.

(3) Install the feather key on the starting shaft.

(4) Install the starting gear to the starting shaft.

(5) Install the circlip in the circlip groove of the starting shaft.

(6) Turn the starting gear and check the starting shaft rotates smoothly.

3.2.4.2 Install the lube oil pump

(1) Install the inner rotor and outer rotor in the gear case.

(2) Install new o-ring in the groove of the gear case.

(3) Install the lube oil pump cover using 3 bolts.

(4) Turn the inner rotor and check the lube oil pump turns smoothly.

3.2.5 Installation of Gear Case

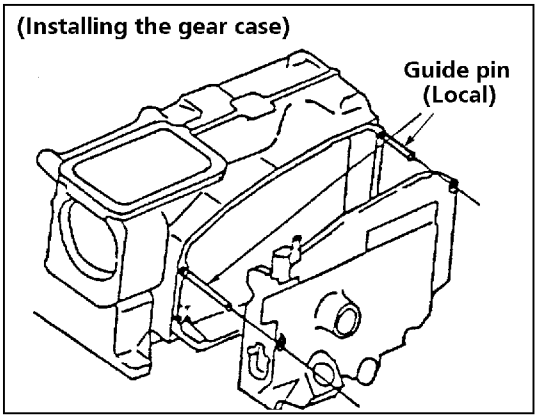
3.2.5.1 Install the gear case to the cylinder block.

(1) Install new gasket to the cylinder block using 2 guide pins or greas to fit the cylinder block flange as shown in the illustration.

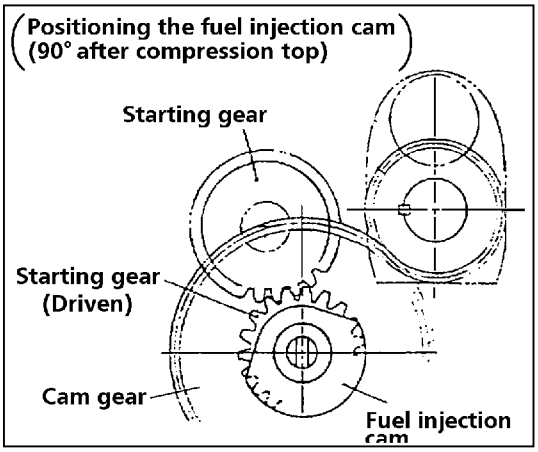
(2) Install the gear case to the cylinder block with the bolts. Uniformly tighten the bolts in two passes.

Tightening torque:

Model	Tightening torque N·m (kgf·m)
TF50 series	7.8 to 9.8 (0.8 to 1.0)
TF60, 70, 80-M, 90-M, 110-M, 120-M series	9.8 to 11.7 (1.0 to 1.2)
TF140, 160 series	24.5 to 26.4 (2.5 to 2.7)



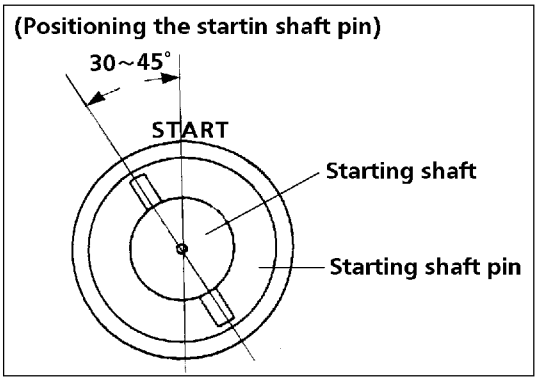
1) Turn the cam gear and locate the fuel injection cam not to interfare with the starting gear while install the gear case to the cylinder block.
(See illustration)



3) Turn the starting gear and locate the starting shaft pin to start easily and safely as shown in the illustration.

3) Place the lube oil inner rotor to align the slit of the crankshaft or camshaft while installing the gear case to the cylinder block.

Crankshaft drive: TF60, 70, 140, 160 series
Camshaft drive: TF50, 80-M, 90-M, 110-M, 120-M series



3.2.5.2 Install the fuel injection pump

(1) Install the injection timing adjusting shim as they had installed.

(2) Install the fuel injection pump to the gear case with 3 nuts.

1) Turn the crankshaf to set the piston at the botlom dead center.

2) Set the speed control lever to the stop position.

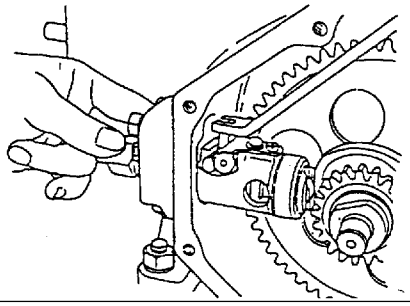
3) Align the fuel injection pump rack pin to the fork of the governor lever.

(3) Uniformly tighten the nut in two passes.

Tightening torque:

Model	Tightening torque N·m (kgf·m)
All	22.6 to 28.4 (2.3 to 2.9)

(Alighning the fuel injection pump rack pin)



3.2.5.3 Install the fuel injection pipe

3.2.5.4 Install the fuel oil pipe to the fuel injection pump

3.2.5.5 Tighten the bolt for fuel oil filter on the gear case

3.2.5.6. Fill up lube oil to the upper limit of the oil dipstick

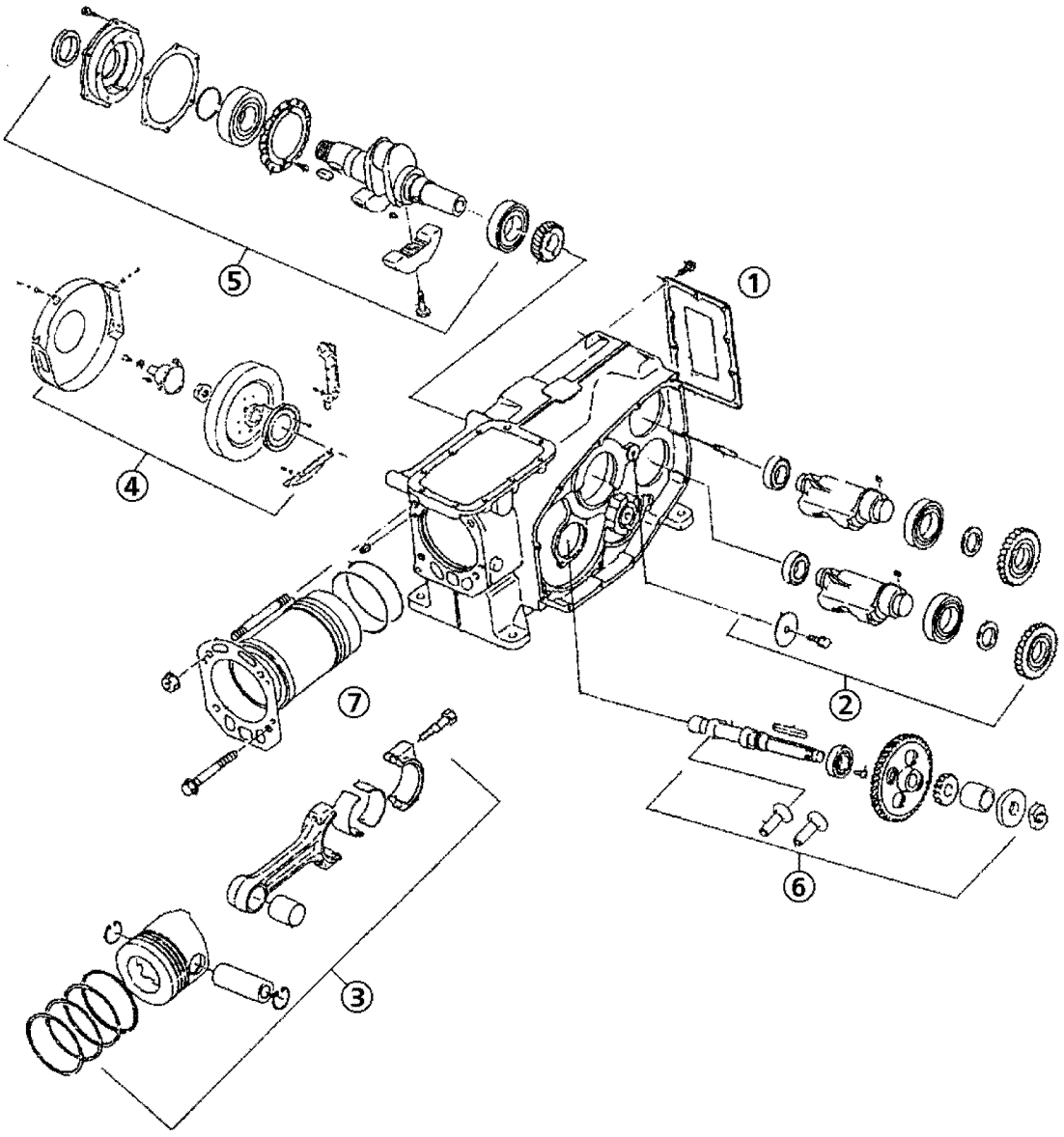
3.2.5.7 Bleed air in the fuel oil piping using the fuel cock attached the fuel filter

3.2.5.8 Start the engine and check for oil leakage

3.2.5.9 Check the lube oil level again and, if need, replenish up to the upper level of the oil dipstick

3.3 Cylinder Block

3.3.1 Components



No.	Part name	Note
①	Cylinder body cover	
②	Balancer shaft assy.	Except TF50 series
③	Piston and connecting rod assy.	
④	Flywheel and flywheel cover assy.	
⑤	Crankshaft and bearing assy.	
⑥	Camshaft assy.	
⑦	Cylinder liner assy.	

-E version: First of all, remove the starter motor

3.3.2 Disassembly of Cylinder Block

3.3.2.1 Remove the cylinder head

(See 3.1.2 Removal of Cylinder Head)

3.3.2.2 Remove the gear case

(See 3.2.2 Removal of Gear Case)

3.3.2.3 Inspect backlash of the gears

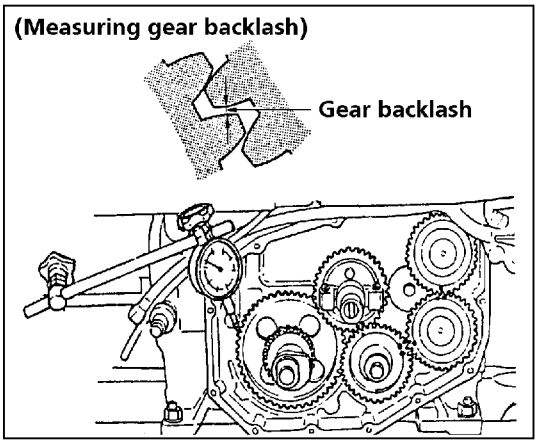
(1) Measur the backlash using a dial gauge.

Model	Item	Standard (mm)	Limit (mm)
All	Crank gear to cam gear	0.080 to 0.196	0.300
	Balancer gear ※		
	Balancer gear to idler gear ※		
	Idler gear to balancer drive gear ※		

※: Excep TF50 series

If measured gear backlash exceeds the limit, replace the gears as set and bearings.

(Measuring gear backlash)



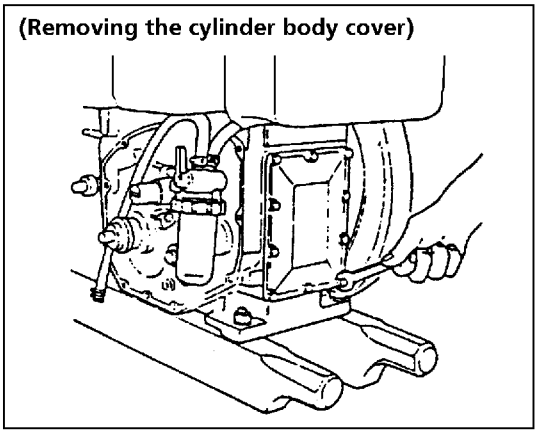
3.3.2.4 Remove the cylinder body cover

(1) Remove the bolts.

(2) Pry out the cylinder body cover.
※-E version: First of all, remove the starter motor

[NOTICE]
Pay attention so as not to damage the contact surface of all parts and cylinder block.

(Removing the cylinder body cover)

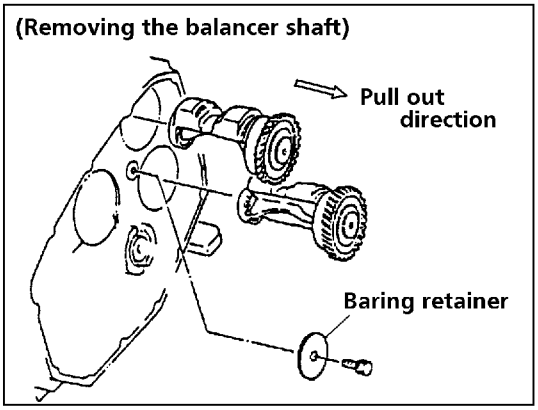


3.3.2.5 Remove the balancer shaft assy. (Except TF50 series)

(1) Remove the bearing retainer loosening the bolt.

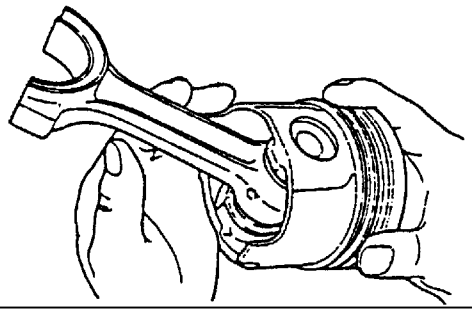
(2) Tap out the balancer shaft from inside the cylinder block to the gear case side using a plastic hammer.

(Removing the balancer shaft)



3.3.2.6 Remove the piston and connecting rod assy.

(Removing the piston and connecting rod assy)



(1) Check the connecting rod thrust clearance moving the connecting rod right and left using athickness gauge befor remove the connec-tingrod cap.

Thrust clearance:

Model	Thrust clearance (mm)
All	0.2 to 0.4

(2) Remove the connecting rod cap.

1) Turn the crankshaft and place the piston to the bottom dead center.

2) Remove two connecting rod cap bolts.

3) Remove the connecting rod cap.

- Install the crank pin bearing of the cap side to the connecting rod cap so that it will be reassembled at original position.

(3) Remove the piston and connecting rod assy. from the cyfinder block.

1) Turn the crank shaft together with connecting rod to the top dead center.

2) Push the connecting rod big end to pull out the piston and connecting rod to the cylinder head side using a wooden bar. (Ex.grip end of hammer)

[NOTICE]

- ***Pay attention so as not to damage the crank pin bearing while pulling out the piston and connecting rod.***
- ***Pay attention so as not to damage the cylind liner by conneting rod big end while pulling out the piston and connecting rod.***

3.3.2.7. Remove the flywheel

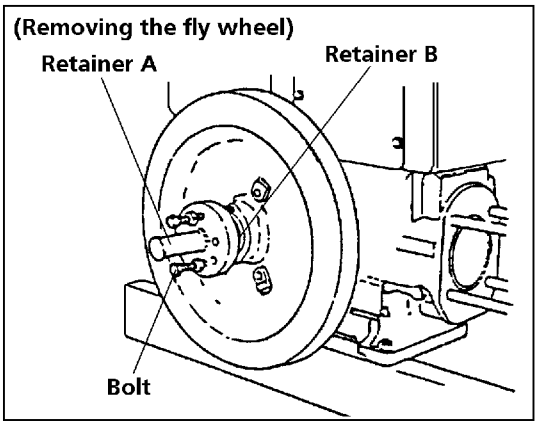
(1) Remove the flywheel cover.

(2) Loosen the V-belt tension pulley, and then remove the V-belt(Except-H series).

(3) Remove the flywheel end nut using the end nut wrench.

Tools P/N: 105010-92100(TF50 series)
104200-92100(TF60, 70, 80-M, 90-M series)
103338-92100(TF140, 160 series)

(4) Remove the flywheel using the retainer A, retainer B and borts.



Tools P/N

Model	RetainerA	RetainerB	Bolt
TF50 series	105090-92110	104200-92120	104200-92130
TF60, 70, TF80-M, 90-M series	104200-92110		
TF110-M, 120-M, TF140,160 series	104300-92110	104300-92120	

1) Install the retainer A to the crankshaft end adjusting the clearance about 3 mm between flywheel end surface and retainer A.

2) Install the retainer B and bolts and then Altenately tighten two bolts until the taper is dismated.

[NOTICE]

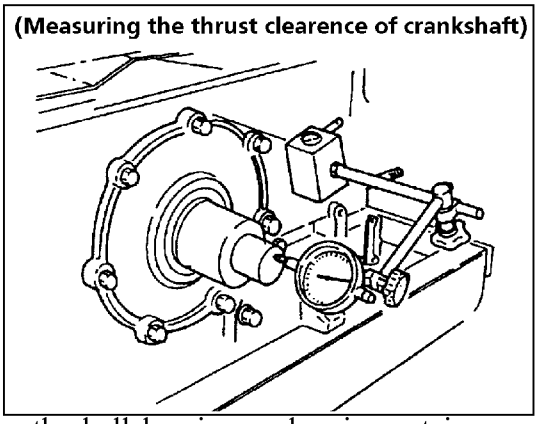
Pay attention so as not damage the thread of cranshaft end.

⚠ CAUTION

Never completely remove the flywheel end nut from the crankshaft when revmov the flywheel using another puller for flywheel.
If use another puller, loosen the end nut adjusting the clearance about 3 mm between flywheel end surface and the end nut seat.
Othewise, you will be hurt by fallen flywheel.

3.3.2.8 Remove the crankshaft and bearing assy.

(1) Check the thrust clearance of crankshaft be-fore removing crankshaft.



Thrust clearence:

Model	Thrust clearence (mm)	Limit (mm)
TF50, 60, 70 series	0.010 to 0.210	0.300
TF80-M, 90-M series	0.069 to 0.269	0.350
TF110-M, 120-M TF140, 160 series	0.087 to 0.287	0.400

If the measured thrust clearance exceeds the limit, replace the ball bearing or bearing retainer or both.

(2) Remove the governor weight.

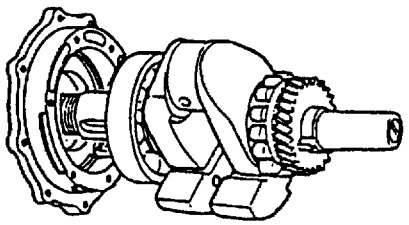
1) Loosen the 2 bolts and remove the govenor weight together with balancer gear(drive)(TF50:spacer) from the crankshaft end(gear case side).

(3) Remove the crankshaft and bearing assy..

1) Remove the bolt(TF50 series: nut) for bearing housing.

2) Locate the balance weight of the crankshaft to pull out the crankshaft and bearing housing assy. to the cutout of the bearing housing hole of cylinder block.

(Removing the crankshaft and bearing assy)



3.3.2.9 Remove the camshaft

(1) Remove the gear cover.

(2) Remove the idler gear.

Loosen the bolt to remove it and remove the idler gear together with idler gear shaft.

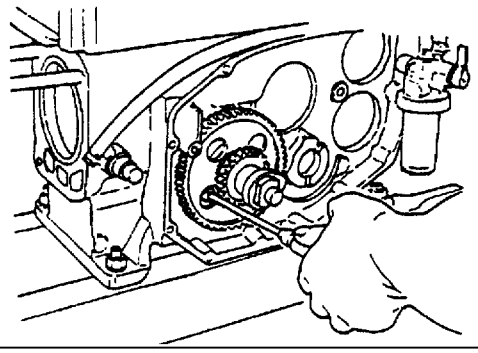
(3) Remove the camshaft bearing retaining bolt.

(4) Tap out the camshaft from the inside of cylinder block to the gear case side using a plastichammer.

[NOTICE]

- ***Pay attention so as not to contact with exhaust cam top and cylinder liner wh-ile removing the camshaft assy..***
- ***Mark to distinguish the tappet to the exhaust and intake side so that they will be reassembled in the original position.***

(Removing the camshaft bearing retaining bolt)



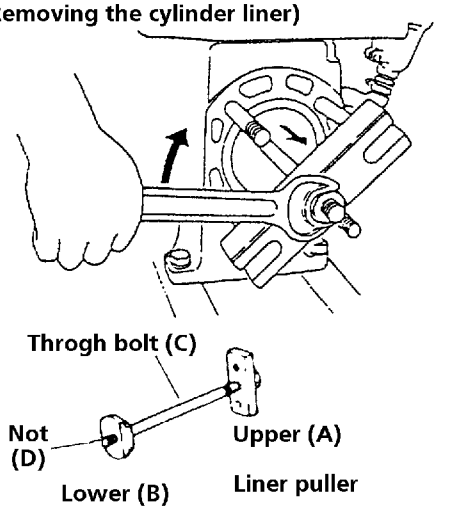
3.3.2.10 Remove the cylinder liner

Remove the cylinder liner using the cylinder liner puller as shown in the illustration.

Cylinder liner puller P/N:

Model	A	B	C	D
TF50	172200-92020	105090-92010	103338-92030	26712-160002
TF60		101300-92010		
TF70		105200-92010		
TF80-M		172300-92010		
TF90-M		101400-92010		
TF110-M				
TF120-M		120220-92010		
TF140		105700-92010		
TF160		101504-92010		

(Removing the cylinder liner)

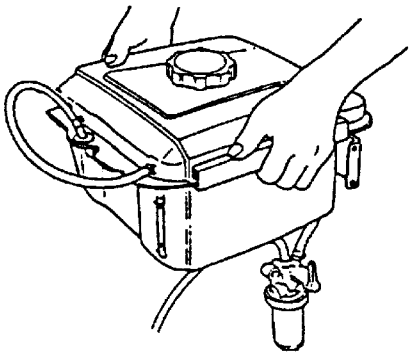


3.3.2.11 Remove the fuel oil tank assy.

(1) Remove the bolts and nuts for fuel oil tank.

(2) Remove the fuel oil tank.

(Removing the fuel oil tank)

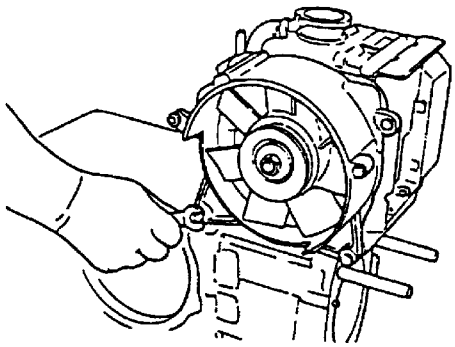


3.3.2.12 Remove the fan casing

(1) Check that the cooling fan rotates smoothly.

(2) Clean the cooling fan blades.

(Removing the fan casing)



3.3.2.13 Remove the radiator

(1) Remove the cooling water subtank.

(2) Clean the radiator fin using water shower.

[NOTICE]

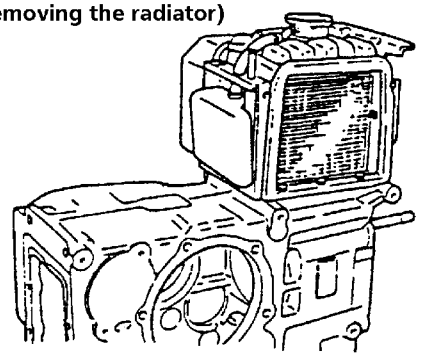
Never use pressured water or blow or br-ush to clean the radiator fin.

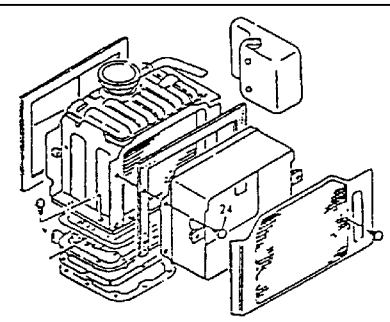
(3) Remove the radiator.

