

YAMAHA

SERVICE MANUAL

TF series

YANMAR

SERVICE MANUAL

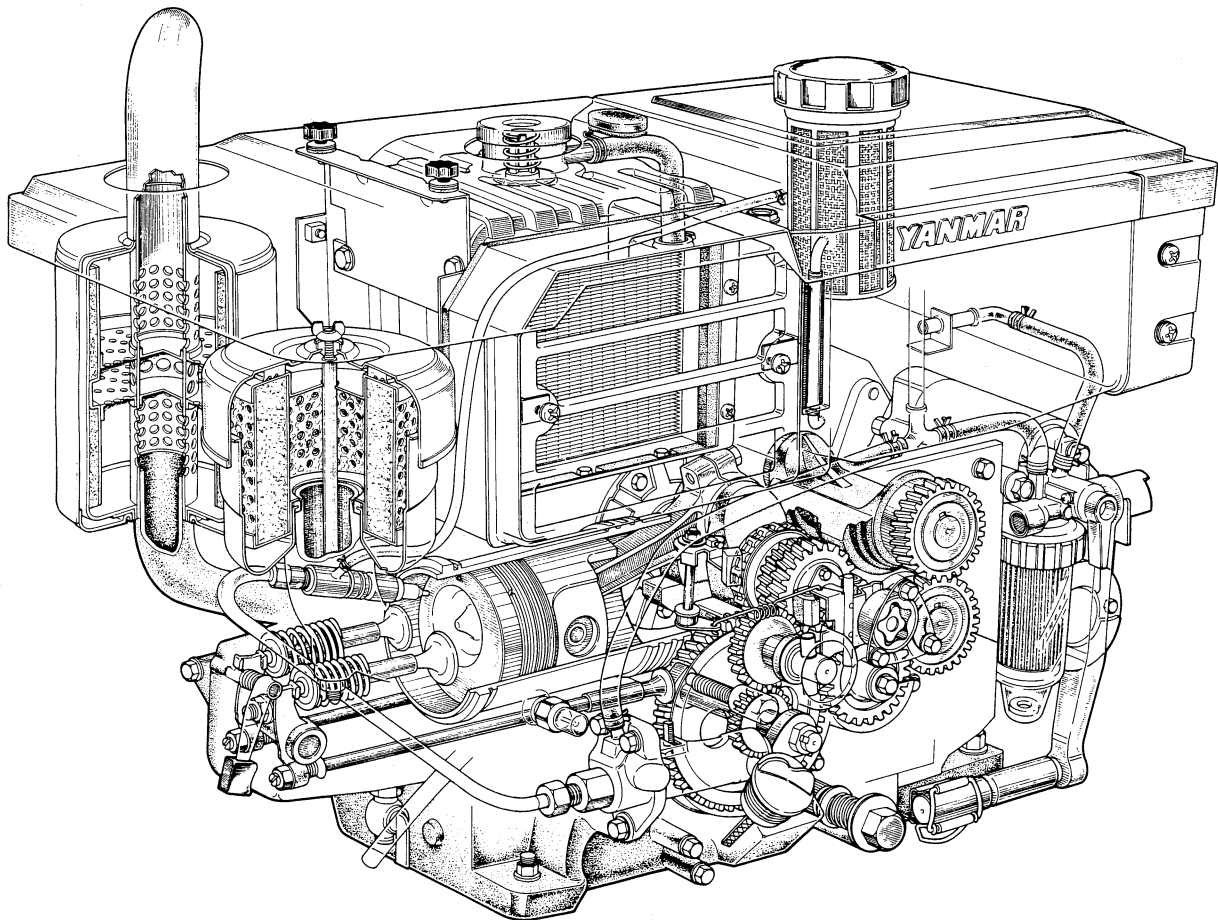
Model
TFseries

FOREWORD

This service manual describes the disassembly, reassembly, and inspection procedures for servicing the TF Engine. Before starting servicing of the engine, you are recommended to read through this manual carefully. You are requested to perform routine checks and periodical servicing diligently to ensure the long and satisfactory operation of your engine.

Reference should be made to the Dimensions and Proper Installations section of the Product Information booklet you received upon installation.

These engine construction and servicing procedures are subject to change without notice, for the improvement of quality and performance. If you have any questions or suggestions, please feel free to call us.

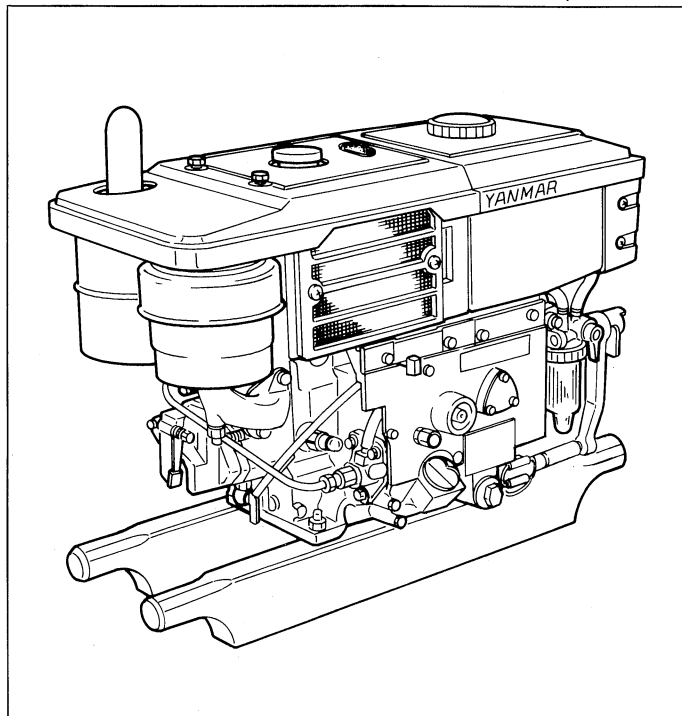


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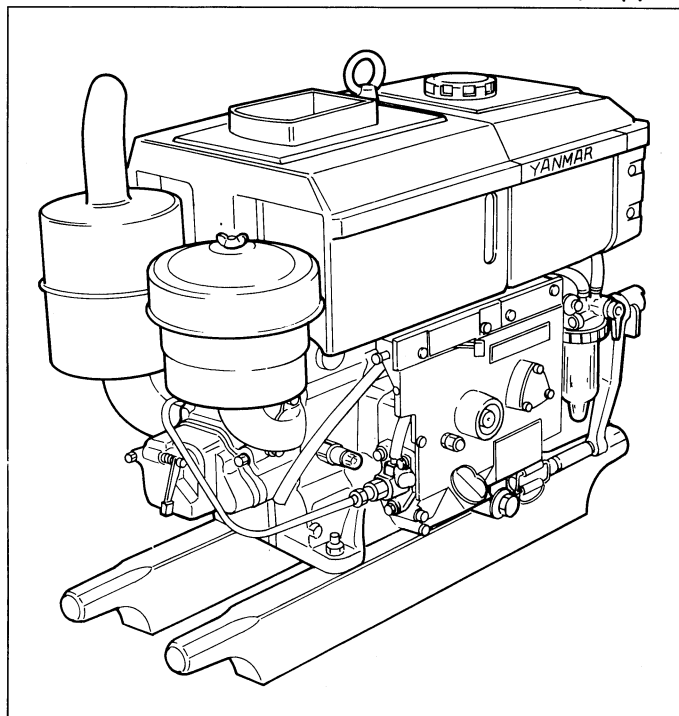
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1. External Views

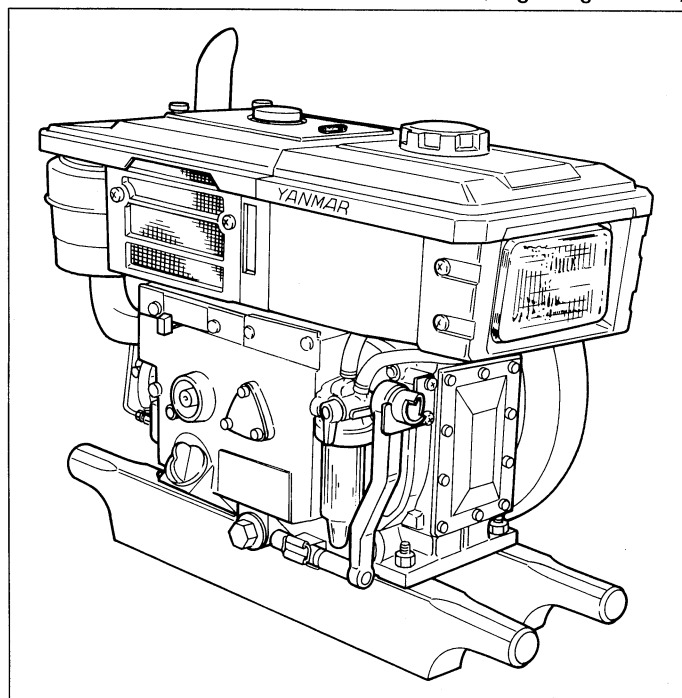
TF
(Radiator)



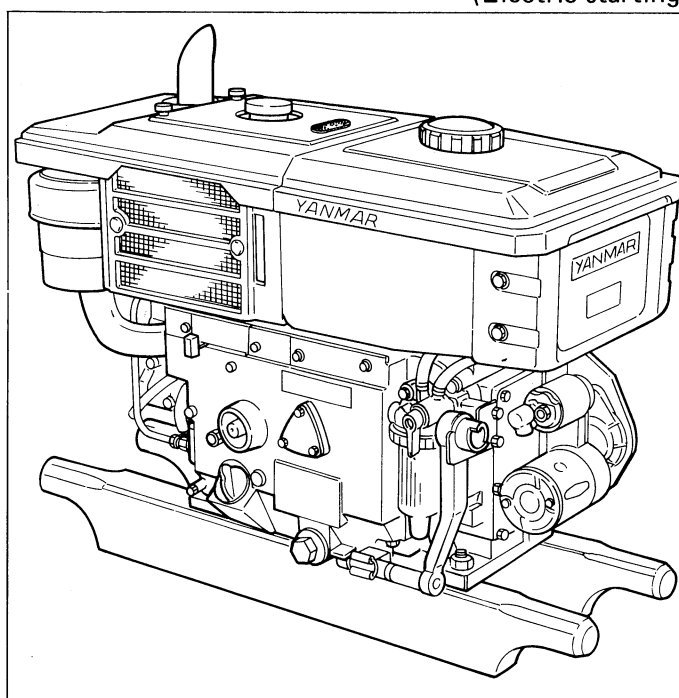
TF-H
(Hopper)



TF-L
(Lighting device)

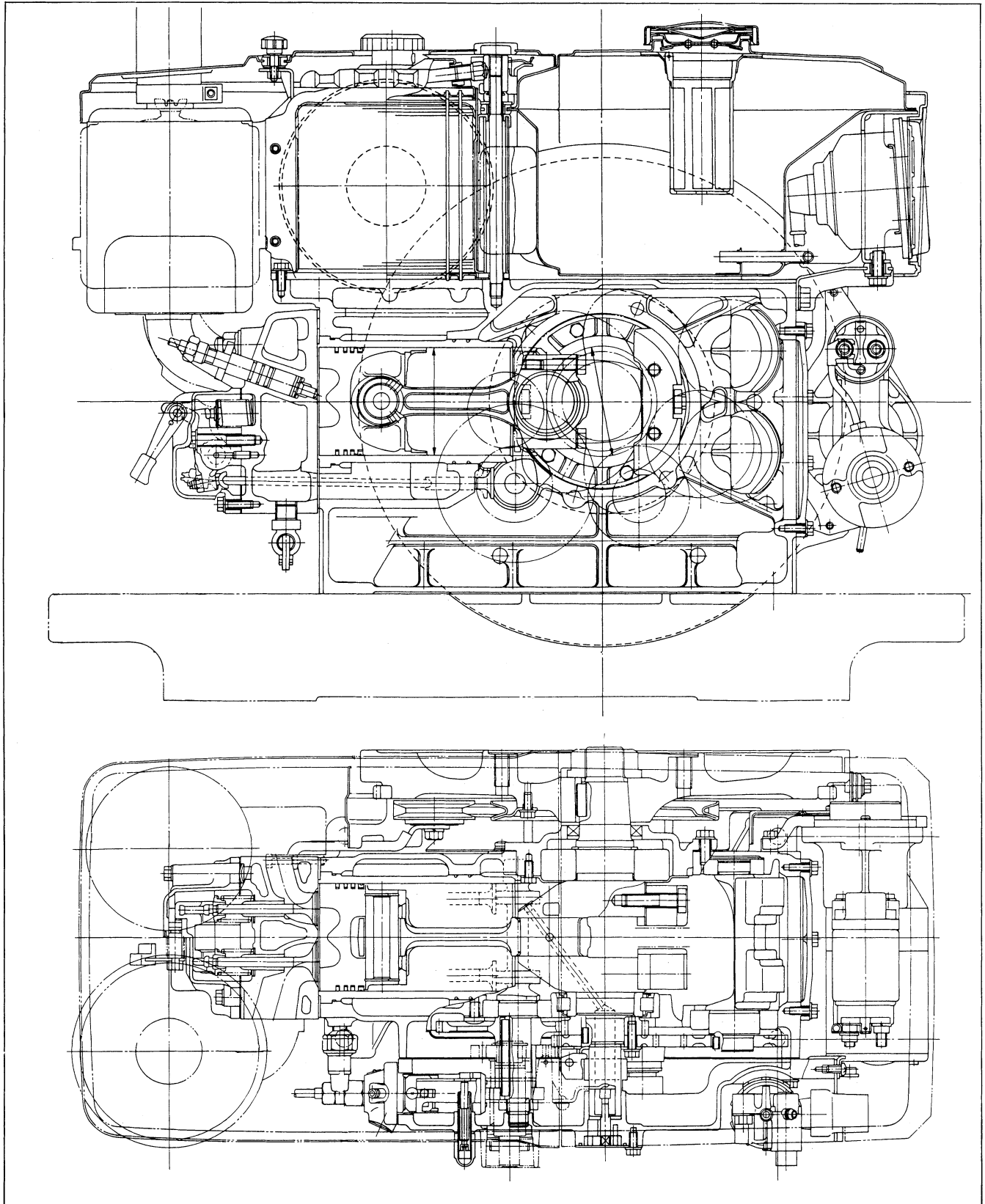


TF-E
(Electric starting)



(Except Models TF140 and TF160)

2. Sectional Views



w/Dual Balancer: Models TF80 ~ TF160 Standard specifications
w/o Dual Balancer: Models TF60 and TF70 (as possible in optional)

3. Specifications

3-1 Specifications of engine with radiator and hopper

Model	Unit	TF50	TF50-H	TF60	TF60-H	TF70	TF70-H	TF80	TF80-H	TF90	TF90-H	TF110	TF110-H	TF120	TF120-H	TF140	TF140-H	TF160	TF160-H		
Type		Horizontal, water-cooled 4-cycle diesel																			
Combustion system		Direct injection																			
No. of cylinders		1																			
Borex stroke	mm	74 x 72		75 x 80		78 x 80		80 x 87		85 x 87		88 x 96		92 x 96		96 x 105		102 x 105			
Displacement	ℓ	0.309		0.353		0.382		0.437		0.493		0.583		0.638		0.760		0.857			
Rated continuous output	HP/rpm	4.5/2400		5.0/2400		6.0/2400		7.5/2400		8.5/2400		10.0/2400		10.5/2400		12.5/2400		14.0/2400			
	kW/rpm	3.4/2400		3.7/2400		4.5/2400		5.6/2400		6.3/2400		7.5/2400		7.8/2400		9.3/2400		10.4/2400			
At 1-hr. rated output	HP/rpm	5.0/2400		6.0/2400		7.0/2400		8.5/2400		9.5/2400		11.0/2400		12.0/2400		14.0/2400		16.0/2400			
	kW/rpm	3.7/2400		4.5/2400		5.2/2400		6.3/2400		7.1/2400		8.2/2400		9.0/2400		10.4/2400		11.9/2400			
Specific fuel consumption	g/HP-hr	175				174				170				169				155			
Compression ratio		18.4		17.9		18.1		18.0				17.9		17.7		17.8					
Position of PTO		Flywheel side																			
Direction of crankshaft rotation		Counterclockwise viewed from flywheel																			
Fuel oil applicable		Gas-oil or Light oil (UK BS 2869 A1 or Equivalent)																			
Fuel injection pump		Bosch type																			
Injection timing	deg.	bTDC 12.5		bTD 17.0				bTDC18.0				bTDC 17.0									
Injection pressure	kg/cm ²	200																			
F.O. tank capacity	ℓ (US gal)	5.6 (1.48)		7.1 (1.88)				10.5 (2.77)				11.0 (2.91)				14.3 (3.78)					
Lubrication system		Complete enclosed forced lubricating system with hydraulic pressure regulating valve																			
Lubricating oil applicable		API grade CB or CC																			
Lubricating oil capacity (Oil pan) Effective/Total	ℓ (US gal)	0.4/1.2 (0.11/0.32)		0.6/1.8 (0.16/0.48)				0.8/2.2 (0.21/0.58)				1.0/2.8 (0.26/0.74)				1.5/3.0 (0.40/0.79)					
Cooling system		Radiator	Hopper	Radiator	Hopper	Radiator	Hopper	Radiator	Hopper	Radiator	Hopper	Radiator	Hopper	Radiator	Hopper	Radiator	Hopper	Radiator	Hopper		
Cooling water capacity	ℓ (US gal)	1.20 (0.32)	5.0 (1.32)	1.25 (0.33)	8.00 (2.11)	1.25 (0.33)	8.00 (2.11)	1.65 (0.44)	8.9 (2.35)	1.65 (0.44)	8.9 (2.35)	2.3 (0.61)	12.0 (3.17)	2.3 (0.61)	12.0 (3.17)	3.00 (0.79)	13.00 (3.43)	3.00 (0.79)	13.00 (3.43)		
Starting system		Manual or Electric																			
Engine dimensions	Overall Length	mm	523		607				675				696				776				
	Overall Width	mm	311		311				329				349				380				
	Overall Height	mm	463		469				496				530				621				
Engine dry weight	kg (lb)	47.5 (104.7)	46 (101.4)	68 (149.9)	65 (143.3)	68 (149.9)	65 (143.3)	86.5 (190.7)	85 (187.4)	86.5 (190.7)	85 (187.4)	101 (220.7)	99 (218.3)	101 (220.7)	99 (218.3)	140 (308.6)	136 (299.6)	140 (308.6)	136 (299.8)		

TF series
Specifications

3-2 Specifications of engine with electric starter and lighting device

Model		Unit	TF50E	TF50-L	TF60E	TF60-L	TF70-E	TF70-L	TF80-E	TF80-L	TF90-E	TF90-L	TF110-E	TF110-L	TF120-E	TF120-L	TF140-E	TF140-L	TF160-E	TF160-L
Engine dimensions	Overall length	mm	601	588	607	607	607	607	675	675	675	675	711	696	711	696	776	—	776	—
	Overall Width	mm	311	311	311	311	311	311	329	329	329	329	349	349	349	349	379	—	379	—
	Overall Height	mm	463	463	469	469	469	469	496	496	496	496	530	530	530	530	621	—	621	—
Engine dry weight		kg (lb)	54 (119.0)	49 (108.0)	68 (149.9)	69 (152.1)	68 (149.9)	69 (152.1)	93.5 (206.1)	87.5 (192.9)	93.5 (206.1)	87.5 (192.9)	108.5 (239.2)	102 (224.9)	108.5 (239.2)	102 (224.9)	140 (308.6)	—	140 (308.6)	—

Note: Items other than the above are the same as those for engines with a radiator.

