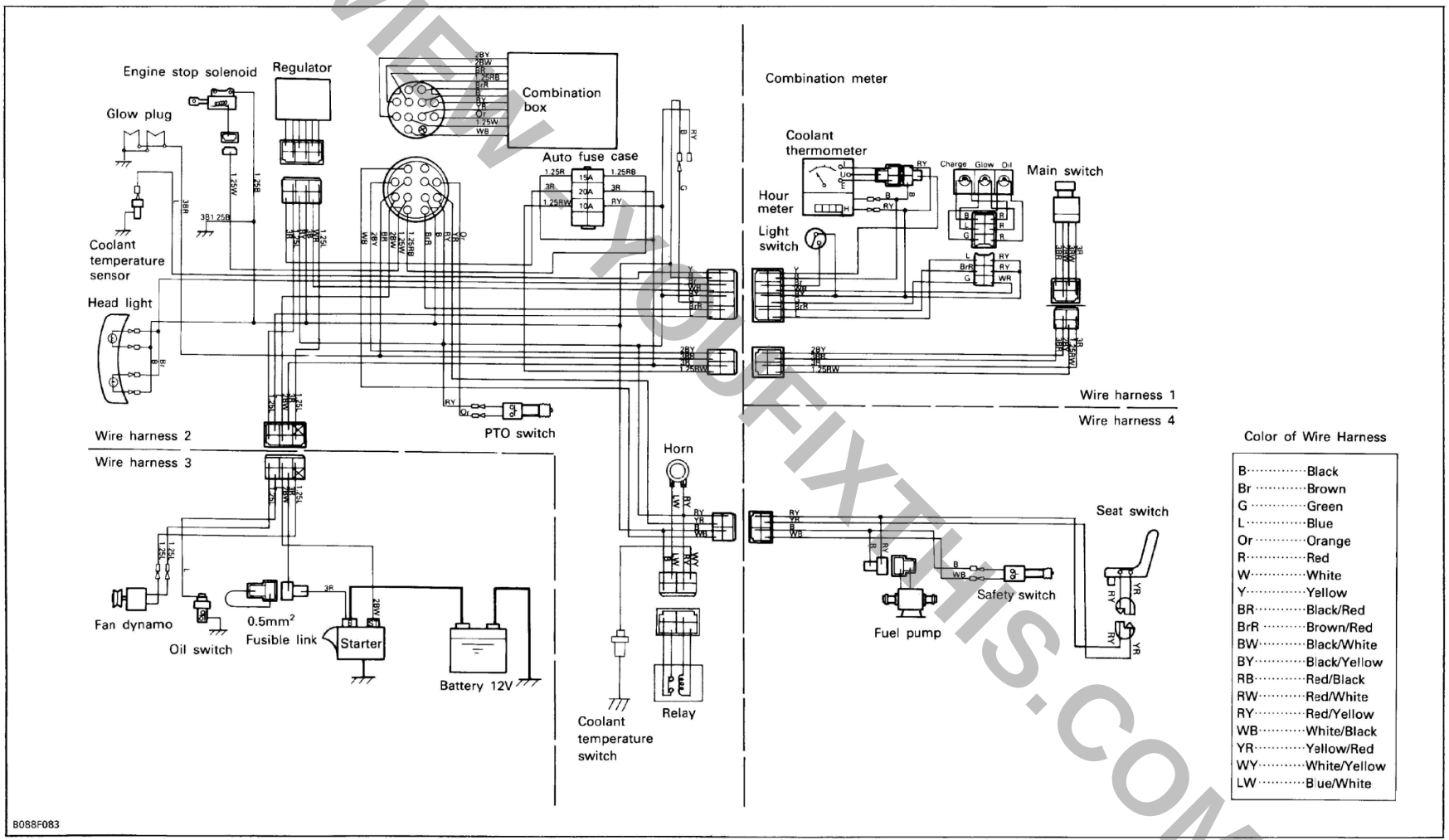
3 ELECTRICAL SYSTEM

[1] WIRING DIAGRAM AND ELECTRICAL CIRCUIT

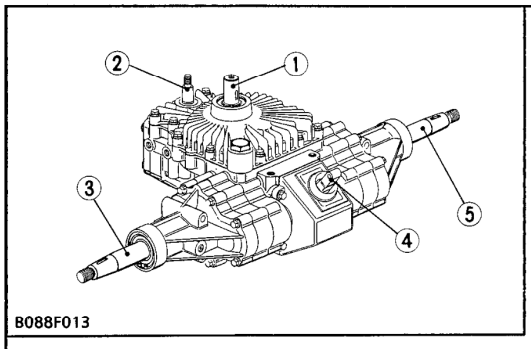


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2 TRANSMISSION

[1] HYDROSTATIC TRANSAXLE

[Vehicle Serial No. : Up to 49999]