- Remove gasket material and seal packing adhesion from the cylinder block, spacer and radiator.
- Seal packing is used between radiator and radiator spacer contact surface.
- Gasket is used between radiator spacer and cylinder block surface.

(Gasket is non-reusable part)

(Removing the radiator)



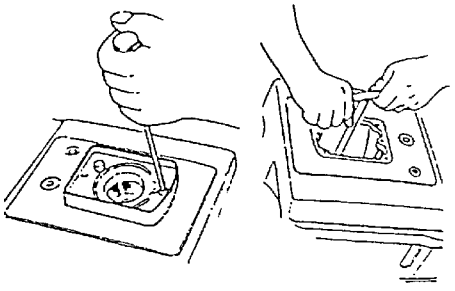


3.3.2.14 Remove the hopper(-H version)

(1) Remove the inside core.

(2) Remove the hopper.

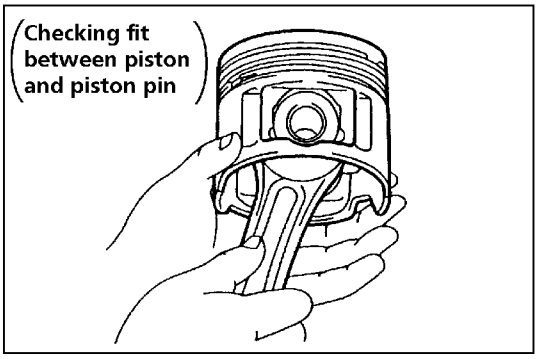
(removing the hopper)(-H version)



3.3.3 Inspection and Servicing of Piston and Connecting Rod

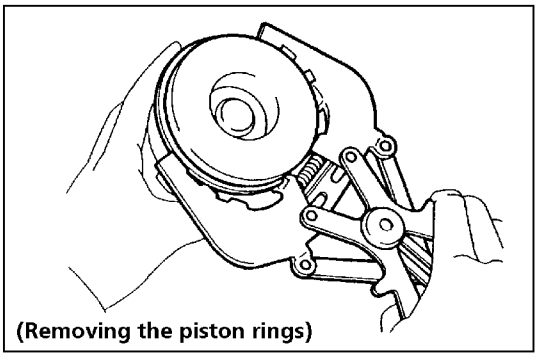
3.3.3.1 Check fitting between the piston and piston pin

Move the piston on the piston pin back and forth.
If any movement is felt, replace the piston and piston pin as a set.



3.3.3.2 Remove the piston ring

(1) Remove the piston rings using the piston ring expander.


(Removing the piston rings)

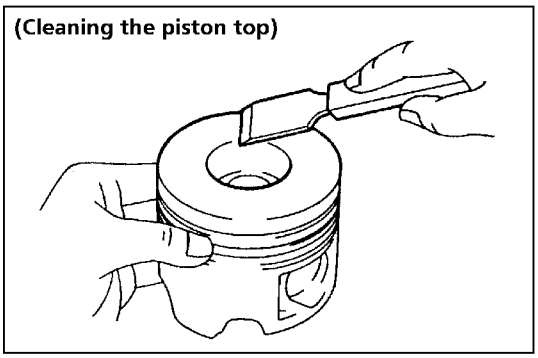
3.3.3.3 Remove the connecting rod

(1) Remove the circlip using a nose pliers.

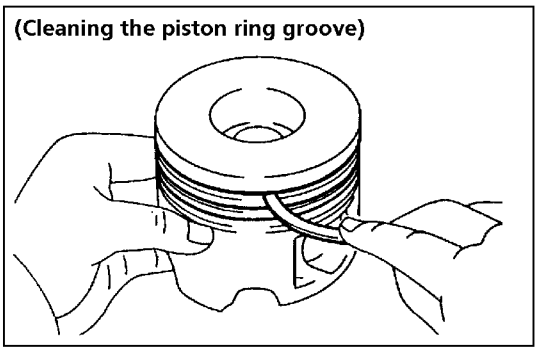
(2) Remove the piston pin.

3.3.3.4 Clean the piston

(1) Clean the carbon deposits of the piston top using a scraper.


(Cleaning the piston top)

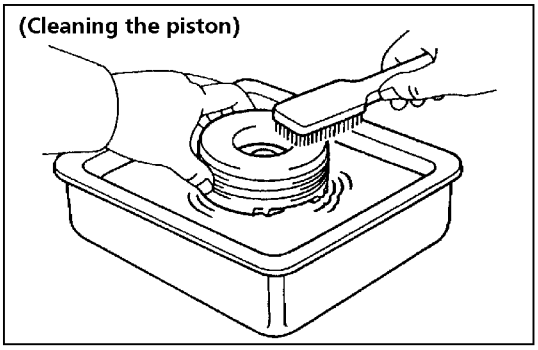
(2) Clean the piston ring groove using a damaged ring.


(Cleaning the piston ring groove)

(3) Completely clean the piston using a brush and solvent.

•

[NOTICE] ***wire brush.***


(Cleaning the piston)

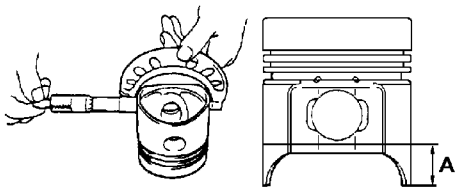
3.3.3.5 Inspect the piston and piston ring

(1) Measure the piston diameter at right angle to the piston pin at an "A" position from the piston bottom using a micrometer.

Piston diameter:

Model	Standard (mm)	Limit (mm)	A (mm)
TF50 series	73.891 to 73.921	73.790	15.0
TF60 series	74.889 to 74.919	74.760	
TF70 series	77.883 to 77.913	77.750	
TF80-M series	79.879 to 79.909	79.730	
TF90-M serues	84.869 to 84.899	84.720	
TF110-M series	87.863 to 87.893	87.705	
TF120-M series	91.855 to 91.885	91.695	
TF140 series	95.858 to 95.888	95.690	20.0
TF160 series	101.850 to 101.880	101.680	10.0

(Measuring the piston diameter)



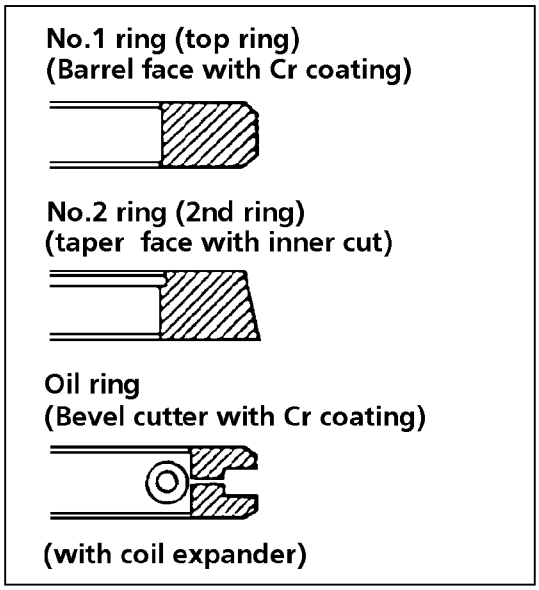
A: Measurement position

If the measured piston diameter exceeds the specified limit, replace the piston.

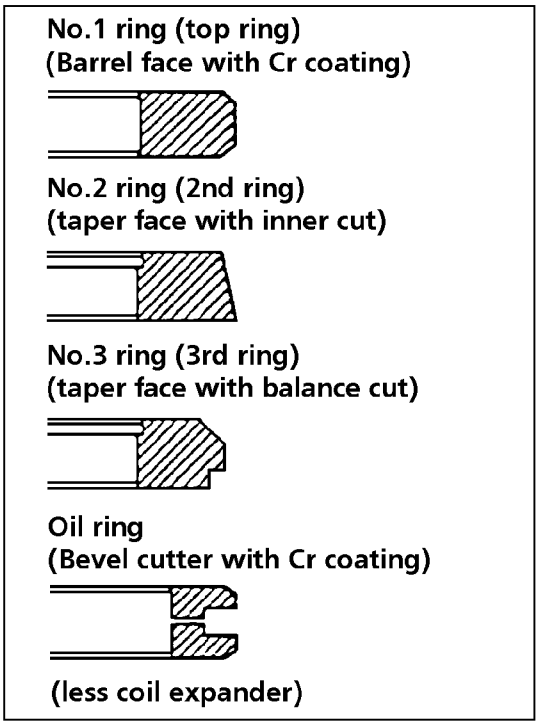
(2) Measure the clearance of piston ring

1) Piston ring arrangement

·TF50 series



·Except TF50 series



2) Measure the piston ring clearance between the new piston ring and ring groove using a thickness gauge.

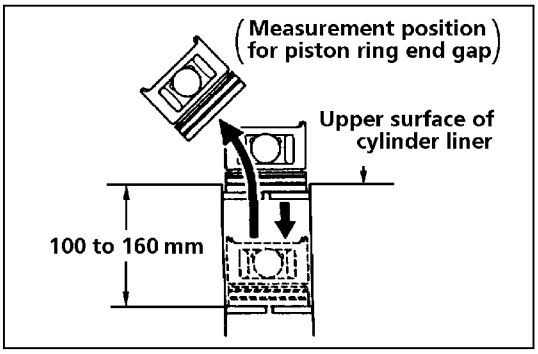
Clearance of piston ring:

Model	Item	Standard (mm)	Limit(mm)
TF50 series	No.1 ring	0.070 to 0.106	0.20
	No.2	0.045 to 0.080	0.20
	Oil ring	0.020 to 0.055	0.15
TF60, 70 series	No.1 ring	0.095 to 0.130	0.20
	No.2, No.3	0.050 to 0.085	0.20
	Oil ring	0.020 to 0.055	0.15
TF80-H, 90-H 110-H, 120-H series	No.1 ring	0.095 to 0.130	0.20
	No.2, No.3	0.050 to 0.085	0.20
	Oil ring	0.020 to 0.055	0.15
TF140, 160 series	No.1 ring	0.095 to 0.130	0.20
	No.2, No.3	0.050 to 0.085	0.20
	Oil ring	0.025 to 0.060	0.15

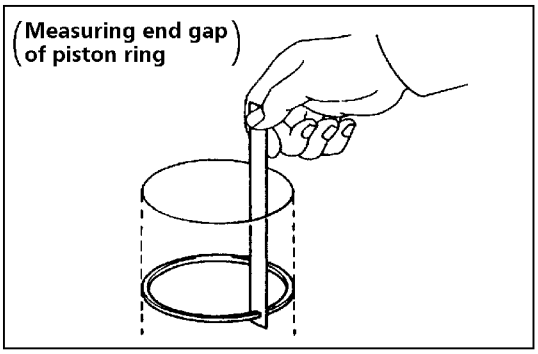
If the measured clearance exceeds the specified limit, replace the piston.

3) Measure the piston ring end gap.

- Insert the piston ring in the cylinder liner.
- Press in the piston ring to a position 100 to 160 mm from the cylinder liner top surface using the piston.



- Measure the end gap using a thickness gauge.



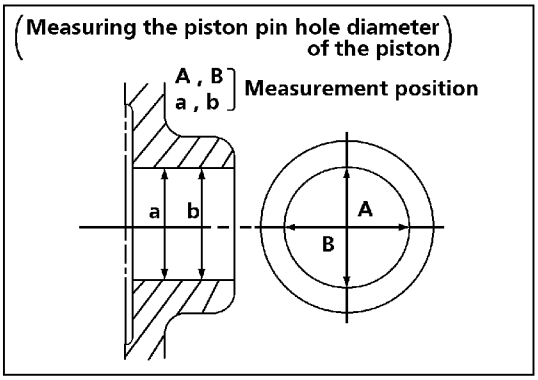
End gap:

Model	Item	Standard (mm)	Limit(mm)
TF50 series	No.1 ring	0.25 to 0.45	1.50
	No.2	0.25 to 0.45	
	Oil ring	0.10 to 0.30	
TF60, 70 series	No.1 ring	0.20 to 0.40	1.50
	No.2, No.3	0.20 to 0.40	
	Oil ring	0.20 to 0.40	
TF80-H, 90-H 110-H, 120-H series	No.1 ring	0.30 to 0.50	1.50
	No.2, No.3	0.30 to 0.50	
	Oil ring	0.30 to 0.50	
TF140, 160 series	No.1 ring	0.30 to 0.50	1.50
	No.2, No.3	0.30 to 0.50	
	Oil ring	0.30 to 0.50	

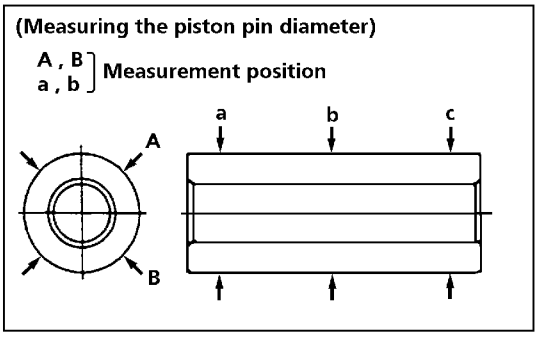
If the measured end gap exceeds the specified limit, replace the piston ring.
If the end gap still exceeds the specified limit even when the new piston ring is used, replace the cylinder liner.

3.3.3.6 Inspect the piston pin fit

(1) Measure the piston pin hole diameter of the piston using a cylinder gauge.



(2) Measure the piston pin diameter using a micrometer.



(3) Subtract the piston pin diameter from the pistonpin hole diameter.

Oil Clearance of piston pin for piston

Model	Item	Standard (mm)	Limit (mm)
TF50 serioes	Piston pin hole diameter	22.000 to 22.009	22.029
	Piston Pin diameter	21.991 to 22.000	21.941
	Oil clearance	0 to 0.018	0.100
TF60, 70 series	Piston pin hole diameter	23.000 to 23.009	23.029
	Piston pin diameter	22.991 to 23.000	22.941
	Oil clearance	0 to 0.018	0.100
TF80-M, 90-M series	Piston pin hole diameter	26.000 to 26.011	26.031
	Piston pin diameter	25.989 to 26.000	25.939
	Oil clearance	0 to 0.022	0.100
TF110-M,120-M series	Piston pin hole diameter	28.000 to 28.009	28.029
	Piston pin diameter	27.987 to 28.000	27.937
	Oil clearance	0 to 0.022	0.100
TF140,160 series	Piston pin hole diameter	32.000 to 32.011	32.031
	Piston pin diameter	31.989 to 32.000	31.930
	Oil clearance	0 to 0.022	0.100

If the measured oil clearance exceeds the specified limit, replace the piston or the piston pin or both.

3.3.3.7 Inspect the connecting rod

(1) Visually check the connecting rod for crack.

- at the Radious portion of the big end to I section and small end to I section.
- at the oil port of piston pin bearing.
- for coloring or deformation of piston pin bearing.

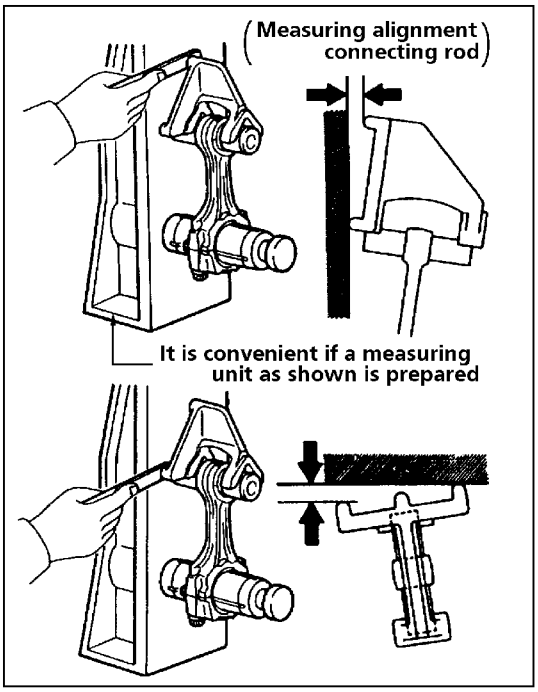
If any discovered, replace the connecting rod assy. or the bearing.

(2) Measure the alignment of the connecting rod using a rod aligner and thickness gauge.

1) Mesure the bend of the connecting rod.

Standard bend. 0.03 mm per 100 mm
Limit bend. 0.08 mm per 100 mm

If the measured bend exceeds the specified limit, replace the connecting rod assy..



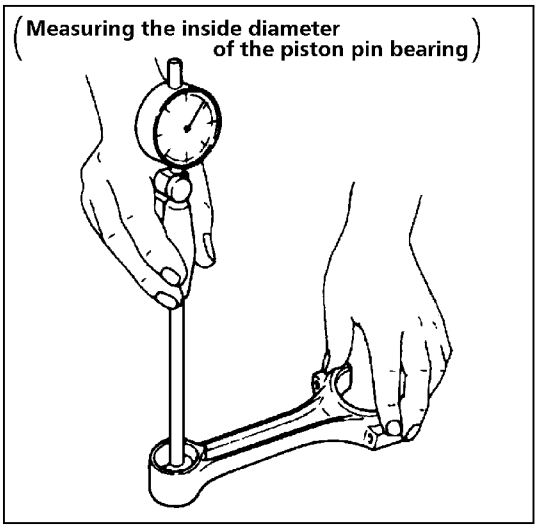
2) Measure the twist of the connecting rod.

Standard twist. 0.03 mm per 100 mm
Limit twist. 0.08 mm per 100 mm

If the measured twist exceeds the specified limit, replace the connecting rod assy..

(3) Measure the oil clearance of the piston pin.

1) Measure the inside diameter of the piston pin bearing using a cylinder gauge.



2) Measure the piston pin diameter.
see 3.3.3.6(2)

3) Substract the piston pin diameter from the inside diameter of the piston pin bearing.

Oil clearence of piston pin bearing:

Model	Item	Standard (mm)	Limit (mm)
TF50 series	piston pin bearing inside dia.	22.025 to 22.038	22.100
	piston pin dia.	21.991 to 22.000	21.941
	Oil clearance	0.025 to 0.047	0.150
TF60, 70 series	Piston pin bearing inside dia.	23.025 to 23.038	23.100
	piston pin dia.	22.991 to 23.000	22.941
	Oil clearance	0.025 to 0.047	0.150
TF80-M, 90-M series	Piston pin bearing inside dia.	26.025 to 26.038	26.100
	Piston pin dia.	25.989 to 26.000	25.939
	Oil clearance	0.025 to 0.051	0.150
TF110-M,120-M series	Piston pin bearing inside dia.	28.025 to 28.038	28.100
	Piston pin dia.	27.987 to 28.000	27.937
	Oil clearance	0.025 to 0.051	0.150
TF140, 160 series	Piston pin bearing inside dia.	32.030 to 32.050	32.100
	Piston pin dia.	31.989 to 32.000	31.939
	Oil clearance	0.030 to 0.061	0.150

If the measured oil clearance exceeds the specified limit, replace the piston pin or the piston pin bearing or both.

3.3.4 Inspection and Servicing of Crankshaft Assy.

3.3.4.1 check the oil seal

- Visually check the oil seal. If oil leakage, replace the oil seal.

3.3.4.2 Check the ball bearing

- check if the ball bearing rotates smoothly and has no play.

If any resistance or play, replace the ball bearing.

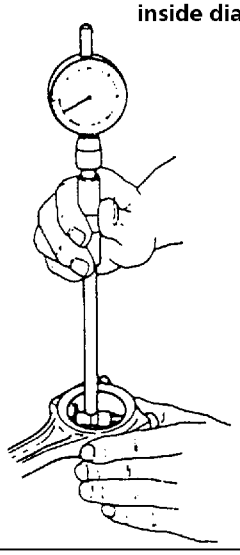
3.3.4.3 Inspect the crank pin bearing oil clearance

(1) Check the crank pin bearing surface for flaking, melting and seizing. If any, replace the bea-ring.

(2) Measure the crank pin bearing inside diameter using a cylinder gauge.

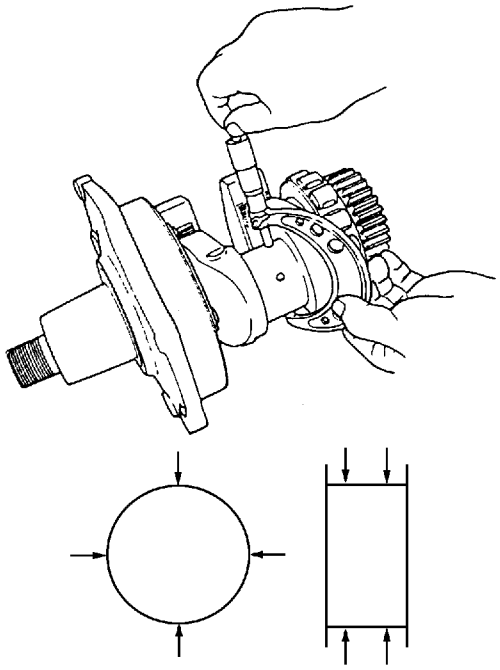
- Install the crank pin bearing cap to the connecting rod installing the crank pin bearing and tighten the connecting rod bolts to the specified tightening torque.

(Measuring the crank pin bearing inside diameter)



Tightening torque of rod bolt	
Model	Tightening torque N·m (kgf·m)
TF50 series	19.7 to 23.5 (2.0 to 2.4)
TF60, 70, 80-M, 90-M series	36.8 to 41.6 (3.75 to 4.25)
TF110-M, 120-M series	51.4 to 56.3 (5.25 to 5.75)
TF140, 160 series	55.9 to 61.7 (5.70 to 6.30)

(Measuring diameter of crank pin)



(3) Measure the crank pin diameter using a mic-rometer.

(4) Subtract the crank pin diameter from the crank pin bearing inside diameter.

Oil clearance of crank pin bearing:

Model	Item	Standard (mm)	Limit (mm)
TF50 series	Crank pin bearing inside diameter	36.000 to 36.042	36.100
	Crank pin diameter	35.965 to 35.982	36.890
	Oil clearance	0.018 to 0.077	0.150
TF60, 70 series	Crank pin bearing inside diameter	43.000 to 43.042	43.100
	Crank pin diameter	42.956 to 42.972	42.880
	Oil clearance	0.028 to 0.086	0.150
TF80-M, 90-M series	Crank pin bearing inside diameter	45.000 to 45.042	45.100
	Crank pin diameter	44.956 to 44.972	44.880
	Oil clearance	0.028 to 0.086	0.150
TF110-M,120-M series	Crank pin bearing inside diameter	48.000 to 48.038	48.100
	Crank pin diameter	47.952 to 47.973	47.880
	Oil clearance	0.028 to 0.086	0.150
TF140, 160 series	Crank pin bearing inside diameter	54.000 to 54.045	54.100
	Crank pin diameter	53.953 to 53.978	53.880
	Oil clearance	0.022 to 0.092	0.150

If the measured oil clearance exceeds the specified limit, replace the crank pin bearing or grind the crank pin to apply the under size bearing.

(5) Measure the out - of - round of the crank pin.

Out - of - round:

Model	Limit (mm)
All	Less than 0.08

If the measured out-of-round excee-ds the specified limit, grind the crank pin to apply the under size bearing.