4. Service Standards

Unit: mm

Division	Component	Item	TF50		TF60, TF70		TF80, TF90		TF110, TF120		TF140, TF160		Corrective Action		
			Standard	Limit	Standard	Limit	Standard	Limit	Standard	Limit	Standard	Limit			
Engine main part	Cylinder head	Cylinder head combustion surface distortion	0.03 or less	0.05	0.03 or less	0.05	0.03 or less	0.05	0.03 or less	0.05	0.03 or less	0.05	Correct with a surface grinder		
		Valve seat angle (deg.)	Intake	120°	—	120°	—	120°	—	120°	—	120°	—		
			Exhaust	90°	—	90°	—	90°	—	90°	—	90°	—		
		Top clearance	0.56 ~ 0.74	—	TF60 0.56~0.74 TF70 0.56~0.74	—	TF80 0.65~0.85 TF90 0.65~0.86	—	TF110 0.70~0.90 TF120 0.70~0.90	—	TF140 0.75~0.95 TF160 0.75~0.95	—			
	Piston	Cylinder liner to-piston clearance	0.079 ~ 0.139	0.30	TF60 0.094~0.154 TF70 0.100~0.160	0.30	TF80 0.103~0.163 TF90 0.113~0.178	0.32	TF110 0.121~0.186 TF120 0.129~0.194	0.35	TF140 0.112~0.177 TF160 0.120~0.185	0.34			
		Piston pin bore diameter	φ22.000~φ22.009	φ22.029	φ23.000~φ23.009	φ23.029	φ26.000~φ26.009	φ26.029	φ28.000~φ28.009	φ28.029	φ32.000~φ32.011	φ32.031	Replace if beyond limit		
		Piston pin bore-pin clearance	0~0.018	0.045	0~0.018	0.045	0~0.022	0.045	0~0.022	0.045	0~0.022	0.045			
		Piston pin outside diameter	φ21.991~φ22.000	φ21.950	φ22.991~φ23.000	φ22.950	φ25.987~φ26.009	φ25.960	φ27.987~φ28.000	φ27.960	φ31.989~φ32.000	φ31.960	Replace if beyond limit		
	Piston ring	Piston ring end gap	No. 1	0.25~0.45	1.5	TF60 0.20~0.40 TF70 0.20~0.40	1.5	TF80 0.20~0.40 TF90 0.30~0.50	1.5	TF110 0.25~0.45 TF120 0.30~0.50	1.5	0.30~0.50	1.5	Replace if beyond limit	
			No. 2, 3	0.25~0.45		0.20~0.40		0.30~0.50							0.30~0.50
			Oil	0.10~0.30		0.20~0.40		0.30~0.50							0.30~0.50
		Ring-to-groove clearance	No. 1	0.070~0.105	0.2	0.095~0.130	0.2	0.095~0.130	0.2	0.095~0.130	0.2	0.095~0.130	0.2	0.2	
			No. 2, 3	0.045~0.080	0.15	0.070~0.105		0.050~0.085		0.050~0.085					
	Oil		0.20~0.055	0.15	0.020~0.055	0.15		0.020~0.055		0.15		0.020~0.055			0.15
	Connecting rod	Crank pin bearing inside diameter	φ36.000~φ36.042	φ36.1	φ43.000~φ43.042	φ43.1	φ45.000~φ45.042	φ45.1	φ48.001~φ48.038	φ48.1	φ54.000~φ54.045	φ54.1	Replace the crankpin bearing		
		Crank pin-to-bearing clearance	0.018~0.077	0.1	0.028~0.086	0.1	0.028~0.086	0.1	0.028~0.086	0.1	0.022~0.092	0.1			
		Crank pin bearing surface	—	—	—	—	—	—	—	—	—	—	Replace if im- properly surface		
		Piston pin-bearing inside diameter	φ22.025~φ22.038	φ22.1	φ23.025~φ23.038	φ23.1	φ26.025~φ26.038	φ26.1	φ28.025~φ28.038	φ28.1	φ32.030~φ32.050	φ32.1	Replace the piston pin bearing		
		Piston pin-to-bearing clearance	0.025~0.047	0.10	0.025~0.047	0.11	0.025~0.051	0.11	0.025~0.051	0.11	0.030~0.061	0.12			
		Thrust clearance	0.2~0.4	0.6	0.2~0.4	0.6	0.2~0.4	0.6	0.2~0.4	0.6	0.2~0.4	0.6			
		Bent or twisted rod	—	0.08/100	—	0.08/100	—	0.08/100	—	0.08/100	—	—	—	Replace if beyond limit	
	Cylinder liner	Cylinder liner inside diameter	φ74.000~φ74.030	φ74.18	TF60 φ75.000~φ75.030 TF70 φ78.000~φ78.030	TF60 φ75.22 TF70 φ78.23	TF80 φ80.000~φ80.030 TF90 φ85.000~φ85.035	TF80 φ80.18 TF90 φ85.19	TF110 φ88.000~φ88.035 TF120 φ92.000~φ92.035	TF110 φ88.20 TF120 φ92.21	TF140 φ96.000~φ96.035 TF160 φ102.000~φ102.035	TF140 φ96.22 TF160 φ102.23	Replace if beyond limit		
		Cylinder liner projection	0.020~0.080	—	0.02~0.08	—	0.02~0.08	—	0.02~0.08	—	0.02~0.08	—			
	Cylinder block	Distortion of head combustion surface	0.05 or less	—	0.05 or less	—	0.05 or less	—	0.05 or less	—	0.05 or less	—	Re-fit with surface grinder		
	Main bearing	Main bearing	—	—	—	—	—	—	—	—	—	—	1. Ensure smooth and noiseless rotation 2. Replace if rota- tion is rough and noisy		
	Crank shaft	Crank pin outside diameter	φ35.965~φ35.982	φ35.89	φ42.956~φ42.972	φ42.88	φ44.956~φ44.972	φ44.88	φ47.952~φ47.973	φ47.88	φ53.953~φ53.978	φ53.953	Replace if beyond limit		
		Crankshaft side gap	0.02~0.45	—	0.01~0.21	—	0.56~1.09	—	0.66~1.24	—	1.02~1.61	—			
		Crankshaft to crank pin bearing clearance	0.018~0.077	0.1	0.028~0.086	0.1	0.028~0.086	0.1	0.028~0.086	0.1	0.022~0.092	0.1			
Worn oil seal		—	—	—	—	—	—	—	—	—	—	1. Check for oil leakage 2. Replace if oil leaks			

Unit: mm

Division	Component	Item	TF50		TF60, TF70		TF80, TF90		TF110, TF120		TF140, TF160		Corrective Action			
			Standard	Limit	Standard	Limit	Standard	Limit	Standard	Limit	Standard	Limit				
Engine main part	Cam shaft	Cam height	Intake valve cam	34.3	34.0	37.25	36.95	39.5	39.2	39.5	39.2	44.8	44.50	Replace if beyond limit		
			Exhaust valve cam	34.3	34.0	37.25	36.95	39.5	39.2	39.5	39.2	44.8	44.50			
			Fuel pump cam	45.0	44.9	45.0	44.90	45.0	44.9	45.0	44.9	47.0	46.90			
				Camshaft bearing rotation	-	-	-	-	-	-	-	-	-	-	1. Check for smooth and noiseless rotation 2. Replace if rotation is rough and noisy	
				Camshaft outside diameter (flywheel side)	φ19.939-φ19.960	φ19.9	φ21.939-φ21.960	φ21.9	φ21.939-φ21.960	φ21.9	φ21.939-φ21.960	φ21.9	φ24.939-φ24.960	φ24.9	Replace if beyond limit	
				Cylinder bore diameter	φ20.000-φ20.021	φ20.05	φ22.000-φ22.021	φ22.05	φ22.000-φ22.021	φ22.05	φ22.000-φ22.021	φ22.05	φ25.000-φ25.021	φ25.05		
				Camshaft-to-cylinder bore clearance	0.040-0.082	0.15	0.040-0.082	0.15	0.040-0.082	0.15	0.040-0.082	0.15	0.040-0.082	0.15		
		Tappet	Tappet outside diameter	φ9.980-φ9.995	φ9.95	φ9.980-φ9.995	φ9.95	φ9.980-φ9.995	φ9.95	φ9.980-φ9.995	φ9.95	φ12.984-φ12.966	φ12.95	Replace if beyond limit		
			Cylinder tappet bore inside diameter	φ10.020-φ10.040	φ10.08	φ10.020-φ10.040	φ10.08	φ10.020-φ10.040	φ10.08	φ10.020-φ10.040	φ10.08	φ13.020-φ13.040	φ13.08			
			Tappet-to-cylinder clearance	0.025-0.060	0.1	0.025-0.060	0.1	0.025-0.060	0.1	0.025-0.060	0.1	0.036-0.074	0.15			
			Tappet-to-cam contacting surface	-	-	-	-	-	-	-	-	-	-		Replace if appreciably worn or deformed	
			Bend push rod	-	0.3	-	0.3	-	0.3	-	0.3	-	0.3	Repair or replace if beyond limit		
		Intake/Exhaust valve	Intake/exhaust valve stem outside diameter	φ6.960-φ6.975 / φ6.945-φ6.960	φ6.90	φ6.945-φ6.960	φ6.90	φ6.945-φ6.960	φ6.85	φ7.945-φ7.960	φ7.85	φ8.945-φ8.960	φ8.85	Replace if beyond limit		
				Intake/exhaust valve guide inside diameter	φ7.005-φ7.020	φ7.09	φ7.005-φ7.020	φ7.09	φ7.005-φ7.020	φ7.09	φ8.005-φ8.020	φ8.09	φ9.005-φ9.020		φ9.09	
				Valve guide-to-valve stem clearance	0.030-0.060 / 0.045-0.075	0.15	0.045-0.075	0.15	0.045-0.075	0.15	0.045-0.075	0.15	0.045-0.075		0.15	
				Valve guide projection	-	-	12.0	-	11.0	-	15.0	-	15.0	-		
				Valve head thickness	Intake	1.0-1.4	0.7	1.0-1.4	0.7	1.0-1.4	0.7	1.0-1.4	0.7	1.1-1.5	0.7	Replace if beyond limit
					Exhaust	0.8-1.2	0.5	0.8-1.2	0.5	0.8-1.2	0.5	0.8-1.2	0.5	0.8-1.2	0.5	
			Intake/exhaust valve sinkage	Intake	0.35	0.6	0.35	0.6	0.30	0.6	0.40	0.7	0.35	0.7	Replace if beyond limit	
				Exhaust	0.75	1.0	0.75	1.0	0.70	1.0	0.80	1.1	1.00	1.1		
		Valve spring	Free length	36.12	34.5	36.12	34.5	36.12	34.5	42	40.5	43.5	42.0	Replace if beyond limit		
				Squareness	-	1.2	-	1.2	-	1.2	-	1.4	-		1.4	
			Intake/exhaust valve clearance	0.15	-	0.2	-	0.2	-	0.2	-	0.2	-	Adjusting standard		
		Intake/Exhaust valve rocker arm	Intake/exhaust valve rocker arm shaft diameter	φ13.982-φ14.000	φ13.9	φ13.982-φ14.000	φ13.9	φ13.982-φ14.000	φ13.9	φ15.982-φ16.000	φ15.9	φ15.982-φ16.000	φ15.9	Replace if beyond limit		
				Valve rocker arm inside diameter	φ14.016-φ14.034	φ14.1	φ14.016-φ14.034	φ14.1	φ14.016-φ14.034	φ14.1	φ16.016-φ16.034	φ16.1	φ16.016-φ16.034		φ16.1	
				Shaft-to-rocker arm clearance	0.016-0.052	0.15	0.016-0.052	0.15	0.016-0.052	0.15	0.016-0.052	0.15	0.016-0.052		0.15	
		Starting shaft	Starting shaft diameter	φ24.972-φ24.993	φ24.95	φ24.972-φ24.993	φ24.95	φ24.972-φ24.993	φ24.95	φ24.972-φ24.993	φ24.95	φ24.972-φ24.993	φ24.95	Replace if beyond limit		
				Gear case bore inside diameter	φ25.030-φ25.060	φ25.2	φ25.030-φ25.060	φ25.2	φ25.030-φ25.060	φ25.2	φ25.030-φ25.060	φ25.2	φ25.030-φ25.060		φ25.2	
				Starting shaft-to-gear case clearance	0.037-0.088	0.15	0.037-0.088	0.15	0.037-0.088	0.15	0.037-0.088	0.15	0.037-0.088		0.15	
		Timing gears backlash	Balancer drive gear to idle gear	0.080-0.196	0.3	0.080-0.196	0.3	0.080-0.196	0.3	0.080-0.196	0.3	0.080-0.196	0.3	Replace the pair of meshed gears if beyond limit		
				Crankgear to camgear	0.080-0.196	0.3	0.080-0.196	0.3	0.080-0.196	0.3	0.080-0.196	0.3	0.080-0.196		0.3	
				Idle gear to balancer gear	0.080-0.196	0.3	0.080-0.196	0.3	0.080-0.196	0.3	0.080-0.196	0.3	0.080-0.196		0.3	
			Upper to lower balancer gears	0.080-0.196	0.3	0.080-0.196	0.3	0.080-0.196	0.3	0.080-0.196	0.3	0.080-0.196	0.3			
		Gear tooth face	-	-	-	-	-	-	-	-	-	-	If damaged replace the gear			
		Lubricating oil pressure (kg/cm ²)	2.5	-	2.5	-	2.5	-	2.5	-	2.5	-	Clean the pressure regulator valve			
	Lubricating oil pump	Outer rotor to housing clearance	0.120-0.161	0.2	0.100-0.151	0.20	0.100-0.151	0.20	0.120-0.171	0.22	0.120-0.171	0.22	Replace pump if beyond limit			
			Outer rotor to inner rotor clearance	0.14	0.2	0.14	0.20	0.14	0.20	0.14	0.20	0.14		0.20		
			Side clearance of inner/outer rotor to housing	0.01-0.06	0.09	0.02-0.04	0.07	0.02-0.04	0.07	0.01-0.05	0.08	0.02-0.08		0.15		

Unit: mm

Division	Component	Item	TF50		TF60, TF70		TF80, TF90		TF110, TF120		TF140, TF160		Corrective Action		
			Standard	Limit	Standard	Limit	Standard	Limit	Standard	Limit	Standard	Limit			
Fuel system		Injection quantity at limit (cc)	17.0–18.0	–	TF60 18.5–19.5 TF70 22.0–23.0	–	TF80 27.6–28.6 TF90 35.0–36.0	–	TF110 39.2–40.2 TF120 41.0–42.0	–	TF140 44.5–45.5 TF160 51.5–52.5	–			
		Measured stroke	1,000	–	1,000	–	1,000	–	1,000	–	1,000	–			
		RPM of cam shaft	1,200	–	1,200	–	1,200	–	1,200	–	1,200	–			
		<ul style="list-style-type: none"> • Nozzle injection pressure: 200 kg/cm² • Injection pipe: <ul style="list-style-type: none"> TF50 φ6 × φ1.2 × ℓ235 TF60/70 φ6 × φ1.2 × ℓ250 TF80/90 φ6 × φ1.5 × ℓ270 TF110/120 φ6 × φ1.5 × ℓ350 TF140/160 φ6 × φ1.6 × ℓ370 • Fuel oil: Light oil 	–	–	–	–	–	–	–	–	–	–			
Electric appliances	Starting motor	Battery terminal and upper	Make sure that the terminal is free from rust and corrosion and the battery upper surface is unsoiled and kept dry.										After cleaning be sure to dry the battery.		
		Electrolyte quantity	Make sure that the electrolyte level is always 10–20 mm higher than the top of the electrode.										Add purified water.		
		Specific gravity of electrolyte	1.260/20°C ... 100% capacity 1.200/20°C ... 50% capacity										Recharge		
		Terminal voltage and capacity	12 V–35 AH		12 V–35 AH		12 V–56 AH		12 V–80 AH		12 V–80 AH				
		Type and output	12 V–1.2 kW		12 V–1.2 kW		12 V–1.2 kW		12 V–1.2 kW		12 V–1.2 kW				
	Starting motor	Brush	Spring force (kg-mm)	1.6	Over 1.4–1.8	1.6	Over 1.4–1.8	1.6	Over 1.4–1.8	1.6	Over 1.4–1.8	1.6	Over 1.4–1.8	Replace and make sure that the brush moves smoothly in the holder.	
			Brush size	–	12	–	12	–	12	–	12	–	12		
		Commutator	Magnetic switch resistance at 20°C	Series coil 0.325Ω Shunt coil 0.601Ω	–	Series coil 0.325Ω Shunt coil 0.601Ω	–	Series coil 0.325Ω Shunt coil 0.601Ω	–	Series coil 0.325Ω Shunt coil 0.601Ω	–	Series coil 0.325Ω Shunt coil 0.601Ω	–	Replace it beyond specified valve.	
			Outside diameter	φ30.0	φ29.0	φ30.0	φ29.0	φ30.0	φ29.0	φ30.0	φ29.0	φ30.0	φ29.0	Replace if beyond limit.	
			Difference between maximum and minimum diameters	0.03	0.2	0.03	0.2	0.03	0.2	0.03	0.2	0.03	0.2		
			Mica depth	0.5–0.8	0.2	0.5–0.8	0.2	0.5–0.8	0.2	0.5–0.8	0.2	0.5–0.8	0.2	Repair if beyond limit.	
			Commutator deflection	0.03	0.2	0.03	0.2	0.03	0.2	0.03	0.2	0.03	0.2	Repair if beyond limit.	
		Each bearing	Check for smooth and noiseless rotation.										Replace if unsatisfactory.		
		Dynamo regulator	No-load output	Pinion gear projection size	31.5–34.5	–	31.5–34.5	–	31.5–34.5	–	31.5–34.5	–	31.5–34.5	–	
				Voltage	12 V	–	12 V	–	12 V	–	12 V	–	12 V	–	
Current	105 A or less			–	105 A or less	–	105 A or less	–	105 A or less	–	105 A or less	–			
No. of revolutions	4000 rpm or more			–	4000 rpm or more	–	4000 rpm or more	–	4000 rpm or more	–	4000 rpm or more	–			
Dynamo regulator		Regulated voltage (7000 rpm, 12 V–35 AH, electrolyte Charged, 20°C ±5°)	14–15 V	–	14–15 V	–	14–15 V	–	14–15 V	–	14–15 V	–			
		Voltage rise (at a battery voltage of 13 V)	3500 rpm or less	–	3500 rpm or less	–	3500 rpm or less	–	3500 rpm or less	–	3500 rpm or less	–			
		Charging current	6 A or more at 7000 rpm and 14 V.	–	6 A or more at 7000 rpm and 14 V.	–	6 A or more at 7000 rpm and 14 V.	–	6 A or more at 7000 rpm and 14 V.	–	6 A or more at 7000 rpm and 14 V.	–			
Charge lamp		Appropriate battery	12 V	–	12 V	–	12 V	–	12 V	–	12 V	–			
		Set voltage	12.5–13 V	–	12.5–13 V	–	12.5–13 V	–	12.5–13 V	–	12.5–13 V	–			
		Battery voltage range	0–16 V	–	0–16 V	–	0–16 V	–	0–16 V	–	0–16 V	–			
		Current consumption	30 mA or less (12 V)	–	30 mA or less (12 V)	–	30 mA or less (12 V)	–	30 mA or less (12 V)	–	30 mA or less (12 V)	–			

5. Main Bolt/Nut Tightening Torques

Unit: kg-m

Name of parts	TF50	TF60, TF70	TF80, TF90	TF110, TF120	TF140, TF160
Balance weight bolt	4.50 – 5.50	←	←	←	8.3 – 9.3
Fuel cam tightening nut	9.00 – 11.00	←	←	←	←
Fuel pump clamping nut	2.30 – 2.90	←	←	←	←
Fuel injection valve retaining nut	2.00	←	←	←	2.3 – 2.9
High-pressure cap nut	2.60 – 3.00	2.70 – 3.30	←	←	←
Connecting rod bolt	2.20 – 2.40	3.75 – 4.25	←	5.25 – 5.75	5.70 – 6.30
Cylinder head clamp bolt and nut	9.50 – 10.50	←	←	13.10 – 14.10	19.00 – 21.00
Main bearing housing clamping nut	2.30 – 2.90	←	←	←	←
Flywheel end nut	17.00 – 20.00	25.00 – 29.00	←	30.00 – 35.00	←
Fuel injection pump delivery valve holder	4.00 – 4.50	←	←	←	4.50 – 5.00

Standard bolt tightening torque

Unit : kg-m

	Thread dia.	Tightening torque
Hexagonal bolt/nut	M6	1.00 – 1.20
	M8	2.35 – 2.85
	M10	4.50 – 5.50
	M12	8.00 – 10.00
	M14	12.50 – 15.50
	M16	21.00 – 25.00
Pipe flange bolt	M8	1.35 – 1.65
	M10	2.05 – 2.55
	M12	2.70 – 3.30
	M14	4.00 – 5.00
	M16	5.00 – 6.00
	M18	6.75 – 8.25
	M20	8.50 – 10.50
PT plug	1/8	1.00 – 1.20
	1/4	1.60 – 2.00
	3/8	2.05 – 2.55
	1/2	5.50 – 6.50
Stud bolt	M6	0.80 – 0.90
	M8	1.80 – 2.20
	M10	3.60 – 4.40
	M12	6.50 – 7.90

6. Disassembly and Reassembly

6.1 Preparation for Disassembly and Reassembly

Make the following preparations prior to disassembling and reassembling the engine.

1) Selection of work area

Select a clean area – well organized, and free of dirt and rubbish.

2) Preparation of parts storage area and parts containers

Prepare a suitable area and containers to ensure that the parts will not be stained or damaged.

3) Preparation of cleaner or cleaning can

Prepare a parts washing cleaner. Otherwise, make use of half of an 18-liter can, prepared by cutting the can vertically.

4) Preparation and check of tools and instruments

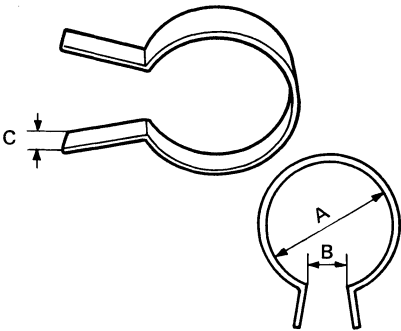
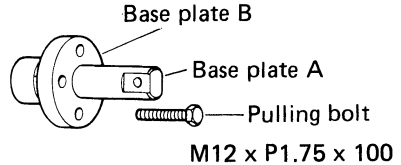
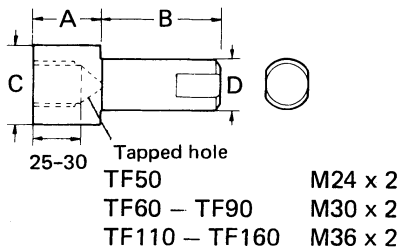
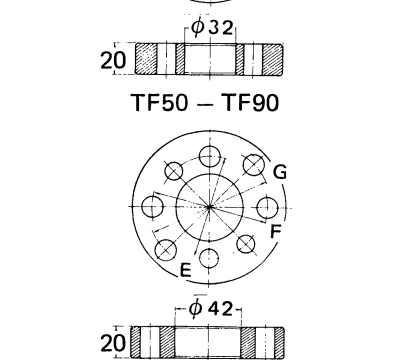
The following listings show the tools and instruments required for disassembling and reassembling engines. Suitable items should be used selectively according to the complexity and sections of the engine to be disassembled.

