YANMAR

YANMAR DIESEL AMERICA CORP.
3168 Doolittle Drive
Northbrook, Illinois 60062

MODEL VARIATIONS: Variations of basic models 1GM, 2GM, 3GM and 3HM have been produced. Models with suffix "F", i.e. 2GMF, are fresh-water cooled. Model 3GMD is coupled to a different gearbox than basic model 3GM. The following service sections cover basic models, but the information also applies to model variations.

ENGINE SERVICE DATA

NOTE: Metric fasteners are used throughout engine.

ENGINE MODEL	1GM	2GM	3GM	3HM
General				
Cylinders	1	2	3	
Displacement	293 cc	586 cc	879 cc	1126 cc
Bore		72 mm		75 mm
Stroke		72 mm		85 mm
Output-hp @ rpm	6.5/3400	12/3400	20/3400	27/3200
Compression Ratio		23:1		22.7:1
Firing Order	1	1-2	1-3-2	
Cylinder numbering system (from flywheel)	1	1-2	1-2-3	
Main Bearings (number of)	2	3	4	
Crankshaft Rotation (viewed from flywheel end)		Counterclockwise		
Tune-Up				
Fuel Injection Timing		15° BTDC	18° BTDC	19° BTDC
Fuel Injection Pressure		16.66 MPa		15.68 MPa
Idle Speed		850 rpm		
Maximum Speed (no load)		3750 rpm		3600 rpm
Valve Clearance (cold)		0.2 mm		
Oil Pump Pressure		294-392 kPa @ 3600 rpm		294-392 kPa @ 3400 rpm
Oil Pump Volume (liters/min.)	3.9 @ 3600 rpm	12.5 @ 3600 rpm		12 @ 3400 rpm
Starter Current Draw:				
No Load		60 amps		90 amps
Loaded		460 amps		420 amps
Starter Brush Length		16 mm		22 mm
Alternator Output		27.5 amps @ 2500 rpm		
Sizes – Clearances				
Fuel Injection Pump Type	YPFR-1K	YPFR-2K	YPFR-3K	YPFR 0707
Injection Nozzle Type		YDN-OSYD1		
Diameter		1 mm		
Angle of Injection		5°-10°		
Spring Free Length		30.0 mm		
Spring Installed Length		28.7 mm		
Spring Load @ Installed Length		14.14 kg		
Fuel Lift Pump Type	105582-52010		121256-52020	
Delivery Volume		0.3 liter/min. @ 1000 rpm		
Delivery Pressure		9.8 kPa @ 600-1800 rpm		
Suction		60 mm Hg @ 600 rpm		

Illustration courtesy Yanmar

ENGINE SERVICE DATA (CONT.)

ENGINE MODEL	1GM	2GM	3GM	3HM
Sizes – Clearances (Cont.)				
Governor:				
Main Regulator Spring:				
Wire Diameter	1.8 mm	2.3 mm		
Coil Outside Diameter	13.8 mm	18.3 mm		
Number of Coils	8.5	7.5		
Free Length	See Text			
Sub Regulator Spring:				
Wire Diameter	0.8 mm	1.2 mm		
Coil Outside Diameter	6.8 mm	9.2 mm		
Number of Coils	4	7		
Free Length	See Text			
Crankshaft Outside Diameter	24.972-24.993 mm			
Governor Sleeve Inside Diameter	25.053-25.083 mm			
Governor Sleeve Length	14.9-15.1 mm			
Thrust Collar Thickness	3 mm			
Timing Gear Backlash	0.05-0.13 mm			
Cylinder Head Distortion Max.	0.7 mm			
Valve Seat Angle	45°			
Valve Seat Width	1.77 mm			
Valve Head Depth	0.95-1.25 mm			1.25-1.55 mm
Intake Valve Diameter	32 mm			
Exhaust Valve Diameter	26 mm			27 mm
Valve Angle	45°			
Valve Head Thickness	0.75-1.15 mm			0.85-1.15 mm
Valve Stem Diameter	6.9-7.0 mm			
Valve Guide Inside Diameter	7 mm			
Valve Stem Clearance:				
Intake	0.045-0.070 mm	0.040-0.065 mm		
Exhaust	0.045-0.070 mm			
Valve Guide Protrusion	7 mm			
Valve Guide Interference Fit	0.005-0.034 mm	0.018-0.047 mm		
Valve Spring Free Length	38.5 mm			
Valve Spring Assembled Height	29.2 mm			30.2 mm
Valve Spring Pressure at Assembled Height	16.16 kg	13.7 kg	14.43 kg	12.2 kg
Valve Head to Piston Clearance	0.7 mm			0.8 mm
Rocker Arm Shaft Diameter	12.0 mm	14.0 mm		
Rocker Arm Shaft to Bushing Clearance	0.0016-0.0052 mm			
Camshaft Timing:				
Intake Valve Opens	20° BTDC			
Intake Valve Closes	50° ABDC			
Exhaust Valve Opens	50° BBDC			
Exhaust Valve Closes	20° ATDC			
Camshaft Lobe Height	28.70-29.0 mm	34.70-35.0 mm		
Camshaft Fuel Pump Lobe Height	20 mm	33 mm		33.5 mm
Camshaft Journal Diameter				
Flywheel side	20 mm	30 mm		
Center	.....	.....	41.5 mm	
Camshaft Bearing Clearance	0.050-0.10 mm			
Valve Lifter Stem Diameter	9.95-10.0 mm			
Valve Lifter Clearance	0.025-0.060 mm	0.010-0.040 mm		
Push Rod Length	143 mm	136 mm		171 mm
Injection Pump Camshaft Lobe Height	44.90-45 mm			
Piston Diameter	71.913-71.943 mm			74.907-74.937 mm
Piston Pin Bore Diameter	19.995-20.008 mm			22.995-23.008 mm
Piston Pin Diameter	19.991-20.0 mm			22.991-23.0 mm
Piston Pin to Piston	0.005 mm Interference to 0.017 mm Loose			
Compression Ring Width	1.97-1.99 mm			
Compression Ring Thickness	3.10-3.30 mm			3.20-3.40 mm

Illustration courtesy Yanmar

ENGINE SERVICE DATA (CONT.)

ENGINE MODEL	1GM	2GM	3GM	3HM
Sizes – Clearances (Cont.)				
Oil Control Ring Width	3.97-3.99 mm			
Oil Control Ring Thickness	2.60-3.00 mm			2.40-2.80 mm
Piston Ring End Gap	0.20-0.40 mm			
Piston Ring Side Clearance:				
First Compression Ring	0.06-0.10 mm			0.065-0.10 mm
Second Compression Ring	0.035-0.07 mm			
Oil Control Ring	0.020-0.055 mm			
Connecting Rod Bearing Bore Diameter	40.0-40.10 mm			44.0-44.10 mm
Connecting Rod Bearing Clearance	0.028-0.086 mm			0.036-0.092 mm
Connecting Rod Side Clearance	0.2-0.4 mm			
Piston Pin Bushing Bore Diameter	20.0-20.10 mm			23.0-23.10 mm
Piston Pin to Bushing Clearance	0.025-0.047 mm			
Crankshaft Main Bearing Journal Diameter:				
Front	43.964-43.950 mm			46.964-46.950 mm
Intermediate	.....	43.964-43.950 mm		46.964-46.950 mm
Rear	59.964-59.950 mm			64.964-64.950 mm
Crankshaft Connecting Rod Journal Diameter	39.964-39.950 mm			43.964-43.950 mm
Crankshaft Main Bearing Clearance:				
Front and Intermediate	0.036-0.092 mm			0.036-0.095 mm
Rear	0.036-0.095 mm			0.036-0.099 mm
Crankshaft End Play	0.06-0.19 mm	0.09-0.19 mm		0.09-0.18 mm
Crankshaft to Crankcase Thrust Washer Thickness	2.25-2.45 mm			
Crankshaft to Gear Case Thrust Washer Thickness	2.75-2.95 mm			
Cylinder Bore Diameter	72.0-72.28 mm	.....	.....	.....
Cylinder Liner Inside Diameter	.....	72.0-72.10 mm		75.0-75.10 mm
Piston Clearance	0.057-0.117 mm			0.0380-148 mm
Cylinder Liner Projection	.....	0.005-0.075 mm		
Cylinder Liner Outside Diameter:				
Classification A	.....	76.0-76.010 mm		79.0-79.010 mm
Classification B	.....	75.990-76.0 mm		78.990-79.0 mm
Classification C	.....	75.980-75.990 mm		78.980-78.990 mm
Oil Pump:				
Outer Rotor-to-Pump Body Clearance	0.050-0.15 mm			
Outer-to-Inner Rotor Clearance	0.050-0.15 mm			
Inner/Outer Rotor End Play	0.03-0.13 mm			
Rotor Shaft to Pump Body Clearance	0.015-0.050 mm			
Starter:				
Standard Spring Load	1.6 kg			0.85 kg
Brush:				
Standard Length	16 mm			22 mm
Wear Limit	12 mm			8 mm
Magnetic Switch:				
Series Coil Resistance	0.324 ohms			0.267 ohms
Shunt Coil Resistance	0.694 ohms			0.590 ohms
Commutator Diameter	32.0-33.0 mm			40.0-43.0 mm
Armature Shaft Diameter	12.450-12.468 mm			14.950-14.968 mm
Alternator:				
Slip Ring Diameter	30.6-31.6 mm			
Brush Length	9.0-16.0 mm			
Tightening Torques (All values are in newton meters.)				
Alternator Mounting Bolt	21.5-26.5			
Anti-corrosion Zinc	45.0-58.8			

Illustration courtesy Yanmar

ENGINE SERVICE DATA (CONT.)

