



CM214

**WORKSHOP
MANUAL**



SHIBAUURA TRACTOR

Introduction

Shibaura developed a front mower incorporating new technology for more improved passenger mowing garden tractor.

This manual describes the structure, functions, maintenance and service of model CM214 so that their functions are fully exhibited in actual operation.

Please read this carefully to promote sales and service, to improve the service techniques and guide users for proper operation of Shibaura tractors.

Figures or other conditions in this manual may be changed without notice in order to improve the performance or for other objects.

**Quality Assurance Department
Tractor Division
Ishikawajima-Shibaura Machinery Co., Ltd.**

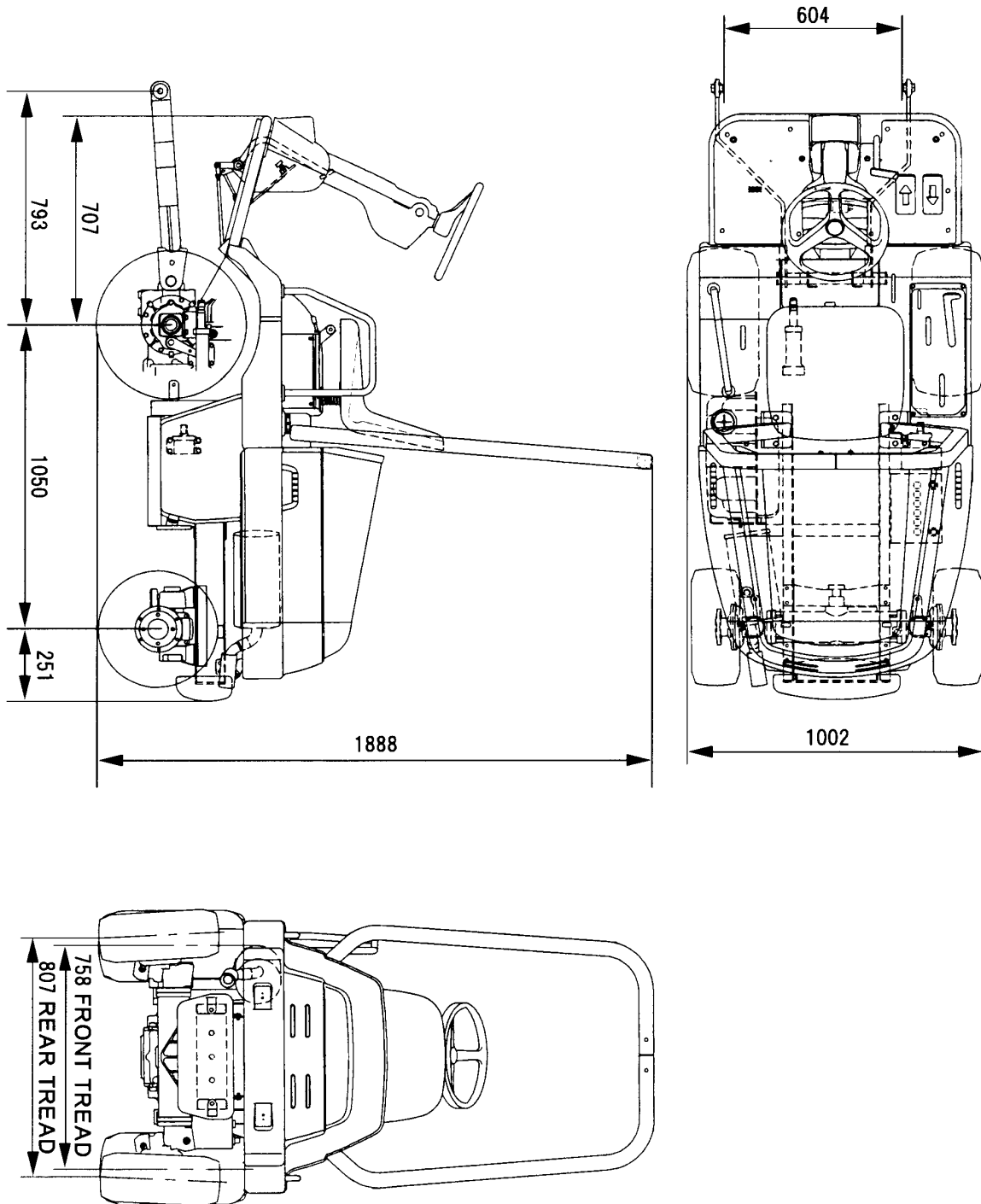
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Chapter 1. GENERAL

1-1 External Views

mm



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1-2 Specifications & Performances

Model			CM214	
Engine	Model		S773	
	Type		Water-Cooled 4-Cycle Vertical Diesel Engine	
	Number of Cylinders		3	
	Total Stroke Volume		1005 cc	
	Maximum Output		16.0 kW (22 PS)/2700 rpm	
	Compression Ratio		23 : 1	
	Fuel		Diesel Fuel Oil	
	Starting Method		By Starting Motor	
	Overall Length		2130 mm	
	Overall Height		1875 mm (Top of ROPS)	
	Overall Width		1000 mm	
	Weight		530 kg (with POPS)	
	Maine Body	Tire	Front Wheel	20 × 10.0 – 8
			Rear Wheel	16 × 6.5 – 8
No. of Running Speeds		1 Forward Speeds, 1 Reverse Speeds (Continuously variable speed)		
Transmission System		All Hydraulic Continuously Variable Speed (HST)		
Brake		Internal Wet Disc Brake		
Steering		Full hydraulic Power Steering		
Relief Set Pressure		6.37 MPa {65 kgf/cm ² }		
Running Speed		Forward	0 – 14 km/H	
		Reverse	0 – 8 km/H	
Capacity	Fuel Tank		28 ℓ	
	Engine Oil		3.5 ℓ (Including oil filter)	
	Transmission Gear Oil		Front 14 ℓ, Rear 1.0 ℓ	
	Cooling Water		3.5 ℓ	
Electric Units	Battery		12 V – 45 AH	
	Starting Motor		12 V – 10 kW	
	Alternator		12 V –20 A	
	Warning Lamp	Battery Charge Lamp	3.4 W	
		Engine Oil Pressure Lamp	3.4 W	
		Air Cleaner Restriction Lamp	3.4 W	
		Glow Plug Indicator Lamp	3.4 W	

1-3 Precautions Before Servicing

1. Have the tractor washed clean and have the oil, fuel, and cooling water drained out as would be required by the work to be performed.
2. Service shop should always be kept clean to prevent dust from rising and should be well lighted.
3. The disassembled parts shall have the oil and grease washed off and arranged on a stand separated by groups.
4. Clothing, service tools and equipments shall be checked to ensure safety in performing the operation.

1-4 Basic Understanding on Servicing

1. Engine, transmission, and hydraulic apparatus have been specially manufactured to high accuracy so that care shall be exercised to maintain them in clean state and not to do any unnecessary disassembly.
2. Defective parts due to wear and other causes shall be discarded and new parts ordered with the tractor model, serial No., code No., and part name clearly defined. (Keep the defective parts on hand to enable showing it to the customer.)
3. When assembling, it is essential to have oil applied to all moving parts so that they will be provided with initial oil film until normal lubrication takes place.
4. Unless specially instructed, bolts and nuts shall be tightened by proper tools to the proper tightening torque.

METRIC BOLT TORQUE SPECIFICATIONS

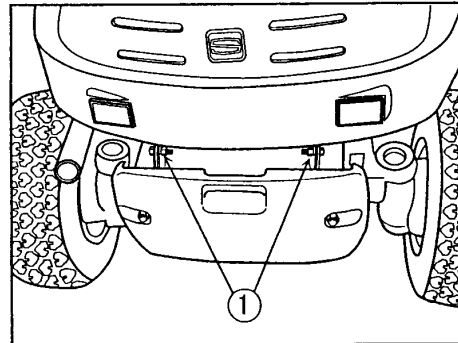
Bolt Size	Grade No.	Coarse Thread			Fine Thread		
		Pitch (mm)	Newton Meters	Kiro-gram Meters	Pitch (mm)	Newton-Meters	Kiro-gram Meters
M6	4T, 4.8	1.0	4.9-6.9	0.5-0.6	-----	-----	-----
	7T, 8T, 8.8		8.3-11.3	0.85-1.15			
	10T, 11T		11.7-15.7	1.2-1.6			
M8	4T, 4.8	1.25	12.7-16.7	1.3-1.7	1.0	15.2-20.1	1.55-2.05
	7T, 8T, 8.8		22.6-28.4	2.3-2.9		26.5-34.3	2.7-3.5
	10T, 11T		28.5-36.3	2.9-3.7		30.4-40.2	3.1-4.1
M10	4T, 4.8	1.5	25.5-33.3	2.6-3.4	1.25	28.4-36.2	2.9-3.7
	7T, 8T, 8.8		44.1-55.9	4.5-5.7		49.0-62.7	5.0-6.4
	10T, 11T		54.0-69.6	5.5-7.1		57.8-73.5	5.9-7.5
M12	4T, 4.8	1.75	37.3-47.0	3.8-4.8	1.25	43.1-54.9	4.4-5.6
	7T, 8T, 8.8		65.7-83.3	6.7-8.5		74.5-94.1	7.6-9.6
	10T, 11T		92.0-116	9.4-11.8		99.0-126	10.1-12.9
M14	4T, 4.8	2.0	62.8-80.4	6.4-8.2	1.5	69.6-87.2	7.1-8.9
	7T, 8T, 8.8		104-132	10.6-13.4		117-148	11.9-15.1
	10T, 11T		139-175	14.2-17.8		149-184	15.2-18.8
M16	4T, 4.8	2.0	86.1-110	8.8-11.2	1.5	91.1-114	9.3-11.7
	7T, 8T, 8.8		149-185	15.2-18.8		157-192	16.0-19.6
	10T, 11T		205-255	21-26		221-269	22.5-27.5
M18	4T, 4.8	2.0	113-141	11.6-14.4	1.5	132-162	13.4-16.6
	7T, 8T, 8.8		196-236	20-24		231-279	23.5-28.5
	10T, 11T		275-333	28-34		298-367	30.5-37.5
M20	4T, 4.8	2.5	144-180	14.7-18.3	1.5	172-210	17.5-21.5
	7T, 8T, 8.8		240-290	24.5-29.5		275-333	28.0-34.0
	10T, 11T		363-441	37-45		397-485	40.5-49.5

Bolt head identification mark	Strength grade	Example
	4.8	
	8.8	
	10.9	

Chapter 2. ENGINE

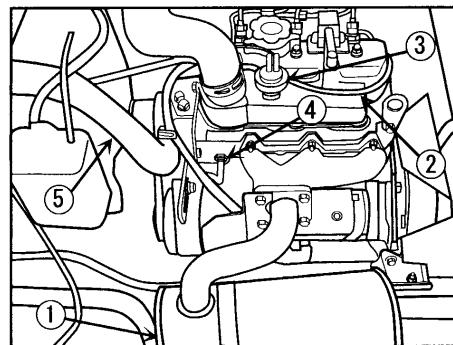
2-1 Engine Removal

- 1) If necessary, remove bolts and nuts ① and the bonnet.



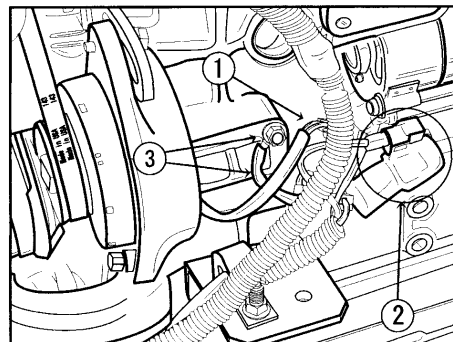
100V

- 2) Remove the muffler ① from the engine.
- 3) Disconnect the fuel return hose ② from the fuel return pipe.
- 4) Disconnect the wiring from the air cleaner clogging sensor ③.
- 5) Disconnect the wiring from the water temperature sensor ④.
- 6) Remove the radiator hoses ⑤ from the engine.



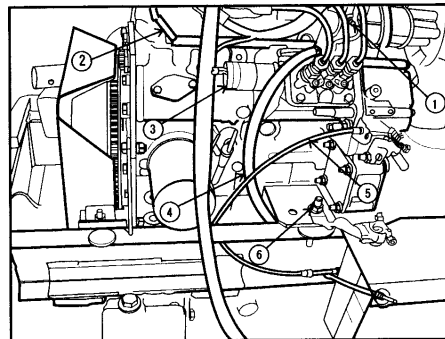
101V

- 7) Disconnect the wiring from the alternator ①.
- 8) Disconnect the wiring from the starting motor ②.
- 9) Remove the bolt ③ and ground wire from the cylinder block.



102V

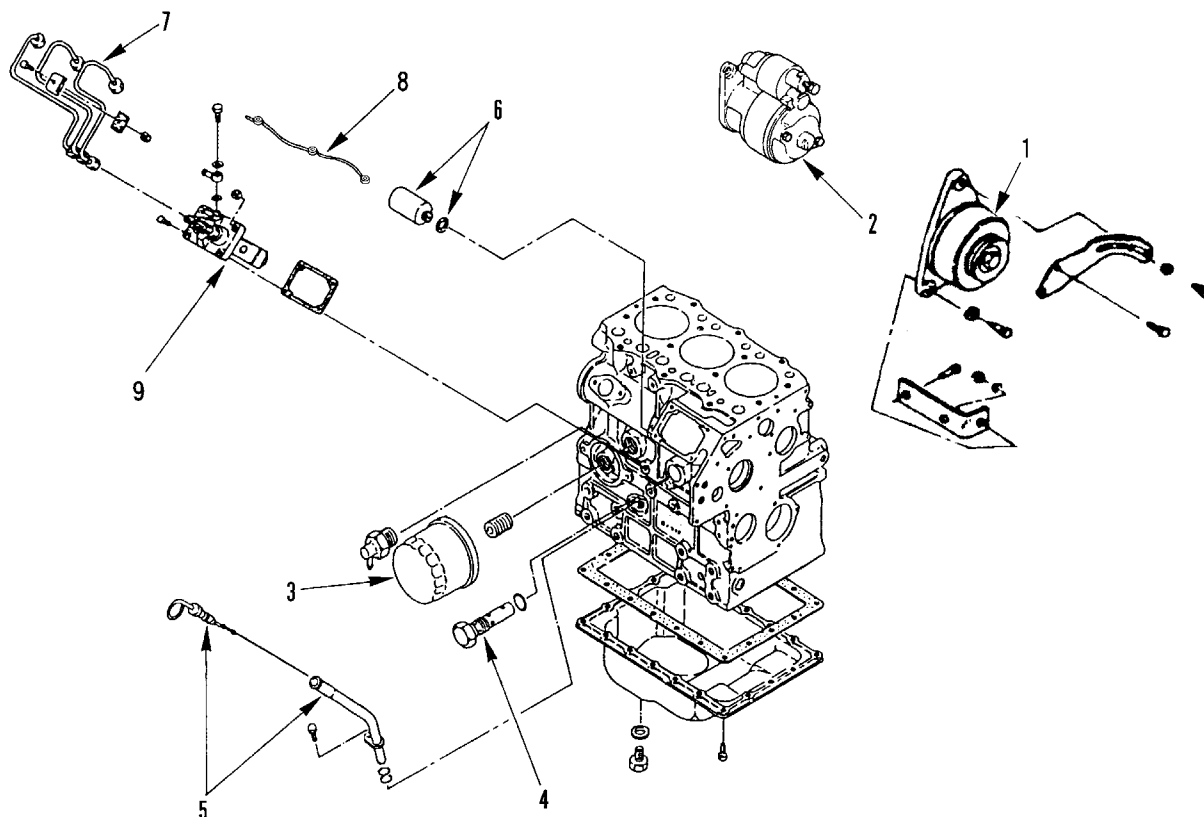
- 10) Disconnect the wiring from the engine oil pressure switch ①.
- 11) Disconnect the wiring from the glow plug connector ②.
- 12) Disconnect the wiring from the engine stop solenoid ③.
- 13) Disconnect the fuel pipe ④ from the injection pump.
- 14) Remove the accelerator wire ⑤ from the engine.
- 15) Remove the engine attaching nuts ⑥ and hoist the engine from the frame.



103V

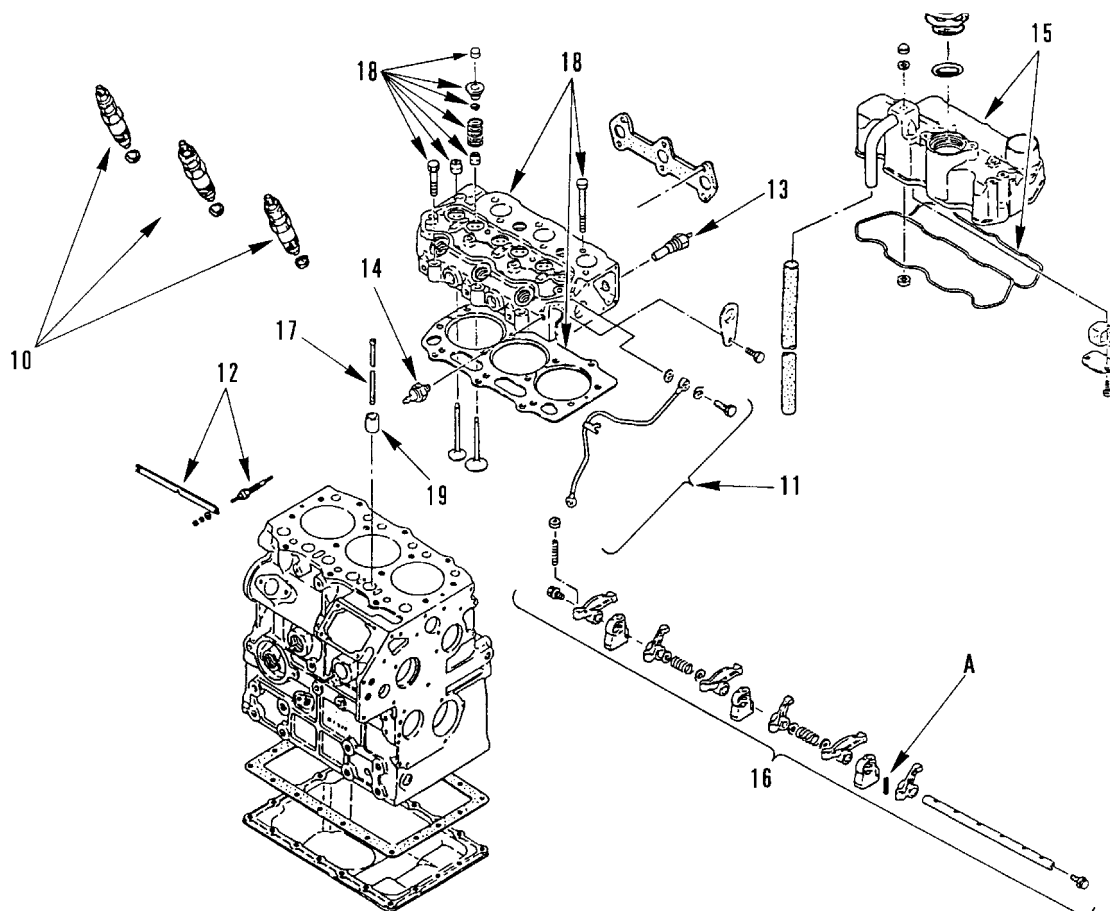
2-2 Disassembly, Inspection and Reassembly

1. DISASSEMBLY



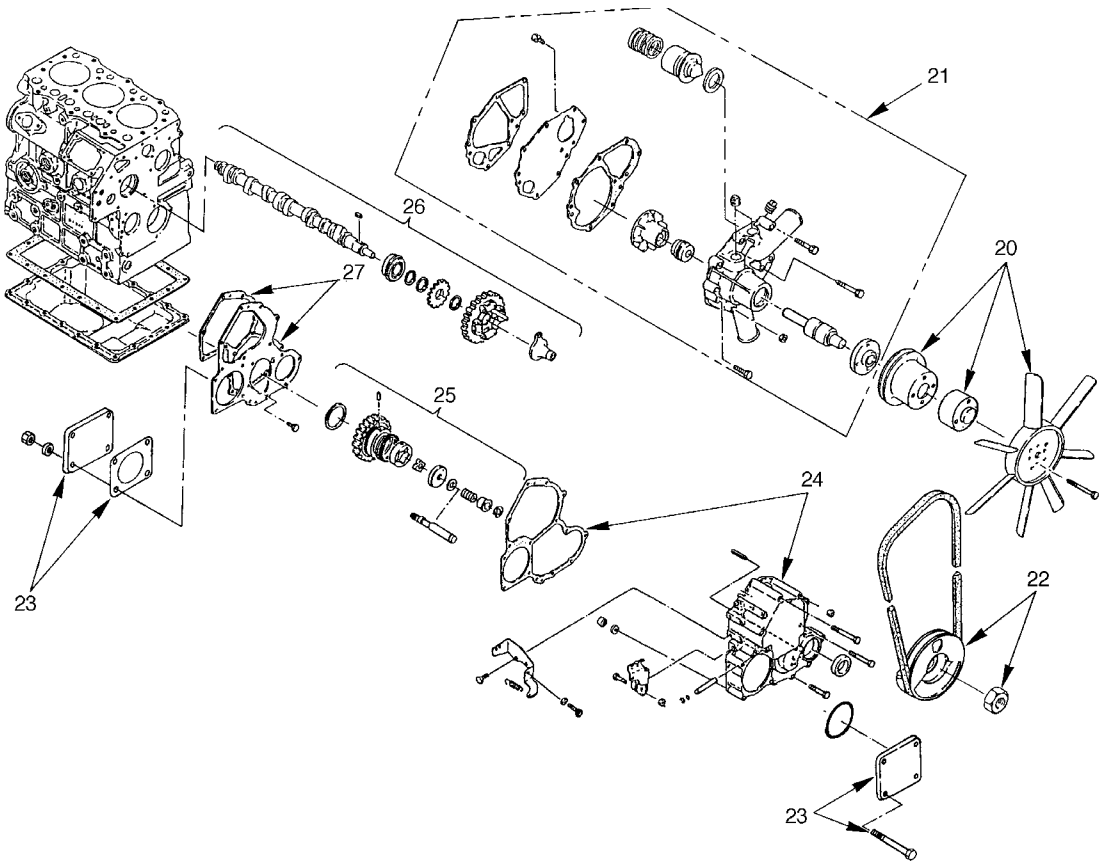
104V

Order	Disassembly Parts Name
1	Alternator
2	Starting motor
3	Oil filter
4	Relief valve
5	Oil level gauge · Gauge guide
6	Engine stop solenoid · Seal washer
7	Injection pipe
8	Return pipe
9	Injection pump NOTE: 1. Remove the injection pipes and engine stop solenoid before remove the injection pump. 2. Raise the injection pump and disconnect the governor link from the control rack by remove the snap pin. 3. Injection timing has been adjusted by the shims between injection pump and cylinder block. Take note of their thickness and number when removing the injection pump.



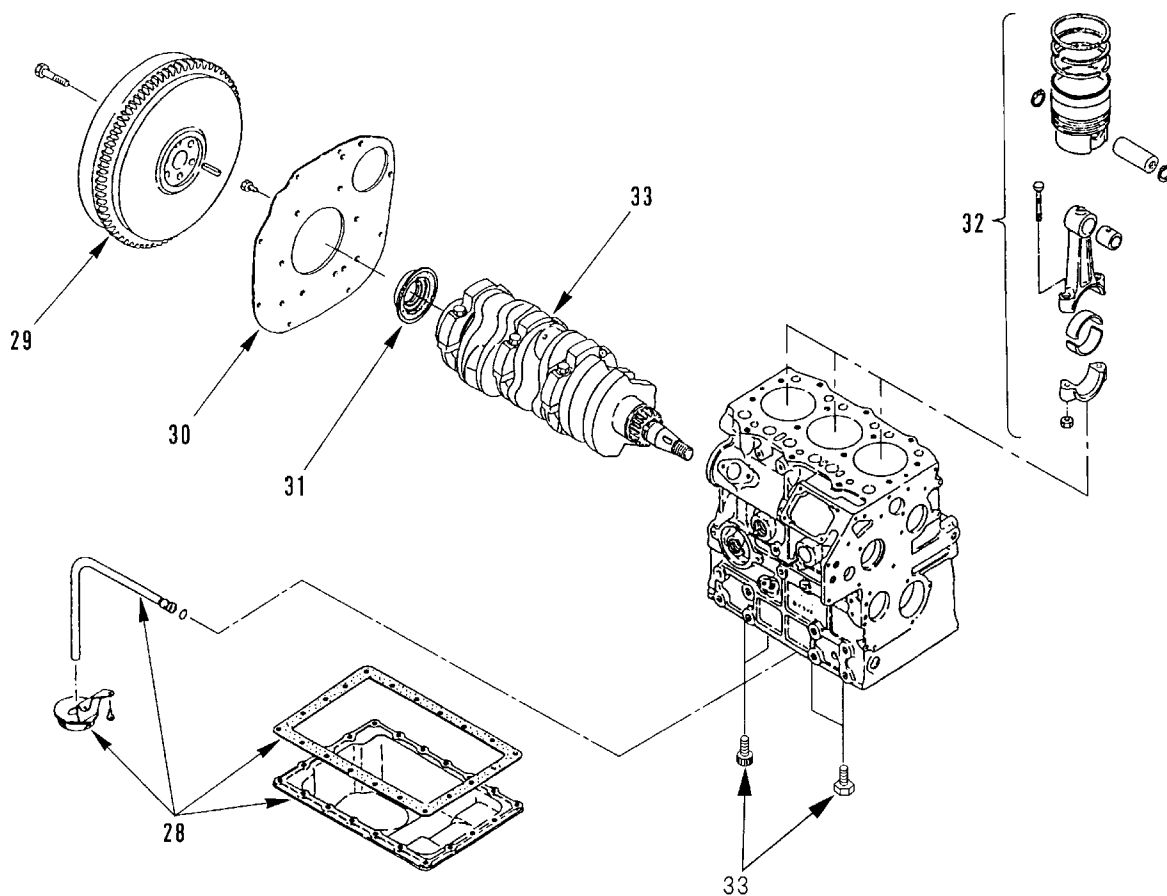
105V

Order	Disassembly Parts Name
10	Injection nozzle · gasket
11	Oil transfer pipe · Eye bolt · Seal washer
12	Connector · Glow plug
13	Thermo-sensor
14	Oil pressure switch
15	Head cover · O-ring
16	Rocker arm assembly NOTE: Draw out the roll pin (A) from the No. 1 rocker arm bracket, and remove the rocker arm shaft.
17	Push rod
18	Cylinder head · Head gasket NOTE: 1. Untighten the cylinder head bolts in several steps and remove the cylinder head assembly and head gasket.
19	Tappet



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Order	Disassembly Parts Name
20	Cooling fan · V-belt · Fan holder · Fan pulley
21	Water pump assembly · Thermostat · Gasket
22	Crankshaft pulley
23	Covers
24	Timing gear case assembly · Gasket NOTE: Remove the engine stop solenoid and injection pump assembly at first.
25	Idle gear · Oil pump assembly
26	Cam shaft assembly NOTE: Remove the bolts and plate at first, and draw out the cam shaft assembly.
27	Front plate · Gasket



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Order	Disassembly Parts Name
28	Oil pan · Gasket · Suction filter · Suction pipe
29	Fly wheel
30	Rear plate
31	Oil seal
32	Piston and connecting rod assembly NOTE: 1. Before extracting piston, remove the carbon deposit from the TDC in the cylinder. 2. Place the connecting rod, cap and bearing removed in order of the cylinders.
33	Crank shaft and bearing holder assembly NOTE: Remove the four bolts, and draw out the crank shaft and bearing holder assembly as a set.

2. DISASSEMBLY AND INSPECTION OF ENGINE MAIN PARTS

* Cautions before start

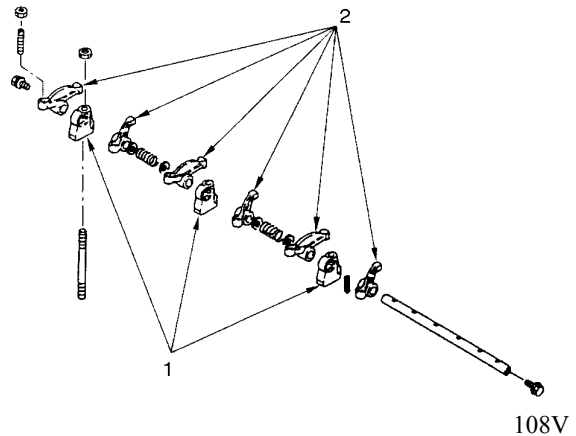
- 1) Check the cylinder block and cylinder head for wear, leakage and damage.
- 2) Remove deposit in oil holes of each part with air and check for clogging.
- 3) Wash each part well to remove dust, contaminated oil, carbon, and other foreign matter.
- 4) Remove carbon deposite on the piston, cylinder head, valves, etc. carefully not to damage parts. (Great care is necessary specifically for aluminum alloy parts.)
- 5) Valves, pistons, connecting rods, metals and other parts which are to be combined as specified should be attached match marks beforehand to prevent confusion.

1) Rocker arm ass'y

Disassembly

- (1) Remove the bolts at both ends of the rocker arm shaft and take out the rocker arm, rocker arm bracket, spring and shim.
- (2) Extract the spring pin which has been driven into the No. 1 cylinder rocker arm bracket and take out the rocker arm, spring and bracket.

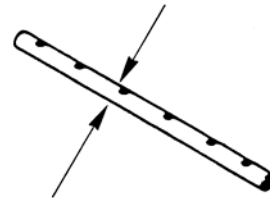
1. Rocker arm bracket
2. Rocker arm



Inspection and service

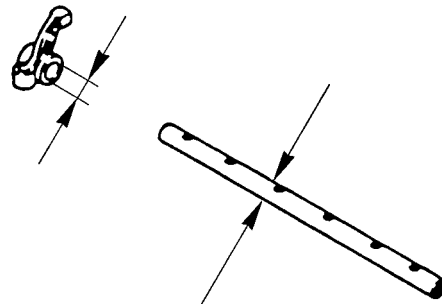
- (1) Using a micrometer, check outside diameter of the rocker arm shaft. If the shaft is worn exceeding service limit, replace it with new one.

Wear of rocker arm shaft (Ø)	
Standard assembling value	Service limit
11.65 – 11.668	Less than 11.57



- (2) Measure the inside diameter of the rocker arm. Calculate the clearance between the rocker arm and rocker arm shaft. If the clearance is excessive, replace the part.

Clearance between rocker arm and rocker arm shaft (mm)	
Standard assembling value	Service limit
0.032 – 0.068	More than 0.2

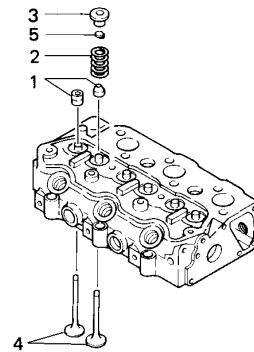


2) Cylinder head ass'y

Disassembly

- (1) Using a valve spring replacer, compress the valve spring to remove the valve cotter, retainer, spring and valve.
- (2) Remove the valve guide seal.

- | | |
|---------------------|-----------------|
| 1. Valve guide seal | 4. Valve |
| 2. Spring | 5. Valve cotter |
| 3. Retainer | |

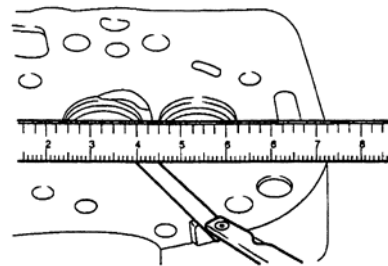


111V

Inspection and service

- (1) Distortion of cylinder head bottom surface.
Apply a straight edge to the bottom surface of the cylinder head, and insert a thickness gauge at 6 points from A to F in the right figure and measure distortion. If the distortion exceeds the repair value, correct with surface grinder or the like.

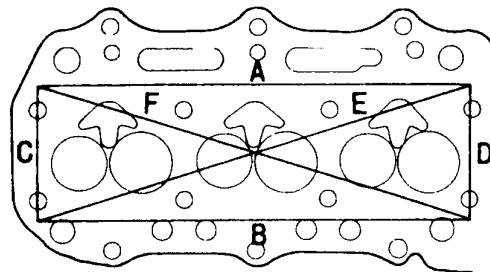
Distortion at cylinder head bottom surface (mm)	
Standard assembling value	Repair value
Less than 0.05	More than 0.12



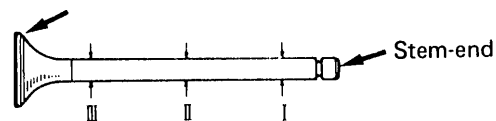
112V

- (2) Valve guide and valve stem
 - ① Check the head and stem of each valve and replace if burnout, wear or deformation is remarkable.
 - ② Measure the outside diameter at the position I, II, and III on the valve stem with a micrometer and replace if the result is less than the service limit.