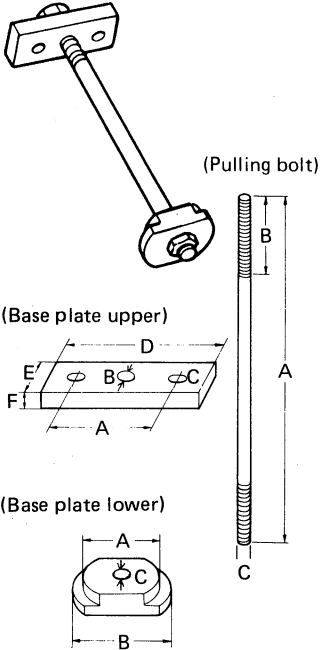
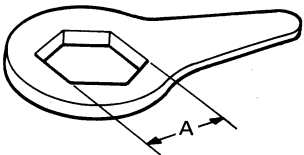
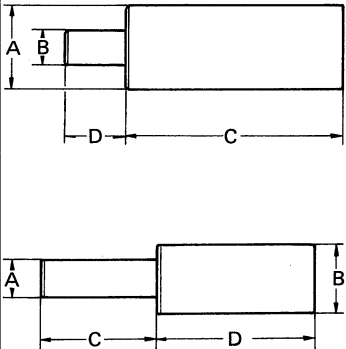
5) Before starting assembly

- Thoroughly wash and inspect all the parts to be assembled.
- Apply fresh engine oil to rubbing or rotating surfaces before assembly.
- Replace gaskets and O-rings with new ones.
- Apply, if necessary, liquid sealant to prevent water or oil leakage.
- Assemble parts after inspecting oil clearances and thrust clearances.
- Assemble parts with matching marks so that the marks align correctly. Take care that the matching pairs are correctly assembled.
- Do not use wrong bolts, nuts, and washers. Tighten standard bolts and nuts to the specified tightening torques. Take special care when assembling aluminum-alloy parts.
- Apply engine oil to the thread and seat of principal bolts before tightening them.

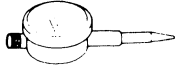

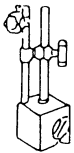
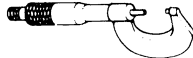
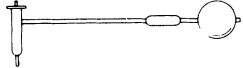

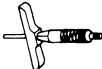


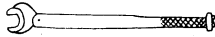
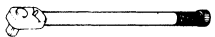
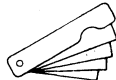
6.2 Disassembling/Assembling tools (Special Tools)

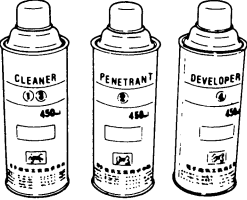
Unit: mm

Tool (Yanmar code No.)	Dimensions	Illustration																																										
<p>Piston insertion tool (Optional)</p> <table border="1" data-bbox="165 436 488 743"> <thead> <tr> <th>Model</th> <th>Code No.</th> </tr> </thead> <tbody> <tr> <td>TF50, TF60</td> <td>101300-92140</td> </tr> <tr> <td>TF70, TF80</td> <td>102700-92140</td> </tr> <tr> <td>TF90</td> <td>101400-92140</td> </tr> <tr> <td>TF110, TF120</td> <td>101404-92140</td> </tr> <tr> <td>TF140</td> <td>174200-92141</td> </tr> <tr> <td>TF160</td> <td>101504-92140</td> </tr> </tbody> </table>	Model	Code No.	TF50, TF60	101300-92140	TF70, TF80	102700-92140	TF90	101400-92140	TF110, TF120	101404-92140	TF140	174200-92141	TF160	101504-92140	<table border="1" data-bbox="607 436 964 777"> <thead> <tr> <th>Model</th> <th>A</th> <th>B</th> <th>C</th> </tr> </thead> <tbody> <tr> <td>TF50, TF60</td> <td>80</td> <td>22</td> <td>26</td> </tr> <tr> <td>TF70, TF80</td> <td>85</td> <td>22</td> <td>26</td> </tr> <tr> <td>TF90</td> <td>90</td> <td>22</td> <td>26</td> </tr> <tr> <td>TF110, TF120</td> <td>90</td> <td>25</td> <td>26</td> </tr> <tr> <td>TF140</td> <td>102</td> <td>28</td> <td>26</td> </tr> <tr> <td>TF160</td> <td>106</td> <td>28</td> <td>26</td> </tr> </tbody> </table>	Model	A	B	C	TF50, TF60	80	22	26	TF70, TF80	85	22	26	TF90	90	22	26	TF110, TF120	90	25	26	TF140	102	28	26	TF160	106	28	26	
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<p>Liner puller (Optional) Base plate upper</p> <table border="1" data-bbox="173 352 574 432"> <tr> <th>Model</th> <th>Base plate upper</th> </tr> <tr> <td>TF50 – TF160</td> <td>172200-92020</td> </tr> </table> <p>Base plate lower</p> <table border="1" data-bbox="173 510 574 810"> <tr> <th>Model</th> <th>Base plate lower</th> </tr> <tr> <td>TF50, TF60</td> <td>105090-92010</td> </tr> <tr> <td>TF70</td> <td>105200-92010</td> </tr> <tr> <td>TF80</td> <td>172300-92010</td> </tr> <tr> <td>TF90, TF110</td> <td>101400-92010</td> </tr> <tr> <td>TF120</td> <td>120220-92010</td> </tr> <tr> <td>TF140</td> <td>105700-92010</td> </tr> <tr> <td>TF160</td> <td>101504-92010</td> </tr> </table> <p>Pulling bolt</p> <table border="1" data-bbox="173 884 574 963"> <tr> <th>Model</th> <th>Pulling bolt</th> </tr> <tr> <td>TF50 – TF160</td> <td>103338-92030</td> </tr> </table>	Model	Base plate upper	TF50 – TF160	172200-92020	Model	Base plate lower	TF50, TF60	105090-92010	TF70	105200-92010	TF80	172300-92010	TF90, TF110	101400-92010	TF120	120220-92010	TF140	105700-92010	TF160	101504-92010	Model	Pulling bolt	TF50 – TF160	103338-92030	<p>Base plate upper</p> <table border="1" data-bbox="632 315 1022 579"> <tr> <th colspan="2">TF50 – TF160</th> </tr> <tr> <td>A</td> <td>102 – 132</td> </tr> <tr> <td>B</td> <td>18</td> </tr> <tr> <td>C</td> <td>16</td> </tr> <tr> <td>D</td> <td>165</td> </tr> <tr> <td>E</td> <td>38</td> </tr> <tr> <td>F</td> <td>19</td> </tr> </table> <p>Base plate lower</p> <table border="1" data-bbox="632 655 1134 833"> <tr> <th></th> <th>TF50, TF60</th> <th>TF70</th> <th>TF80</th> <th>TF90, TF110</th> </tr> <tr> <td>A</td> <td>73</td> <td>77.5</td> <td>79.5</td> <td>84.5</td> </tr> <tr> <td>B</td> <td>84</td> <td>85</td> <td>89</td> <td>94</td> </tr> <tr> <td>C</td> <td>18</td> <td>18</td> <td>18</td> <td>18</td> </tr> </table> <table border="1" data-bbox="632 842 1022 995"> <tr> <th></th> <th>TF120</th> <th>TF140</th> <th>TF160</th> </tr> <tr> <td>A</td> <td>90.5</td> <td>95.5</td> <td>99.5</td> </tr> <tr> <td>B</td> <td>104</td> <td>100</td> <td>110</td> </tr> <tr> <td>C</td> <td>18</td> <td>18</td> <td>18</td> </tr> </table> <p>Pulling bolt</p> <table border="1" data-bbox="639 1050 1027 1203"> <tr> <th colspan="2">TF50 – TF160</th> </tr> <tr> <td>A</td> <td>380</td> </tr> <tr> <td>B</td> <td>170</td> </tr> <tr> <td>C</td> <td>M16</td> </tr> </table>	TF50 – TF160		A	102 – 132	B	18	C	16	D	165	E	38	F	19		TF50, TF60	TF70	TF80	TF90, TF110	A	73	77.5	79.5	84.5	B	84	85	89	94	C	18	18	18	18		TF120	TF140	TF160	A	90.5	95.5	99.5	B	104	100	110	C	18	18	18	TF50 – TF160		A	380	B	170	C	M16	
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B	84	85	89	94																																																																																
C	18	18	18	18																																																																																
	TF120	TF140	TF160																																																																																	
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B	104	100	110																																																																																	
C	18	18	18																																																																																	
TF50 – TF160																																																																																				
A	380																																																																																			
B	170																																																																																			
C	M16																																																																																			
<p>Hexagonal nut (26712 – 160002) End nut wrench (Optional)</p> <table border="1" data-bbox="173 1293 574 1493"> <tr> <th>Model</th> <th>Code No.</th> </tr> <tr> <td>TF50</td> <td>105010-92100</td> </tr> <tr> <td>TF60, TF70 TF80, TF90</td> <td>104200-92100</td> </tr> <tr> <td>TF110, TF120 TF140, TF160</td> <td>103338-92100</td> </tr> </table>	Model	Code No.	TF50	105010-92100	TF60, TF70 TF80, TF90	104200-92100	TF110, TF120 TF140, TF160	103338-92100	<p>Hexagonal nut M16, P2.0</p> <table border="1" data-bbox="632 1293 1118 1400"> <tr> <th></th> <th>TF50</th> <th>TF60, TF70 TF80, TF90</th> <th>TF110, TF120 TF140, TF160</th> </tr> <tr> <td>A</td> <td>36</td> <td>48</td> <td>58</td> </tr> </table>		TF50	TF60, TF70 TF80, TF90	TF110, TF120 TF140, TF160	A	36	48	58																																																																			
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<p>Connecting rod small-end bush puller (made by user)</p> <p>Intake/exhaust valve guide pulling/insertion tool (made by user)</p> <p>(Valve guide for Model TF50 are integrated with cylinder head)</p>	<p>Connecting rod small-end bush puller</p> <table border="1" data-bbox="632 1497 1134 1715"> <tr> <th></th> <th>TF50</th> <th>TF60, TF70 TF90</th> <th>TF80, TF90</th> <th>TF110, TF120</th> <th>TF140, TF160</th> </tr> <tr> <td>A</td> <td>24</td> <td>26</td> <td>29</td> <td>31</td> <td>35</td> </tr> <tr> <td>B</td> <td>22</td> <td>23</td> <td>26</td> <td>28</td> <td>32</td> </tr> <tr> <td>C</td> <td>75</td> <td>75</td> <td>75</td> <td>75</td> <td>75</td> </tr> <tr> <td>D</td> <td>25</td> <td>25</td> <td>25</td> <td>25</td> <td>25</td> </tr> </table> <p>Intake/exhaust valve guide pulling/insertion tool</p> <table border="1" data-bbox="632 1751 1134 1963"> <tr> <th></th> <th>TF60, TF70</th> <th>TF80, TF90</th> <th>TF110, TF120</th> <th>TF140, TF160</th> </tr> <tr> <td>A</td> <td>7</td> <td>7</td> <td>8</td> <td>9</td> </tr> <tr> <td>B</td> <td>12</td> <td>12</td> <td>13</td> <td>14</td> </tr> <tr> <td>C</td> <td>40</td> <td>←</td> <td>←</td> <td>←</td> </tr> <tr> <td>D</td> <td>70</td> <td>←</td> <td>←</td> <td>←</td> </tr> </table>		TF50	TF60, TF70 TF90	TF80, TF90	TF110, TF120	TF140, TF160	A	24	26	29	31	35	B	22	23	26	28	32	C	75	75	75	75	75	D	25	25	25	25	25		TF60, TF70	TF80, TF90	TF110, TF120	TF140, TF160	A	7	7	8	9	B	12	12	13	14	C	40	←	←	←	D	70	←	←	←																												
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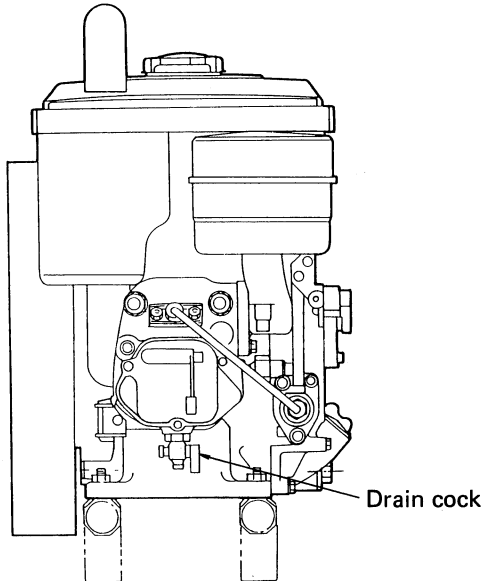
6.3 Meters, Instruments and Service Accessories

Instrument	Remarks		Illustration						
Dial gauge	1 div.: 0.01 mm Range: 0–5 mm 0–10 mm	To measure the straightness of shafts, flatness of planes, and gap widths.							
Test indicator	1 div.: 0.01 mm Range: 0–0.8 mm	To measure positions too narrow and too deep for normal dial indicators.							
Magnet stand	<table border="1"> <thead> <tr> <th>Trunk bar (dia. x length) (mm)</th> <th>Branch bar (dia. x length) (mm)</th> </tr> </thead> <tbody> <tr> <td>12 x 176</td> <td>10 x 165</td> </tr> <tr> <td>14 x 183</td> <td>12 x 165</td> </tr> </tbody> </table>	Trunk bar (dia. x length) (mm)	Branch bar (dia. x length) (mm)	12 x 176	10 x 165	14 x 183	12 x 165	To attach dial indicators to various positions for easy accurate viewing.	
Trunk bar (dia. x length) (mm)	Branch bar (dia. x length) (mm)								
12 x 176	10 x 165								
14 x 183	12 x 165								
Micrometer	Range (mm) 0–25 50–75 25–50 50–100	To measure the O.D. of the crankshaft, pistons, and piston pins.							
Cylinder gauge	Range (mm) 10–18 35–60 18–35 50–100	To measure the I.D. of the cylinder liners and main bearings.							
Vernier calipers	1 div.: 0.05 mm Range: 0–150 mm 0–200 mm	To measure various O.D., depths, thicknesses, and widths.							
Depth micrometer	Range (mm) 0–25	To measure valve sinkage and liner projection.							
Square	Size: 100 mm	To measure the inclination of valve springs and squareness of various parts.							
V-block	Size: 100x50x55 mm	To be used when measuring the straightness of a shaft.							
Torque wrench	<table border="1"> <thead> <tr> <th>Bolt/nut size (mm)</th> <th>Range (kg-m)</th> </tr> </thead> <tbody> <tr> <td>6 – 14</td> <td>0.4 – 3.0 3.1 – 8.0</td> </tr> <tr> <td>17, 19, 21</td> <td>3.1 – 16.0</td> </tr> </tbody> </table> Range (kg-m): 0.4 – 1.2, 1.0 – 4.5, 4.0 – 18.0, 4.0 – 28.0, 6.0 – 42.0, 10.0 – 55.0	Bolt/nut size (mm)	Range (kg-m)	6 – 14	0.4 – 3.0 3.1 – 8.0	17, 19, 21	3.1 – 16.0	To be used when tightening bolts and nuts with specified torques.	 
Bolt/nut size (mm)	Range (kg-m)								
6 – 14	0.4 – 3.0 3.1 – 8.0								
17, 19, 21	3.1 – 16.0								
Thickness gauge	Length 75 x 9 sheets	To measure clearances between piston rings and piston grooves or between shaft couplings during installation, etc.							

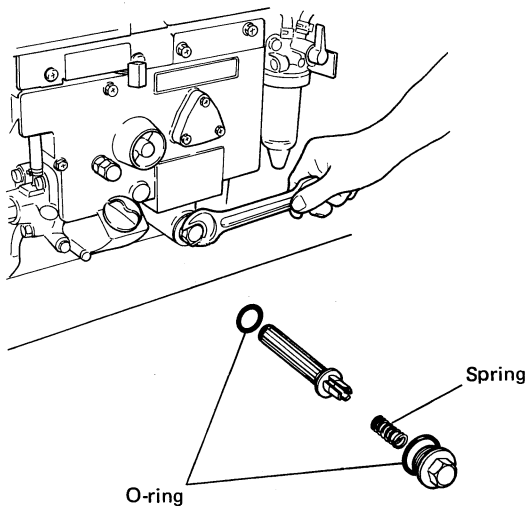
Instrument (Yanmar code No.)	Remarks	Illustration
<p>Color check (for flaw detection)</p> <p>Set product (6 bottles) (97550- 004560)</p>	<p>Penetrant (450 cc) (97550-00451)</p> <p>Developer (450 cc) (97550-00452)</p> <p>Cleaning agent (450 cc) (97550-00453)</p>	<p>To be used in detecting flaws.</p> 

6.4. Disassembly

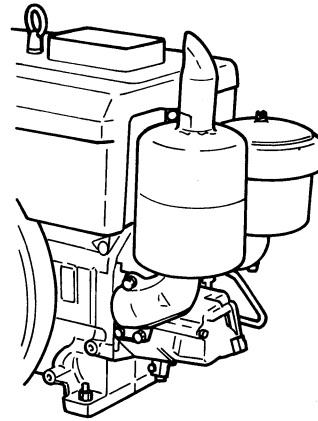
1. **Drain out the cooling water.**
Remove the radiator cap. Open the drain cock at the bottom of the cylinder head.



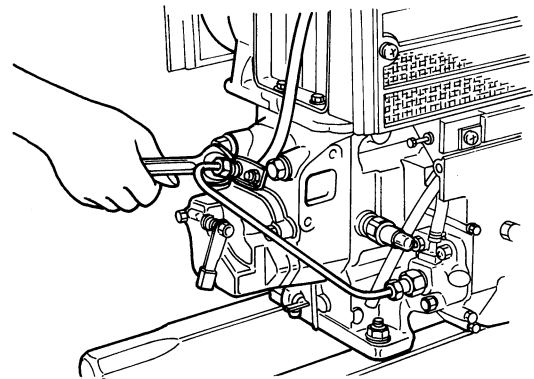
2. **Cut off fuel oil.**
Close the fuel oil filter cock. (Turn the lever up.)
3. **Drain out lubricating oil.**
(Only when required)
Remove the drain plug to drain out lubricating oil.
 - Be careful not to damage the L.O. strainer and O-rings.
 - Do not lose the spring.



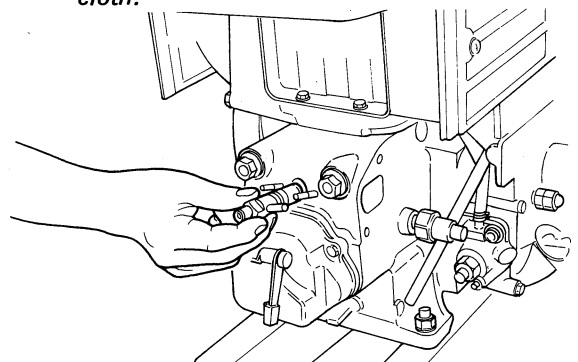
4. **Remove the air cleaner together with the intake pipe.**
5. **Remove the exhaust muffler.**



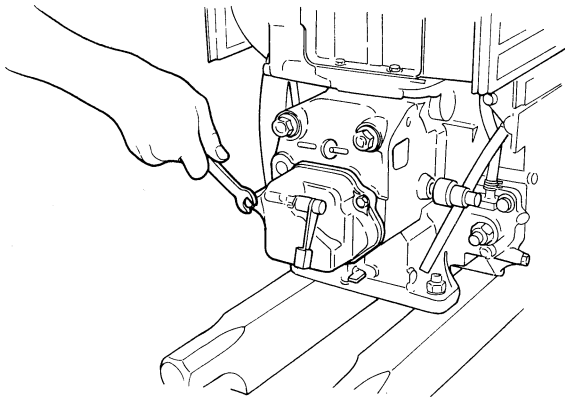
6. **Disconnect the F.O. high-pressure pipe.**



7. **Dismount the fuel injection valve.**
 1. Remove the fuel injection valve retainer.
 2. Disconnect the overflow pipe.
 3. Remove the fuel injection valve.
 4. Remove the insulating packing (Replace the insulating packing with the new one when reassembling.)
 - Take care of four very small holes at the top of the nozzle. Protect the nozzle with soft cloth.

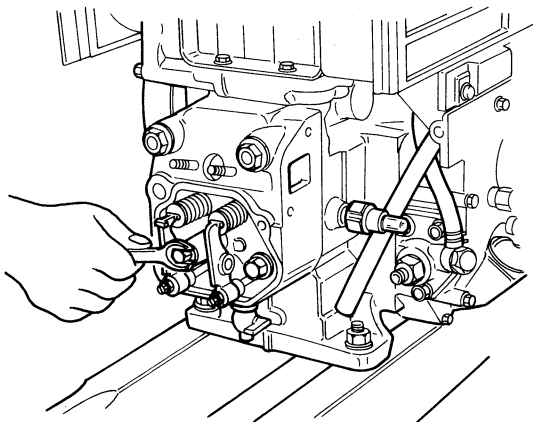


8. Take off the bonnet.



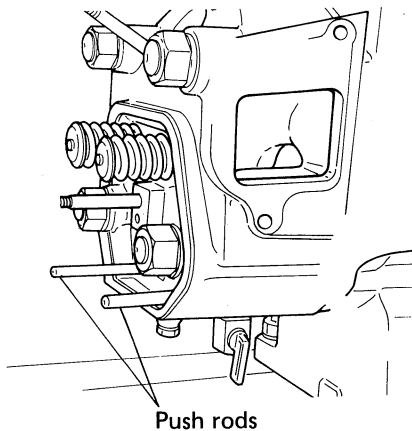
9. Remove the valve rocker arms and valve rocker arm supports.