ENGINE MODEL	1GM	2GM	3GM	3HM
Tightening Torques (Cont.)				
Camshaft End Nut	68.6-78.4			
Camshaft Set Screw	19.6			
Connecting Rod Bolt	24.5			44.1
Crankshaft Pulley Bolt	98			
Cylinder Head Bolt	.....	24.5		29.4
Cylinder Head Nut	73.5	98	127.5	
Cylinder Head Stud	24.5-29.4	39.2-44.1		
Exhaust Manifold Nut	44.1			
Flywheel Bolt	63.7-68.6			
Flywheel Cover Bolt	44.1			
Fresh Water Pump Bolt	.....	19.6-24.5		
Fuel Injection Pump Delivery Valve	39.2-44.1			
Governor Retaining Nut	78.4-98			
Heat Exchanger Nut	.....	19.6-24.5		
Heat Exchanger Stud	.....	9.8-14.7		
Injection Pump Mounting Nut	24.5			
Injector Cap Nut	68.6-78.4			
Injector Hold-Down Nut	19.6			
Injector Nozzle Nut	98			
Intermediate Main Bearing Housing Bolt	.....	29.4-34.3		44.1-45
Main Bearing Housing Set Bolt	.....	44.1-45		
Oil Pan Bolt	8.8			
Oil Pressure Switch	98			
Oil Pump Mounting Bolt	8.8			
Raw-Water Pump Bolt	8.8	24.5		
Rear Main Bearing Housing Bolt	24.5			
Rocker Arm Support Nut	36.3			
Starter Mounting Bolt	44.1-45			73.5-78.4
Timing Gear Cover Bolt	8.8	24.5		
Water Temperature Sender	9.8-14.7			

MAINTENANCE

LUBRICATION

Use of a good quality SAE grade CB or CC lubricating oil is recommended. Oil viscosity selection should be based on anticipated ambient temperature for next 100 hours of operation. Use 10W or 20-20W weight oil for temperatures below 10°C. If temperature is between 10°C and 20°C, use a 20 or 20-20W weight oil. Use 30 or 40 weight oil when temperature is between 20°C and 35°C. If temperature is 35°C or higher use a 50 weight oil. In a new or rebuilt engine change oil and filter after first 20 hours of operation, then again after next 30 hours of operation. After third oil and filter change replace oil and filter after each 100 hours of operation or seasonally, whichever is more frequent.

FUEL SYSTEM

BLEED FUEL SYSTEM. Place throttle in full speed position. Loosen bleed screw (1–Fig. Y1-1) on top of fuel filter and operate fuel pump priming lever (2) until air-free fuel appears. Tighten fuel filter bleed screw. In firing order sequence, loosen injector fuel return line (1–Fig. Y1-2) banjo bolt and operate fuel pump priming lever until air-free fuel appears, then tighten bolt. Loosen fuel line nipple on inlet side of injector (2–Fig. Y1-2), set compression release lever to its decompression position, and crank engine until air-free fuel appears from all injection lines. Tighten injection line nipples.

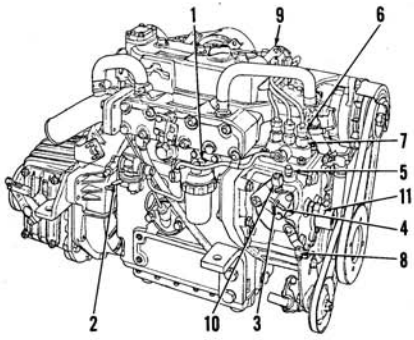


Fig. Y1-1—Illustration showing major fuel system components of 3GM engine. All other engine models are similar.

1. Fuel filter bleed screw
2. Fuel priming lever
3. Idle speed screw locknut
4. Idle speed screw
5. Maximum speed screw
6. Fuel injection line nut
7. Delivery valve
8. Engine stop lever
9. Compression release lever
10. Engine speed lever
11. Maximum fuel adjustment screw

Illustration courtesy Yanmar

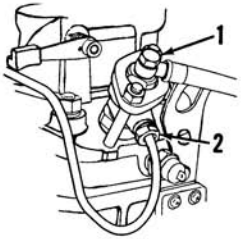


Fig. Y1-2—Illustration showing location of fuel return line banjo bolt (1) and injection line fitting (2). See text for fuel system bleeding procedure.

After performing above operation, set throttle lever in mid-position and place compression release lever in decompression position. Crank engine two or three times until fuel injection can be heard in all cylinders. Use caution when cranking engine in this condition to avoid flooding combustion chambers with fuel. If after a short time fuel injection cannot be heard in all cylinders repeat bleeding operation.

ENGINE SPEED ADJUSTMENT. IDLE SPEED ADJUSTMENT. Idle speed is adjusted by loosening locknut (3—Fig. Y1-1) and turning adjusting screw (4). Idle speed should be set with transmission in neutral and engine at normal operating temperature.

MAXIMUM ENGINE SPEED. Maximum engine speed is set at factory, wired and lead sealed. If adjustment becomes necessary care should be taken to properly rewire and seal adjusting screw cap. Maximum no-load speed adjusting screw is located at (5—Fig. Y1-1). Before performing maximum speed adjustment, engine should be at normal operating temperature. Remove cap nut (1—Fig. Y1-3) and washer (2).

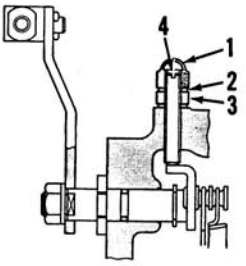


Fig. Y1-3—Maximum no-load engine speed may be adjusted after removing cap nut (1) and washer (2). Loosen locknut (3) and turn screw (4) to adjust engine speed as outlined in text.

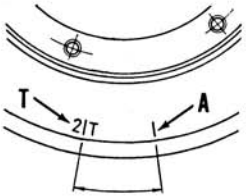


Fig. Y1-4—Flywheel has TDC mark (T) for each piston. Use mark (A) when setting fuel injection timing for each cylinder as outlined in text.

Loosen locknut (3). Start engine and with transmission in neutral advance throttle to full speed position. Turn adjusting screw (4) until no-load engine speed specified in ENGINE SERVICE DATA section is achieved. Being careful not to move adjustment screw (4) tighten locknut (3). Advance and retard engine speed several times to check adjustment. Stop engine, install washer (2) and cap nut (1).

FUEL INJECTION TIMING. Fuel injection timing procedures are similar for all model engines. Each cylinder has a flywheel TDC mark and a stamped timing advance mark for correctly setting fuel injection pump timing. TDC marks are numbered to individual cylinders, i.e. 1/T, 2/T, 3/T. Injection timing marks are stamped lines and are specific to different model engines. See Fig. Y1-4. These lines are 15°, 18° or 19° BTDC depending on engine model.

To check injection timing, disconnect number 1 cylinder fuel injection line (6—Fig. Y1-1) from delivery valve (7). Bleed air from system as previously outlined and place throttle in mid-position. Be sure fuel is flowing to injection pump. Turn flywheel by hand in direction of normal rotation with piston on compression stroke until fuel just stops flowing from delivery valve nipple.

When properly timed injection timing mark (A—Fig. Y1-5) will be aligned with flywheel cover mark (M) at same time fuel stops flowing from delivery valve nipple. Adjust timing by removing or installing injection timing shims (I—Fig. Y1-6). A 0.1 mm thickness change of injection pump timing shim will change timing by 1 crankshaft degree. Add to shim thickness to retard timing and subtract from shim thickness to advance injection timing.

Repeat timing procedure for remaining cylinders of 2GM, 3GM and 3HM models to verify injection pump internal timing. If injection timing varies between cylinders, then injection pump timing must be adjusted internally by a diesel shop experienced in fuel injection pump repair.

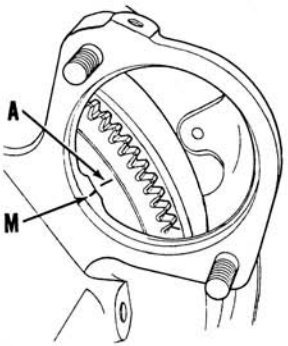


Fig. Y1-5—When setting fuel injection timing align advance mark (A) with flywheel cover mark (M) to establish correct timing advance for each cylinder.

VALVE ADJUSTMENT

Valve clearance should be adjusted with engine cold after every 300 hours of operation or after removal and installation of cylinder head. Remove valve rocker arm cover and position number 1 piston at TDC on compression using timing marks as shown in Fig. Y1-4. Loosen rocker arm adjusting screw locknut and using adjusting screw adjust valve clearance to 0.2 mm for both intake and exhaust valves. Be careful not to move adjusting screw when tightening locknut. Repeat procedure for remaining cylinders.

REPAIRS

INJECTORS

Before removing injection nozzle from engine, clean all dirt and grease from

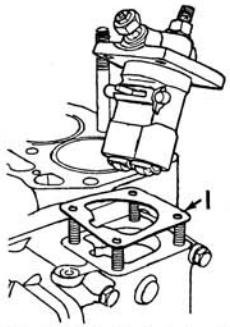
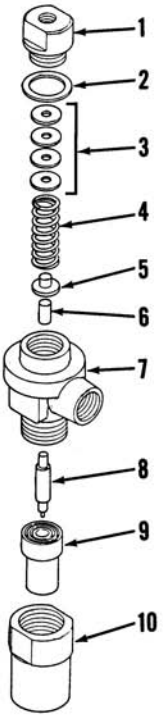


Fig. Y1-6—Adjust injection timing by adding or subtracting shims (I) as outlined in text.

Illustration courtesy Yanmar



Y1-7 – Exploded view of typical Yanmar injection nozzle.

1. Cap nut
2. Washer
3. Adjustment shims
4. Spring
5. Seat
6. Pin
7. Body
8. Nozzle valve
9. Nozzle
10. Nozzle nut

fuel line fittings and surrounding cylinder head area using solvent and compressed air. Cap all fuel lines as they are removed, be careful not to allow pieces of dirt or carbon to fall into cylinder when nozzle is removed. Remove all dirt and carbon from injection nozzle using clean fuel and a brass brush.

Loosen nozzle cap nut (1 – Fig. Y1-7). Remove nozzle nut (10) and gently withdraw nozzle body (9) and nozzle valve (8) as a unit. Remove cap nut (1), shims (3), spring (4), seat (5) and pin (6) from nozzle body (7).

Parts should be washed in clean diesel fuel and all carbon removed from nozzle body (9) and nozzle nut (10). Do not interchange parts from one injector to another, they must be kept separate. Inspect all parts for corrosion and wear; renew components as necessary. After cleaning and inspection, hold nozzle body (9) upright and lift valve (8) about one-third its length out of body. Nozzle valve and body are in good condition if valve drops smoothly by its own weight when released. Renew valve and body if valve sticks or drops freely. When installing a new nozzle valve and body assembly, remove seal, peel and soak parts in clean diesel fuel to remove all rust preventative, and check nozzle valve to body fit as previously outlined. Inspect nozzle spring (4) for broken or collapsed coils. Spring free length should be 30.0 mm, spring pressure should be 14.14 kg at a compressed length of 28.7 mm. Inspect seat (5) and pin (6) for wear or metal flaking and renew as necessary.

Assemble injection nozzle in reverse order while leaving cap nut (1) loose until nozzle body assembly and nozzle nut (10) have been properly installed. See ENGINE SERVICE DATA section for tightening torque specifications.