Under size crank pin bearing:

Mark	Size
US 25	0.25 mm smdller than standard bearing in diameter
US 50	0.5 mm smaller than standard bearing in diameter

3.3.5 Inspection and Servicing of Balancer Shaft Assy. (except TF50 series)

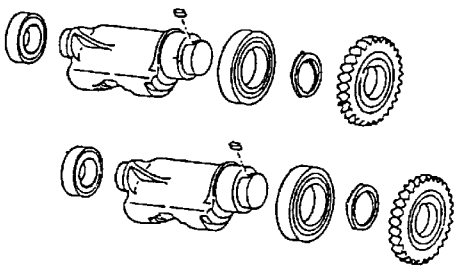
3.3.5.1 Check the ball bearings and gears

(1) Check if the ball bearings rotate smoothly and no play. If any resistance or play, replace the bearing.

(2) Check the gears for wear or damage of gear tooth face. If any worn or damaged, replace the gear.

- Since the gears are shrinkage fitted to the balancer shafts, heat the gear up 180 to 200℃ to remove or install.

(Removing balancer gear)



3.3.6 Inspection and Servicing of Camshaft

3.3.6.1 Check the ball bearing, gears and the bearing portion of camshaft end (TF50 series: both side)

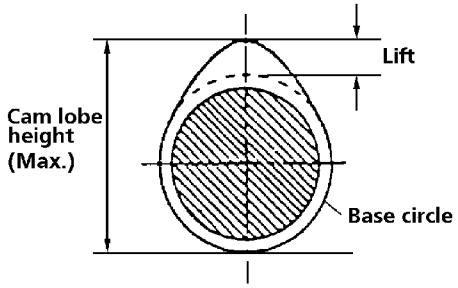
(1) Check it the ball bearing rotates smoothly and no play. If any resistance or play replace the ball bearing. (except TF50 series)

(2) Check the bearing portion of camshaft end forseizing. (TF50 series: both side)

If any damaged, replace the camshaft.

(3) Check the cam gear for wear or damage of gear tooth face. If any worn or damaged, re-place the cam gear.

(Measuring intake and exh. cam lobe height)



3.3.6.2 Check the intake and exh.cam lobe height

(1) Measure the cam lobe height (Max.).

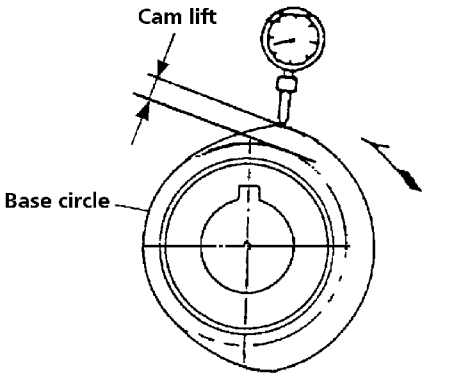
3.3.6.3 Measure the fuel injection cam lift using a dial indicator

(1) Set the camshaft on a V-block.

(2) Measure the max. cam lift using a dial indicator.

- Set a daial indicator on the cam base circle. (0 reading)
- Turn the camshaft to the direction as shown in the illustration and read the max. indicating of a dial indicator.

(Measuring fuel injection cam lift)



Cam lobe height and cam lift:

Model	Item	Cam lobe height(Max.)(mm)		Cam lift (mm)	
		Standard	Limit	Standard	Limit
TF50 series	Intake, Exh.cam	34.30	34.00	(5.30)	(5.00)
	F.O.cam	------	------	7.00	6.90
TF60, 70 series	Intake, Exh.cam	37.25	36.95	(5.25)	(4.95)
	F.O.cam	------	------	7.00	6.90
TF80-M, 90-M series	Intake cam	41.00	40.70	(6.00)	(5.70)
	Exh.cam	39.50	39.20	(5.50)	(5.20)
	F.O.com	------	------	7.00	6.90
TF110-M, 120-M series	Intake, Exh.cam	39.50	39.20	(5.50)	(5.20)
	F.O.cam	------	------	7.00	6.90
TF140, 160 series	Intake, Exh.cam	44.80	44.50	(6.80)	(6.50)
	F.O.cam	------	------	9.00	8.90

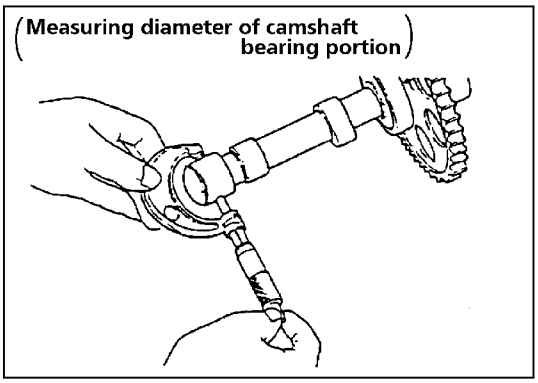
If the measured cam lobe height or cam lift exceeds the specified limit, replace the camshaft.

3.3.6.4 Check the oil clearence of the bearing portion of camshaft.

(1) Measure the inside diameter of camshaft bearing hole in the cylinder block using a cy-linder gauge.

(2) Measure the camshaft diameter of camshaft bearing portion using a micrometer.

(3) Subtract the measured camshaft end dia-meter from the measured inside diameter of camshaft bearing hole.



Oil clearance:

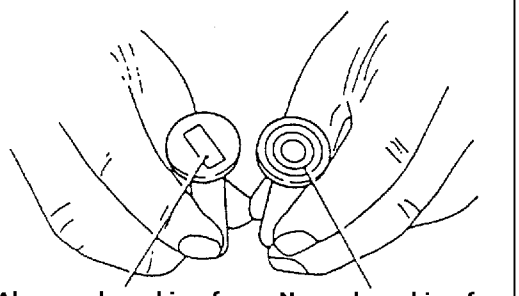
Model	Item		Standard (mm)	Limit (mm)
TF50 series	Flywheel Side	Inside dia.of bearing hole	20.000 to 20.021	20.050
		Camshaft bearing portion dia.	19.939 to 19.960	19.900
		Oil clearance	0.040 to 0.082	0.150
	Gear side	Inside dia.of bearing hole	40.000 to 40.025	40.060
		Camshaft bearing portion dia.	39.950 to 39.980	39.900
		Oil clearance	0.020 to 0.075	0.150
TF60, 70, 80-M, 90-M, 110-M, 120-M series	Flywheel side	Inside dia.of bearing hole	22.000 to 22.021	22.050
		Camshaft bearing portion dia.	21.939 to 21.960	21.900
		Oil clearance	0.010 to 0.082	0.150
TF140,160 series	Flywheel side	Inside dia.of bearing hole	25.000 to 25.021	25.050
		Camshaft bearing portion dia.	24.939 to 24.960	24.900
		Oil clearance	0.010 to 0.082	0.150

If the measured oil clearance exceeds the specified limit, replace the camshaft or cylinder block or both.

3.3.6.5 Check the tappet

(1) Visually check if the contact surface to the cam is normal contact. If poor contact or worn, replace the tappet.

(Checking on tappet)

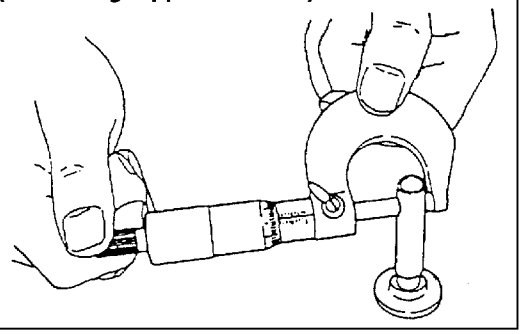


(2) Measur the tappet hole diameter in the cy-linder block using a cylinder gauge.

(3) Measure the tappet diameter using a micro-meter.

(4) Subtract the measured tappet diameter from the measured tappet hole diameter.

(Measuring tappet diameter)



Oil clearance:

Model	Item	Standard (mm)	Limit (mm)
TF50, 60, 70 80-M, 90-M 110-M, 120-M series	Tappet hole diameter	10.020 to 10.040	10.080
	Tappet diameter	9.980 to 9.995	9.950
	Oil clearance	0.025 to 0.060	0.120
TF140, 160 series	Tappet hole diameter	13.020 to 13.040	13.080
	Tappet diameter	12.966 to 12.984	12.950
	Oil clearance	0.036 to 0.074	0.150

If the measured oil clearance exceeds the specified limit, replace the tappet or cylinder block or both.

3.3.7 Inspection of Cylinder Liner

3.3.7.1 Visually check the cylinder liner

Visually check for coloring or cracks of the cylinder surface. If any suspecting cracks are found, confirm them using color checking. If any coloring or cracks, replace the cylinder liner.

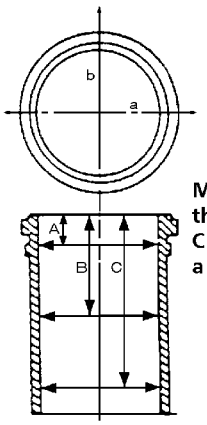
3.3.7.2 Measure the cylinder bore diameter

The cylinder bore diameter must be measured at three places A, B and C from the cylinder liner top.

Circularity: Difference between the maximum and minimum in the same cross section.

Cylindricity: Difference between the maximum and minimum in the same direc-tion.

(Measuring position of cylinder bore)



Make measurments at the points of A, B and C in two directions of a and b.

Cylinder bore diameter:

Model & Item	Standard (mm)	Limit (mm)	Measuring position (mm)		
			A	B	C
TF50 series	74.000 to 74.030	74.180	14	52	93
TF60 series	75.000 to 75.030	75.180	15	62	108
TF70 series	78.000 to 78.030	78.180			
TF80-M series	80.000 to 80.030	80.180	16	67	118
TF90-M series	85.000 to 85.035	85.200			
TF110-M series	88.000 to 88.035	88.200	18	73	129
TF120-M series	92.000 to 92.035	92.200			
TF140 series	96.000 to 96.035	96.220	21	83	144
TF160 series	102.000 to 102.035	102.230			
Circularity	0.015 or less	0.050	----------		
Cylindricity	0.015 or less	0.050	----------		

If the measured cylinder bore diameter exceeds the specified limit, replace the cylinder liner.

3.3.7.3 Check the cylinder block

- Visually check for cracks on the cylinder block and for clogging of oil passage in the cylinder block.

If any suspecting cracks are found, confirm them using color checking.

- Clean the oil passage.

3.3.8 Checking the Bearings

3.3.8.1 Check the roller bearing (Gear case side)

Check that roller bearing is not rough or worn(smoothly rotating or no radial play). If any rough or worn, replace the roller bearing.

(If needed)

(1) Remove the crankshaft gear. Heat up to 180 to 200℃ the gear and pull it out from the crank shaft.

(2) Remove the inner race integulated cage and rollers using a gear puller.

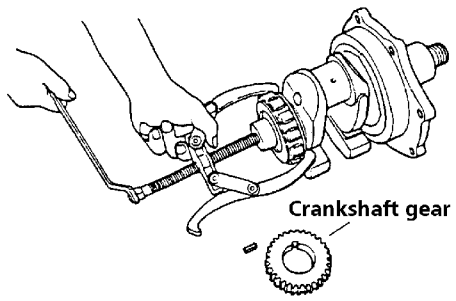
(Except TF50, 60, 70 series.
These engines are used ball bearing.)

(3) Remove the outer race of the roller bearing from the cylinder block.

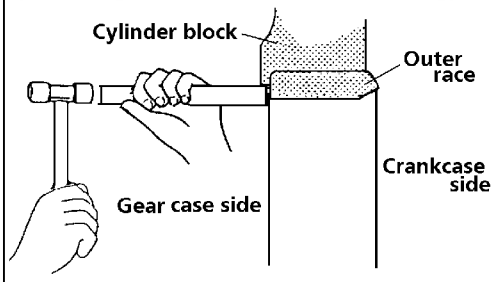
(Except TF50, 60, 70 series.)

- Tap out the inner race to the crank case side using a non-metalic bar(aluminum or copper bar) and a plastic hammer so as not to damage on the cylinder block.

(Removing the inner race of roller bearing)



(Removing the outer race of roller bearing)



3.3.8.2. Check the ball bearing (Flywheel side)

Check that ball bearing is smoothly rotating and crankshaft thrust clearance in the limit.
(See 3.3.2.8(1) Check the thrust clearance of the crankshaft before removing crankshaft) If any, replace the ball bearing.

(If needed)

(1) Remove the key on the crankshaft.

(2) Remove the retainer for ball bearing loosening 6 bolts.

(3) Put the crankshaft with bearing housing on the stand as shown in the illustration.

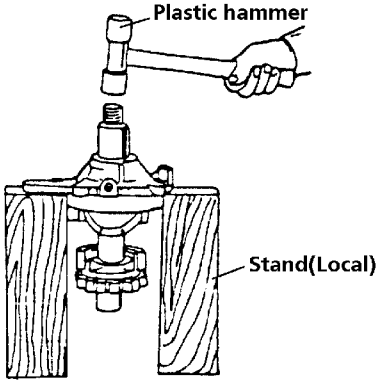
(4) Slowly remove(lightly tap on the end of the crankshaft using a plastic hammer) the bea-ring housing so as not to damage oil seal lip.

(5) Remove the circlip on the crankshaft.

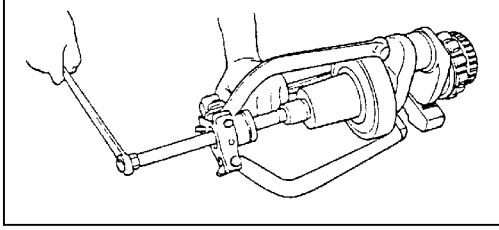
(TF50, 60, 70 series only.)

(6) Remove the ball bearing using a gear puller.

(Removing the bearing housing)



(Removing the ball bearing)



3.3.9 Installation of the Bearings

3.3.9.1 Install the roller bearing on the crankshaft.

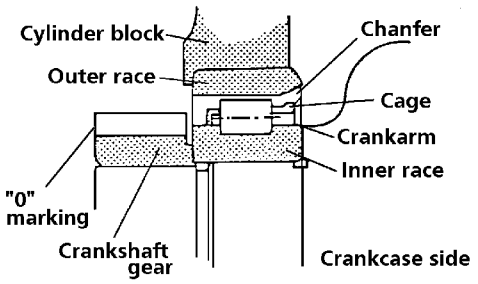
(1) Insert the outer race of the roller bearing into the bearing hole of the cylinder block.

- TF50, 60, 70 series are used ball bearing.

1) Face the chanfer on the bore side of the outer race to the crankcase side.

2) Insert the outer race toward the gear side until the outer race end surface contacts the bea-ring hole flange of the cylinder block.

(Installing the roller bearing)



(2) Press fit the inner race integulated cage and rollers to the crankshaft.

1) Lightly apply grease to the crankshaft.

2) Face the open side of the cage to the crankarm side.

(3) Shrinkage fit the crankshaft gear heating up to 180 to 200℃.

- Face the mating mark "0" to the outside.

3.3.9.2 Install the ball bearing on the crankshaft

(1) Insert the ball bearing to the crankshaft using a ball bearing inserting tool(Local supply).

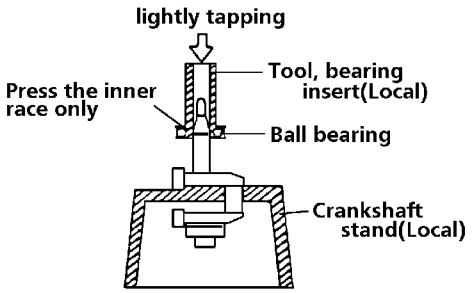
1) Set the crankshaft on the crankshaft stand (Local supply).

2) Lightly apply grease to the crankshaft.

3) Put the ball bearing on the crankshaft.

4) Lightly tap the ball bearing inserting tool using a plastic hammer until the inner race surface contacts to the crankshaft.

(Installing the ball bearing)



[NOTICE]

- ***Use a crankshaft stand so as not to deform the crankshaft while installing the bearing.***

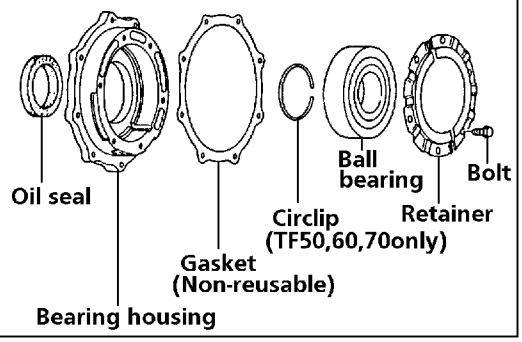
Bearing inserting tool should be designed to press only the inner race end surface so as not to damage the bearing.

(2) Install the circlip on the crankshaft.
(TF50, 60, 70 series only)

(3) Install the bearing housing.

1) Replace the oilseal, if needed.
- Pry out the oil seal using a screwdriver and hammer.
- Tap in the new oil seal until its surface is rush with the bearing housing edge.

(Components of the flywheel side bearing)



2) Apply grease to the oil seal lip.

3) Install the bearing housing to the bearing on the crankshaft so as not to damage the oil seal lip.

4) Turn the bearing housing on the crankshaft by hand and confirm that the bearing housing smoothly rotates.

5) Install the retainer(2 pieces separated) on the bearing housing with 6 bolts.
(tighten uniformly)

6) Install the feather key on the crankshaft so as not to damage the feather key and oil seal.

3.3.10 Assembly of Cylinder Block

3.3.10.1 Install the radiator

[NOTICE]

Confirm that there are no materials for bolts, tools etc. in the cylinder jacket.

(1) Install the new gasket to the cylinder block.

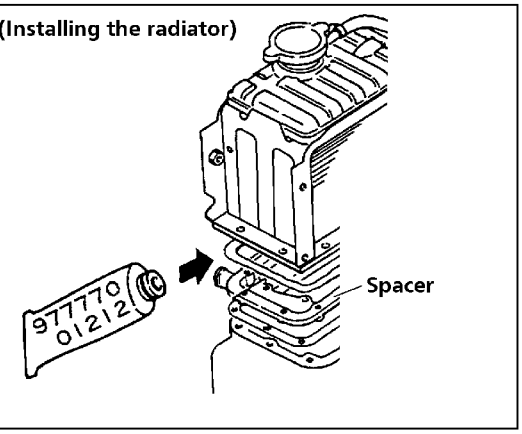
(2) Install the spacer with the bolts.
Uniformly tighten the bolt in several passes.

(3) Apply the seal packing to the spacer suface installing the radiator.
- Apply the seal packing to the inside portion of the tightening surface of the bolt holes as shown in the illustration.

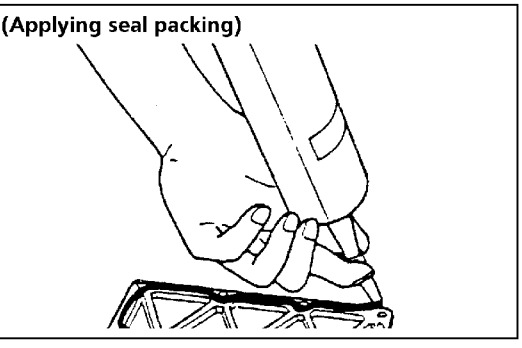
(4) Install the radiator with the bolts.
Uniformly tighten the bolts in several passes.

(Seal packing: Three Bond TB1212
YANMAR P/N: 977770-01212)

(Installing the radiator)



(Applying seal packing)

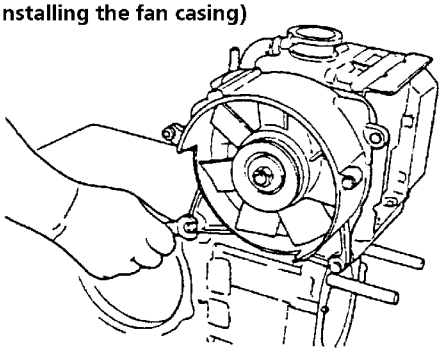


(5) Install the sub tank to the radiator.

- Put in the radiator overflow hose to the subtank untill the hose end contacts the bottom of sub tank.
- Surely install the hose clip to the radiator side hose end.

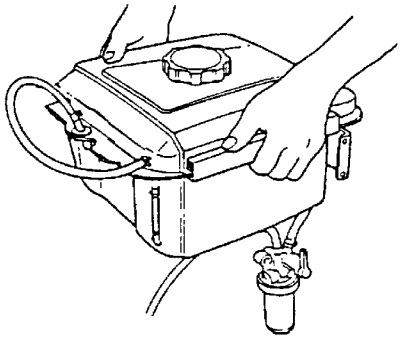
(6) Install the fan casing.

(Installing the fan casing)



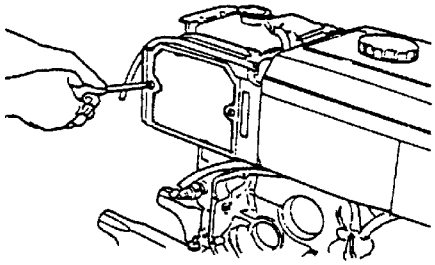
(7) Install the fuel oil tank.

(Installing the fuel oil tank)



(8) Install the screen.

(Installing the screen)



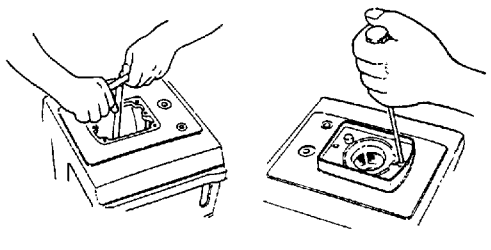
(9) Install the hopper.(-H version).

1) Install the new gasket to the cylinder block.

2) Install the hopper with the bolt.
Uniformly tighten the bolts in several passes.

3) Install the inside core with the bolt.

(Installing hopper) (-H version)



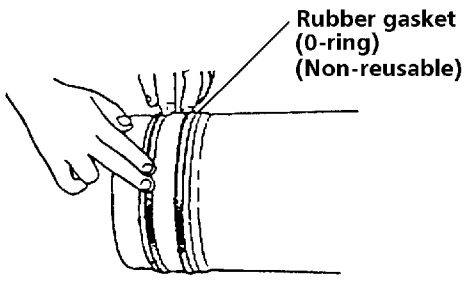
3.3.10.2 Install the cylinder liner

(1) Clean the grooves for the rubber gasket on the cylinder liner.

(2) Try to install the cylinder liner to the cylinder block without rubber gaskets(o-ring) if the cylinder liner can be inserted to the cylinder block smoothly.

(3) If not, completely remove the scale or rust on the cylinder block.

(Installing the cylinder liner)



(4) Install the new rubber gasket(o-ring) to the grooves on the cylinder liner not to skew the rubber gasket.

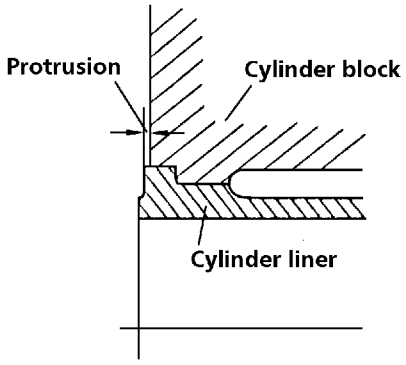
(5) Uniformly and lightly apply the whilte paint(NB-2041-1) to the neck and flare(fitting portion to the cylinder block) of the cylinder liner for anti-rust and easy installation.
(White paint: Nippon Paint NB-2041-1)

(6) Install the cylinder liner with the rubber gaskets to the cylinder block by hand.

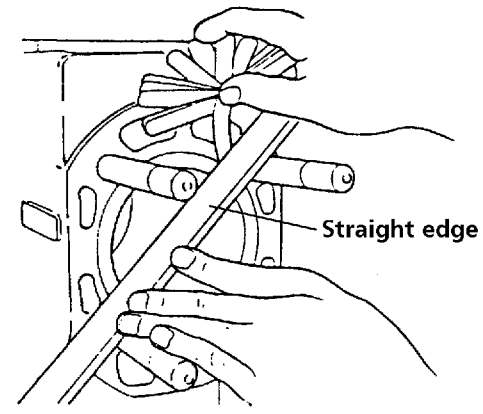
(7) Confirm the protrusion.
Measure the protrusion of the cylindern liner using a staraight edge and thickness gauge to confirm the specified.

