G GENERAL

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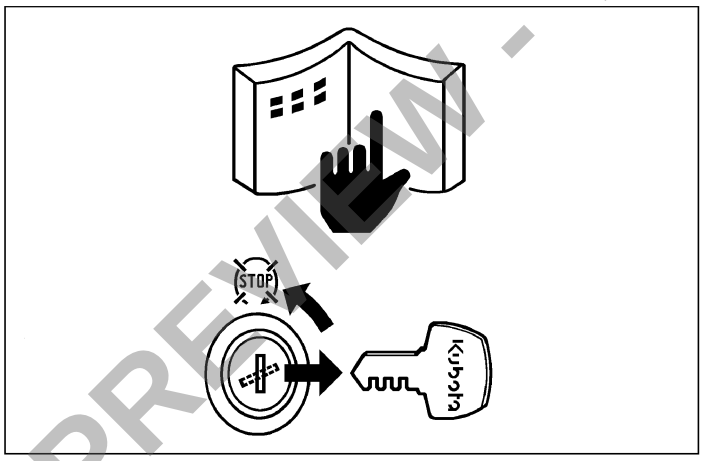
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⚠ SAFETY FIRST

This symbol, the industry's "Safety Alert Symbol", is used throughout this manual and on labels on the machine itself to warn of the possibility of personal injury. Read these instructions carefully.

It is essential that you read the instructions and safety regulations before you attempt to repair or use this unit.

⚠ **DANGER**	**: Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.**
⚠ **WARNING**	**: Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.**
⚠ **CAUTION**	**: Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.**
■ **IMPORTANT**	**: Indicates that equipment or property damage could result if instructions are not followed.**
■ **NOTE**	**: Gives helpful information.**

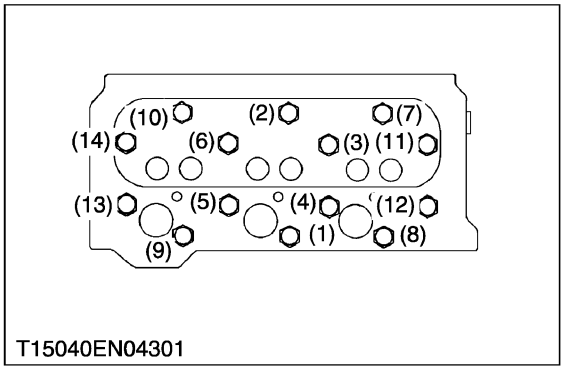


BEFORE SERVICING AND REPAIRING

- Read all instructions and safety instructions in this manual and on your generator safety decals.
- Clean the work area and generator.
- Park the machine on a firm and level ground, and set the parking brake.
- Lower the implement to the ground.
- Stop the engine, and remove the key.
- Disconnect the battery negative cable.
- Hang a "**DO NOT OPERATE**" tag in operator station.

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T15040EN04301

Cylinder Head

1. Loosen the pipe clamp, and remove the water return pipe.
2. Remove the cylinder head bolt in the order of (14) to (1).
3. Lift up the cylinder head to detach.
4. Remove the cylinder head gasket and O-ring.

(When reassembling)

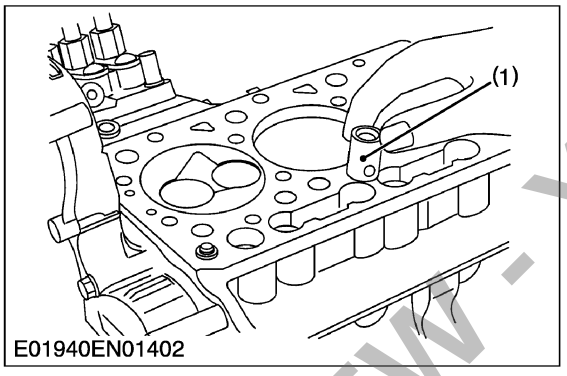
- Replace the cylinder head gasket with a new one.
- Securely fit the O-ring to the pipe pin.
- Tighten the cylinder head screws after applying sufficient oil.
- Tighten the cylinder head screws in diagonal sequence starting from the center. (Refer to figure left.)
- Tighten them uniformly, or the cylinder head may deform in the long run.
- Retighten the cylinder head screws after running the engine for 30 minutes.