- Distinguish between the intake and exhaust sides.
(The exhaust valve rocker arm has a machined surface on the rear side.)

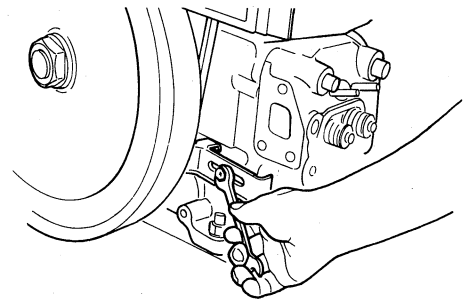


10. Slide the push rods out.

- Distinguish between the intake and exhaust sides.)

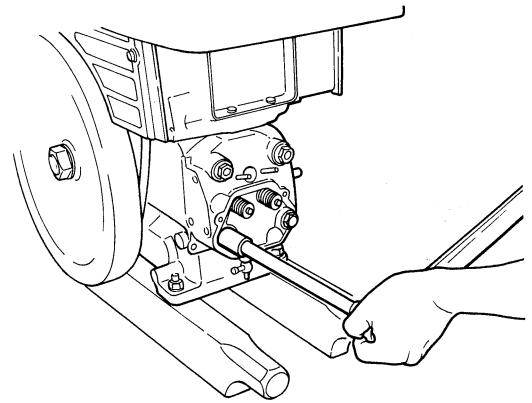


**11. Loosen the tension lever for cooling fan belt.
Only radiator cooling type**



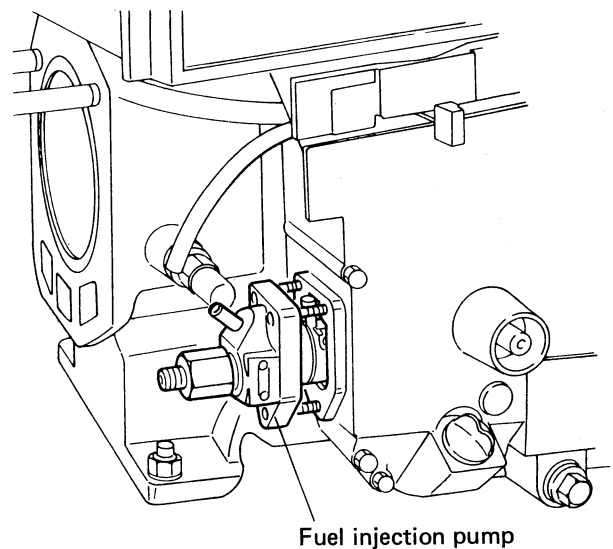
12. Remove the cylinder head.

- Loosen the head clamp nuts, loosening pairs of opposite nuts.



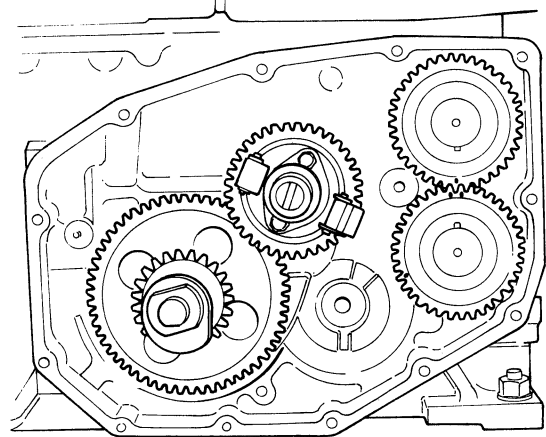
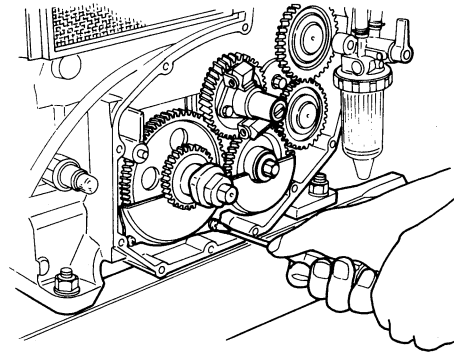
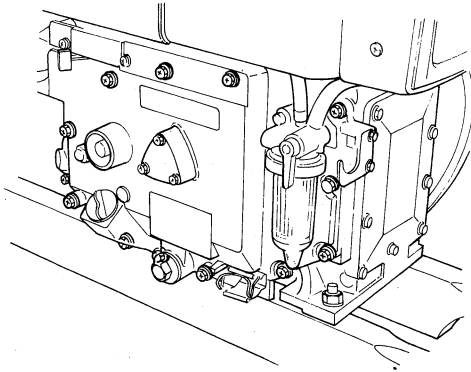
13. Dismount the fuel injection pump.

- 1) Disconnect the fuel intake pipe.
 - 2) Take out the pump.
- When taking out the pump, be careful not to interfere with the pump rack.
(Operate the regulator handle while removing the pump.)
 - Check the number of the adjusting shims.



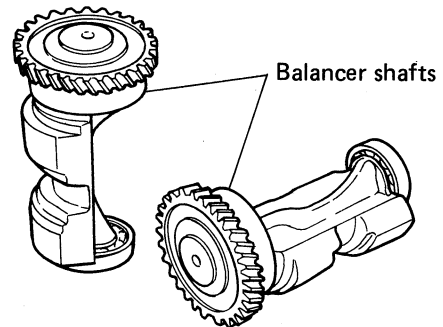
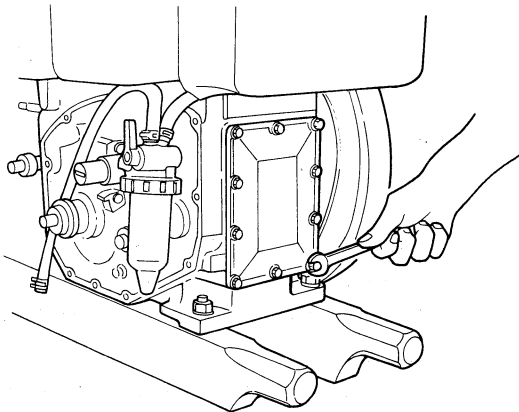
14. Take off the gear housing.

- 1) Remove the fuel filter attaching bolts.
(Leave the inlet and outlet pipes of the fuel filter attached.)
- 2) Remove the gear housing bolts.
(Check whether all bolts at the bottom are removed.)



15. Take off the cylinder rear cover.

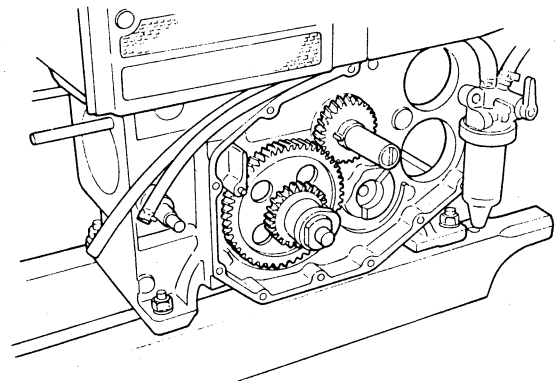
- *The cover uses liquid sealant.*



(except TF50, TF60, TF70)

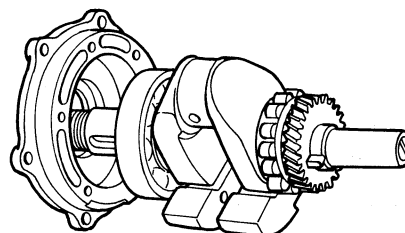
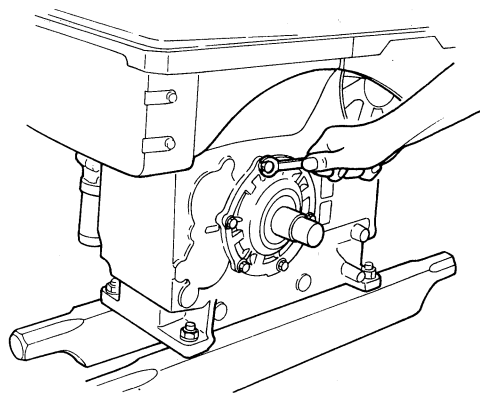
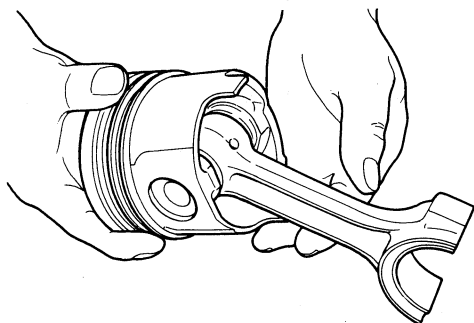
16. Pull out the balancer shaft.

1. Remove the gear cover.
2. Remove the idle gear.
3. Remove the balancer shaft bearing retainer.
4. Pull out the balancer shafts.
 - *Balancer shaft timing marks.*
 - 1 on the upper
 - 3 on the lower
 - *Use a mallet or a plastic hammer to pull out the balancer shaft.*



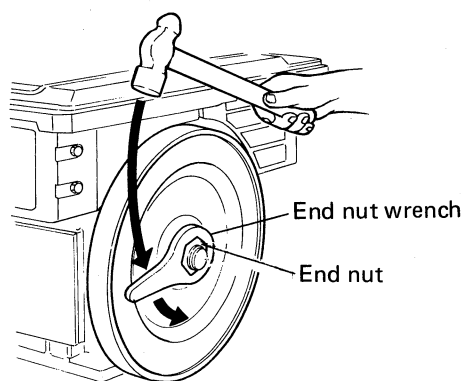
17. Remove the piston and the connecting rod.

1. Position the piston at Bottom Dead Center (B.D.C.). Remove the rod bolts, then remove the connecting rod cap.
2. Raise the piston up to Top Dead Center (T.D.C.).
3. Push out the connecting rod and pull out the piston, while taking care of the crank pin bearing.
(Use a hammer handle, etc.)



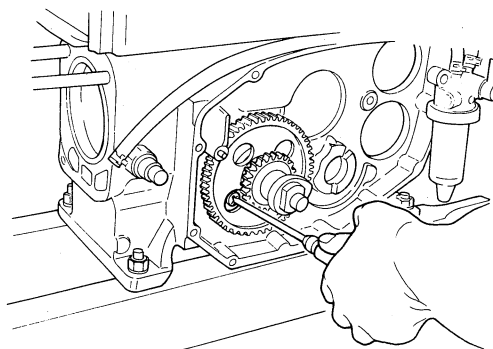
18. Dismount the flywheel.

1. Remove the end nut.
(Use the special wrench for the end nut.)
2. Take off the flywheel with the flywheel puller.
 - *Screw in the pull-out bolt all the way.*
 - *Never strike the end of the crankshaft.*
 - *Do not stand facing the flywheel front.*
3. Remove the V-belt.
4. Take off the tension lever.
5. Dismount the crankshaft key.



20. Remove the camshaft and tappet.

1. Remove the camshaft bearing retainer.
2. Take out the camshaft toward the fuel pump side.
(Use a hammer handle.)
(When taking out the camshaft take care of the position of the exhaust cam. The exhaust cam top may interfere with the liner.)
3. Take out the tappet.
(Distinguish between the intake and exhaust sides.)

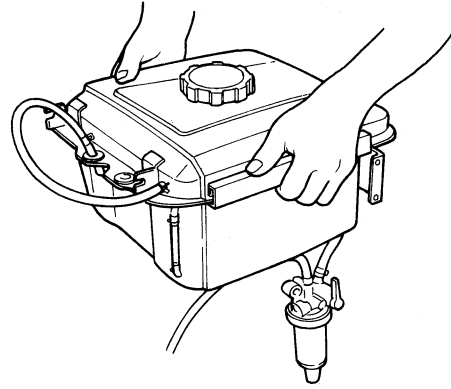
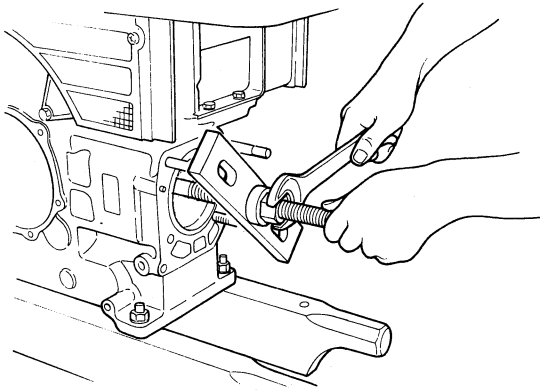


19. Remove the crankshaft assembly.

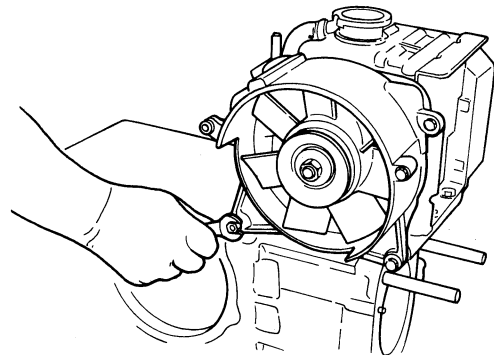
1. Remove the main bearing housing bolt.
2. Remove the governor assembly.
 - *Prevent the gear from turning by using a hammer handle or the equivalent.*
3. Remove the balancer driven gear. (TF80 – TF160)
4. Take off the crankshaft toward the flywheel side.

21. Pull out the liner.

- Use the liner puller.



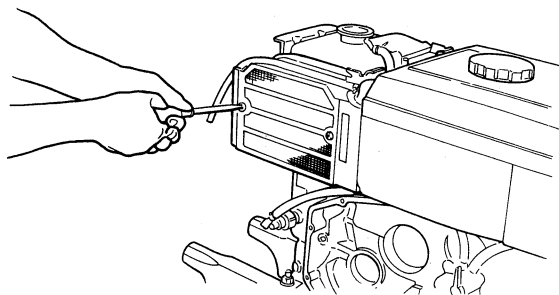
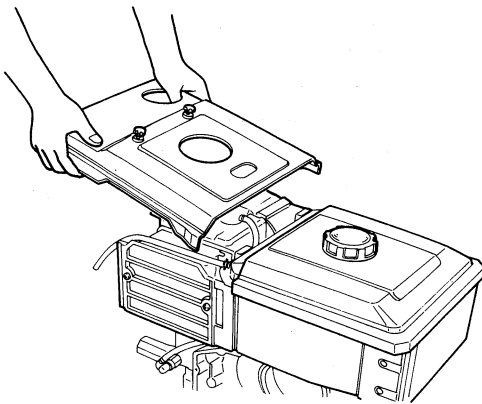
3. Detach the fan case assembly.



Radiator Disassembly Procedure

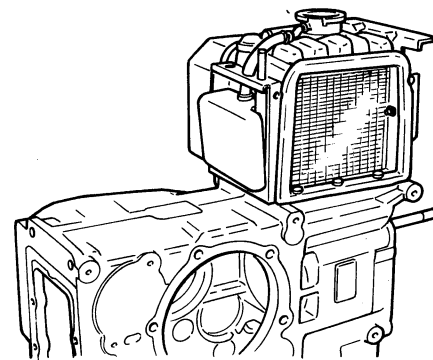
1. Remove the radiator cover.

- 1) Slacken off the radiator cap.
- 2) Take off the radiator cover.
- 3) Take off the screens on both sides.



4. Detach the radiator.

- Radiator bottom side uses liquid sealant.



2. Dismount the fuel tank.

- 1) Remove the light cover. (TF60 – TF120)
- 2) Slacken off the fuel tank clamp bolts.
Remove the self-locking nut.
- 3) Remove the fuel tank.

6.5. Reassembly

1. Installing the Radiator and Hopper tank

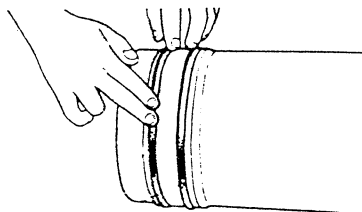
- 1) Clean the fitting surface of the radiator or hopper tank.
(Scrape off the old liquid sealant)
- 2) Apply the liquid sealant to fitting surface.
- 3) Install the radiator or hopper tank and tighten the bolt.
 - *Make sure the apply a coating of liquid sealant evenly and do not discontinuous.*
 - *Installing the parts uses liquid sealant, take care the parts shift in position.*
After installing the radiator, fit the cooling fan and screen.

2. Installing the fuel tank

Install the fuel tank.

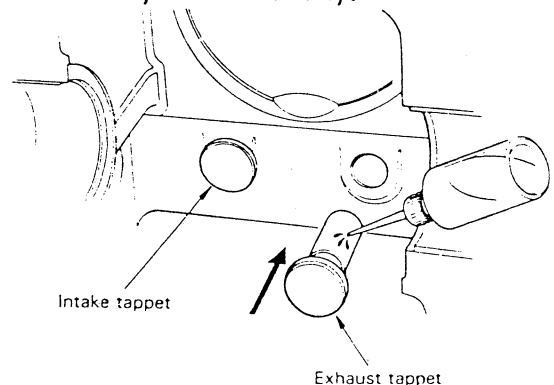
3. Insertion of the liner

- 1) Before inserting the liner, make sure that the liner can be inserted lightly without the cylinder liner rubber packing.
- 2) Never apply an undue force to insert the liner. If it is difficult to insert the liner, the cylinder block has too much rust.
- 3) Be sure to use a new cylinder liner rubber packing.
 - *Clean the rubber packing grooves on the circumference of the liner.*
 - *Insert the rubber packings while keeping it from torsion.*



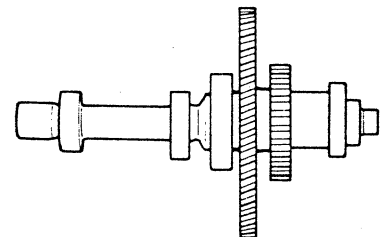
4. Insert the tappets

- 1) Recheck that the tappets have been correctly identified for the intake and exhaust sides.
- 2) Apply lubricating oil to the tappets.
- 3) After inserting the tappets, make sure that they work smoothly.



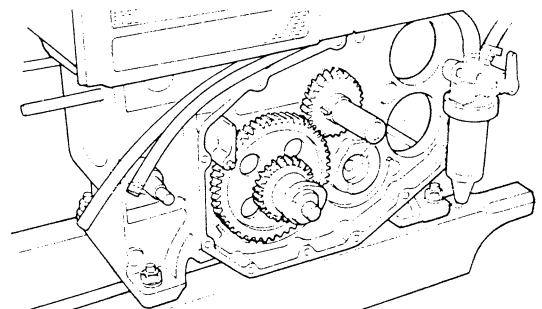
5. Install the camshaft assembly.

- 1) Apply lubricating oil to the camshaft assembly.
- 2) When inserting the camshaft assembly, check the position of the exhaust cam. The top of the exhaust cam may interfere with the liner.



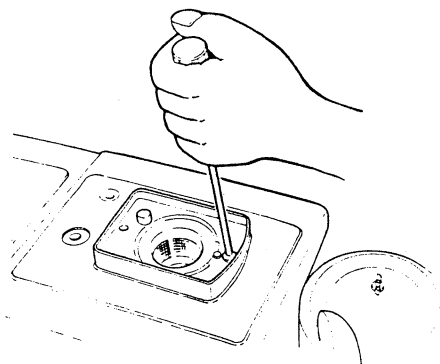
6. Insert the crankshaft assembly.

- 1) Install the crankshaft and main bearing housing assembly.
- 2) Align the matchmark on the cam gear with that on the crank gear.
Cam gear matchmark: 1-point mark
Crank gear matchmark: 2-point mark

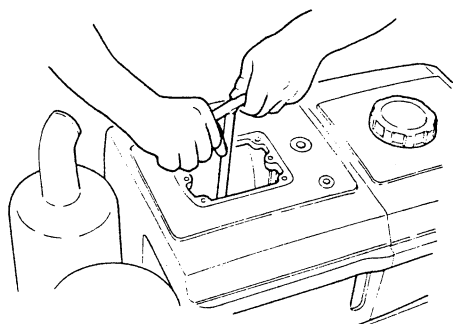


Hopper Disassembly Procedure

1. Slacken off the eye nut.
2. Take out the core.

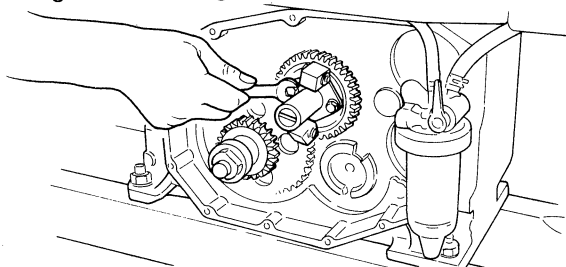


3. Remove the hopper clamp bolt.



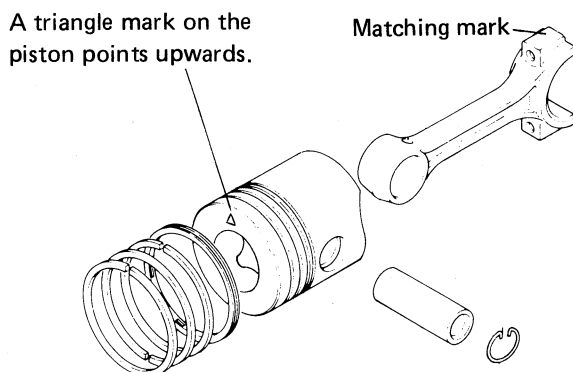
○ *Hopper bottom side uses liquid sealant.*

- 3) Mount the balancer drive gear (adopted to Models TF80–160. As for Models TF50–70, a distance piece is equipped.) and governor support on the crankshaft. (Align the 2-point cam gear matching mark with the 1-point balancer drive gear matching mark.)