Model	Specified protrusion (mm)
All	0.02 to 0.08

(Confirming the protrusion)



(Measuring the protrusion)



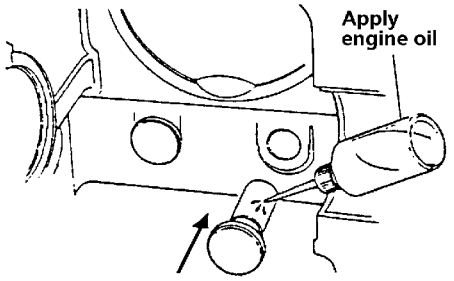
3.3.10.3 Install the tappet

(1) Make sure that tappets should be installed to the original position of the exhaust and intake side.

(2) Lightly apply engine oil to the tappet.

(3) Confirm that tappets move smoothly.

(Installing the tappet)



3.3.10.4 Install the camshaft assy.

(1) Lightly apply engine oil to the bearing surface and cam profile.

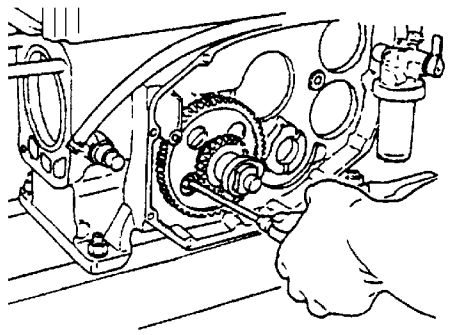
(2) Install the camshaft.
Lightly tap on the camshaft end.

[NOTICE]

Face the exhaust cam top to the direction of the cylinder body cover so as not to contact with exhaust cam top and cylinder liner while installing the camshaft assy.

(3) Set the camshaft bearing retaining bolt.

(Installing the camshaft assy.)



3.3.10.5 Install the crankshaft assy.

(1) Install the new gasket for bearing housing.

(2) Install the crankshaft assy..
Match the mating mark on the cam gear and crankshaft gear as shown in the illustaration.

(3) Unformly tighten the bolts for bearing housing.
(Tightening forque: 22.6 to 28.4 N・m (2.3 to 2.9 kgf・m))

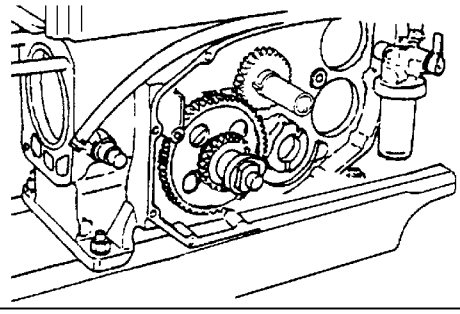
(4) Install the balancer drive gear to the crankshaft.
(TF50 series: spacer)

(5) Install the governor weight to the balancer drive gear with 2 bolts.

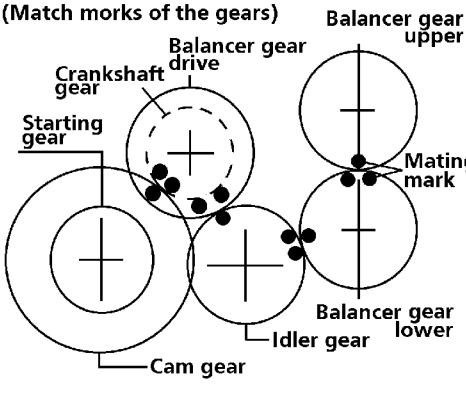
(6) Temporarily install the tension pulley to the cylinder block. (except (-H) version)

(7) Temporarily install the V-belt to the fan pulley.
(except (-H) version)

(Installing the crankshaft assy.)



(Match morks of the gears)



3.3.10.6 Install the flywheel

(1) Install the flywheel back covers.

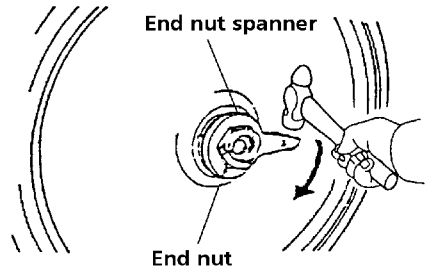
(2) Install the flywheel.

1) Wipe the taper porlions of the crankshaft and flywheel using a clean cloth.

2) Install the flywheel to the crankshaft tempo-rarily installing the V-belt on the flywheel V pulley.

3) Apply engine oil to the end nut seat and cra-nkshaft thread.

(Installing the flywheel)



4) Tighten the end nut using the end nut spanner as shown in the illustration or torque wrench.

When use torque wrench, secure the flywheel not to rotate using the taps on the flywheel for installing stubshaft.

Tightening torque:

Model	Tightening torque N·m (kgf·m)
TF50 series	166.7 to 196.1 (17 to 20)
TF60, 70, 80-M, 90-M series	245.2 to 284.3 (25 to 29)
TF110-M, 120-M TF140, 160 series	294.2 to 343.2 (30 to 35)

3.3.10.7 Install the piston and connecting rod assy.

(1) Assemble the piston and connecting rod.

1) Install the new circlip to one of the snap ring grooves.

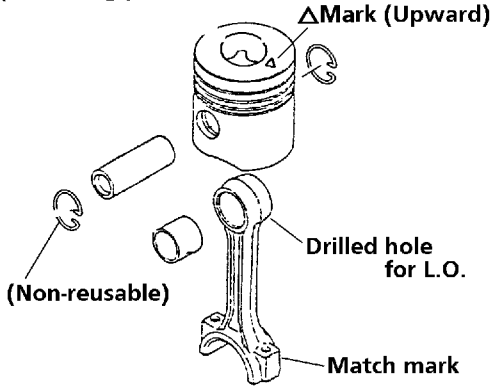
2) Slowly heat the piston to 50 to 60℃ in a oil bath.

3) Apply engine oil to the piston pin.

4) Align upward marks of the piston and conn-ecting rod and then press in the piston pin by the thumb.

5) Install the new circlip to the circlip groove on the opposite side.

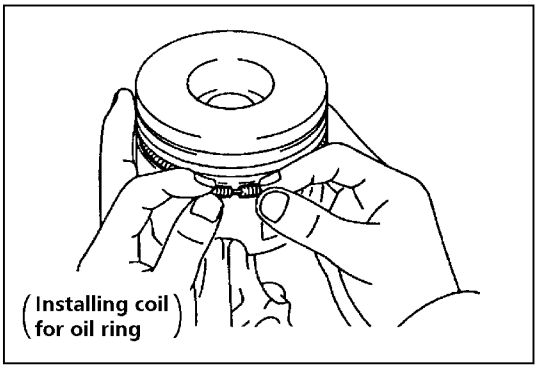
(Aligning the piston and connecting rod mounting position)



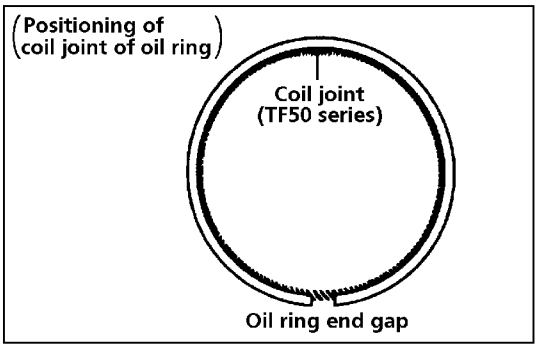
(2) Install the piston ring

1) Manually install the coil for oil ring.
(TF50 series only)

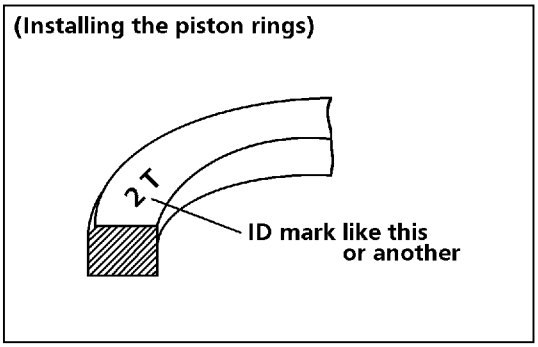
2) Install the oil ring using a piston ring expander.



- Install the oil ring so that the ring end faces the opposite side of the coil joint.



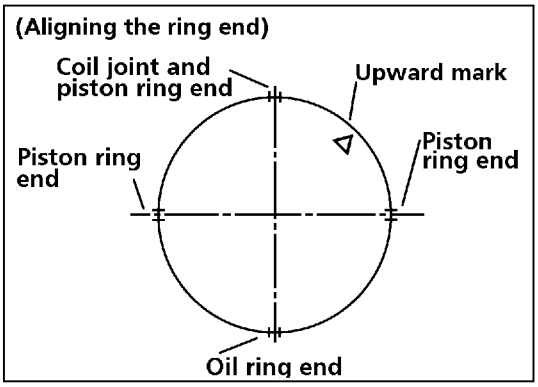
- Install the piston rings using a piston ring expander in a way that the identification mark(if they have ID mark) faces up.



- Install the piston rings so that the ring ends are located as shown in the illustration.

[NOTICE]

Pay attension so that the ring ends are not overlapped at the same position.



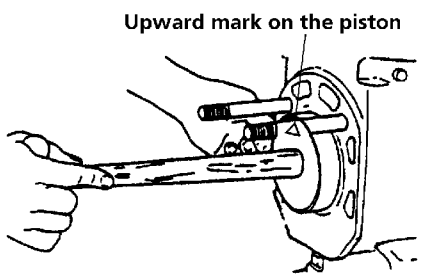
(3) Install the piston and connecting rod assy. to the cylinderblock.

1) Uniformly apply engine oil to the piston and piston rings sliding surface with cylinder liner.

2) Turn the crankshaft to locate the crank pin to the T·D·C· position(cylinder head side).

3) Using a piston ring compressor, push the piston and connecting rod assy. facing the upward mark on the piston top to the upward untill the crank pin bearing contacts to the crank pin.

(Installing the piston and connectin rod assy.)



4) Slowly turn the crankshaft along with the connecting rod to the B·D·C· pushing the piston using a hammer grip end.

5) Install the connecting rod cap on the connecting rod.
- Match the mark on the connecting rod and connecting rod cap. (confirm that the marks are located upside)

6) Install the connecting rod bolt.
- Lightly apply engine oil to the thread and seat.
- Alternately tighten the connecting rod bolt with specified tightening torque.

Tightning torque:

Model	Tightening torque N·m (kgf·m)
TF50 series	19.7 to 23.5 (2.00 to 2.40)
TF60, 70, 80-M, 90-M series	36.8 to 41.6 (3.75 to 4.25)
TF110-M, 120-M series	51.5 to 56.3 (5.25 to 5.75)
TF140, 160 series	55.9 to 61.7 (5.70 to 6.30)

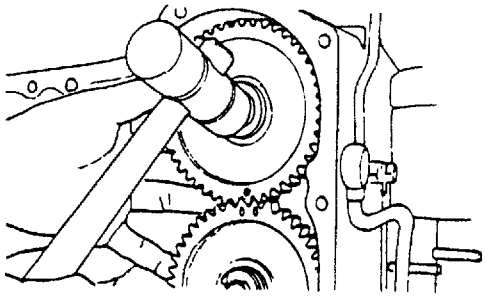
(apply engine oil to the thread and seat)

3.3.10.8 Install the balancer shaft assy. (Except TF50 series)

(1) Turn the crankshaft to locate the piston to the T·D·C·.

(2) Install the balancer shaft matching the match marks as shown in the illustration.

(Installing the balancer shaft assy.)



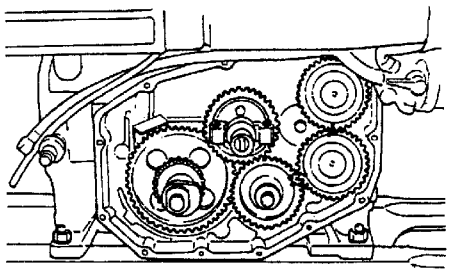
(3) Install the bearing retainer for the balancer shaft with bolt.

(4) Install the idler gear together with the idler gearshaft matching the match mark with the balancer gear drive and balancer gear lower as shownin the illustration.

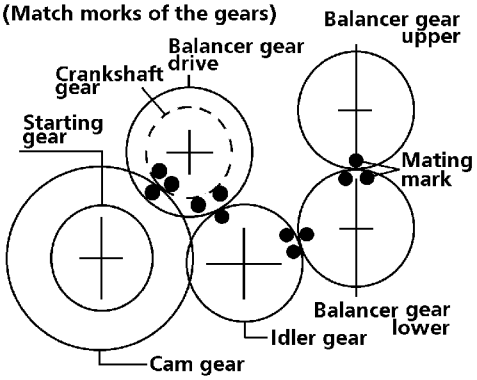
Tightening torque of the idler gear shaft bolt:
44.1 to 53.9 N·m (4.5 to 5.5 kgf·m)

(5) Install the gear cover.

(Installing the bearing retainer and idler gear)



(Match morks of the gears)



3.3.10.9 Install the cylinder body cover

(1) Completely remove the adhering packing material on the sealing surface.

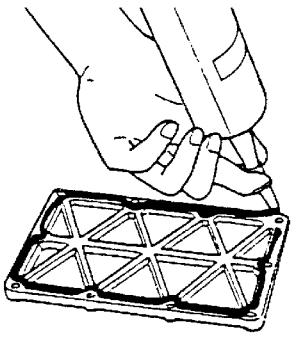
(2) Apply the seal packing to the cylinder body cover sealing surface.

- Apply the seal packing to the inside portion of the tightening surface of the bolt holes as shown in the illustration.

(3) Install the cylinder body cover with the bolts. Uniformly tighten the bolts in several passes.

(Seal packing: Three Bond TB1212
YANMAR P/N: 977770-01212)

(Applying seal packing on the cylinder body cover)



3.3.10.10 Install the gear case

(See 3.2.5 Installation of Gear Case)

3.3.10.11 Install the cylinder head

(See 3.1.6 Installation of Cylinder Head)

3.3.10.12 Adjust the V-belt for fan drive (Except -H version)

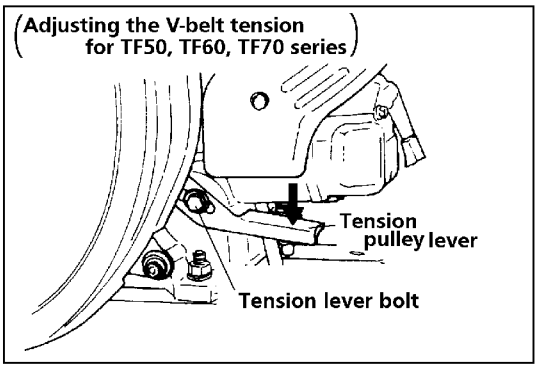
[NOTICE]

- ***Adjust the V-belt tension in the specified not to damag for fan bearing and V-belt due to too tight, or not to slip V-belt due to too loose.***
- ***Do not contaminate the V-belt with oil.***

(1) For TF50, TF60, TF70 series

1) Adjust the V-belt tension pressing down the tension pulley lever contemporarily installed.

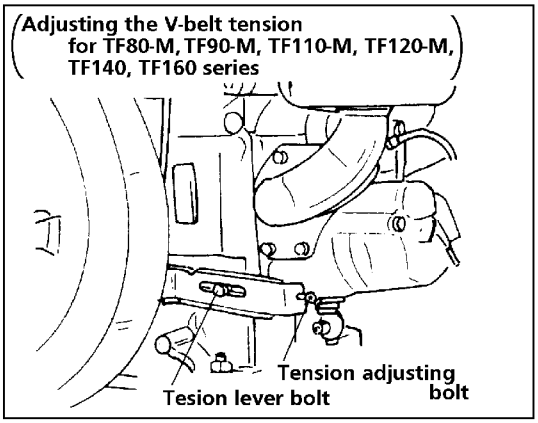
2) Securely tighten the tension lever bolt ad-justing the specified tension of the V-belt using a spanner.



(2) For TF80-M, TF90-M, TF110-M, TF120-M, TF140,TF160 series.

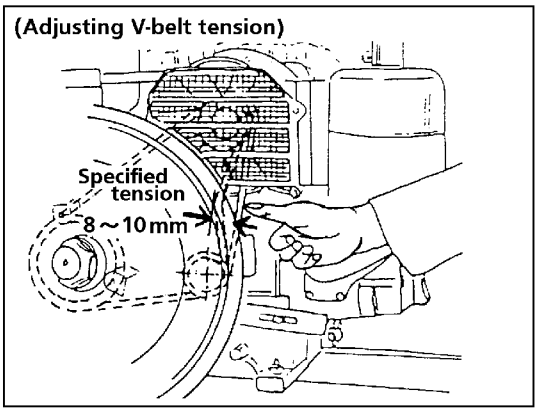
1) Adjust the V-velt tension turning the tension pulley adjusting bolt contemporarily installed.

2) Securely tighten the tension pulley lever bolt adjusting the specified using a spanner.



3) Adjust the specified V-belt tension. Press the V-belt on the midle by thumb as shown in the illustration.

Specified V-belt tension: 8 to 10 mm



3.3.10.13 Install the starter motor (-E version)

3.3.10.14 Install the flywheel cover

3.3.10.15 Install the radiator cover

3.3.10.16 Fill with engine coolant

3.3.10.17 Fill up engine lube oil to the upper level of the oil dipstick

3.3.10.18 Bleed the air in the fuel oil pipe using the fuel cock attached fuel filter

3.3.10.19 Start the engine and check for oil leakage

3.3.10.20 Check the lube oil level again and, if need, replenish up to the upper level of the oil dipstick

3.3.11 Checking for the Fresh Water Leakage

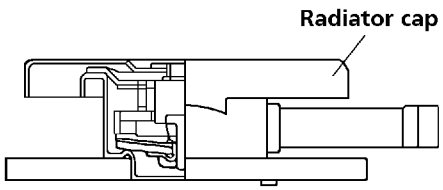
3.3.11.1 Remove the radiator cap (Except -H version)

- Confirm that fresh water in the radiator is full.

⚠ WARNING

Never remove the radiator cap while the engine and radiator are hot.
Otherwise, you will be burnt by hot water and steam.

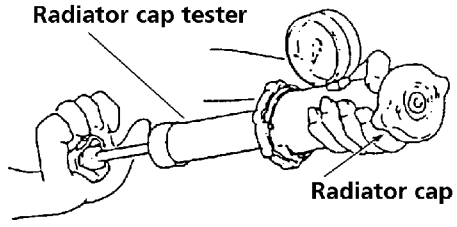
(Radiator cap appearence)



3.3.11.2 Check the radiator cap

- If the radiator cap is contaminated by foreign matter, wash with water.
- Measure the valve opening pressure by applying pressure to the radiator cap using the radiator cap tester.

(Inspecting the radiator cap)



Standard valve opening pressure:
0.074 to 0.102 Mpa (0.75 to 1.05 kgf/cm^2)
Minimum valve opening pressure:
0.059 Mpa (0.6 kgf/cm^2)

- Use the maximum reading of the tester as the valve opening press.

If the measured valve opening press. is less than specified min. valve opening press., replace the radiator cap.

3.3.11.3 Check for the fresh water leakage

(1) Full the radiator and engine with fresh water and bleed air from the radiator and engine.

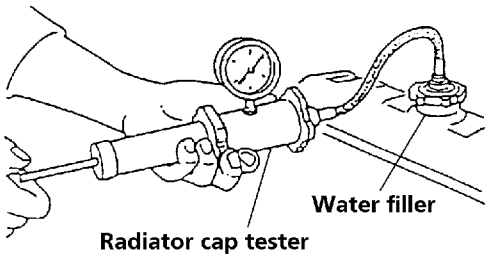
(2) Attach the radiator cap tester to the water filler.

(3) Inclease the pressure to 0.117Mpa(1.2 kgf/cm^2) by the radiator cap tester and check that the pressure does not drop.

If it does, check the radiator, the radiator installing contact surface for leakage.

If no leakage is discovered from the outside, check the cylinder block and cylinder head.

(Checking fresh water leakage)



3.4 Inspection and Adjustment of Fuel Injection Timing

3.4.1 Installation of a Test Pipe for Measuring Injection Timing

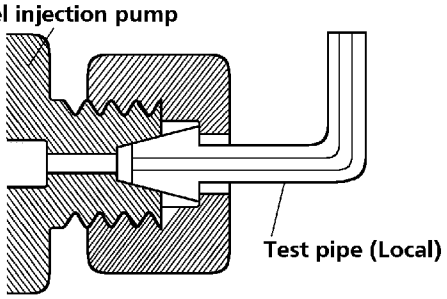
(1) Bleed the air in the fuel pipe line using the fuel cock attached to the fuel filter.

(2) Set the speed control lever to the "start" pos-ition.

(3) Remove the fuel injection pipe.

(4) Install the test pipe for measuring fuel injection timing on the fuel injection pump.

(Installing the test pipe for measuring injection timing)



3.4.2 Checking the Fuel Injection Timing

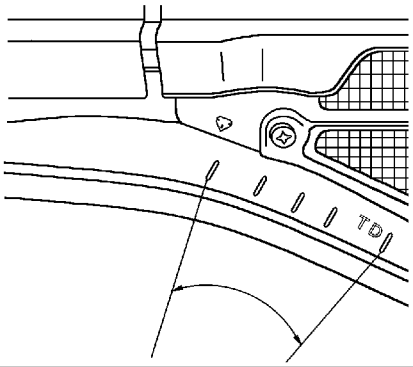
slowly turn the flywheel to counter-clockwise viewing from the flywheel side and watch the fuel oil starting to show up from the open end of a test pip and then read the timing mark on the flywheel matching the point of the match mark.

Repeat the procesure in several times and decide the exact fuel injection timing.

Fuel injection timing:

Model	Standard deg. (b.T.D.C.)
TF50 series	12.5
TF60, 70, 110-M, 120-M, 140, 150 series	17.0
TF80-M, 90-M series	18.0

(Checking the fuel injection timing)



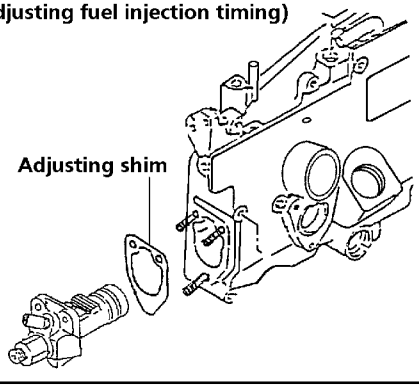
3.4.3 Adjusting the Fuel Injection Timing

If the measured fuel injection timing is out of specified, adjust it using the adjusting shim.

Adding a shim, retards the fuel injection timing about 2 deg.