■ **NOTE**

- **To Loosen : 14 to 1**
- **To Tighten : 1 to 14**

Tightening torque	Cylinder head screw	D722 D782	37.2 to 42.1 N·m 3.8 to 4.3 kgf·m 28.0 to 31.7 ft-lbs
		D1105	63.7 to 68.6 N·m 6.5 to 7.0 kgf·m 47.0 to 50.6 ft-lbs

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E01940EN01402

Tappets

1. Remove the tappets (1) from the crankcase.

(When reassembling)

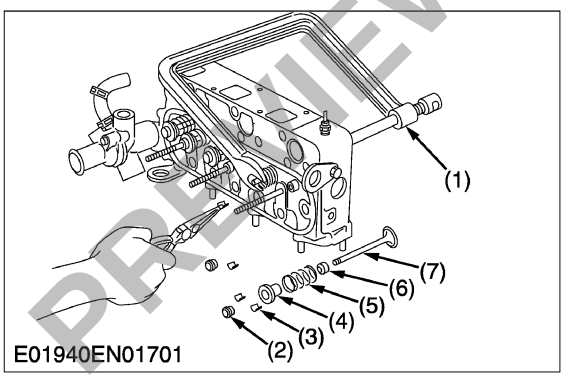
- Before installing the tappets, apply engine oil thinly around them.

■ **IMPORTANT**

- **Mark the cylinder number to the tappets to prevent interchanging.**

(1) Tappet

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E01940EN01701

Valves

1. Remove the valve caps (2).
2. Remove the valve spring collet (3), pushing the valve spring retainer (4) by valve spring replacer (1).
3. Remove the valve spring retainer (4), valve spring (5) and valve stem seal (6).
4. Remove the valve (7).

(When reassembling)

- Wash the valve stem and valve guide hole, and apply engine oil sufficiently.
- After installing the valve spring collets, lightly tap the stem to assure proper fit with a plastic hammer.

■ **IMPORTANT**

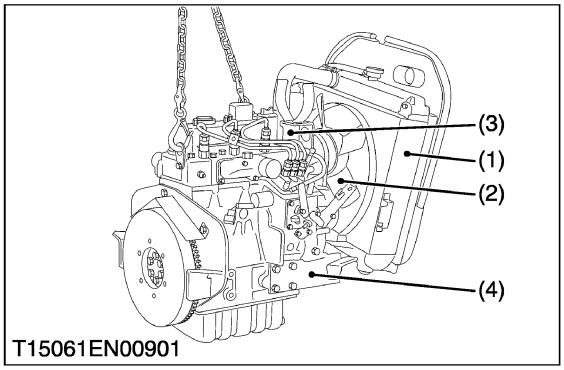
- **Don't change the combination of valve and valve guide.**

(1) Valve Spring Replacer
(2) Valve Cap
(3) Valve Spring Collet
(4) Valve Spring Retainer
(5) Valve Spring
(6) Valve Stem Seal
(7) Valve

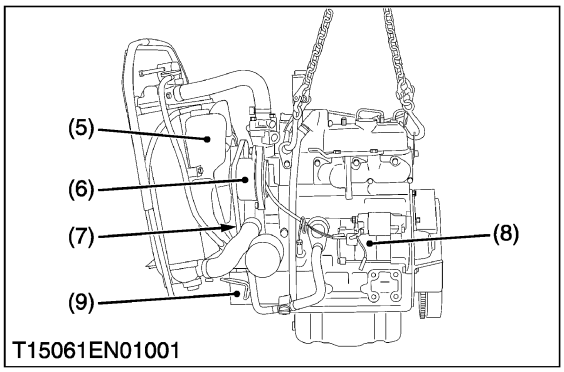
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T15061EN00901



T15061EN01001

Dynamo, Fan Belt and Muffler

1. Disconnect the radiator hoses and separate the radiator (1) with recovery tank (5) from engine assembly.
2. Remove the cooling fan (2) and fan pulley.
3. Remove the dynamo (6) and fan belt (7).
4. Remove the starter (8).
5. Remove the air cleaner stay (3).
6. Remove the wire bracket.
7. Remove the engine support LH (9) and RH (4).

(When reassembling)

- Check to see that there are no cracks on the belt surface.