Wear of valve stem (mm)			
Intake valve		Exhaust valve	
Standard assembling value	Service limit	Standard assembling value	Service limit
6.955 – 6.97	6.89	6.94 – 6.955	6.84



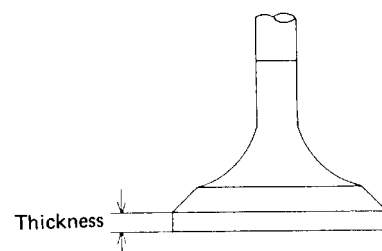
113V



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- ③ Replace a valve if its head thickness is less than service limit.

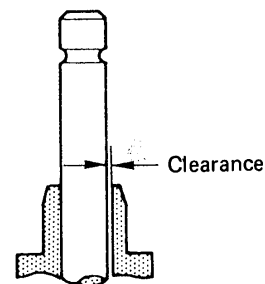
Valve head thickness (mm)	
Standard assembling value	Service limit
0.775 – 1.075	Less than 0.5



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- ④ Replace the valve if the clearance between the stem and guide exceeds the service limit.

Clearance between valve stem and valve guide (mm)			
Intake valve		Exhaust valve	
Standard assembling value	Service limit	Standard assembling value	Service limit
0.03 – 0.06	More than 0.2	0.045 – 0.075	More than 0.25



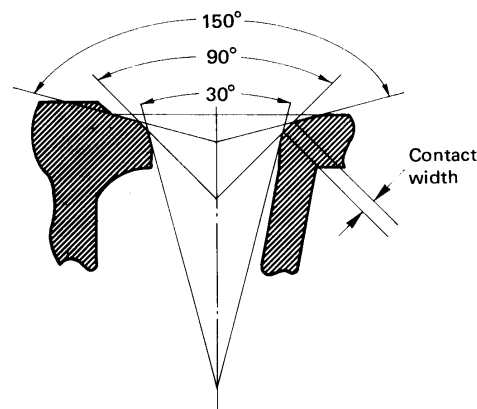
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(3) Valve seat

- ① Since the valve seat is corrected according to the valve guide, be sure to check the valve guide for wear condition first before correcting the seat.

- ② Correct the seat to the standard assembling values of the contact width and recess using seat cutters of 15°, 45° and 75°.

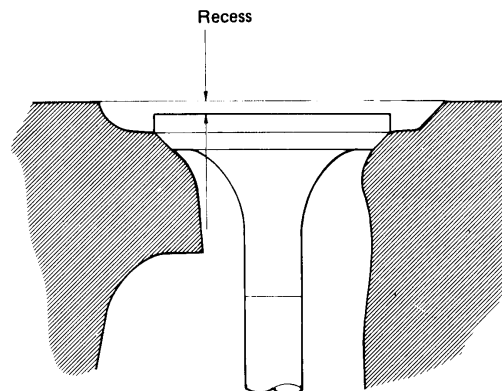
Valve seat contact width (mm)	
Standard assembling value	Repair value
1.7 – 2.1	More than 2.5



117V

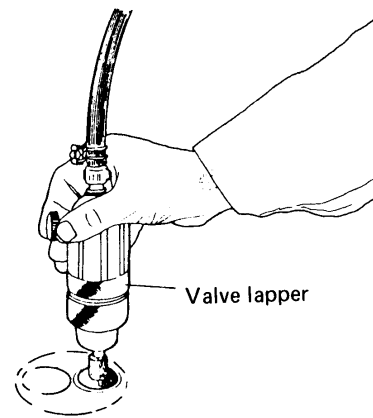
- ③ When the seat recess exceeds the service limit, replace the cylinder head.

Valve seat recess (mm)	
Standard assembling value	Service limit
0.85 – 1.15	More than 1.8



118V

- ④ Coat the valve seat surface with compound and lap the contact surface turning the valve.
- ⑤ Check that the valve contact surface is within the standard value and the contact position is even.
- ⑥ When the cylinder head is replaced with new one, adjust the seat contact width and seat recess to the specified values with a seat cutter before lapping.

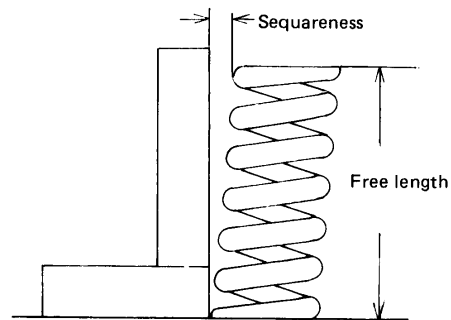


119V

(4) Valve spring

- ① Check the valve spring visually for damage.
- ② Measure the squareness of the spring using a square on a surface plate and replace if the service limit is exceeded.
- ③ Check the free length and spring force with a spring tester and replace if the service limit is exceeded.

	Standard assembling value	Service limit
Squareness (mm)	1.2	More than 2
Free length (mm)	35	Less than 33.5
Spring force (when compressed to 30.4 mm)	72.9 N {8.1 kgf}	68.6 N {Less than 7 kgf}



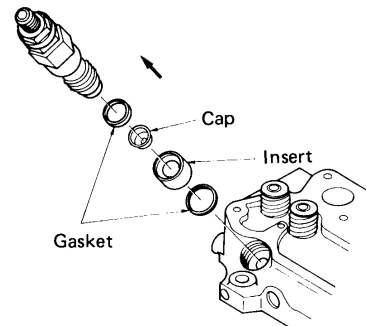
120V

(5) Inner face of combustion chamber

Pull out the cap from the cylinder head. Check and clean the combustion chamber.

NOTE:

1. Do not remove the insert.



121V

Reassembly

Reassemble components in the reverse order to disassembly taking care to the following point.
When assembling the valve spring, retainer and cotter, take deep care not to damage the valve guide seal.

3) Cylinder block

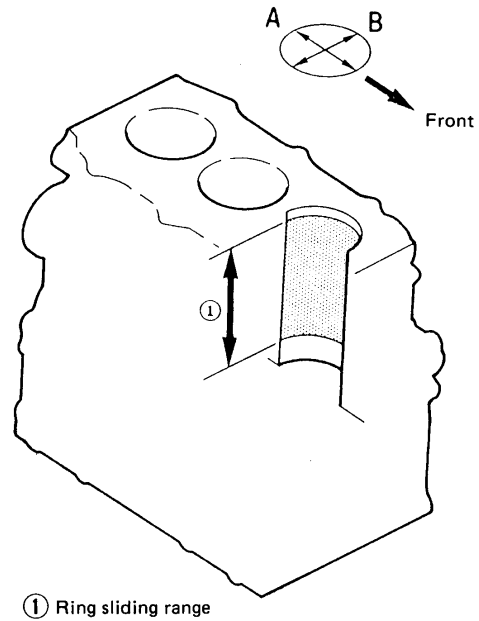
Inspection and service

(1) Check for crack, damage and distortion on the top of the block in the same way as in the cylinder head.

(2) Measurement of cylinder bore

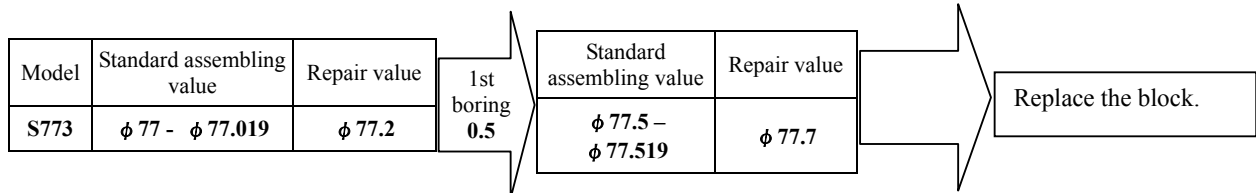
- ① There should be no scratch, rust, corrosion, etc. on the cylinder bore when checked visually.
- ② Measure the cylinder bore at the top, center and bottom respectively in the crankshaft direction (A) and the direction at right angle to it (B). If the repair value is exceeded, finish to an oversize by boring.
- ③ The above-described bore top corresponding to the top ring position at the piston TDC about **10 mm** below the cylinder block top surface, and the bottom corresponds to the oil ring position at the BDC about **100 mm** below the cylinder block top surface.
- ④ Use a cylinder gauge (inside dial gauge) for the measurement. Apply the gauge correctly at right angle to the bore wall surface.
- ⑤ Cylinder honing shall be conducted by boring according to the following specifications. Honing specifications (2-step honing according to Dia specifications)
 - Grinding stone: Tokyo Dia SD200
N100M (bronze type)
 - Finishing: GC600JB
 - Grinding stone size: 100L × 4W
 - Speed: 162 rpm
 - Axial feeding speed: 13 m/min
 - Gauge pressure: Rough finishing: 15kgf/cm²
Finishing: 5 kgf/cm²
 - Finishing stroke: 9
 - Honing allowance: 0.04 mm (diameter)
 - Cross hatch overall angle: 40°
 - Surface roughness: 2 – 4 μ

Distortion on cylinder block top surface (mm)	
Standard assembling value	Repair value
Less than 0.05	More than 0.12



122V

(Unit: mm)

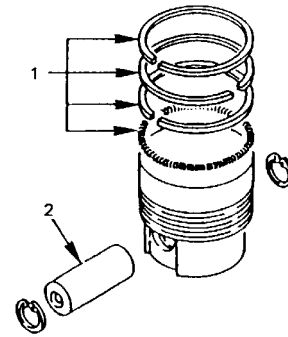


4) Piston and piston ring

Disassembly

- (1) Remove the piston ring using a piston ring tool.
- (2) Remove the snap ring and extract the piston pin.

1. Piston ring
2. Piston pin



Inspection

(1)Piston

- ① Check the piston for crack, streak and burnout on the outside surface and replace if remarkable.
- ② Measure the longer diameter at 10 mm above the lower end of the piston skirt and bore of the cylinder in the thrust direction, calculate the clearance, and replace if the repair value is exceeded.
- ③ When the cylinder is substituted with an oversize one, use a piston of an oversize.

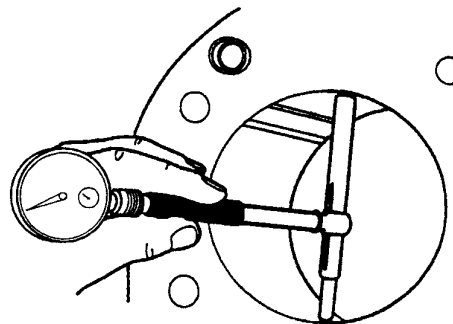
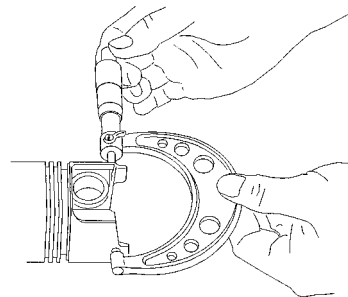
Clearance between cylinder and piston (mm)		
Model	Standard assembling value	Service limit
S773	0.0525 – 0.0815	0.25

Piston skirt bottom longer dia. (mm)		
Model	Standard assembling value	Service limit
S773	φ 76.9325-76.9475	φ 76.7

Model	Piston size	Part code No.	Skirt bottom longer dia.
S773	S.T.D	115317630	76.9325-76.9475
	O.S. 0.5	115317640	77.4325-77.4475

- ④ Measure the piston pin hole diameter and piston pin outside diameter and replace if the clearance exceeds the service limit.

Clearance between piston pin hole and piston pin (mm)	
Standard assembling value	Service limit
-0.004 ~ +0.006	0.02



123V

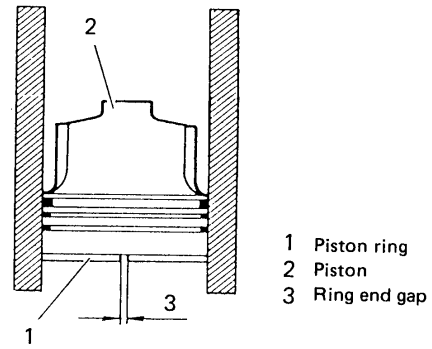
124V

125V

(2) Piston ring

- ① Replace worn out or damaged piston ring, if any.
- ② Insert a ring at a right angle to the least worn out skirt of a cylinder, measure the clearance of ring end gap with a thickness gauge and replace if the end gap exceeds the service limit.

Piston ring end gap (mm)		
	Standard assembling value	Service limit
Top ring	0.2 – 0.35	1.0
Second ring	0.2 – 0.35	1.0
Oil ring	0.15 – 0.35	1.0



126V

- ③ Measure the clearance between the piston ring groove and ring and replace if the service limit is exceeded.

Clearance between piston ring groove and ring (mm)		
	Standard assembling value	Service limit
Top ring	0.06 – 0.1	More than 0.25
Second ring	0.05 – 0.09	More than 0.25
Oil ring	0.02 – 0.06	More than 0.15

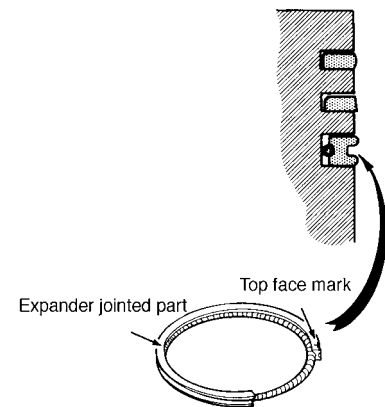
- ④ When the cylinder is replaced with an over size one, use a piston ring set of over size accordingly. Piston kit composed of piston and piston rings are available.

Model	Piston ring size	Part code No.
S773	S.T.D.	115107240
	O.S. 0.5	115107430

Piston kit		
Model	Size	Part code No.
S773	S.T.D.	115016990
	O.S. 0.5	115016980

⑤ Piston ring installing procedure

Install the piston ring to the piston as shown in the right figure.



127V

(3) Piston pin

Measure the outside diameter of the piston pin and replace if the service limit is exceeded.

Piston pin outside dia. (ø)	
Standard assembling value	Service limit
20.998 – 21.002	Less than 20.98

5) Connecting rod

Inspection

- (1) Check for torsion, parallelism and damage.
Measure the torsion and parallelism using a connecting rod aligner and correct or replace if the repair value is exceeded.
- (2) Measure the bore of the connecting rod small end bush and replace if the clearance to the piston pin exceeds the service limit.
- (3) Install the connecting rod to the crankshaft, measure the axial play and replace the connecting rod if the service limit is exceeded.

6) Connecting rod metal

Inspection

- (1) Check the metal and if peeling, melting, uneven wear, improper contact or other damage is noticed, replace the metal.
- (2) Measure the oil clearance of the crank pin and metal using plasti-gauge.
 - ① Remove oil dust or other foreign matter stuck to the metal and crank pin.
 - ② Cut plasti-gauge to the length same as the metal width and place it on the crank pin in parallel with the crankshaft avoiding the oil hole.
 - ③ Install the connecting rod metal and connecting rod cap and tighten with the specified tightening torque.

Tightening torque	29.4 – 34.3 N·m {3.0 – 3.5 kgf·m}
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NOTE: Never turn the connecting rod at this time.

- ④ Remove the connecting rod cap and measure the plasti-gauge width with the scale printed on the gauge envelope.

NOTE: Measure the widest part of the plasti-gauge.

- (3) If the oil clearance exceeds the service limit according to the result of the measurement, replace the metal or grind the crank pin and replace with a metal of undersize.

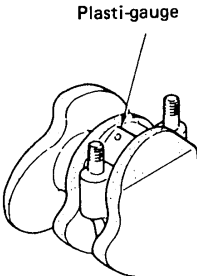
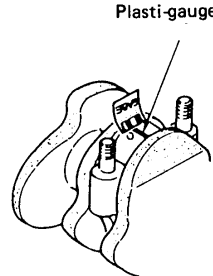
NOTE:

1. When the crank shaft pin outside is ground, check the oil clearance before installing it.
2. Grind the crank pin precisely referring to the paragraph of the crank shaft about the finishing accuracy and oil holes.

Torsion and parallelism of connecting rod (mm)		
	Standard assembling value	Repair value
Torsion (per 100 mm)	Less than 0.08	More than 0.2
Parallelism (per 100 mm)	Less than 0.05	More than 0.15

Clearance between bush and piston pin (mm)	
Standard assembling value	Service limit
0.008 – 0.023	More than 0.08

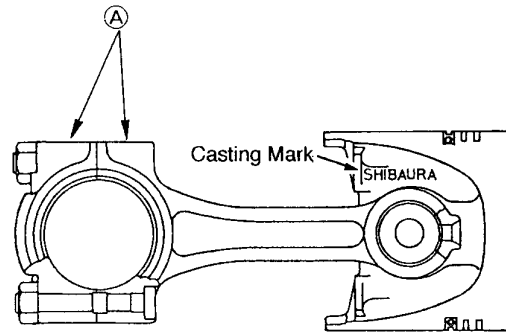
Axial play of connecting rod and crank pin (mm)	
Standard assembling value	Service limit
0.1 – 0.3	More than 0.7

Clearance between crank pin and connecting rod metal (oil clearance) (mm)	
Standard assembling value	Service limit
0.035 – 0.083	0.2
Set a plasti-gauge.  128V	Measure the oil clearance.  129V

Metal size	Metal code No.	Crankshaft pin outside dia. Finishing dimension (φ)
S.T.D.	198517130	38.964 – 38.975
U.S. 0.25	198517134	38.714 – 38.725
U.S. 0.50	198517137	38.464 – 38.475

Reassembly (piston and connecting rod)

- (1) Heat the piston to about 100°C with a piston heater or the like and install it aligning the SHIBAURA mark in the piston and match mark at ① of the connecting rod.
- (2) Care should be taken to the figure match mark at ① of the connecting rod.
- (3) Install the piston ring to the piston facing the stamp at the end surface of the ring end gap upward.
- (4) When the connecting rod or piston and piston pin are replaced, weight variation among cylinders with the rod, piston and piston ring installed should be within 10 g.



130V

7) Disassembly, inspection and reassembly of bearing holder

Disassembly and inspection

Center bearing

- (1) Remove the bearing holder, and replace the metal if peeling, melting, uneven wear, or improper contact is noticed.
- (2) Measure the oil clearance of the crankshaft center journal and metal using a plasti-gauge.
- (3) If the oil clearance exceeds the service limit according to the result of the measurement, replace the metal or grind the crankshaft center journal according to paragraph 9) and replace with a metal of undersize.

NOTE: Care should be taken about the No. 4 bearing of S773 since it is made of aluminum and the oil clearance is different from that of other journals.

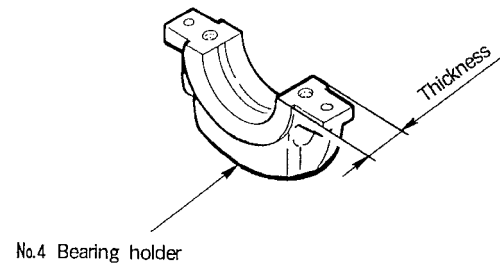
Clearance between crankshaft center journal and metal (oil clearance) (mm)		
Standard assembling value		Service limit
No.2 and 3	0.039 – 0.092	0.2
No. 4	0.029 – 0.082	

Metal size	Metal code No.	Crankshaft center journal finishing dimension (φ)	
S.T.D.	198517101 (upper) 198517110 (lower)	No.2 and 3	45.964 – 45.975
		No. 4	45.954 – 45.965
U.S. 0.25	198517105 (upper) 198517114 (lower)	No.2 and 3	45.714 – 45.725
		No. 4	45.704 – 45.715
U.S. 0.50	198517108 (upper) 198517117 (lower)	No.2 and 3	45.464 – 45.475
		No. 4	45.464 – 45.465

No.4 bearing holder

Check the bearing holder thrust surface and replace if wear, improper contact, seizure or other troubles are noticed or if the thickness is below the service limit.

Rear bearing holder thickness (Made of aluminium die cast only) (mm)	
Standard assembling value	Service limit
21.85 – 21.95	21.55



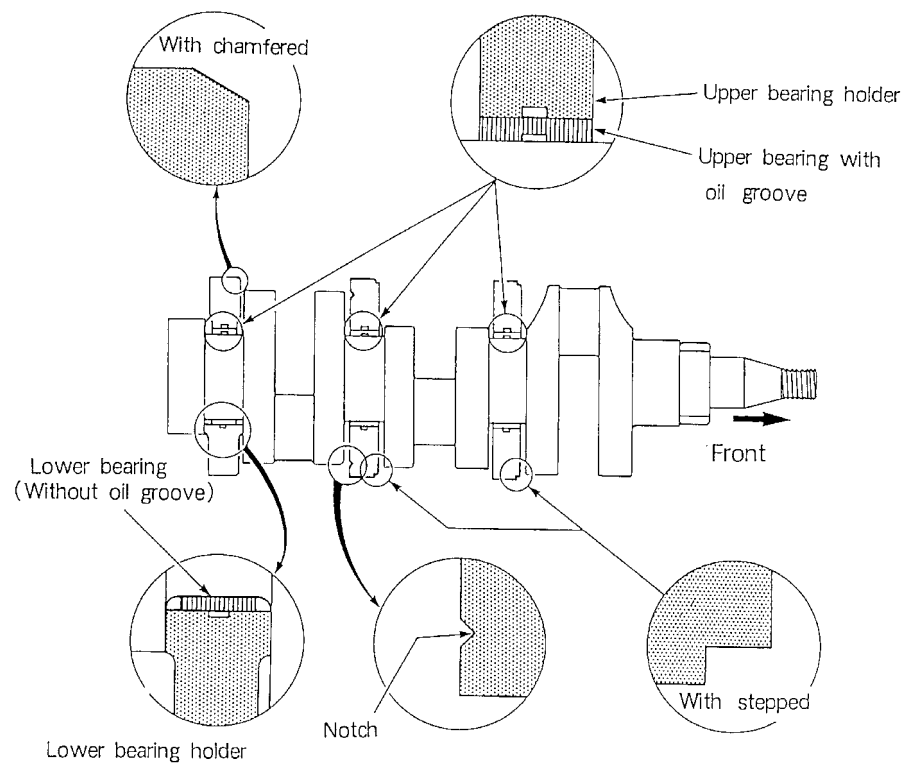
131V

Reassembly (bearing holder, center bearing, thrust washer)

- (1) Install the metal with oil groove to the upper bearing holder and the metal without oil groove to the lower bearing holder
- (2) Install the aluminum bearing holder to the flywheel side with the stepped part facing the front and the bearing holder with identification cutting mark at the center.

Bearing holder tightening torque	$20 - 25 \text{ N} \cdot \text{m}$ $\{2.0 - 2.5 \text{ kgf} \cdot \text{m}\}$
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NOTE: Be sure to confirm that the oil holes of the bearing holder and that of the block are in the same direction.



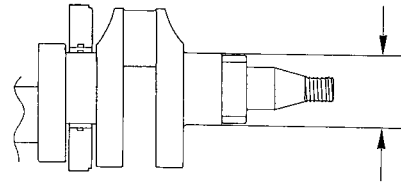
132V

8) Crankshaft bearing (bush)

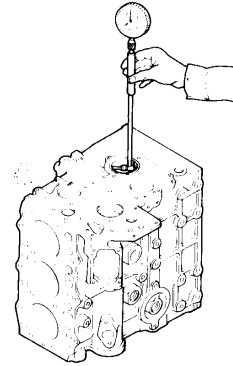
Inspection

- (1) Check the bearing (bush) and replace if peeling, melting, uneven wear, improper contact, or other damage is notice.
- (2) Measure the oil clearance of the bearing (bush) and crankshaft journal using a cylinder gauge and micrometer.
- (3) If the oil clearance exceeds the service limit according to the result of measurement, replace the bearing (bush) or grind the crankshaft journal according to paragraph 9) and replace with a bearing (bush) of undersize.

Clearance between crankshaft journal and bearing (bush) (oil clearance) (mm)		
Model	Standard assembling value	Service limit
S773	0.039 – 0.106	More than 0.2



133V

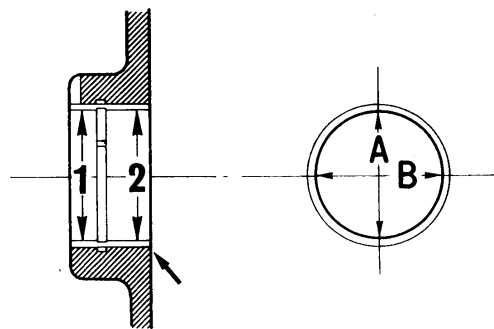


134V

Model	Bush size	Bush code No.	Crankshaft journal outside dia. Finishing dimension (ϕ)
S773	S.T.D.	198517080	45.964 – 45.975
	U.S. 0.25	198517084	45.714 – 45.725
	U.S. 0.50	198517087	45.464 – 45.475

NOTE:

1. Measure the dimensions in the A and B directions at the position 1 and 2 in the right figure avoiding the oil hole of the bearing (bush) and calculate difference from the maximum value of the crankshaft journal (oil clearance).
2. When replacing the bush, push it up using a press or the like. At this time, align the oil holes and push it up until the bush end surface becomes level with the outside machined surface of the cylinder block (see the arrow mark in the right figure).
3. When the crankshaft journal is ground, confirm the oil clearance before reinstalling it.

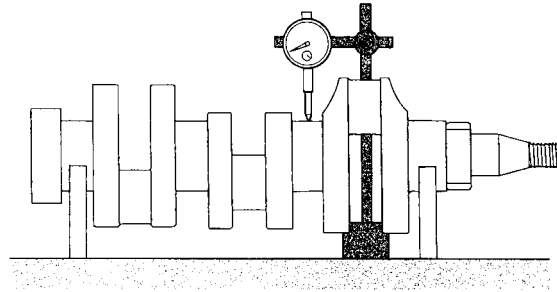


T135

9) Crankshaft

Inspection

- (1) To measure run-out of the crankshaft, support the crankshaft using a V block as shown in the right figure, apply a dial gauge to the crankshaft center journal, read the indication on the dial gauge rotating the shaft one turn gently. If the service limit is exceeded, correct or replace.

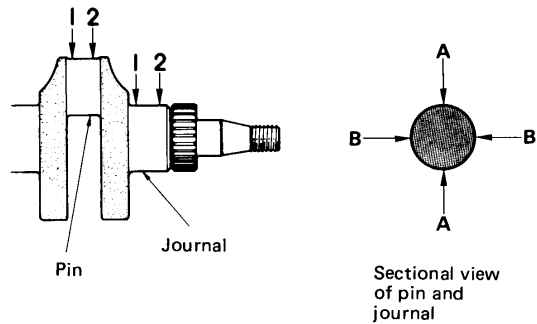


136V

Crankshaft run-out (mm)	
Standard assembling value	Service limit
Less than 0.03	More than 0.06

- (2) Check the crankshaft oil seal for damage or wear on the contact surface and oil hole clogging.

- (3) Check the crankshaft journal and pin for damage, irregular wear (ellipticity, conicalness), and shaft diameter and grind the journal and pin if the service limit or repair value is exceeded and replace the bearing (bush) and connecting rod metal respectively with one of undersize. Measure the dimensions of the journal and pin in the AA and BB directions at the position 1 and 2 avoiding the oil holes.

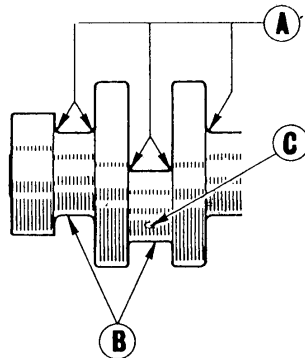


137V

NOTE: Finishing accuracy when grinding the crankshaft to undersize shall be as follows.

- (A) R at pin and journal: **3R ± 0.2**
- (B) Finishing accuracy: **1.6 Z (▽▽▽)**
- (C) R around oil hole
 - At max. part: **2R**
 - At min. part: **0.5R**

Finish using #400 sand paper.



138V

Irregular wear limit of crankshaft journal and pin (mm)		
More than 0.05		
Shaft dia. At crankshaft journal		
	Outside dia. Finishing dimension	Repair value
S.T.D.	45.964 – 45.975	Less than 45.9
U.S. 0.25	45.714 – 45.725	Less than 45.65
U.S. 0.50	45.464 – 45.475	Less than 45.40
Shaft dia. At crankshaft pin (φ)		
	Outside dia. Finishing dimension	Repair value
S.T.D.	38.964 – 38.975	Less than 38.90
U.S. 0.25	38.714 – 38.725	Less than 38.65
U.S. 0.50	38.464 – 38.475	Less than 38.40

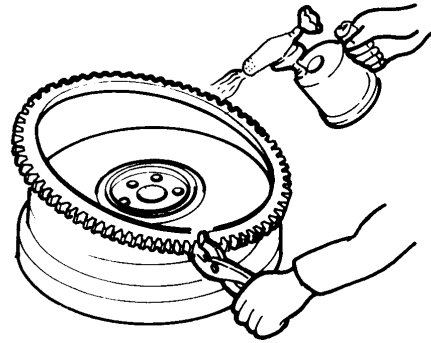
*Replace the crankshaft if U.S. 0.50 is exceeded.

10) Flywheel and ring gear

Inspection

Check the ring gear and replace if damage or remarkable wear is noticed.

When the wear is limited to a small area, remove the ring gear, turn it about 90 degrees and shrinkage-fit to reuse it. To shrinkage-fit the ring gear, heat it to 120 – 150°C to allow it to expand.



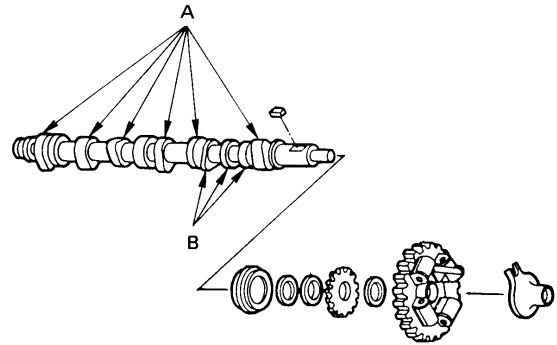
139V

11) Cam shaft ass'y

Inspection

- (1) Check the journal and cam for wear and damage and replace if the service limit is exceeded.
- (2) Correct insignificant uneven wear or scars on the cam surface using oil stone or the like.

A. Height of intake/exhaust valve cams (mm)	
Standard assembling value	Service limit
26.56 – 26.63	Less than 26.1
B. Height of injection pump cams (mm)	
Standard assembling value	Service limit
33.94 – 34.06	Less than 33.8



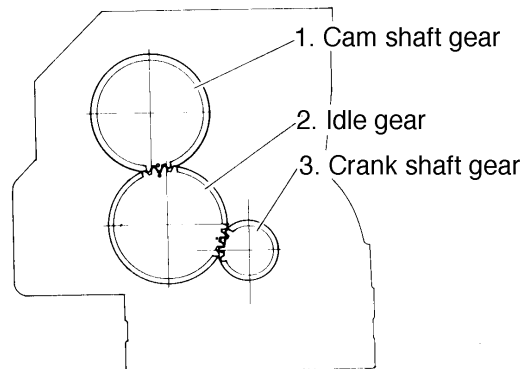
140V

12) Timing gear

Inspection

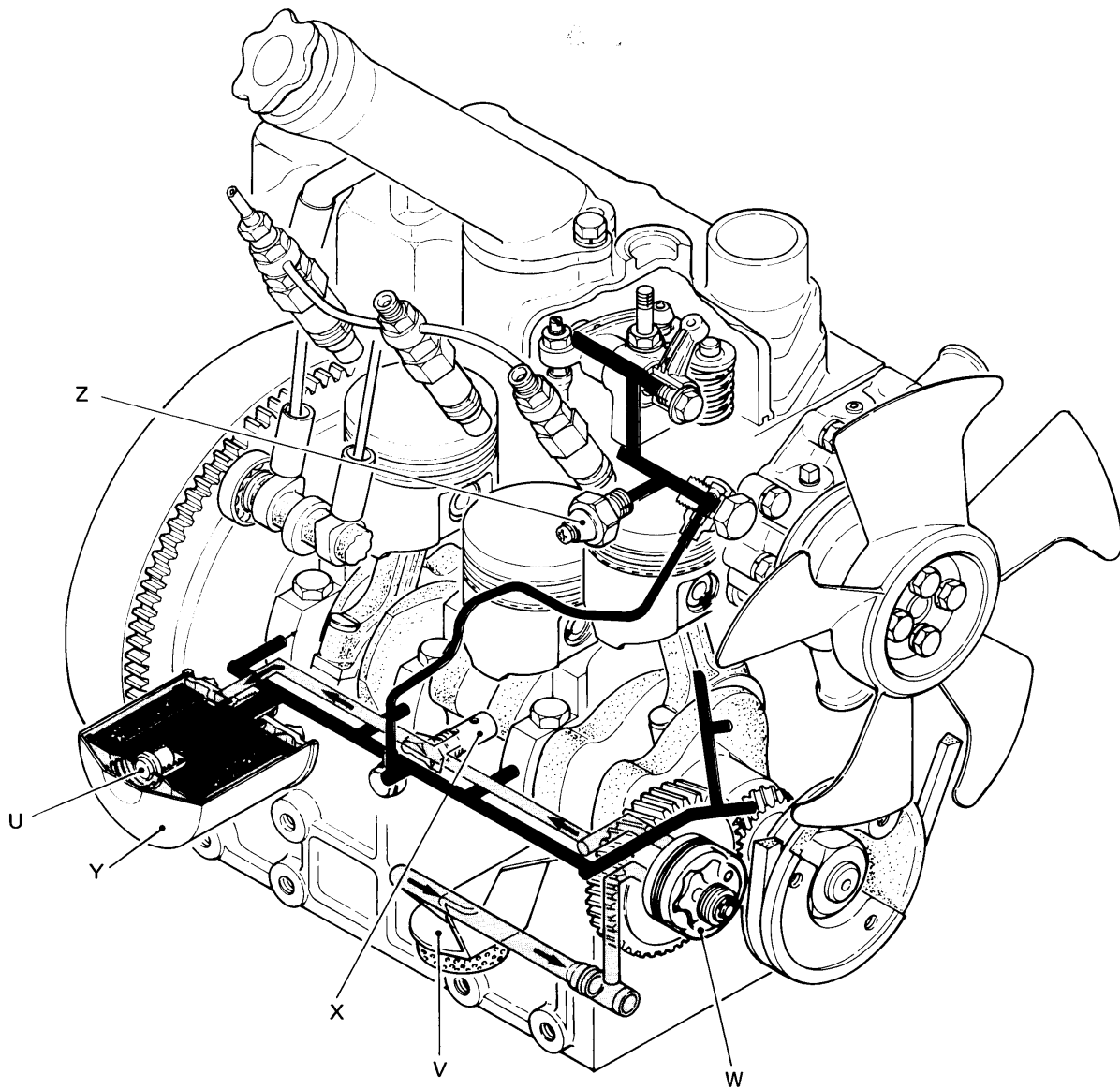
- (1) If pitting or remarkable wear is observed on the tooth face of gears, replace the gear.
- (2) Measure the backlash of gears and replace if the service limit is exceeded.