(1) Input Shaft
(2) Control Shaft
(3) Rear Axle (Right)
(4) Brake Lever
(5) Rear Axle (Left)
(6) Cover
(7) Dump Valve Bracket
(8) Port Plate
(9) Ball Piston Motor (Right)
(10) Reduction Gear (Right)
(11) Brake Shaft
(12) Reduction Gear (Left)
(13) Brake Cover
(14) Brake Assembly
(15) Ball Piston Motor (Left)
(16) Housing
(17) Ball Piston Pump
(18) Cam Ring

T1600H is installed with Eaton's hydrostatic transaxle for easy changeover between forward and reverse travelings and speed control by one foot pedal. Clutch operation and shift lever operation are unnecessary. The hydrostatic transaxle, in its compact package, has the hydrostatic transmission, rear axle case with reduction gear and parking brake mechanism. The hydrostatic transmission block adopts a simple design consisting of one ball piston pump and two ball piston motors, attaining excellent durability requiring least maintenance.

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[7] TIGHTENING TORQUES

(1) Tightening Torques for Important Screws, Bolts and Nuts

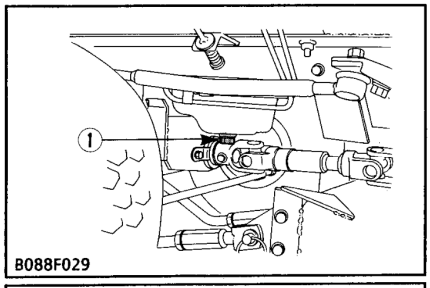
Section	Item	N·m	kgf·m	ft-lbs
Engine	Starter B terminal nut	8.8 (8.8 to 11.7)	0.9 (0.9 to 1.2)	6.5 (6.5 to 8.7)
	Engine mounting nut	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
	Injection pipe nut	24.5 to 34.3	2.5 to 3.5	18.1 to 25.3
	Overflow pipe nut	19.6 to 24.5	2.0 to 2.5	14.5 to 18.1
	* Head cover cap nut	3.9 to 5.9	0.4 to 0.6	2.9 to 4.3
	Nozzle holder	49.0 to 68.6	5.0 to 7.0	36.2 to 50.6
	Glow plug	7.85 to 14.7	0.8 to 1.5	5.79 to 10.8
	* Rocker arm bracket nut	9.81 to 11.3	1.0 to 1.15	7.23 to 8.32
	* Cylinder head bolt	39.2 to 44.1	4.0 to 4.5	28.9 to 32.5
	Injection pump retaining screw and nut	9.81 to 11.3	1.0 to 1.15	7.23 to 8.32
	Fan drive pulley retaining screw	98.1 to 107.9	10.0 to 11.0	72.3 to 79.6
	Gear case screw	9.81 to 11.3	1.0 to 1.15	7.23 to 8.32
	Oil pan screw	9.81 to 11.3	1.0 to 1.15	7.23 to 8.32
	* Connecting rod screw	26.5 to 30.4	2.7 to 3.1	19.5 to 22.4
	* Flywheel screw	53.9 to 58.8	5.5 to 6.0	39.8 to 43.4
	Main bearing case cover screw	9.81 to 11.3	1.0 to 1.15	7.23 to 8.32
	* Bearing case screw 1	12.7 to 15.7	1.3 to 1.6	9.4 to 11.6
	* Bearing case screw 2	26.5 to 30.4	2.7 to 3.1	19.5 to 22.4
	Nozzle holder to nozzle nut	34.3 to 39.2	3.5 to 4.0	25.3 to 28.9
	Nozzle assembly to cylinder head	49.0 to 68.6	5.0 to 7.0	36.2 to 50.6
Transmission and Rear Axle	Hydrostatic transaxle mounting screw	48.1 to 55.9	4.9 to 5.7	35.4 to 41.2
	Rear wheel retaining screw	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
	Drive shaft retaining screw	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
	Neutral adjuster retaining screw	18.6 to 24.5	1.9 to 2.5	13.7 to 18.1
	Neutral arm holder retaining screw	12.7 to 15.7	1.3 to 1.6	9.4 to 11.6
	Speed change arm retaining nut	18.6 to 24.5	1.9 to 2.5	13.7 to 18.1
	Brake arm shaft retaining screw	12.7 to 15.7	1.3 to 1.6	9.4 to 11.6
	Wheel hub retaining nut	118 to 147	12 to 15	87 to 108
	Axle housing retaining screw	14.0	1.4	10.3
	Cover retaining screw	14.0	1.4	10.3
	Dump valve nut	17.0	1.7	12.5
Front Axle and Steering	Drag link nut	39.2 to 45.1	4.0 to 4.6	28.9 to 33.3
	Tie-rod mounting nut	39.2 to 45.1	4.0 to 4.6	28.9 to 33.3
	Tie-rod lock nut	39.2 to 45.1	4.0 to 4.6	28.9 to 33.3
	Knuckle arm retaining screw	39.2 to 45.1	4.0 to 4.6	28.9 to 33.3
	Pitman arm retaining nut	77.5 to 90.2	7.9 to 9.2	57.1 to 66.5
Mower	Cover retaining screw	17.7 to 20.6	1.8 to 2.1	13.0 to 15.2
	Gear case retaining screw	77.5 to 90.2	7.9 to 9.2	57.1 to 66.5
	Blade screw	123 to 147	12.5 to 15.0	90.4 to 108
	Gear case cover retaining screw	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3