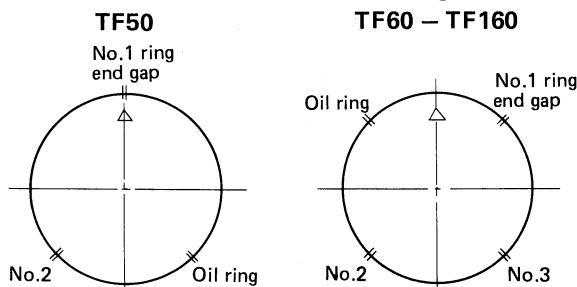


7. Install the piston and the connecting rod.

- The piston is embossed with "UP" mark inside the piston skirt.



- 1) Set the piston rings with their end gaps at following figures positions around the piston. (TF50 has three rings)



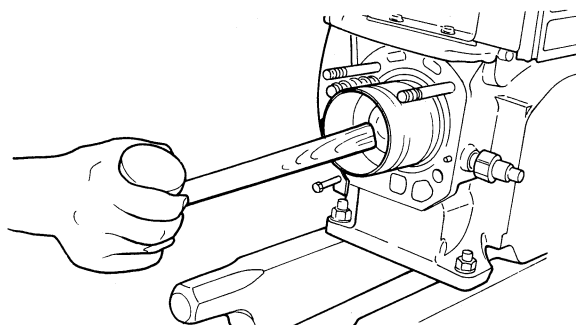
- Point the gap of No. 1 ring toward the intake side.

- 2) When the piston and connecting rod removed, align the triangle mark on the piston with the connecting rod large end matching mark.
- 3) Point the connecting rod large end (with the matching mark) upward.
- 4) Inset the piston so that the crank pin comes to the head side. (T.D.C position) (Use the piston insertion tool.)

- 5) When the large end has been brought in close contact with the crank pin, push the piston head slowly with a hammer handle until the piston reaches the B.D.C..
- 6) After coating lubricating oil on the threaded part of the connecting rod bolts, fit the connecting rod into place with the cap matching mark facing upwards.
- 7) Tighten the connecting rod bolts to the specified torque.

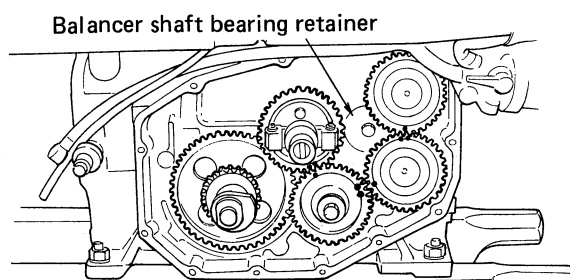
(Unit: kg-m)

	Connecting rod bolt tightening torque
TF50	2.2 – 2.4
TF60, TF70 TF80, TF90	3.75 – 4.25
TF110, TF120	5.25 – 5.75
TF140, TF160	5.70 – 6.30

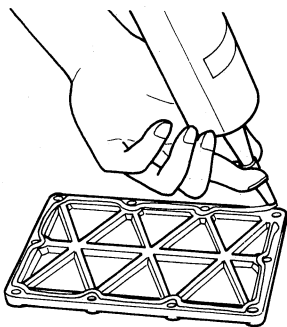


8. Mount the balancer shafts (except TF50 – TF70)

- 1) Assemble the lower balancer shaft.
- 2) Assemble the upper balancer shaft.
- 3) Attach the balancer shaft bearing retainer.
 - Align the 2-point mark on the lower balancer gear with the 1-point mark on the upper balancer gear.
- 4) Mount the idle gear.
 - Align the 1-point mark on the idle gear with the 2-point mark on the balancer drive gear.
 - Align the 2-point mark on the idel gear with the 1-point mark on the lower balancer gear.
- 5) Attach the gear cover.



- 9. Attach the cylinder rear cover.**
Use liquid sealant.



- Make sure the apply a coating of liquid sealant evenly and do not discontinuous.
- Installing the parts uses liquid sealant, take care the parts shift in position.

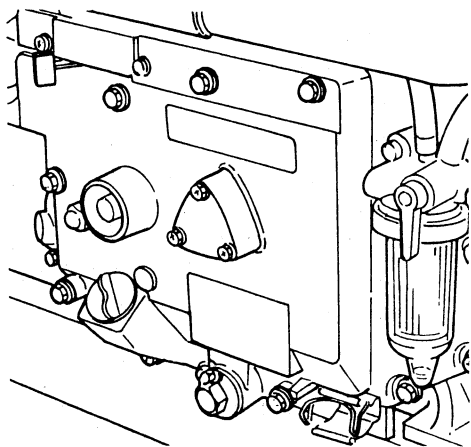
10. Mount the flywheel.

- 1) After cleaning the tapered end, mount the flywheel.
- 2) Pass the fan belt around the pulley. (Only radiator cooling type)
- 3) Tighten the end nut to the specified torque.

(Unit: kg-m)

Model	End nut tightening torque
TF50	17.00 – 20.00
TF60, TF70 TF80, TF90	25.00 – 29.00
TF110, TF120 TF140, TF160	30.00 – 35.00

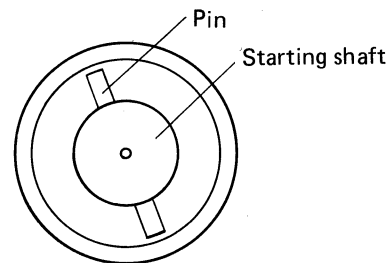
11. Attach the gear case.



Caution when attaching the gear case.

- 1) Remove the L.O. trochoid pump from the gear case.
(Cover, outer ring, and inner ring)

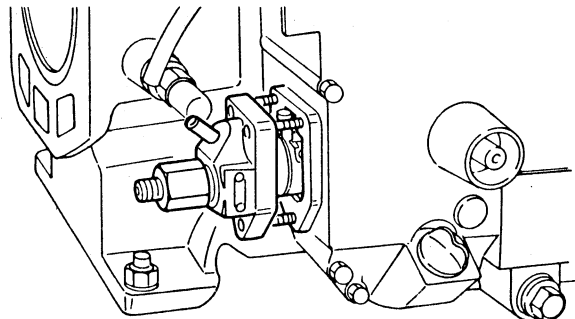
- 2) Turn the flywheel so that the governor weights are horizontally aligned before the piston reaches the T.D.C..
(Make sure that the governor weight is properly in the sleeve.)
- 3) Point the starting shaft pin of the gear case in the direction shown below before attaching the gear case to the cylinder.



- 4) Install the L.O. trochoid pump.
(Ensure the pump shaft fits correctly in the crankshaft notch.)

12. Install the fuel injection pump.

- 1) Install the fuel injection pump with the adjusting shims.
- 2) Connect the fuel intake pipe.
 - When inserting the fuel intake pipe, carefully operate the regulator handle so that the fuel pump rack does not interfere with the governor lever.

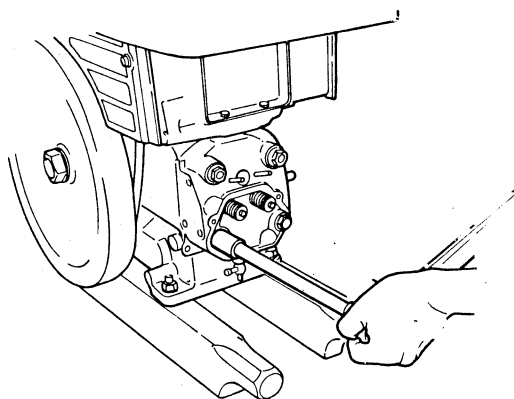


13. Mount the cylinder head.

- 1) Clean up the contact surface of the cylinder block and cylinder head.
- 2) Attach the cylinder head gasket.
When reassembling the cylinder head, replace the gasket with a new one.
Do not confuse the front and rear sides of the gasket.
- 3) Assemble the cylinder head.
When assembling the cylinder head, tighten opposite pairs of bolts evenly to the specified torque.

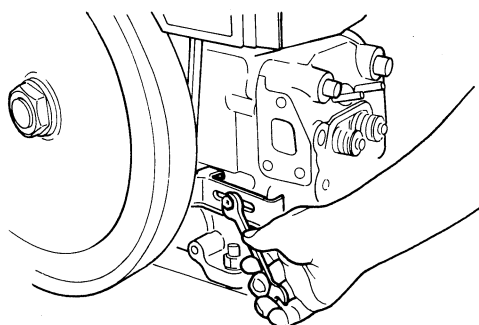
(Unit: kg-m)

Model	Cylinder head bolt tightening torque
TF50, TF60, TF70, TF80, TF90	9.50 – 10.50
TF110, TF120	13.10 – 14.10
TF140, TF160	19.00 – 21.00



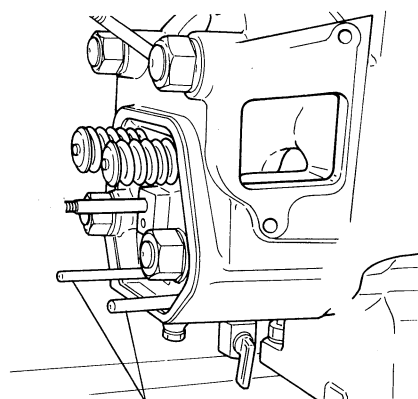
14. Attach the belt tension device.

- Make sure installing the fan belt in properly.



15. Insert the push rods.

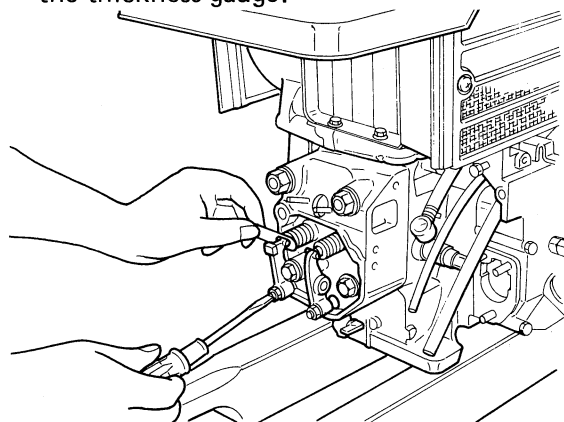
Do not confuse the intake and exhaust sides.



Push rods

16. Attach the valve rocker arm and valve rocker arm support.

Adjust the valve clearance to 0.2 mm for TF60–160 and 0.15 mm for TF50 with the thickness gauge.

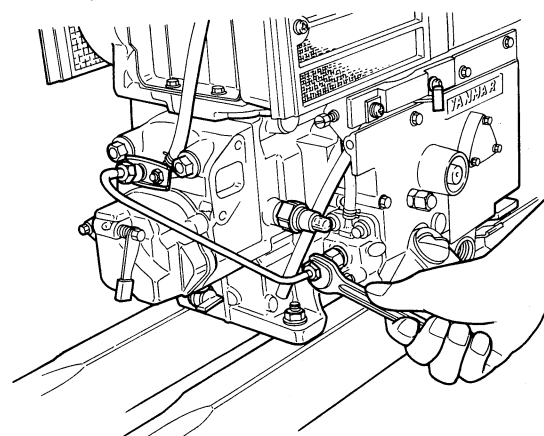


17. Mount the bonnet.

18. Assemble the fuel injection valve .

Replace the insulating packing.

19. Connect the F.O. high-pressure pipe.



20. Install the air cleaner and exhaust muffler.

21. Add lubricating oil, cooling water, and fuel oil.

- 1) Close the C.W. drain cock.
- 2) Add clean water up to the upper limit in the cooling water filler port.
- 3) Add the specified quantity of lubricating oil.

Check the amount with the dipstick.

When reassembling, add lubricating oil generously.

7. Inspection and Servicing

7.1 Cylinder head

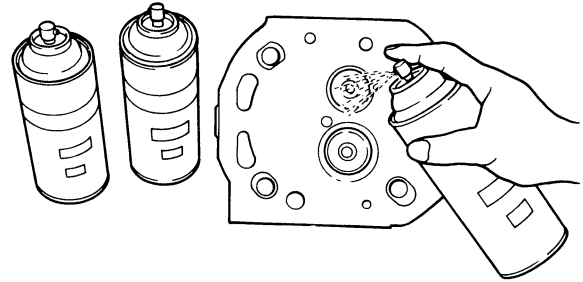
1. Check of combustion surface

Remove the fuel injection, intake and exhaust valves. After cleaning, check the combustion surface for damage due to burning or cracking. For cracks not visible to the naked eye, use the color check.

Distortion of cylinder head fitting surface (Unit: mm)

Dimension Model	Standard	Limit
TF50 – TF160	0.03	0.05

○ The standard limit is indicated in distortion per 100 mm.



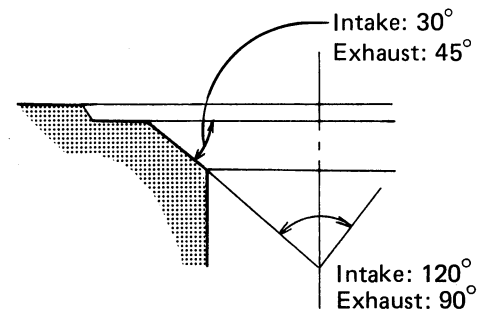
Checking the combustion surface for distortion

2. Valve seat

1) If the valve seat check finds damage or defects on the contact surface, etc., re-shape the seat.

Valve seat angle (Unit: mm)

Dimension Model	Intake	Exhaust
TF50 – TF160	120°	90°



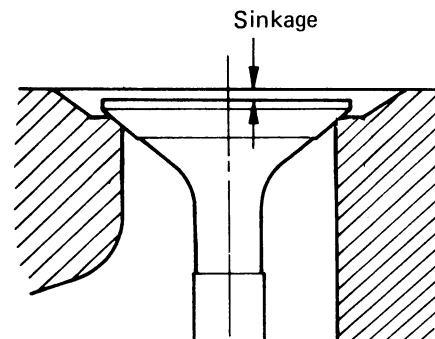
Valve contact surface

2) Valve sinkage

As valves are used over long periods and are lapped several times, they eventually sink and combustion performance deteriorates. Measure the valve sinkage and, if it exceeds the specified limit, replace the cylinder head or the valves.

Intake and exhaust valve sinkage (Unit: mm)

Dimension Model	Intake valve		Exhaust valve	
	Standard	Limit	Standard	Limit
TF50, TF60, TF70	0.35	0.6	0.75	1.0
TF80, TF90	0.30	0.6	0.75	0.7
TF110, TF120	0.70	1.0	0.80	1.1
TF140, TF160	0.35	0.7	1.00	1.2



Valve sinkage

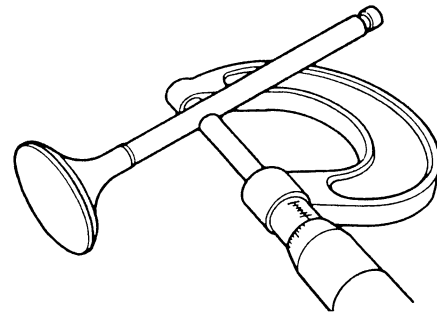
7.2 Intake and exhaust valves

1. Check of intake and exhaust valves

- 1) Check the head and stem of the intake and exhaust valves. Replace if excessively worn, burnt, or deformed.
- 2) Replace if head thickness is below the specified dimensions.

Outside diameter (O.D.) of intake and exhaust valve stem
(Unit: mm)

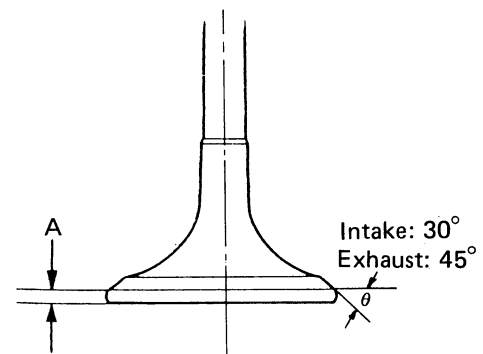
Model	Dimension	Standard	Limit
TF50	intake	$\phi 6.960 - \phi 6.975$	$\phi 6.90$
	exhaust	$\phi 6.945 - \phi 6.960$	
TF60, TF70		$\phi 6.945 - \phi 6.960$	$\phi 6.90$
TF80, TF90		$\phi 6.945 - \phi 6.960$	$\phi 6.85$
TF110, TF120		$\phi 7.945 - \phi 7.960$	$\phi 7.85$
TF140, TF160		$\phi 8.945 - \phi 8.960$	$\phi 8.85$



Measuring the intake and exhaust valve stem O.D.

Dimension A (Valve head thickness)
(Unit: mm)

Model	Dimension	Standard	Limit
TF50 – TF120	Intake valve	1.0 – 1.4	0.7
	Exhaust valve	0.8 – 1.2	0.5
TF140, TF160	Intake valve	1.1 – 1.5	0.7
	Exhaust valve	0.8 – 1.2	0.5



Measuring intake and exhaust valve head thickness

2. Check of intake and exhaust valve guides

For each of the intake and exhaust valves measure the clearance between the stem and valve guide. If the measurement exceeds the specified limit, replace the valve and its guide.

Inside diameter (I.D.) of intake and exhaust valve guide
(Unit: mm)

Model	Dimension	Standard	Limit
TF50, TF60, TF70		$\phi 7.005 - \phi 7.020$	$\phi 7.09$
TF80, TF90		$\phi 7.005 - \phi 7.020$	$\phi 7.09$
TF110, TF120		$\phi 8.005 - \phi 8.020$	$\phi 8.09$
TF140, TF160		$\phi 9.005 - \phi 9.020$	$\phi 9.09$

Clearance between valve guide and valve stem (Unit: mm)

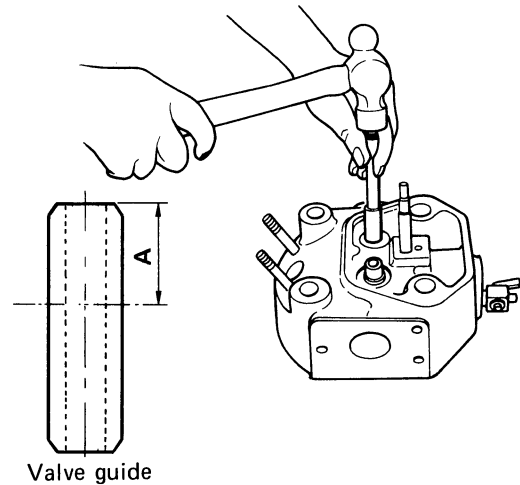
Model	Dimension	Standard	Limit
TF50	intake	0.030 – 0.060	0.15
	exhaust	0.045 – 0.075	
TF60 – TF160		0.045 – 0.075	0.15

3. Replacement of intake/exhaust valve guide (except TF50)

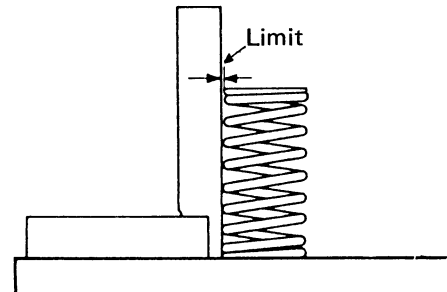
- 1) Draw the valve guide out toward the spring side, using the special tool.
- 2) Using the same tool, press the valve guide from the spring side, and ream out the inside diameter with a reamer. The guide should be pressed down as shown on the right. (As for TF50, the valve guide is integrated with the cylinder head and therefore, adjustment of it is not required.)

(Unit: mm)

Model	A dimension
TF60, TF70	12 mm
TF80, TF90	11 mm
TF110, TF120	15 mm
TF140, TF160	15 mm



Replace the valve guide



Valve spring squareness

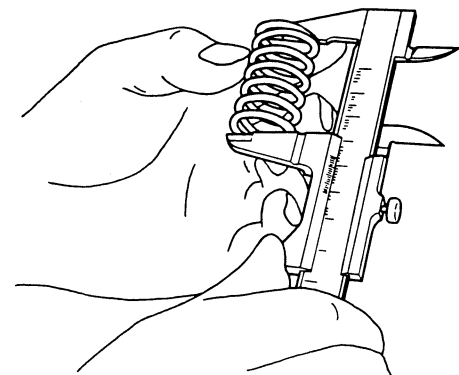
4. Intake/exhaust valve spring

- 1) Check the squareness of the valve spring on a surface plate, using a square. Replace any spring with an inclination which exceeds the specified limit.

Intake and exhaust valve spring squareness (Unit: mm)

Dimension Model	Limit
TF50, TF60, TF70 TF80, TF90	1.2
TF110, TF120 TF140, TF160	1.4

- 2) Measure the spring dimensions and spring load, using a spring tester. If the values are less than the limits, replace the spring.



Measuring the valve spring free length

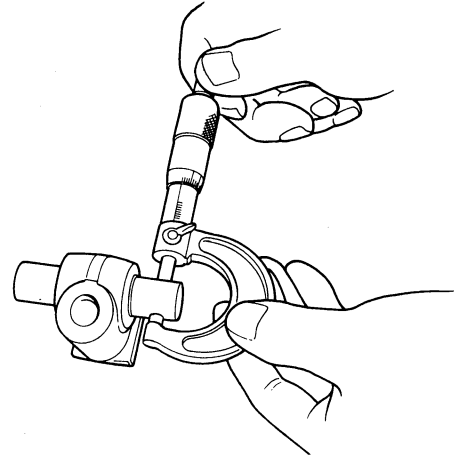
Free length

(Unit: mm)

Dimension Model	Free length	
	Standard	Limit
TF50, TF60, TF70	36.12	34.5
TF80, TF90	36.12	34.5
TF110, TF120	42.00	40.5
TF140, TF160	43.50	42.0

5. Intake/exhaust valve rocker arm, and rocker arm support assembly

- 1) Blow air through the oil holes to check for obstructions in the oil passage.
- 2) Check each part. Repair or replace if damaged or worn.
 - If a contact surface of an intake/exhaust valve rocker arm shows slightly uneven wear, repair the surface with oil-stone or other suitable means.
- 3) Measure the clearance between the I.D. of the intake/exhaust valve rocker arm and the valve rocker arm shaft. If the clearance exceeds the limit, replace the valve rocker arm or rocker arm support.