Timing gear backlash (mm)	
Standard assembling value	Service limit
0.08	More than 0.25



141V

13) Oil flow



U: Safety valve

V: Suction filter

W: Oil pump

X: Relief valve

Y: Oil filter

Z: Oil pressure switch

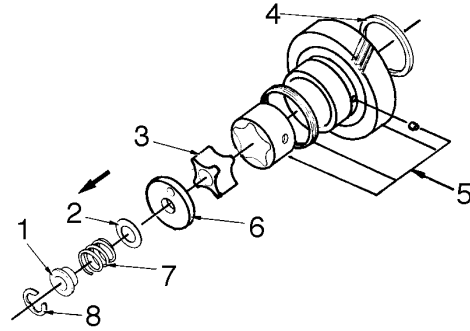
142V

14) Oil pump

Disassembly

Removal from engine

- (1) Remove the snap ring.
- (2) Take out the collar, spring and shim.
- (3) Take out the idle gear, vane, and oil pump cover together.
- (4) Extract the rotor and thrust washer.
- (5) Extract the oil pump cover from the idle gear.

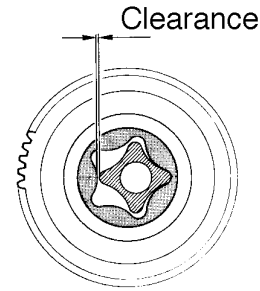


143V

- | | |
|------------------|--------------------|
| 1. Collar | 5. Idle gear ass'y |
| 2. Shim | 6. Oil pump cover |
| 3. Rotor | 7. Spring |
| 4. Thrust washer | 8. Snap ring |

Inspection and reassembly

- (1) Check the oil pump cover, rotor and vane and replace if worn out or damaged remarkably.
- (2) Check the clearance between the rotor and vane and replace if the service limit (0.25 mm) is exceeded.
- (3) Reassemble in the order reverse to disassembly.
 - ① Install the crankshaft gear and idle gear aligning the match mark.
 - ② Adjust the side clearance of the rotor and vane to **0.1 – 0.15 mm**. (See the assembling order 12, 164V.)

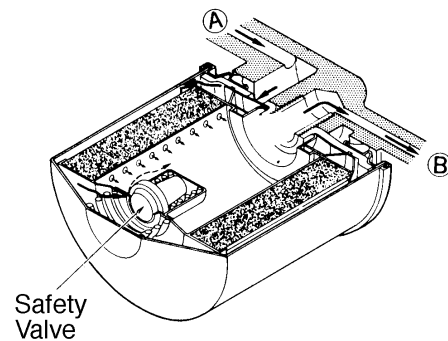


144V

15) Oil filter

Structure and Functions

- (1) The cartridge type oil filter is excellent in filtering performance.
- (2) Since it is of the full-flow type, when the filter is clogged, the safety valve is opened to allow the oil to flow, preventing seizure or other troubles.
- (3) The oil fed under pressure with the oil pump enters ①, is filtered by the element, and supplied to each part from ②.
When the element is clogged, the oil is supplied to each part without passing through the element.



145V

Replacement

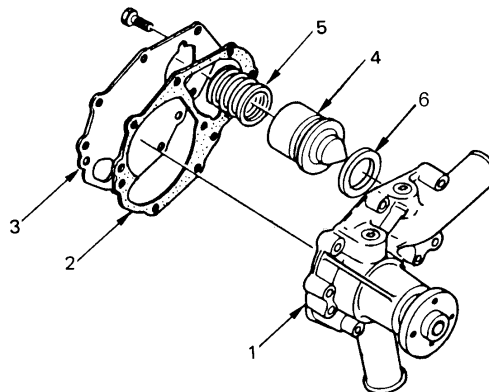
- (1) Replace the oil filter every 200 hours of operation.
- (2) Coat the filter mounting surface with oil and tighten the filter by hand.
- (3) Do not reuse the filter if it is removed once.

16) Water pump assembly and thermostat

Disassembly

- (1) Remove the set plate gasket.
- (2) Remove the thermostat spring.
 1. Water pump ass'y
 2. Gasket
 3. Set plate
 4. Thermostat
 5. Spring
 6. Gasket

NOTE: The pump main body is aluminum die cast and should be replaced as ass'y if subjected to water leakage or other troubles.



146V

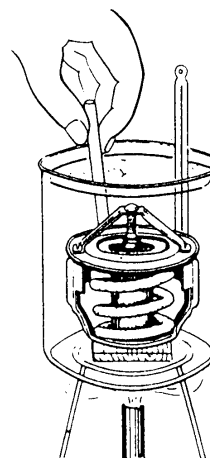
Specification and inspection

Thermostat

- (1) Replace if the valve is opened even only slightly at normal temperature.
- (2) Immerse the thermostat in water, increase the water temperature gradually and check the valve opening temperature and valve lift.

NOTE: 3 to 5 minutes are required until the valve is operated.

Model	S773
Type	Wax pellet
Opening temperature	80° - 84°C
Full-opening temperature	95°C
Valve lift (at water temperature 95°C)	8.0 mm



147V

Reassembly

Reassemble the components in the reverse order to disassembly.

17) Radiator

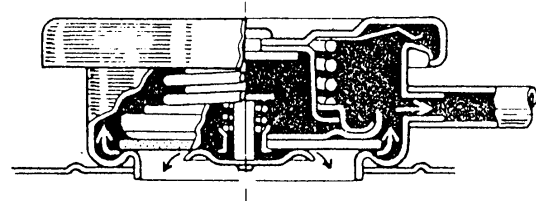
Specifications and structure

Structure

- (1) The radiator is provided with the plate fin having superior anti-vibration characteristics.
- (2) The radiator cap is of the pressure type (sealing type) for higher cooling efficiency.

When the cooling water is heated to high temperature (high pressure), the pressure valve is pushed and opened to release excessive pressure from the overflow pipe (shown by white arrow mark).

When the cooling water temperature reduces and the inside pressure becomes lower than the atmospheric pressure, the negative pressure valve is opened to protect the radiator from being crushed under the atmospheric pressure (shown by black arrow mark).



148V

Specifications	
Fin type	Corrugated
Cooling water volume	3.5 ℓ
Pressure valve starting pressure	68.6 – 88.2 kPa {0.7 – 0.9 kgf/cm ² }
Negative pressure valve starting pressure	3.92– 4.9 kPa {0.04 – 0.05 kgf/cm ² }
Heat radiation volume	15,000 kcal/h

Inspection

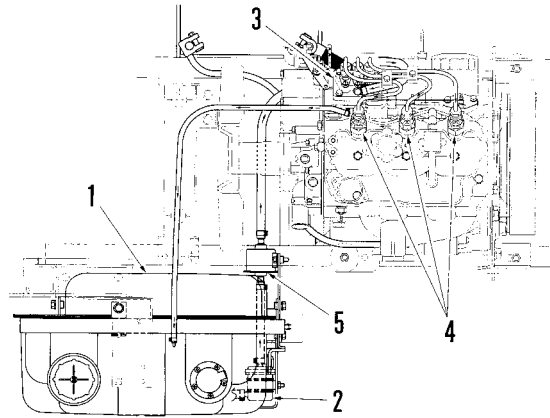
- (1) Check the radiator pipe for water leakage and repair or replace if unsatisfactory.
- (2) Check the radiator fin and remove dust, mud, or other foreign matter clogging in the air passage, if any.
- (3) Check the pressure valve and negative pressure valve of the radiator cap for valve opening pressure and sealing condition. Replace of defective.
- (4) Check the radiator hose and replace if damaged or aged.
- (5) If the net is clogged, remove and clean.

18) Fuel filter

Fuel passage

The fuel flows as shown in the figure from the tank, pressurized by the injection pump to high pressure, and fed to the nozzle and injected to the combustion chamber. The fuel after lubricating the nozzle needle is returned to the tank through the overflow pipe.

- | | |
|----------------|----------------------|
| 1. Tank | 3. Injection pump |
| 2. Fuel filter | 4. Nozzle and holder |
| | 5. Feed pump |



149V

Inspection

If water is observed in the transparent plastic case, drain the water.

If dust, or other foreign matter is observed in the transparent plastic case, replace the filter if necessary.

Disassembly and reassembly

1. Provide a suitable pan to catch the fuel from the tank.
2. Remove the clips on the both side of the fuel filter.
3. Drain the fuel from the tank.
4. Loosen the clamping bolt securing the fuel filter.
5. Drain water, or replace the fuel filter.
6. Reassembly generally follows the disassembly procedure in reverse.

⚠ WARNING: KEEP AWAY FROM FIRE.

19) Governor

Structure and functions

(1) Governor

This governor is a mechanical all-speed governor. It is installed in the gear case. The fly weight ass'y is installed to the cam shaft and its movement is transmitted to the control rack of the injection pump through the slider control lever link. The spring which controls the movement of the fly weight is hitched to the arm COMPL and tension lever. The spring tension is changed by changing the governor lever so as to control the engine speed.

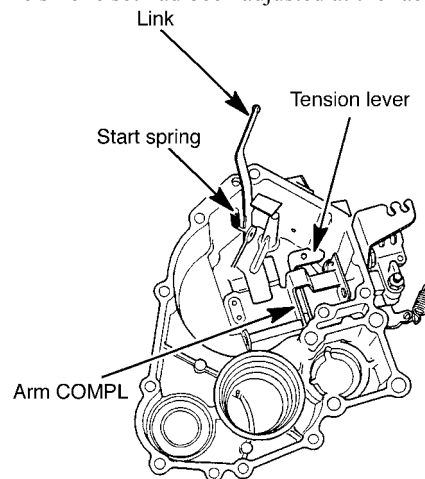
(2) Maximum speed set bolt

A bolt is mounted on the cylinder block. This bolt limits the movement of the arm COMPL (unloaded maximum rpm). This bolt has been adjusted and sealed at the factory.

(3) Smoke set, start spring

These are built into the cylinder block, to regulate fuel injection amount at high speed range. Regulation of fuel injection amount at middle speed range is made with torque control spring to realize bigger torque.

A start spring is placed between the gear case and link. This spring automatically functions to increase injection amount of fuel at the time of engine start. The smoke set had been adjusted at the factory.



150V

20) Injection pump

Specification

Engine Model	Part Code No.	Manufacturer and Injection Pump Type
S773	131017710	NIPPON DENSO 094500 – 7410

Disassembly, Inspection and Reassembly

- (1) Disassembly, inspection, and reassembly of injection pump. If the trouble has been verified to be in the injection pump, do not disassemble other than at shop specializing in this operation.

21) Nozzle and holder

Specifications

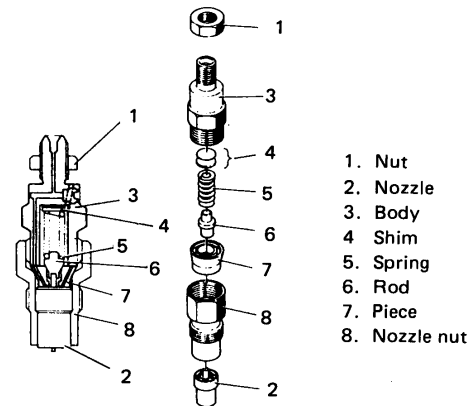
Part code	131406330	Nozzle type	Throttle type
Ass'y No.	093500 – 3320	Needle valve dia.	$\phi 6$
		Pintle dia.	$\phi 1$
		Valve opening pressure	11.27 – 12.25 MPa {115 – 125 kgf/cm ² }
Nozzle holder	093100 – 3320 (ND-KCA46SD332)	Adjustment pressure	12.25 – 12.74 MPa {125 – 130 kgf/cm ² }
Nozzle	093400 1460 (ND-DN4SDND146)	Injection angle	4°

Structure and functions

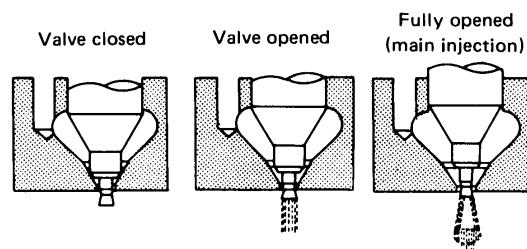
The nozzle is finished super-precisely to inject the fuel which is fed from the injection pump under pressure to the combustion room in good condition. Components as shown in the right figure are incorporated.

The fuel is fed under pressure from the oil hole of the nozzle holder main body to the nozzle body. When the pressure exceeds the specified value, it pushes the spring, injected from the nozzle, and at the same time lubricates and cools the nozzle and nozzle body.

The oil leaking at this time is returned to the tank by the return pipe.



151V



152V

Disassembly and inspection

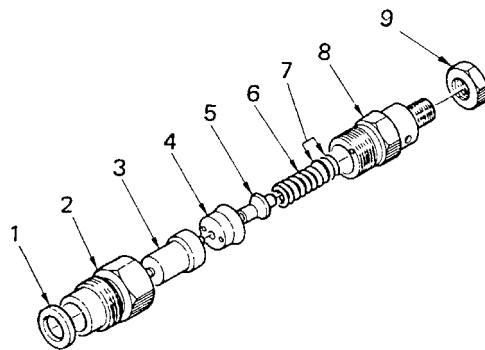
- (1) Place the nozzle holder (body) in a vice and disassemble turning the nozzle nut.

NOTE: Take care not to allow the needle valve to drop when removing the nozzle.

- (2) Wash the nozzle and needle valve and check for seizure and sticking of the nozzle and fuel leakage on the seat surface. Correct fuel leakage of the seat by lapping.
- (3) Check the distance piece upper and lower contact areas and correct to be stucked closely.
- (4) Check the push rod for wear on the nozzle needle valve contact surface and check the spring seat for crack.

Reassembly and adjustment

- (1) When assembling a new nozzle ass'y, heat light oil to 50 - 60°C and remove the rust preventive oil in it. Slide the body and needle valve to ensure that they slide lightly.
- (2) Invert the body, place the shim, spring, rod, piece and nozzle on it in this order, cover the nozzle nut and tighten.
- (3) After assembly, check for the nozzle injection pressure.
 1. Adjust by the adjusting washer (shim) so that the injection is started at 11.76 MPa {120 kgf/cm²} using a nozzle tester.
 2. The pressure increases or decreases about 0.98 MPa {10 kgf/cm²} by a washer of 0.1 mm.
- (4) Injection condition
 1. Small drops should not be mixed in the spray.
 2. The oil should be injected describing a cone by straight lines toward the center line of the nozzle.
 3. Place white paper at about 30 cm from the nozzle and confirm that the spray is approximately circular when injected.
 4. Keep the oil pressure lower by 1.96 MPa {20 kgf/cm²} than the specified value 11.76 MPa {120 kgf/cm²} and check that the test oil does not drop from the nozzle end.



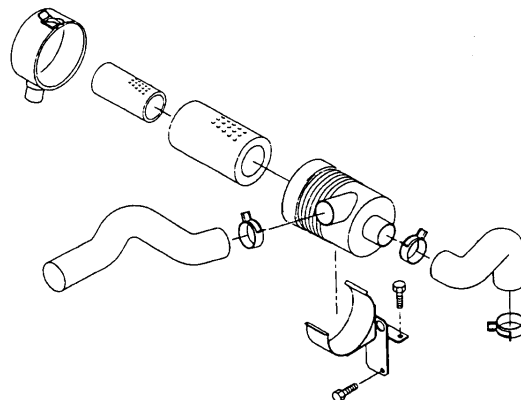
153V

1. Gasket
2. Nozzle nut
Tightening torque: 29.4 – 49 N·m {3 – 5 kgf·m}
3. Nozzle
4. Piece
5. Rod
6. Spring
7. Shim
8. Body
9. Nut
Tightening torque: 29.4 – 39.2 N·m {3 – 4 kgf·m}

22) Air Cleaner

Structure and functions

- (1) The air cleaner is connected to the cylinder with the air cleaner hose.
- (2) The air cleaner is of the cyclone type incorporating filter element and removes dust from the intake air.



154V

Inspection and replacement

- (1) Take out the element every 100 – 200 hours and blow compressed air (less than 0.686 MPa, {7 kgf/cm²}) from the inside and clean. (Clean the dust deposit on the dust pan also.)
- (2) If soot or oil has stuck to the element, immerse it in neutral detergent for about 15 minutes and then wash by shaking several times. Rinse in clean water sufficiently and dry naturally.
- (3) When the air cleaner is used in dusty place, clean it earlier.
- (4) After cleaning 6 times or once every year, replace the element with new one.
- (5) After completion of cleaning, apply light from the inside of the element and it should be replaced with new one if breakage, pin hole, and especially thinner part is observed or if the gasket is broken.
- (6) Do not use the element before drying completely.

3. ENGINE REASSEMBLY

★ Cautions before assembly

1. Wash parts to be installed. (Especially wash oil passage, bearing, piston and cylinder bore carefully.)
2. Coat the sliding and rotating parts of the cylinder bore, piston, bearing and other parts with new oil before installing.
3. Replace the gaskets with new ones. If necessary, use liquid packing to prevent oil leakage.
4. Do not tighten bolts and nuts for aluminum alloy parts excessively. Tighten them with specified torque.

Reassembly

1. Relief valve assembly with O-ring.

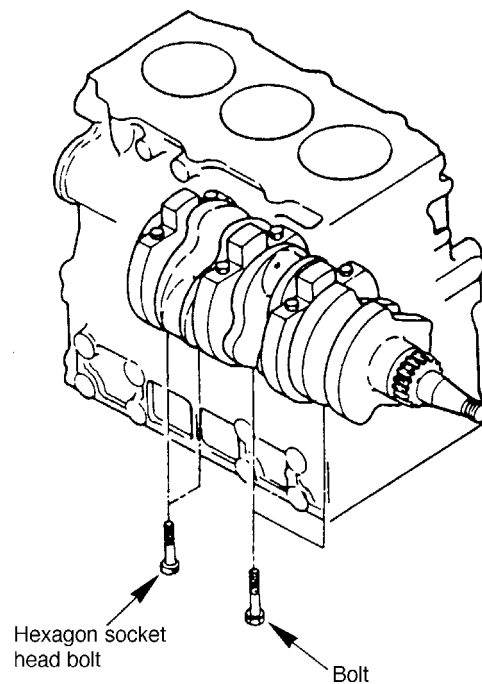
Relief valve tightening torque
59 – 69 N·m {6 – 7 kgf·m}

2. Crank shaft and bearing holder assembly.

Cylinder block to bearing holder tightening torque
25 – 29 N·m {2.5 – 3.0 kgf·m}

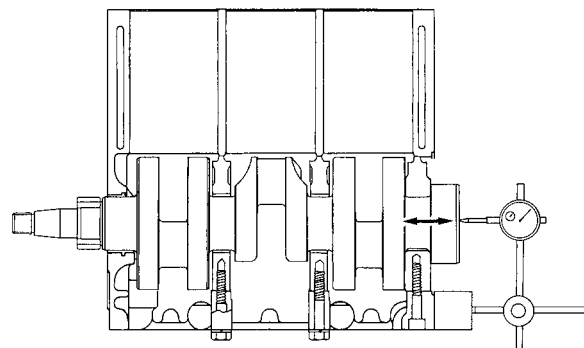
NOTE:

1. Take care not to damage the bush in the cylinder block by the crank shaft gear when install the crank shaft and bearing holder assembly
2. Install the two hexagon socket head bolts for the fly wheel side bearing holder.
3. Measure the end play of crank shaft.



155V

Crankshaft end play	
Standard value	0.05 – 0.3 mm
Service limit	0.5 mm



156V

3. Oil seal

4. Rear plate

NOTE: Apply the liquid gasket to around the M 10 screw holes for rear plate.

Rear plate tightening torque:
46 – 54 N·m {4.7 – 5.5 kgf·m}

5. Fly wheel

Align the hole to the roll pin on the crankshaft.

Fly wheel tightening torque
69 – 78 N·m {7.0 – 8.0 kgf·m}

6. Piston and connecting rod assembly

- ① Coat the metal surface, piston and piston ring with engine oil.
- ② Turn the ring to allow the oil to ensure the ring groove sufficiently, and set the ring end gaps at 120° respectively avoiding piston pin direction and the direction at a right angle to the piston pin.
- ③ Insert the ring facing the connecting rod figure match mark toward the injection pump side, using ring pliers.

NOTE: Place the smallest connecting rod figure match mark to the front side so that the figures increase gradually.

- ④ Tighten the connecting rod cap with the specified torque and check for the axial play.

Connecting rod tightening torque
29 – 34 N·m {3.0 – 3.5 kgf·m}

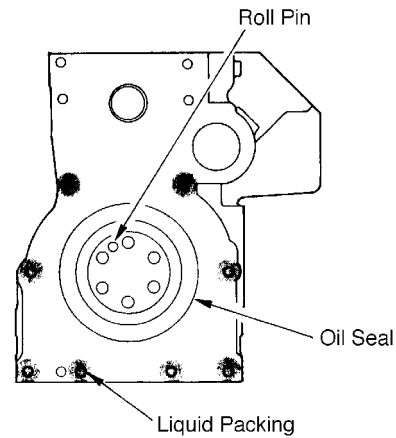
NOTE:

1. After tightening, confirm that the crankshaft moves lightly.
2. The connecting rod should move 0.1 – 0.3 mm in the axial direction.

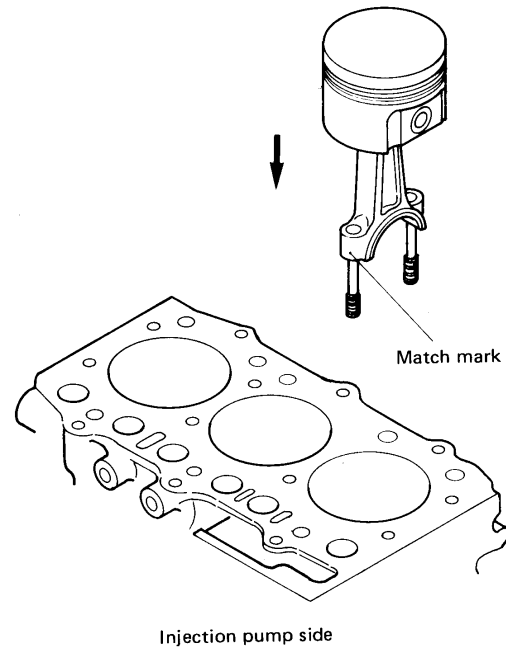
7. Suction pipe and Suction filter

- ① Fit an O-ring to the suction pipe and insert the suction pipe to the cylinder block.
- ② Place the suction pipe end into the suction filter and fix the suction filter.

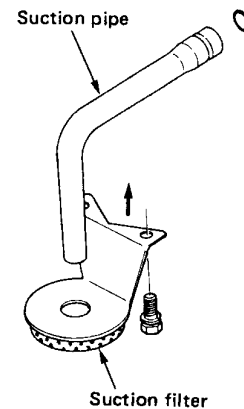
Suction filter tightening torque
9 – 13 N·m {0.9 – 1.3 kgf·m}



157V



158V

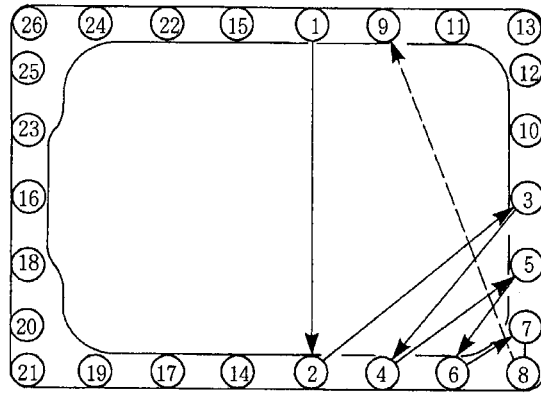


159V

8. Oil pan

Start tightening the bolts of the oil pan from the center, then tighten the opposing bolt on opposite side on the diagonal and specified torque.

Oil pan tightening torque
10 – 12.7 N·m {1.0 – 1.3 kgf·m}



Tightening Order

9. Oil level gauge and Gauge guide

160V

Install the oil level gauge and gauge guide using 2 O-rings.

10. Front plate

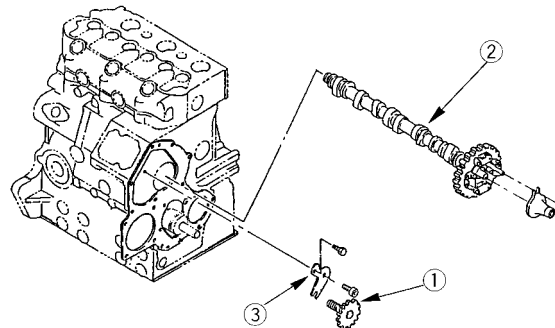
Install the front plate together with the gasket.

11. Cam shaft ass'y

Tachometer shaft · Plate

- ① Install the tachometer shaft.
- ② Install the cam shaft ass'y (taking care to the bearing).
- ③ Fix the tachometer shaft and cam shaft ass'y with the plate.

Plate tightening torque
9 – 13 N·m {0.9 – 1.3 kgf·m}



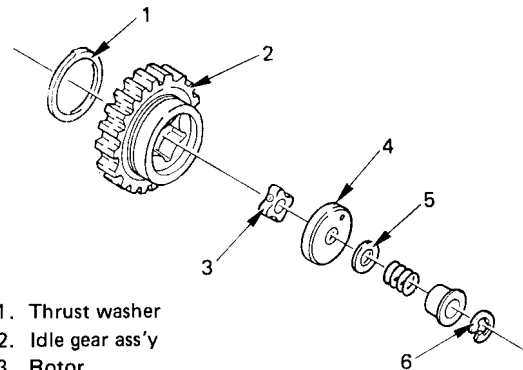
161V

NOTE: Install the timing gear case taking care so that the slider is not dislocated from the guide pin.

12. Idle gear

Oil pump ass'y

- ① Install a thrust washer to the idle gear shaft.
- ② Install the idle gear ass'y.
- ③ Align the match marks of the idle gear, crankshaft gear and cam shaft gear and install idle gear ass'y to the idle gear shaft.
- ④ Install the rotor.
- ⑤ Install the oil pump cover, shim, spring and collar and fix with a E shape clip.

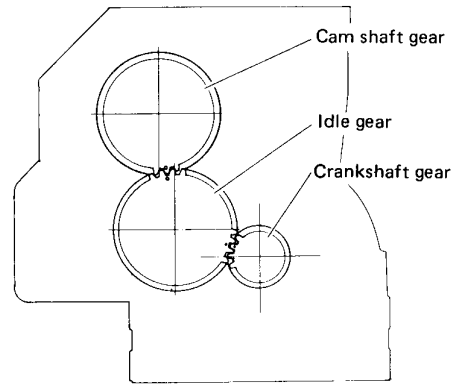


1. Thrust washer
2. Idle gear ass'y
3. Rotor
4. Oil pump cover
5. Shim
6. E shape clip

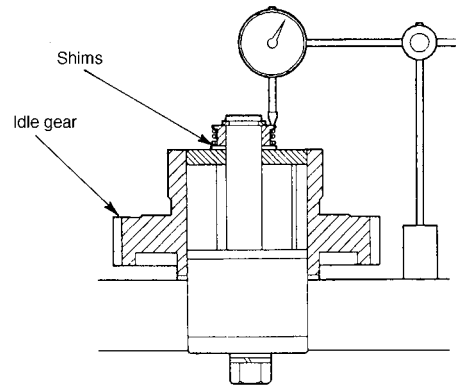
162V

NOTE:

1. Coat the rotor and vane both sides with grease before installing them.
2. Never turn the crankshaft until the timing gear case is installed.
3. Turn the oil pump cover clockwise and counterclockwise, fix the hole at the center of the spring pin inserting hole moving distance, and then install the gear case.



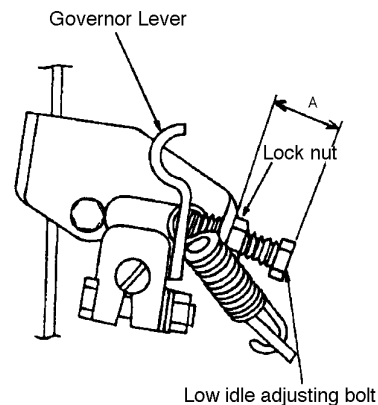
- ⑥ Adjust the shims so that the oil pump, rotor and vane side clearance is **0.1 – 0.15 mm**.



163V

13. Timing gear case Cover

- ① Untighten the lock nut and remove the low idle set bolt.
- ② Install the start spring between the timing gear case and governor link.
- ③ Inserting the link into the cylinder block hole while turn the governor lever to clockwise and hold it, and then install the timing gear case.
- ④ Reinstall the low idle set bolt and secure the lock nut.
- ⑤ Install the covers.



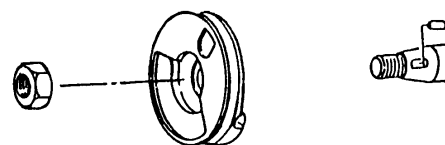
164V

165V

14. Crankshaft pulley

Install the key and assemble the crankshaft pulley and crankshaft.

Crankshaft pulley tightening torque
118 – 127 N·m {12 – 13 kgf·m}

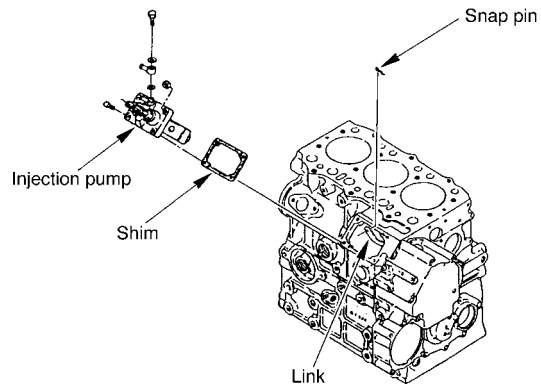


166V

15. Injection pump assembly

- ① Fit the shim which has been removed at the time of disassembly, connect the control rack of the injection pump and link, and fix with the snap pin.
- ② Tighten the injection pump with bolts and nut.

Injection pump tightening torque
5 – 7 N·m {0.5 – 0.7 kgf·m}

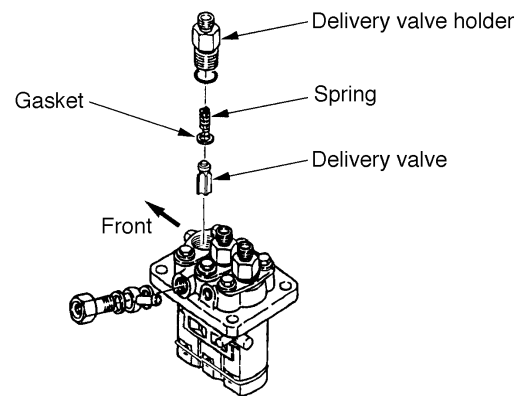


16. Injection timing adjustment

Usually the injection timing is adjusted properly by the step of the order 15.

When the injection pump, cam shaft assembly or cylinder block is replaced, adjust the injection timing in the following procedure.