Install assembled injector on a suitable pressure tester. Slowly operate tester handle and read pressure at instant injection begins. Opening pressure should be 16.1-17.1 MPa for all models except 3HM engine which should be 15.1-16.1 MPa. If opening pressure is too low remove cap nut (1) and increase spring shim (3) thickness, if nozzle opening pressure is too high reduce spring shim thickness. Injection pressure changes approximately 980 kPa per 0.1 mm change in spring shim thickness.

After correct nozzle opening pressure has been achieved, wipe nozzle tip dry and apply a pressure 1.9 MPa lower than specified opening pressure. At this pressure nozzle tip should remain dry. If moisture appears, clean or renew nozzle valve and body assembly.

Operate tester handle at a rate of 4-6 strokes per second and check nozzle spray pattern, spray should be cone shaped and well atomized.

After injection nozzle has passed all tests outlined above it can be placed in service. Install injector in cylinder head using a new gasket. Be sure to install injector hold-down plate with notched side towards cylinder head. Tighten hold-down nuts evenly to specification given in ENGINE SERVICE DATA section.

INJECTION PUMP

To remove injection pump disconnect fuel supply and injection lines. Remove pump retaining nuts and lift pump out of cylinder block. See Fig. Y1-6. Care should be taken not to lose or damage injection pump timing shim (1).

Injection pump should be tested and overhauled by a shop that specializes in diesel injection pump repair.

Install injection pump in reverse order of removal and tighten hold-down nuts evenly to 54.5 N·m. Bleed fuel system as previously outlined. Start engine and carefully check for fuel leaks.

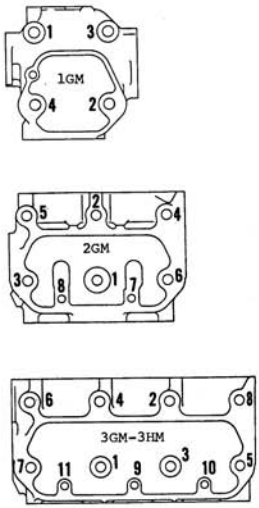


Fig. Y1-8 – Use appropriate head bolt tightening sequence shown above when installing cylinder head.

CYLINDER HEAD

Cylinder head is an integral type casting with renewable valve guides and two-piece precombustion chambers. When removing cylinder head loosen retaining nuts and bolts in opposite order of tightening sequence shown in Fig. Y1-8.

Valve seat grinding should be closely coordinated with valve refacing and valve guide renewal. Reface valves and grind valve seats to a true 45 degree angle. After grinding, valve seat should not be more than 1.77 mm wide. Use 15 and 65 degree stones to lower or raise valve contact point. When refacing valves remove only enough material to eliminate any pitting. Finished valve face width should be 3.04 mm for Model 3HM and 3.15 mm for all other models. Valve head margin should not be less than 0.75 mm. If after grinding and refacing operations have been performed depth of valve in cylinder head exceeds 1.55 mm on 3HM engine or 1.25 mm on all other models, valve and/or cylinder head must be renewed.

Intake and exhaust valve guides incorporate a gas blow cut (1 – Fig. Y1-9) and

Illustration courtesy Yanmar

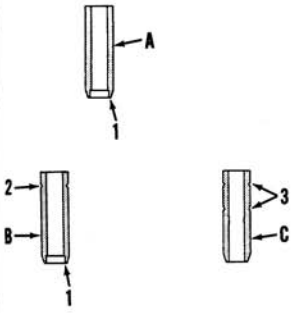


Fig. Y1-9—Valve guide (A) incorporates a gas cut (1) and is used on both intake and exhaust valves in 1GM engine. Valve guide (B), with gas cut (1) and single groove (2), is used for exhaust valves in all models except 1GM. Valve guide (C), without gas cut and with two grooves (3), is used for intake valves on all models except 1GM.

are identical on Model 1GM. On all other models, the exhaust valve guide (B) is identified by gas blow cut (1) and single external groove (2). Intake valve guide (C) on all models except 1GM, is identified by two external grooves (3) and the absence of the gas blow cut. Remove loose or worn valve guides from bottom of cylinder head using a suitable shoulder punch and hammer. Install new guide from top of cylinder head, using suitable shoulder punch and hammer, so bottom edge of top groove of guide is flush with cylinder head surface or valve guide protrusion is 0.7 mm.

Cylinder head must be flat to within 0.07 mm from end-to-end and from side-to-side. If cylinder head distortion exceeds this limit it should be renewed as manufacturer does not recommend grinding cylinder head to correct unevenness.

Install head gasket with "TOP" mark facing up. After installation of cylinder head on engine but before installation of precombustion chamber(s) and injector(s) check for proper piston-to-cylinder head clearance. Lower piston to

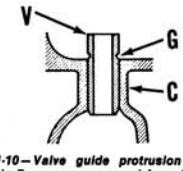


Fig. Y1-10—Valve guide protrusion on 1GM engine is 7 mm, as measured from top of cylinder head (C) to top of valve guide (G). On all other models valve guide is driven into cylinder head until bottom of groove (G) is flush with top of cylinder head.

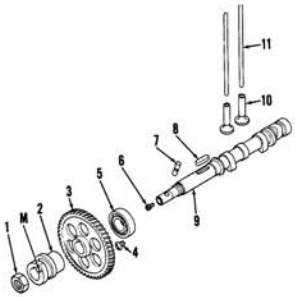


Fig. Y1-11—Exploded view of valve and fuel injection pump camshafts. Install injection pump camshaft so "O" mark (M) is facing out.

1. Locknut
2. Injection pump camshaft
3. Camshaft drive gear
4. Bearing retaining screw
5. Bearing
6. Set screw
7. Injection pump camshaft drive pin
8. Key
9. Camshaft
10. Valve lifters
11. Push rods

be checked and insert a length of 1.2 mm solder into cylinder through injector hole, being careful that wire does not enter intake or exhaust valve ports or groove in combustion surface. Rotate crankshaft by hand and crush solder between piston and cylinder head. Lower piston and measure thickness of crushed part of wire. Top clearance should not be less than 0.8 mm for Model 3HM or 0.7 mm for all other models. If clearance is insufficient, cylinder head gasket or cylinder head should be renewed.

CAMSHAFT

Injection pump cam is attached to front of camshaft on all engine models. Pump cam is inserted into camshaft together with camshaft gear by matching key and slot and is held in place by nut (1—Fig. Y1-11). When installing injection pump cam be sure "0" mark (M—Fig. Y1-11) on cam lobe faces outward.

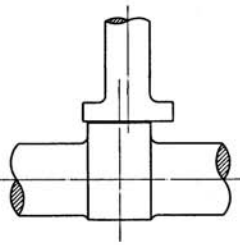


Fig. Y1-12—Center of camshaft lobe and center of valve lifter are offset to prevent eccentric wear of contact surfaces.

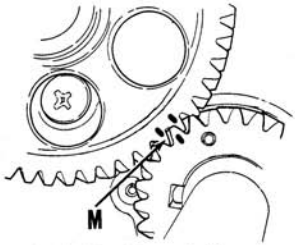


Fig. Y1-13—Align timing marks (M) as shown when reinstalling timing gears.

Mushroom type valve lifters are offset (Fig. T1-12) to prevent wear and ensure valve lifter rotation. There should be no uneven contact between valve lifter and camshaft lobe. Renew valve lifter if there is any uneven contact or wear and determine reason for lack of valve lifter rotation. Correct camshaft and crankshaft gear timing mark alignment is shown in Fig. Y1-13.

PISTON, RINGS AND CONNECTING ROD

On all models except Model 3HM, connecting rods and caps are punch marked with the cylinder number to ensure correct alignment upon installation. Model 3HM engine connecting rods and caps should be punch marked prior to disassembly to aid in correct match-up upon installation.

Measure piston diameter at a point 9.0 mm from bottom of piston skirt and

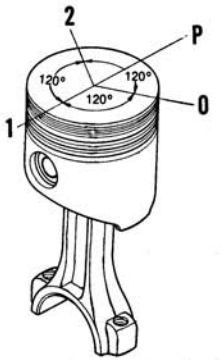


Fig. Y1-14—Position piston ring end gaps as shown around piston pin (P) centerline.

O. Oil control ring
1. Top compression ring
2. Second compression ring

Fig. Y1-15—Oil control ring expander gap (E) should be installed 180 degrees apart from rail gaps (R).

perpendicular to piston pin. To properly install piston on connecting rod, piston should be soaked in an 80°C oil bath for 15 minutes. Remove piston from hot oil, center small end of connecting rod in piston and insert piston pin with a rotating motion. Top compression is barrel faced and second compression ring is tapered. Be sure compression rings are installed in correct groove with the manufacturer's markings facing up. Ring end gaps should be located as shown in Fig. Y1-14 with oil ring expander gap 180 degrees apart from rail gap (Fig. Y1-15). See ENGINE SERVICE DATA section for piston and connecting rod specifications.

CRANKSHAFT

Crankshaft construction for all models is identical with the exception of 1GM engine which has no intermediate main bearing journal or intermediate bearing housing. On all models front and rear main bearings are full circle type with front bearing pressed directly into cylinder block while rear main bearing is fitted into a removable bearing housing. See Fig. Y1-16 or Y1-17 for exploded view of crankshaft assembly.

To remove crankshaft, remove crank gear and flywheel, place cylinder block in a vertical position with flywheel end up and remove rear main bearing housing. Attach a rope to crankshaft and using a chain hoist, or other suitable piece of lifting equipment, lift crankshaft slightly and remove intermediate bearing housing set bolts (B—Fig. Y1-18) on models so equipped.

If crankshaft is lifted too much or too little, set bolts will be very difficult to remove and damage to bolts, housing and cylinder block may result. After set bolts have been removed lift crankshaft, with bearing housings attached, out of cylinder block. After removal of crankshaft remove each intermediate main bearing housing.

Check front and rear main bearing diameters in their installed positions. To measure intermediate main bearing diameter, assemble housing with bearing and torque bolts to specification given in ENGINE SERVICE DATA section. The intermediate main bearing on Model 2GM engine and flywheel side intermediate main bearing on 3GM and 3HM models is a flange type bearing which controls crankshaft end play. Measure flange width as well as inside diameter. Crankshaft end play on 1GM engines is controlled by thrust washers (6 and 8—Fig. Y1-16) located on either side of front main bearing. See ENGINE SERVICE DATA section for specifications.