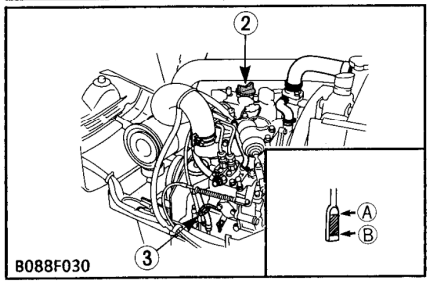
■ NOTE
- For "*" marked screws, bolts and nuts on the table, apply engine oil to their threads and seats before tightening.

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[9] CHECK AND MAINTENANCE

(1) Check Points of Initial 50 Hours

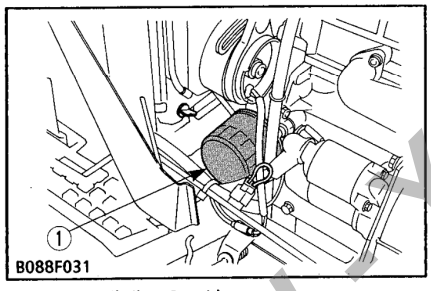




Changing Engine Oil

1. Remove the drain plug at the bottom of the engine to drain the oil completely. Oil can be drained easily when the engine is still warm.
2. Screw in the drain plug.
3. Fill new oil up to the upper notch on the dipstick.

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



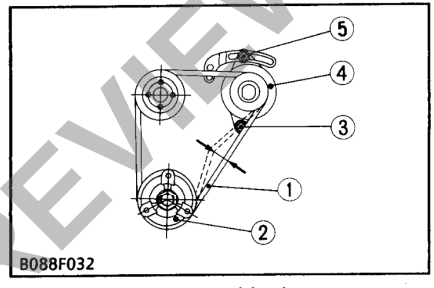
(1) Engine Oil Filter Cartridge

Changing Engine Oil Filter Cartridge

- Be sure to stop the engine before changing the oil filter cartridge.

1. Remove the engine oil filter cartridge (1).
2. Apply a slight coat of oil onto the rubber gasket of new cartridge.
3. Install the new cartridge, screwing it in by hand. Over tightening may cause deformation of the rubber gasket.
4. After the cartridge has been changed, the engine oil normally decrease a little. So replenish engine oil up to the specified level.

(2) Check Points of Every 50 Hours



(1) Fan Belt
(2) Fan Drive Pulley
(3) Tension Screw
(4) Alternator
(5) Adjusting Screw