Measuring the valve rocker arm shaft O.D.

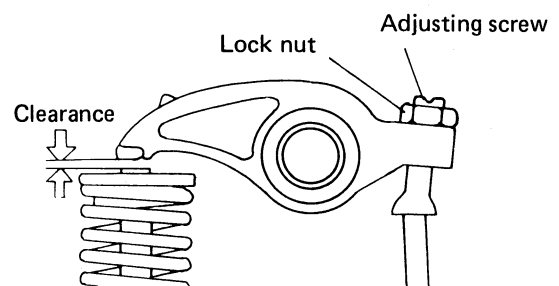
Intake/exhaust valve rocker arm

(Unit:mm)

Dimension Model	Intake/exhaust valve rocker arm shaft O.D.		Rocker arm I.D.		Clearance between rocker arm and shaft	
	Standard	Limit	Standard	Limit	Standard	Limit
TF50, TF60, TF70 TF80, TF90	$\phi 13.982 - \phi 14.000$	$\phi 13.9$	$\phi 14.016 - \phi 14.034$	$\phi 14.1$	0.016 – 0.052	0.15
TF110, TF120 TF140, TF160	$\phi 15.982 - \phi 16.000$	$\phi 15.9$	$\phi 16.016 - \phi 16.034$	$\phi 16.1$	↑	↑

6. Adjustment of intake/exhaust valve clearance

Check this clearance at the time of disassembly/reassembly and after every 300 hours of operation. Correct the clearance as necessary.



Adjusting the valve clearance

(Unit: mm)

Dimension Model	Intake/exhaust valve clearance (Cold state)
TF50	0.15
TF60 – TF160	0.2

- *When adjusting the clearance, make sure that the piston is at the T.D.C. of the compression stroke. With the piston in this position, the intake/exhaust rocker arm will not move when the crank shaft is swung about the T.D.C.*

7. Top clearance

- 1) The top clearance requires checking as it greatly affects the engine performance.

(Unit: mm)

Dimension	TF50 TF60, TF70	TF80, TF90	TF110, TF120	TF140, TF160
Top clearance	0.56 – 0.74	0.65 – 0.85	0.70 – 0.90	0.75 – 0.95
Fuse used	φ1.2 – φ1.5			

- 2) If the top clearance exceeds the specification, locate the cause. Possible causes which should be checked include.

- (1) Improperly tightened cylinder head
- (2) Wear in crank pin bearing or piston pin bearing
- (3) Bent connecting rod

Replace any faulty parts.

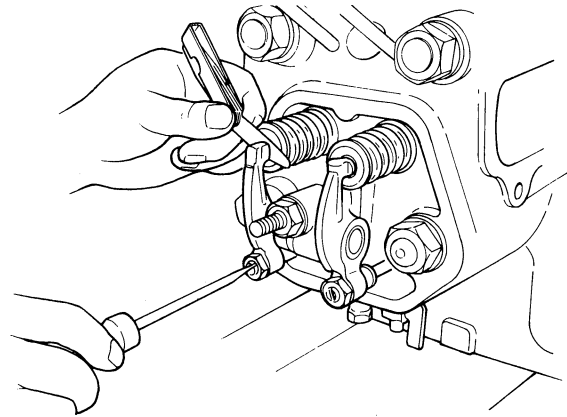
7.3 Cylinder liner

1. Measurement of cylinder liner bore diameter

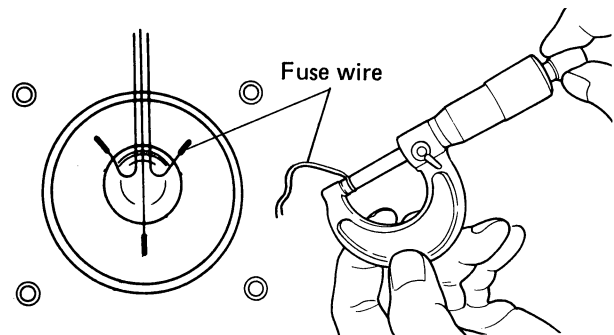
Measure the bore diameter with the cylinder gauge. Rebore or replace the liner if wear exceeds the specified limit.

2. Replacement of cylinder liner

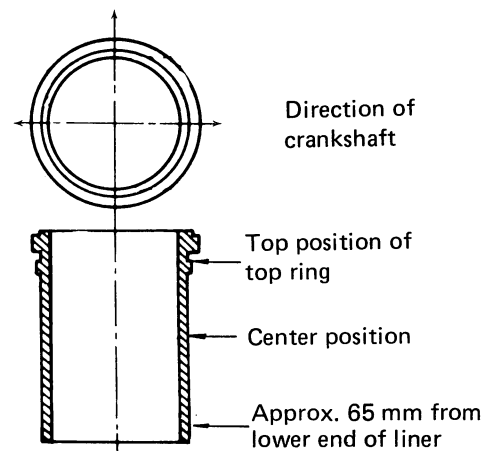
Replace the cylinder liner if its bore surface is badly damaged or if it is worn to a mirror surface.



Valve clearance adjustment



Measuring the top clearance

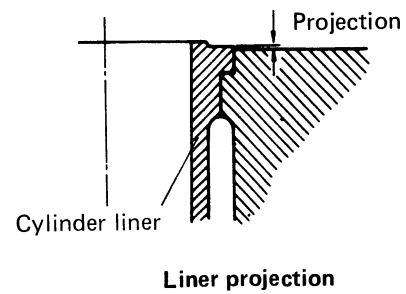


Cylinder liner measuring point

Cylinder liner I.D.

(Unit: mm)

Model \ Dimension	Standard	Limit
TF50	$\phi 74.000 - \phi 74.030$	$\phi 74.18$
TF60	$\phi 75.000 - \phi 75.030$	$\phi 75.22$
TF70	$\phi 72.000 - \phi 78.030$	$\phi 78.23$
TF80	$\phi 80.000 - \phi 80.030$	$\phi 80.18$
TF90	$\phi 85.000 - \phi 85.035$	$\phi 85.19$
TF110	$\phi 88.000 - \phi 88.035$	$\phi 88.20$
TF120	$\phi 92.000 - \phi 92.035$	$\phi 92.21$
TF140	$\phi 96.000 - \phi 96.035$	$\phi 96.22$
TF160	$\phi 102.000 - \phi 102.035$	$\phi 102.23$

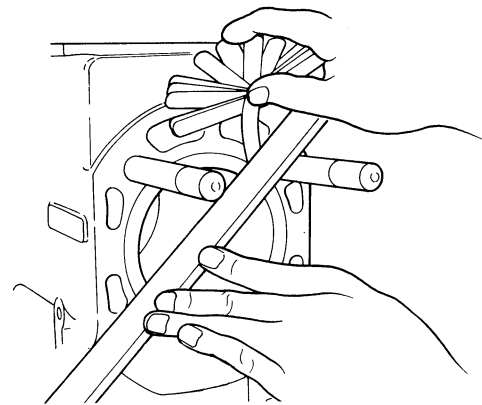


3. Measurement of cylinder liner projection

Check that the top edge of the cylinder liner projects slightly from the block surface.

(Unit: mm)

Item \ Dimension	TF50 – TF160
	Standard
Cylinder liner projection	0.02 – 0.08

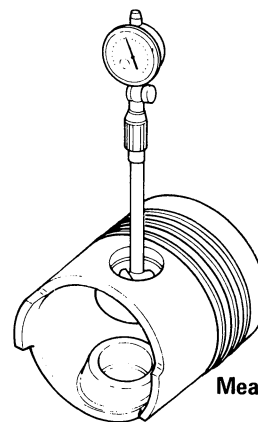


Measuring the liner projection

7.4 Piston

1. Piston replacement

The piston pin and piston pin bore fit together as shown in the following table. When replacing the piston pin, the piston pin bore should be just large enough to allow the piston pin to be pressed into the bore by thumb pressure when the piston is warmed to between 50 and 60°C.



Measuring the piston pin hole I.D.

(Unit: mm)

Item \ Dimension	TF50		TF60, TF70		TF80, TF90		TF110, TF120		TF140, TF160	
	Standard	Limit	Standard	Limit	Standard	Limit	Standard	Limit	Standard	Limit
Piston Pin bore I.D.	$\phi 22.000$ } $\phi 22.009$	$\phi 22.029$	$\phi 23.000$ } $\phi 23.009$	$\phi 23.029$	$\phi 26.000$ } $\phi 26.009$	$\phi 26.029$	$\phi 28.000$ } $\phi 28.009$	$\phi 28.029$	$\phi 32.000$ } $\phi 32.011$	$\phi 32.031$
Clearance between the piston pin hole and piston pin	0 – 0.018	0.045	0 – 0.018	0.045	0 – 0.022	0.045	0 – 0.022	0.045	0 – 0.022	0.045

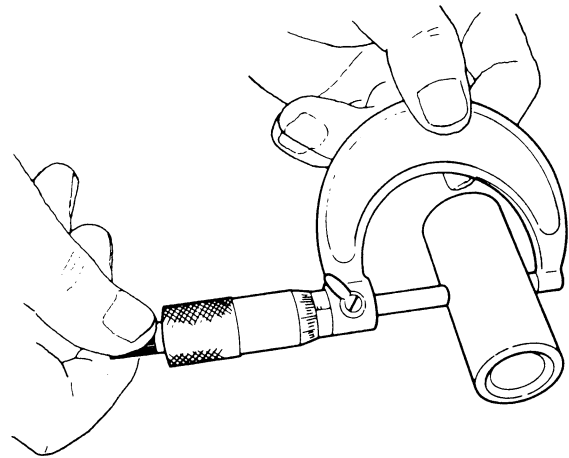
2. Piston pin

If the piston pin is worn beyond its specified outside diameter or is unevenly worn, replace it.

Piston pin O.D.

(Unit: mm)

Dimension Model	Standard	Limit
TF50	$\phi 22.000 - \phi 21.991$	$\phi 21.950$
TF60, TF70	$\phi 23.000 - \phi 22.991$	$\phi 22.950$
TF80, TF90	$\phi 25.987 - \phi 26.000$	$\phi 25.96$
TF110, TF120	$\phi 27.987 - \phi 28.000$	$\phi 27.96$
TF140, TF160	$\phi 32.000 - \phi 31.989$	$\phi 31.960$

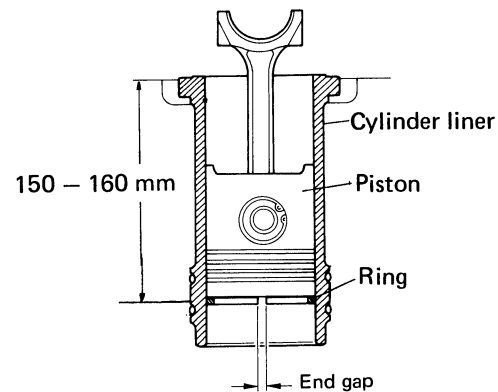


Measuring the piston pin O.D.

3. Piston ring

1) Measure the end gap in the piston rings, and also the clearance between each piston ring and its mating groove. Replace any ring with improper dimensions.

To make this measurement, press a piston ring under the piston head and into the cylinder. Measure the end gap in the piston ring with a thickness gauge. For measurement the ring should be positioned 150 to 160 mm from the end of the liner.



Measuring the piston ring end gap

Piston ring end gap

(Unit: mm)

Dimension Item	TF50		TF60, TF70		TF80, TF90		TF110, TF120		TF140, TF160	
	Standard	Limit	Standard	Limit	Standard	Limit	Standard	Limit	Standard	Limit
No. 1	0.25 - 0.45	1.5	0.20 - 0.40	1.5	TF80 0.20 - 0.40	1.5	0.30 - 0.50	1.5	0.30 - 0.50	1.5
No. 2, No. 3	0.25 - 0.45				TF90 0.30 - 0.50					
Oil ring	0.10 - 0.30				0.30 - 0.50					

Clearance between the piston ring and groove

(Unit: mm)

Dimension Item	TF50		TF60, TF70		TF80, TF90		TF110, TF120		TF140, TF160	
	Standard	Limit	Standard	Limit	Standard	Limit	Standard	Limit	Standard	Limit
No. 1	0.070-0.105	0.2	0.095-0.130	0.2	0.095-0.130	0.2	0.095-0.130	0.2	0.095-0.130	0.2
No. 2, No. 3	0.045-0.080	0.15	0.070-0.105	0.2	0.050-0.085	0.2	0.050-0.085	0.2	0.050-0.085	0.2
Oil ring	0.020-0.055	0.15	0.020-0.055	0.15	0.020-0.055	0.15	0.020-0.055	0.15	0.025-0.060	0.15

7.5 Crankshaft

1. Crankshaft outside diameter and out-of-roundness

Check the crankshaft pin for damage and uneven wear (out-of-roundness and degree of taper). Grind, repair, or replace if the specified limit is exceeded.

Cranker pin O.D. (Unit: mm)

Model	Standard	Limit
TF50	$\phi 36.965 - \phi 35.982$	$\phi 35.890$
TF60, TF70	$\phi 42.956 - \phi 42.972$	$\phi 42.880$
TF80, TF90	$\phi 44.956 - \phi 44.972$	$\phi 44.880$
TF110, TF120	$\phi 47.952 - \phi 47.973$	$\phi 47.880$
TF140, TF160	$\phi 53.953 - \phi 53.978$	$\phi 53.953$

2. Crankshaft side gap

Shift the crankshaft to one side, set a dial gauge to one end of the crankshaft, and measure the side gap play of the crankshaft. If the gap exceeds the specified limit, replace the roller bearing or deep-groove ball bearing, or both.

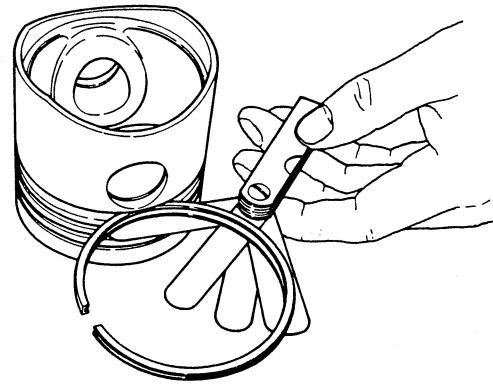
Crankshaft side gap (Unit: mm)

Model	Standard
TF50	0.02 – 0.45
TF60, TF70	0.01 – 0.21
TF80, TF90	0.56 – 1.09
TF110, TF120	0.66 – 1.24
TF140, TF160	1.02 – 1.61

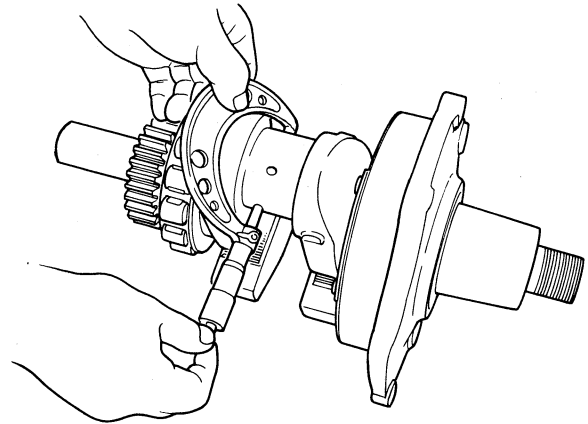
3. Check of crankshaft bearing

Check the bearing components such as the balls, rollers, inner and outer races, and case for defects such as damaged or dented surface, uneven rotation, unusual noise or play, or discoloration due to seizure. Replace the whole bearing if it has any defect.

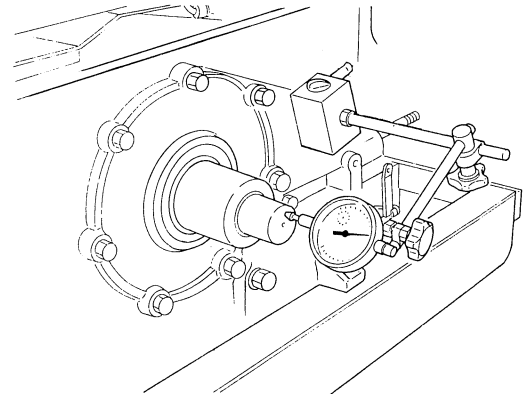
- 1) Check that the bearing turns smoothly when it is turned with the fingers.
- 2) Check that the bearing does not produce any unusual noise when it is turned rapidly.



Measuring the clearance between the piston ring and groove



Measuring the crankshaft pin O.D.



Measuring the crankshaft side gap

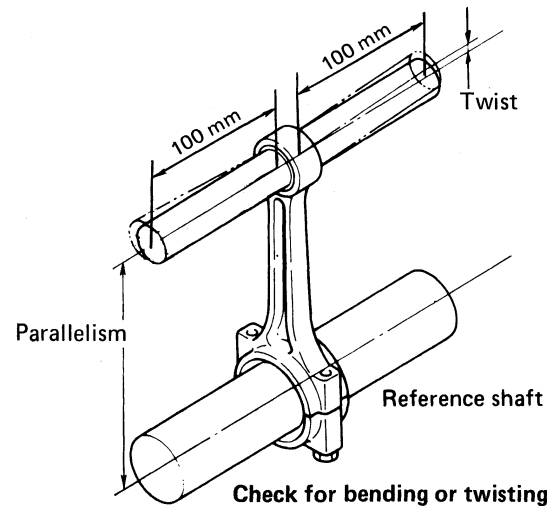
7.6 Connecting rod

1) Twist and parallelism of big and small ends

Measure the bending or twisting of the holes using a connecting rod aligner. If the specified limit is exceeded, make corrections so that the three points of the V-block have correct contact with the face plate, or replace the connecting rod.

Bending or twisting of the rod (Unit: mm)

Dimension	Limit
Model	
TF50 – TF160	0.08/100



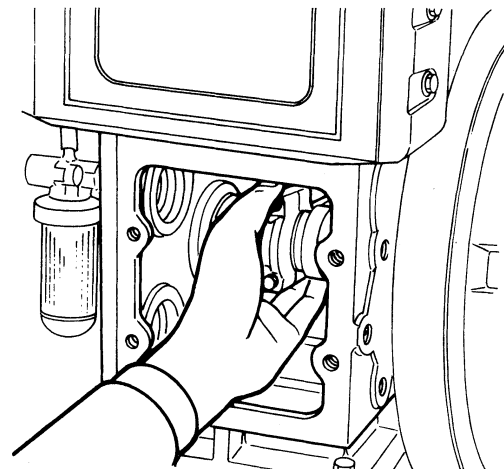
2) Connecting rod thrust clearance

Mount the connecting rod on the crank pin. Try to move the connecting rod in the axial direction by hand. Check to make certain that there is chattering a little, which is acceptable.

If there is no chattering, the connecting rod is improperly mounted. If so, disassemble the connecting rod and crank pin once more. Check and reassemble them.

3) Replacement of piston pin bearing

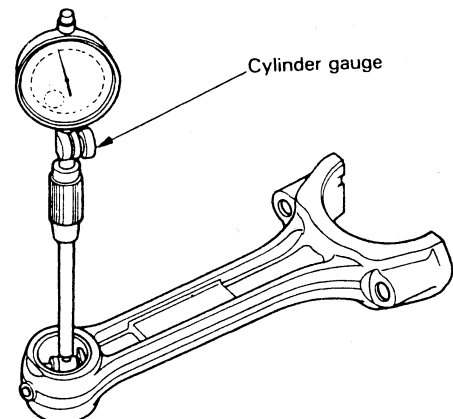
(1) If the piston pin bearing of the connecting rod is worn or damaged, replace the piston pin bearing using the special tool for piston pin bearing removal.



(Unit: mm)

Dimension	TF50		TF60, TF70		TF80, TF90		TF110, TF120		TF140, TF160	
	Standard	Limit	Standard	Limit	Standard	Limit	Standard	Limit	Standard	Limit
Piston pin bearing I.D.	$\phi 22.025 - \phi 22.038$	$\phi 22.1$	$\phi 23.025 - \phi 23.038$	$\phi 23.1$	$\phi 26.025 - \phi 26.038$	$\phi 26.1$	$\phi 28.025 - \phi 28.038$	$\phi 28.1$	$\phi 32.030 - \phi 32.050$	$\phi 32.1$
Clearance between the piston pin and bearing	0.025 – 0.047	0.10	0.025 – 0.047	0.11	0.025 – 0.051	0.11	0.025 – 0.051	0.11	0.030 – 0.061	0.21

- Press in the piston pin bearing so that its oil hole is aligned with the oil hole in the connecting rod small end.
- (2) After pressing in the piston pin, finish the inside face of the bearing with a honing tool or reamer so that the piston pin fits correctly.
- The bearing and piston should fit so that when coated with engine oil the piston pin can be inserted by thumb pressure at room temperature.



Measuring the piston pin bearing I.D.

4) Crankpin bearing

- (1) Check for flaking, seizure, scuffing, bearing surface condition, etc. Replace the crankpin bearing if found defective.