- ① Install the injection pump inserting a shim of 0.5 mm in thickness according to the procedure of order 15.
- ② Remove the delivery valve holder on the injection pump front side (radiator side).
- ③ Extract the delivery valve and spring and reinstall the delivery valve holder.
- ④ Move the governor lever in the fuel increasing direction and flow the fuel near 25° before compression TDC of the No. 1 piston (front side) and then the fuel flows out of the delivery valve holder.
- ⑤ Turn the crankshaft gently clockwise from the condition of above ④, and then the fuel flowing out of the delivery holder stops. Read the piston position before TDC at this time. If it is late more than 22° decrease the shim thickness and if earlier more than 24° increase the shim thickness.



Injection timing adjusting shim	
Thickness (mm)	Part code
0.2	131437590
0.3	131437600
0.4	131437610
0.5	131437620
0.5	*131437630
* without beading	

NOTE:

1. When shim is not required, coat required packing before installing.
2. Mix assemble a shim (0.5 mm) with beading and a shim (0.5 mm) without beading when you need adjusting shims more than 1.0 mm.

Injection timing (before TDC)	22 – 24°
Piston displacement (before TDC)	3.44 – 4.08 mm

Piston displacement to crankshaft angle (before TDC)			
Angle (°)	Displacement (mm)	Angle (°)	Displacement (mm)
20	2.850	25	4.411
21	3.137	26	4.761
22	3.436	27	5.132
23	3.749	28	5.496
24	4.074		

- ⑥ Install the delivery valve (IN) and spring.

Delivery holder tightening torque
39.2 – 44.1 N·m {4.0 – 4.5 kgf·m}

17 Engine stop solenoid

Tighten the engine stop solenoid lightly with pliers.

18 Tappet

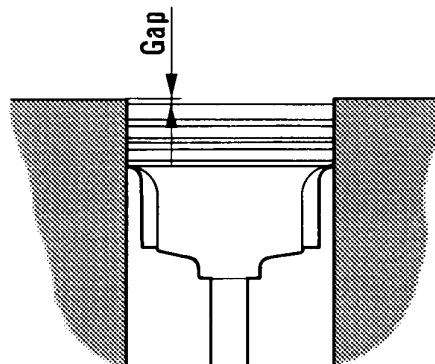
Coat the oil to tappets and install.

19 Cylinder head

- ① Position each of the pistons at top dead center and, using a dial indicator, determine the distance each piston top to the face of the block.

NOTE:

1. Measure each of the pistons while holding a slight down pressure on the piston.
2. The variation in the amount of gap among all pistons must be within 0.1 mm.

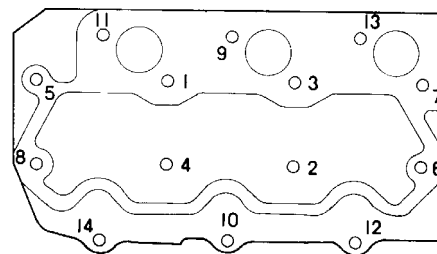


169V

Measured value (mm)	Head gasket part code No.	Tightened Thickness
More than 0.3 – less than 0.4	111147370	t = 0.3

- ② Tighten the cylinder head in several steps in the order as shown in the right figure and tighten with the specified torque finally.

Cylinder head tightening torque
49 – 52 N·m {5.0 – 5.3 kgf·m}



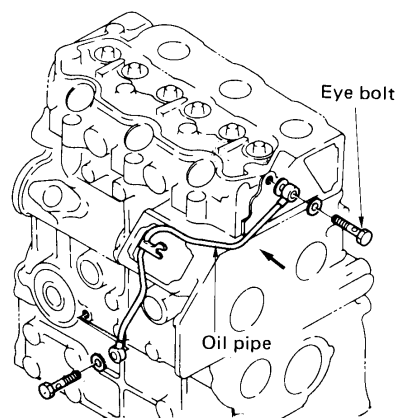
170V

NOTE:

1. Take care to the spring pin which positions the cylinder head ass'y.
2. Coat the thread with grease containing disulfide molybdenum.

20 Oil pipe

Eye bolt tightening torque
10 – 13 N·m {1.0 – 1.3 kgf·m}

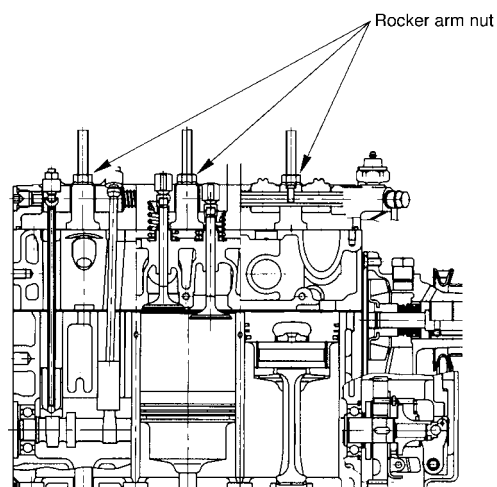


171V

21 Push rod Rocker arm ass'y

Install the push rod and rocker arm ass'y

Rocker arm ass'y tightening torque
20 – 25 N·m {2.0 – 2.5 kgf·m}



172V

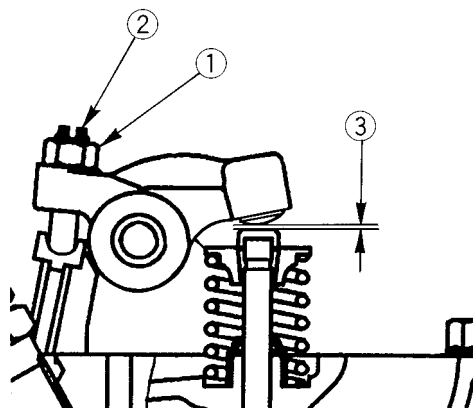
22 Valve clearance adjustment

Untighten the nut of the intake and exhaust valves and adjust to 0.2 mm with adjust screw.

NOTE:

1. Adjust the valve clearance while cold.
2. Set the No. 1 cylinder at the compression TDC, adjust the valve clearance of the No. 1 intake and exhaust valves, and No. 2 exhaust valve, turn the crankshaft 240° counterclockwise when viewed from the front side, and adjust the No. 2 intake, and No. 3 intake and exhaust valves.

1. Locknut
2. Adjusting screw
3. Valve clearance 0.2 mm



173V

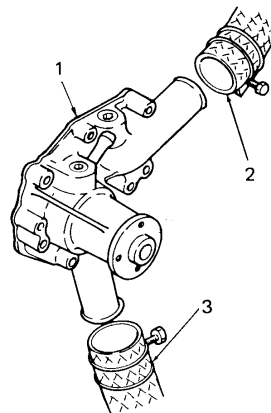
23 Head cover

Evenly tighten the cylinder head cover, taking care on the packing.

Head cover tightening torque
10 – 12 N·m {1.0 – 1.2 kgf·m}

24 Water pump ass'y Radiator hose

1. Water pump ass'y
2. Radiator hose (upper)
3. Radiator hose (lower)



25 Glow plug Connector

174V

Model	Glow plug tightening torque
S773	15 – 20 N·m {1.5 – 2.0 kgf·m}

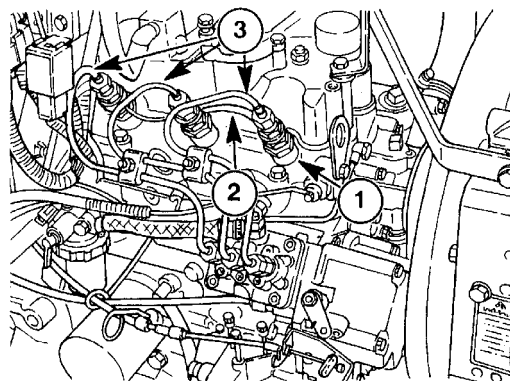
26 Oil pressure switch

Oil pressure switch tightening torque
15 – 20 N·m {1.5 – 2.0 kgf·m}

27 Nozzle and holder ass'y

Tighten the cap and gasket positively, tighten with specified torque using a nozzle holder socket, and install the return pipe.

Model	Nozzle and holder tightening torque
S773	78 – 83 N·m {8.0 – 8.5 kgf·m}



1. Nozzle and holder
2. Return pipe
3. Injection pipe

28 Return pipe COMPL Injection pipe

175V

After installing the return pipe, install the injection pipe.

Injection pipe tightening torque
19.6 – 24.5 N·m {2.0 – 2.5 kgf·m}

29 Alternator ass'y

Install the alternator ass'y taking care to the direction of the adjusting plate.

30 V belt

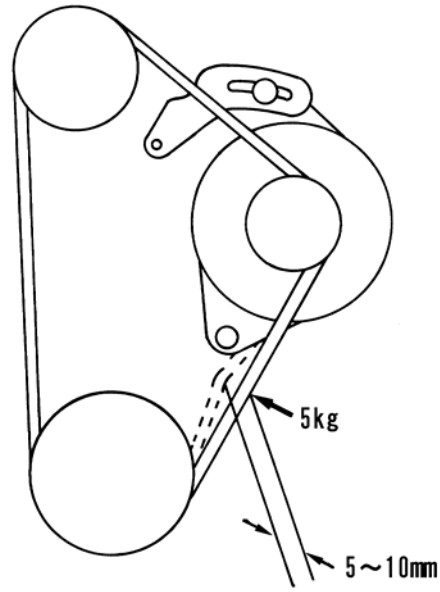
Fan pulley

Cooling fan

- ① Install the fan pulley and cooling fan and then V belt.
- ② Adjust the belt tension with the alternator so that it is deflected 5~10 mm at the middle point between the crankshaft pulley and alternator pulley when depressed by a finger (about 5 kg) and tighten.

Cooling fan tightening torque
8.8 – 12.7 N·m {0.9 – 1.3 kgf·m}

31 Exhaust manifold (Muffler assembly)



177V

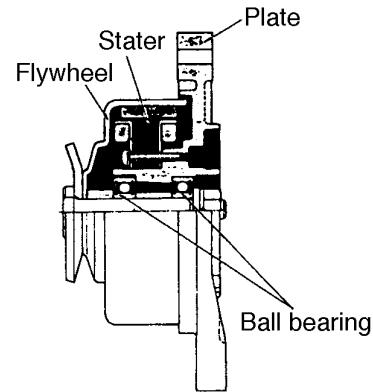
2-3 Electrical Units

1. ALTERNATOR

1) Specifications and performance

Part code No.	185046400
Type	GP9165
Rotating direction	Clockwise (viewed from pulley end)
Working rpm	1300 – 5000 rpm
Charging performance	20 A – 21 A at 12 V, 4500 rpm
Charging start speed	Less than 1300 rpm
Regulator combined	RS5137

2) Structure



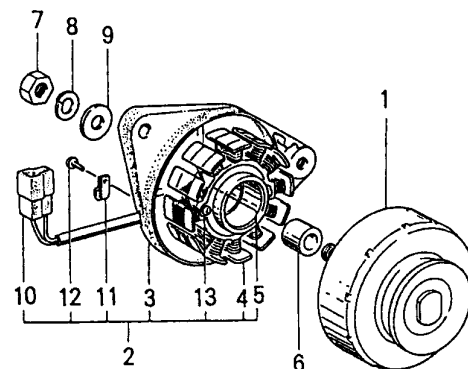
178V

3) Disassembly, Inspection and Reassembly

Disassembly

When the alternator is defective or the flywheel turns abnormally, disassemble the alternator as explained below.

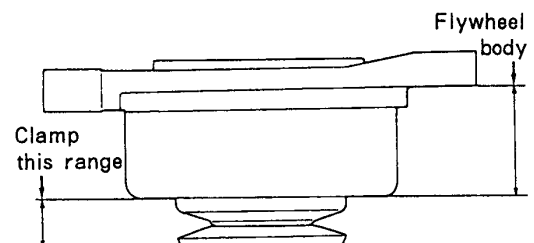
- (1) Hold the pulley side jaw of the flywheel COMPL with a vice, loosen the nut.
- (2) Pull out the spring washer and washer.
- (3) Pull out the flywheel COMPL. (If it is hard to remove, tap the M10 threads with a plastic hammer.)
- (4) Disconnect the coupler terminal stopper from the plate COMPL.
- (5) Loosen the M4 screw and remove the clamp.
- (6) Remove the M4 screw.
- (7) pull out the stator COMPL from the coil plate.
- (8) Position the coil plate rear side on the surface plate, and insert a rod having diameter of approximately 24 mm.
Then, push the bearing with a press to pull it out.
(Replace the front bearing as a flywheel COMPL.)



- | | |
|-------------------|------------------|
| 1. Flywheel COMPL | 8. Spring washer |
| 2. Plate COMPL | 9. Washer |
| 3. Coil plate | 10. Coupler |
| 4. Stator COMPL | 11. Clamp |
| 5. Bearing | 12. Screw |
| 6. Collar | 13. Screw |
| 7. Nut | |

179V

NOTE: Never clamp the flywheel body with any vice.



180V

Inspection

Rotate the bearing manually to confirm that it rotates without noise.

Assembling

Reassemble the alternator in the reverse of order of its disassembly, paying attention on the following precautions.

- (1) When installing the bearing, place the bearing housing side of the coil plate on the flat plate. Then, press the bearing from rear side of the coil plate using a rod of $\phi 31$ diameter. (Apply a rod on the outer race of the bearing, without mistake.)
- (2) Tighten the nut with the torque of $29.4 \sim 34.3 \text{ N}\cdot\text{m}$ {3.0 to 3.5 kgf·m}
- (3) Clamp the flywheel COMPL, only with permitted part as explained before.
- (4) Never hang the alternator with a lead wire.

2. REGULATOR

1) Specification and performance

Part No.	185516130	Adjusted voltage	$14.5 \pm 0.5 \text{ V}$
Type	RS5137	Charging lamp	12 V 3.4 W

2) Inspection

- (1) Inspect the regulator by circuit tester. (We recommend circuit tester model SP-15D made by SANWA.)
Never use the Mega – tester.
- (2) Inspect the regulator after disconnect the wirings from the regulator.
- (3) In the () value is resistance value when take the “ $\times 1\text{k}\Omega$ ” range of the tester.
- (4) Set the tester at high resistance range. “ON” denotes the fluctuation of the tester pointer while “OFF” denotes no fluctuation of the pointer. If the below results are attained, the regulator is in good condition.

CIRCUIT TESTER CHECKING TABLE

		Circuit tester positive lead side (+)						
Circuit tester negative lead side (-)	Wiring color	Red	Blue	Blue	Blue	Green	Yellow	Black
	Red		OFF	OFF	OFF	OFF	OFF	OFF
	Blue	ON (7k Ω)		OFF	OFF	OFF	OFF	OFF
	Blue	ON (7k Ω)	OFF		OFF	OFF	OFF	OFF
	Blue	ON (7k Ω)	OFF	OFF		OFF	OFF	OFF
	Green	OFF	OFF	OFF	OFF		OFF	OFF
	Yellow	ON (32k Ω)	ON (29k Ω)	ON (29k Ω)	ON (29k Ω)	OFF		ON (40k Ω)
	Black	OFF	OFF	OFF	OFF	OFF	OFF	

3) Trouble Shooting (1)

TEST CONDITION	NORMAL READING		ABNORMAL READING	REMARKS
- No-load voltage and current test. - Engine speed – 2500 rpm. - Connect voltmeter leads to the battery posts. - Connect the amperemeter leads to positive battery post and positive cable.	(1) Less than DC 14 V and more than 28 A.	More than AC 23 V	(1) More than DC 15 V and more than 28 A.	(1) Faulty regulator.
	(2) Charging current is 0.5~28 A at the charging voltage is 12~15 V.		(2) Charging current is 0A.	(1) Faulty regulator. (2) Faulty alternator.
			(3) Charging current is ON (flow) but battery posts voltage is low.	(1) Too much discharged battery. (2) Faulty battery.
- Disconnect the alternator from the regulator and connect the voltmeter leads to the each out put terminals of the alternator. - Engine speed – 2500 rpm.	Terminal No. 1 to No.2.	More than AC 23 V	(1) Less than AC 23 V. (2) 0 V	(1) Reduce the magnetic field. (2) Broken coil.
	Terminal No. 2 to No. 3.			
	Terminal No. 3 to No. 1.			
- Connect the circuit tester and inspect the continuity test of the alternator terminals. - Engine stops.	Terminal No. 1 to No.2.	Continuity	No continuity	(1) Broken coil.
	Terminal No. 2 to No. 3.	Continuity	No continuity	(2) Resistance of each terminal is about 0.13 ohms at 20°C.
	Terminal No. 3 to No. 1.	Continuity	No continuity	
- Continuity test of the alternator each terminals to coil plate. - Engine stops.	No continuity		Continuity	Coil is short circuit.

CONDITION		CAUSE	REMEDY
No charging	Is the flywheel (alternator) rotating? NO	1. The magnet damaged. 2. Some object seized. 3. The bearing defective. 4. The flywheel damaged.	Replace the alternator assembly.
	YES		
	Is the alternator generating? NO	1. Broken the stater coil. 2. Disconnect the out put wirings. 3. Reduced the flywheel magnet field.	1. Replace the alternator assembly. 2. Replace the stater or repair the wirings. 3. Replace the flywheel.
	YES	1. Faultly the regulator. 2. Faultly the battery. 3. Slip the V-belt. 4. Disconnect or misconnect the wirings.	1. Replace the regulator. 2. Replace the battery. 3. Adjust the V-belt tension. 4. Repair the wirings.
Abnormal sound		1. Some object seized. 2. The bearing defective.	1. Remove the object. 2. Replace the bearing.

4) Precaution Upon Handling

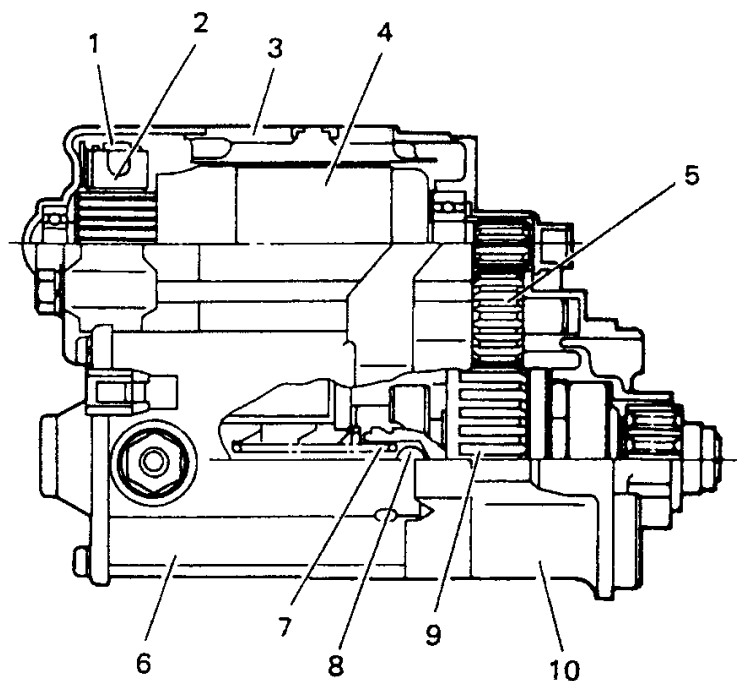
- (1) As large current flows through the regulator generating heat, the regulator must be positioned to the specified place.
- (2) Never remove the battery wiring during machine operation. If removed, trouble of the safety monitor, etc. is resulted.

3. STARTING MOTOR

1) Specifications and Performance

Part code No.	185086340	Pinion ejecting voltage (V)		Less than 8
Type	128000-0101	Unloaded	Terminal voltage (V)	11.5
Continuous operation (second)	30		Current (A)	Less than 90
Output (V-kW)	12 – 1.0		Speed (rpm)	More than 3000
Rotating direction (viewed from pinion)	Clockwise	Loaded	Terminal voltage (V)	2.5
Clutch type	Overrunning		Current (A)	Less than 300
Engaging type	Magnetic shift		Torque (kgf·m)	More than 0.7

2) Structure



- | | |
|-------------------|--------------------|
| 1. Brush spring | 6. Magnetic switch |
| 2. Brush holder | 7. Spring |
| 3. Yoke | 8. Steel ball |
| 4. Armature ass'y | 9. Clutch |
| 5. Idle gear | 10. Housing |

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3) Disassembly, inspection and reassembly

Disassembly

- (1) Remove the nut ① and connecting lead ② which connects the magnetic switch and the yoke.
- (2) Remove two thru bolts ③, which tighten the yoke ④ to the housing ⑤, from the end frame ⑥.
- (3) Remove two screws (end frame-to-brush holder) ⑦ to remove the end frame ⑥.
- (4) Remove the two (+) positive side brushes from the brush holder ⑦.

NOTE: Do not put oil on the brush and commutator.

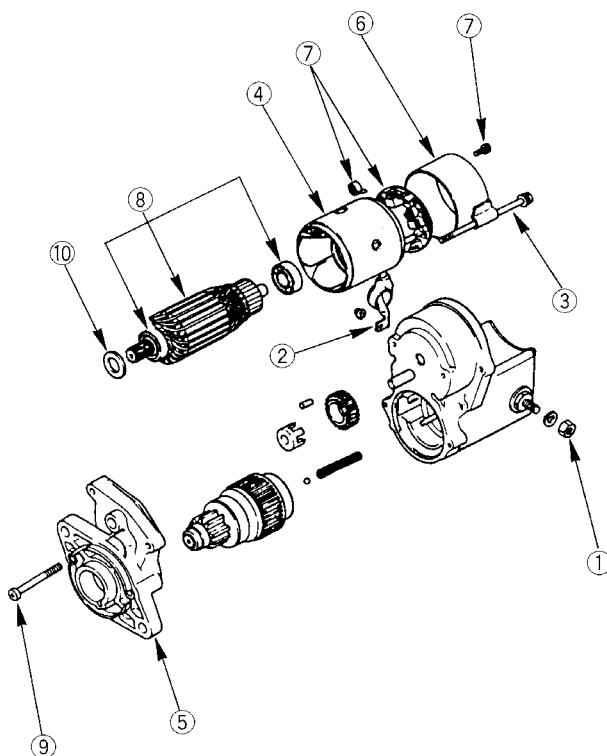
- (5) Remove the brush and remove the yoke ④ from the housing ⑤.
- (6) Remove the armature ⑧ from the housing ⑤.

NOTE: Do not miss the felt washer ⑩.

- (7) Remove two screws ⑨ (magnetic switch-to-housing) to remove the housing ⑤.
- (8) Remove the clutch from the housing.

NOTE:

1. Never disassemble the magnetic switch. (If the switch is found to be defective, replace as a magnetic switch assembly.)
2. Never loosen the nut at the magnetic switch contact bolt (terminal bolt).

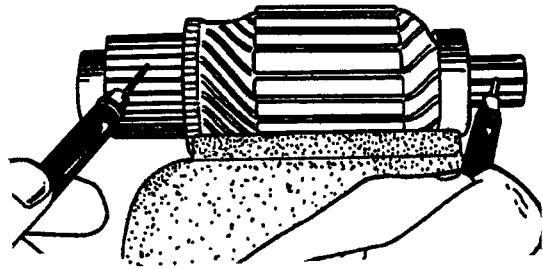


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Inspection

(1) Armature

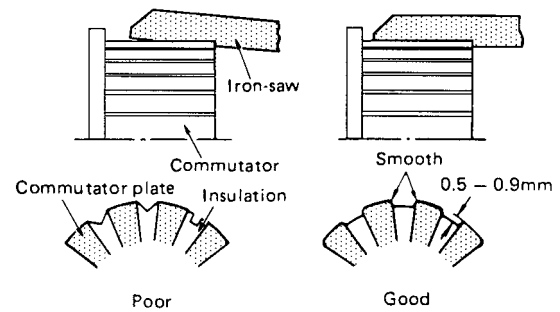
- ① Check continuity between the commutator and shaft (or core) with a circuit tester. Replace the armature if continuity is indicated.
- ② Check the coil for short circuit with a growler tester and replace if it is short-circuited.
- ③ Correct the commutator surface roughness, burning or run-out more than 0.05 mm or replace the commutator.



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- ④ Correct the depth of the insulator between segments as shown in the right figure if the depth is below the repair value.

Standard assembling value	Repair value
0.5 – 0.9 mm	0.2 mm



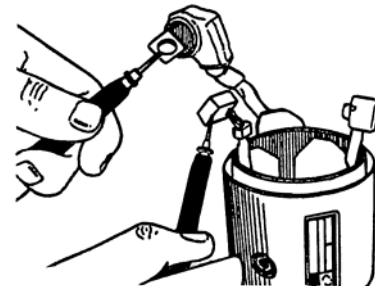
184V

- ⑤ Check for the commutator outside diameter and replace the commutator if the diameter is below the service limit.

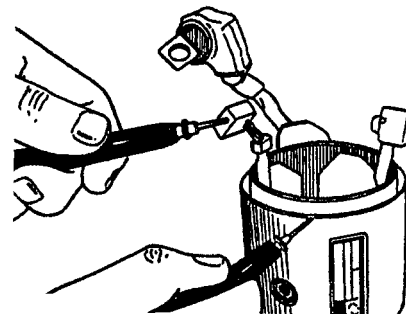
Standard assembling value	Service limit
30 mm	29 mm

(2) Field coil

- ① Check for continuity between both ends of the coil (or both brushes) and replace the yoke ass'y if continuity is not noticed.
- ② Check for continuity between the connector (or brush) and yoke. If continuity is indicated, repair poor insulator or replace the yoke ass'y.



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(3) Brush and brush holder

- ① Roughness on the brush face
If the face is rough, correct it by wrapping the commutator with a sand paper (No. 300).
- ② Replace the brush if the length is below the service limit.

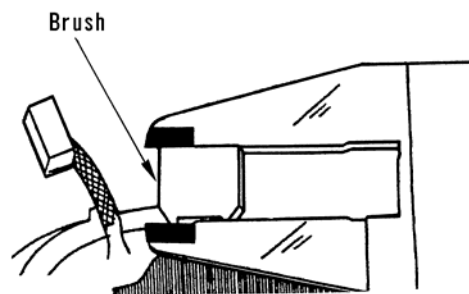
Brush length (mm)	
Standard length	Service limit
13.5	9

- ③ Check that the brush moves smoothly in the brush holder.
- ④ Check the brush spring pressure and replace if the pressure is below the service limit.

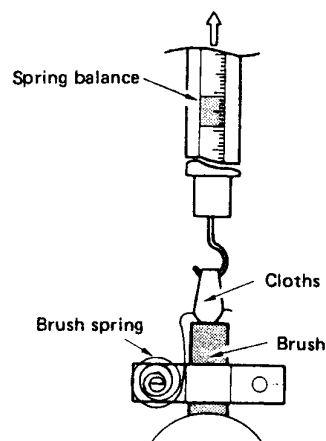
Brush spring pressure (kg)	
Standard assembling value	Service limit
1.7	1.2

- ⑤ Check the continuity between the plate and brush holder. Replace the brush holder ass'y if continuity is noticed.

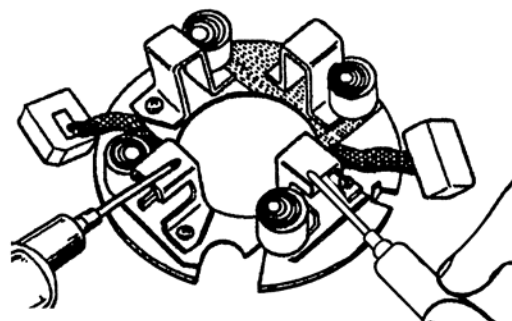
NOTE: Carry out the insulation test after cleaning the brush holder with gasoline, to prevent checking error due to foreign matters.



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(4) Clutch

- ① Replace the gear with new one if worn away or damaged.
- ② Turn the gear by hand and replace if turned in both directions or not turned smoothly in one direction.

NOTE: Do not wash the clutch in light oil to prevent the grease inside the clutch from flowing out.

(5) Bearing

Rotate the bearing to check its catching or noise. If it is caught or generates noise, replace it with new.

Inspection

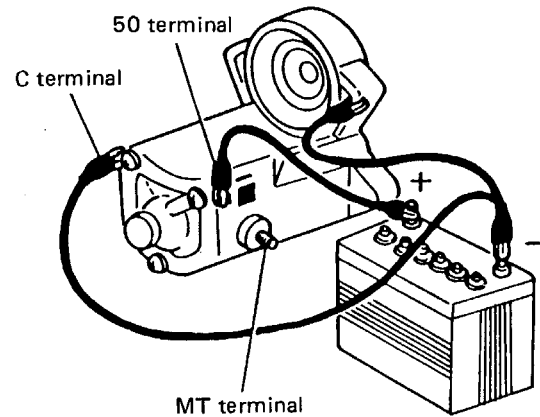
(6) Magnetic switch

NOTE:

1. Do not continue the following tests for more than 5 seconds.
2. Perform the test with 1/2 of the rated voltage.

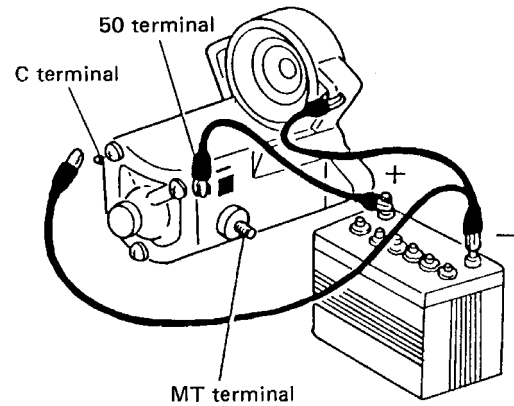
① Check of pull-in coil

Check that the pinion gear comes out when the (-) terminal of the battery is connected to the magnet switch body and C terminal and then the (+) terminal of the battery to the 50 terminal.



② Check of holding coil, holding condition

When removing the wire from the 'C' terminal, the pinion gear should be kept on coming out. If the gear is returned, the holding coil is defective.



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Reassembly

Perform reassembly of the starting motor in the reverse order of its disassembly. Before assembling the felt washer, retainer and steel ball, coat them with clean grease.

4) Troubleshooting

(1) The pinion does not move when the key switch is set to start position.

Trouble	Case	Remedy
Wiring	Disconnection, loosened terminals of the battery or switch	Repair and retighten.
Key Switch	Insufficient contact. No current flows.	Repair the contact area or replace
Starting motor	Pinion shaft helical spline is stuck and the pinion does not move.	Replace or repair
Magnetic switch	Irregular movement of the magnetic switch plunger, disconnection or short circuit of the coil.	Repair or replace

(2) Pinion is engaged, motor rotates, but the engine does not crank.

Trouble	Case	Remedy
Starting motor	Faulty clutch Damaged reduction gear	Replace Replace

(3) Pinion is engaged with the ring gear but starting motor does not run.

Trouble	Case	Remedy
Wiring	Disconnection or breakage of the wire connecting the battery and magnetic switch or improper grounding . Insufficient tightening of wiring connecting the magnetic switch and motor terminal.	Replace, retighten or correct the wire
Starting motor	Locked ball bearing Improper installation of the starting motor Dirty commutator Worn out brush, faulty contact of the brush spring Faulty armature and field coil Insufficient connection of the field coil and brush	Replace. Reinstall. Correct. Replace Repair or replace. Retighten
Magnetic switch	Insufficient contact of the contactor Rough contact surface of the contactor Broken holding coil	Replace Replace Replace
Battery	Discharged	Recharge

(4) The motor rotates at full speed before the pinion engages with the ring gear.

Trouble	Case	Remedy
Starting motor	Improper sliding of the pinion shaft Worn pinion gear end Improper coming out direction of pinion	Replace Correct Replace
Engine	Worn ring gear	Replace
Magnetic switch	Defective switch	Replace

(5) After the engine starts, the motor does not stop when the key switch is released.