■ **IMPORTANT**

- **After reassembling the fan belt, be sure to adjust the fan belt tension.**

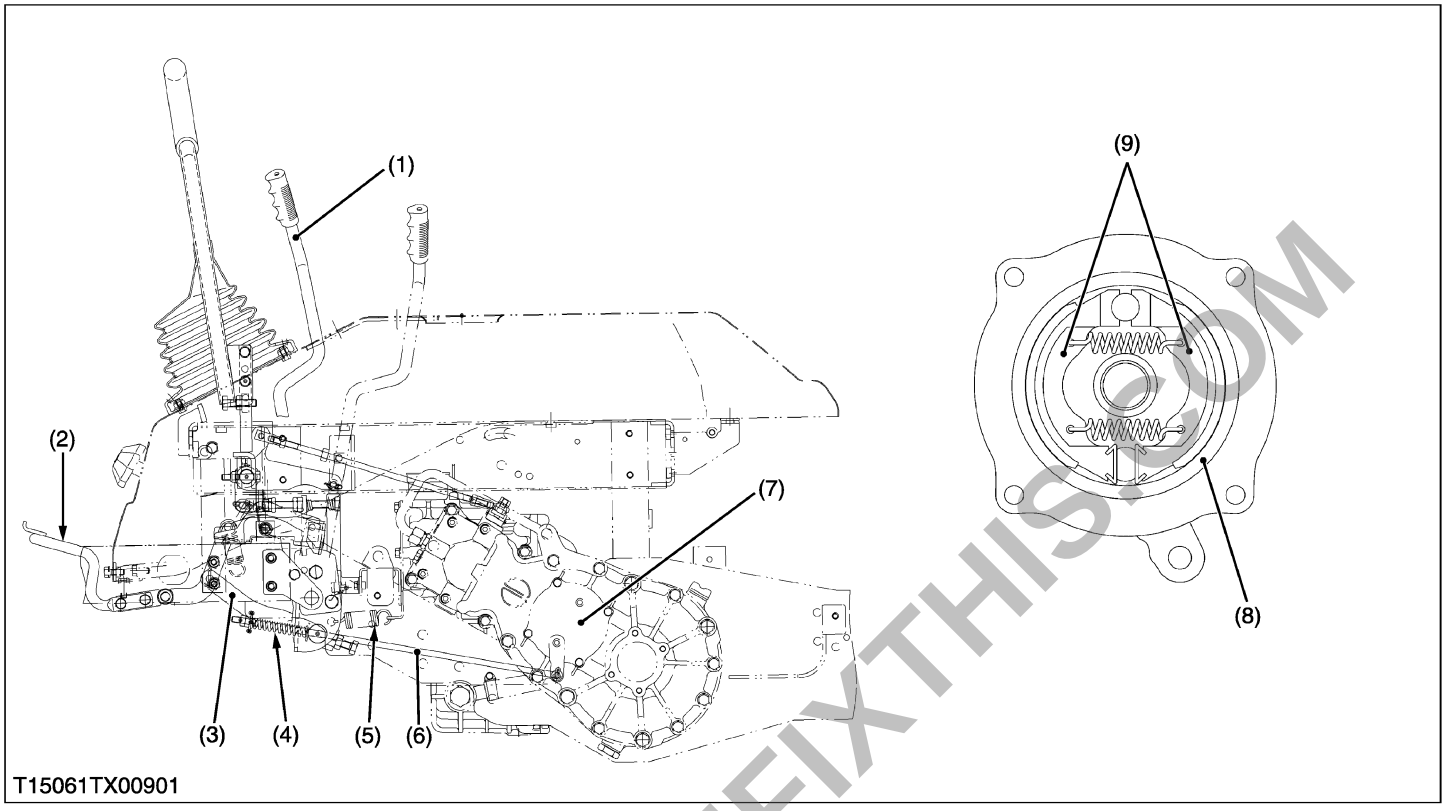
Tightening torque	Engine support mounting screw	48.1 to 55.9 N·m 4.9 to 5.7 kgf·m 35.4 to 41.2 ft-lbs

(1) Radiator
(2) Cooling Fan
(3) Air Cleaner Stay
(4) Engine Support RH
(5) Recovery Tank
(6) Dynamo
(7) Fan Belt
(8) Starter
(9) Engine Support LH

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(B) Parking Brake



(1) Parking Brake Lever
(2) Parking Brake Lock Pedal
(3) Brake Plate
(4) Parking Brake Spring
(5) Return Spring
(6) Parking Brake Rod
(7) Brake Assembly
(8) Brake Drum
(9) Brake Shoe

The parking brake is composed of parking brake lever (1), parking brake lock pedal (2), brake plate (3), parking brake rod (6) and brake assembly (7). The brake is mechanical internal-expansion type with leading-trailing brake shoes (9).

As the parking brake lock pedal (2) is pressed and the parking brake lever (1) is lifted up, the brake will be applied and locked.

When the parking brake is released, the brake can be released if the parking brake lever is pulled back.

To prevent the brake from dragging when the parking brake is applied, this machine is designed so that the engine may stop if the parking brake lever (1) is not released within few seconds after the engine is started.