Removal and installation of front and rear full circle main bearings requires

Fig. Y1-16—Exploded view of Model 1GM crankshaft assembly.

1. Oil seal
2. Rear bearing housing
3. "O" ring
4. Rear main bearing
5. Crankshaft
6. Thrust washer
7. Front main bearing
8. Thrust washer
9. Thrust plate
10. Crankshaft drive gear
11. Governor weight assy.
12. Locknut
13. Governor sleeve
14. Thrust bearing
15. Thrust washer
16. Roller bearing
17. Oil seal
18. Belt pulley
19. Locknut

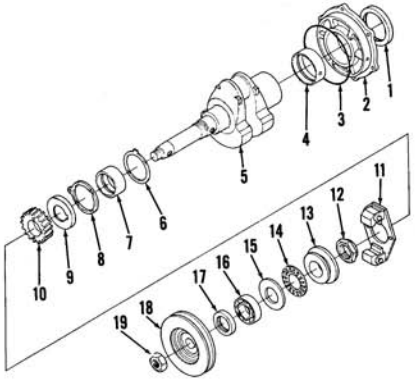
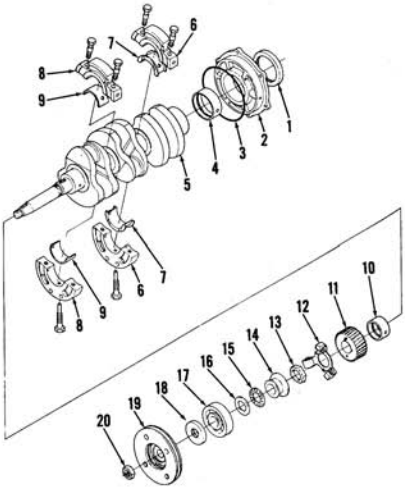


Fig. Y1-17—Exploded view of Model 3GM crankshaft assembly. Model 2GM and 3HM crankshaft assemblies are similar.

1. Oil seal
2. Rear main bearing housing
3. "O" ring
4. Rear main bearing
5. Crankshaft
6. Rear intermediate main bearing housing
7. Rear intermediate main bearing
8. Front intermediate main bearing housing
9. Front intermediate main bearing
10. Front main bearing
11. Crankshaft gear
12. Governor weight assy.
13. Locknut
14. Governor sleeve
15. Thrust bearing
16. Thrust washer
17. Roller bearing
18. Oil seal
19. Belt pulley
20. Locknut



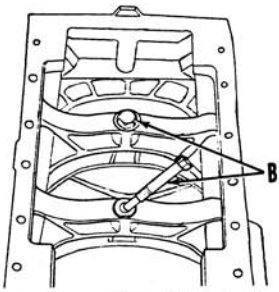


Fig. Y1-18—Intermediate main bearing housings are centered and held in place by set bolts (B).

Illustration courtesy Yanmar

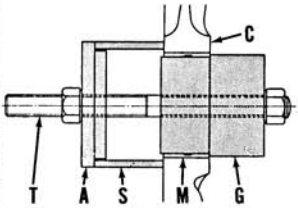


Fig. Y1-19—Removal of front or rear main bearing requires use of Yanmar special tool number 124085-92400 for all models except 3HM which uses special tool number 128670-92400. Install special tool as shown and draw old bearing (M) out through front of cylinder block (C).

A. Pulling plate
C. Cylinder block
G. Extraction & insertion guide
M. Main bearing
S. Spacer sleeve
T. Through-bolt

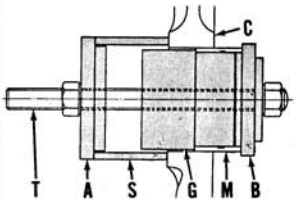


Fig. Y1-20—Installation of front or rear main bearing requires use of Yanmar special tool number 124085-92400 for all models except 3HM which requires special tool number 128670-92400. Install special tool as shown and pull new bearing into place being careful not to distort new bearing.

A. Pulling plate
B. Insertion plate
C. Cylinder block
G. Extraction & insertion guide
M. New main bearing
S. Spacer sleeve
T. Through-bolt

Yanmar special tool number 124085-29400 for 1GM, 2GM and 3GM engines while special tool number 128670-92400 is required for Model 3HM engines. Following tool manufacturer's instructions, install special tool as shown in Fig. Y1-19 to remove either front or rear main bearing. Fig. Y1-20 shows proper use of special tool when installing either front or rear main bearing. Always coat outside of new bearings with oil before installation. After installation always check bearing bore diameter for distortion. If any distortion exists repeat removal and installation operation using another new bearing.

Clean all parts thoroughly before installation. Assemble intermediate main bearing housings to crankshaft by aligning arrows (A—Fig. Y1-21) and positioning housings so "F" side is towards flywheel end of crankshaft. Be sure bearing housing with flanged bearing is the number 3 main bearing on Models 3GM and 3HM. Tighten housing bolts to torque listed in ENGINE SERVICE DATA and check for free crankshaft rotation.

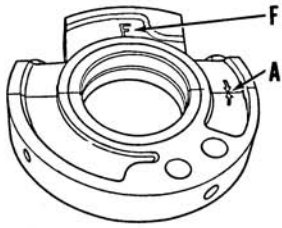


Fig. Y1-21—Intermediate main bearing housings should be assembled so arrows (A) are pointing towards each other. Install housing in cylinder block with (F) mark facing front of engine.

Lower crankshaft assembly vertically into cylinder block using a chain hoist or other suitable piece of lifting equipment until intermediate main bearing housing set bolts can be started by hand. First hand tighten timing gear side set bolt then slowly torque flywheel side set bolt to specification. Next tighten timing gear side set bolt to torque specification then check crankshaft for free rotation. If necessary loosen set bolts and adjust bearing housings vertically and retighten to torque specification until free crankshaft rotation is achieved. Install a new oil seal (1—Fig. Y1-16 or Y1-17) in rear main bearing housing (2) and install housing over flywheel end of crankshaft with "DOWN" mark pointing towards oil pan side of cylinder block. Torque rear main bearing housing bolts to specification and again check crankshaft for free rotation.

CYLINDER BLOCK

Model 1GM

Model 1GM engines do not incorporate a cylinder liner. Piston rings are in direct contact with cylinder bore. Cylinder bore measurements should be taken at top, middle, and bottom of ring travel parallel to crankshaft centerline and perpendicular to crankshaft centerline. When cylinder wear exceeds maximum limit given in ENGINE SERVICE DATA section cylinder should be rebored to a diameter of 72.25-72.28 mm. Only a 0.25 mm oversize piston and ring set are available so care must be taken not to overbore cylinder as further oversizes are not available. Measure cylinder block distortion along lines shown in Fig. Y1-22; maximum allowed distortion at any one point is 0.07 mm.

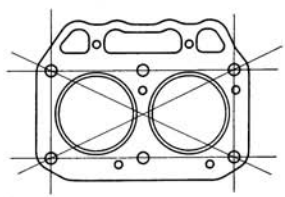


Fig. Y1-22—Check cylinder head and cylinder block for flatness along lines shown. Maximum allowable distortion at any point is 0.07 mm.

All Other Models

Dry type cylinder liners are factory fitted to a clearance of 0.01-0.03 mm. Liners are classified A, B or C with the identifying letter stamped on outside of liner 20 mm from top edge. Model 2GM and 3GM "A" liner O.D. is 76.0-76.01 mm, "B" liner O.D. is 75.99-76.0 mm, and "C" liner O.D. is 75.98-75.99 mm. Model 3HM "A" liner O.D. is 79.0-79.01 mm, "B" liner O.D. is 78.99-79.0 mm, and "C" liner O.D. is 78.98-78.99 mm. Class "B" liner for each model engine is the only liner available as a service part.

Cylinder liner bore diameter should be measured at top, middle and bottom of ring travel parallel to crankshaft centerline and perpendicular to crankshaft centerline to determine wear and taper. See ENGINE SERVICE DATA section for specifications.

Cylinder liner projection should be 0.005-0.75 mm as measured from top of cylinder block to top of cylinder liner.

Remove cylinder liner from top of cylinder block using a suitable puller and press plate as shown in Fig. Y1-23.

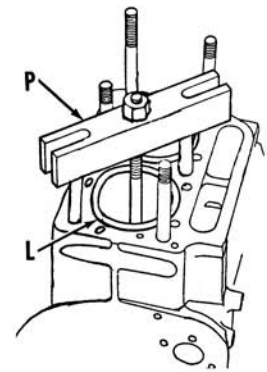


Fig. Y1-23—Using a suitable puller and press plate extract cylinder liners from top of cylinder block as illustrated.

Illustration courtesy Yanmar

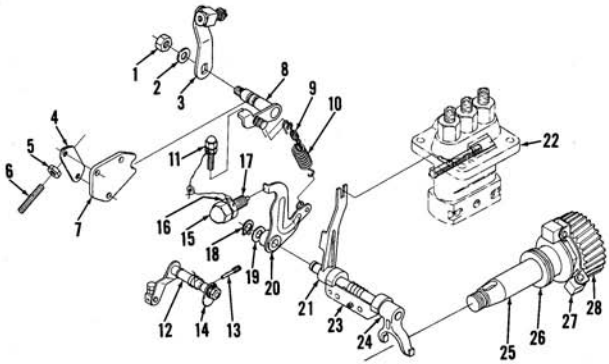


Fig. Y1-24—Exploded view of fuel control system used on Yanmar marine diesel engines.

1. Nut
2. Washer
3. Speed control lever
4. Bracket
5. Locknut
6. Idle speed screw
7. Gearcase side cover
8. Speed control shaft
9. Secondary regulator spring
10. Primary regulator spring
11. Maximum speed regulator assy.
12. Engine stop lever
13. Lockscrew
14. Cam
15. Cap nut
16. Locknut
17. Fuel injection limiter adjustment screw
18. Snap ring
19. Washer
20. Fuel control lever
21. Governor lever 2
22. Fuel injection pump assy.
23. Lever shaft support
24. Governor lever 1
25. Crankshaft
26. Governor sleeve
27. Governor weight assy.
28. Crankshaft gear

When installing cylinder liner be sure shoulder area is free of all rust and corrosion to ensure correct liner protrusion. Insert liner by hand after coating entire outside with engine oil. Do not tap or hammer liner into place as liner distortion will result.