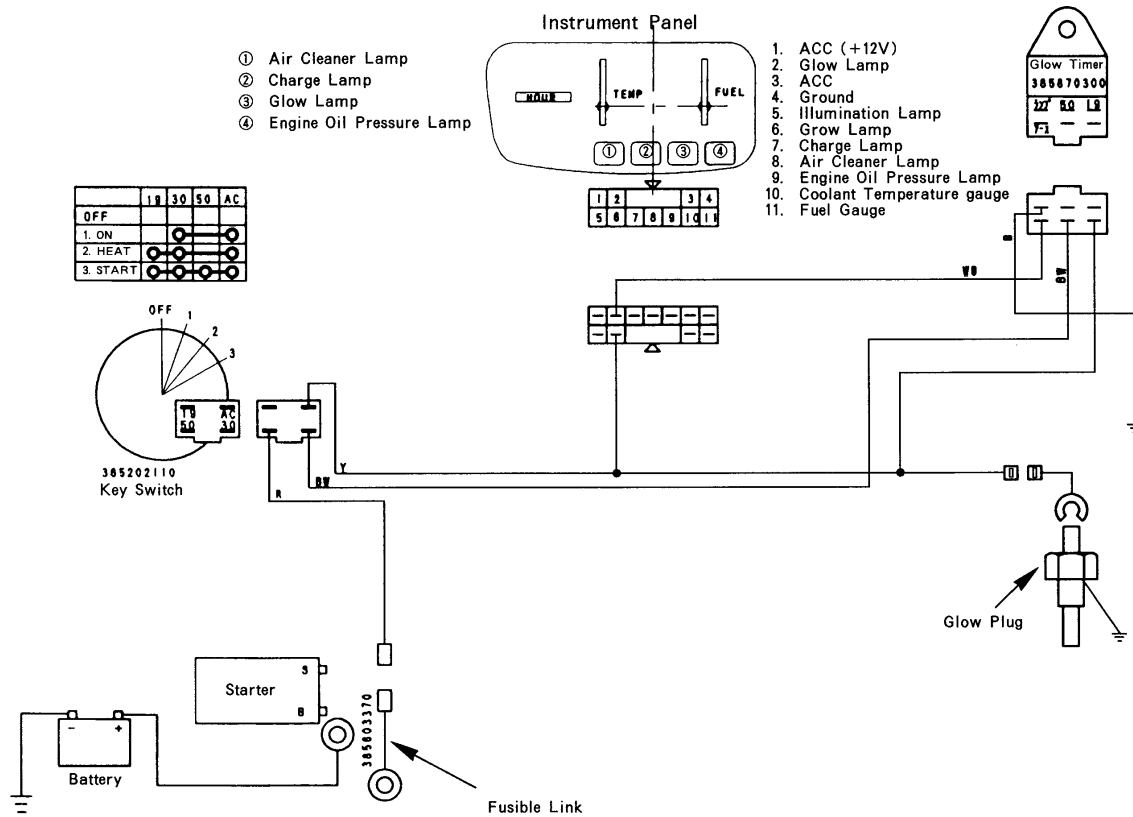
Trouble	Case	Remedy
Key switch	Faulty switch	Replace
Magnetic switch	Faulty magnetic switch	Replace

4. IQS SYSTEM

1) Summary

The IQS system comprises the indicator lamp and glow plug. When the key switch is at the HEAT or START position, power is supplied to the glow plug to heat it quickly.

2) Circuit diagram



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3) Inspection of each part

(1) Glow plug Y701RS

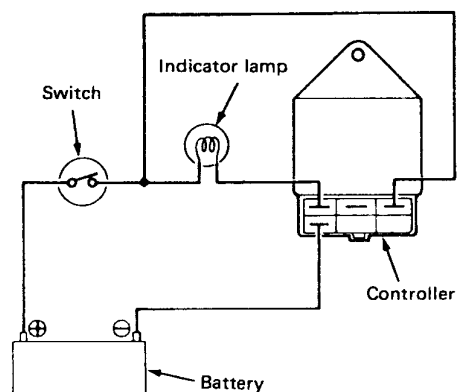
Conduct a continuity test using a circuit tester. If no continuity is indicated, replace the plug.

Normal temp. resistance	Less than 0.8 Ω
-------------------------	------------------------

NOTE: Do not give voltage over 10 V directly to the glow plug.

(2) Controller

Intall the wire as shown in the right figure and turn ON the switch S1. It is normal if the indicator lamp goes out about 4.5 seconds after the switch is turned ON.



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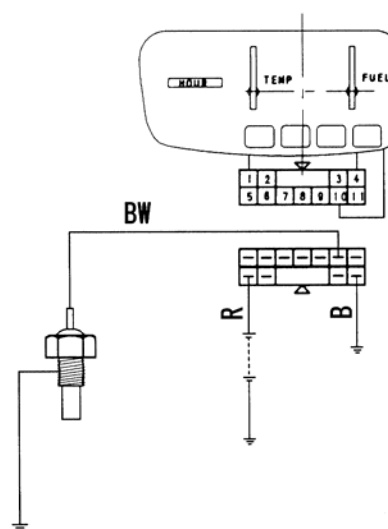
5. THERMOMETER AND THERMOSENSOR

1) Specifications (thermosensor) and structure

Part code No.	385720011
Operating range	50°C – 120°C
Standard resistance value (Ω) (The resistance rating is measure on the special circuit.)	$\left[50^{\circ}\text{C} \rightarrow 153.9_{-20}^{+25} \right]$ $80^{\circ}\text{C} \rightarrow 51.9_{-4.4}^{+4.9}$ $100^{\circ}\text{C} \rightarrow 27.4_{-1.2}^{+1.9}$ $\left[120^{\circ}\text{C} \rightarrow 16.1_{-1.2}^{+1.2} \right]$

Electric thermosensor composed of a receiver and transmitter is used for this tractor.

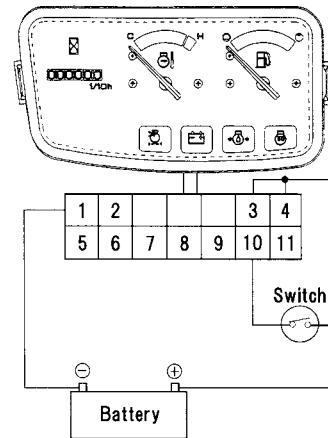
The receiver employs a thermister in which electric resistance varies according to temperature to increase the current flowing the circuit when the cooling water temperature rises and indicator of the receiver indicates the corresponding position.



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(1) Thermometer

- ① Remove the meter ass'y.
- ② Connect the (-) (negative) wire of the battery to the No. 1 terminal of the connector.
Connect the (+) (positive) wire of the battery to the No. 4 terminal of the connector.
- ③ Set the switch between No. 10 terminal of the connector and the battery negative post.
- ④ Turn the switch go on.
- ⑤ If the pointer of the meter ass'y moves from C to H after a while, the thermometer is normal.



194-1V

6. OIL PRESSURE SWITCH

The oil pressure switch is used to give a warning about the engine oil pressure. When the pressure drops below 19.6 ~ 39.2 kPa {0.2 – 0.4 kgf/cm²}, the oil pressure lamp lights up to give a warning.
The oil pressure switch enhouses a combination of a diaphragm and contact points.

7. BATTERY

1) Specifications

Capacity	12 V – 45 AH
Electrolyte specific gravity (at 20°C)	1.28/When charged fully

2) Specific gravity of electrolyte and charging condition

The specific gravity of electrolyte decreases approximately lineally in proportion to the discharged electricity of battery. By measuring the specific gravity of the electrolyte using a hydrometer, residual capacity of the battery can be known.

The specific gravity value measured by the hydrometer should be compensated with respect to temperature. The specific gravity of battery electrolyte is based on the temperature of 20°C. As the temperature varies 1°C, the specific gravity value increases or decreases 0.0007. Therefore measured values can be compensated by the following equation.

$$S_{20} = S_t + 0.0007 (t - 20)$$

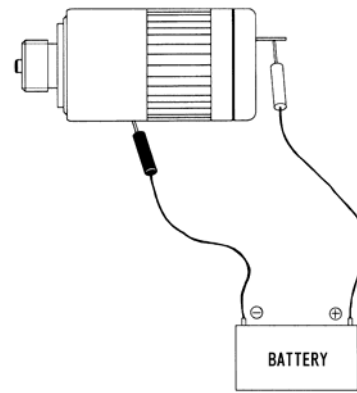
└──────────────────┘ Electrolyte temperature in measured value
└──────────┘ Measured specific gravity
└──────────────────────────────────┘ Specific gravity converted to the value at 20°C

The table indicates relation between the specific gravity values and battery residual capacity.

Specific gravity value and residual capacity of battery		
Specific gravity (20°C)	Discharged electricity (%)	Residual capacity (%)
1.280	0	100
1.225	25	75
1.170	50	50
1.116	75	25
1.060	100	0

8. ENGINE STOP SOLENOID

- (1) The solenoid is provided with suction and holding terminal. Connect the positive side of the battery with a terminal, connect the negative side to the main body and inspect.
- (2) At this time, it is normal if the plunger is sucked and held to the main body.



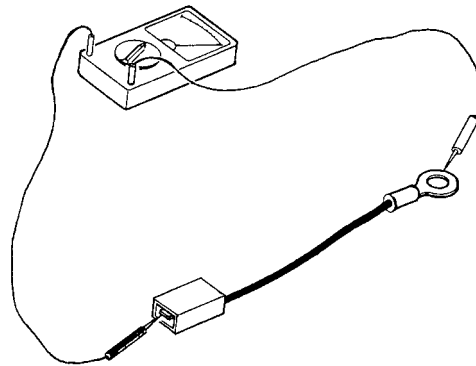
9. FUSIBLE LINK

Inspection

The fusible link is installed between the battery and fuse box to protect such parts that could not be protected by fuses or a circuit (starter circuit) to which large current flows instantaneously. Check the continuity with a circuit tester.

NOTE:

1. If a fusible link is burnt out again immediately after it is replaced, short circuit of the wiring can be considered as the reason. Check the wiring harness in such a case.
2. Never use a substitute wire, or the like when the fusible link is burnt out.



10. WIRING HARNESS

- (1) Disconnect the negative cord of the battery when inspecting or servicing the wiring harness.
- (2) Check each wiring for damage of sheathing due to wiring or for some other reason, or looseness at the connecting parts at the time of its inspection or service. If there is some defective point, repair the insulation or replace the wiring harness. (The band becomes breakable when becoming old. Be sure to substitute in such a case.)
- (3) After completion of service for the tractor, etc., protect wiring at the plugging parts with vinyl tube, use clamping fixtures with vinyl cover, and check that the figures are not in direct contact with wiring. (Replace uncovered fixtures.) Especially check carefully where wiring may be caught between something.
- (4) Check very carefully where positive current flows constantly and confirm sheathing is free from troubles.
 - ① Starting motor
 - ② Alternator
 - ③ Key switch
- (5) After Check, protect the wiring with corrugated tube or the like.

2-4 Trouble Shooting

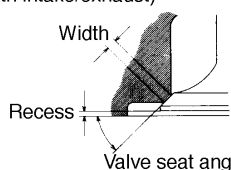
Condition	Cause	Remedy
Engine does not start.	Defective key switch Insufficient charging or completely discharged battery. No fuel. Air mixed in the fuel system. Clogged fuel filter. Irregular of improper fuel supply. Defective glow plug. Improper viscosity of lubricating oil. Clogged air cleaner. Not compressed. Defective engine stop solenoid.	Connect or correct contact points propely. Charge. Replenish the fuel. Correct points allowing the air to enter the fuel. Replace the fuel filter. Trouble of injection pump. Have corrected in work specified by Nippon Denso. Replace. Check and change. Clean the air cleaner. Check and correct each part. Check or replace wiring.
Irregular engine speed	Air mixed in the fuel system. Uneven fuel injection. Clogged fuel filter. Trouble of speed governor. Improper function of engine main body.	Discharge air from the fuel. Trouble of injection pump. Have corrected or replaced in a work specified by Nippon Denso. Replace the fuel filter. Check and adjust. Overhaul, check and correct each part.
Engine stops during operation	No fuel in fuel tank. Clogged fuel filter. Air mixed in the fuel system. Improper functions of engine main body.	Replenish fuel. Replace the filter. Correct points to allow the air to enter the fuel system. Check and correct each part.
Engine overheat	Insufficient cooling water. Loosened or slipping fan belt. Failure of fan belt. Clogged radiator. Clogged radiator fin. Cooling water passage clogged with dust, fur, etc. Improper function of thermostat. Insufficient lubricating oil. Overload.	Replenish the cooling water, and check and repair water leaking points. Clean oil dust, etc. and retighten. Replace. Clean the radiator. Clean. Wash. Check and replace Replenish. Decrease the load.

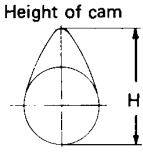
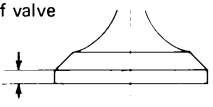
Condition	Cause	Remedy
Improper color of engine exhaust (white or blue)	Too much engine oil. Too low viscosity of engine oil. Improper injection timing.	Check and adjust the quantity. Check and change. Too late. Correct.
Improper engine exhaust (black or dark gray)	Improper fuel. Excessive fuel injection. Improper function of engine main body. Overload. Clogged air cleaner.	Check and change. Check and adjust. Check an correct each part. Reduce the load. Clean the element.
Improper charging.	Loosened fan belt. Trouble in wiring of each part. Defective battery. Defective alternator. Defective regulator	Correct belt tension. Check and repair. Replace. Replace. Replace.
Starting motor does not operate.	Loosened or disconnected wiring of each part. Dropped battery voltage. Defective safety switch. Trouble in starting motor. Disconnected wire of fusible link.	Check and install or tighten. Charge the battery. Replace. Check and correct the starting motor. Replace.
Oil pressure lamp does not go out.	Insufficient engine oil. Trouble in oil pressure switch. Oil leakage from lubricating system. Short circuit wiring between oil pressure lamp and oil pressure switch.	Replenish to specified gauge level. Replace the switch. Check and retighten. Repair.
Oil pressure lamp does not light up with the key switch turned ON. (While engine stops.)	Burnt out lamp. Disconnected wire between battery and oil pressure lamp.	Replace the lamp. Repair.

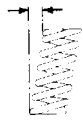
2-5 Engine Maintenance Standard Table

S773

* Unit for values without unit in the column of inspection item is mm.

Unit	Part	Inspection Items	Standard Dimension	Standard Assembling Value	Repair Value	Service Limit	Remarks
Engine main body	Cylinder head	Cylinder compression pressure MPa {kgf/cm ² }		More than 29.4 {30}	24.5 {25}		Engine speed at 200 rpm
		Cylinder head tightening torque N·m {kgf·m}		49 – 52 {5.0 – 5.3}			Coat Molycoat grease.
		Distortion of cylinder head bottom surface (mounting surface)		Less than 0.05	0.12		
		Valve seat resess (both intake/exhaust)  198V		0.85 – 1.15		1.8	Valve sheet angle 45°
		Valve seat contact width	Intake	1.7 – 2.1	2.5		
			Exhaust	1.7 – 2.1	2.5		
	Cylinder block	Liner type	Wet type (incorporated type)				
Main moving part	Piston	Bore	φ 77	φ 77 – 77.019	φ 77.2	φ 77.7	Oversize (0.5)
		Distortion on cylinder block top surface		Less than 0.05	0.12		
		Longer dia. at skirt	φ 77	φ 76.9325 – 76.9475		φ 76.7	Oversize (0.5)
	Piston pin	Clearance to cylinder		φ 0.0525 – 0.0815		0.25	At 20°C
		Clearance between piston pin hole and pin		-0.004 - +0.006		0.02	
		Pin outside dia.		φ 20.998 – 21.002		φ 20.98	
	Piston ring	Clearance between piston ring groove and ring	Top ring	0.06-0.10		0.25	
			2nd ring	0.05-0.09			
		Ring width	Oil ring	0.02-0.06		0.15	
			Top ring	2	1.97-1.99		Oversize (0.5)
			2nd ring	1.5	1.47-1.49		
			Oil ring	4	3.97-3.99		
		Piston ring end gap	Top ring	0.20-0.35		1.0	
			2nd ring		0.2-0.35	1.0	
			Oil ring		0.15-0.35	1.0	

Unit	Part	Inspection Items		Standard Dimension	Standard Assembling Value	Repair Value	Service Limit	Remarks
Main moving part	Connecting rod	Torsion of large end and small end holes (per 100 mm)			Less than 0.08	More than 0.2		
		Parallelism of large end and small end holes (per 100 mm)			Less than 0.05	More than 0.15		
		Longitudinal play of connecting rod and crank pin			0.1 – 0.3		0.7	
		Clearance between connecting rod bearing and crank pin			0.035 – 0.083		0.2	Oil clearance
		Connecting rod tightening torque N·m {kgf·m}			29–34 {3.0–3.5}			
		Weight variation of piston after assembly (g)			Less than 10			
	Crank shaft	Journal dia.	No. 1, 2, 3	φ 46	45.964 – 45.975	φ 45.90	φ 45.40	Undersize (0.25, 0.5)
			No. 4	φ 46	45.954 – 45.965			
		Crank pin dia.		φ 39	φ 38.964 – 38.975	φ 38.90	φ 38.40	Undersize (0.25, 0.5)
		Journal and pin finishing accuracy		1.6Z				
		Run-out of crankshaft			Less than 0.03	More than 0.06		
		Axial play of crankshaft			0.1 – 0.3	0.5		
		Thickness of No. 4 bearing holder			21.85 – 21.95		21.55	
		Bush (journal metal) bore × outside dia.		φ 46 × φ 50				Under size (0.25, 0.5)
		Clearance between crank journal and bush (journal metal)			0.039 – 0.092		0.2	Oil clearance
		Center bearing (bore × outside dia.)		φ 46 × φ 50				Undersize (0.25, 0.5)
		Clearance between crank journal and center bearing			0.039 – 0.092		0.2	Upper No.2,3 Lower No.4 Oil clearance
					0.029 – 0.082			
		Bearing holder (upper and lower) tightening torque N·m {kgf·m}			20–25 {2.0 – 2.5}			
Valve system	Cam shaft		For intake and exhaust valves		26.565 – 26.62		26.1	
			For injection pump		33.94 – 34.06		33.8	
		Cam gear backlash			0.08		0.25	
	Valve	Intake valve stem		6.97	6.955 – 6.97		6.89	
		Exhaust valve stem		6.95	6.94 – 6.95		6.84	
		Clearance between valve stem and valve guide	Inlet		0.03 – 0.06		More than 0.2	
			Exhaust		0.05 – 0.075		More than 0.25	
		Thickness of valve 		1.0	0.925 – 1.075		0.5	

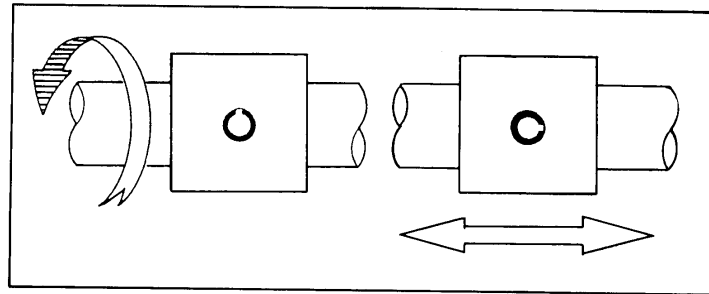
Unit	Part	Inspection Items	Standard Dimension	Standard Assembling Value	Repair Value	Service Limit	Remarks
Valve system	Valve	Valve clearance (both intake and exhaust)		0.2	0.5		When cold
		Valve spring	Spring force (when intalling length is compressed to 30.4 mm)	8.1		7	
			Free height	35		33.5	
			Squareness  201V	1.2		2.0	
		Inlet valve	Opening angle before TDC	13°			
			Closing angle after BDC	43°			
		Exhaust valve	Opening angle before BDC	43°			
			Closing angle after TDC	13°			
	Push rod	Overall length	157	156.8 – 157.2			
		Outer diameter	φ 6.3				
	Rocker arm	Wear of rocker arm shaft	φ 11.66	φ 11.65 – 11.67		φ 11.57	
		Clearance between rocker arm and shaft		0.032 – 0.068		0.2	Oil clearance
Lubricating system	Oil pump	Discharge rate: ℓ/min. Engine speed 3000 rpm Discharge pressure 0.3-0.5 MPa {3-5 kgf/cm ² } Oil temperature 50°C-80°C SAE30		13.2			
		Oil pressure switch working pressure MPa {kgf/cm ² }	0.03 {0.3}	0.02 – 0.04 {0.2 – 0.4}			
		Relief pressure opening pressure MPa {kgf/cm ² }		0.25 – 0.35 {2.5 – 3.5}			
		Lubrication oil volume ℓ	3.2				At replacing filter 3.7 ℓ
		Tip clearance (between rotor and vane)		0.1 – 0.15		0.25	
		Side clearance (between rotor and cover)		0.1 – 0.15		0.2	
Fuel system	Injection pump	Type	094500-7410				NIPPON DENSO
		Pump plunger dia.	φ 5.5				
		Pump plunger stroke	6				
		Injection timing	Before T.D.C.	22 - 24°			
			Piston displacement (before T.D.C.)	3.44 – 4.08			

Unit	Part	Inspection Item	Standard Dimensions	Standard Assembling Value	Repair Value	Service Limit	Remarks
Fuel system	Injection nozzle	Type	(Nozzle) 093400-2840 (ND-DNOSD189)				NIPPON DENSO
		Injection pressure MPa {kgf/cm ² }	11.76 {120}	11.27 – 12.25 {115 – 125}			
		Injection angle	4°				
		Nozzle and holder tightening torque N·m {kgf·m}		78.4 – 83.3 {8 – 8.5}			Install cylinder head
Cooling system	Cooling conditions	Cooling method	Forced circulation water cooling				
		Cooling water amount ℓ	5.5				
		Thermostat operating temperature °C	82	80 – 84			
		Thermostat full open temperature °C	95				
		Pump discharge rate ℓ/mm (Engine speed: 3000 rpm, Water temperature: Normal)		54.4			
		V belt (fan) looseness (load at center 9.8 N {1 kgf})		5			
		Start to open pressure of radiator cap pressure valve kPa {kgf/cm ² }	88.2 {0.9}	73.5 – 102.9 {0.75 – 1.05}			
		Start to open pressure of radiator cap negative pressure valve kPa {kgf/cm ² }	4.9 {0.05}	3.9 – 4.9 {0.04 – 0.05}			
Electrical system	Starting motor	Model	128000 – 0101				NIPPON DENSO
		No. of teeth of pinion gear	9				
		Pinion gear shifting method	Magnetic shifting				
		Wear of commutator dia.	φ 30			φ 29	
		Pinion shaft axial play		0.1 – 0.5			
		Brush length	13.5			9.0	
		Brush spring pressure N {kgf}	1.7			1.2	
	Alternator	Type	GP9165				Kokusan Denki
	Regulator	Type	RS5137				Kokusan Denki
		Regulating voltage (V)	14.5	14 – 15			

Chapter 3 TRACTOR MAIN BODY

NOTES: Precautions before start

- 1) Wash each part sufficiently and remove dust, liquid packing, gasket, etc.
- 2) Store bolts and O-rings in order not to be confused at the time of reassembly since their sizes vary depending on positions of use.
- 3) Handle gears carefully not to damage and store carefully so that they are not reassembled in incorrect direction.
- 4) Remove steel balls, springs and other small parts carefully not to miss when overhauling the transmission case and install them without fail at the time of reassembly.
- 5) When driving in a spring pin, apply the driving force and face the spring pin gap as shown in the figure below.

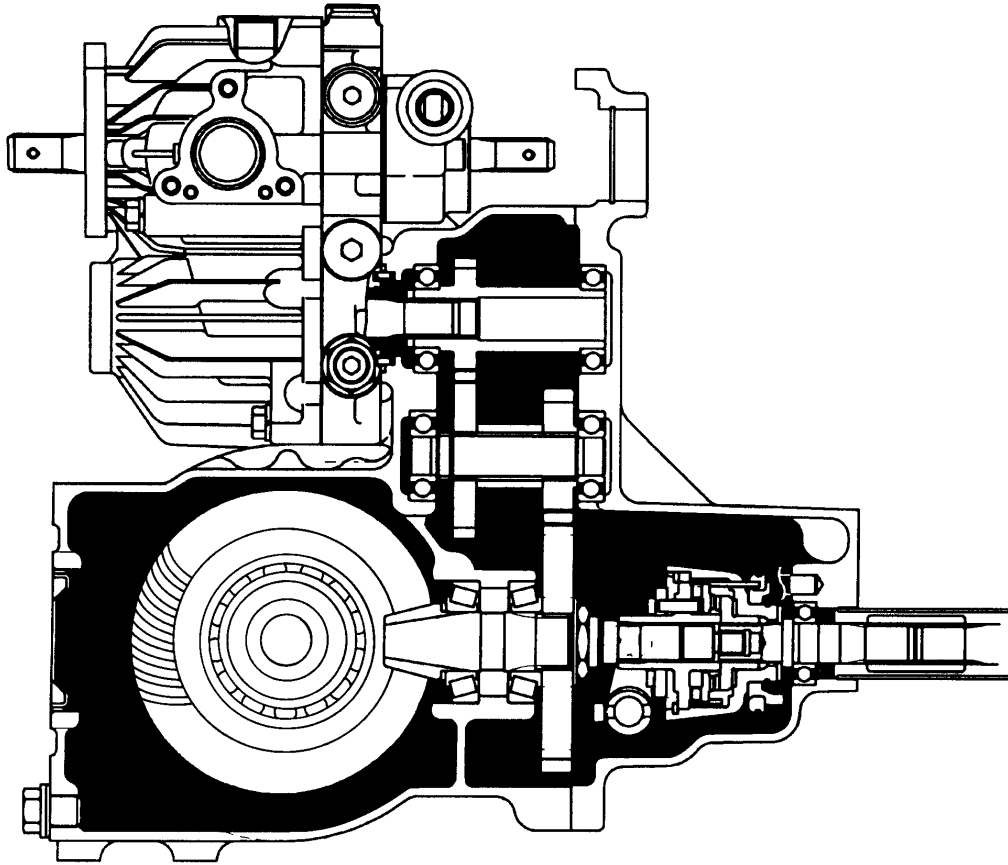


400V

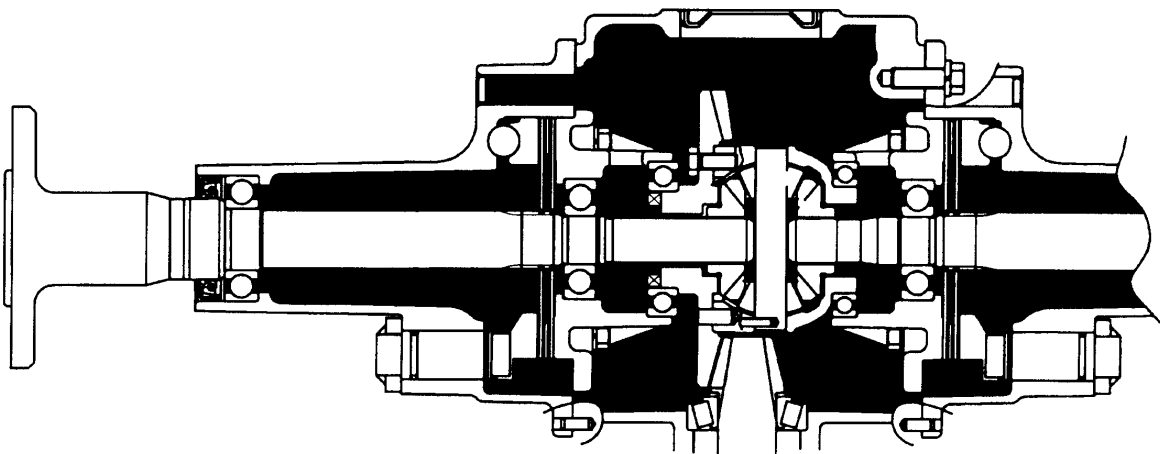
- 6) Replace the lock washers, wires and gaskets with new ones.
- 7) Be sure to coat liquid packing where liquid packing had been coated and leave it for 3 to 5 minutes before reassembly. (Use semi-dry, fluidity type liquid packing.)
- 8) Drain oil and water if required.

3-1 Front Axle, Transmission and Brake

1. SECTIONAL VIEWS



401V



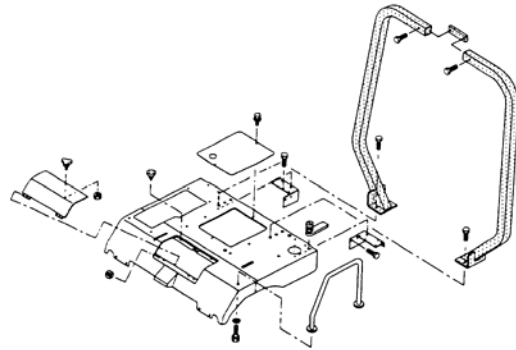
402V

2. FRONT AXLE, TRANSMISSION AND HST UNIT

1) Removal

1. ROPS

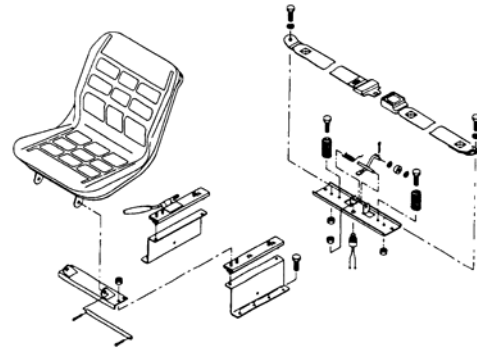
Remove the ROPS from the main frame.



2. Seat assembly

403V

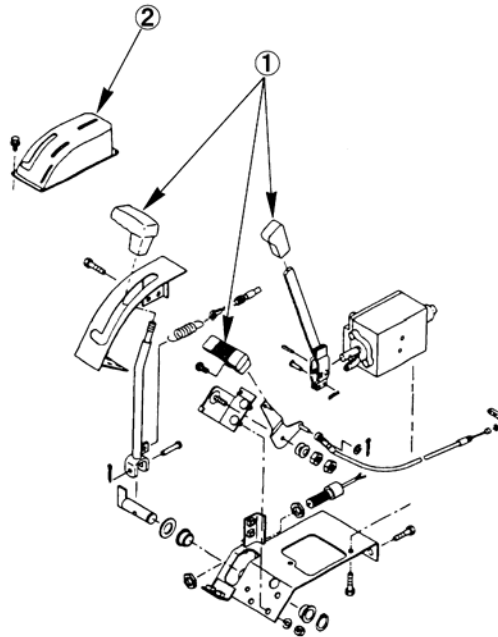
- ① Disconnect the seat switch wire at the connector.
- ② Remove the seat assembly and seat support as a set.



404V

3. Lever guide (R.H.)

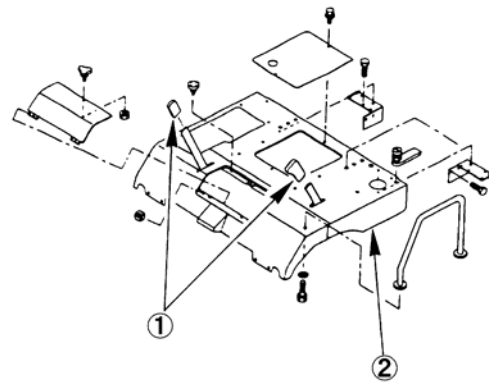
- ① Remove the grips from the hand throttle control lever, hydraulic control lever and PTO control lever.
- ② Remove the right lever guide.



405V

4. Fender

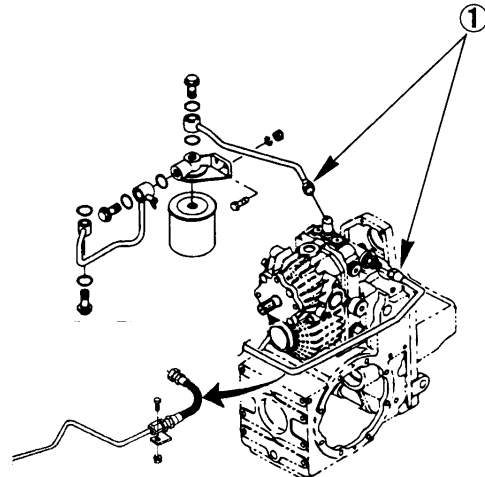
- ① Remove the grips from the parking brake lever and four wheel drive select lever.
- ② Remove the fender.



406V

5. Piping

- ① Disconnect the piping from charge pump and top of the HST unit.

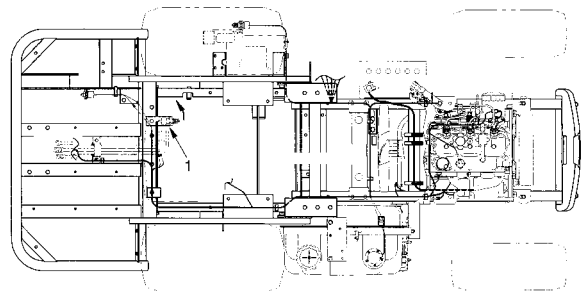


407V

6. HST neutral switch

- ① Untighten the bolt and turn the stay with HST neutral switch to the counterclockwise.

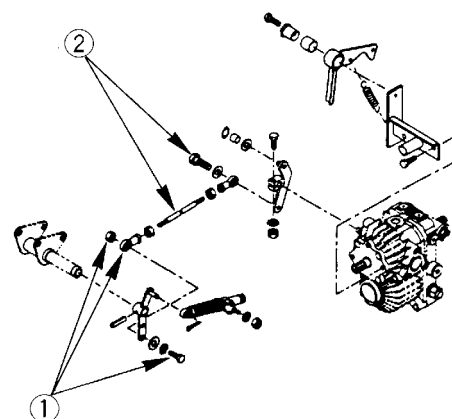
1. HST neutral switch



408V

7. HST speed control rod

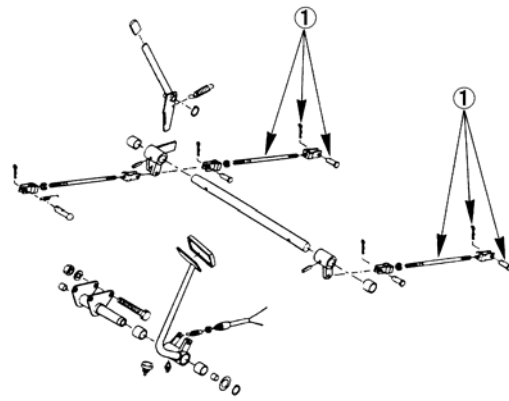
- ① Remove the bolt and nut.
- ② Disconnect the HST speed control rod at the HST unit side.