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6. MAINTENANCE CHECK LIST

No.	Items \ Period		Indication on hour meter						After purchase		Important	Reference page
			50	50	100	150	200	400	1 year	2 years		
1	Engine oil	Change	★				☆					G-16
2	Engine oil filter	Replace	★				☆					G-17
3	Transmission fluid	Change					★	☆				G-19
4	Transmission oil filter	Replace	★				☆					G-17
5	Transmission strainer	Clean					★	☆				G-19
6	Rear axle gear case (RH & LH) fluid	Change					★	☆				G-20
7	Front axle pivot	Adjust			★		☆					G-18
8	Safety device	Check	☆									G-21
9	Greasing (without mower)	–	☆									G-23
10	Mower gear box oil	Check	☆									G-25
		Change				☆						G-30
11	Air cleaner element	Clean	☆								*1	G-25
		Replace							☆		*2	G-32
12	Battery condition	Check		☆								G-25
13	Fan belt	Adjust		☆								G-27
14	Parking brake	Adjust		☆								G-28
15	Fuel filter element	Check		☆								G-27
		Replace						☆				G-32
16	Fuel line	Check		☆								G-27
		Replace								☆		G-35
17	Radiator hose and clamp	Check					☆					G-30
		Replace								☆		G-35
18	Hydraulic hose	Check					☆					G-30
		Replace								☆		G-35
19	Intake air line	Check					☆					G-31
		Replace								☆		G-35
20	Motion control lever pivot	Adjust					☆					G-31
21	Radiator	Clean							☆			G-33
22	Coolant	Change							☆			G-33
23	Mower gear box oil seal	Replace								☆		G-35
24	Fuel system	Bleed	Service as required									G-37
25	Fuse	Replace										G-36
26	Blade	Replace										G-37
27	Mower belt	Replace										G-37

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■ **IMPORTANT**

- **The jobs indicated by ★ must be done initially.**

***1 Air cleaner should be cleaned more often in dusty conditions than in normal conditions.**

***2 Every year or every 6 times of cleaning.**

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TRAVELLING GEAR SHIFT SECTION

Symptom	Probable Cause	Solution	Reference Page
Noise from Transmission	• Transmission oil insufficient • Gear worn or broken • Bearings worn	Refill Replace Replace	– – 2-S24

W1014322

PTO SECTION

PTO Clutch Slip	• Operating pressure is low • PTO clutch valve malfunctioning • Clutch disc or drive plate excessively worn	Check Repair or replace Replace	– 2-S18 2-S19
PTO Shaft Does Not Rotate	• PTO clutch malfunctioning	Repair or replace	2-S18
PTO Clutch Operating Pressure Is Low	• Transmission oil improper or insufficient • Regulator valve malfunctioning	Replenish or change Check or replace	2-S11 2-S20
PTO Clutch Drags	• Brake plate excessively worn • Clutch spring weaken or broken • Deformation of pressure plate or steel plate	Replace Replace Replace	2-S19 2-S19 2-S19

W1011614

PARKING BRAKE SECTION

Brake Drags	• Brake spring play too small • Brake return spring weaken or broken	Adjust Replace	G-28 –
Poor Braking Force	• Brake spring play excessive • Brake shoe worn • Grease or oil on brake shoe	Adjust Replace Replace	G-28 2-S21 2-S21

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SPECIFICATIONS

Model		ZD18	ZD21	ZD28
Maximum gross power		13.4 kW (18 HP)*1	15.7 kW (21 HP)*1	20.9 kW (28 HP)*1
Engine	Model	D722-E-XFM5	D782-E-XFM5	D1105-E-ZD
	Type	Indirect injection, vertical, water cooled, 4-cycle diesel engine		
	Number of cylinders	3		
	Bore and stroke	67.0 × 68.0 mm (2.64 × 2.68 in.)	67.0 × 73.6 mm (2.64 × 2.90 in.)	78.0 × 78.4 mm (3.07 × 3.09 in.)
	Total displacement	719 cm^3 (43.9 cu.in.)	778 cm^3 (47.5 cu.in.)	1123 cm^3 (68.5 cu.in.)
	Rated revolution	3200 rpm		3000 rpm
	Combustion chamber	Spherical type (E-TVCS)		
	Fuel injection pump	Bosch MD type mini pump		
	Governor	Centrifugal ball mechanical governor		
	Injection nozzle	Bosch throttle type		Throttle type
	Injection timing	0.33 to 0.37 rad. (19° to 21°) before T.D.C.		
	Injection order	1-2-3		
	Injection pressure	13.73 MPa (140 kgf/cm^2, 1990 psi)		
	Lubricating system	Forced lubrication by gear pump		
	Cooling system	Pressurized radiator, forced circulation with water pump		
	Lubricating oil	API Service classification CC or CD, Below 0 °C (32 °F) : SAE 10W or 10W-30, 0 to 25 °C (32 °F to 77 ° F) : SAE 20 or 10W-30, Above 25 °C (77 °F) : SAE 30 or 10W-30		
	Starting system	Electric starter (12 V, 1.1 kW)		
	Battery	51 R (12 V, 450 CCA)		
	Fuel	No. 2-D Diesel fuel (ASTM D975) [No. 1-D diesel fuel, if temperature is below – 10 °C (14 °F)]		
Capacities	Fuel tank	30 L (5.8 U.S.gals., 4.8 Imp.gals.)		
	Engine crankcase	3.2 L (3.4 U.S.qts., 2.8 Imp.qts.)	3.5 L (3.7 U.S.qts., 3.1 Imp.qts.)	3.4 L (3.6 U.S.qts., 3.0 Imp.qts.)
	Engine coolant	2.6 L (2.7 U.S.qts., 2.3 Imp.qts.)		3.8 L (4.0 U.S.qts., 3.3 Imp.qts.)
	Recovery tank	0.25 L (0.26 U.S.qts., 0.22 Imp.qts.)		
	Transmission (Including HST and cylinder)	4.0 L (4.2 U.S.qts., 3.5 Imp.qts.)*2		
	Rear axle gear case	1.8 L (1.9 U.S.qts., 1.6 Imp.qts.)*2 each		
	Mower gear case oil	0.40 L (0.42 U.S.qts., 0.35 Imp.qts.)		
Tires	Front	15 × 6.0-6 (4PR) Rib		
	Rear	23 × 10.5-12 (4PR) Turf	24 × 12.0-12 (4PR) Turf	
Travelling speeds	Forward	0 to 14.5 km/h (0 to 9.0 mph)*3	0 to 15.0 km/h (0 to 9.3 mph)*3	0 to 15.0 km/h (0 to 9.3 mph)*4
	Reverse	0 to 8.0 km/h (0 to 5.0 mph)*3	0 to 8.3 km/h (0 to 5.2 mph)*3	0 to 8.3 km/h (0 to 5.2 mph)*4