Checking Fan Belt Tension

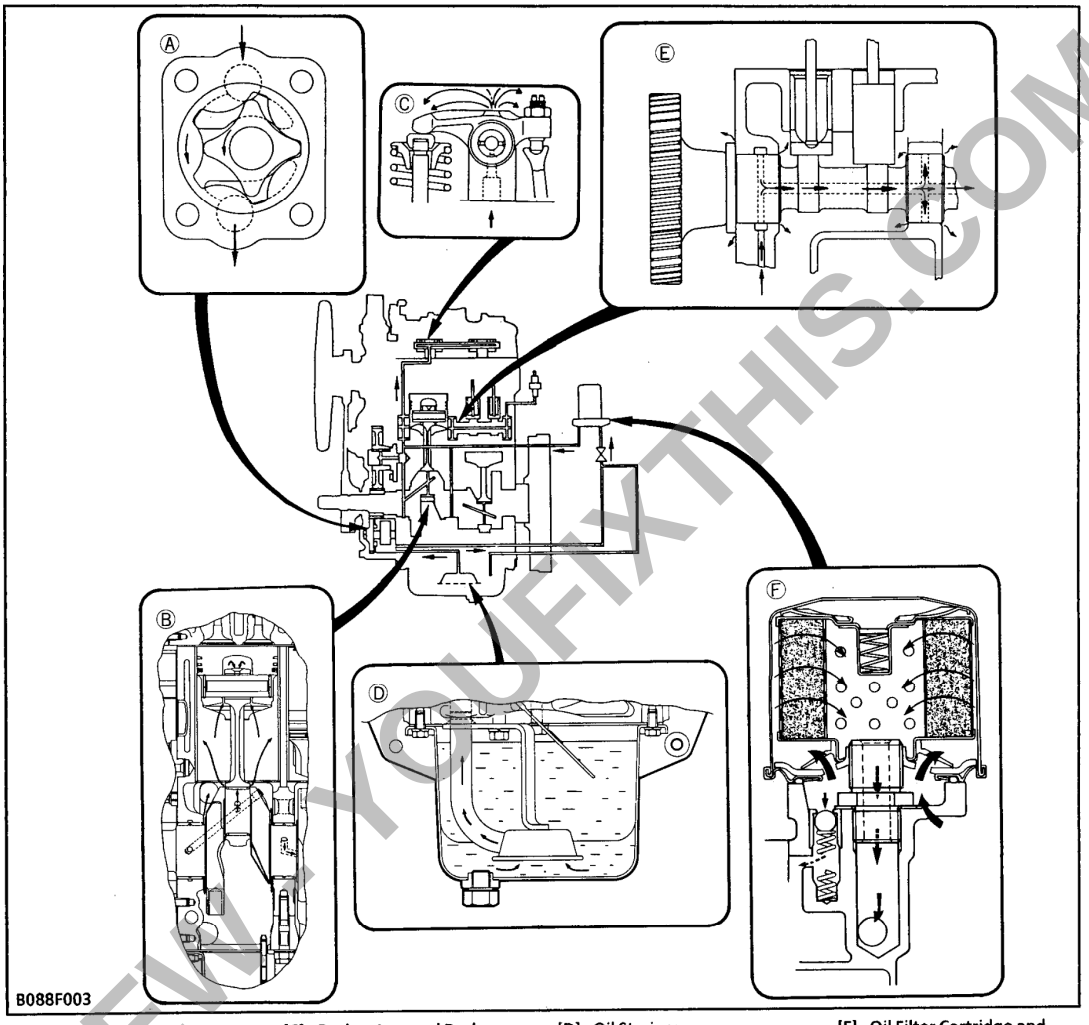
1. Depress the center of the belt (1) between the alternator (4) and fan drive pulley (2) with finger pressure of 98 N (10 kgf, 22 lbs). Measure the deflection.
2. If the measurement is not the factory specifications, loosen the tension screw (3) and adjusting screw (5) then move the alternator to adjust the tension.
3. After adjusting, securely tighten the screws.

Fan belt tension	Factory spec.	10 mm 0.4 in.

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[4] LUBRICATING SYSTEM



[A] Oil Pump
[B] Crankshaft and Piston
[C] Rocker Arm and Rocker Arm Shaft
[D] Oil Strainer
[E] Camshaft
[F] Oil Filter Cartridge and Relief Valve

This engine lubricating system consists of oil strainer, oil pump, relief valve, oil filter cartridge and oil switch.

The oil pump is of rotor type working smoothly and noiselessly, sucks lubricating oil from the oil pan through the oil strainer. Then the oil flows to the oil filter cartridge, where it is further filtered.

Oil filter cartridge has a by-pass valve inside, to prevent the lack of oil in case that the element is clogged. When the pressure difference before filtering and after is more than 98.1 kPa (1 kgf/cm^2, 14.2 psi), the by-pass valve opens.

Near the oil filter cartridge is a relief valve, preventing damage to the lubrication system due to high oil pressure. When the oil pressure exceeds 441 kPa (4.5 kgf/cm^2, 64 psi), the valve opens and the oil escapes.

The filtered oil is force-fed to the crankshaft, connecting rods, idle gear, camshaft and rocker arm shaft through the oil passage in the crankcase and the crankshaft to lubricate each part.

Some part of oil, splashed by the crankshaft or thrown off from gaps of each part, lubricate these parts; the pistons, the cylinder walls, the piston pins, the tappets, the push rods and the inlet and exhaust valves.

Oil switch is mounted on the crankcase and is led to the oil passage. When the oil pressure falls below 49.0 kPa (0.5 kgf/cm^2, 7.1 psi), the oil switch closes to turn on the oil pressure warning lamp.