409V

8. Brake rod

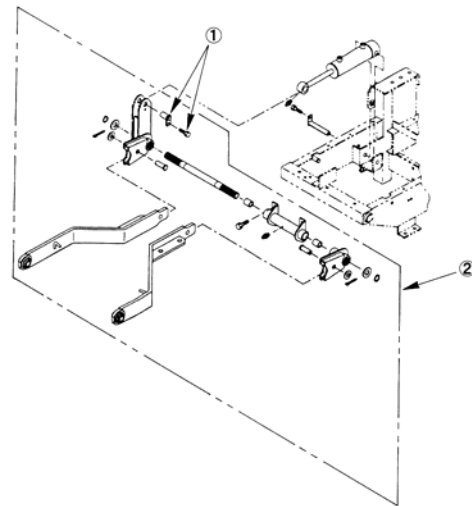
- ① Remove the sprit pin and flat head pin, and disconnect the brake rods at the brake lever.



410V

9. Lift arm

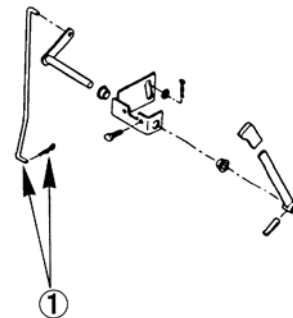
- ① Remove the bolt and pin, and disconnect the lift arm and hydraulic lift cylinder.
- ② Remove the lift arm assembly as a set.



411V

10. 4 WD control shift link

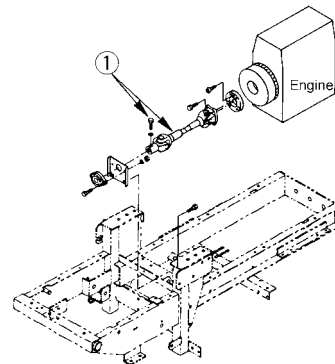
- ① Remove the sprit pin, and disconnect the 4WD control shift link at the bottom.



412V

11. Universal joint assembly

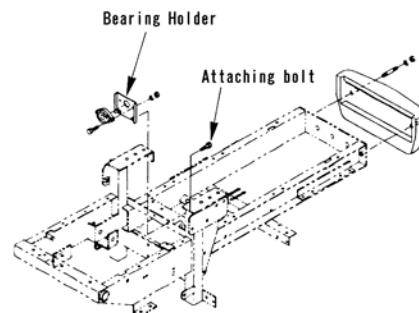
- ① Remove the bolt and disconnect the joint by slide the input shaft to rearward.



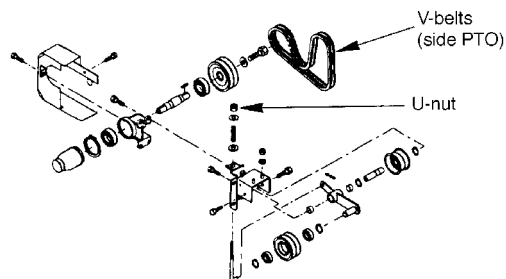
413V

12. V-Belts

- ① Remove the V-belts for front PTO and side PTO as follows:
 - Remove the bearing holder attaching bolts for input shaft.
 - Untighten the tension U-nut for side PTO.
 - Turn the bearing holder for make the gap and remove the two V-belts from the input shaft pulley for side PTO.



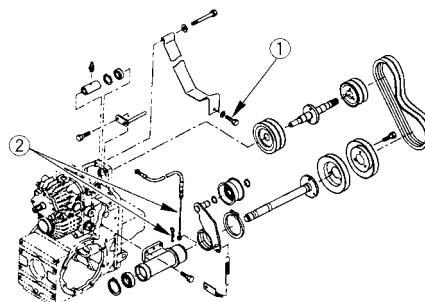
414V



415V

13. Front PTO tension wire

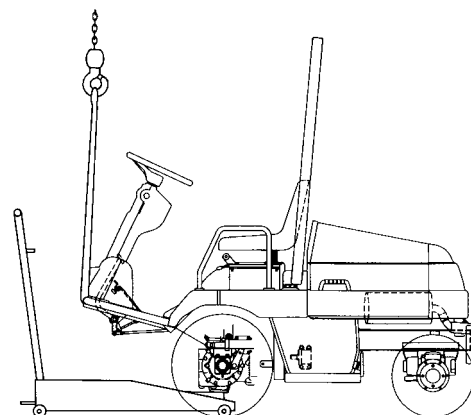
- ① Remove the bolt from left side frame for PTO belt cover.
- ② Remove the sprit pin and tension wire from the shift arm for front PTO.



416V

14. Front axle and transmission assembly

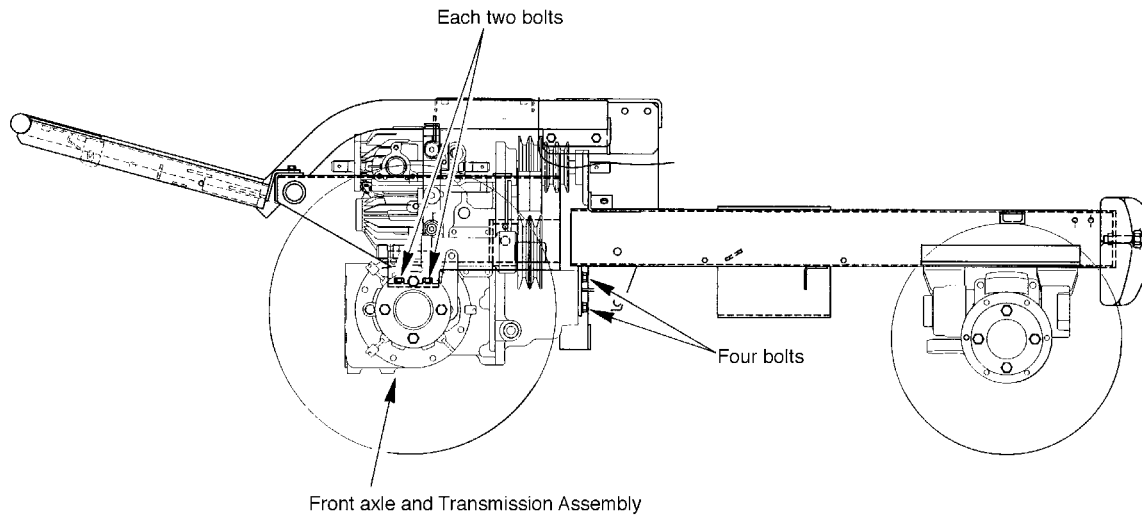
- ① Pull up and hold the frame by the hoist.
- ② Support the bottom of front axle and transmission assembly by the garage jack.



417V

③ Remove the front axle and transmission assembly as follows:

- Remove each two bolts for tightening frame and front wheel shaft housing at the L.H. and R.H.
- Remove the four bolts from rear of front axle and transmission assembly.
- Move the front axle and transmission assembly to forward until disconnect the rear wheel drive shaft.
- Pull up the frame by hoist and remove the front axle and transmission assembly.



419V

2) Installation

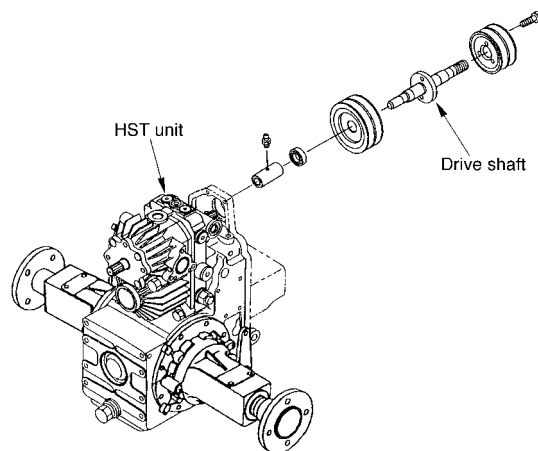
Reinstall the front axle, transmission, and HST assembly to the frame in the reverse order.

3) Transmission and Front Axle Assembly

(1) Disassembly

1. Drive shaft

Drive out the drive shaft (input shaft), pulleys and bearings as a set to rearward.



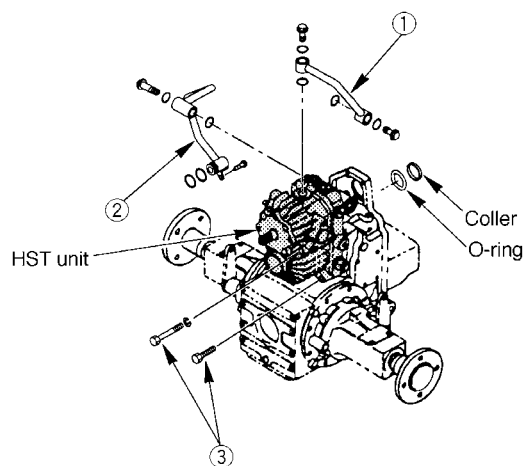
420V

2. HST unit

Remove the HST unit from the transmission housing as follows:

- ① Remove the eye bolts and return pipe with O-rings.
- ② Remove the eye bolt and fixing bolt, and then remove the suction oil pipe with O-rings.
- ③ Remove the 4 fixing bolts and HST unit from the transmission housing.

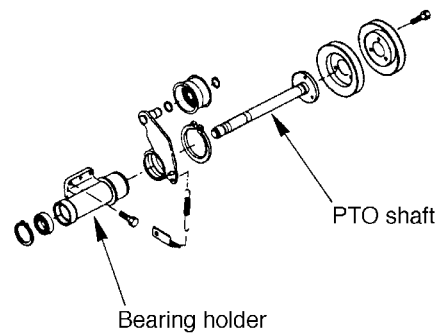
NOTE: If removed, keep the O-ring and collar from between the transmission housing and HST unit.



421V

3. Front PTO shaft and bearing holder

Remove the front PTO shaft and bearing holder as a set.



422V

4. Wheel shaft assemblies

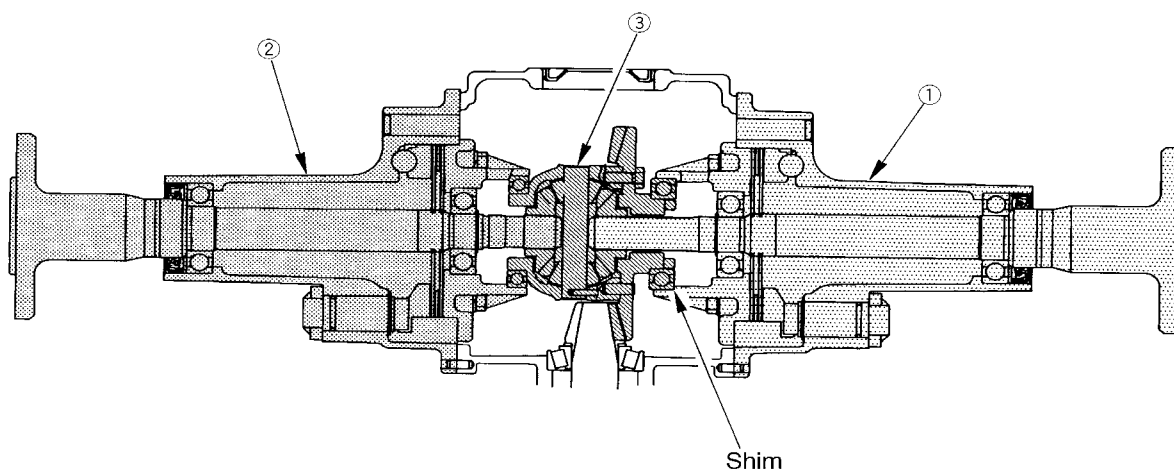
Remove the wheel shaft assemblies as follows:

- ① Remove the L.H. wheel shaft assembly from transmission housing at first.

NOTE:

1. Take care the differential assembly will be removed and fall down from in the housing.
2. Note the thickness and number of shims fitted between bearing carrier and bearing (No. 6010).

- ② Remove the differential assembly in the housing, if remaining.
- ③ Remove the R.H. wheel shaft housing from transmission housing.



423V

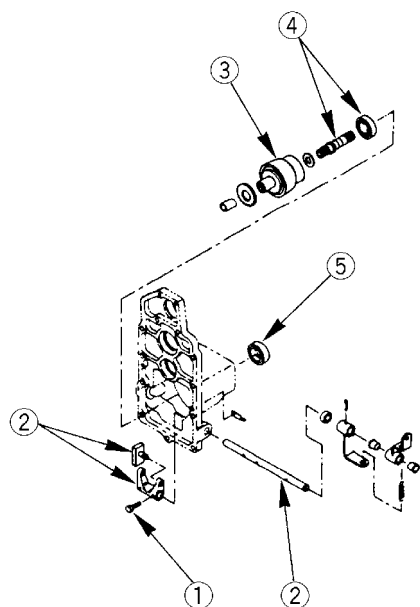
5. Transmission cover

Remove the transmission cover and two way clutch assembly as a set.

6. Two way clutch assembly

Remove the two way clutch assembly as follows:

- ① Heat the bolts head by burner, and then remove them from the shifter fork.
- ② Slide the shaft out of the housing and take out the shifter fork with two blocks.
- ③ Remove the two way clutch assembly from in the cover.
- ④ Drive out the drive shaft and bearing from the cover.
- ⑤ If necessary, remove the oil seal.



424V

7. Drive shaft

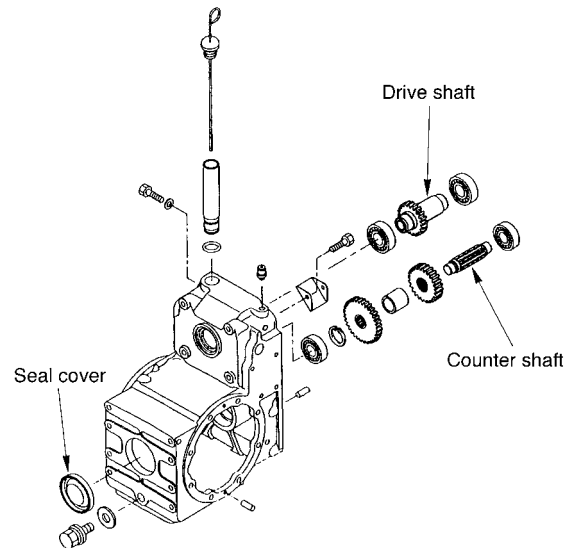
Remove the drive shaft and two bearings as a set.

8. Counter shaft

Remove the countershaft and two bearings as a set.

9. Seal cover

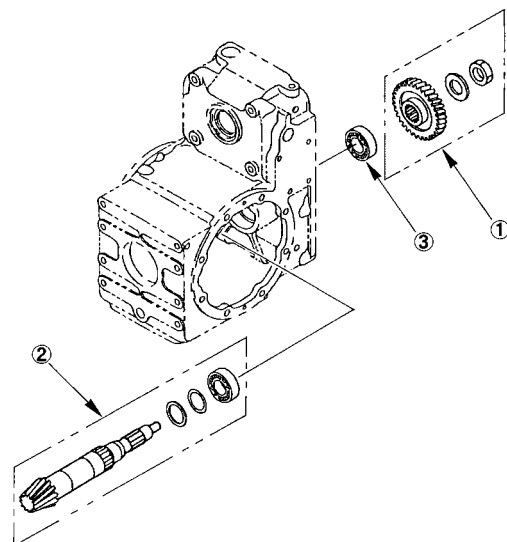
Remove the seal cover for inspect the ring gear back lash.



425V

10. Drive pinion shaft

- ① Remove the lock nut, washer and fixed gear from on the drive pinion shaft.
- ② Drive out the drive pinion, shims, washer and bearing as a set to the front ward.
- ③ Remove the bearing from in the housing.



426V

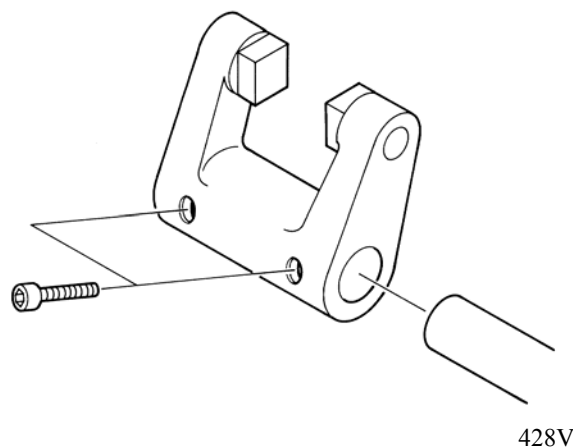
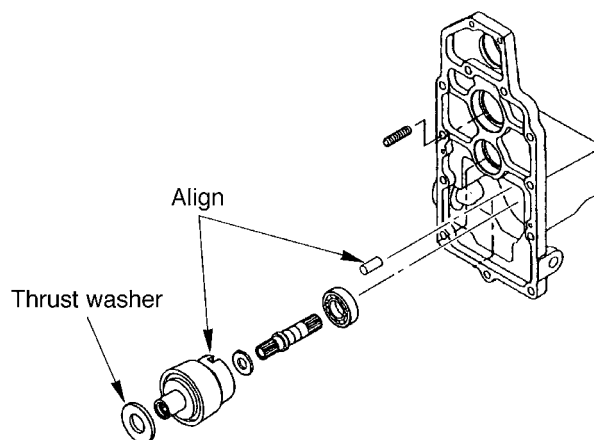
(2) Assembly and Adjustment

Reassembly generally follows the disassembly procedure in reverse.
During assembly observe the following:

Four Wheel drive shifter fork assembly

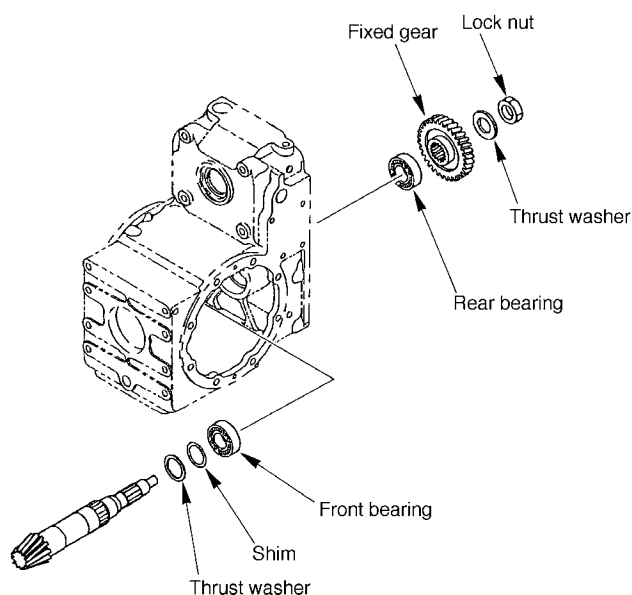
1. Install the two way clutch assembly with align the pin in the transmission cover and notch of two way clutch assembly.
2. Install the thrust washer on the two way clutch assembly.
3. Remove the oil stain from the bolt thread and shaft thread by cleaning solvent.
4. Apply the thread sealant to bolt thread, and install the shifter fork , two blocks and shaft secure with two bolts in the transmission cover.

NOTE: Take care at the direction of shifter fork.
The spotted face of shifter fork toward the drive pinion.



Drive pinion assembly

1. Install the outer bearings in the transmission housing.
2. Assemble the thrust washer, shims and front inner taper roller bearing on the drive pinion shaft. Insert the pinion shaft in the housing.
3. Install the rear inner taper roller bearing, fixed gear and washer secure with lock nut.

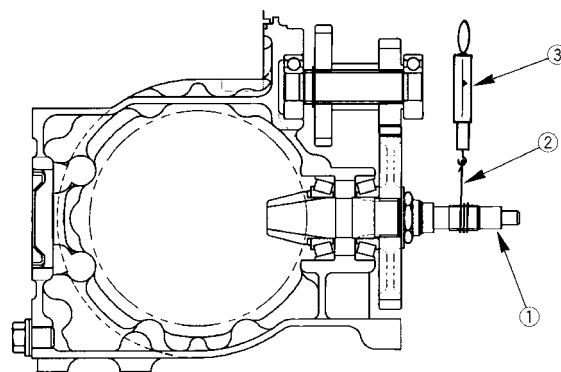


429V

4. Adjust the pinion bearing pre-load using a strong cord wrapped around the pinion shaft and a pull scale. Tighten the pinion nut to obtain the specified kilograms of constant pull to rotate the pinion assembly.
Tighten the lock nut and crimp it at the ditch of the pinion shaft.

Pinion bearing pre-load constant pull
196 N {20 kgf}

NOTE: Turn drive pinion several times by hand before performing pull scale test.



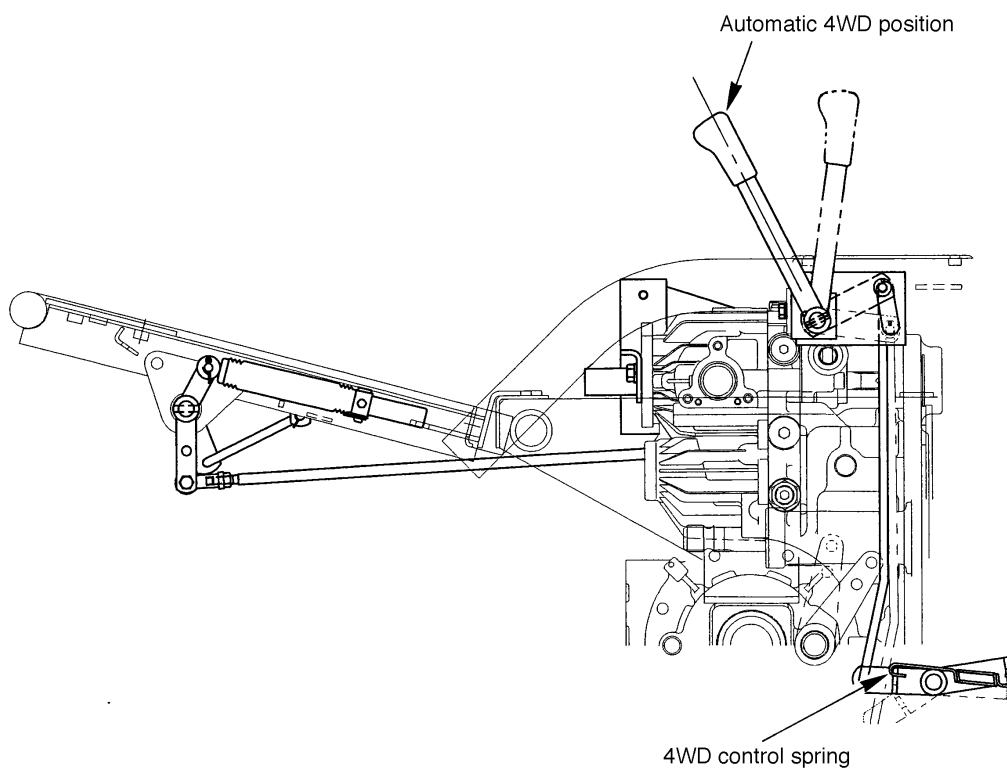
Pinion Pre-Load Adjustment

1. Pinion Shaft
2. String
3. Pull Scale

430V

4WD Control Spring

If removed spring from the 4WD control lever , install the spring direction as illustrations.

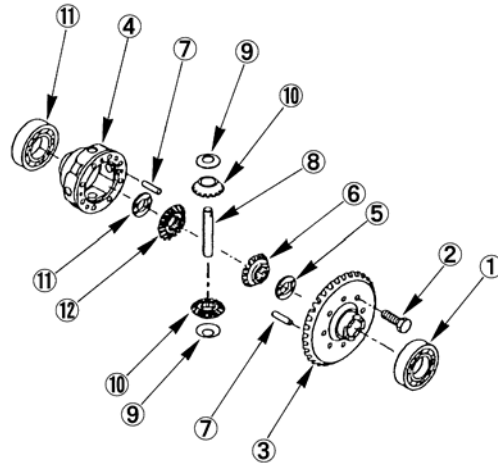


431V

4) Differential Assembly

(1) Disassembly

1. If installed, remove the bearings ①.
2. Remove the bolts ②, and separate the ring gear ③ from the differential housing ④.
3. Remove the thrust washer ⑤ and differential gear ⑥.
4. Remove the pin ⑦ from in the differential housing ④.
5. Draw out the pinion shaft ⑧ and remove the thrust washers ⑨, pinion gear ⑩, thrust washer ⑪ and differential gear ⑫ from in the differential housing ④.



432V

(2) Assembly

Reassembly generally follows the disassembly procedure in reverse.

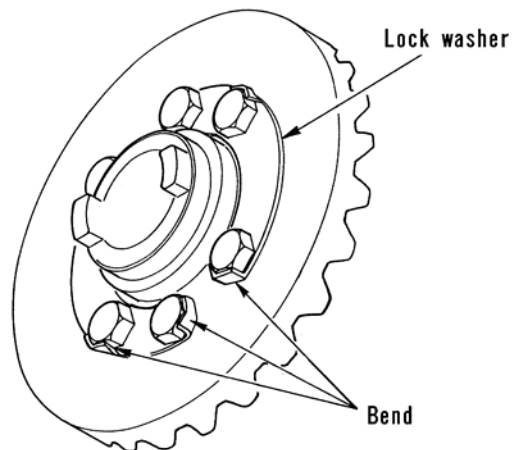
During assembly observe the followings:

1. Install the ring gear bolts with two lock washers (No. 399310270), and tighten to specified torque.

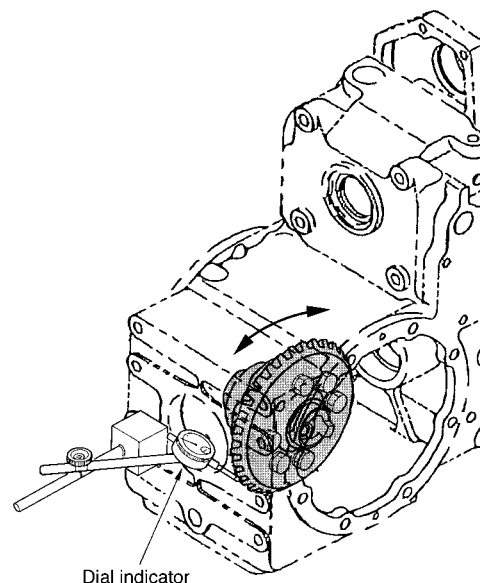
NOTE: The lock washers are installed reassembly only.

Ring gear tightening torque
$25.5 \pm 2.9 \text{ N}\cdot\text{m}$ { $2.6 \pm 0.3 \text{ kgf}\cdot\text{m}$ }

2. Bend the lock washers at the three positions of each one.
3. If new differential components are used, adjust the backlash and ring gear contact patterns as follows:
 - a. Install the drive pinion refer to "TRANSMISSION AND FRONT AXLE ASSEMBLY" in this section.
 - b. Using prussian blue on the pinion gear teeth.
 - c. Install the differential gear assembly and both wheel shaft assemblies on the transmission housing.
 - d. Place the dial indicator at a right angle to the top of a ring gear tooth.
 - e. Rock the ring gear back and forth and observe the dial indicator reading.



433V



434V

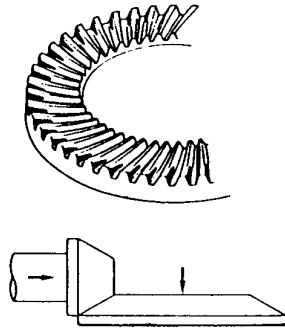
- f. Adjust the shims to obtain the correct backlash.

Ring Gear Backlash	
Standard	0.1 – 0.2 mm
Service limit	0.4 mm

Rotate the pinion gear and check the gear tooth pattern. Adjust the differential and pinion shims to obtain the correct tooth pattern. See “Ring gear and pinion gear pattern specification and adjustment”.

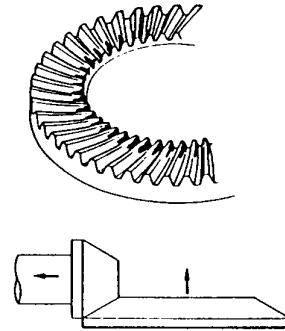
Ring gear and pinion gear pattern specification and adjustment

HEEL CONTACT:

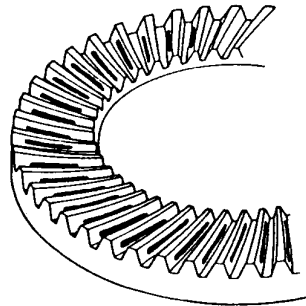


Select the shims so that the drive pinion is put nearer to the ring gear.

TOE CONTACT:

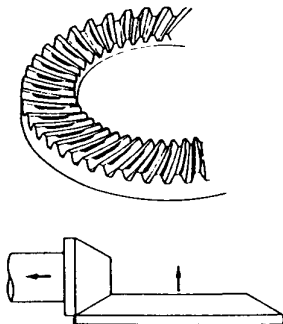


Select the shims so that the drive pinion is put farther from the ring gear.



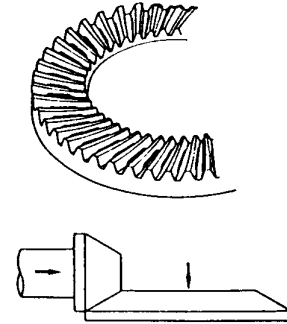
Correct pinion gear to ring gear tooth contact.

FACE CONTACT:



Select the shims so that the ring gear is put near to the drive pinion.

FLANK CONTACT:



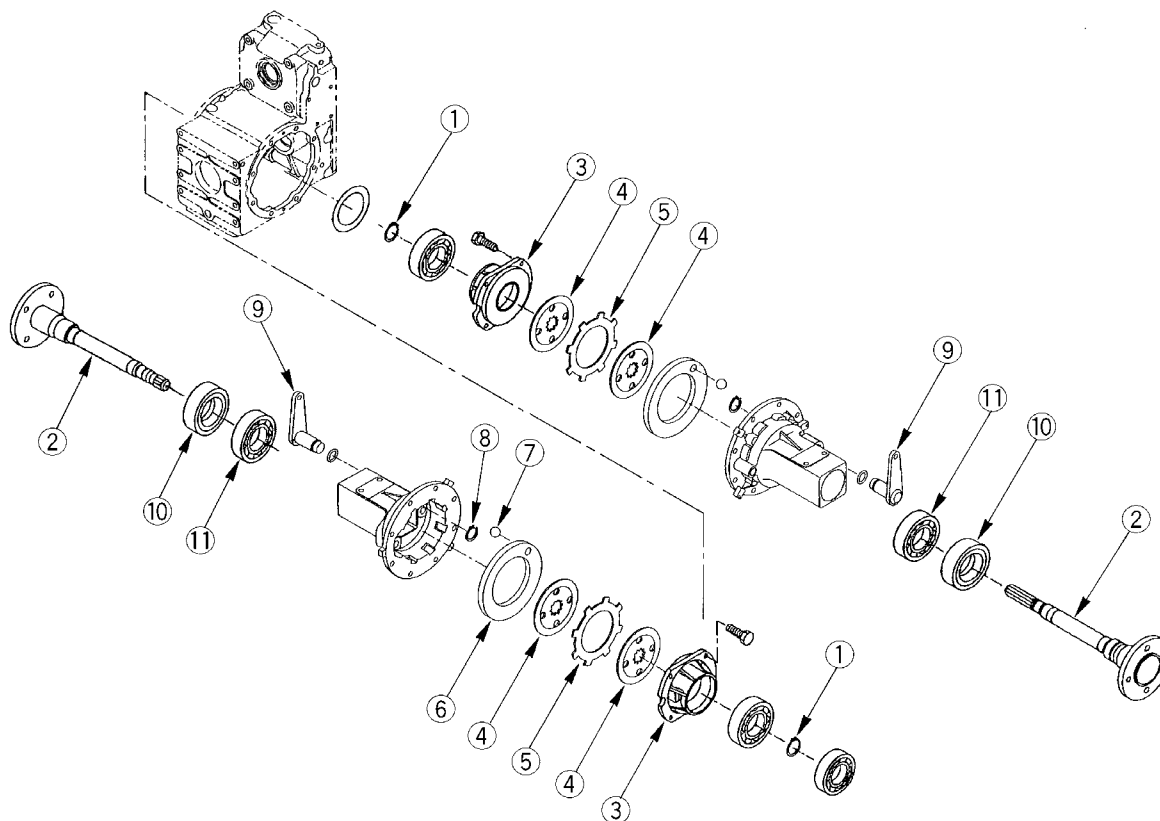
Select the shims so that the ring gear is put farther from the drive pinion.

435V

5) Front Wheel Shaft

(1) Disassembly

1. Remove the snap ring (1) from the wheel shaft.
2. Drive out the wheel shaft (2).
3. Remove the bolts, and take out the bearing carrier (3), brake discs (4), stator (5), plate (6) and balls from in the wheel shaft housing (7).
4. Remove the snap ring (8) and brake lever (9) from the housing.
5. If necessary, remove the oil seal (10) and bearing (11) from the housing.