(See 3.2.2.6 Remove the fuel injection pump)
(See 3.2.5.2 Install the fuel injection pump)

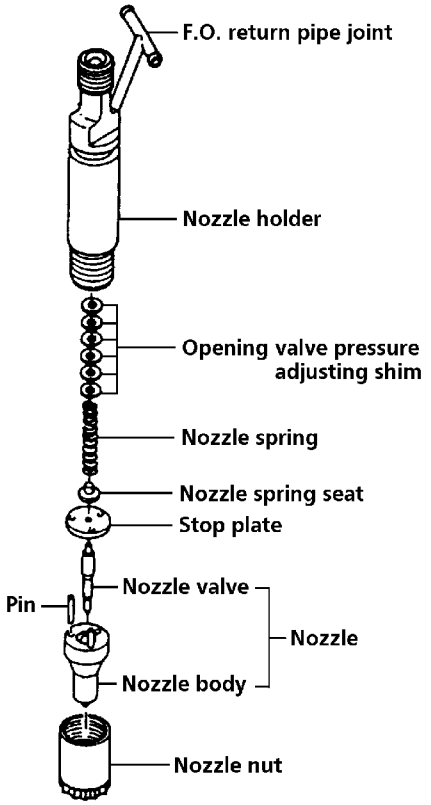
(Adjusting fuel injection timing)



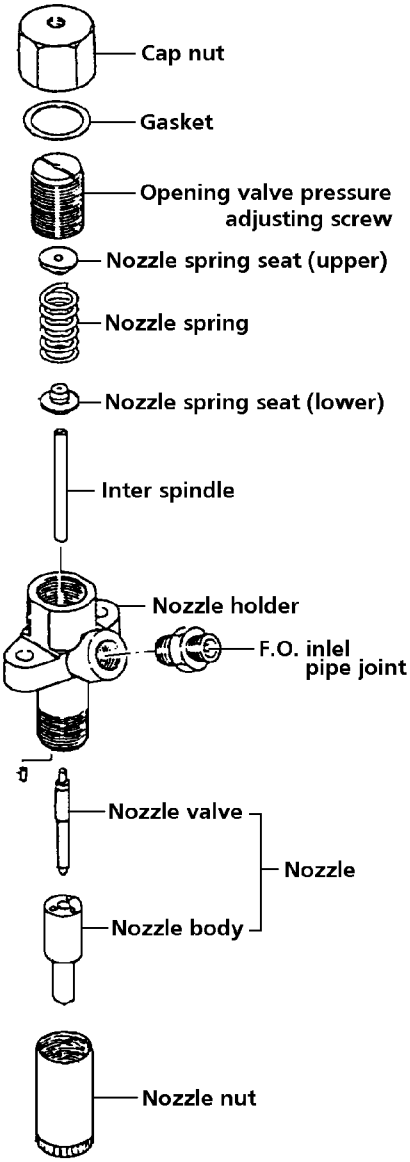
3.5 Fuel Injection Nozzle

3.5.1 Components

- TF50, 60, 70, 80-M, 90-M, 110-M, 120-M series



- TF140, 160 series

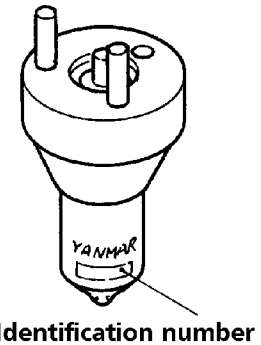


Nozzle body identification number.
The type of nozzle can be determined from the number inscribed on the outside of the nozzle body.
Hole type fuel injection nozzles.

Sample

Y DLL A — 150 P 244JO

- Y: YANMAR
- DLL: Type (DLL: semi-long type)
- A: Mounting angle of nozzle on cylinder head. Code A: at angle. No code: not at angle
- 150: Spray angle
- P: Nozzle size P size, S size
- 244JO: Design code



Identification number

3.5.2 Removal of Fuel Injection Nozzle

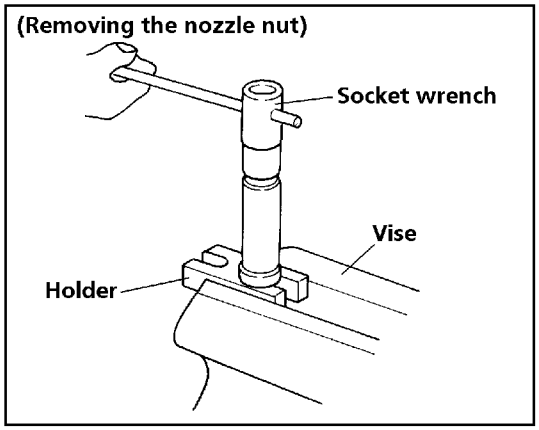
(See 3.1.2 Removal of Cylinder Head)

3.5.3 Disassembly and Cleaning

3.5.3.1 Remove the nozzle nut

(1) Use a vise attaching holder to set the nozzle holder as shown in the illustration.
(Holder P/N: 158090-51700)

(2) Loosen the nozzle nut using the socket wrench.
(Socket wrench(4D-15)
P/N: 158090-51710)



3.5.3.2 Remove the inner parts

Remove the nozzle nut from the fuel injection nozzle and disassemble each part.

[NOTICE]

Be careful not to lose the spring seat, adjusting shims and other small parts.

3.5.3.3 Clean the parts

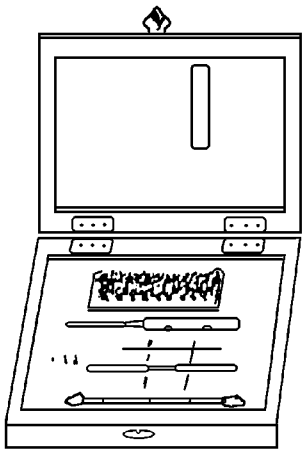
Clean the disassembled parts with new diesel fuel oil using the nozzle cleaning kit.

[NOTICE]

- ***Be careful not to scratch fitting surface or seats.***
- ***Do not use a wire brush.***
- ***Soak the nozzle in new diesel fuel oil.***

Nozzle cleaning kit

- Zexel
  Type: NP-8486B No.5789-001
- Anzen Motors
  Type: NCK-001



3.5.4 Checking the Parts

3.5.4.1 Check the fitting surfaces(stop plate and nozzle body) and spring seat for scratches dents, wear, and rust.

If any damage, replace the assembly.

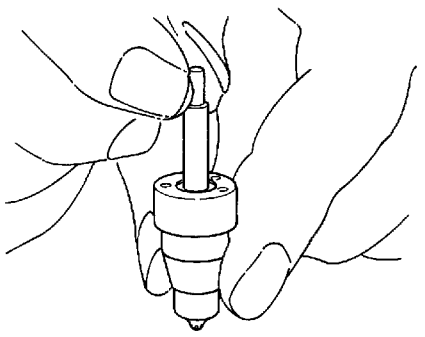
3.5.4.2 Check the nozzle

(1) Check the nozzle sliding part and seat.

Visually check the sliding part of the nozzle for scratches, wear and the nozzle seat for corrosion, dents or other damage. If any, replace the assembly.

(2) After cleaning the nozzle valve and the nozzle body with clean diesel fuel oil, assemble the nozzle valve and nozzle body. Pull the nozzle valve out approxmately halfway, turn slightly and then release it. Check to see that it slides down smoothly into the place on it own. If it does not, replace the assembly.

(Checking the nozzle)



3.5.4.3 Reassemble the fuel injection nozzle

The fuel injection nozzle is reassembled in the opposite order to disassembly.

- Insert the asjusting shim, nozzle spring and nozzle spring seat to the nozzle holder and then install the stop plate between the nozzle body and nozzle holder with pins and install the nozzle nut to the nozzle holder.

(TF50, 60, 70, 80-M, 90-M, 110-M, 120-M series.)

- Insert the inter spindle to the nozzle holder and install the nozzle spring seat(lower), nozzle spring and nozzle spring seat(upper) in the nozzle holder. Temporarily install the valve opening pressure adjusting screw to the nozzle holder.

Install the nozzle to the nozzle holder with pin and install the nozzle nut to the nozzle holder. (TF140, 160 series)

Tightening torque for nozzle nut:

Model	Tightening torque N·m (kgf·m)
TF50, 60, 70, 80-M, 90-M, 110-M, 120-M, series	39.2 to 44.1 (4.0 to 4.5)
TF140, 160 series	68.6 to 73.5 (7.0 to 7.5)

[NOTICE]

Be sure to tighten the nozzle nut to the specified torque. If the torque is out of the speci-fied range, the alignment faces may become rough, deforma-tion and fuel leakage result.

3.5.4.4 Adjust the opening valve pressure

Measure the opening valve pressure using the nozzle tester.

If the measured opening valve pressure is out of the specified, adjust the opening valve pressure using the opening valve press. adjusting shim

(TF60, 70, 80-M, 90-M, 110-M, 120-M series).

For TF140, 160 series, turn the opening valve pressure adjusting screw to clockwise or counter-clockwise.

Specified opening valve pressure:

Model	Opening valve press. MPa (kgf/cm^2)
All	19.6 to 20.1 (200 to 205)

- Opening valve press. adjusting shim.

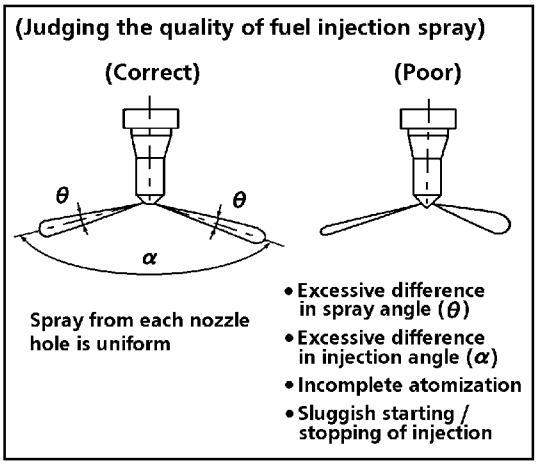
(TF50, 60, 70, 80-M, 90-M, 110-M, 120-M series)

Opening valve press. adjusting shim thickness (mm)
0.13, 0.15, 0.18 and 0.40, 0.45, 0.50 - - - - - - to 0.85 thickness [Changing the adjusting shim by 0.1 mm, changes the opening valve pressure by appoximately 1.96 Mpa (20kgf/cm^2)]

- Operation of the nozzle tester.

① After 2 to 3 injections, gradually inclease the opening valve press. to almost 2Mpa (20.4kgf/cm^2) and after keeping at this pressure for 5 sec., and check to see the fuel is not dropping from the nozzle tip.

② Operate the nozzle tester lever at a speed of 1 to 2 times per second and check to see that the condition of the injection spray is good.



⚠ CAUTION

Be sure to have adequate ventilation for the area where you using the no-zzle tester. Inhaling the fuel spray may result in injuries.

⚠ WARNING

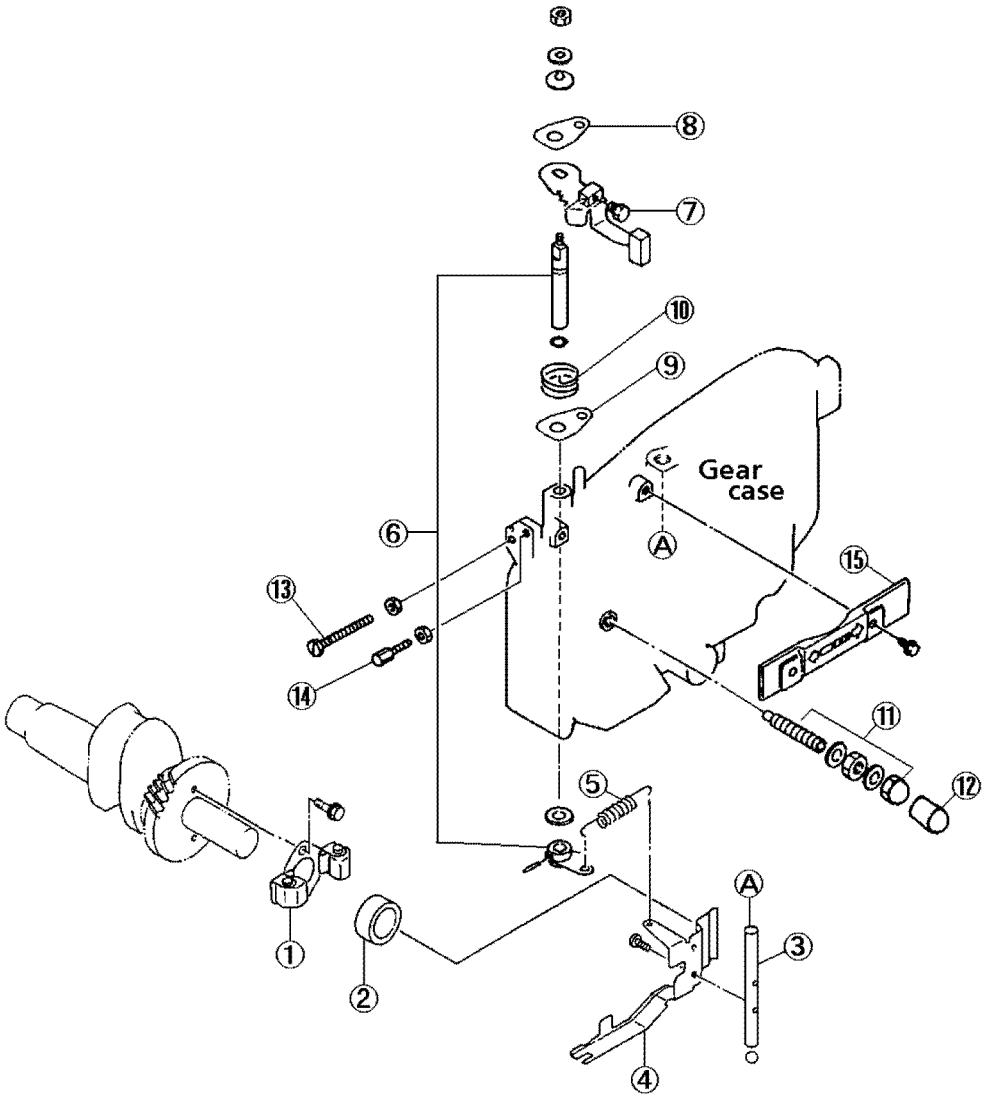
Do not put your hand in front of the injection hole. Doing so may result injury.

3.5.5 Installation of Fuel Injection Nozzle

(See 3.1.6.6 Install the fuel injection nozzle)

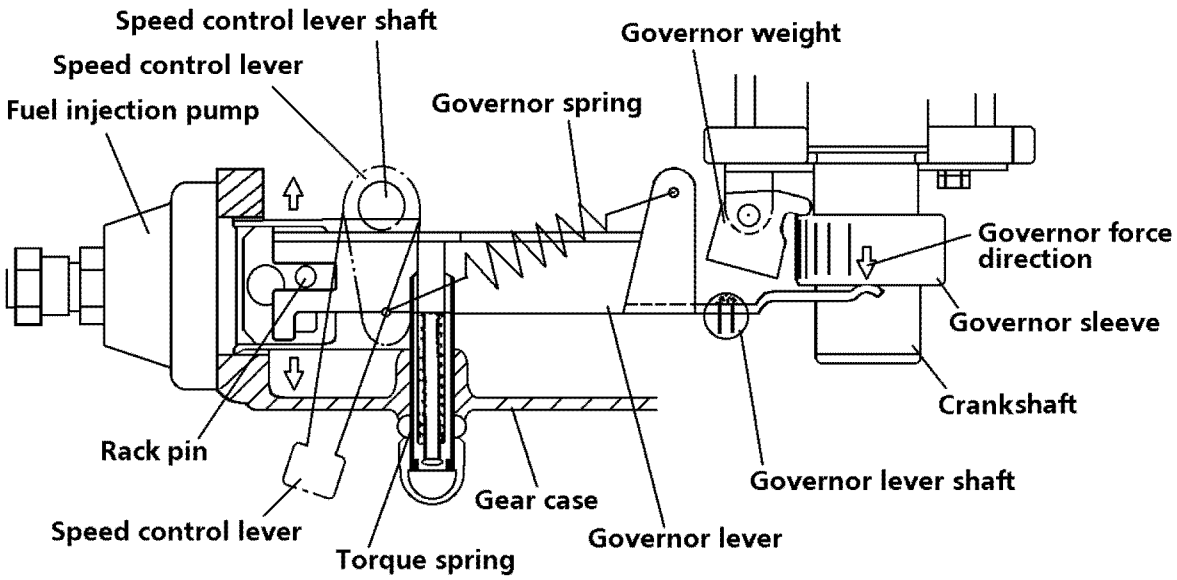
3.6 Governor

3.6.1 Components



①	Governor weight assy.
②	Governor sleeve
③	Governor lever shaft
④	Governor lever
⑤	Governor spring
⑥	Speed control lever shaft assy.
⑦	Speed control lever
⑧	Friction plate
⑨	Plate retainer
⑩	Return spring
⑪	Torque spring
⑫	Cap nut
⑬	High idle adjusting bolt
⑭	Speed control wire support
⑮	Speed control lever cover

3.6.2 Structure of Governor Linkage



3.6.3 Inspection of Governor

3.6.3.1 Remove the gear case

(See 3.2.2 Removal of Gear Case)

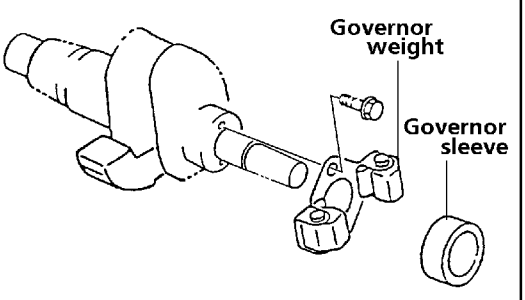
3.6.3.2 Visually check the governor weight and governor sleeve for wear

(1) Remove the governor sleeve and governor weight assy. loosening 2 bolts from the crankshaft.

(2) Check the governor weight contacting surface with governor sleeve for wear or abnormal contact. If any, replace the governor weight assy. or governor sleeve.

(3) Check the governor weight supporting pin and governor weight supporting hole for wear.
If any, replace the governor weight assy..

(Removing the governor weight)

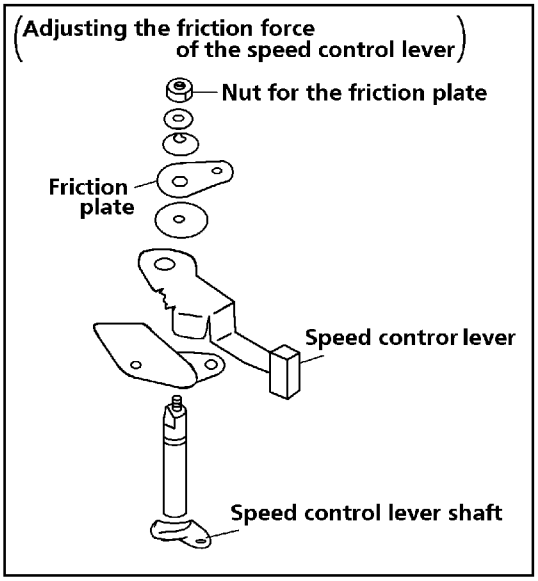


(4) Install the governor weight to the crankshaft with 2 bolts and insert the governor sleeve to the crankshaft.

(5) Check that the governor sleeve smoothly slides on the crankshaft.

3.6.3.3. Check the governor link

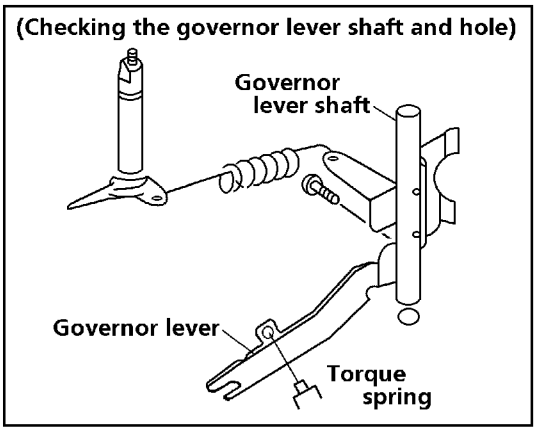
(1) Adjust the friction force of the speed control lever by tightening or loosening the nut for the friction plate.



(2) Check the governor lever shaft and the shaft hole on the gear case for wear.

- Move the governor lever to the left and right by hand and check that the governor lever shaft moves smoothly.
- If does not so, remove the governor lever shaft from the gear case and check the governor lever shaft and the shaft hole for scratching or seizing.
- Measure the governor lever shaft diameter using a micrometer and measure the shaft hole inside diameter using a caliper gauge.
- Subtract the measured shaft hole inside diameter from the measured lever shaft diameter.

If the measured oil clearance exceeds the specified limit, replace the lever shaft or gear case or both.



Model	Item	Standard (mm)	Limit (mm)
All	Governor lever shaft dia.	9.985 to 10.000	9.950
	Shaft hole inside dia.	10.035 to 10.057	10.100
	Oil clearance	0.035 to 0.072	0.100

3.6.3.4 Adjust the torque spring

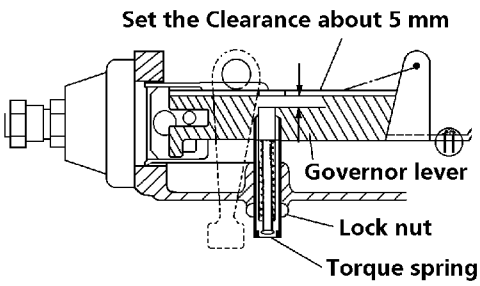
(1) Contemporarily install the fuel injection pump to the gear case.

(2) Remove the cap nut from the torque spring and loosen the lock nut.

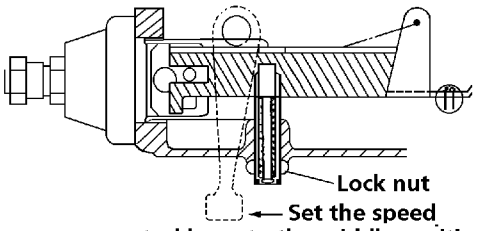
(3) Set the speed control lever to the middle position (middle of "RUN" and "STOP" posi-tion).

Turn the torque spring counter-clockwise and set the clearance between the torque spring tip and the governor lever about 5 mm.

(Setting the torque spring)



(Positioning the Speed control lever)



(4) Turn the torque spring clockwise to contact with the governor lever.

(5) Slowly move the speed control lever tward "RUN" mark until the torque spring begins to be compressed.

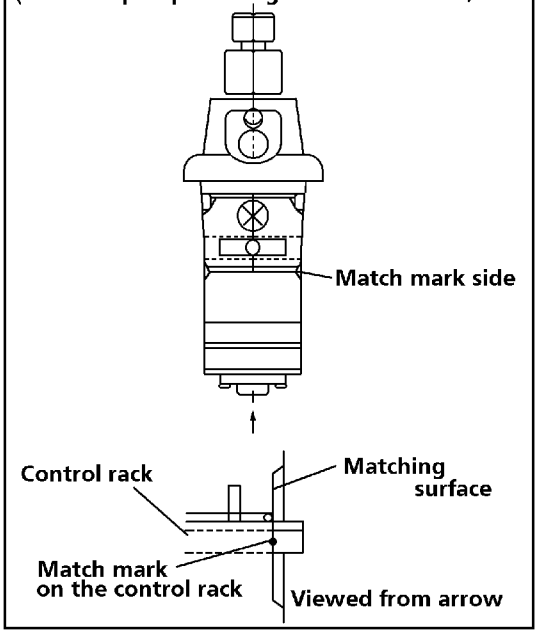
(6) More over turn the torque spring until the match mark on the control rack appears and match the match mark center to the match surface of the pump housing as shown in the illustration.

(7) Not so strictly tinghten the lock nut and cap nut to the torque spring.

[NOTICE]

Never adjust the torque spring except that the engine power output is not sufficient.