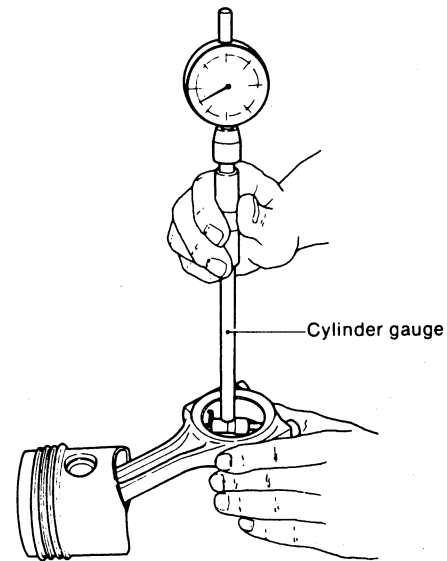
(Unit: mm)

Dimension Item	TF50		TF60, TF70		TF80, TF90		TF110, TF120		TF140, TF160	
	Standard	Limit	Standard	Limit	Standard	Limit	Standard	Limit	Standard	Limit
Crankpin bearing I.D.	$\phi 36.000 - \phi 36.042$	$\phi 36.1$	$\phi 43.000 - \phi 43.042$	$\phi 43.1$	$\phi 45.000 - \phi 45.042$	$\phi 45.1$	$\phi 48.001 - \phi 48.038$	$\phi 48.1$	$\phi 54.000 - \phi 54.045$	$\phi 54.1$
Clearance between the crankpin and bearing	0.018 – 0.077	0.1	0.028 – 0.086	0.1	0.028 – 0.086	0.1	0.028 – 0.086	0.1	0.022 – 0.092	0.1

- The crankpin bearing inside diameter should be measured after tightening the bolt to the specified torque.

(Unit: kg-m)

	Connecting rod bolt tightening torque
TF50	2.20 – 2.40
TF60, TF70	3.75 – 4.25
TF110, TF120	5.25 – 5.75
TF140, TF160	5.70 – 6.30



Measuring the crankpin bearing I.D.

7.7 Camshaft

1. Check of camshaft

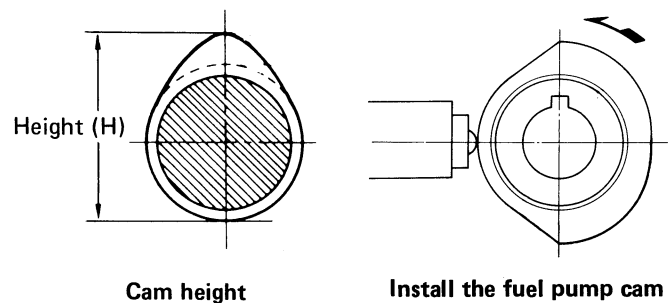
Measure the height of the each cam. If the wear exceeds the limit, replace the camshaft or fuel cam.

(Unit: mm)

Dimension Item	TF50		TF60, TF70		TF80, TF90, TF110, TF120		TF140, TF160	
	Standard	Limit	Standard	Limit	Standard	Limit	Standard	Limit
Intake valve cam height	34.30	34.00	37.25	36.95	39.50	39.20	44.80	44.50
Exhaust valve cam height	34.30	34.00	37.25	36.95	39.50	39.20	44.80	44.50
Fuel pump cam height	45.00	44.90	45.00	44.90	45.00	44.90	47.00	46.90

2. Check of camshaft bearing

Check the camshaft bearing for damage or dents in the balls and inner/outer races, uneven rotation, unusual noise and play. If any defect is found, replace the bearing.

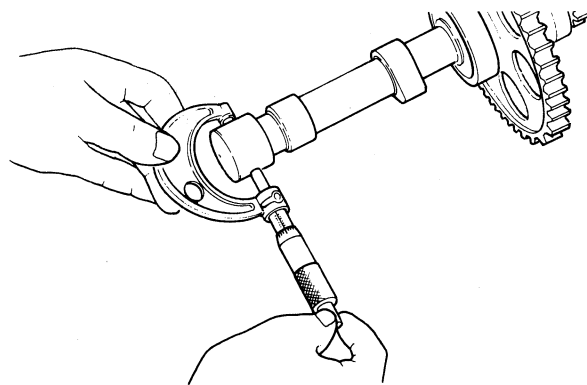


Cam height

Install the fuel pump cam

3. Check of camshaft and cylinder body journal bore

Measure the camshaft outside diameter at its journal end, as well as the diameter of the cylinder body journal bore. If the clearance determined from this measurement exceeds the limit, replace the camshaft or cylinder body.



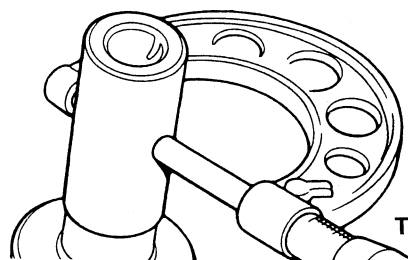
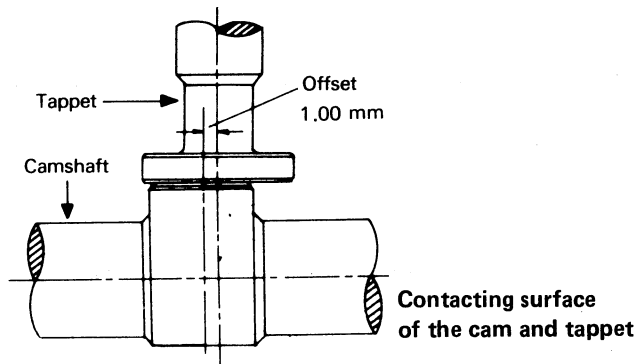
Checking the camshaft bearing

(Unit: mm)

	TF50		TF60, TF70		TF80, TF90		TF110, TF120		TF140, TF160	
	Standard	Limit	Standard	Limit	Standard	Limit	Standard	Limit	Standard	Limit
Cam shaft O.D. (Flywheel side)	$\phi 19.939 - \phi 19.960$	$\phi 19.90$	$\phi 21.939 - \phi 21.960$	$\phi 21.9$	$\phi 21.939 - \phi 21.960$	$\phi 21.9$	$\phi 21.939 - \phi 21.960$	$\phi 21.9$	$\phi 24.939 - \phi 24.960$	$\phi 24.9$
Cylinder bore diameter	$\phi 20.000 - \phi 20.021$	$\phi 20.05$	$\phi 22.000 - \phi 22.021$	$\phi 22.05$	$\phi 22.000 - \phi 22.021$	$\phi 22.05$	$\phi 22.000 - \phi 22.021$	$\phi 22.05$	$\phi 25.000 - \phi 25.021$	$\phi 25.05$
Camshaft to cylinder clearance	0.040 – 0.082	0.15	0.040 – 0.082	0.15	0.040 – 0.082	0.15	0.040 – 0.082	0.15	0.040 – 0.084	0.15

7.8 Tappet

- 1) The tappet foot is offset from the cam centerline. This is to avoid the lopsided wear which would otherwise result from the rotation of the tappet. Check the tappet foot for wear on the contacting surface. If the wear is excessive, replace the tappet.
- 2) Check the tappet diameter for wear and damage, and replace if necessary.



Tappet O.D. measurement

(Unit: mm)

Dimension	TF50 – TF120		TF140, TF160	
	Standard	Limit	Standard	Limit
Tappet O.D.	$\phi 9.980 - \phi 9.995$	$\phi 9.95$	$\phi 12.984 - \phi 12.966$	$\phi 12.95$
Cylinder tappet bore I.D.	$\phi 10.020 - \phi 10.040$	$\phi 10.08$	$\phi 13.020 - \phi 13.040$	$\phi 13.08$
Clearance between the tappet and cylinder	0.025 – 0.060	0.1	0.036 – 0.074	0.15

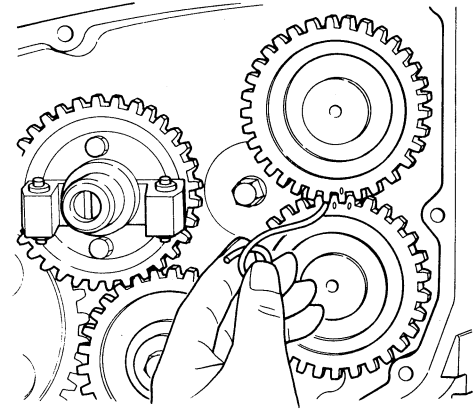
7.9 Gears

1. Check of each gear

- 1) Check the tooth surface of each gear.
If the tooth surface is damaged or worn, replace the gear.
- 2) Measure the backlash of mating gears.
If the backlash exceeds the limit, replace the pair of meshed gears.

2. Balancer gear

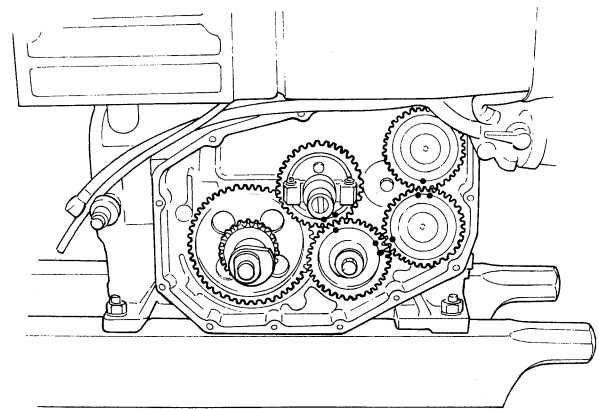
When installing the balancer shafts, the timing marks on the gears should be aligned accurately. Failure here will result in cranking failure or cause breakage of associated parts due to excessive vibration.



Checking backlash of balancer gears with a fuse.

Backlash (Unit: mm)

Item	Dimension	TF50 – TF160	
		Standard	Limit
Balancer drive gear and idle gear		0.080 ~ 0.196	0.3
Crank gear and cam gear		0.080 ~ 0.196	0.3
Idle gear and balancer gear		0.080 ~ 0.196	0.3
Lower and upper balancer gears		0.080 ~ 0.196	0.3



Gear timing

7.10. Starting shaft

1. If there is oil leakage at the starting shaft, disassemble the shaft to replace the oil seal, and also check the bearing for wear.
2. Check the starting shaft and its bearing for wears. If the wear is excessive, replace the gearcase and the starting shaft.

(Unit: mm)

Item	Dimension	TF50 – TF160	
		Standard	Limit
Starting shaft O.D.		ϕ 24.972 ~ ϕ 24.993	ϕ 24.95
Gear case bore I.D.		ϕ 25.030 ~ ϕ 25.060	ϕ 25.2
Clearance between starting shaft and gear case		0.037 ~ 0.088	0.15

7.11 Fuel injection pump

The fuel injection pump used in the PFR type of Bosch construction. This pump is simple in structure, and capable of supplying the proper amount of fuel both at starting and peak load.

The amount of fuel delivered to the engine is controlled by balancing the spring force of the regulator spring against the centrifugal force developed in the governor weight during engine rotation.

1. Fuel injection timing adjustment

Fuel injection timing must carefully be adjusted. If the timing is earlier or later than the standard, it causes difficulty in starting, knocking, insufficient output, unsatisfactory exhaust color, and various other problem.

Be sure to adjust the governor linkage and injection pressure before adjusting the injection timing. With long usage the injection pump plunger wear, and this delays injection timing. Replace the plunger if it is worn, and then check the injection timing.

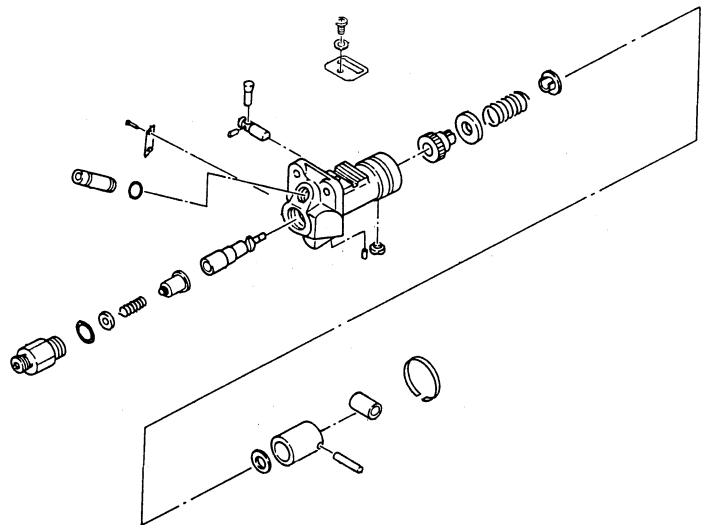
1) How to check injection timing

- Turn the regulator handle to "RUN" position.
- Remove the fuel injection pipe on the fuel injection valve side. Tilt the pipe upwards to allow the fuel to flow out.
- Align the piston is at the T.D.C. nearest position of the compression stroke.
- Bleed the air from the high pressure pipe. (Turn the flywheel in several times, check the moment when fuel comes out from the high pressure pipe.)
- Align flywheel is an angle of nearest 30 degrees at the bTDC in the compression stroke.
- Notice the position on the flywheel when fuel comes out from the high pressure pipe by turning the flywheel slowly to rotating direction.

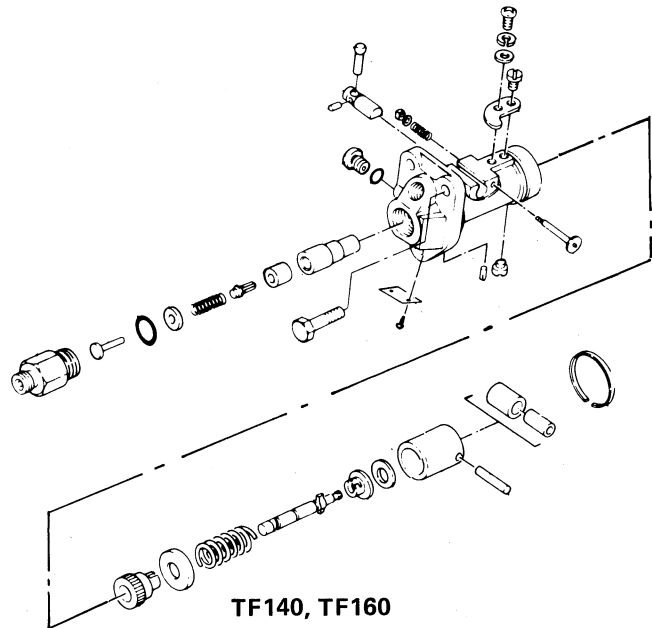
This moment is fuel injection timing.

2) How to adjust injection timing

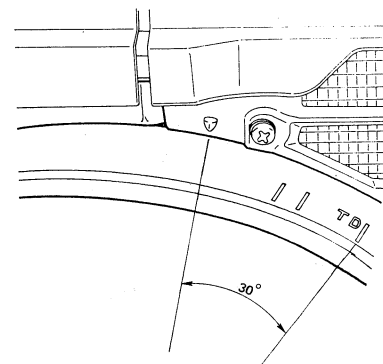
- Remove the fuel injection pump.



TF50 – TF120



TF140, TF160



- If the injection timing is not properly set, Adjust it with the timign shims.
If the injection timing is off, add adjusting shims when the timing is slow, and remove shims when the timing is fast.
An extra thickness of 0.1 mm is equivalent to a change of 1 degree.

Model	TF50, TF60, TF70, TF80, TF90	TF110, TF120	TF140, TF160
Item			
Pump type No.	PFR0807		PFR1-1AW
Plunger diameter	φ6.5	φ8.0	φ9.0

7.12 Fuel injection valve

Model	TF50	TF60, TF70	TF80, TF90	TF110, TF120	TF140, TF160
Item					
Nozzle type No.	150P194FO	150P204FO	150P224FO	150P264FO	150S294NO
Injection pressure	200 – 210 kg/cm ²				
Injection hole diameter x number of holes	0.19 mm x 4	0.20 mm x 4	0.22 mm x 4	0.26 mm x 4	0.29 mm x 4
Injection angle	150°				

1. Check

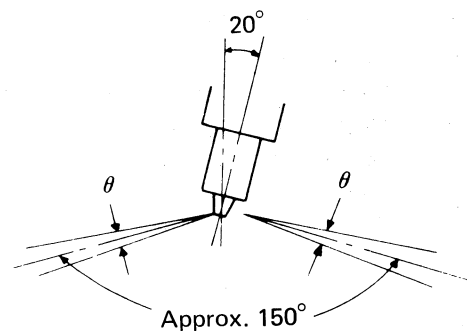
a) Carbon flower

When carbon is deposited on the injection hole in the form of a flower, it is known as a carbon flower. Carbon flowers cause deterioration of engine performance. If a large amount of carbon has been deposited, clean it out.

b) Spray pattern

Check the spray pattern by operating the nozzle tester lever at a rate of 1 to 2 swings per second. The normal spray pattern is illustrated on the right. In words, the pattern is correct if:

- (1) The injection angle variation (θ) is limited to a reasonable range.
- (2) The spray consists entirely of minute atomized fuel.
- (3) There is little or no variation between each injection hole.



Normal spray pattern

2. Precautions for installaing the injection valve

- (1) The nozzle case nut of the fuel injection valve should be tightened to te specified torque.

(Unit kg-m)

Case nut tightening torque	7.00 – 7.50
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- (2) Clean the sleeve face. Also, remember to replace the insulating packing.
- (3) Apply a coating of molybdenum disulfide over the circumferential surface of the fuel injection valve body to prevent seizure.

3. Disassembly and reassembly

The fuel injection valve can be disassembled into individual component parts by removing the nozzle case nut. Be sure to use a torque wrench as the entire valve has a thin-wall structure. Normally, the positioning pin of the valve need not be removed.

- *As with the fuel injection pump, the fuel injection valve should be disassembled in a clean environment. Care should be exercised so that the internal parts will not drop out of place.*

4. Adjustment

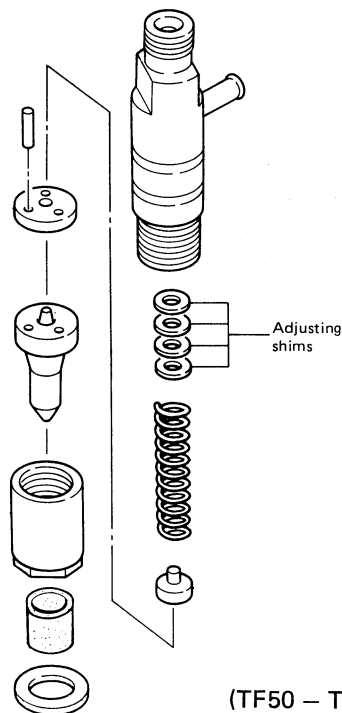
(For TF50 – TF120)

The injection pressure is 200–210kg/cm². To adjust the pressure to the specified amount by the number of adjusting shims in the nozzle holder.

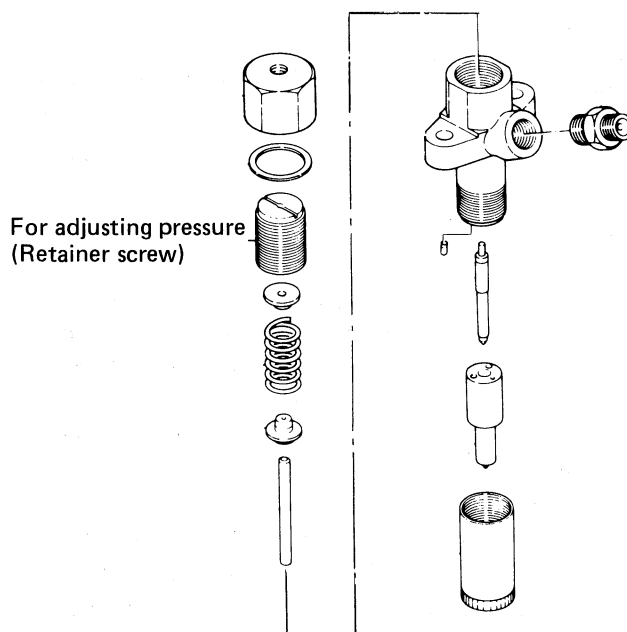
If the injection pressure is lower than the prescribed pressure, remove the nozzle holder and adjust the pressure by adding adjusting shims. The injection pressure increases about 10 kg/cm² when a 0.1 mm adjusting shim is added.

(For TF140, TF160)

To adjust the pressure to the specified amount by the turning the retainer screw in the nozzle holder.



(TF50 – TF120)



(TF140, TF160)

7.13 Fuel filter

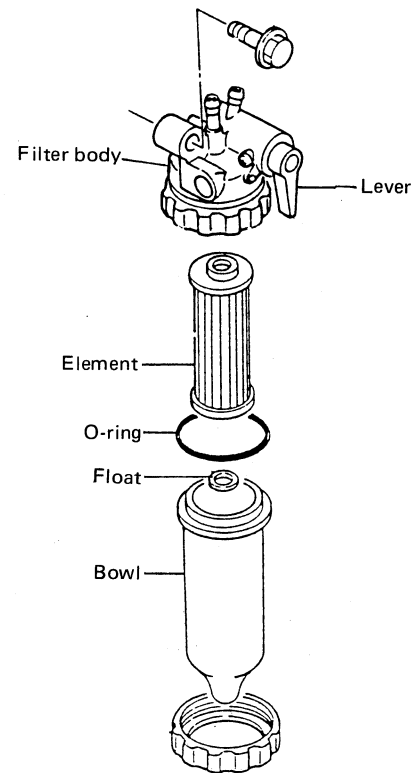
1. Check of fuel filter

The fuel filter should sometimes be cleaned. If water or sediment is found in the sediment bowl of the fuel filter, disassemble the filter and clean it with clean fuel oil until the foreign matter is completely removed.