INJECTION LIMITER

All Models Except 3HM

After installation of fuel injection pump or timing gear case, injection limiter must be adjusted to ensure adequate fuel enrichment under load and smooth acceleration. Remove injection pump adjustment cover (7—Fig. Y1-24). Place engine stop lever (12) in the run position and speed control lever (3) in full speed position. Remove injection limiter cap nut (15), loosen locknut (16) and back out injection control shaft (17) until plunger in end of shaft no longer touches fuel control lever (20). Using governor lever (21) align injection pump fuel control rack center mark (M—Fig. Y1-25) with reference face (F) as shown in Fig. Y1-25. Slowly turn injection control shaft (17—Fig. Y1-24) clockwise until plunger in end of shaft just touches fuel control lever (20). Tighten locknut (16) and install cap nut (15). If, after careful adjustment of injection limiter, engine speed is not well controlled, turn injection limiter counterclockwise slightly. If injection limiter is turned out too far engine will produce excessive exhaust smoke. After adjustment, secure locknut (16) in position using lock wire and then apply a seal.

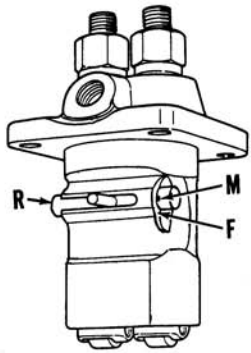


Fig. Y1-25—When performing injection limiter adjustment on all models except 3HM, use governor lever to align center mark (M) on fuel rack (R) with injection pump reference face (F). See text for adjustment procedure.

Model 3HM

Adjustment of Model 3HM injection limiter is basically the same as all other models except fuel stop lever (12—Fig. Y1-24) is used to properly position injection pump fuel rack center mark with reference face, as shown in Fig. Y1-26, instead of fuel control lever.

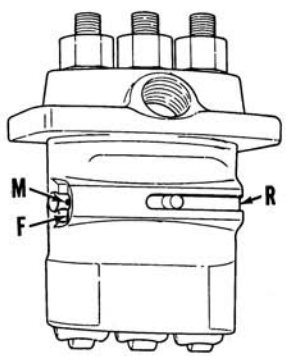


Fig. Y1-26—When performing injection limiter adjustment on Model 3HM engine, use fuel stop lever to align center mark (M) of fuel rack (R) with injection pump body reference face (F). See text for adjustment procedure.

TRANSMISSION

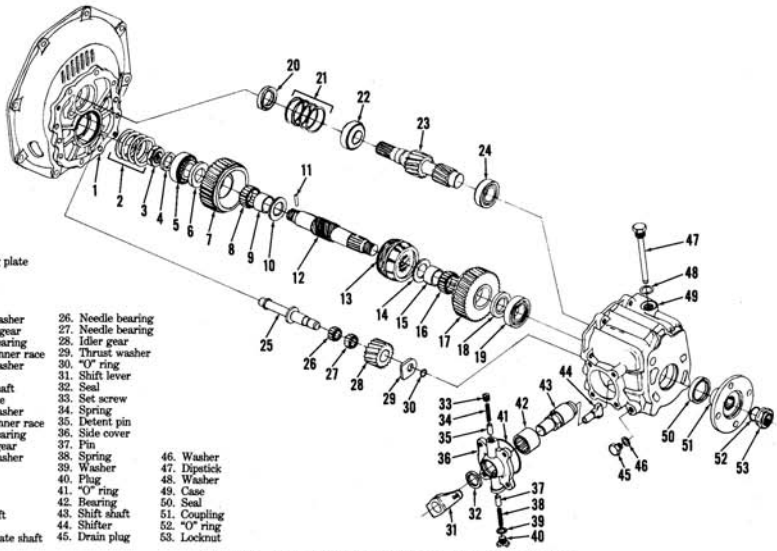
Model 1GM and 2GM engines are coupled to a Model KM2-A transmission while Model 3GMD engine is coupled to a Model KM3-A transmission. Model 3GM and 3HM engines are coupled to a Model KBW-10 transmission. Refer to the following sections for transmission service.

Model KM2-A And KM3-A Transmissions

LUBRICATION. Transmission oil should be changed after each 250 hours of operation or seasonally whichever is more frequent. On a new or newly rebuilt unit change transmission oil after first 50 hours or 30 days of operation, whichever comes first. Use of a good quality SAE 10W-30 CC oil is recommended. Oil capacity of KM2-A transmission is 0.25 liters. KM3-A transmission requires 0.3 liters of oil.

OVERHAUL. Disassemble transmission in following order: Remove output shaft nut (53—Fig. Y1-27) and coupling (51). Note that output shaft has left-hand threads. Remove shift cover (36) and shifter assembly. Unscrew mounting flange bolts then tap off mounting flange (1) using a plastic hammer. Lift out output shaft assembly (1—Fig. Y1-28). Using a suitable drift, drive intermediate shaft (2) out of case as shown in Fig. Y1-29. Remove input shaft (3—Fig. Y1-28). Remove oil seal (50—Fig. Y1-27) and using a suitable puller, remove output shaft rear bearing (19) race from inside of case. Remove input shaft oil seal (20) and input shaft front

Illustration courtesy Yanmar



1. Mounting plate
2. Shims
3. Locknut
4. Collar
5. Bearing
6. Thrust washer
7. Forward gear
8. Needle bearing
9. Bearing inner race
10. Thrust washer
11. Pin
12. Output shaft
13. Drive cone
14. Thrust washer
15. Bearing inner race
16. Needle bearing
17. Reverse gear
18. Thrust washer
19. Bearing
20. Oil seal
21. Shims
22. Bearing
23. Input shaft
24. Bearing
25. Intermediate shaft
26. Needle bearing
27. Needle bearing
28. Idler gear
29. Thrust washer
30. "O" ring
31. Shift lever
32. Seal
33. Set screw
34. Spring
35. Detent pin
36. Side cover
37. Pin
38. Spring
39. Washer
40. Plug
41. "O" ring
42. Bearing
43. Shift shaft
44. Shifter
45. Drain plug
46. Washer
47. Dipstick
48. Washer
49. Case
50. Seal
51. Coupling
52. "O" ring
53. Locknut

Fig. Y1-27—Exploded view of KM2-A and KM3-A transmissions.

bearing (22) race from mounting flange (1) using a suitable puller. Be careful not to lose or intermix input and output shaft adjusting shims (2 and 21) when bearing races are removed from mounting flange (1).

To disassemble output shaft (12), clamp forward end of locknut (3) in a vise and, using a suitable puller, withdraw reverse gear (17), collar (18) and output shaft rear bearing (19) as a unit. Clamp shaft coupling (51) in a vise and insert splined end of output shaft (12) in coupling as shown in Fig. Y1-30. Remove locknut (3—Fig. Y1-27). Note that shaft has left-hand threads. Using a suitable puller, remove forward gear (7), thrust washer (6) and bearing (5) as a unit. Withdraw pin (11). Carefully mark drive cone forward and reverse ends for proper assembly. Hold drive cone (13) in one hand and using a plastic hammer tap on splined end of output shaft (12) to remove drive cone (13) and inner bearing race (15).

To disassemble side cover first remove shift lever (31) then set screw (33), spring (34) and detent pin (35). Remove plug (40), spring (38) and pin (37). Pull shifter (44) from end of shift shaft (43) and push shift shaft out of side cover in direction of transmission mating surface. To remove bearing (42) from side cover (36), heat side cover to 100°C and drive bearing out using a suitable drift.

Carefully inspect all parts prior to assembly paying particular attention to the following items: Drive cone (13) contact faces must be 24.1-24.7 mm wide for KM2-A and 29.6-30.2 mm wide for

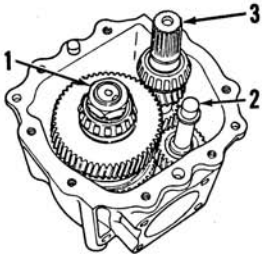


Fig. Y1-28—When disassembling KM2-A and KM3-A transmission first remove output shaft (1), then tap out intermediate shaft (2) followed by input shaft (3).

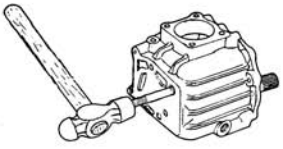


Fig. Y1-29—Using a bolt or other soft punch, drive intermediate shaft assembly out of case.

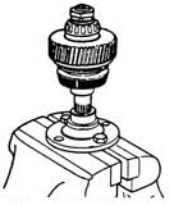


Fig. Y1-30—Use output shaft coupling as a holding fixture to aid in disassembly of output shaft.

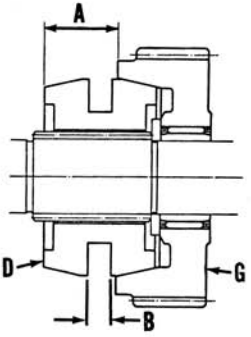


Fig. Y1-31—To measure drive cone (D) contact face wear, place forward/reverse gear (G) on appropriate contact face and measure distance (A). Shifter slot measurement is taken at point (B).

Illustration courtesy Yanmar

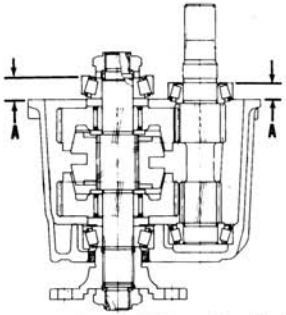


Fig. Y1-32—Measure (A) between top of front bearing races and case mating surface to determine shim thickness as outlined in text.

KM3-A when measured as shown in Fig. Y1-31. Drive cone slot width (B) must be 8.0-8.3 mm. Thickness of thrust washer (10—Fig. Y1-27) must not be less than 0.05 mm and thrust washer (14) should not be less than 0.20 mm thick. Width of shifter (44) should be 7.7-7.85 mm and shifter-shaft diameter is 9.95-10.015 mm.

After thorough inspection and cleaning of all parts assemble transmission in the following order: Clamp coupling (51) in a vise as previously outlined and insert splined end of output shaft (12) in coupling. Place thrust washer (10) on shaft with stepped side up, then using a suitable drift install bearing race (9). Install bearing (8) and forward gear (7) making sure gear rotates freely on shaft. Install thrust washer (6) and insert pin (11) in shaft, then drive bearing (5) cone into place. Install collar (4) so groove mates with pin (11). Install locknut (3) and tighten to 9.8-14.7 N·m. Note that nut has left hand threads and should be staked to output shaft. Reposition assembly so locknut (3) is clamped in a vise. Install drive cone (13) and thrust washer (14) so previously marked forward end of drive cone is down and stepped side of thrust washer is up. Drive bearing race (15) onto shaft. Install bearing (16) and reverse gear (17) so gear is free to rotate. Install thrust washer (18) and using a suitable bearing driver install bearing (19) cone. Install output shaft rear bearing race and oil seal (50) in case (49). Insert input shaft (23) assembly into case then tap intermediate shaft (25) assembly into place using a plastic hammer. Holding input shaft assembly back, insert output shaft assembly into case while meshing intermediate shaft gear and input shaft gears with forward and reverse gears on output shaft as output shaft assembly is lowered into place.