(Matching the match mark on the control rack and pump housing)



3.6.3.5. Remove the fuel injection pump from the gear case

3.6.4 Installation of Gear Case

(See 3.2.5 Installation of Gear Case)

3.6.5 Installation of Fuel Injection Pump

(See Install the fuel injection pump)

3.7 Fuel Injection Pump

3.7.1 Components

- TF50, 60, 70, 80-M, 90-M, 110-M, 120-M series

- TF140, 160 series

①	Delivery valve holder
②	O-ring
③	Delivery packing
④	Delivery valve spring
⑤	Delivery valve assy.
(⑤-1)	Delivery valve
(⑤-2)	Delivery valve seat
⑥	Plunger assy.
(⑥-1)	Plunger barrel
(⑥-2)	Plunger
⑦	Joint, fuel oil inlet
⑧	Fuel pump housing
⑨	Control rack
⑩	Control rack stopper
⑪	Control pinion
⑫	Plunger spring seat A
⑬	Plunger spring
⑭	Plunger spring seat B
⑮	Plunger position adjusting shim
⑯	Tappet assembly
(⑯-1)	Roller guide
(⑯-2)	Roller
(⑯-3)	Roller pin
⑰	Tappet stopper circlip
⑱	Tappet stopper
⑲	Delivery valve stopper
⑳	Control rack stopper
㉑	Control rack stopper position adjusting screw
㉒	Stopper shaft
㉓	Control rack stopper mounting screw
㉔	Deflector Plug

3.7.2 Removal of Fuel Injection Pump

(See 3.2.2 Removal of Gear Case)

3.7.3 Overhaul and Inspection of Fuel Injection Pump

3.7.3.1 Clean the fuel injection pump outside with clean diesel fuel oil using a brush

[NOTICE]

Do not loosen or remove the control rack stopper mounting screw for TF140, 160 series except if needed.

[NOTICE]

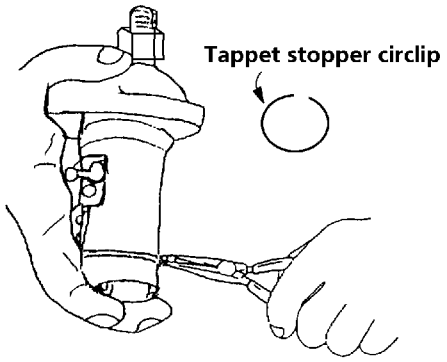
- ***Do not use a wire brush while wash the parts.***
- ***Perform work in a clean area.***
- ***Keep disassembled parts in an orderly manner.***

3.7.3.2 Disassemble the fuel injection pump

(1) Pry to remove the tappet stopper circlip⑰.

(2) Pushing the tappet assembly upward, remove the tappet stopper⑱ using a nose pliers.

(Removing the tappet stopper pin)

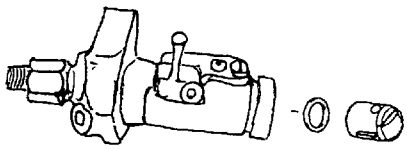


(3) Remove the tappet assy⑯ and the plunger position adjusting shim⑮.

[NOTICE]

Keep the plunger position adjusting shim to not lose.

(Removing the tappet assy.)

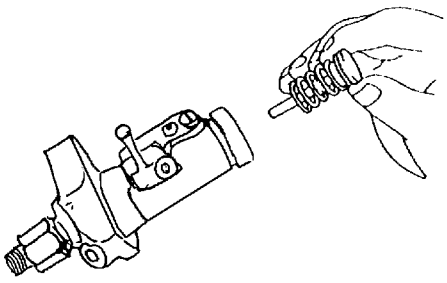


(4) Remove the plunger(⑥-2), plunger spring seat B ⑭, plunger spring⑬ and the plunger spring seat A⑫.

[NOTICE]

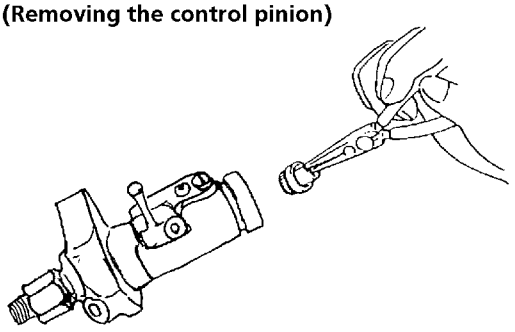
Pay attension so as not to damage the plunger sliding surface and the plunge top end.

(Removing the plunger)



(5) Remove the controle pinion⑪ using a nose pliers.

(Removing the control pinion)

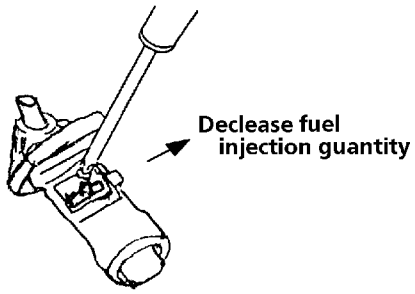


(6) Loosen the screw for control rack stopper using a screwdriver and remove the control rack stopper ⑩.

And then remove the control rack⑨.

As for TF140, 160 series, move the control rack to the declease fuel injection direction and remove the control rack .
(These engines have no rack stopper.)

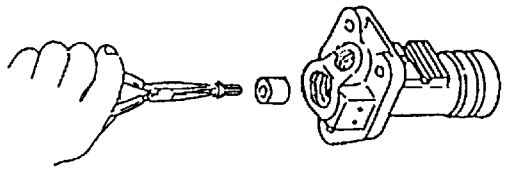
(Removing the control rack)



(7) Use a vise to chuck the flange of the fuel injection pump strictly and loosen the delivery valve holder ① using a spanner. And then remove the delivery valve assy. ⑤, delivery valve spring ④ and delivery valve packing.

[NOTICE]
Keep the delivery valve (⑤-1) and the delivery valve seat (⑤-2) as the delivery valveassy.⑤.

(Removeing the delivery valve assy.)

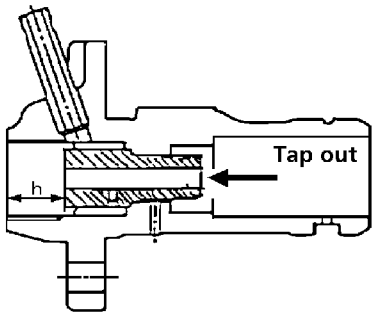


(8) Measure the dimension "h" using a depth gauge and recordt for reassembling.

(9) Lightly tap out the plunger barrel using a wooden end of the hamer from the tappet side of the pump body inside.

[NOTICE]
Keep the plunger barrel (⑥-1) and the plunger (⑥-2) as the plunger assy.⑥.

(Removing the plunger barrel)



3.7.3.3 Inspect the parts

Wash the each part in new diesel fuel oil so as not to damage the contact surface of the parts.

[NOTICE]

Do not use a wire brush.

(1) Inspect the plunger assy.

1) Visually check the plunger and plunger barrel for scratching or coloring.

If any damage was found, replace the plunger assy.

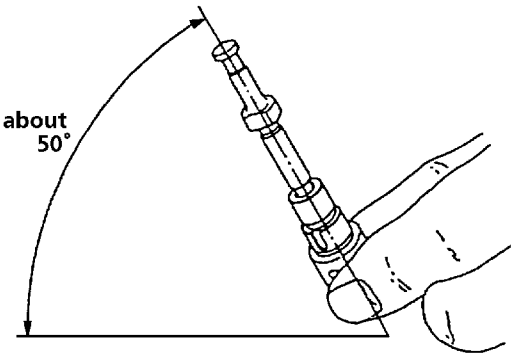
2) Check the plunger movement.

Wash the plunger assy. in new diesel fuel oil and then Incline the plunge assy. about 50° and pull out the plunge by about 1/3 of its overall length.

3) Check that the plunger return smoothly in to the plunger barrel by its own weight.

4) Repeat the above test several times after turning the plunger. If the plunger fail to return slowly and smoothly(Quick returns or stops in the way), replace the plunger assy.

(Checking the plunger movement)

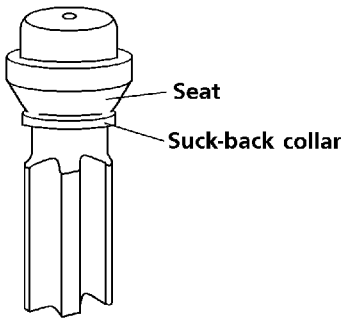


(2) Inspect the delivery valve assy.

1) Visually check the delivery valve seat and the suck-back collar for scoring, scuffing and wearing..

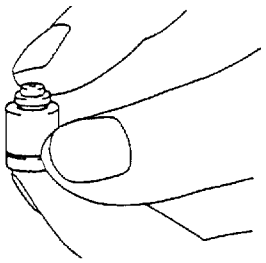
If any, replace the delivery valve assy.

(Visually checking the delivery valve)



2) Apply diesel fuel oil to the delivery valve. Check that the delivery valve returns by itself when released after being pushed it down with your finger while the hole in the bottom of the delivery valve seat are covered. If not so, replace the delivery valve assy.

(Checking the fitness)

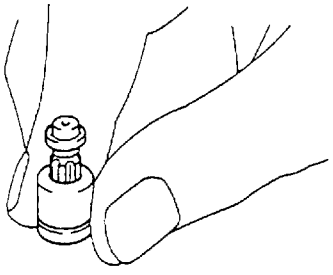


3) Apply diesel fuel oil to the delivery valve.

Check that the delivery valve slides down slowly and smoothly by its own weight when put the delivery valve on the hole of the delivery valve seat.

If not so, replace the delivery valve assy.

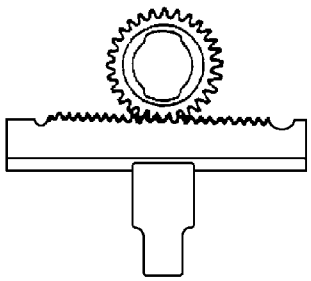
(Checking the delivery valve movement)



(3) Inspect the control rack and the control pinion

- Visually check the control rack and the control pinion for deformation, wear on tooth and wear on sliding surface.If any, replace them.

(Checking the controle rack and the control pinion)



(4) Inspect the tappet assy.

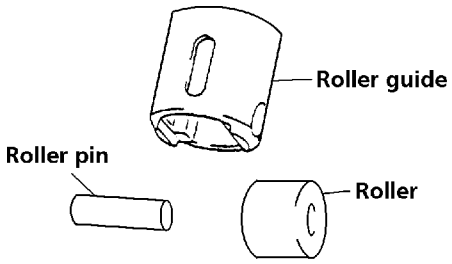
1) Visually check the roller for wear or flake. If the surface is worn or flaked, replace it.

2) Visually check the roller guide sliding surface for wear or scratches. If any, replace it. (Check the inside sliding surface of pump body also.)

3) Measure the roller and roller pin for oil clearence.

If measured oil clearence exceeds 0.2mm, replace the roller and roller pin as a set.

(Checking the tapett assy.)



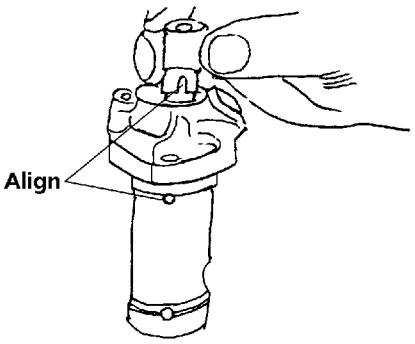
3.7.3.4 Reassemble the parts

(1) Install the plunger barrel (⑥-1) to the pump body and insert the plunger.

1) Insert the plunger barrel to the pump body aligning the match groove of the plunger bar-rel with the positioning pin on the pump body.

2) Measure the dimension "h" as the same way described 3.7.3.2(8) and confirm that the measured "h" is the same dimension mea-sured at 3.7.3.2(8).

(Installing the plunger barrel)



(2) Install the delivery valve assy.

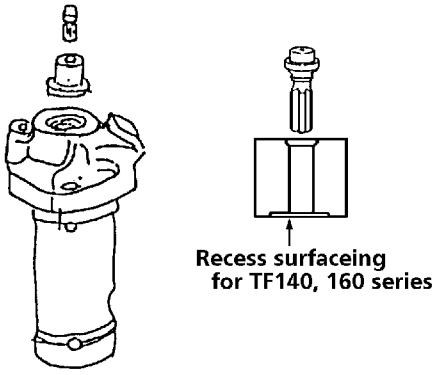
1) Install the delivery valve assy. to the pump body downward the flanged side of the delivery valve seat. (Downward the recess surface side for TF140, 160 series).

2) Install the delivery valve spring, delivery packing on the delivery valve assy..

3) Install the O-ring to the delivery valve holder and tighten the delivery valve holder to spe-cified torque.

Tightening torque: 39.2 to 44.1 N·m
(4.0 to 4.5 kgf·m)

(Installing the delivery valve assy.)



(3) Install the control rack and control pinion

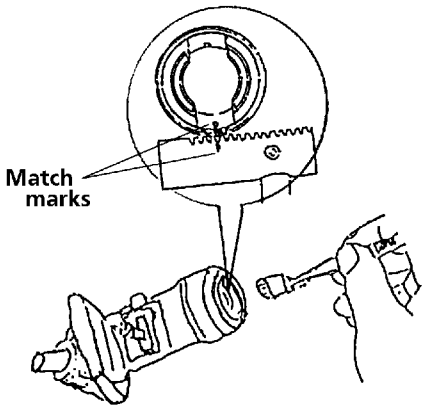
1) Install the control rack to the pump body.

2) Install the control pinion to the pump body aligning the match marks of the control rack and the control pinion using a nose pliers.

3) Confirm that the match marks are aligned.
To see easily the match marks on the toofh, spot the light into the pump body using a handy light.

4) Install the control rack stopper and tighten the screw for the control rack stopper using a screwdriver.

(Installing the control rack and pinion)



(4) Install the plunger

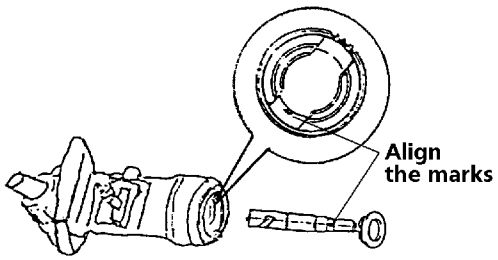
1) Install the plunger into the control pinion aligning the match marks of the control pinion and the plunger as shown in the illustration.

2) Install the plunger spring seat A.

3) Install the plunger spring.

4) Install the plunger spring seat B.

(Installing the plunger)



(5) Install the tappet assy.

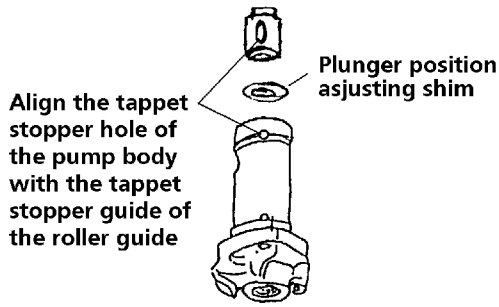
1) Install the plunger position adjusting shim.

2) Install the tappet assy. into the pump body aligning the pin hole of the pump body with the pin guide of the roller guide.

3) Install the tappet stopper into the tappet stopper hole pushing the roller by the thumb.

4) Install the tappet stopper circlip to the circlip groove of the pump body using a nose pliers.

(Installing the tappet assy.)



4. Troubleshooting

Problem	Cause	Corrective action	Reference
(1) Does not engine start or difficult to start.	(1) No engagement of pi-nion gear of the starter motor. (-E version) 1) Loose terminal of batte-ry / engage magneto. 2) Poor contact of starter switch. 3) Open coil of engage magneto. 4) Unsmooth operation of shifter. 5) Barr of gear tooth tip. 6) Poor clearance between pinion and ring gear. 7) Seizure of starter motor bearing.	1) Tighten. 2) Correct using a sandpa-per or replace. 3) Replace. 4) Correct using a sandpa-per or apply grease. 5) Correct. 6) Correct. 7) Replace.	--------
	(2) Although engaged with ring gear, no rotation of pinion gear. (-E version) 1) Loose battery terminal or starter motor terminal. 2) Poor contact of engage magneto switch. 3) Worn brush. 4) Dirty or rough surface of commutator of starter motor. 5) Open circuit of starter motor coil. 6) Worn commutator. 7) Slippage of clutch of st-arter motor. 8) Excessive resistance of cable between battery and starter motor. 9) Insufficient of battery ca-pacity.	1) Tighten. 2) Correct using a sandpa-per. 3) Replace. 4) Correct using a sandpa-per #500 to #600. 5) Replace. 6) Correct the under-cut or replace. 7) Replace. 8) Inclease the cable size or shorten. 9) Change.	--------

To be continued

To continue

Problem	Cause	Corrective action	Reference
(1) Does not engine start or difficult to start.	(3) No fuel injection.		
	1) Air invasion into fuel in-jection system.	1) Bleed air using the filter cock.	
	2) Speed control lever po-ision is "STOP".	2) Adjust the speed control lever to "RUN".	
	3) Clogged fuel filter.	3) Clean the filter element or replace.	-------
	4) Low oil lever of fuel oil tank.	4) Add fuel to the tank.	
	5) Closed cock of fuel tank.	5) Open the cock.	
	6) Clogged fuel pipe.	6) Clean.	
	(4) Failure of fuel injection nozzle.		
	1) Faulty nozzle seat.	1) Replace the nozzle.	3.5.4
	2) Sticking of nozzle.	2) Replace the nozzle.	↑
	3) Worn nozzle.	3) Replace the nozzle.	↑
	4) Clogged injection hole.	4) Replace the nozzle or clean.	↑
	5) Drop in injection press.	5) Readjust.	↑
	(5) Failure of fuel injection pump.		
	1) Worn plunger.	1) Replace the plunger assy..	3.7.3
	2) Broken plunger spring.	2) Replace the plunger sp-ring.	↑
	3) Sticking plunger.	3) Replace the plunger assy..	↑
	4) Oil leak from delivery valve.	4) Replace the Plunger as-sy..	↑
	5) Air invasion into the fuel injection pump.	5) Bleed the air removing the fuel injection pipe.	--------
	6) Broken delivery valve spring.	6) Replace the delivery va-lve spring.	3.7.3
	(6) Failure in fuel injection system.		
	1) Deviated injection timing of fuel injection pump.	1) Readjust.	3.4
	2) Loose injection pipe joint.	2) Tighten firmly.	--------
	3) Broken fuel injection pipe.	3) Replace the fuel injec-tion pipe.	--------
	4) Air invasion into the fuel injection pipe.	4) Bleed the air removing the joint of the fuel in-jection nozzle side.	--------
	(7) Compression air leak.		
	1) Air leak from intake and exh. valve.	1) Carry out lapping of the valve and valve seat.	3.1.4.6
	2) No valve clearance.	2) Readjust.	3.1.6.4
	3) Failure of head gasket.	3) Replace the head gas-ket.	3.1.2, 3.1.6
	4) Worn cylinder liner upp-er portion.	4) Replace the cylinder liner.	3.3.2.10, 3.3.7.2 3.3.10.2
	5) Worn piston ring.	5) Replace the piston ring.	3.3.3, 3.3.3.6
	6) Sticking piston ring.	6) Replace the piston ring.	↑
	7) Insufficient tigtening he-ad bolt.	7) Retighten the bolt uni-formly.	3.1.6

To be continued

To continue

Problem	Cause	Corrective action	Reference
(1) Does not engine start or difficult to start.	8) Broken valve spring.	8) Replace the spring.	3.1.3.1, 3.1.5.1
	(8) Others. 1) Improper thick of head gasket. 2) Poor installing of speed control link. 3) Clogged intake or exh..	 1) Replace the appropriate gasket. 2) Reinstall correctly. 3) Clean the intake, exh. pipe (Air cleaner) or exh. silencer.	 3.1 3.6.2 --------
(2) Unsmooth running.	(1) Operation failure of in-jection nozzle. 1) Nozzle operation failure. 2) Broken valve spring.	 1) Replace the nozzle. 2) Replace the valve spring.	 3.5.4 3.1.3.1, 3.1.5.1
	(2) Uneven fuel injection quantities. 1) Failure in operation of fuel pump plunger. 2) Damaged fuel pum pl-unger. 3) Broken plunger spring. 4) Incomplete installing of fuel injecion pump. 5) Clogged fuel filter.	 1) Clean the plunger assy.. 2) Replace the plunger as-sy.. 3) Replace the plunger sp-ring. 4) Install the pump corre-ctly. 5) Clean or replace the fuel filter element.	 3.7.3 ↑ ↑ 3.2.5.2 --------
	(3) Failure of governor. 1) Failure in operation of governor link. 2) Sticking governor slee-ve. 3) Failure in operation of governor weight.	 1) Repair. 2) Correct for smooth mo-vement. 3) Correct for smooth mo-vement.	 3.6.2 3.6.2 3.6.2
	(4) Others. 1) Over load operation. 2) Moving part seizure.	 1) Reduce the load. 2) Disassemble, inspect and conduct servicing.	 --------
(3) Sudden engine stop.	(1) No fuel feed. 1) Low fuel level in fuel tank. 2) Air invasion into the syst-em or fuel injection pump. 3) Water invasion into the tank. 4) Fuel cock closes for re-asons. 5) Clogged fuel filter. 6) Broken fuel injection pi-pe.	 1) Add the fuel into the tank. 2) Bleed the air. 3) Clean the fuel filter (element). 4) Inspect and repair as needed 5) Clean or replace the fuel filter element. 6) Replace the fuel injec-tion pipe.	 --------

To be continued

To continue

Problem	Cause	Corrective action	Reference
((3) Sudden engine stop.)	(2) Faulty operation gover-nor. 1) Broken governor spring. 2) Sticking governor slee-ve.	 1) Replace. 2) Inspect and repair as needed.	 3.6.2 3.6.2
	(3) Others. 1) Moving part seizure. • No cooling water in the radiator or hopper. • No lube oil. • Broken lube oil pump.	1) Disassemble and repair or replace the new part.	---
(4) Poor exh. gas color.	(1) Fuel injection pump fail-ure. 1) Faulty operation of plun-ger. 2) Worn plunger. 3) Faulty delivery valve. 4) Uneven injection quan-tity. 5) Improper injection tim-ing.	 1) Replace the plunger as-sy.. 2) Replace the plunger as-sy.. 3) Replace the delivery va-lve assy.. 4) Readjust. 5) Readjust.	--- 3.7.3 3.7.3 3.7.3 --- ---
	(2) Fuel injection nozzle fai-lure. 1) Clogged injection nozz-le. 2) Sticking nozzle. 3) Drop in injection press. 4) Poor atomization status. 5) Carbon deposit on nozz-le.	 1) Replace the nozzle or cle-an. 2) Replace the nozzle. 3) Readjust. 4) Clean or replace the no-zzle. 5) Clean.	 3.5.4 ↑ ↑ 3.5.4 ↑
	(3) Others. 1) Over load operation. 2) Too high lube oil level. 3) Carbon deposit on the intake / exh. Valve. 4) Poor fuel quality. 5) Clogged intake / exh. pi-pe. 6) Clogged air cleaner.	 1) Reduce the load. 2) Adjust the lube oil level appropriately. 3) Clean. 4) Replace with good fuel oil. 5) Clean. 6) Clean.	 --- --- 3.1.3 --- --- ---