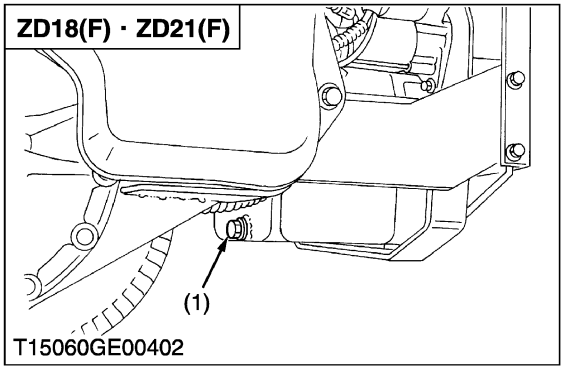
NOTE: *1 Manufacturer's estimate
*2 Oil amount when the oil level is at the upper level.
*3 At 3200 engine rpm
*4 At 3000 engine rpm

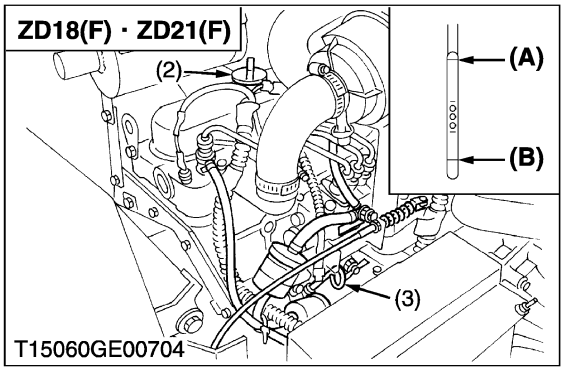
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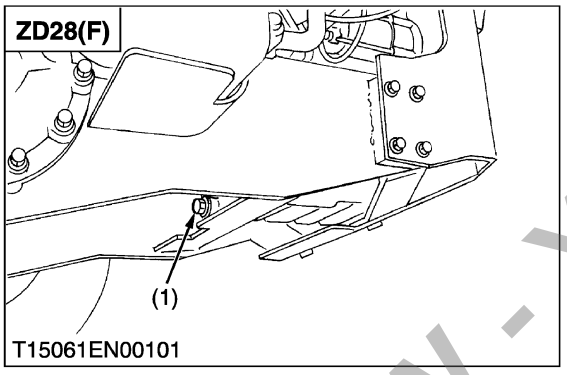
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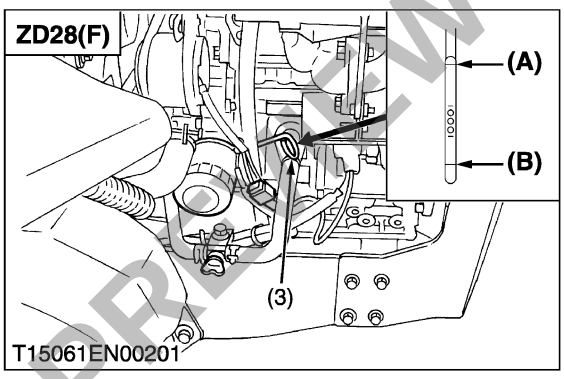
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[2] CHECK POINTS OF INITIAL 50 HOURS









Changing Engine Oil

CAUTION

- **Be sure to stop the engine before changing oil.**

1. Start and warm up the engine for approx. 5 minutes.
2. Place an oil pan underneath the engine.
3. To drain the used oil, remove the drain plug (1) at the bottom of the engine and drain the oil completely.
4. Screw in the drain plug (1).
5. Fill new oil up to upper line on the dipstick (3).