436V

(2) Inspection, Service and Assembly

Inspection

- ① Disk
Measure the lining thickness and replace if the measurement is below the service limit.
- ② Stator
Replace the stator if the lining-contact surface is roughened or the difference of level height is more than 0.1 mm.
- ③ Check the brake cover, steel ball, brake cam, and spring and replace defective ones.

Standard dimension	Service limit
2.8 mm	2.5 mm

Level height difference of contact surface	
Service limit	0.1 mm

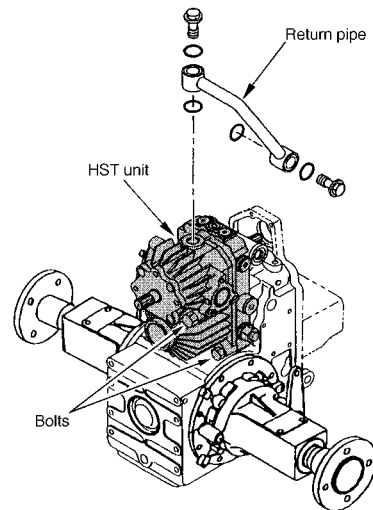
Reassembly

Reassembly generally follows the disassembly procedure in reverse.

6) HST Unit

For removal and installation of the HST unit only, follows the step 1 to 7 of the “2. Removal and installation of front axle and transmission, and HST unit” in Chapter 3-1 and refer to as follows:

1. Drain the transmission oil about 2 liters.
2. Disconnect the return pipe from top of the HST unite.
3. Remove the four bolts for tightening HST unit to transmission housing. (four bolts, return pipe, HST unit)
4. Slide the HST unit forward and take out it.



437V

(1) Disassembly

Reference – Figure 440 V

★ Caution:

1. Never disassemble the HST unit during the claim warranty term. If it is disassembled, claim is not accepted.
2. If disassembly is unavoidably required, the HST unit should be handled vary carefully since it is finished precisely.

1. Remove the charge pump as follows:

- ① Remove the two socket head bolts (91), charge pump case (83) and O-ring (89) from the port block.
- ② Remove the trochoid rotor sub assembly (86).
- ③ Remove the pin (87) from the shaft (8), and remove the plate (84), O-ring (90) and pin (88).

2. Remove the port block as follows:

- ① Remove the eight socket head bolts (55) and port block (2).

NOTE: Take care do not fall down the valve plates (6 and 7).

- ② Remove the pins (50), valve sub assembly (28), gasket (49) and spring (22).

- ③ Remove the valve plates (6 and 7).

3. Remove the cylinder block assembly (3, 5, 20 and 41) for pump.

4. Remove the cylinder block assembly (3, 5, 20 and 41) for motor.

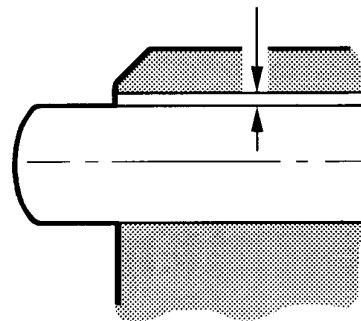
5. Remove the swash plate (4), bush (17), guide assembly (51) as a set from the housing (1).
6. Remove the thrust bearing (13), bush (16), slide metal (18), bearing (54) and pin (53) from the housing (1).
7. Remove the thrust bearing (13) for motor from the housing (1).
8. Remove the shaft as follows:
 - ① Remove the four screws (71), cover (19), pin (50) and O-ring (82) from the housing (1).
 - ② Remove the snap ring (37) and the shaft (9) from the housing.
9. Remove the trunnion shaft as follows:
 - ① Remove the snap ring (69), and tap the shaft end by soft jaw hammer and remove the trunnion shaft (10) from the housing.
 - ② Remove the bearing (66).
10. Disassemble the port block as follows:
 - ① Remove the plug (33) for check valve, and remove the spring (21) and poppet from the port block (2).
 - ② Remove the valve sub assembly (27).
 - ③ Remove the plug (74) for neutral valve, and remove the two shims A(79), three shims B(80), spring (75) and piston assembly from the port block.

(2) Inspection

Replace the parts or HST unit, if clearance is exceeds the service limit.

1. Piston and cylinder block assembly
Replace if the diameter clearance between the piston and cylinder block exceeds the service limit.

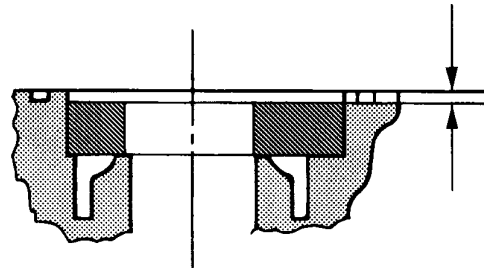
Standard assembly value	Service limit
0.02 mm	0.03 mm



438V

2. Charge pump assembly
Measure the side clearance of the trochoid rotor sub assembly and replace if the service limit is exceeded.

Standard assembling value	Service limit
0.025 – 0.052 mm	0.055 mm



439V

(3) Reassembly

Reference – Figure 440 V

★ Caution before reassemble

1. Wash each parts by washing solvent and blow with compressed air.
2. Keep each parts free from dust deposit, indentations or faults.
3. Replace seals with new one.
4. Coat oil seals and O-rings with lithium grease (especially oil seal lip).

1. Install the trunnion shaft as follows:

- ① Install the snap ring (38) and oil seal (67) in the housing (1).
- ② Install the ball bearing (65) on the trunnion shaft (10), and install them in the housing (1).
- ③ Install the washer (72) and ball bearing (66) in the housing (1) and secure with snap ring (69).

2. Install the shaft for pump as follows:

- ① Install the bearing (14)-A and snap ring (36)-A on the pump shaft (8), and then install them in the housing (1) and secure with snap ring (37)-A.
- ② Install the pins (50) and O-ring (82) to the housing (1).
- ③ Install the oil seal (61) in the cover (19), and install them with screws (71) on the housing (1).
Screw (71) tightening torque: $17.2 \pm 2 \text{ N}\cdot\text{m}$ $\{1.75 \pm 0.2 \text{ kgf}\cdot\text{m}\}$

3. Install the shaft for motor as follows:

- ① Install the ball bearing (14)-B on the shaft (9) secure with snap ring (36)-B, and install them in the housing (1) and secure with snap ring (37)-B.
- ② Install the seal cover (11) in the housing (1) and secure with snap ring (37)-C.

4. Install the thrust bearing (13)-A and swash plate (4) in the housing as follows:

- ① Install the thrust bearing (13)-A in the housing.

NOTE: Thrust bearing's reference mark is installed against the housing.

- ② Install the bush (16), pin (53) and roller bearing (54) in the housing.
- ③ Install the slide metal (18) to the trunnion shaft (10).
- ④ Install the thrust bearing (13)-B in to the swash plate assembly {consist swash plate (4), bush (17) and guide (51)}, and install them into the housing (1).

NOTE:

1. Thrust bearing's reference mark is installed against the swash plate.
2. Install the swash plate assembly as follows:
 - The ball of guide assembly is inserted to the hole of housing while align the guide assembly and ditch of roller bearing supporter.
3. Inspect the swash plate moving is smoothly while move it by hand. If it is not move smoothly, check the roller bearing location.

5. Install the cylinder block assemblies in the housing as follows:

- ① Install the spring holder (41) and spring (20) in the pistons (5).
- ② Install the nine pistons into the each cylinder block (3), and install them into the housing (1).

6. Install the port block assembly as follows:

- ① Install the valve plates (6 and 7) with the brass color face toward the cylinder block assembly.

NOTE:

1. Apply the grease to the valve plates (6 and 7) for prevent fall down them.
2. The pump side valve plate has two notches (V shape ditch), and take care at the direction.

- ② Apply the grease to the valve sub assembly (28) and install it to the port block.
- ③ Apply the grease to the spring (22), and install the pins (50), spring (22) and gasket (49) to the housing (1).
- ④ Install the port block assembly with socket head bolts (55).
Socket head bolt tightening torque is $49 \pm 5 \text{ N}\cdot\text{m}$ { $5 \pm 0.5 \text{ kgf}\cdot\text{m}$ }

7. Install the charge pump as follows:

- ① Install the pins (88), O-ring (90) and plate (84) to the port block.

NOTE: Position the plate (84) with the brass color face toward the charge pump.

- ② Install the pin (87) into the input shaft (8), and install the trochoid rotor sub assembly with engage to the pin.

NOTE: Align the pin (88) center with peened marks of trochoid rotor sub assembly when install them.

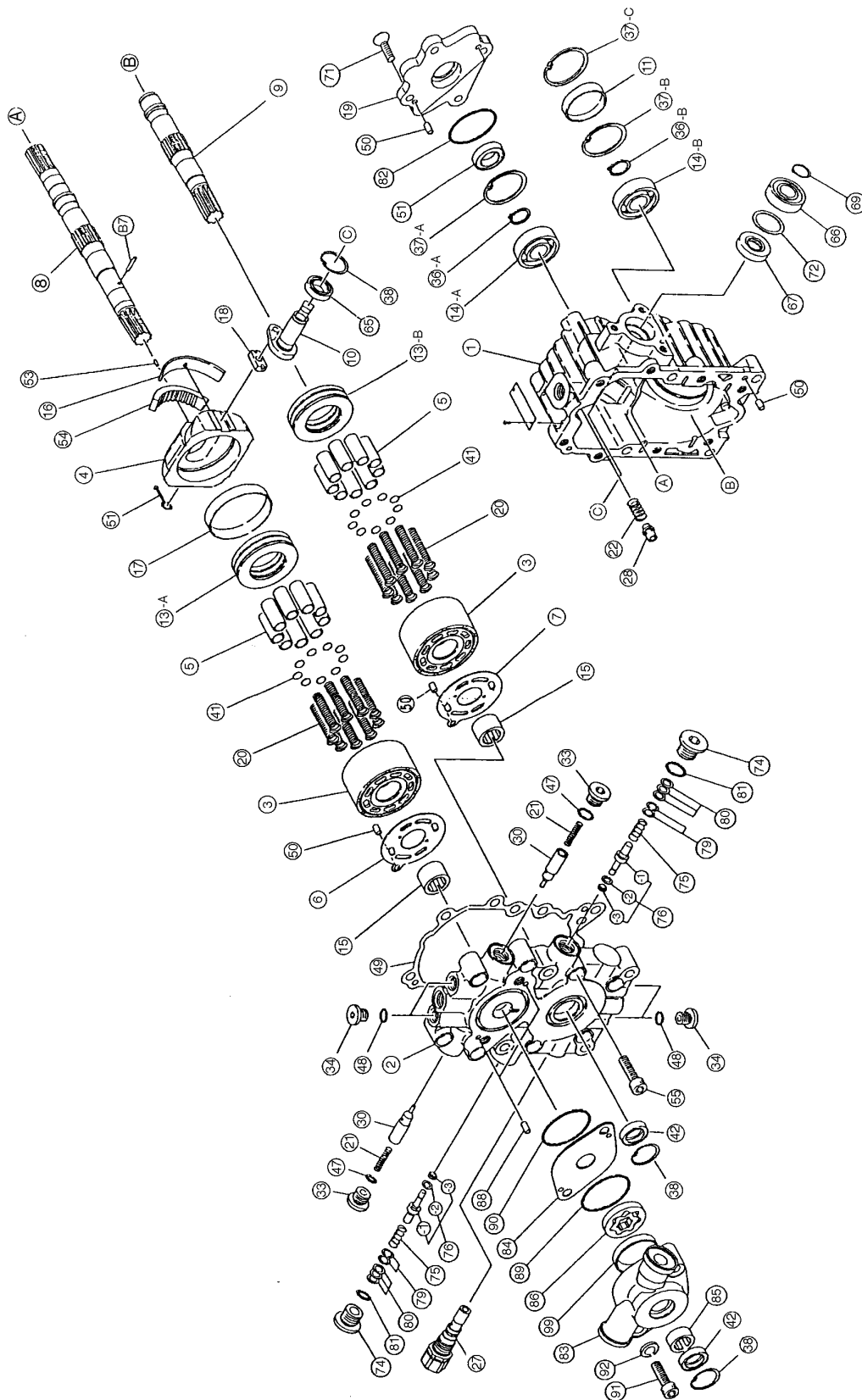
- ③ Install the charge pump case sub assembly and tighten the socket head bolts to specified torque.
Socket head bolt tightening torque is $49 \pm 5 \text{ N}\cdot\text{m}$ { $5 \pm 0.5 \text{ kgf}\cdot\text{m}$ }
- ④ Inspect the both shafts (8 and 9) are rotated smoothly by adjustable wrench after assembled.

(4) Troubleshooting

Replace the HST main body, if defective, as an ass'y as a rule.

Condition	Possible cause	Remedy
1. Output shaft fails to rotate when the HST pedal is set at forward or reverse position.	1. Improper operation of HST pump or motor.	Check the trunnion shaft movement and replace the ass'y.
	2. Damaged charge pump.	Measure the charge pressure and replace the ass'y.
	3. Too low set pressure of low pressure relief valve.	Measure the low circuit pressure and replace part.
	4. Too low set pressure of high pressure relief valve.	Measure the high pressure circuit pressure and replace parts.
	5. Defective seat of HST check valve.	Replace the part.
2. Output shaft fails to stop rotating with the HST pedal at neutral position.	1. Improper operation of neutral and check valve.	Disassemble, wash, and them reassemble (correction of valve).
	2. Clogged throttle part of check and neutral valve.	Disassemble, wash, and them reassemble.
	3. Damaged spring for check and neutral valve.	Replace the part.
3. Insufficient speed of HST output shaft or abnormal sound in the HST unit.	1. High pressure oil leaking due to wear at sliding part of HST pump or motor.	Clean in the oil circuit and replace HST unit.
	2. Lack of oil by clogging oil filters.	Replace oil filters.
	3. The air is mixture in the HST oil circuit.	Inspect the suction line of the charge pump or lack of the oil in the sump.
	4. Lack of discharge oil quantity by abnormal oil temperature.	· When low temperature: Warm up the tractor. · When low temperature: Stop the engine and restart the engine after cooled.
4. Oil leaks at shaft and seal.	Oil leakage due to damaged oil seal or O-ring.	Replace damaged oil seal or O-ring with new one. In this case, take sufficient care not to damage the lip when inserting the oil seal.

(5) HST Exploded Assembly Viw



440V

(6) Adjustment

HST speed control rod adjustment

Adjust the HST speed control rod length to 510 mm.

Neutral position adjustment

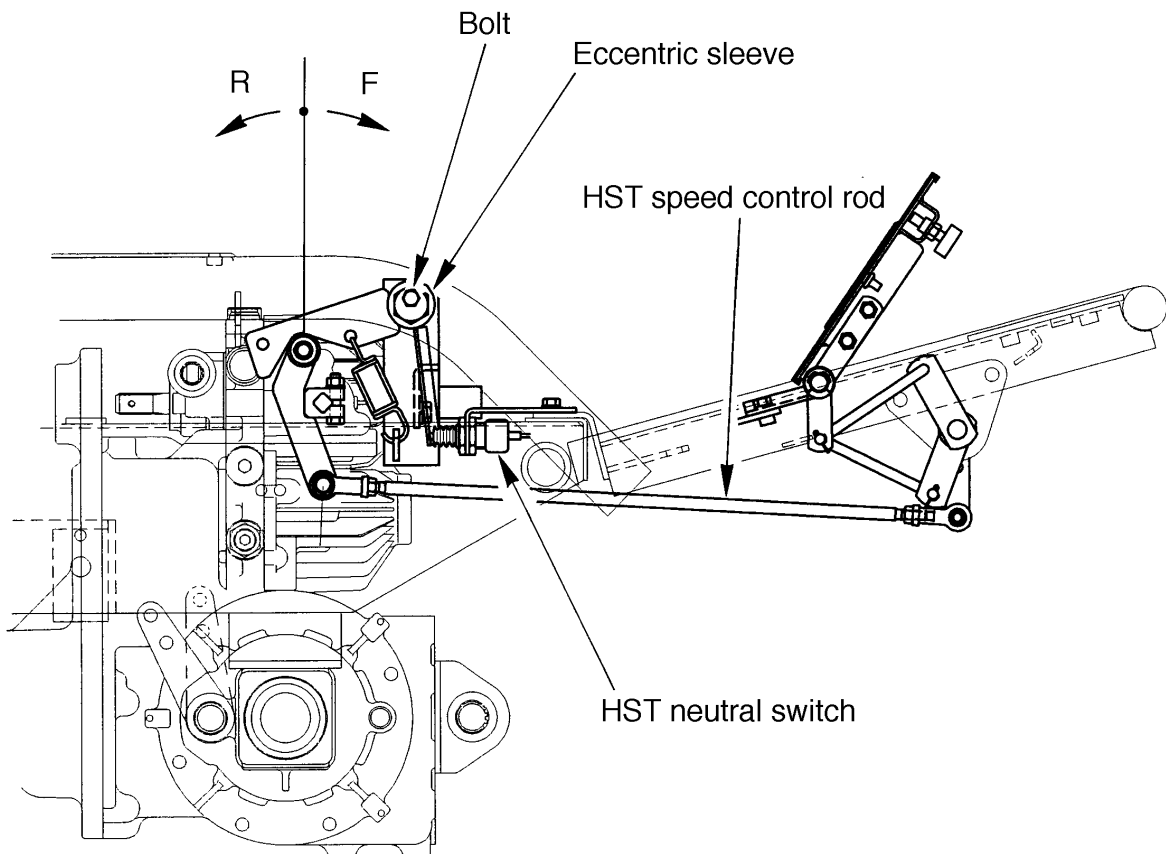
1. Jack up the front and rear wheels off of the ground and place jack stands under the axles.
Make sure all four wheels are clear of the ground and the commercial mower is properly supported.
2. Disconnect the wire from the seat neutral switch and connect a jumper wire between the two harness leads. Apply the master brake pedal and start the engine, release the brake pedal.
3. Set the throttle at low speed.
4. If the wheels rotate at this time, loosen the bolt and rotate the eccentric sleeve until the wheels stop and tighten the bolt.

NOTE: Turning the eccentric sleeve clockwise will cause wheels rotate in forward and turning counterclockwise the wheels will rotate in the reverse direction.

5. Stop the engine and remove the jack stands. Lower the wheels to the ground.
6. Reconnect the seat neutral start switch wires.
7. While seated in the operators seat, start the engine, and increase the engine speed to full throttle.
The commercial mower should not move in either direction.

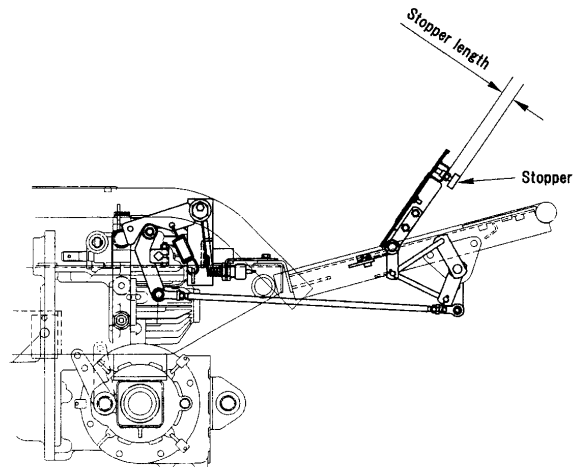
HST neutral switch adjustment

1. Adjust the HST neutral switch after adjusted the neutral position.
Adjust the plunger is pushed 2 ~ 3 mm in the body with ON position when HST pedal is at the neutral position.



HST pedal stopper adjustment

1. HST pedal stopper length adjust to 25 mm for forward pedal, an 30 mm for reverse pedal.

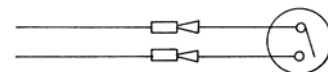


442V

(7) Pressure Check

High pressure relief check

1. Jack up the front and rear wheels off of the ground and place jack stands under the axles. Make sure all four wheels are clear of the ground and the commercial mower is properly supported.
2. Disconnect the wire from the seat neutral switch and connect a jumper wire between the two harness leads.
3. Remove the fender as follows the step 1. ROPS to 5. Fender or the "2. Removal and installation of front axle and transmission, and HST unit" in Chapter 3-1.
4. Remove the plug from port "A", and install a 0–30 MPa {0–300 kgf/cm²} gauge and house.



Seat switch

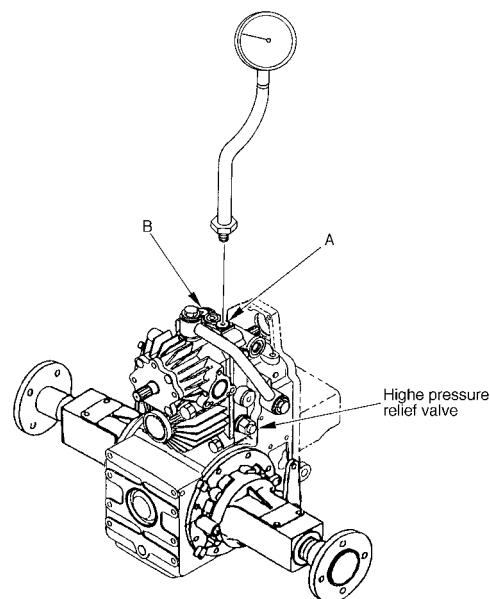


Jumper wire

NOTE: Port "A" (L.H. when seated) will check the high pressure relief valve for forward travel and port "B" for reverse.

5. Start the engine and depress the forward pedal a third of the way down.
6. Increase the engine speed to full throttle.
7. Apply the master brake pedal and read the pressure on the gauge.

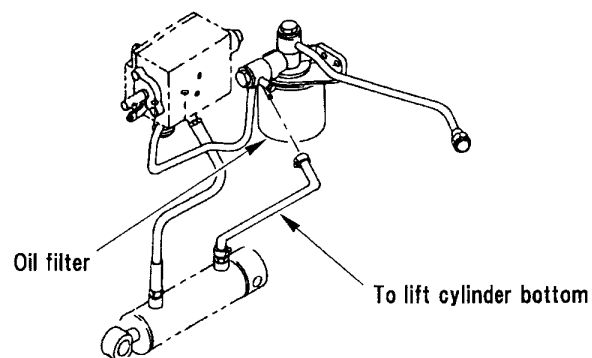
NOTE: Measure the pressure reading in 2–3 seconds. The pressure must be 17.7 MPa {180 kgf/cm²}. If the pressure is not within specifications replace the relief valve assembly.



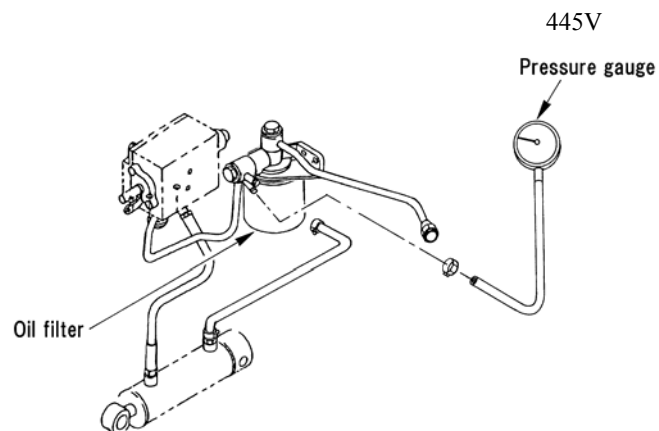
444V

Low pressure relief valve

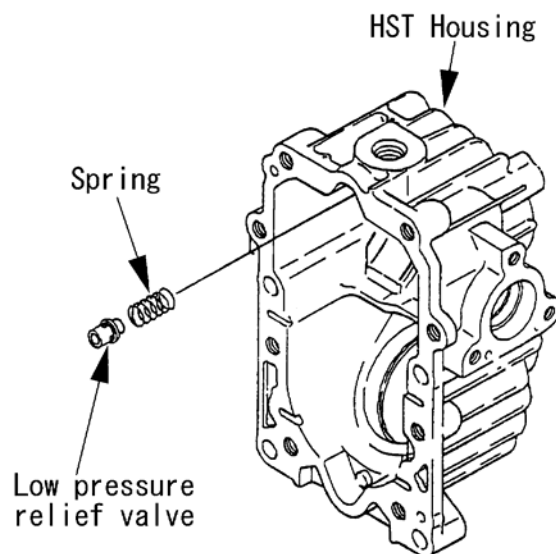
1. Untighten the hose band, and disconnect the oil hose to the cylinder bottom of the hydraulic cylinder at the oil filter side.



2. To check the low pressure relief valve, connect the 0–3 MPa {0–30 kgf/cm²} pressure gauge to the oil pipe and secure with hose band.



3. Start the engine and increase the engine speed to full throttle and read the pressure.
The low pressure relief setting is 0.49 MPa {5 kgf/cm²}. If the pressure is low, replace the low pressure relief valve and spring. (Refer to HST unit disassembly)



7) V-Belt

(1) Inspection

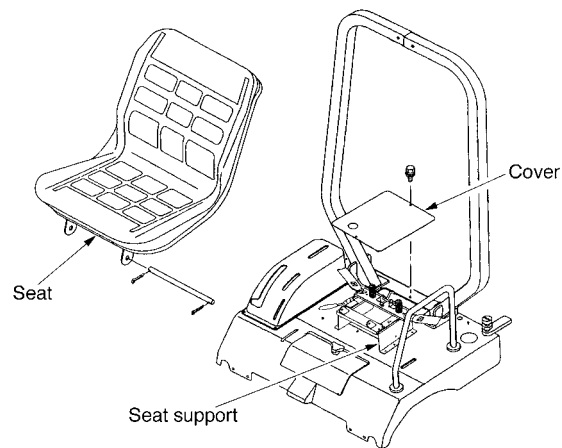
Inspect the V-belts, if find the wear or some damaged replace the V-belts and adjust the belt tension.

(2) Removal

① Disconnect the wiring from the seat switch.

② Remove the seat and seat support.

③ Remove the cover from the fender.

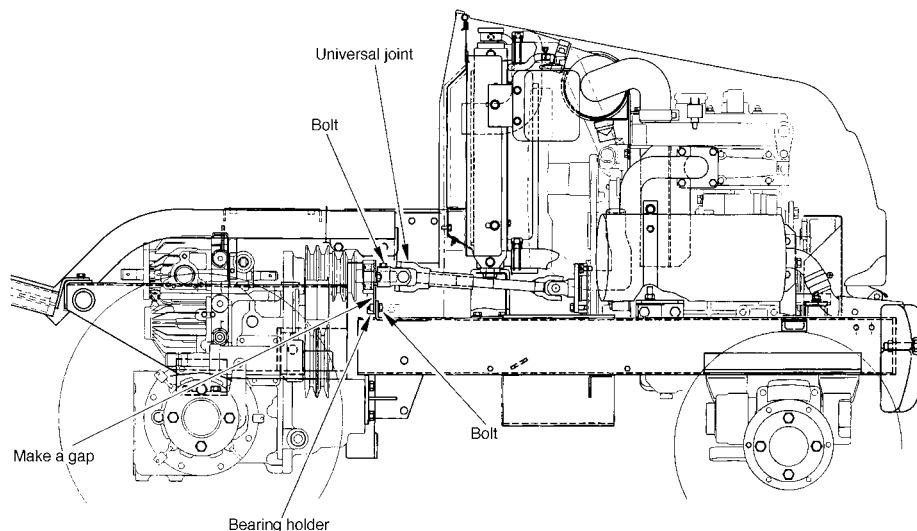


④ Remove the bearing holder attaching bolts for input shaft.

448V

⑤ Remove the bolt and disconnect the universal joint by slide the input shaft to rearward.

⑥ Untighten the tension U-nut for side PTO V-belts.



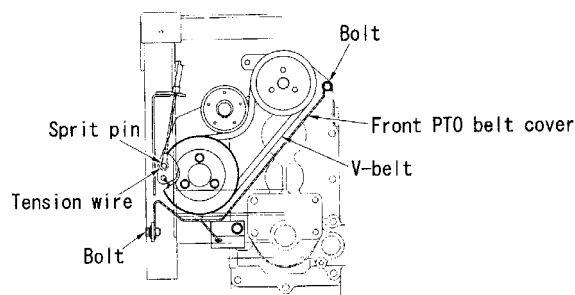
449-1V

⑦ Remove the bolts and front PTO belt cover.

⑧ Turn the bearing holder for make up the gap and remove the two V-belts from the input shaft pulley for side PTO.

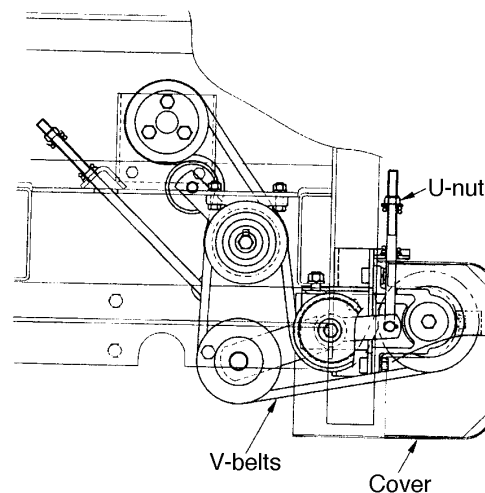
⑨ Remove the sprit pin and tension wire from the shift arm for front PTO.

⑩ Remove the V-belts for front PTO.



450V

- ⑪ Remove the cover for the side PTO.
- ⑫ Untighten the U-nut for side PTO.
- ⑬ Remove the two V-belts for side PTO.



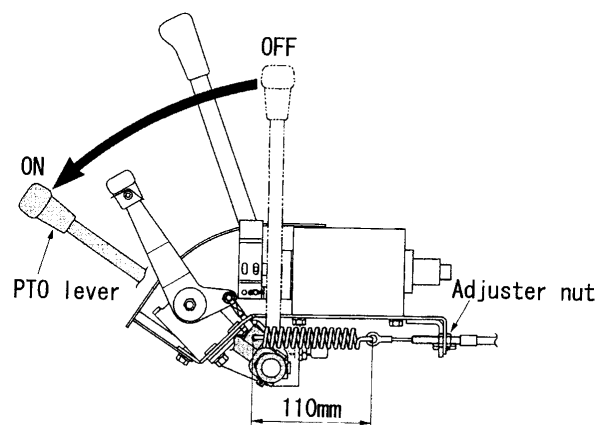
(3) Installation

Reassembly of the V-belts generally follows the disassembly procedure in reverse order.

(4) Adjustment

① Front PTO belt tension

Adjust the front PTO tension spring length by turn the adjuster nut until the spring length to 110 mm at the PTO lever "ENGAGED" position.

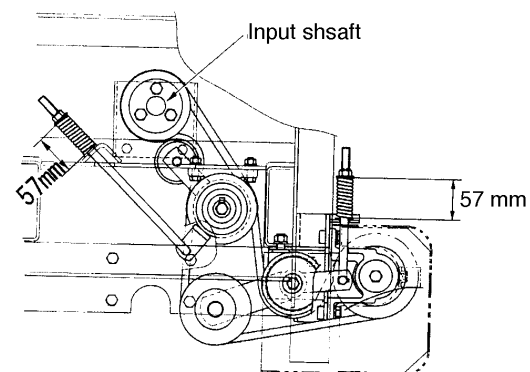


451V

452V

② Side PTO belt tension

Adjust the side PTO two tension springs length by turn the adjuster U-nuts until the spring length to 57 mm.



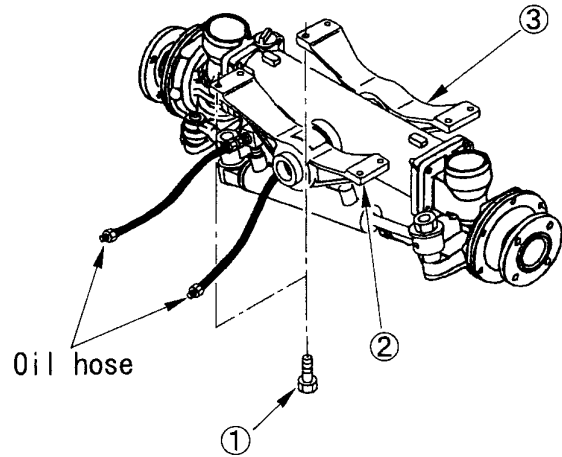
Viewed from the Rear

454V

3-2 Rear Axle Assembly

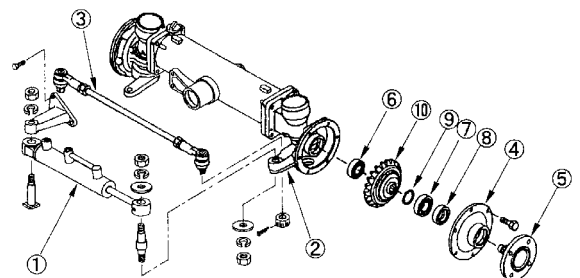
1) Removal

1. Oil hose
Disconnect the oil hoses from the power steering cylinder.
2. Rear axle assembly
 - a. Pull up and hold the engine by hoist.
 - b. Remove the bolts ① for fixing the front bearing holder ② and rear bearing holder, ③ and remove the rear axle assembly from the frame.