The filter element should be replaced regularly after every 600 hours of service. It should be replaced earlier if the filter shows signs of internal contamination, deformation, or damage.

The fuel filter on the TF engine is equipped with an oil/water separator. If the float is raised by the separated water, remove the bowl to drain the water.

Internal cleaning of fuel filter	Every 300 hours of service
Replacement of filter element	Every 600 hours of service



7.14 Air cleaner

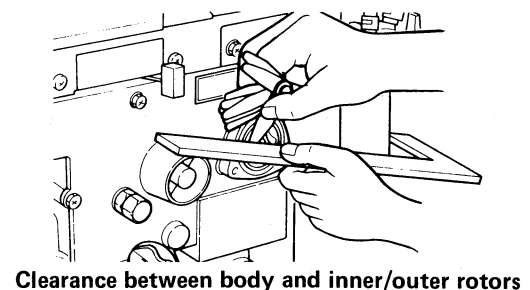
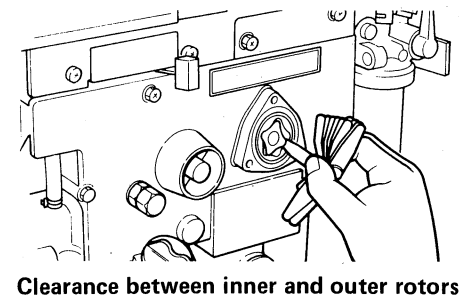
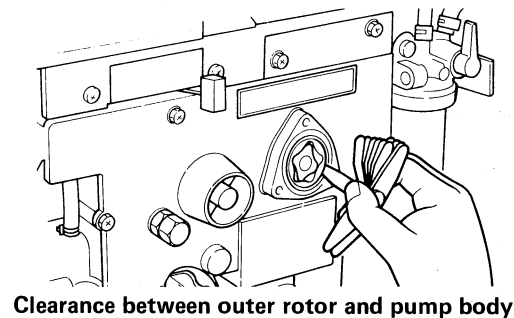
The air cleaner is solid type. It uses a filter element made of resin-impregnated non-woven fabric. Clean the filter element by flushing every 100 hours.

- *Never use a wet filter.*
- *Use a dried filter for spare.*

7.15 Lubricating oil pump

1. Check of lubricating oil pump

- 1) Check the clearance between the outer rotor and the body. If it exceeds the limit, replace both the rotor or gear housing.
- 2) Clearance between outer rotor and inner rotor
Press the convex part of the inner rotor fully into the concave part of the outer rotor, and insert a thickness gauge in the space where the convex parts of both rotors are in contact with each other. If this measurement, representing the outer-to-inner rotor clearance, exceeds the limit, replace the rotors.
- 3) Side clearance between body and inner/outer rotors
If the side clearance between the body and inner/outer rotors exceeds the limit, replace the gear housing as well as the rotors.

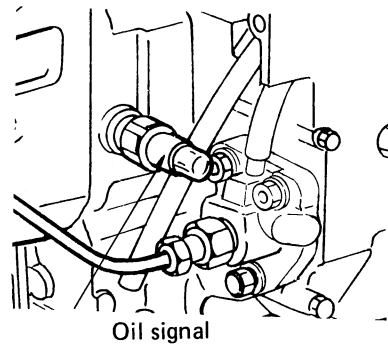


(Unit: mm)

Item	TF50		TF60, TF70, TF80, TF90		TF110, TF120		TF140, TF160	
	Standard	Limit	Standard	Limit	Standard	Limit	Standard	Limit
Clearance between outer rotor and pump body	0.120–0.161	0.20	0.1–0.151	0.20	0.12–0.171	0.22	0.12–0.171	0.22
Clearance between inner/outer rotors	0.14	0.20	0.14	0.20	0.14	0.20	0.14	0.20
Clearance between pump body and inner/outer rotors	0.01–0.06	0.09	0.02–0.09	0.12	0.02–0.08	0.12	0.02–0.08	0.15

7.16 Oil signal

This TF series is equipped with an oil signal which allows visual checking of the oil pressure. The oil signal is blue for normal oil pressure and red if the pressure drops excessively. If the oil signal turns red, immediately stop the engine to check the oil system.



7.17 V-belt for cooling fan

The V-belt needs to be replaced if its edge is rubbed shiny against the pulley. Locate the cause by checking the rubber for deterioration, cracking, wear, oil deposition, or other possible faults.

V-belt size

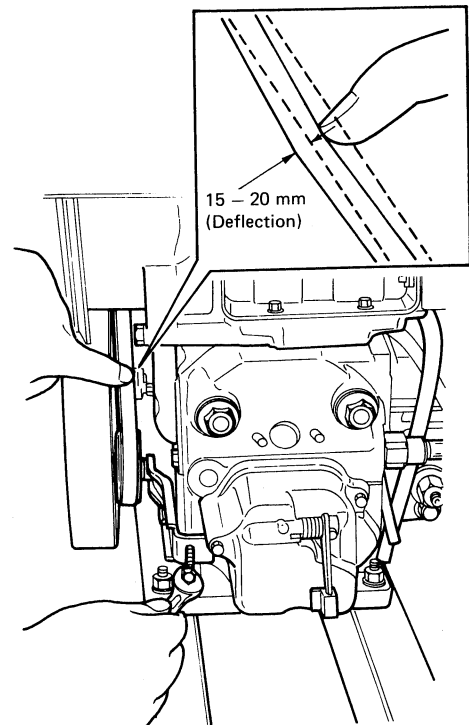
	TF50	TF60, TF70	TF80, TF90	TF110, TF120	TF140, TF160
Size	MF1330	MF1350	MF1380	MF1385	MF1405

1. Check of V-belt tension

Check belt deflection at the midpoint between the fan and tension pulley. The amount of deflection, which varies with the load on the belt, is generally measured by applying a finger pressure of 3 to 5 kg.

(Unit: mm)

Standard deflection amount	15 – 20
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7.18 Cooling water quantity

To check the cooling water quantity, fill with clean water up to the upper limit in the cooling water filler port.

In winter when the cooling water may freeze, be sure to mix anti-freeze into the water to prevent breakage by freezing, or to drain the water on completion of work.

8. Maintenance Schedule

System	Item	Daily	Every 100 hrs.	Every 300 hrs.	Every 600 hrs.
Fuel system	Fuel level check and refilling	○			
	Fuel tank draining		○		
	Fuel filter element cleaning		○ (If the deposited water raises the float, remove the bowl to drain the water on completion of work.)		
	Replace fuel filter element				○
Lubricating oil system	Crank-case oil level check and refill	○			
	Lubricating oil change	In the initial oil change after purchase, change the oil with new one. after 40 hours for CB. after 50 hours for CC.	In the 2nd oil change and subsequent changes, every 80 hours for CB and every 100 hours for CC.		
	Lubricating oil strainer cleaning		○		
Cooling water system	Cooling water refill	○ Ensure the floating level in hopper type, usually.			
	Water leakage check	○			
	Radiator screen cleaning		○		
	Radiator fin cleaning		○		
	V-belt tension adjustment	(10–50 hrs. after installation of new belt)	○		
Air cleaner	Air cleaner element cleaning		○ (Clean by flushing)		
	Replace air cleaner element	Every 1,000 hours at places laden with dust. Every 2,000 hours at other places.			
Items associated with cylinder head	Tightening of bolts & nuts	Note. 1	○		
	Valve clearance adjustment			○	
	Valve seat reconditioning				○
Fuel injection valve cleaning					○
Tightening of main bolts		Note. 1	○		

Note 1: In case of the initial operation, retighten the bolts and nuts after 50 hours.

9. Troubleshooting

Trouble and possible cause	Remedy
<p>Insufficient output</p> <ol style="list-style-type: none"> 1. Reduction in compression pressure <ol style="list-style-type: none"> (1) Improper intake/exhaust valve clearance (2) Poor contact of intake/exhaust valve seat (3) Valve stem seizing (4) Damaged or broken valve spring (5) Pressure leak through cylinder head gasket (6) Broken or sticking piston ring (7) Worn piston ring or liner 2. Incorrect fuel injection system <ol style="list-style-type: none"> (1) Poor injection timing (2) Defective nozzle 3. Incorrect fuel system <ol style="list-style-type: none"> (1) Clogging in fuel strainer element (2) Air bubbles in fuel system (3) Contamination in tank (4) Oil leakage in fuel injection pipe (5) Poor fuel flow in fuel injection pump (6) Poor fuel injection caused by improperly adjusted governor linkage. 4. Poor air inflow <ol style="list-style-type: none"> (1) Clogging in air cleaner element (2) Excessive intake/exhaust valve clearance 5. Overheating <ol style="list-style-type: none"> (1) Wrong engine oil (2) Insufficient cooling water (3) Worn or broken V-belt (4) Clogging or leakage in radiator (6) Improper intake/exhaust valve clearance (7) Excess back pressure in exhaust system (8) Inaccurate injection timing 6. Excessive engine oil consumption <ol style="list-style-type: none"> (1) Loose gearcase bolt or drain plug (2) Deteriorated crankshaft oil seal (3) Defective cylinder head bonnet gasket packing (4) Wear of intake/exhaust valve or valve guide (5) Broken piston ring (6) Incorrect position of piston ring end gaps (7) Worn or sticking piston ring (8) Piston ring fitted in opposite position (9) Worn piston or cylinder liner 	<p>Adjust to the proper clearance (0.2 mm) Re-fit valve and seat. Repair or replace valve stem. Replace spring. Replace gasket. Replace piston ring. Disassemble and repair engine.</p> <p>Adjust injection timing. Repair or replace nozzle.</p> <p>Replace element. Bleed the fuel system. Clean the tank. Tighten or replace injection pipe. Repair the pump by disassembly. Readjust the governor linkage.</p> <p>Wash with water or replace element. Adjust to the proper clearance (0.2 mm).</p> <p>Switch to the specified engine oil. Add water. Adjust or replace belt. Repair, clean or replace radiator. Adjust to the proper clearance (0.2 mm). Clean out or replace exhaust system. Adjust the injection timing after checking.</p> <p>Increase the tightening torque. Replace oil seal. Replace gasket packing. Replace valve or valve guide. Replace piston ring. Adjust ring position. Replace piston or piston rings. Fit to the correct position Replace piston or cylinder liner</p>

Trouble and possible cause	Remedy
<p>Poor starting</p> <p>1. Cranking speed too low</p> <ul style="list-style-type: none"> (1) Engine oil with too high a viscosity (2) Clutch remains in (3) Too much V-belt tension <p>2. Incorrect fuel injection system</p> <ul style="list-style-type: none"> (1) Fuel leak in fuel injection pipe (2) Defective nozzle (3) Air bubbles in the system (4) Delay in fuel injection timing (5) Poor fuel control rack performance <p>3. Insufficient compression pressure</p> <ul style="list-style-type: none"> (1) Poor contact of intake/exhaust valve seat (2) Worn piston, cylinder liner, or ring (3) Broken cylinder head gasket (4) Defective insulating packing for fuel injection valve (5) Incorrectly assembled fuel injection valve 	<p>Switch to the specified oil. Release the clutch. Adjust tension.</p> <p>Tighten or replace fuel injection pipe. Repair or change nozzle. Bleed the fuel system. Adjust the injection timing. Clean or repair rack.</p> <p>Re-fit valve and seat. Repair the engine by overhauling. Replace gasket. Replace insulating packing Correct by tightening.</p>
<p>Wrong idling speed</p> <p>1. Fuel injection pump system</p> <ul style="list-style-type: none"> (1) Poor fuel control rack performance (2) Poor governor linkage performance <p>2. Engine block</p> <ul style="list-style-type: none"> (1) Improper intake/exhaust valve clearance (2) Poor contact of intake/exhaust valve seat (3) Engine speed too low (4) Engine insufficiently warmed up 	<p>Clean or repair the rack by disassembly. Repair or replace governor linkage.</p> <p>Adjust to the proper clearance (0.2 mm). Re-fit valve and seat. Adjust idling speed. Warm up the engine.</p>

Engine knock

Engine knock may occur due to mechanical problems relating to the rotating or sliding parts, or it may be fuel knock. The source of the knock must first be identified. Locate the cause by loosening the fuel injection pipe nut and stopping injection.

Trouble and possible cause	Remedy
<p>1. Crankshaft bearing</p> <ul style="list-style-type: none"> (1) Worn bearing (2) Seized bearing <p>2. Connecting rod and crankpin bearing</p> <ul style="list-style-type: none"> (1) Worn crankpin bearing (2) Worn crankshaft pin (3) Bent connecting rod (4) Burnt crankpin bearing 	<p>Replace bearing. Replace bearing.</p> <p>Replace bearing Replace crankshaft Replace connecting rod. Replace bearing</p>

Trouble and possible cause	Remedy
3. Piston, piston pin, and piston ring (1) Too much clearance in cylinder liner because of wear (2) Worn piston or piston pin (3) Seized piston (4) Broken piston ring	Repair the engine by disassembly. Replace piston or piston pin. Replace piston or piston ring. Replace ring and check each part of the engine.
4. Other (1) Worn tappet (2) Improper intake/exhaust valve clearance. (3) Worn timing gear	Change tappet. Adjust to the proper clearance (0.2 mm). Replace gear.

Fault diagnosis by exhaust smoke

Trouble and possible cause	Remedy
Engine is difficult to start or starts without exhaust smoke 1. No fuel at the injection pump (1) Air bubbles in the fuel pipe (2) Clogging in fuel filter element or fuel system 2. No pressurized fuel at injection nozzle (1) Looseness or cracks in fuel injection pipe (2) Fuel control rack will not move to the injection position (3) Fuel pump delivery valve will not function	Bleed the fuel system. Clean element and fuel system, or replace element. Tighten or replace fuel injection pipe. Clean or replace the rack by disassembly. Replace delivery valve.
Engine will not start but emits a little exhaust smoke 1. Insufficient fuel injection (1) Incorrect governor linkage adjustment	Adjust or replace governor linkage.
Engine will not start but emits much exhaust smoke 1. Incorrect timing in fuel injection 2. Injection spray is improper (1) Nozzle seizing (2) Carbon deposit on nozzle tip 3. Compressed air does not rise to ignition temperature (1) Improper intake/exhaust valve clearance (2) Poor contact of intake/exhaust valve seat (3) Insufficient engine starting rpm 4. Wrong fuel used (1) Fuel cetane value too low or viscosity too high (2) Water in the fuel	Adjust injection timing. Replace nozzle. Clean or replace nozzle. Adjust to the proper clearance. (0.2 mm) Re-fit valve and seat. Check and adjust the belt tension: check oil. Change to the specified fuel oil. Change fuel oil.

Trouble and possible cause	Remedy
<p>Engine starts, but doesn't reach required rpm</p> <ol style="list-style-type: none"> 1. Too low compression temperature or compression pressure <ol style="list-style-type: none"> (1) Worn piston, piston ring, or cylinder liner (2) Poor contact of intake/exhaust valve seat (3) Improper intake/exhaust valve clearance (4) Loose fuel injection valve 2. Wrong fuel used: fuel deteriorated or contaminated <ol style="list-style-type: none"> (1) Fuel cetane value too low or viscosity too high (2) Water in the fuel 	<p>Repair engine by disassembly. Re-fit valve and seat. Adjust to the proper clearance. Tighten valve.</p> <p>Change to the specified fuel. Change fuel.</p>
<p>Black exhaust smoke at starting</p> <ol style="list-style-type: none"> 1. Injection occurring too early <ol style="list-style-type: none"> (1) Fuel control plate improperly installed 2. Improper spraying <ol style="list-style-type: none"> (1) Nozzle seizing (2) Carbon deposit on nozzle tip 3. Uneven air supply to the engine <ol style="list-style-type: none"> (1) Clogging in air cleaner (2) Improper intake/exhaust valve clearance 	<p>Adjust plate.</p> <p>Replace nozzle. Clean or replace nozzle.</p> <p>Clean or change element. Adjust to the proper clearance.</p>
<p>Too much exhaust during operation</p> <ol style="list-style-type: none"> 1. White exhaust smoke <ol style="list-style-type: none"> (1) Delayed injection (2) Leak in compression pressure (3) Water in the fuel (4) Engine oil up or down (sometimes blue-whitish or dark brown smoke) 	<p>Check and adjust injection timing. Repair the engine by disassembly. Change fuel oil. Check oil level, repair the engine by disassembly.</p>
<p>Black exhaust smoke</p> <ol style="list-style-type: none"> (1) Too much fuel injected to the cylinders (2) Air starvation (3) Wrong fuel (4) Fuel injection too early (5) Engine oil up or down (6) Overloading 	<p>Adjust the fuel injection timing. Clean or replace air cleaner element. Change to the specified fuel. Adjust fuel injection timing Check oil level, or repair the engine by disassembly. Decrease the load.</p>
<p>Fuel injection valve</p> <ol style="list-style-type: none"> 1. Fuel leakage <ol style="list-style-type: none"> (1) Defective nozzle Insulating packing. (2) Loose nozzle spring retainer or nozzle mounting nut 	<p>Replace insulating packing. Increase the tightening torque</p>
<ol style="list-style-type: none"> 2. Improper spraying <ol style="list-style-type: none"> (1) Leakage or foreign matter in valve seat (2) Nozzle tip damage or distortion 	<p>Clean or replace nozzle Replace nozzle</p>

Trouble and possible cause	Remedy
3. Insufficient injection pressure (1) Incorrect injection pressure setting (2) Deteriorated nozzle spring (3) Worn nozzle (4) Fuel leakage	Adjust to the specified pressure of 200–210 kg/cm ² Replace spring. Replace nozzle. Increase the tightening torque or change whole unit.

Fuel Injection Pump

Before checking the fuel injection pump, make sure that all the components and systems are in perfect condition.

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|---|----------------------------|
| (1) Engine cooling water temperature | (9) Clean the air cleaner |
| (2) Compression pressure | (10) Bleed the fuel system |
| (3) Fuel filter | |
| (4) Operating condition of the fuel injection valve | |
| (5) Fuel oil | |
| (6) Operating condition of the governor linkage | |
| (7) Leak (or cracks) in the fuel injection pipe | |
| (8) Piston top clearance | |

Trouble and possible cause	Remedy
Engine will not start 1. No exhaust smoke (1) Fuel control rack will not move from neutral (2) Air bubbles in the fuel injection pipe 2. Exhaust smoke occurs (1) Delayed fuel injection	Clean and repair the rack by disassembly Bleed the pipes Adjust fuel injection timing

Trouble and possible cause	Remedy
<p>Incorrect engine idling</p>	
<p>1. Hunting</p> <ul style="list-style-type: none"> (1) Inaccurate injection timing (2) Fuel control rack moves heavily (3) Poor delivery valve function 	<p>Adjust injection timing Repair the pump by disassembly Replace delivery valve</p>
<p>2. Engine can not be run at low rpm.</p> <ul style="list-style-type: none"> (1) Control rack is difficult to move smoothly 	<p>Repair the pump by disassembly</p>
<p>Engine will not run at high rpm:</p>	
<p>1. At no-load</p> <ul style="list-style-type: none"> (1) Delayed fuel injection timing (2) Poor pump plunger operation (broken spring) 	<p>Adjust injection Repair the pump by disassembly</p>
<p>2. At full-load running</p> <ul style="list-style-type: none"> (1) Insufficient fuel injected to the engine (rack set) (2) Poor pump plunger operation (broken spring) (3) Delayed fuel injection 	<p>Adjust the pump by disassembly Repair the pump by disassembly Adjust fuel injection timing</p>
<p>Insufficient engine output</p>	
<ul style="list-style-type: none"> (1) Insufficient fuel injected to the engine (rack set) (2) Inaccurate fuel injection timing (3) Plunger operates improperly (broken spring) 	<p>Adjust the pump by disassembly Adjust injection timing Repair the pump by disassembly</p>
<p>Too much black exhaust smoke</p>	
<ul style="list-style-type: none"> (1) Inaccurate fuel injection timing 	<p>Adjust injection timing</p>
<p>Too much white exhaust smoke</p>	
<ul style="list-style-type: none"> (1) Delayed fuel injection timing 	<p>Adjust injection timing</p>
<p>Cooling System</p>	
<p>Overheating</p>	
<ul style="list-style-type: none"> (1) Insufficient cooling water 	<p>Replenish water; check the system for leaks and repair if required</p>
<ul style="list-style-type: none"> (2) Slack in V-belt 	<p>Adjust the V-belt tension</p>
<ul style="list-style-type: none"> (3) Contamination on V-belt 	<p>Replace V-belt</p>
<ul style="list-style-type: none"> (4) Clogging in radiator screen 	<p>Clean the radiator screen</p>
<ul style="list-style-type: none"> (5) Clogging in radiator fins 	<p>Clean the radiator fins</p>
<ul style="list-style-type: none"> (6) Defective packing or looseness in radiator cap 	<p>Tighten the cap or replace packing</p>
<ul style="list-style-type: none"> (7) Leak in cooling pipe 	<p>Repair or replace pipe</p>
<ul style="list-style-type: none"> (8) Inaccurate injection timing 	<p>Adjust injection timing</p>
<ul style="list-style-type: none"> (9) Leak in radiator 	<p>Repair or replace</p>
<ul style="list-style-type: none"> (10) Leak because of defective cylinder head gasket 	<p>Repair by checking</p>

YANMAR DIESEL ENGINE CO.,LTD.



OVERSEAS OPERATIONS DIVISION

1-1, 2-chome, Yaesu, Chuo-ku, Tokyo 104, Japan

Telex: 0222-4733, 0222-2310 Telephone: 03-275-1111

Facsimile: 03-272-0687 Cable: YANMAR TOKYO