■ **IMPORTANT**

- **When using an oil of different manufacture or viscosity from the previous one, remove all of the old oil.**
- **Never mix two different type of oil.**
- **Use the proper SAE engine oil according to ambient temperatures.**
  Refer to "LUBRICANTS, FUEL AND COOLANT".
  (See page G-7.)

Engine oil capacity	ZD18(F)	3.2 L 3.4 U.S.qts. 2.8 Imp.qts.
	ZD21(F)	3.5 L 3.7 U.S.qts. 3.1 Imp.qts.
	ZD28(F)	3.4 L 3.6 U.S.qts. 3.0 Imp.qts.

(1) Drain Plug
(2) Oil Inlet Plug
(3) Dipstick

(A) Upper Level
(B) Lower Level

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5. TIGHTENING TORQUES

[1] GENERAL USE SCREWS, BOLTS AND NUTS

Screws, bolts, and nuts whose tightening torques are not specified in this Workshop Manual should be tightened according to the table below.

Indication on top of bolt	⬡ 4 No-grade or 4T						⬡ 7 7T						⬡ 9 9T		
Material of bolt	SS400, S20C						S43C, S48C						SCr435, SCM435		
Material of opponent part	Ordinariness			Aluminum			Ordinariness			Aluminum			Ordinariness		
Unit / Diameter	N·m	kgf·m	ft-lbs	N·m	kgf·m	ft-lbs	N·m	kgf·m	ft-lbs	N·m	kgf·m	ft-lbs	N·m	kgf·m	ft-lbs
M6 (6 mm, 0.24 in.)	7.85 to 9.31	0.80 to 0.95	5.79 to 6.87	7.85 to 8.82	0.80 to 0.90	5.79 to 6.50	9.81 to 11.2	1.00 to 1.15	7.24 to 8.31	7.85 to 8.82	0.80 to 0.90	5.79 to 6.50	12.3 to 14.2	1.25 to 1.45	9.05 to 10.4
M8 (8 mm, 0.31 in.)	17.7 to 20.5	1.8 to 2.1	13.1 to 15.1	16.7 to 19.6	1.7 to 2.0	12.3 to 14.4	23.6 to 27.4	2.4 to 2.8	17.4 to 20.2	17.7 to 20.5	1.8 to 2.1	13.1 to 15.1	29.5 to 34.3	3.0 to 3.5	21.7 to 25.3
M10 (10 mm, 0.39 in.)	39.3 to 45.1	4.0 to 4.6	29.0 to 33.2	31.4 to 34.3	3.2 to 3.5	23.2 to 25.3	48.1 to 55.8	4.9 to 5.7	35.5 to 41.2	39.3 to 44.1	4.0 to 4.5	29.0 to 32.5	60.9 to 70.6	6.2 to 7.2	44.9 to 52.0
M12 (12 mm, 0.47 in.)	62.8 to 72.5	6.4 to 7.4	46.3 to 53.5	–	–	–	77.5 to 90.2	7.9 to 9.2	57.2 to 66.5	62.8 to 72.5	6.4 to 7.4	46.3 to 53.5	103 to 117	10.5 to 12.0	76.0 to 86.7
M14 (14 mm, 0.55 in.)	108 to 125	11.0 to 12.8	79.6 to 92.5	–	–	–	124 to 147	12.6 to 15.0	91.2 to 108	–	–	–	167 to 196	17.0 to 20.0	123 to 144
M16 (16 mm, 0.63 in.)	167 to 191	17.0 to 19.5	123 to 141	–	–	–	197 to 225	20.0 to 23.0	145 to 166	–	–	–	260 to 304	26.5 to 31.0	192 to 224
M18 (18 mm, 0.71 in.)	246 to 284	25.0 to 29.0	181 to 209	–	–	–	275 to 318	28.0 to 32.5	203 to 235	–	–	–	344 to 402	35.0 to 41.0	254 to 296
M20 (20 mm, 0.79 in.)	334 to 392	34.0 to 40.0	246 to 289	–	–	–	368 to 431	37.5 to 44.0	272 to 318	–	–	–	491 to 568	50.0 to 58.0	362 to 419