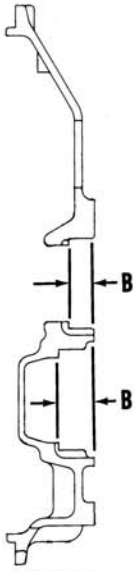


Fig. Y1-33—Measure (B) between bottom of front bearing race bores and mounting flange mating surface to determine shim thickness as outlined in text.

After output shaft assembly has been properly installed in case, position transmission assembly so open end of case is facing up and no pressure is being applied to splined end of output shaft. Install outer race on both input shaft and output shaft front bearings and measure distance (A—Fig. Y1-32) from case mating surface to top of bearing races. Record these "A" measurements for future reference. Next measure distance (B—Fig. Y1-33) from mounting flange mating surface to bottom of bearing race bore for both input and output shaft front bearings. Subtract "A" measurements from "B" measurements and record the difference in millimeters. Using the following calculation, install shims (21—Fig. Y1-27) to provide desired input shaft end play. Establish a shim height that is equal to or not more than 0.05 mm thinner than thickness indicated by difference between "A" and "B" measurements.

Input Shaft Example:

Dimension "B"	19.05 mm
Minus Dimension "A"	17.85 mm
Difference	1.20 mm
Minus desired end play	0.0-0.5 mm
Desired shim thickness	1.15-1.20 mm

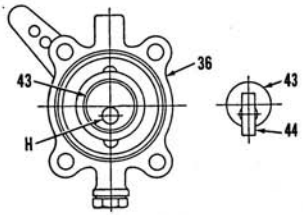


Fig. Y1-34—When installing shifter assembly be sure hole (H) in shifter shaft (43) is below shaft centerline before inserting shifter (44).

Using the following calculation, install shims (2—Fig. Y1-27) to provide desired preload of 0.0-0.1 mm on output shaft bearings.

Output Shaft Example:

Dimension "B"	18.05 mm
Minus Dimension "A"	16.93 mm
Difference	1.12 mm
Plus desired preload	0.0-0.10 mm
Desired shim thickness	1.12-1.22 mm

After correct shim thickness has been selected for each shaft, place shims in mounting flange and install bearing races. Install oil seal (20—Fig. Y1-27). Apply RTV sealer to mating surface of transmission case and mounting flange and install mounting flange (1) tightening bolts evenly. Invert transmission and install output shaft coupling (51). Install locknut (53) and tighten to 98.0-112.5 N·m. After tightening locknut stake it in place using a cold chisel and hammer.

Install bearing (42) and oil seal (32) in side cover (36) then push shaft (43) through cover from inside. Install pin (37), spring (38) and cap (40). Install pin (35), spring (34) and set screw (33) using RTV sealer on screw threads before in-

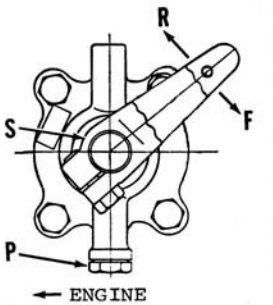


Fig. Y1-35—Install shifter assembly in case with plug (P) pointing down. Position shift lever (S) on shaft at a 45 degree angle checking that there is an equal amount of travel in both forward (F) and reverse (R) directions.

Illustration courtesy Yanmar

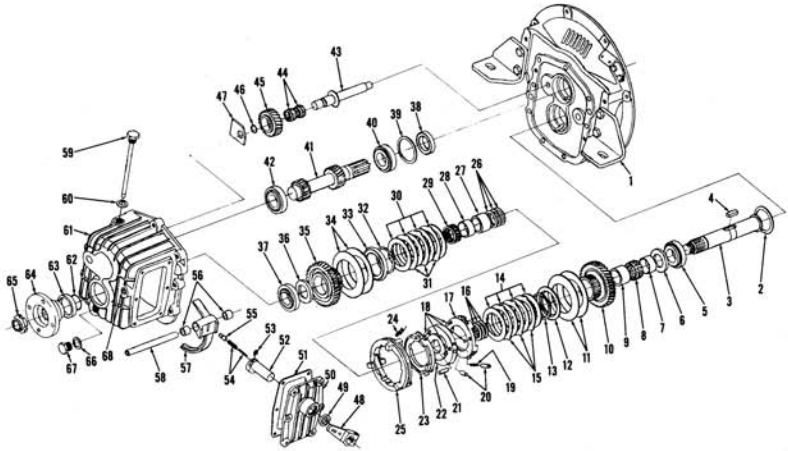


Fig. Y1-36—Exploded view of KBW-10 transmission.

1. Mounting plate
2. Shim
3. Output shaft
4. Key
5. Bearing
6. Thrust washer
7. Bearing inner race
8. Needle bearing
9. Spacer
10. Forward gear
11. Belleville springs
12. Spring retainer
13. Snap ring
14. Friction plates
15. Steel plates
16. Shims
17. Pressure plate
18. Steel balls
19. Spring
20. Detent pins
21. Alignment pins
22. Driving plate
23. Pressure plate
24. Return spring
25. Shift ring
26. Shims
27. Spacer
28. Bearing inner race
29. Needle bearing
30. Friction plates
31. Steel plates
32. Snap ring
33. Spring retainer
34. Belleville springs
35. Reverse gear
36. Thrust washer
37. Bearing
38. Oil seal
39. Shim
40. Bearing
41. Input shaft
42. Bearing
43. Intermediate shaft
44. Needle bearing
45. Idler gear
46. "O" ring
47. Thrust washer
48. Shift lever
49. Oil seal
50. Side cover
51. Gasket
52. Cam
53. Snap ring
54. Springs
55. Detent pin
56. Bushings
57. Shift fork
58. Shift bar
59. Dipstick
60. Gasket
61. Case
62. "O" ring
63. Oil seal
64. Coupling
65. Locknut
66. Gasket
67. Drain plug
68. Allen plug

stallation. To install side cover assembly center drive cone (13) between forward and reverse gears. Hold side cover so plug (40) is pointing down and shifter hole (H—Fig. Y1-34) is below centerline of shaft (43) as shown in Fig. Y1-34. Install shifter (44) and coat mating surface of side cover with RTV sealer, install side cover onto transmission being careful not to move drive cone off center. Install shift lever (31) on shaft (43) at an angle of 45 degrees as shown in Fig. Y1-35, leaving a 0.05 mm clearance between shift lever and side cover. When correctly installed shift lever will move the same distance off-center when engaging forward and reverse gears. If distance of travel is not equal, loosen side cover bolts slightly and move side cover assembly straight forward or straight backward to equalize lever travel.

Model KBW-10 Transmission

LUBRICATION. Transmission fluid should be changed after each 300 hours of operation or seasonally, whichever is more frequent. On a new or rebuilt transmission change fluid after first 100 hours of operation. Use of a good quality Dexron ATF is recommended. Fluid capacity of KBW-10 transmission is 0.7 liter. When checking fluid level with dipstick do not screw in the oil filler screw; it should rest on top of the oil filler hole. Oil level should be maintained between end of dipstick and groove on dipstick. Do not overfill transmission.

OVERHAUL. Disassemble transmission by removing locknut (65—Fig. Y1-36), coupling (64), seal (63) and "O" ring (62). Remove side cover (50) with shifter assembly intact. Remove shift bar plug (68) using an 8 mm Allen wrench, pull shift bar (58) out rear of case after installing a 10mm bolt in threaded end of shift bar, and lift out shift fork (57). Remove mounting flange (1) leaving alignment pins in mating surface of case (61). In the following order, lift output shaft assembly (3—Fig. Y1-37), intermediate shaft assembly (43) and input shaft assembly (41), from case (61), in that order. Using a suitable puller, remove outer races of input and output shaft rear bearings (37 and 42—Fig. Y1-36) from case (61). Using a suitable puller, remove outer races of input and output shaft front bearings (5 and 40) from mounting flange (1). Be careful not to intermix or lose input shaft adjusting shim (39) or output shaft adjusting shim (2). Remove front oil seal (38).

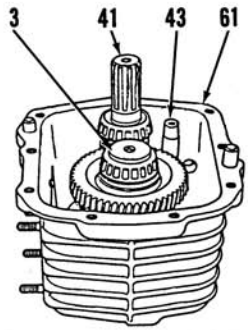


Fig. Y1-37—When disassembling KBW-10 transmission, first remove output shaft assembly (3) followed by intermediate shaft assembly (43) and input shaft assembly (41), in that order.

Using a suitable puller remove output shaft from forward and reverse gear assemblies as shown in Fig. Y1-38. When removing output shaft care should be taken that puller does not distort threads on end of output shaft. Make

Fig. Y1-38—Using a suitable puller, remove output shaft from forward and reverse gear assemblies as illustrated. Care should be taken to protect threaded end of output shaft.

sure forward gear parts and reverse gear parts are not mixed together. Remove spacer (9—Fig. Y1-36) and bearing race (7) from output shaft (3). Secure output shaft threaded end so threads are protected, and place outer race over bearing (5). Using a suitable bearing driver gently drive inner bearing race away from shaft collar approximately 10 mm. Place pulling support plate, Yanmar special tool 17099-09030, between collar of output shaft and bearing. Using Yanmar special tool 17095-09070, as shown in Fig. Y1-39, complete removal of output shaft from support bearing using a press or hammer.

Remove friction plates (14—Fig. Y1-36) and steel plates (15) from forward gear (10). Using Yanmar special tool 17095-09070, compress Belleville springs (11) and remove snap ring (13) from forward gear as shown in Fig. Y1-40. Disassemble reverse gear (35) in same manner and sequence as just described.

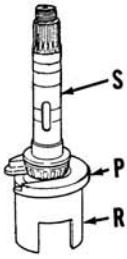


Fig. Y1-39—Following procedure given in text, install Yanmar 17099-09030 support plate (P) between output shaft (S) collar and rear bearing. Position 2 Yanmar special tool 17095-09070 (R) as a support and press output shaft out of rear bearing.