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[5] TROUBLESHOOTING

ENGINE

Symptom	Probable Cause	Solution	Reference Page
Engine Does Not Start	• No fuel	Replenish fuel	–
	• Air in the fuel system	Bleed air	S-18
	• Water in the fuel system	Replace fuel and repair or replace fuel system	–
	• Fuel pipe clogged	Clean	–
	• Fuel filter clogged	Replace	S-18,19
	• Excessively high viscosity of fuel or engine oil at low temperature	Use the specified fuel or engine oil	S-2
	• Fuel with low cetane number	Use the specified fuel	S-2
	• Fuel leak due to loose injection pipe retaining nut	Tighten nut	S-28
	• Incorrect injection timing	Adjust	S-46
	• Fuel cam shaft worn	Replace	–
	• Injection nozzle clogged	Clean	S-47
	• Injection pump defective	Repair or replace	S-46
	• Fuel pump defective	Repair or replace	–
	• Seizure of crankshaft, camshaft, piston or bearing	Repair or replace	–
	• Compression leak from cylinder	Replace head gasket, tighten cylinder head bolt, glow plug and nozzle holder	S-26
	• Improper valve seat alignment, valve spring broken, valve seized	Repair or replace	S-35
	• Improper valve timing	Adjust	S-7
	• Piston ring worn	Replace	S-39
	• Excessive valve clearance	Adjust	S-26
[Starter Does Not Work]	• Battery discharged	Charge	S-59
	• Starter defective	Repair or replace	S-60
	• Main switch defective	Repair or replace	S-65
	• Wiring disconnected	Connect	–
	• Brake switch is not depressed	Adjust the brake switch position	S-64
	• Brake switch defective	Replace	S-64
	• PTO lever **"ENGAGE"**	Set the PTO lever to **"DISENGAGE"**	–
	• PTO switch defective	Replace	S-64
	• Combination box defective	Replace	S-64
Engine Revolution Is Not Smooth	• Fuel filter clogged or dirty	Replace	S-18,19
	• Air cleaner clogged	Clean or replace	S-19
	• Fuel leak due to loose injection pipe retaining nut	Tighten nut	S-28
	• Injection pump defective	Repair or replace	S-46
	• Incorrect nozzle opening pressure	Adjust	S-47
	• Injection nozzle suck or clogged	Repair or replace	S-47
	• Fuel over flow pipe clogged	Clean	–
	• Governor defective	Repair	–

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SPECIFICATIONS

Model			T1600H
Engine	Model		Z482
	Type		Vertical, liquid cooled, 4-cycle, diesel engine
	Number of Cylinders		2
	Bore x Stroke		67 x 68 mm (2.64 x 2.68 in.)
	Total Displacement		479 cm^3 (29.3 cu.in.)
	Brake Horsepower (SAE Gross)		10.0 kW (13.5 HP)
	Rated Engine Speed		3200 rpm
	Combustion Chamber		N-TVCS (Serial No. : up to 488290), E-TVCS (Serial No. : 488291 and above)
	Fuel Injection Pump		Bosch MD mini pump
	Governor		Centrifugal ball mechanical governor
	Injection Nozzle		Throttle type (DN4PD62)
	Injection Timing		19 to 21° (0.33 to 0.37 rad.) before TDC
	Injection Pressure		13.73 MPa (140 kgf/cm^2, 1991 psi)
	Direction of Rotation		Counter-clockwise (viewed from flywheel)
	Compression Ratio		23 to 1
	Lubricating System		Forced lubrication by trochoid pump
	Cooling System		Pressurized radiator, Forced circulation with water pump
	Starting System		Electric starter (12 V, 0.8 kW)
	Charging System		AC dynamo (12 V, 150 W)
	Battery		12 V, 28 AH
	Engine Stop		Key stop
	Fuel		Diesel fuel No.2 [above –10°C (14°F)], No.1 [below –10°C (14°F)]
	Lubricating Oil		API service CC or CD
	Weight (Dry)		62.5 kg (includes radiator, air cleaner and muffler)
Dimensions	Overall Length		1725 mm (67.9 in.)
	Overall Width		1430 mm (56.3 in.)
	Overall Height		1100 mm (43.3 in.)
	Wheel Base		1200 mm (47.2 in.)
	Tread	Front	720 mm (28.3 in.)
		Rear	690 mm (27.2 in.)
Weight			300 kg (662 lbs.)
Fuel Tank Capacity			10 ℓ (2.6 gals)
Tire Size	Front		15 x 6.00–6
	Rear		20 x 10.00–8
Steering System			Manual
Brake (Parking Brake)			Dry disc (Serial No. : up to 49999), Wet disc (Serial No. : 50001 and above)
Transmission			Hydrostatic transmission
Traveling Speed	Forward		0 to 9 km/h (0 to 5.6 mph)
	Reverse		0 to 5 km/h (0 to 3.1 mph)
PTO	Direction of Revolution		Counter-clockwise viewed from front
	Revolution		2740 rpm (at engine 3200 rpm)
	PTO Clutch		Belt tension
Mower	Mounting Method		Parallel linkage
	Adjustment of Cutting Height		Gauge wheel
	Cutting Height		25.4 to 102 mm (1.0 to 4.0 in.)
	Cutting Width		1118 mm (44 in.)
	Number of Blades		3
	Weight		55 kg (121 lbs.)
	Dimensions	Total Length	825 mm (32.5 in.)
		Total Width	1430 mm (56.3 in.)
		Total Height	282 mm (11.1 in.)
	Discharge		Right side