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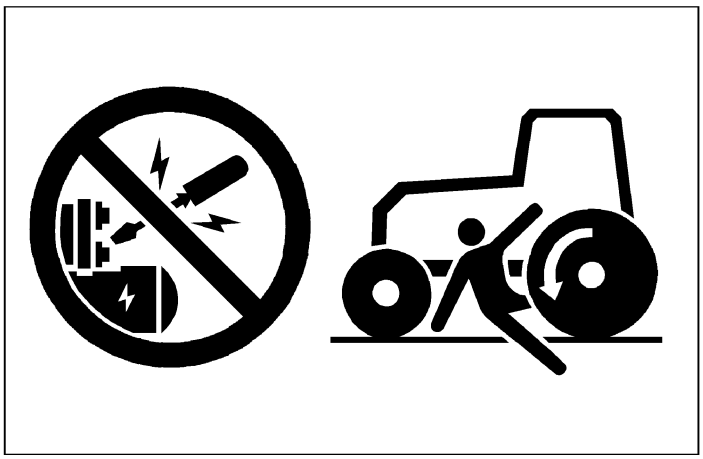
[2] METRIC SCREWS, BOLTS AND NUTS

Grade / Unit / Nominal Diameter	Property class 8.8 ⬡ 8.8			Property class 10.9 ⬡ 10.9		
	N·m	kgf·m	ft-lbs	N·m	kgf·m	ft-lbs
M8	23.6 to 27.4	2.4 to 2.8	17.4 to 20.2	29.4 to 34.3	3.0 to 3.5	21.7 to 25.3
M10	48.1 to 55.8	4.9 to 5.7	35.5 to 41.2	60.8 to 70.5	6.2 to 7.2	44.9 to 52.1
M12	77.5 to 90.1	7.9 to 9.2	57.2 to 66.5	103.0 to 117.0	10.5 to 12.0	76.0 to 86.8
M14	124.0 to 147.0	12.6 to 15.0	91.2 to 108.0	167.0 to 196.0	17.0 to 20.0	123.0 to 144.0
M16	196.0 to 225.0	20.0 to 23.0	145.0 to 166.0	260.0 to 303.0	26.5 to 31.0	192.0 to 224.0

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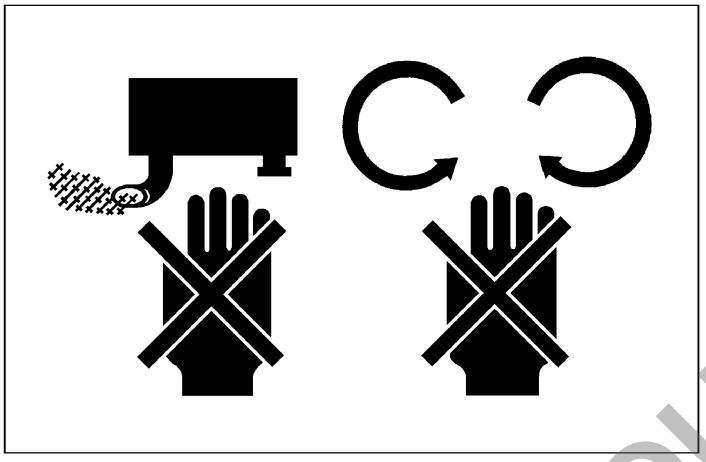
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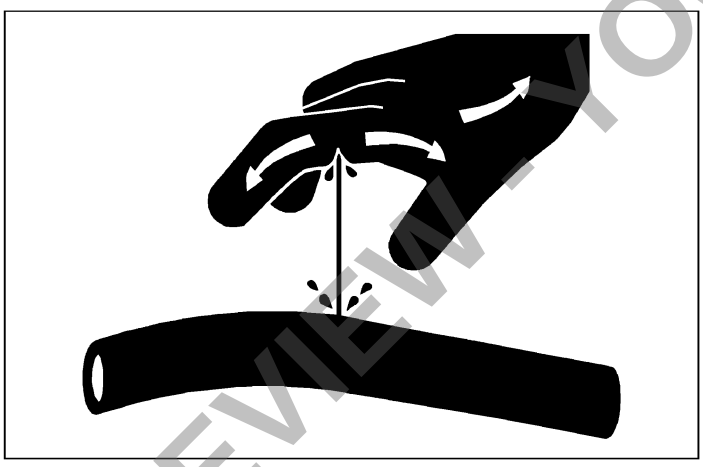
SAFETY STARTING