Problem	Cause	Correct action	Reference
(5) Insufficient output.	(1) Insufficient fuel supply by fuel injection pump.		
	1) Worn plunger.	1) Replace the plunger as-sy..	3.7.3
		2) Replace the plunger.	
	2) Sticking plunger.	3) Tigten firmly.	↑
	3) Fuel oil leak from fuel injection pipe joint.		--------
		4) Replace the delivery va-lve assy..	
	4) Fuel oil leak from deli-very valve assy..		3.7.3
		5) Readjust.	
	5) Improper position of sp-eed control lever.		--------
		6) Clean or replace.	
	6) Clogged fuel filter.	7) Clean.	--------
	7) Clogged fuel pipe.		--------
	8) Broken delivery valve spr-ing.	8) Replace the delivery va-lve spring.	3.7.3
	(2) Insufficient injection by fuel injection nozzle.		
	1) Clogged injection hole.	1) Clean or replace the no-zzle.	3.5.4
	2) Faulty nozzle valve seat.	2) Replace the nozzle.	3.5.4
	3) Sticking nozzle valve.	3) Replace the nozzle.	3.5.4
	4) Loose fuel injection pipe joint.	4) Tighten firmly.	--------
	5) Worn nozzle.	5) Replace the nozzle.	3.5.4
	(3) Governor failure.		
	1) Drop in governer spring force.	1) Replace the govenor sp-ring.	3.6.2
	(4) Compressed gas leak in the cylinder.		
	1) Gas leak from intake and exh. valve.	1) Carry out lapping of the valve and valve seat.	3.1.4.6
	2) Too small valve cleara-nce.	2) Readjust.	3.1.6.4
		3) Replace the cylinder lin-er.	3.3.2.10, 3.3.7.2 3.3.10.2
	3) Worn upper portion of cylinder bore.	4) Replace the piston ring.	3.3.3, 3.3.10.6
	4) Warn piston ring.	5) Replace the piston ring.	↑
	5) Sticking piston ring.		
	(5) Improper fuel injection timing.		
	1) Too fast injection timing.	1) Retard the injection tim-ing.	3.4
	2) Too slow injection tim-ing.	2) Advance the injection ti-ming.	↑
	(6) Others		
	1) Improper fuel oil.	1) Replace with good fuel oil.	--------

Problem	Cause	Corrective action	Reference
(6) Knocking.	(1) Fuel injection valve fail-ure.		
	1) Drop in injection press.	1) Readjust.	3.5.4
	2) Broken fuel nozzle spring.	2) Replace the fuel nozzle spring.	↑
	3) Sticking nozzle valve.	3) Replace the nozzle.	3.5.4
	4) Poor atomization of no-zzle.	4) Clean or replace the no-zzle.	↑
	(2) Fuel injection pump fail-ure.		
	1) Too fast injection timing.	1) Retard the injection tim-ing.	3.4
	(4) Others.		
	1) Too large piston top cle-arance.	1) Replaace the head gas-ket.	3.1
	2) Improper fuel oil.	2) Replace with good fuel oil.	
		3) Clean or replace the fuel filter element.	--------
	3) Water invasion into fuel oil.	4) Inspect and conduct se-rving.	--------
	4) Poor compression.		3.3
(7) Other malfunctions.	(1) Noise and vibration gen-eration.		
	1) Loose end nut for fly-wheel.	1) Retighten the end nut.	3.3.10.6
	2) Loose engine mounting bolt.	2) Retighten.	--------
	3) Loose connecting rod bo-lts.	3) Refighten the bolts.	3.3.10.7
	4) Poor engagement gears.	4) Align the gear backlash.	3.3.2.3
	5) Too small intake valve clearance(Back air noi-se).	5) Readjust the intake va-lve clearance.	3.1.6.4
	(2) Excess lube oil consum-ption.		
	1) Excess supply amount of oil.	1) Correctly adjust the oil level.	--------
	2) Worn cylinder liner or piston ring.	2) Replace the cylinder li-ner or piston ring.	3.3.2.9, 3.3.10.6
	3) Faulty stem seal. (TF80-M, 90-M, 110-M, 120-M series)	3) Replace the stem seal.	3.3.3, 3.3.10.6
	4) Worn valve stem.	4) Replace the intake or exh. valve.	3.1.4.6
	5) Worn valve guide.	5) Replace the valve guide or cylinder head. (TF50 series)	3.1.4.5
	(3) Too fast deterioration of lube oil.		
	1) Improper lube oil.	1) Proper lube oil use.	2.5
	2) Piston ring stick, worn cylinder liner, worn pis-ton ring.	2) Inspect and conduct se-rving.	--------

To be continued

To continue

Problem	Cause	Corrective action	Reference
((7) Other malfunctions.)	(4) Excess cooling water co-nsumption. (Radiator version)		
	1) Clogged or dirty radiator fin.	1) Clean the radiator fin.	3.3.2.12
	2) Slipping fan belt.	2) Readjust the v-belt ten-sion.	3.3.10.12
	3) Dirty cooling water pa-ssage.	3) Clean the passage.	--------
	4) Leakage of cooling water passage.	4) Inspect and conduct se-rving.	3.3.11
	5) Faulty radiator cap.	5) Inspect and conduct se-rving.	3.3.11
	6) Loose hose clip or failure of hose between radiator cap and cooling water sub tank.	6) Make sure to attach the hose clip on the hose end or replace the hose.	

5. Periodic Checking List

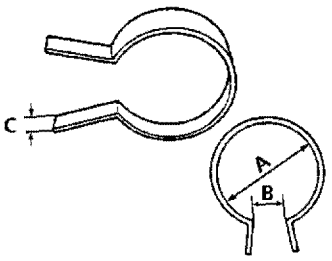
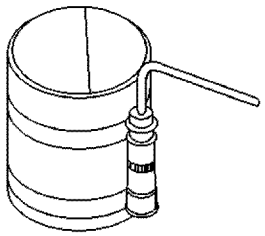
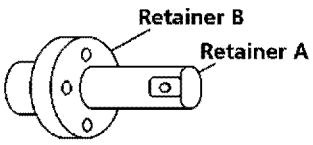
Periodic inspection intervals vary depending on the uses, loads, fuels and lube oils used and handling conditions, and are hard to establish definitively. The following should be treated only as a general standard.

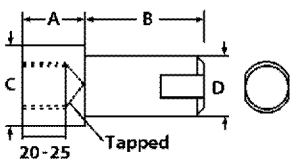
○Check ●Replacement of part

System division	Checking / servicing item	Everyday check-up	Periodic checking				
			Every 10 hours	Every 20 hours	Every 100 hours	Every 300 hours	Every 600 hours
Fuel oil	Check & supply F.O. to the tank	○					
	Clean the fuel filter elem-ent					○	
	Replace the fuel filter ele-ment						●
	Drain the fuel tank					○	
	Check for fuel oil leakage	○					
Lube oil	Check the quantity of lube oil	○					
	Replace the lube oil			First ●	Subsequent ●		
	Clean the lube oil filter element			First ○	Subsequent ○		
	Check for lube oil leakage	○					
Cooling water	Check & supply cooling water	○					
	Replace cooling water					●	
	Check for cooling water leakage	○					
	Check & cleaning of the radiator fin	○			Cleaning ○		
	Check the v-belt tension		First ○		Subsequent ○		
Air cleaner	Clean the filter element				○		
Electrical equipment (-E, -L)	Check the warning lamp and head lamp	○					
	Check & supply electrolyte in batt.				○		
Cylinder head	Adjust the intake & exh. valve clearance					○	
	Lap the intake & exh. valve seat						○
Fuel injection	Check & adjust the fuel injection press. and ato-mizing condition						○
	Check & adjust the fuel in-jection timing						○

6. Tools and Measuring Instruments

(1) Tools

<table>
<tr><th>No.</th><th>Tool's name</th><th>Applied engine and tool's size</th><th>Illustration</th></tr>
<tr><td>1</td><td>piston ring compressor</td><td>(mm)
<table>
<tr><th>Engine</th><th>A</th><th>B</th><th>C</th></tr>
<tr><td rowspan="2">TF50, 60 series</td><td>80</td><td>22</td><td>26</td></tr>
<tr><td colspan="3">P/C: 101300-92140</td></tr>
<tr><td rowspan="2">TF70, 80-M series</td><td>85</td><td>22</td><td>26</td></tr>
<tr><td colspan="3">P/C: 102700-92140</td></tr>
<tr><td rowspan="2">TF90-M series</td><td>90</td><td>22</td><td>26</td></tr>
<tr><td colspan="3">P/C: 101400-92140</td></tr>
<tr><td rowspan="2">TF110-M, 120-M series</td><td>90</td><td>25</td><td>26</td></tr>
<tr><td colspan="3">P/C: 101404-92140</td></tr>
<tr><td rowspan="2">TF140 series</td><td>102</td><td>28</td><td>26</td></tr>
<tr><td colspan="3">P/C: 174300-92140</td></tr>
<tr><td rowspan="2">TF160 series</td><td>106</td><td>28</td><td>26</td></tr>
<tr><td colspan="3">P/C: 105890-92140</td></tr>
</table></td><td> 
</td></tr>
<tr><td></td><td></td><td>
<table>
<tr><th>Engine</th><th>Size</th></tr>
<tr><td>All</td><td>Piston dia. size 60 to 125 mm available</td></tr>
<tr><td colspan="2">P/C: 95550-002476</td></tr>
</table></td><td>  </td></tr>
<tr><td>2</td><td>Flywheel puller
(1) Retainer A</td><td>(mm)
<table>
<tr><th>Engine</th><th>A</th><th>B</th><th>C</th><th>D</th></tr>
<tr><td rowspan="2">TF50 series</td><td>35</td><td>85</td><td>41 (M24×2 tapped)</td><td>32</td></tr>
<tr><td colspan="4">P/C: 105090-92110</td></tr>
<tr><td rowspan="2">TF60, 70, 80-M, 90-M series</td><td>35</td><td>85</td><td>41 (M30×2 tapped)</td><td>32</td></tr>
<tr><td colspan="4">P/C: 104200-92110</td></tr>
<tr><td rowspan="2">TF110-M, 120-M 140, 160 series</td><td>40</td><td>90</td><td>52 (M36×2 tapped)</td><td>42</td></tr>
<tr><td colspan="4">P/C: 104300-42110</td></tr>
</table></td><td> 

Retainer A

</td></tr>
</table>

To be continued

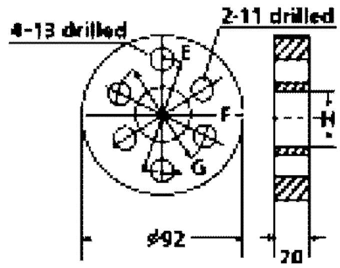
To continue

No.	Tool's name	Applied engine and tool's size	Illustration
(2)	(Flywhee puller) (2) Retainer B	(see table below)	Retainer B

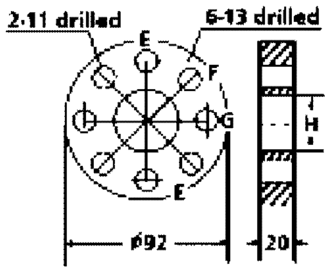
(mm)

Engine	E	F	G	H
TF50, 60, 70, 80-H, 90-H series	65	54	54	32.1
	P/C: 104200-92120			
TF110-M, 120-M, 140, 160 series	65	77	72	32.1
	P/C: 104300-92120			

P/N: 104200-92120



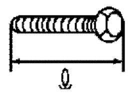
P/N: 104300-92120



(3) Bolt for retainer B

(mm)

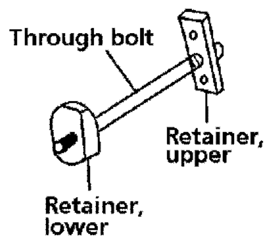
Engine	Size
All	M12×1.75, ・=100
	P/C: 104200-92430

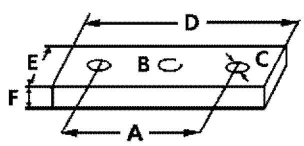


No.	Tool's name	Applied engine and tool's size	Illustration
3	Cylinder liner puller (1) Retainer, upper	(see table below)	

(mm)

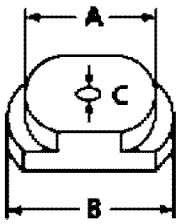
Size \ Engine	All
A	102 to 132
B	18
C	16
D	165
E	38
F	18
P/C: 172200-92020	





To continue

<table>
<tr><th>No.</th><th>Tool's name</th><th>Applied engine and tool's size</th><th>Illustration</th></tr>
<tr><td>(3)</td><td>(Cylinder liner puller)

(2) Retainer, lower</td><td>(mm)
<table>
<tr><th>Engine</th><th>A</th><th>B</th><th>C</th></tr>
<tr><td>TF50 series
P/C: 105090-92010</td><td>73</td><td>84</td><td>18</td></tr>
<tr><td>TF60 series
P/C: 101300-92010</td><td>74.5</td><td>↑</td><td>↑</td></tr>
<tr><td>TF70 series
P/C: 105200-92010</td><td>77.5</td><td>85</td><td>↑</td></tr>
<tr><td>TF80-M series
P/C: 172300-92010</td><td>79.5</td><td>89</td><td>↑</td></tr>
<tr><td>TF90-M series
P/C: 101400-92010</td><td>84.5</td><td>94</td><td>↑</td></tr>
<tr><td>TF110-M series
P/C: 101400-92010</td><td>↑</td><td>↑</td><td>↑</td></tr>
<tr><td>TF120-M series
P/C: 120220-92010</td><td>90.5</td><td>104</td><td>↑</td></tr>
<tr><td>TF140 series
P/C: 105700-92010</td><td>95.5</td><td>100</td><td>↑</td></tr>
<tr><td>TF160 series
P/C: 101504-92010</td><td>99.5</td><td>110</td><td>↑</td></tr>
</table></td><td> 
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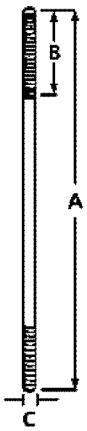
<tr><td></td><td>(3) Through bolt</td><td>(mm)
<table>
<tr><th>Size \ Engine</th><th>All</th></tr>
<tr><td>A</td><td>380</td></tr>
<tr><td>B</td><td>170</td></tr>
<tr><td>C</td><td>M16×2.0</td></tr>
<tr><td colspan="2">P/C: 103338-92030</td></tr>
</table></td><td> 
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<tr><td></td><td>(4) Nut</td><td>(mm)
<table>
<tr><th>Engine</th><th>Size</th></tr>
<tr><td>All</td><td>M16×2.0</td></tr>
<tr><td colspan="2">P/C: 26712-160002</td></tr>
</table></td><td></td></tr>
<tr><td>(4)</td><td>End nut spanner</td><td>(mm)
<table>
<tr><th>Engine</th><th>A</th></tr>
<tr><td rowspan="2">TF50 series</td><td>36</td></tr>
<tr><td>P/C: 105010-92100</td></tr>
<tr><td rowspan="2">TF60, 70, 80-M,
90-M series</td><td>48</td></tr>
<tr><td>P/C: 104200-92100</td></tr>
<tr><td rowspan="2">TF110-M, 120-M,
140, 160 series</td><td>58</td></tr>
<tr><td>P/C: 103338-92100</td></tr>
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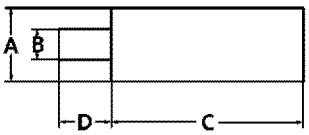
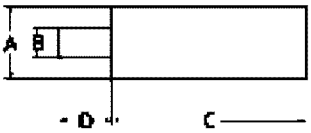
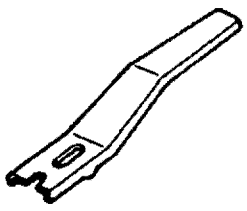
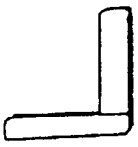
</td></tr>
</table>

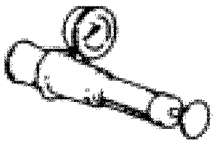
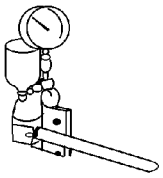
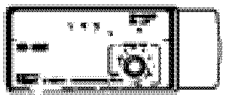
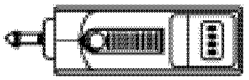
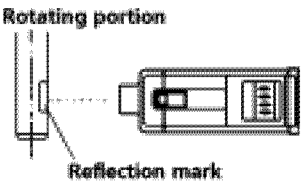
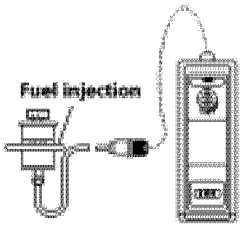
<table>
<tr><th>No.</th><th>Tool's name</th><th>Applied engine and tool's size</th><th>Illustration</th></tr>
<tr><td>5</td><td>Valve guide remo-ving tool (Local supply)</td><td>(mm)<table><tr><th>Engine</th><th>A $^{0}_{-0.2}$</th><th>B $^{0}_{-0.2}$</th><th>C</th><th>D</th></tr><tr><td>TF60, 70, 80-M, 90-M series</td><td>11.5</td><td>6.8</td><td>70</td><td>40</td></tr><tr><td>TF110-M, 120-M, series</td><td>12.5</td><td>7.8</td><td>↑</td><td>↑</td></tr><tr><td>TF140, 160 series</td><td>11.5</td><td>6.8</td><td>100</td><td>50</td></tr></table></td><td>  </td></tr>
<tr><td>6</td><td>Piston pin bearing removal tool (Local supply)</td><td>(mm)<table><tr><th>Engine</th><th>A $^{0}_{-0.2}$</th><th>B $^{0}_{-0.2}$</th><th>C</th><th>D</th></tr><tr><td>TF50 series</td><td>23.5</td><td>21.8</td><td>75</td><td>25</td></tr><tr><td>TF60, 70 series</td><td>25.5</td><td>22.8</td><td>↑</td><td>↑</td></tr><tr><td>TF80-M, 90-M series</td><td>28.5</td><td>25.8</td><td>↑</td><td>↑</td></tr><tr><td>TF110-M, 120-M series</td><td>30.5</td><td>27.8</td><td>↑</td><td>↑</td></tr><tr><td>TF140, 160 series</td><td>34.5</td><td>31.8</td><td>↑</td><td>↑</td></tr></table></td><td>  </td></tr>
<tr><td>7</td><td>Valve spring compressor</td><td><table><tr><th>Engine</th><th>Size</th></tr><tr><td>All</td><td>--------</td></tr><tr><td colspan="2">P/C: 129100-92630</td></tr></table></td><td>  </td></tr>
<tr><td>8</td><td>Piston ring expander (Local supply)</td><td><table><tr><th>Engine</th><th>Size</th></tr><tr><td>All</td><td>--------</td></tr></table></td><td>  </td></tr>
</table>

(2) Measuring instruments

No.	Name	Intended use	Illustration
1	Dial gauge	Measures a bend in a shaft, surface distortion, gap, etc.	
2	Test indicator	Measures narrow or deep places which cannot be measured with a dial gauge.	
3	Magnetic stand	When a dial gauge is used, this tool supports the dial gauge at different angles for adjustments.	
4	Micrometer	Measures the outside diameters of a crank-shaft, piston, piston pin, etc.	
5	Cylinder gauge	Measures the inside diameters of a cylinder liner, metal, etc.	
6	Calipers	Measures various outside diameters, depth, thick-ness, width, etc.	
7	Depth micrometer	Measures depths such as valve sink.	
8	Square	Measures a valve spring inclination, squareness of parts, etc.	
9	V-shaped block	Supports a kind of shaft while measuring a bend in a crankshaft, camshaft, etc.	

To be continued

To continue

No.	Name		Intended use	Illustration
10	Torque wrench		Tightens a bolt and nut to the specified torque.	 
11	Thickness gauge		Measures a valve clearance, ring and ring groove, coupling clearance during installation, etc.	
12	Cap tester		Checks the fresh water system for leakage.	
13	Battery coolant tester		Checks the concentration of non-freezing solution and charging of battery fluid.	
14	Nozzle tester		Check the spray from a fuel injection valve and injection pressure.	
15	Digital thermometer		Measures the temperature of each portion.	 
16	Tachometer	Contact type	Contacts the center hole of a rotating shaft and measures the engine speed.	
		Photoelectric type	With a reflection mark put on the periphery of a rotating portion, measures the engine speed.	
		Fuel injection pipe clamp type	Measures the engine speed irrespective of a rota-ting shaft center and periphery of a rotating por-tion.	

7. Service Specifications

7.1. Engine Adjusting Standards

No.	Item	Model	Adjusting standards	Remarks
1	Intake, exh. valve cleara-nce mm	TF50, 60, 70 series	0.15	In cold condition Refer to 3.1.6.4
		TF80-M, 90-M, 110-M, 120-M, 140, 160 series	0.20	
2	Fuel injection press. MPa(kgf/cm^2)	All	19.6 to 20.1 (200 to 205)	3.5.4.4
3	Fuel injection timing (b.TDC) deg.	TF50 series	12.5	3.4
		TF60, 70, 110-M, 120-M, 140, 160 series	17.0	
		TF80-M, 90-M series	18.0	
4	Lube oil capacity (Oil pan) ·	TF50 series	1.2	2.2
		TF60, 70 series	1.8	
		TF80-M, 90-M series	2.2	
		TF110-M, 120-M series	2.8	
		TF140, 160 series	3.0	
5	Cooling water capacity · ( ): Hopper	TF50 series	1.2 (5.0)	2.2
		TF60, 70 series	1.25 (8.1)	
		TF80-M, 90-M series	1.65 (8.5)	
		TF110-M, 120-M series	2.3 (12.0)	
		TF140, 160 series	3.0 (13.0)	
6	Lube oil pressure (at rating engine speed) MPa(kgf/cm^2)	All	0.245 to 0.294 (2.5 to 3.0)	--------

7.2. Service Standards

(1) Cylinder head

Item			Model	Standard	Limit	Reference
Cylinder head warpage mm			All	0.03 or less	0.1	3.1.4.3
Valve sinking mm		Intake	TF50 series	0.35	0.6	3.1.4.5
		Exhaust		0.75	1.0	
		Intake	TF60, 70 series	0.41 to 0.76	0.8	
		Exhaust		0.75 to 1.05	1.2	
		Intake	TF80-M, 90-M series	0.15 to 0.45	0.6	
		Exhaust		0.55 to 0.85	1.0	
		Intake	TF110-M, 120-M series	0.25 to 0.55	0.7	
		Exhaust		0.65 to 0.95	1.1	
		Intake	TF140, 160 series	0.35	0.7	
		Exhaust		1.00	1.2	
Valve seat	Valve seat angle deg.	Intake	All	120	--------	3.1.4.6
		Exhaust		90		
	Seat width mm	Intake	TF50, 60, 70, 80-M, 90-M series	1.15	1.45	
		Exhaust		1.41	1.71	
		Intake	TF110-M, 120-M 140, 160 series	1.44	1.74	
		Exhaust		1.77	2.07	
Valve guide protrusion mm (except TF50 series)			TF60, 70, 110-M, 120-M series	13.2 to 13.5	--------	3.1.4.5
			TF110-M, 120-M series	9.2 to 9.5		
			TF140, 160 series	14.7 to 15.0		
Valve guide and valve stem	Valve guide inside dia. mm (Cylinder head massive)		TF50 series	7.005 to 7.020	7.040	3.1.4.5
	Valve stem dia. mm	Intake		6.960 to 6.975	6.900	
		Exhaust		6.945 to 6.960		
	Oil clearance mm	Intake		0.030 to 0.060	0.150	
		Exhaust		0.045 to 0.075		
	Valve guid inside dia. mm		TF60, 70, 80-M 90-M series	7.005 to 7.020	7.090	
	Valve stem dia. mm			6.945 to 6.960	6.850	
	Oil clearance mm			0.045 to 0.075	0.150	
	Valve guide inside dia. mm		TF110-M, 120-M series	8.005 to 8.020	8.090	
	Valve stem dia. mm			7.945 to 7.960	7.850	
	Oil clearance mm			0.045 to 0.075	0.150	
	Valve guide inside dia. mm		TF 140, 160 series	9.005 to 9.020	9.090	
	Valve stem dia. mm			8.945 to 8.960	8.850	
	Oil clearance mm			0.045 to 0.075	0.150	