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[6] SERVICING SPECIFICATIONS

ENGINE BODY

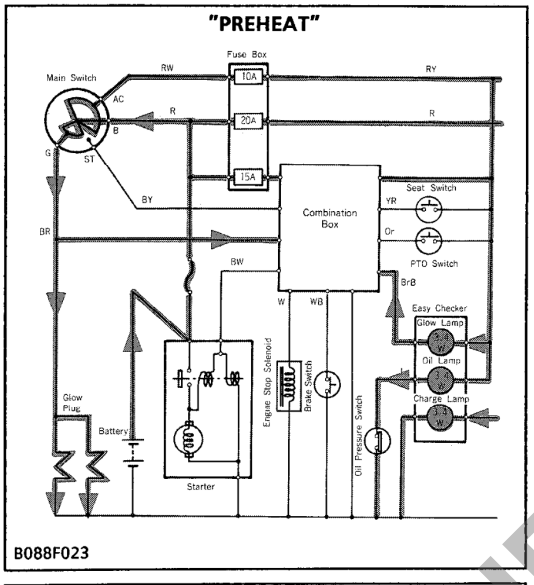
Item		Factory Specification	Allowable Limit
Cylinder Head Surface	Flatness	–	0.05 mm (0.002 in.) per 100 mm (4 in.)
Top Clearance		0.50 to 0.65 mm 0.0197 to 0.0256 in.	–
Compression Pressure		2.84 to 3.24 MPa 29 to 33 kgf/cm^2 412 to 469 psi	2.26 MPa 23 kgf/cm^2 327 psi
Valve Clearance (Cold)	IN., EX.	0.145 to 0.185 mm 0.0059 to 0.0073 in.	–
Valve Seat	Width	2.12 mm 0.0835 in.	–
	Angle	45.0° 0.785 rad.	–
Valve recessing		–0.10 to 0.10 mm –0.0039 to 0.0039 in.	0.30 mm 0.012 in.
Valve Stem to Valve Guide	Clearance	0.030 to 0.057 mm 0.00118 to 0.00224 in.	0.1 mm 0.004 in.
Valve Stem	O.D.	5.968 to 5.980 mm 0.23496 to 0.23453 in.	5.93 mm 0.2335 in.
Valve Guide	I.D.	6.010 to 6.025 mm 0.23661 to 0.23721 in.	–
Valve Timing	I.O.	T.D.C. –20° –0.349 rad.	–
	I.C.	B.D.C. + 45° + 0.785 rad.	
	E.O.	B.D.C. –50° –0.873 rad.	
	E.C.	T.D.C. + 15° + 0.262 rad.	
Valve Spring	Free Length	31.6 mm 1.244 in.	28.4 mm 1.118 in.
	Load/Length	64.7N/27.0 mm 6.6 kgf/27.0 mm 14.6 lbs/1.063 in.	54.9N/27.0 mm 5.6 kgf/27.0 mm 12.3 lbs/1.063 in.
	Tilt	–	1.2 mm 0.047 in.
Rocker Arm Shaft to Rocker Arm	Clearance	0.016 to 0.045 mm 0.00063 to 0.00177 in.	0.15 mm 0.0059 in.
Rocker Arm Shaft	O.D.	10.473 to 10.484 mm 0.41232 to 0.41276 in.	–
Rocker Arm	I.D.	10.500 to 10.518 mm 0.41339 to 0.41409 in.	–
Timing Gear	Backlash	0.041 to 0.124 mm 0.00161 to 0.00488 in.	0.2 mm 0.0079 in.