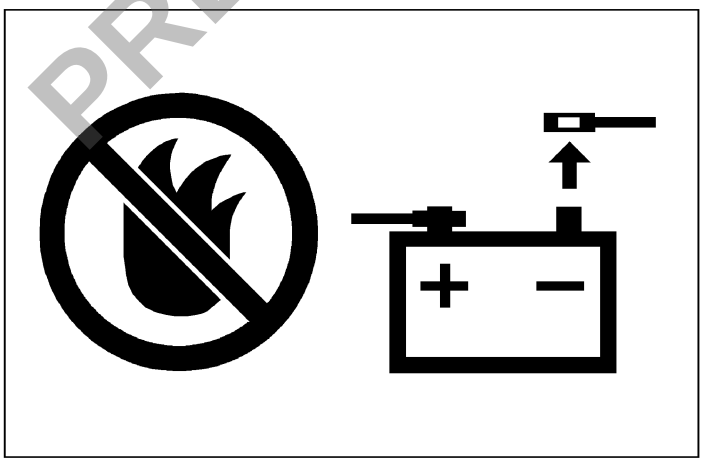
- Do not start the engine by shorting across starter terminals or bypassing the safety start switch.
- Do not alter or remove any part of machine safety system.
- Before starting the engine, make sure that all shift levers are in neutral positions or in disengaged positions.
- Never start the engine while standing on ground. Start the engine only from operator's seat.



SAFETY WORKING

- Do not work on the machine while under the influence of alcohol, medication, or other substances or while fatigued.
- Wear close fitting clothing and safety equipment appropriate to the job.
- Use tools appropriate to the work. Makeshift tools, parts, and procedures are not recommended.
- When servicing is performed together by two or more persons, take care to perform all work safely.
- Do not work under the machine that is supported solely by a jack. Always support the machine by safety stands.
- Do not touch the rotating or hot parts while the engine is running.
- Never remove the radiator cap while the engine is running, or immediately after stopping. Otherwise, hot water will spout out from radiator. Only remove radiator cap when cool enough to touch with bare hands. Slowly loosen the cap to first stop to relieve pressure before removing completely.
- Escaping fluid (fuel or hydraulic oil) under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting hydraulic or fuel lines. Tighten all connections before applying pressure.



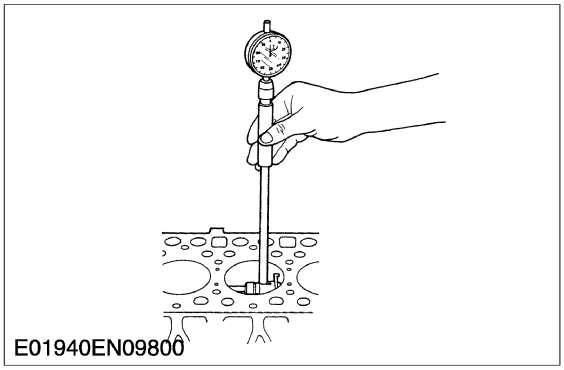


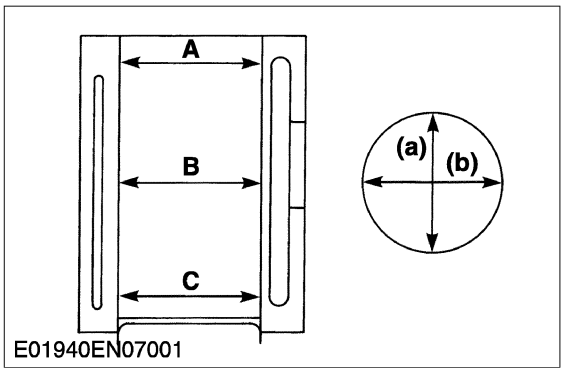
AVOID FIRES

- Fuel is extremely flammable and explosive under certain conditions. Do not smoke or allow flames or sparks in your working area.
- To avoid sparks from an accidental short circuit, always disconnect the battery negative cable first and connect it last.
- Battery gas can explode. Keep sparks and open flame away from the top of battery, especially when charging the battery.
- Mark sure that no fuel has been spilled on the engine.

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Cylinder Wear

1. Measure the cylinder liner I.D. at the six positions (see figure) with a cylinder gauge to find the maximum and minimum I.D.'s.
2. Get the difference (Maximum wear) between the maximum and the minimum I.D.'s.
3. If the wear exceeds the allowable limit, bore and hone to the oversize dimension. (Refer to "Correcting Cylinder".)
4. Visually check the cylinder wall for scratches. If deep scratches are found, the cylinder should be bored. (Refer to "Correcting Cylinder".)

[D722 · D782]

Cylinder liner I.D.	Factory spec.	67.000 to 67.019 mm 2.63779 to 2.63854 in.
	Allowable limit	67.169 mm 2.64444 in.

[D1105]

Cylinder liner I.D.	Factory spec.	72.000 to 72.019 mm 2.83464 to 2.83539 in.
	Allowable limit	72.169 mm 2.84129 in.

(A) Top
(B) Middle
(C) Bottom (Skirt)

(a) Right-angled to Piston Pin
(b) Piston Pin Direction

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