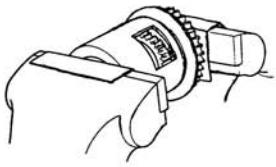


Fig. Y1-40—Illustration showing use of Yanmar special tool 17095-09070 to compress Belleville springs so snap ring may be detached.

Fig. Y1-41—Lay steel plates (S) flat and measure warp (A). Distance (A) should be 1.4-1.7 mm.

Lay shift ring and pressure plate assembly flat and remove pressure plate return springs (24—Fig. Y1-36), then lift off top pressure plate (17) and remove steel balls (18). Lift shift ring (25) and driving plate (22) off bottom pressure plate and remove three remaining steel balls. Slip shift ring (25) off driving plate (22), remove alignment pins (21) and detent pins (20) with springs (19) from driving plate (22).

To disassemble side cover and shifter assembly remove shift lever (48) then pull shift cam (52) out of cover from inside. Push detent pin (55) in so snap ring (53) can be removed through slot in top of cam (52). Remove detent pin (55) and detent pin springs (54). Remove oil seal (49) from side cover (50).

Thoroughly clean and inspect all parts prior to reassembly paying particular attention to the following items: When measured as shown in Fig. Y1-41 steel plate warp must fall between 1.4 and 1.7 mm. Measure width of steel plate (15 and 31—Fig. Y1-36) tangs and grooves in pressure plates (17 and 23); clearance should be 0-0.6 mm. Steel plate tang width should be 11.8-12.0 mm and pressure plate groove width should measure 12.0-12.1 mm.

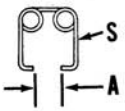


Fig. Y1-42—Pressure plate return spring (S) end gap (A) should be 17.0-17.5 mm.

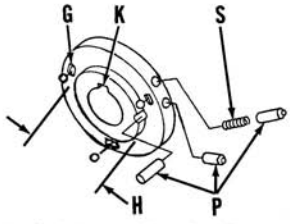


Fig. Y1-43—Inspect driving plate ball grooves (G), detent pins (P) and their bores, and keyway (K) for any noticeable wear. Driving plate hub outside diameter (H) should not be less than 58.8 mm. Detent pin spring (S) free length should be 32.0-32.85 mm.

Friction plate thickness should be 1.70-1.75 mm with a wear limit of 1.5 mm. Both sides of friction plates have a 0.35 mm copper sintered layer. Renew friction plates when copper layer is worn more than 0.2 mm on one side. Sum of wear of four friction plates (forward or reverse) must not exceed 0.8 mm. When wear exceeds 0.8 mm all friction plates (forward or reverse) must be renewed. Assembled thickness of each set of steel and friction plates must exceed 10.0 mm after enough pressure has been applied to remove steel plate warp. Friction plate to gear spline backlash must not exceed 0.9 mm.

Inspect pressure plate (17 and 23—Fig. Y1-36) ball grooves for wear and renew plate if wear is noticeable. Friction plate contact surface thickness should measure 6.3-6.6 mm. Return spring end gap (A—Fig. Y1-42) must be 17.0-17.5 mm.

Check driving plate ball grooves (G—Fig. Y1-43), detent pin bores, detent pins (P) and keyway (K) for any noticeable wear. Driving plate hub outside diameter (H) should not be less than 58.8 mm. Detent pin spring (S) free length should be 32.0-32.85 mm.

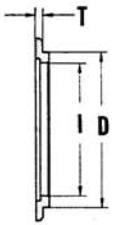


Fig. Y1-44—Plate spring retainer thickness (T) should measure 2.6-2.8 mm, inside diameter (I) should be 57.6-57.8 mm and retainer hub outside diameter (D) must measure 65.7-66.0 mm.

Illustration courtesy Yanmar

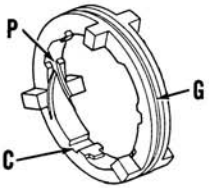


Fig. Y1-45—Inspect shift ring pressure plate grooves (P) and pin contact grooves (C) for any signs of excessive wear. Width of circumferential groove (G) must measure 6.0-6.3 mm.

Plate spring retainer (12 and 33—Fig. Y1-36) thickness (T—Fig. Y1-44) should measure 2.6-2.8 mm. Inside diameter (I) should be 57.6-57.8 mm and retainer hub outside diameter (D) must measure 65.7-66.0 mm. Belleville spring (11 and 34—Fig. Y1-36) free width should be 6.0-6.35 mm.

Inspect shift ring pressure plate grooves (P—Fig. Y1-45) and pin contact grooves (C) for any signs of excessive wear. Circumferential groove (G) width must measure 6.0-6.3 mm.

Shift ring contact surface of shift fork (57—Fig. Y1-36) is plated with molybdenum. Renew shift fork if plating is peeled or shift fork base metal is exposed.

To reassemble transmission install Belleville springs (11—Fig. Y1-36) on forward gear (10) so concave sides are facing each other as shown in Fig. Y1-46. Position retainer (12—Fig. Y1-36) over Belleville springs and slide snap ring (13) onto spline of forward gear. Using Yanmar special tool 177095-09070, compress forward gear assembly in a vise and engage snap ring (13) in groove around forward gear splines. Reassemble reverse gear (35), Belleville springs (34), retainer (33) and snap ring (32) in same manner as forward gear.

To determine correct thickness of shims (16 and 26), install inner bearing race (7 and 28) and spacer (9 and 27) in

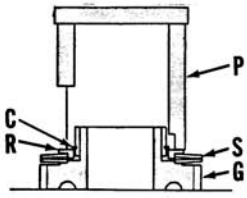


Fig. Y1-46—Concave sides of Belleville springs (S) must face each other. Use Yanmar special tool 177095-09070 to compress springs (S) and retainer (R) so snap ring (C) can be installed in groove of gear.

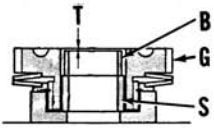


Fig. Y1-47—After installing spacer (S) and inner bearing race (B) into forward or reverse gear (G), measure distance (T) to determine correct shim thickness as outlined in text.

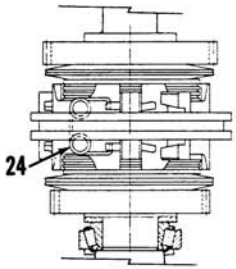


Fig. Y1-48—Attach ends of return springs (24) to holes in pressure plates.

their respective gears (10 and 35). Measure depth (T—Fig. Y1-47) of bearing race from end of gear as shown in Fig. Y1-47. Install shims equal to measure depth.

Alternately install four friction plates (14—Fig. Y1-36) and three steel plates (15) on forward gear (10) splines starting with a friction plate. Assemble reverse gear (35), steel plates (31) and friction plates (30) in same order as forward gear.

Using a suitable bearing driver install output shaft front bearing (5) on output shaft (3) making sure bearing inner race contacts collar on end of output shaft. Install thrust washer (6) on output shaft with sintered copper surface facing away from bearing (5). Using a suitable bearing driver install needle bearing inner race (7) on output shaft making sure race bottoms on thrust washer (6). Install needle bearing (8), spacer (9) and shim (16) on output shaft. Install forward gear assembly on output shaft and align steel plate tangs. Fit key (4) into slot on output shaft so fillet side of key is facing threaded end of output shaft. Install pressure plate (17), with ball slots facing up, so steel plate tangs fit into three slots of pressure plate; be sure pawls of all three steel plates are engaged by pressure plate (17). Install three steel balls into slots on pressure plate then install drive plate (22) on output shaft so side of drive plate with concentric groove is facing forward gear assembly. Be sure all three steel balls remain in place and grooves of pressure plate and drive plate match as drive plate is installed. Insert both locating pins (21) into drive plate so they engage torque limiter slots of pressure plate (17). Install shim (26), spacer (27) and inner needle bearing race (28) on output shaft using a suitable bearing driver. Insert detent pins (20) and springs (19) into drive plate (22), then install shift ring (25) over drive plate so three legs with grooves are facing forward gear and detent pins in drive plate properly engage pin slots of inside diameter of shift ring. Install three steel balls in slots of drive plate (22) and place pressure plate (23)

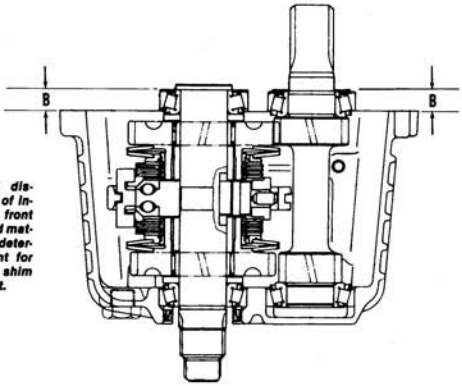


Fig. Y1-49—Measure distance (B) between top of input and output shaft front bearing outer races and mating surface of case to determine "B" measurement for establishing correct shim thickness. See text.

Illustration courtesy Yanmar

over drive plate making sure steel balls remain in position and slots of both plates match. Install pressure plate return springs (24) between shift ring (25) and drive plate (22), and attach spring ends to small holes in side of pressure plates as shown in Fig. Y1-48. Install reverse gear assembly so tangs of all three steel plates properly engage slots in pressure plate (23). Install needle bearing (29) and thrust washer (36) with copper sintered side of thrust washer facing reverse gear. Using a suitable bearing driver install output shaft rear bearing (37) making sure bearing inner race bottoms on thrust washer (36). Check for smooth rotation of both forward and reverse gears and correct operation of shift ring.

Install intermediate shaft assembly in case with beveled edge of thrust washer (47) in the 10 o'clock position as viewed from front of case. Check that idler gear (45) rotates freely on intermediate shaft (43).

To determine the correct thickness for input and output shaft adjusting shims (2 and 39 – Fig. Y1-36), first install input and output shaft rear bearing outer races in case, making sure race is bottomed in case bore. Install output and input shaft assemblies, in that order, in case checking that all gears are properly meshed and shifter ring is in neutral. Support case so no pressure is being applied to output shaft and install input and output shaft front bearing outer races on their respective bearings. Measure the distance from the top of each front bearing outer race to the mating surface of the case as shown in Fig. Y1-49; record this distance as a "B" measurement for future use. Next measure the depth of each front bearing outer race bore in the mounting flange as shown in Fig. Y1-50 and record this as an "A" measurement. Input shaft assembly requires a clearance of 0.0-0.05 mm. To determine thickness of shim (39 – Fig. Y1-36), subtract the "B" input shaft measurement from the "A" mounting flange measurement and adjust shim (39) accordingly to provide the specified clearance.