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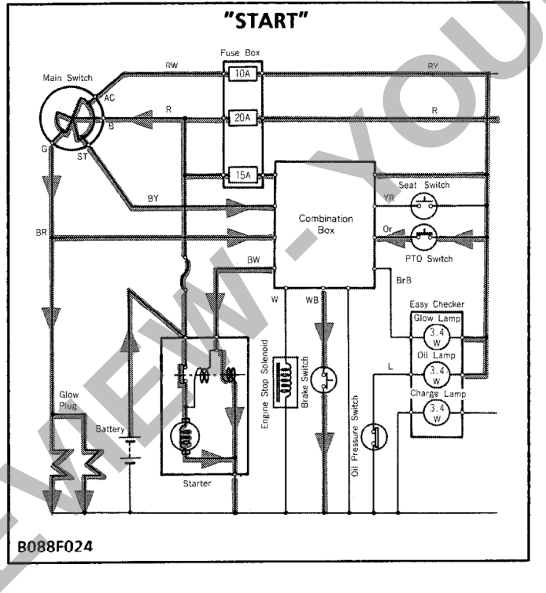
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[2] STARTING SYSTEM

(1) Starting Circuit



When the main switch is turned to the **"PREHEAT"** position, terminal **B** is connected to terminal **AC** and **G**. The glow plug becomes hot. Electric current flows to the combination box through the glow lamp, and the glow lamp lights for 5 seconds by the timer relay in the combination box.



When the main switch is turned to the **"START"** position, terminal **B** is connected to terminal **AC, G** and **ST**. Electric current flows to the combination box from terminal **ST**.

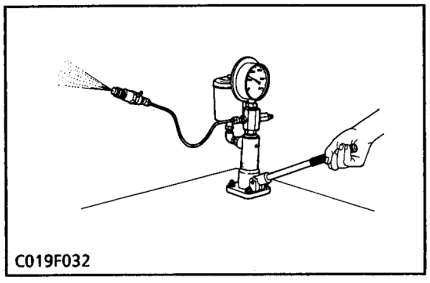
Under the following condition, a start signal flows to the starter and starts the engine.

Starting condition

- Brake switch is **"ON"** (Brake pedal is depressed).
- PTO switch is **"ON"** (PTO lever **"DISENGAGE"**).

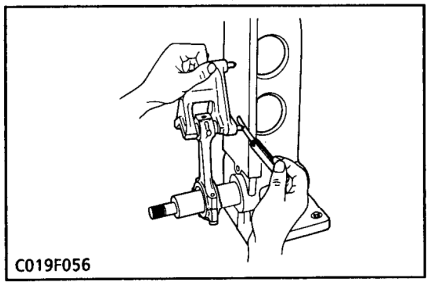
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C019F032

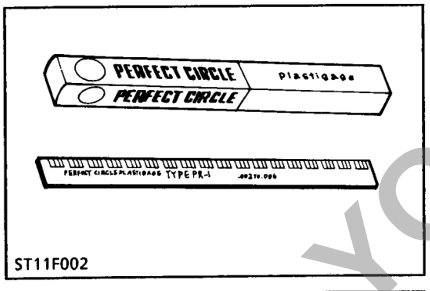
Nozzle Tester

Code No: 07909-31361
Application: Use to check the fuel injection pressure and spraying condition of nozzle.


C019F056

Connecting Rod Alignment Tool

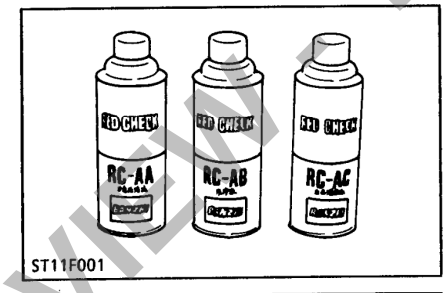
Code No: 07909-31661
Application: Use to check the connecting rod alignment.



ST11F002

Press Gauge

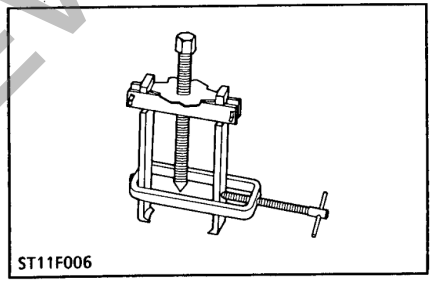
Code No: 07909-30241
Application: Use to check the oil clearance between crankshaft and bearing, etc.
Measuring range: Green – 0.025 to 0.076 mm (0.001 to 0.003 in.)
Red – 0.051 to 0.152 mm (0.002 to 0.006 in.)
Blue – 0.102 to 0.229 mm (0.004 to 0.009 in.)



ST11F001

Red Check (Crack check liquid)

Code No: 07909-31371
Application: Use to check cracks on cylinder head, crankcase, etc.