Item		Model	Standard	Limit	Reference
Rocker arm and rocker arm shaft	Rocker arm inside dia. mm	TF50, 60, 70, 80-M, 90-M series	14.016 to 14.034	14.100	3.1.4.8
	Rocker arm shaft dia. mm		13.982 to 14.000	13.900	
	Oil clearance mm		0.016 to 0.052	0.150	
	Rocker arm inside dia. mm	TF110-M, 120-M, 140, 160 series	16.016 to 16.034	16.100	
	Rocker arm shaft dia. mm		15.982 to 16.000	15.900	
	Oil clearance mm		0.016 to 0.052	0.150	

(2) Gear case and Gear train

Item		Model	Standard	Limit	Reference
Gear backlash mm	Crank gear to cam gear	All	0.080 to 0.196	0.300	3.3.2.3
	Balancer gears	All except TF50 series			
	Balancer gear to idle gear				
	Idler gear to balancer drive gear				
Lube oil p.	Pump body clearance mm	All	0.100 to 0.150	0.200	3.2.3.3
	Rotor tip clearance mm		0.080 to 0.140	0.200	
	Side clearance mm		0.030 to 0.080	0.150	
Lube oil p. inner rotor shaft	Shaft hole inside dia. mm	TF50, 60, 70, 140, 160 series	8.010 to 8.050	8.080	3.2.3.3
	Inner rotor shaft dia. mm		7.985 to 8.000	7.955	
	Oil clearance mm		0.010 to 0.065	0.120	
	Shaft hole inside dia. mm	TF80-M, 90-M, 110-M, 120-M series	12.704 to 12.722	12.752	
	Inner rotor shaft dia. mm		12.664 to 12.688	12.634	
	Oil clearance		0.016 to 0.058	0.120	
Starting shaft	Shaft hole inside dia. mm	All	25.030 to 25.060	25.150	3.2.3.2
	Starting shaft dia. mm		24.972 to 24.993	24.950	
	Oil clearance mm		0.037 to 0.088	0.200	

(3) Cylinder block

Item			Model	Standard	Limit	Reference
Cylinder liner	Bore diameter mm		TF50 series	74.000 to 74.030	74.180	3.3.7.2
			TF60 series	75.000 to 75.030	75.180	
			TF70 series	78.000 to 78.030	78.180	
			TF80-M series	80.000 to 80.030	80.180	
			TF90-M series	85.000 to 85.035	85.200	
			TF110-M series	88.000 to 88.035	88.200	
			TF120-M series	92.000 to 92.035	92.200	
			TF140 series	96.000 to 96.035	96.220	
			TF160 series	102.000 to 102.035	102.230	
	Circularity mm		All	0.015 or less	0.050	
	Cylindricity mm					
	Protrusion mm			0.02 to 0.08	--------	3.3.10.2
Tappet and Tappet hole	Tappet hole dia. mm		TF 50, 60, 70, 80-M, 90-M, 110-M, 120-M series	10.020 to 10.040	10.080	3.3.6.5
	Tappet dia. mm			9.980 to 9.995	9.950	
	Oil clearance mm			0.025 to 0.060	0.120	
	Tappet hole dia. mm		TF140, 160 series	13.020 to 13.040	13.080	
	Tappet dia. mm			12.966 to 12.984	12.950	
	Oil clearance mm			0.036 to 0.074	0.150	
Camshaft and Camshaft bearing hole	Flywheel side	Inside dia. of bearing dia. mm	TF50 series	20.000 to 20.021	20.050	3.3.6.4
		Camshaft bearing portion dia. mm		19.939 to 19.960	19.900	
		Oil clearance mm		0.040 to 0.082	0.150	
	Gear side	Inside dia. of bearing dia. mm		40.000 to 40.025	40.060	
		Camshaft bearing portion dia. mm		39.950 to 39.980	39.900	
		Oil clearance mm		0.020 to 0.075	0.150	
	Flywheel side	Inside dia. of bearing hole mm	TF60, 70, 80-M, 90-M, 110-M, 120-M series	22.000 to 22.021	22.050	
		Camshaft bearing portion dia. mm		21.939 to 21.960	21.900	
		Oil clearance mm		0.010 to 0.082	0.150	
	Flywheel side	Inside dia. of bearing hole mm	TF140, 160 series	25.000 to 25.021	25.050	
		Camshaft bearing portion dia. mm		24.939 to 24.960	24.900	
		Oil clearance mm		0.010 to 0.082	0.150	

(4) Crankshaft

Item		Model	Standard	Limit	Reference
Crank pin and Crank pin bearing	Crank pin bearing inside dia. mm	TF50 series	36.000 to 36.042	36.100	3.3.4.3
	Crank pin dia. mm		35.965 to 35.982	36.890	
	Oil Clearance mm		0.018 to 0.077	0.150	
	Crank pin bearing inside dia. mm	TF60, 70 series	43.000 to 43.042	43.100	
	Crank pin dia. mm		42.956 to 42.972	42.880	
	Oil Clearance mm		0.028 to 0.086	0.150	
	Crank pin bearing inside dia. mm	TF80-M, 90-M series	45.000 to 45.042	45.100	
	Crank pin dia. mm		44.956 to 44.972	44.880	
	Oil Clearance mm		0.028 to 0.086	0.150	
	Crank pin bearing inside dia. mm	TF110-M, 120-M series	48.000 to 48.038	48.100	
	Crank pin dia. mm		47.952 to 47.973	47.880	
	Oil Clearance mm		0.028 to 0.086	0.150	
	Crank pin bearing inside dia. mm	TF140, 160 series	54.000 to 54.045	54.100	
	Crank pin dia. mm		53.953 to 53.978	53.880	
	Oil Clearance mm		0.022 to 0.092	0.150	
Crankshaft thrust clearance mm		TF50, 60, 70 series	0.010 to 0.210	0.300	3.3.2.7
		TF80-M, 90-M series	0.069 to 0.269	0.350	
		TF110-M, 120-M, 140, 160 series	0.087 to 0.287	0.400	

(5) Piston and piston ring

Item		Model	Standard	Limit	Reference
Piston	Piston diameter mm	TF50 series	73.891 to 73.921	73.790	3.3.3.5
		TF60 series	74.889 to 74.919	74.760	
		TF70 series	77.883 to 77.913	77.750	
		TF80-M series	79.879 to 79.909	79.730	
		TF90-M series	84.869 to 84.899	84.720	
		TF110-M series	87.863 to 87.893	87.705	
		TF120-M series	91.855 to 91.885	91.695	
		TF140 series	95.858 to 95.888	95.690	
		TF160 series	101.850 to 101.880	101.680	

Item		Model	Standard	Limit	Reference
Piston and Piston pin	Piston pin hole dia. mm	TF50 series	22.000 to 22.009	22.029	3.3.3.6
	Piston pin dia. mm		21.991 to 22.000	21.941	
	Oil clearance mm		0 to 0.018	0.100	
	Piston pin hole dia. mm	TF60, 70 series	23.000 to 23.009	23.029	
	Piston pin dia. mm		22.991 to 23.000	22.941	
	Oil clearance mm		0 to 0.018	0.100	
	Piston pin hole dia. mm	TF80-M, 90-M series	26.000 to 26.011	26.031	
	Piston pin dia. mm		25.989 to 26.000	25.939	
	Oil clearance mm		0 to 0.022	0.100	
	Piston pin hole dia. mm	TF110-M, 120-M series	28.000 to 28.009	28.029	
	Piston pin dia. mm		27.987 to 28.000	27.937	
	Oil clearance mm		0 to 0.022	0.100	
	Piston pin hole dia. mm	TF140, 160 series	32.000 to 32.011	32.031	
	Piston pin dia. mm		31.989 to 32.000	31.930	
	Oil clearance mm		0 to 0.022	0.100	
Piston ring clearance mm	No.1 ring	TF 50 series	0.070 to 0.106	0.20	3.3.3.5
	No.2 ring		0.045 to 0.080	0.20	
	Oil ring		0.020 to 0.055	0.15	
	No.1 ring	TF60, 70 series	0.095 to 0.130	0.20	
	No.2, No.3 ring		0.050 to 0.085	0.20	
	Oil ring		0.020 to 0.055	0.15	
	No.1 ring	TF80-H, 90-H 110-H, 120-H series	0.095 to 0.130	0.20	
	No.2, No.3 ring		0.050 to 0.085	0.20	
	Oil ring		0.020 to 0.055	0.15	
	No.1 ring	TF140, 160 series	0.095 to 0.130	0.20	
	No.2, No.3 ring		0.050 to 0.085	0.20	
	Oil ring		0.025 to 0.060	0.15	
Piston ring end gap mm	No.1 ring	TF50 series	0.25 to 0.45	1.50	
	No.2 ring				
	Oil ring		0.10 to 0.30		
	No.1 ring	TF60, 70 series	0.20 to 0.40	1.50	
	No.2, No.3 ring				
	Oil ring				
	No.1 ring	TF80-H, 90-H 110-H, 120-H series	0.30 to 0.50	1.50	
	No.2, No.3 ring				
	Oil ring				
	No.1 ring	TF140, 160 series	0.30 to 0.50	1.50	
	No.2, No.3 ring				
	Oil ring				

(6) Connecting rod

Item	Model	Standard	Limit	Reference
Thrust clearance mm	All	0.2 to 0.4	--------	3.3.2.6
Bend mm/100 mm	All	0.03	0.08	3.3.3.7
Twist mm/100 mm	All	0.03	0.08	
Piston pin bearing inside dia. mm	TF 50 series	22.025 to 22.038	22.100	3.3.3.7
Piston pin dia. mm		21.991 to 22.000	21.941	
Oil clearance mm		0.025 to 0.047	0.150	
Piston pin bearing inside dia. mm	TF60, 70 series	23.025 to 23.038	23.100	
Piston pin dia. mm		22.991 to 23.000	22.941	
Oil clearance mm		0.025 to 0.047	0.150	
Piston pin bearing inside dia. mm	TF80-M, 90-M series	26.025 to 26.038	26.100	
Piston pin dia. mm		25.989 to 26.000	25.939	
Oil clearance mm		0.025 to 0.051	0.150	
Piston pin bearing inside dia. mm	TF110-M, 120-M series	28.025 to 28.038	28.100	
Piston pin dia. mm		27.987 to 28.000	27.937	
Oil clearance mm		0.025 to 0.051	0.150	
Piston pin bearing inside dia. mm	TF140, 160 series	32.030 to 32.050	32.100	
Piston pin dia. mm		31.989 to 32.000	31.939	
Oil clearance mm		0.030 to 0.061	0.150	

(7) Camshaft

Item		Model	Standard	Limit	Reference
Intake, Exh. cam lobe height(max.) mm	Intake	TF50 series	34.30 (lift 5.30)	34.00(lift 5.00)	3.3.6
	Exhaust				
	Intake	TF60, 70 series	37.25 (lift 5.25)	36.95(lift 4.95)	
	Exhaust				
	Intake	TF80-M, 90-M series	41.00 (lift 6.00)	40.70(lift 5.70)	
	Exhaust		39.50 (lift 5.50)	39.20(lift 5.20)	
	Intake	TF110-M, 120-M series	39.50 (lift 5.50)	59.20(lift 5.20)	
	Exhaust				
	Intake	TF140, 160 series	44.80 (lift 6.80)	44.50(lift 6.50)	
	Exhaust				
Fuel injection cam lift mm		TF50 series	7.00	6.96	3.3.6.3
		TF60, 70 series	7.00	6.90	
		TF80-M, 90-M series	7.00	6.90	
		TF110-M, 120-M series	7.00	6.90	
		TF140, 160 series	9.00	8.90	

7.3. Nut and Bolt Tightening Torque

(1) For majour nut and bolt

Tightening parts	Model	Size mm	Tightening torque N·m(kgf·m)	Flat width mm	Reference
Cylinder head ※	TF50, 60, 70 80-M, 90-M series	M12×1.5	95.2 to 101.0 (9.7 to 10.3)	17	3.1.6.1
	TF110-M, 120-M series	M14×1.5	128.5 to 138.2 (13.1 to 14.1)	22	
	TF140, 160 series	M16×1.5	186.4 to 205.9 (19.0 to 21.0)	24	
Rod bolt ※	TF50 series	M7×1.0	19.7 to 23.5 (2.00 to 2.40)	12	3.3.10.7
	TF60, 70, 80-M, 90-M series	M8×1.0	36.8 to 41.6 (3.75 to 4.25)	14	
	TF110-M, 120-M series	M9×1.0	51.5 to 56.3 (5.25 to 5.75)	14	
	TF140, 160 series	M11×1.0	55.9 to 61.7 (5.70 to 6.30)	17	
End nut (Flywheel) ※	TF50 series	M24×2.0	166.7 to 196.1 (17 to 20)	36	3.3.10.6
	TF60, 70, 80-M, 90-M series	M30×2.0	24.5 to 284.3 (25 to 29)	46	
	TF110-M, 120-M 140, 160 series	M36×2.0	294.2 to 343.2 (30 to 35)	56	
Nozzle nut	TF50, 60, 70 80-M, 90-M, 110-M, 120-M series	special	39.2 to 44.1 (4.0 to 4.5)	15	3.5.4.3
	TF140, 160 series	special	68.6 to 73.5 (7.0 to 7.5)	19	
Cooling fan	TF50, 60, 70 80-M, 90-M, 110-M, 120-M series	M10×1.5	44.1 to 53.9 (4.5 to 5.5)	14	--------
	TF140, 160 series	M10×1.75	78.5 to 98.0 (8 to 10)	17	
Bering housing	All	M8×1.25	22.6 to 28.4 (2.3 to 2.9)	12	--------
Rocker arm support	TF50, 60, 70 80-M, 90-M, 110-M, 120-M series	M8×1.25	22.6 to 28.4 (2.3 to 2.9)	12	3.1.6.3
	TF140, 160 series	M8×1.5	44.1 to 53.9 (4.5 to 5.5)	14	
Fuel injection nozzle retainer nut	All	M6×1.0	6.86 to 8.82 (0.7 to 0.9)	10	3.1.6.6

※: Apply oil

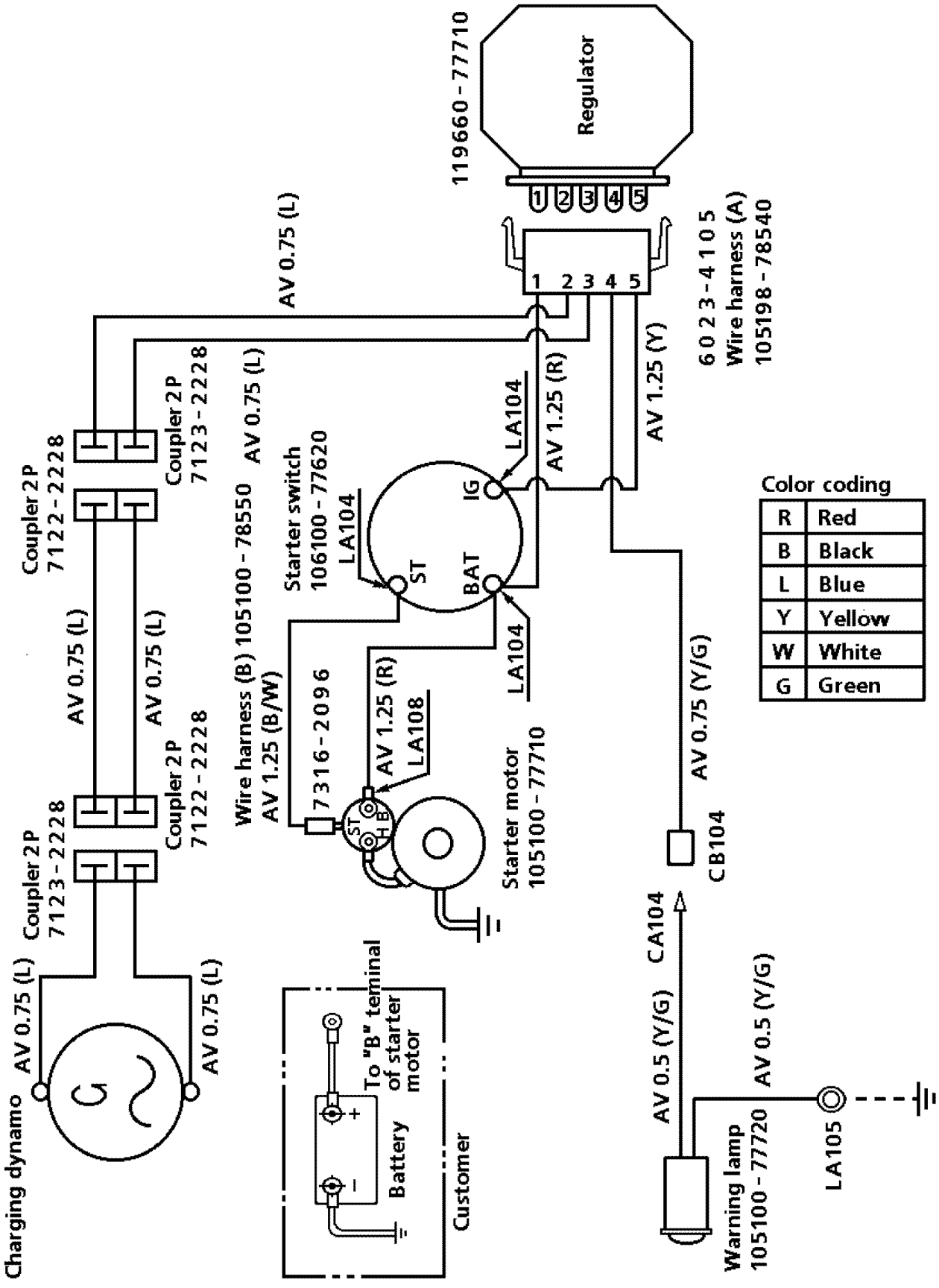
(2) For general

Name	Thread diameter	Tightening torque N·m (kgf-m)	Name	Thread diameter	Tightening torque N·m (kgf-m)
Hexagon bolt (7T) Hexagon nut	M6×1	10.79 (1.1)	PT plug	1/8	9.8 (1.0)
	M8×1.25	25.51 (2.6)		1/4	19.6 (2.0)
	M10×1.5	49.05 (5.0)		3/8	29.4 (3.0)
	M12×1.75	88.29 (9)		1/2	58.8 (6.0)
(note)	M14×2	137.34 (14)	Ball joint bolt	M8	14.7 (1.5)
	M16×2	225.63 (23)		M12	29.4 (3.0)
--------				M14	44.1 (4.5)
				M16	53.9 (5.5)

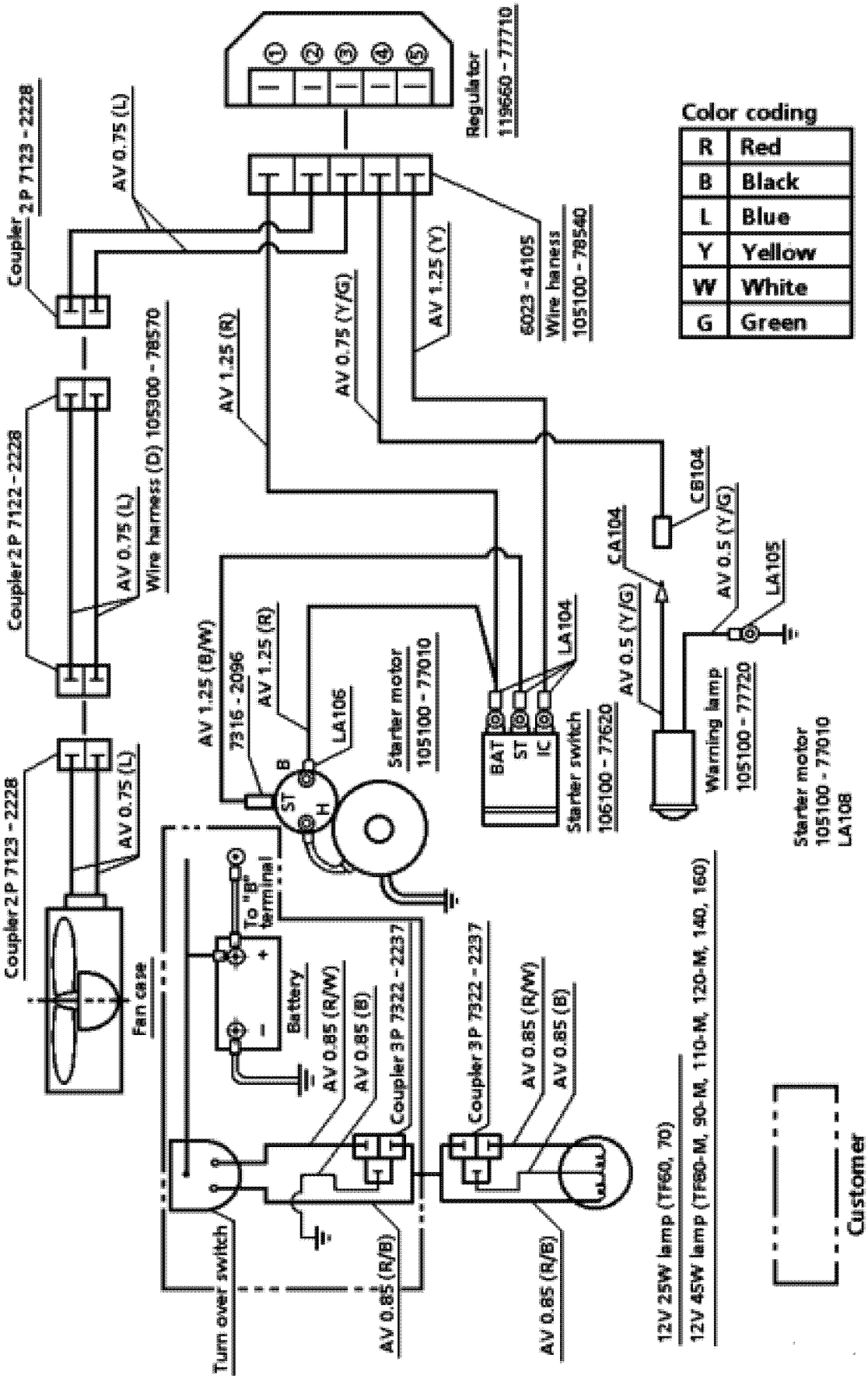
(Note) 80% for Al material of installation side

8. Electric Wiring Diagram

(1) For -E version



(2) -L version


Color coding
R Red
B Black
L Blue
Y Yellow
W White
G Green
Regulator 119660 - 77710
Coupler 2P 7123 - 2228
AV 0.75 (L)
AV 1.25 (R)
AV 0.75 (Y/G)
AV 1.25 (Y)
6023 - 4105 Wire harness 105100 - 78540
Coupler 2P 7122 - 2228
Wire harness (D) 105300 - 78570
AV 1.25 (B/W)
7316 - 2096
LA106
Starter motor 105100 - 77010
BAT
ST
IC
LA104
Starter switch 106100 - 77620
CB104
CA104
AV 0.5 (Y/G)
LA105
Warning lamp 105100 - 77720
Starter motor 105100 - 77010 LA108
To "ig" terminal
Battery
Fan case
AV 0.85 (R/W)
AV 0.85 (B)
Coupler 3P 7322 - 2237
AV 0.85 (R/B)
Turn over switch
12V 25W lamp (TF60, 70)
12V 45W lamp (TF60-M, 90-M, 110-M, 120-M, 140, 160)
Customer

YANMAR DIESEL ENGINE

MODEL TF(-M) series

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