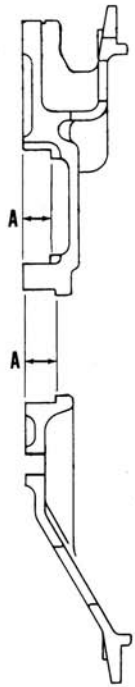


Fig. Y1-50 – Measure distance (A) from mounting flange mating surface to bottom of input and output shaft front bearing outer race bores to determine "A" measurement for establishing correct shim thickness. See text.

Input Shaft Example:

"A" measurement	31.5 mm
Minus "B" measurement	30.3 mm
Difference	1.2 mm
Minus required clearance	0.0-0.05 mm
Required shim thickness	1.2-1.15 mm

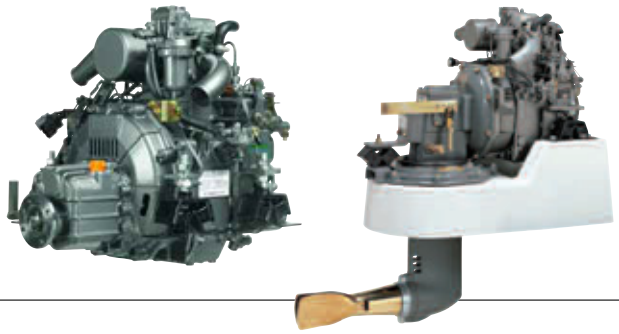
Output shaft requires a bearing clearance of 0.0-0.1 mm, determine correct shim thickness in the same manner used for input shaft.

Output Shaft Example:

"A" measurement	39.3 mm
Minus "B" measurement	38.1 mm
Difference	1.2 mm
Minus required clearance	0.0-0.1 mm
Required shim thickness	1.2-1.1 mm

Install correct input and output shaft front bearing shims in their respective mounting flange bores and using a suitable bearing race driver install outer front bearing races in mounting flange. Install input shaft oil seal (38 – Fig. Y1-36). Coat case mating surface with RTV sealer, install mounting flange and tighten bolts evenly. Place shift ring in neutral position and install shift fork (57) through side cover opening. Insert shift bar (58) through hole in rear of case while installing shift fork (57), then install shift bar plug (68). Be sure threaded end of shift bar is installed towards rear of case. Insert springs (54) and detent pin (55) into cam (52), and secure in place with snap ring (53). Install oil seal (49) in side cover (50) then insert shift cam assembly through side cover and secure in place with shift lever (48). Install side cover and tighten bolts evenly. Check operation of transmission, if lever operates normally a click will be heard when it is put into forward and reverse.

Install "O" ring (62) on output shaft and oil seal (63) into case. Install coupling (64) on output shaft and tighten locknut (65) to 93.1 N·m. Install drain plug and dipstick, fill unit with the previously specified quantity of transmission fluid.



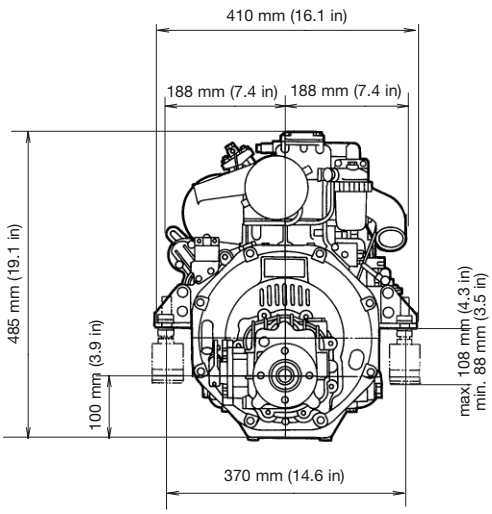
Yanmar type 1GM10
The Powerful Gem

Configuration	4-stroke, vertical, raw water cooled diesel engine
Maximum output at crankshaft	* 6.7 kW (9 hp) / 3600 rpm ** 6.6 kW (9 hp) / 3600 rpm
Continuous rating output at crankshaft	5.9 kW (8 hp) / 3400 rpm
Displacement	0.318 L (19.41 cu in)
Bore x stroke	75 mm x 72 mm (2.95 in x 2.83 in)
Cylinders	1
Combustion system	Indirect injection (special swirl type pre-combustion chamber)
Aspiration	Natural aspiration
Starting system	Electric starting 12 V - 1.0 kW with manual combination
Alternator	12 V – 35 A
Cooling system	Direct seawater cooling by rubber impeller seawater pump
Lubrication system	Enclosed, forced lubricating system
Direction of rotation (crankshaft)	Counter clockwise viewed from stern
Dry weight without gear	71 kg (156.5 lbs)
Environmental	EPA II, BSO II and SAV compliant
Engine mounting	Rubber type flexible mounting

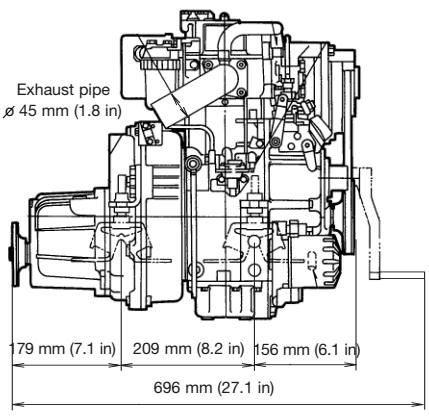
NOTE: Fuel condition: Density at 15°C = 0.842 g/cm³; 1 hp = 0.7355 kW
* Fuel temperature 25°C at the inlet of the fuel injection pump (ISO 3046-1)
** Fuel temperature 40°C at the inlet of the fuel injection pump (ISO 8665)

Dimensions (For detailed line-drawings, please refer to our web-site: www.yanmarmarine.com)

Rear view



Right side view

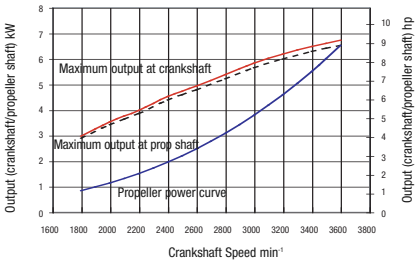


1GM10 w/
KM2P-1 marine gear

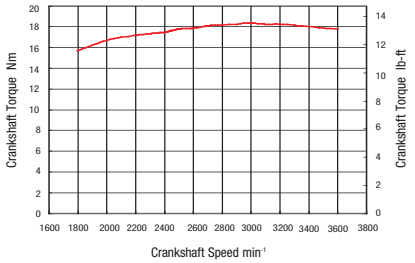
YANMAR marine™

Performance Curves (Output is according ISO 8665 - Output includes +/- 3% tolerance)

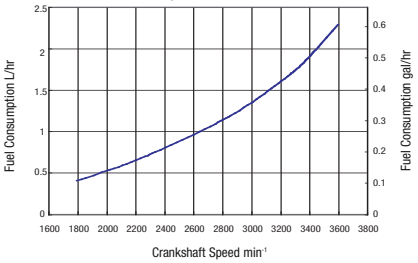
Power



Torque



Fuel Consumption

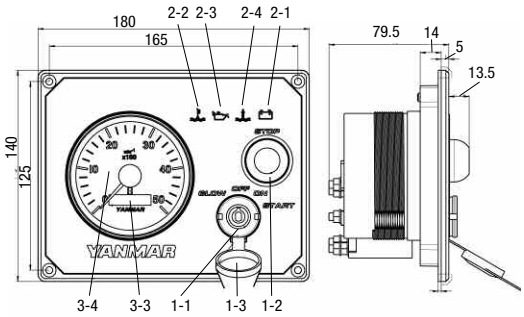


Marine Gears/Drive

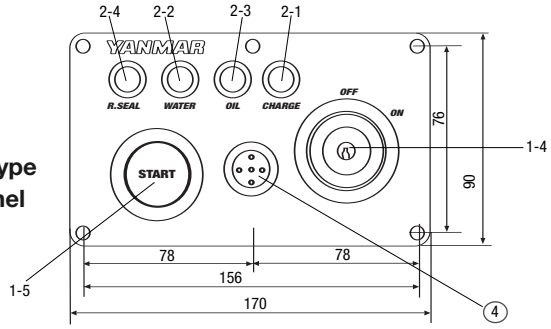
Model	KM2P-1			KM3V (V-drive)			Saildrive (SD20)
Type	Constant mesh gear with servo-cone clutch			Constant mesh gear with servo-cone clutch			Constant mesh gear with dog clutch
Dry weight	10 kg (24 lbs)			19 kg (42 lbs)			30 kg (66 lbs)
Reduction ratio (fwd/asn)	2.21/3.06	2.62/3.06	3.22/3.06	2.36/3.16	2.61/3.16	3.20/3.16	2.64/2.64
Propeller speed (fwd/asn)	1540	1298	1055	1441	1303	1063	1321
Direction of rotation (propeller shaft - fwd)	Clockwise viewed from stern			Clockwise viewed from stern			Counter clockwise viewed from stern
Dry weight engine and gear/drive	81 kg (179 lbs)			90 kg (198 lbs)			104 kg (229 lbs)
Length engine and gear/drive	554 mm (22 in)			680 mm (27 in)			723 mm (29 in)

Instrument Panels

Digital B-type Panel



A-type Panel



Function	Type of instrument panel	
	Digital B-type Panel	A-type Panel
① **Switch unit**		
1-1 Key switch for GLOW/OFF/ON/START (4-position switch)	O	X
1-2 Push button switch for engine stop	O	X
1-3 Moisture cap for key switch	O	X
1-4 Key switch for ON/OFF (2-position switch)	X	O
1-5 Push button switch for engine start	X	O
② **Alarm lamp unit**		
2-1 Battery low charge alarm	O	O
2-2 Coolant high temperature alarm	O	O
2-3 Lubricating oil low pressure	O	O
2-4 Water in sail drive seal alarm	O	O
2-5 Water in fuel filter alarm	X	X
2-6 Sea water insufficient flow alarm	X	X
③ **Meters**		
3-1 Lubricating oil pressure meter	X	X
3-2 Coolant temperature meter	X	X
3-3 Hour meter	O	X
3-4 Tachometer	O	X
④ **Audible alarm buzzer**	O	O

Note: O = Equipped on panel X = Not equipped on panel

Accessories

Standard Package

- Sensor for intrument panel
- Rubber type flexible mounting
- Exhaust/water mixing elbow (L-type)
- Alternator 35 A

Optional

- A-panel
- B-panel
- New B-panel
- Digital B-panel
- Various extension wire harnesses
- Various couplings (straights, tapers, slits)