ST11F006

Special Use Puller Set

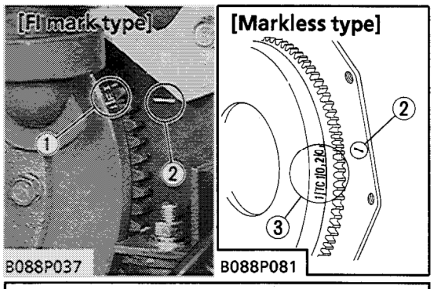
Code No: 07916-09032
Application: Use to pull out bearings, gears and other parts with ease.

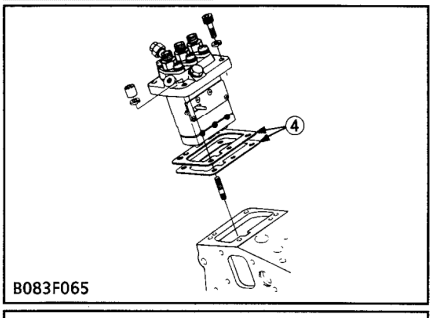
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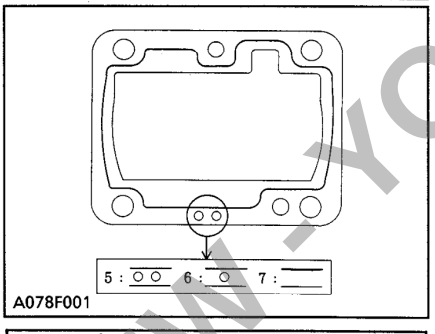
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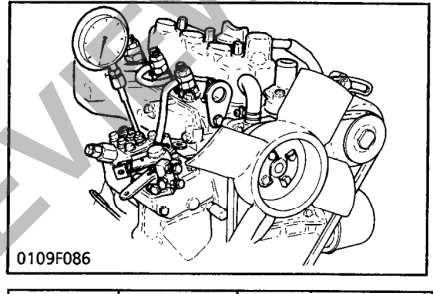
[5] FUEL SYSTEM

CHECKING AND ADJUSTING









Delivery valve fuel tightness	Allowable limit	5 seconds 14.71 → 13.73 MPa 150 → 140 kgf/cm² 2133 → 1991 psi

Injection Timing

1. Remove the injection pipes.
2. Set the speed control lever to the maximum fuel discharge position.
3. Turn the flywheel counterclockwise until the fuel fills up to the hole of the delivery valve holder.
4. Turn the flywheel further and stop turning when the fuel begins to flow over again, to check the injection timing.
5. If the punch mark (2) does not align with the mark **"FI"** or does not indicate the correct angle, add or remove the shim between the injection pump and crankcase to adjust.

Injection timing	Factory spec.	19° to 21° (0.33 to 0.37 rad.) before T.D.C.

■ NOTE

(Engine serial number : up to 488290)

- **Shims are available in thickness of 0.15 mm (0.0059 in.), 0.30 mm (0.0118 in.). Combine these shims for adjustments.**
- **Addition or reduction of shim (0.15 mm, 0.0059 in.) delays or advances the injection timing by approx. 0.026 rad. (1.5°).**
- **After adjusting the injection timing, apply liquid-type gasket (Three Bond 1215 or its equivalent) to both sides of the injection pump shim before reassembling.**

(Engine serial number : 488291 and above)

- **The sealant is applied to both sides of the soft metal gasket shim. The liquid gasket is not required for assembling.**
- **Shims are available in thickness of 0.20 mm (0.0079 in.), 0.25 mm (0.0098 in.) and 0.30 mm (0.0118 in.). Combine these shims for adjustments.**
- **Addition or reduction of shim (0.05 mm, 0.0020 in.) delays or advances the injection timing by approx. 0.0087 rad. (0.5°).**
- **In disassembling and replacing, be sure to use the same number of new gasket shims with the same thickness.**

(1) Mark **"FI"**
(2) Punch Mark
(3) Timing Mark
(4) Shim
(5) 2-holes : 0.20 mm
(6) 1-hole : 0.25 mm
(7) Without hole : 0.30 mm

Fuel Tightness of Pump Element

1. Remove the injection pipe and install the injection pump tester.
2. Set the speed control lever to the maximum speed position, then turn the flywheel by hand ten times or more to increase the pressure.
3. If the pressure cannot reach the allowable limit, replace the pump element or injection pump assembly.

Pump element fuel tightness	Allowable limit	15.71 MPa 150 kgf/cm² 2133 psi

Fuel Tightness of Delivery Valve

1. Set a pressure tester to the fuel injection pump.
2. Rotate the flywheel by hand to increase the pressure to 150 kgf/cm² (14.71 MPa, 2133 psi).
3. Align the plunger with the bottom dead center.
4. Measure the time needed to decrease the pressure.
5. If the measurement is less than allowable limit, replace the delivery valve.

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