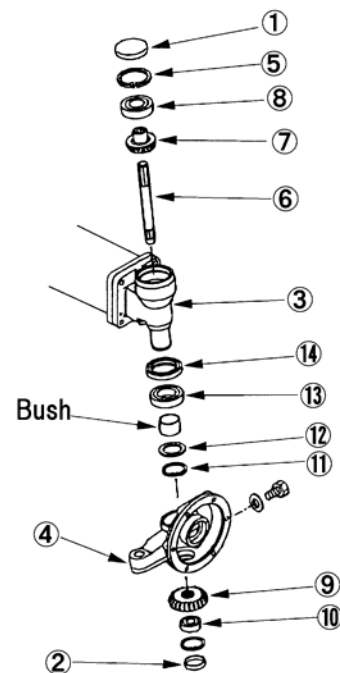
2) Disassembly

1. Remove the rear wheels.
2. Remove the tie rod ① from the both mission cases ②.
3. Remove the power steering cylinder ③ from the front axle assembly.
4. Remove the case cover ④ with wheel shaft ⑤, bearings ⑥ and ⑦, oil seal ⑧, snap ring ⑨ and final gear ⑩ as a set.
5. Remove the bearing ⑥ and final gear ⑩ from the wheel shaft ⑤.
6. Remove the snap ring ⑨ and bearing ⑦, oil seal ⑧ and wheel shaft ⑤ from the case cover ④.
7. Ply the seal covers ① and ② from top of the idler mission case ③ and bottom of mission case ④ by screw driver and discard them.
8. Remove the snap ring ⑤ from in the idler mission case ③.
9. Drive out the idler drive shaft ⑥ and idler gear ⑦ with bearing ⑧ from in the idler mission case ③.
10. Remove the final pinion ⑨ and bearing ⑩ from in the mission case ④.
Remove the snap ring ⑪ and spacer ⑫ from the idler mission case ③, and remove the mission case ④ with bearing ⑬ and oil seal ⑭ from the idler mission case ③.



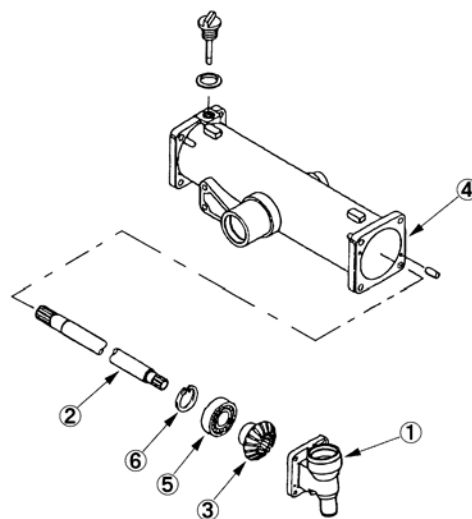
455V

456V



457V

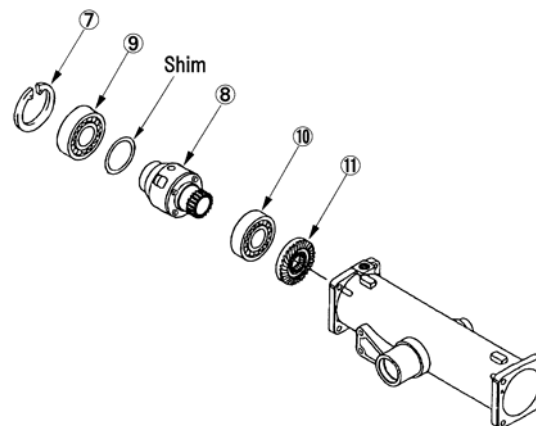
11. Remove the idler mission case ① with differential shaft ② from the wheel shaft housing ④.
12. Remove the differential shaft ②.
13. Remove the snap ring ⑥, bearing ⑤ and idler pinion ③ from the idler mission case ①.
14. Remove the opposite each parts as same manner.



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15. Remove the snap ring ⑦ from in the wheel shaft housing.
16. Remove the differential assembly ⑧ with bearings ⑨ and ⑩, and ring gear ⑪ from R.H. in the wheel shaft housing.

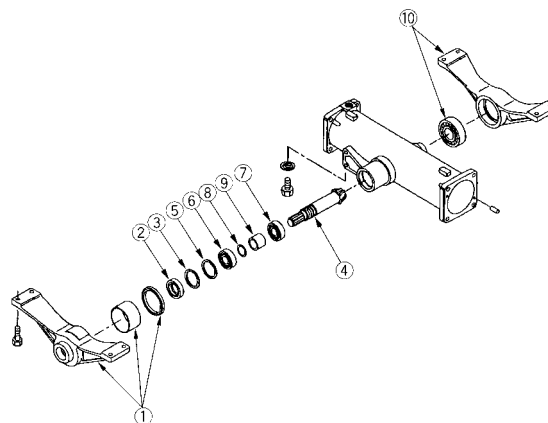
NOTE: Note the thickness and number of shims fitted between differential housing and bearing.



459V

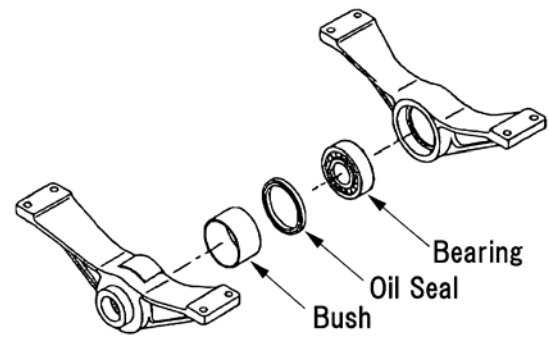
17. Remove the front and rear bearing holder assembly ① and rear bearing holder assembly ⑩.
18. Pry the oil seal ② by screw driver and discard it.
19. Remove the snap ring ③ and drive out the drive pinion ④ with spacer ⑤, bearings ⑥ and ⑦, shims ⑧ and collar ⑨ as a set.
20. Remove the spacer ⑤, bearing ⑥, shims ⑧, collar ⑨ and bearing ⑦ from the drive pinion ④.

NOTE: Note the thickness and number of shims fitted between front bearing and collar.



460V

21. If necessary, remove the oil seal and bush from the front bearing holder.
22. If necessary, remove the bearing from the rear bearing holder.



461V

3) Installation

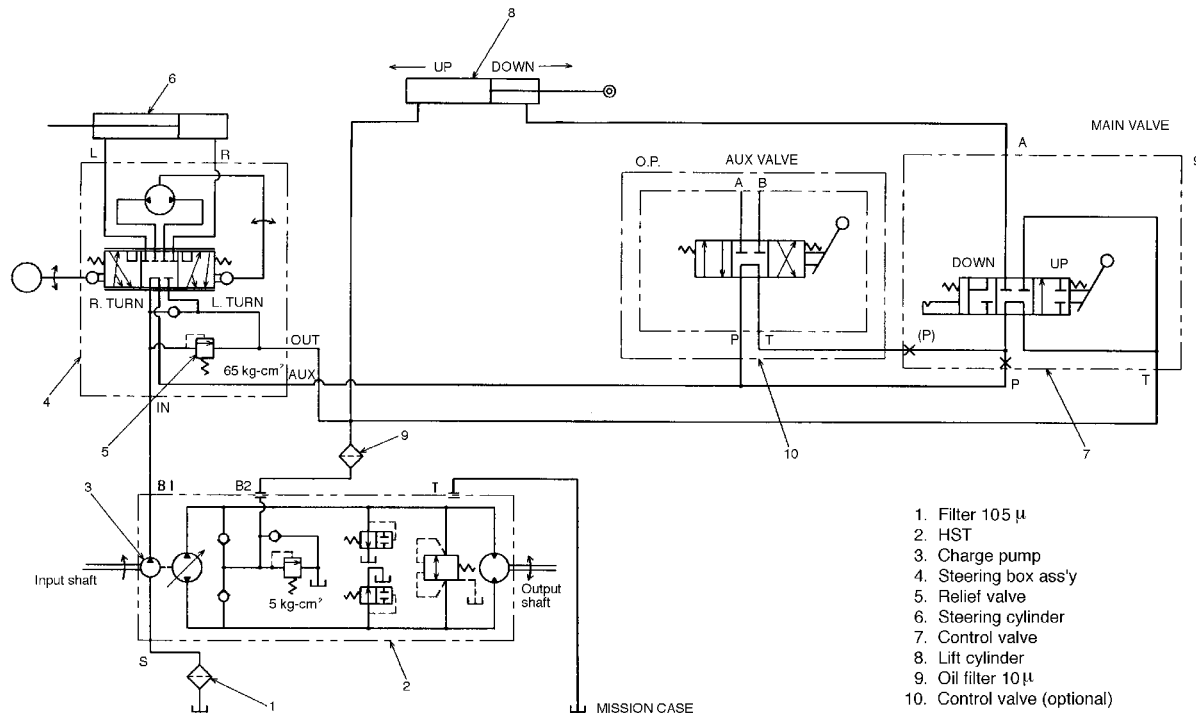
Reinstall the rear axle assembly generally follows the disassembly procedure in reverse.

3-3 Power Steering System

★Caution:

1. Never disassemble the Power steering control valve unit during the claim warranty term. If it is disassembled, claim is not accepted.
2. If disassembly is unavoidably required, the power steering control valve unit should be handled very carefully since it is finished precisely.

1) Oil Flow

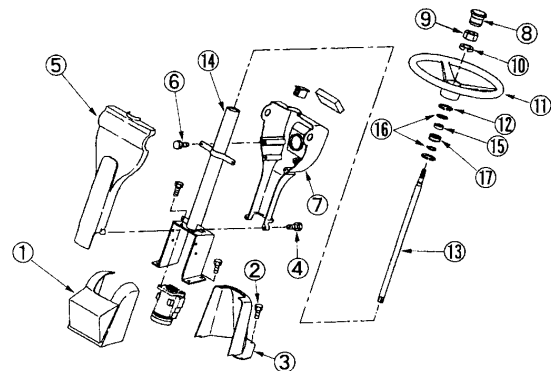


462V

2) Removal

Power steering control valve unit is removed as follows:

1. Pull the lower cover ① and remove it.
2. Remove the bolts ② and rear lower cover ③.
3. Remove the screw ④ and front dash board ⑤.
4. Disconnect the connectors from key switch and meter assembly.
5. Remove the bolts ⑥ and rear dash board ⑦ (meter assembly).
6. Remove the steering cap ⑧, nut ⑨, spring washer ⑩ and steering wheel ⑪.
7. Remove the snap ring ⑫ and draw out the steering shaft ⑬ from the column ⑭ with rubber ⑮, bearing ⑯ and snap rings ⑰.



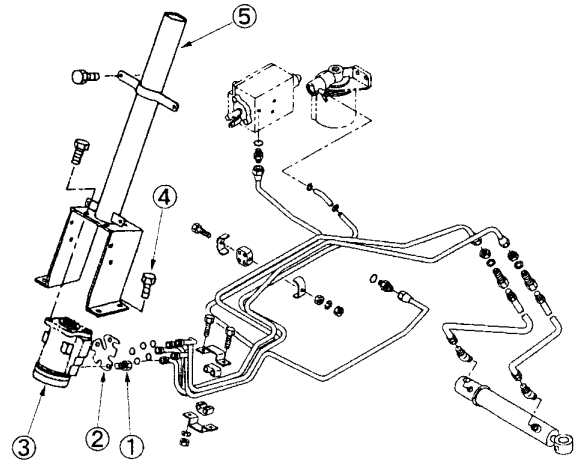
463V

8. Remove the bolts ① and plate ② from steering control valve unit ③.
9. Remove the bolts ④ and steering control valve unit ③ from the steering column ⑤.

3) Installation

Reinstall generally follows the disassembly procedure in reverse and observe the following:

1. Install the oil pipes to the control valve unit by plate and secure tighten the bolts to 49 ~ 62.8 N·m {5.0 ~ 6.4 kgf·m}.



464V

4) Power Steering control Valve Unit

(1) Disassembly – Reference Figure 465V

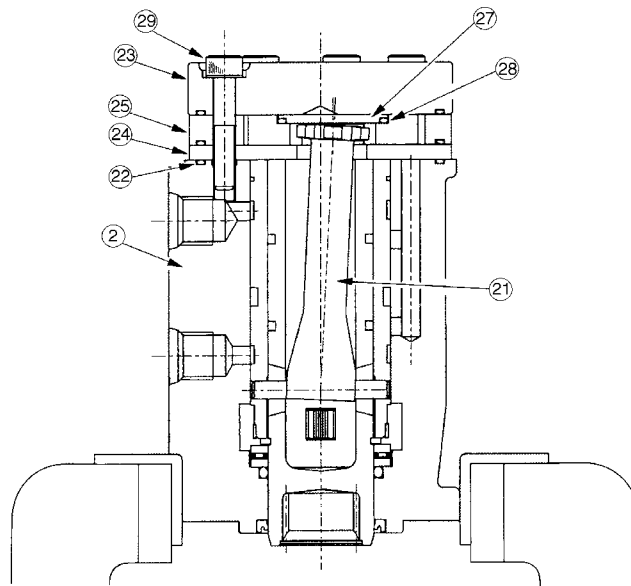
1. Install the unit in a vice facing the end cap (23) upward.

NOTE: Do not tighten strongly since the internal clearance is small and apt to be deformed.

1. Remove the bolts (29) and end cap (23) with O-ring (22).
2. Remove the gerotor (25) with plate (27) and O-ring (22 and 28).

NOTE: Take care not to fall down the inner rotor from the outer of gerotor.

4. Remove the drive (21).
5. Remove the spacer plate (24).
6. Remove the O-ring (22) from the housing (2).



465V

- 7 Remove the housing (2) from the vice and put it shaft center to horizontally on the clean cloth.
- 8 rotate the spool (4) and sleeve (3) assembly until the pin (8) to horizontally. Push and slide out the spool and sleeve assembly by thumbs from the inner spline side ,and remove them from the housing (2).

NOTE: Take care the sleeve (3) not to bites into the housing (2) while remove the spool and sleeve assembly.

9. Remove the retaining ring (9) and pin (8) from the spool and sleeve assembly.

NOTE: Use the proof glasses for prevent eyes by jump out the centering spring.

10. Push a little the spool (4) to centering spring side, and remove the centering springs (6) and flat springs (7) from the spool (4).

11. Remove the sleeve (3) from the spool (4) while rotate the sleeve.

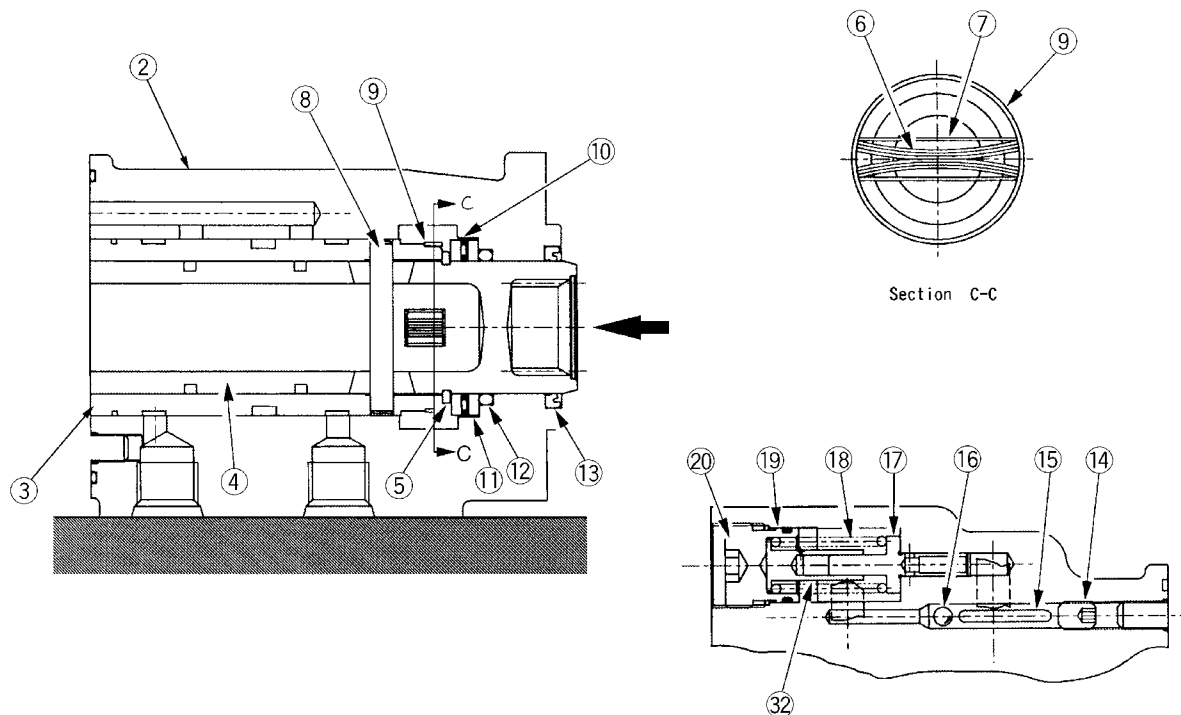
NOTE: Do not remove the retaining ring (5) from the spool.

12. Remove the bearing races (11), thrust needle bearing (10) and oil seal (12) from the housing (2).

13. Remove the dust seal (13) by screw driver form in the housing (2).

14. Remove the retainer screw (14), retainer pin (15) and ball (16) from in the screw hole of the housing (2).

NOTE: Do not remove the relief valve from the housing unnecessary. If removed, need adjust the relief pressure after installed on the tractor.

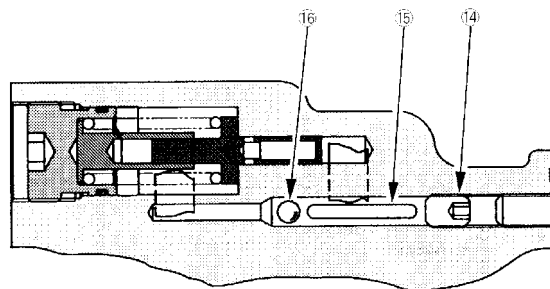


(2) Assembly

NOTE:

1. Inspect the spool and sleeve for evidence of sticking, scuff marks, and any other damage before reassembly. If found defective, replace the control valve assembly.
2. Wash the material parts by clean solvent and air dry. Never use the cloth or paper for prevent the trouble by waste threads.
3. O-ring and seals are installed with new one and apply the thin grease to O-ring when reassembly.

1. Install the ball (16), retainer pin (15) and retainer screw (14) and tighten to 12.7 N·m {1.3 kgf·m}.

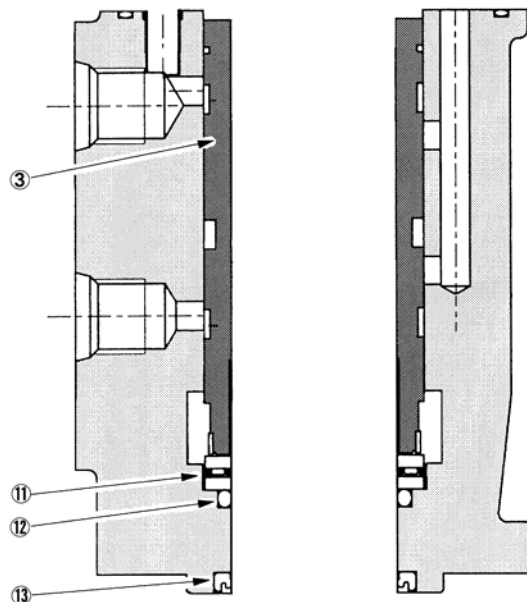


467V

2. Install the dust seal (13) with flat face against the housing.
3. Install the oil seal (12) as follows:
 - a. Makeshift install one bearing race (11) and sleeve (3) in the housing and concentric and keep them.
 - b. Install the oil seal (12) to the ditch between the housing and bearing race.

NOTE: Take care not to twist the oil seal when installed.

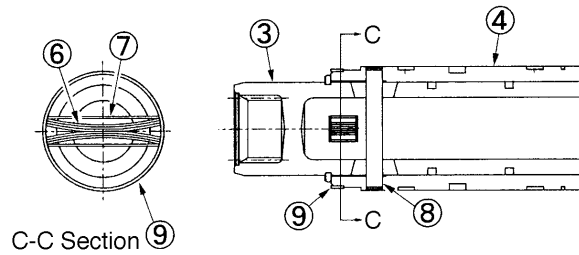
- c. Remove the sleeve and bearing race from the housing after installed oil seal.
4. Install the bearing race (11), needle bearing (10) and bearing race (11) in the housing.



468V

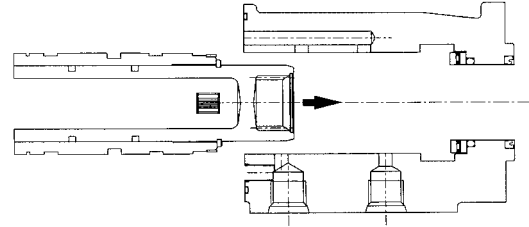
5. Insert the spool (4) in the sleeve (3) and align the spring's ditch.
6. Install two flat springs (7) in the spring's ditch end.
7. Install the centering springs (6) between flat springs at the one time. Install the spring retaining ring (9) on the centering springs.

NOTE: Use a safety pair of glasses for prevent eyes by centering springs, if will be jump out them from the spool and sleeve assembly.



469V

8. Apply the grease between the retaining ring and sleeve for prevent fall down.
9. Install the pin (8) in the sleeve.
10. Install the sleeve and spool assembly in the housing as follows:
 - a. Keep the sleeve center parallel to housing center when installing. If not parallel them will be bite in the housing.
 - b. Keep the pin to horizontally and insert them while a little bit rotate clockwise and counterclockwise.
 - c. Inspect the sleeve and spool assembly is rotate in the housing at align the housing end with sleeve and spool end.

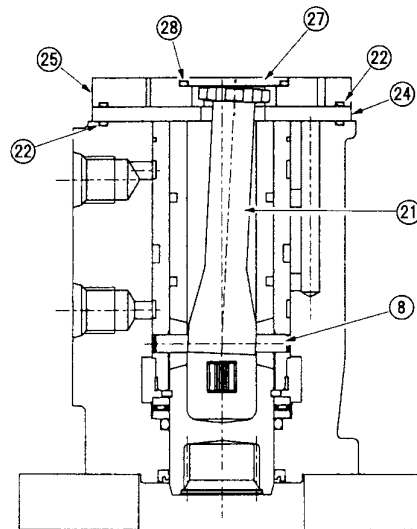


470V

11. Install the O-ring (22) on the housing.
12. Put the spacer plate (24) on the housing and align the bolt holes and oil holes.
13. Insert the drive (21) in the housing, and install the yoke of the drive to the pin (8).
14. Install the O-ring (22) on the gerotor (25), and install them on the spacer plate (24) while matching the spline of the drive and gerotor's star, and align for bolt holes and oil hole.

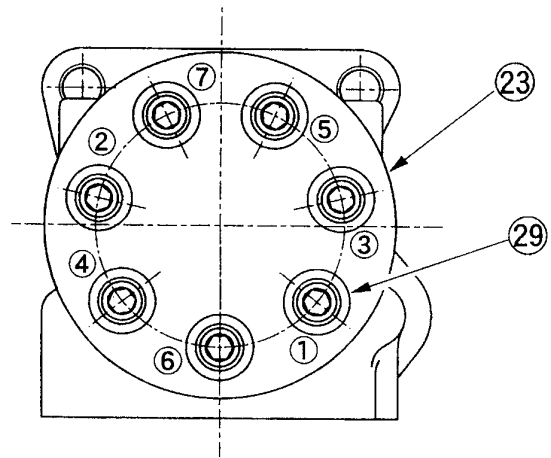
NOTE: O-ring installed surface against the spacer plate (24).

15. Install the O-ring (28) on the plate (27) and install them to the gerotor.



471V

16. Install the O-ring (22) on the end cap (23), and install them on the gerotor while aligning the bolt holes.
17. Apply the oil to the thread of all screw (29), and install the screws and tighten to 4.9 N·m {0.5 kgf·m} at first, and tightening order ① ~ ⑦ as illustrations.
18. Retighten screws to 9.8 N·m {1.0 kgf·m} as same tightening order.



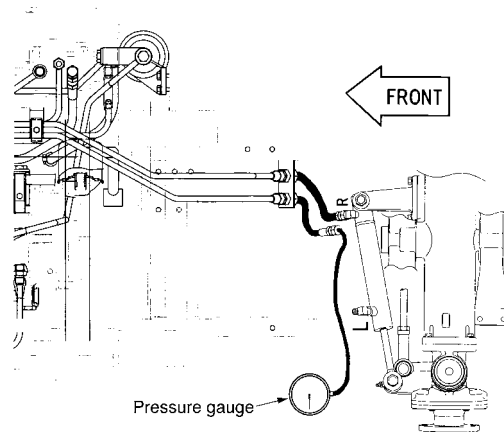
627V

(3) Adjustment

1. Inspection and adjustment of relief valve

- ① After installed power steering parts to tractor, inspect the relief pressure as follows.
- ② Disconnect the oil hose from the adapter or power steering cylinder.
- ③ Connect a 15 MPa {150 kgf/cm²} oil pressure gauge to end of the pressure line from the steering control valve.
- ④ Start the engine and warm up the transmission oil more than 50°C.
- ⑤ Keep the engine to high idle speed and slowly turn the steering wheel, and observe the gauge immediately.

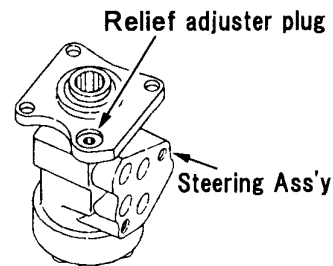
Relief valve adjusting pressure
5.9 – 6.6 MPa {60 – 67 kgf/cm ² }



471-1V

NOTE: The relief adjuster plug is changed 1.47 MPa {15 kgf/cm²} by one turn.

- ⑥ Install the oil hose to the adapter and tighten to 22.3 – 27 N·m {2.25 – 2.75 kgf·m}.
- ⑦ Remove the air in the steering piping by turn the steering wheel counterclockwise and clockwise several times while raise the front wheel.



472-2V

3-4 Hydraulic Control Valve

1) Removal

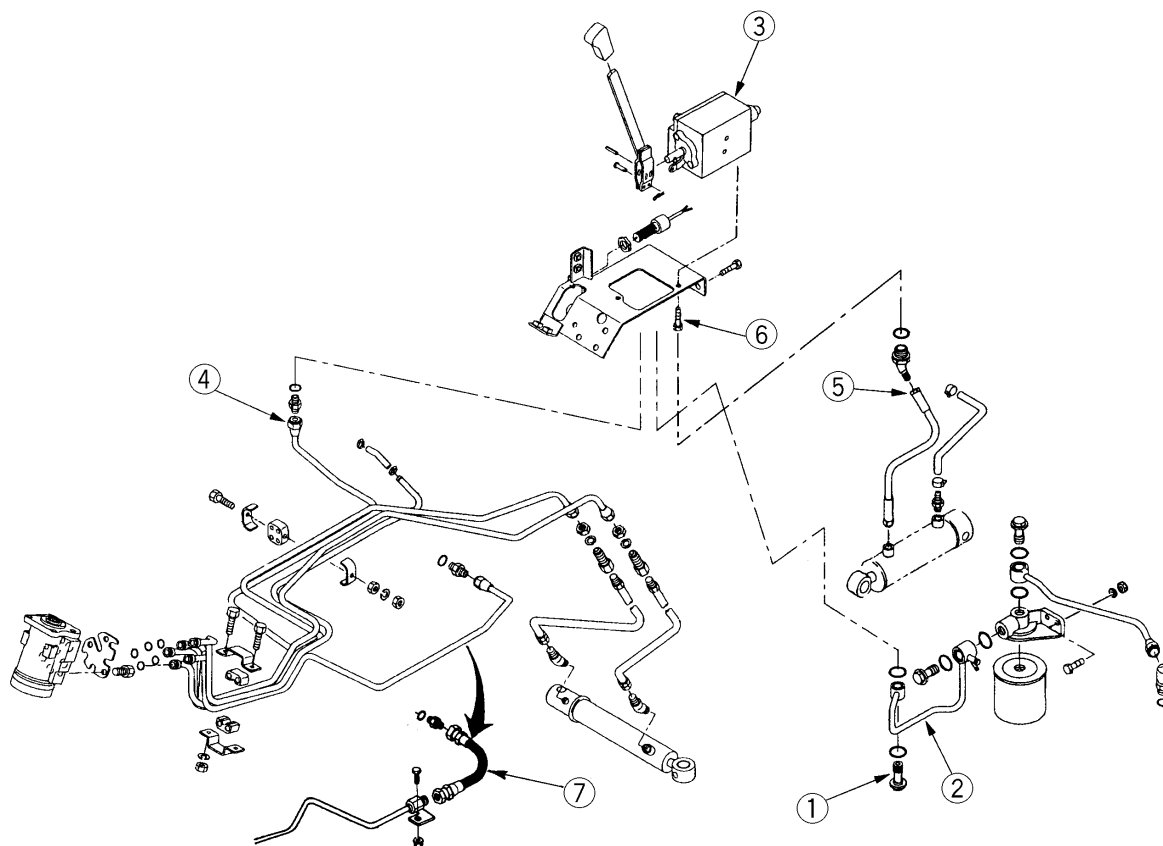
Remove the control valve assembly as follows:

1. Remove the right front wheel and set the safety stand under the tractor.
2. Remove the grips from accelerator lever, PTO control lever and hydraulic control lever.
3. Remove the lever guides.
4. Remove the eye bolts ① and oil pipe ② from under the control valve ③.
5. Disconnect the oil pipe ④ from under the control valve.
6. Disconnect the oil house ⑤ from under the control valve.
7. Remove the bolts ⑥ and control valve assembly ③.

2) Installation

Reinstall the control valve assembly to the tractor in the reverse order and observe the followings:

1. Eye bolt ① tightening torque to 22.1 – 26.5 N·m {2.25 – 2.75 kgf·m}
2. Flare nut ④ of oil pipe and oil hose ⑦ tightening torque to 39.2 – 49.0 N·m {4 – 5 kgf·m}.
3. Oil hose ⑤ to lift cylinder tightening torque to 24.5 N·m {2.5 kgf·m}.



473V

3) Disassembly

Reference – Figure 474V

Repair of the hydraulic control valve is limited to seal replacement only.

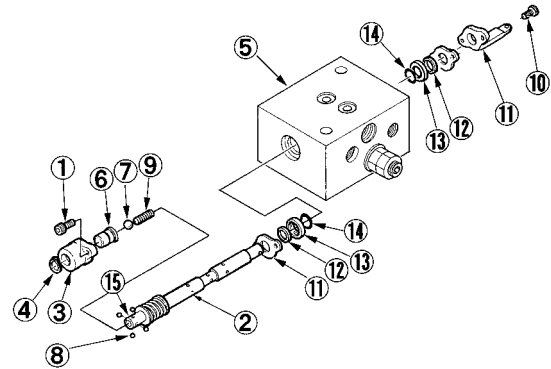
1. Remove the bolts (1) and pull the cap (3) and spool (2) with plate (11) out as an assembly.
2. Place the control end of the spool in a vise and remove the plate (11) and snap ring (4).

NOTE: Do not expand the snap ring to far. The snap ring will become deformed and will not hold during assembly.

3. Using care not to lose balls (7 and 8), remove the holders (6) and spring (9) from the spool.

NOTE: Do not remove the stopper (15), spring and seat from the spool.

4. Remove the sealing plate (11), wiper (12) spacer (13) and O-ring (14) from the valve body.



Control Valve Disassembly

474V

- | | |
|---------------|-------------------|
| 1. Bolt | 9. Spring |
| 2. Spool | 10. Bolt |
| 3. Cap | 11. Plate |
| 4. Snap Ring | 12. Wiper |
| 5. Valve Body | 13. Spacer |
| 6. Holder | 14. O-Ring |
| 7. Ball | 15. Stopper |
| 8. Ball | 16. Lever Support |

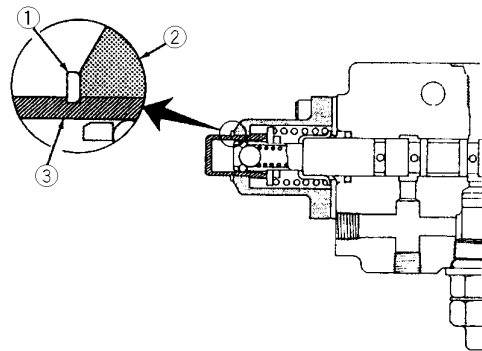
4) Inspection

1. Wash all parts in a suitable solvent and air dry.
2. Discard all O-rings and seals.
3. Inspect the control valve spool and valve body bore for any damage. If either is defective, replace the control valve assembly.

5) Assembly

Prior to assembly coat the valve body bore and spool with clean hydraulic oil. Assembly of the control valve generally follows disassembly procedures in reverse, however, the following must be observed:

- Coat all steel balls with grease during assembly.
- Install the snap ring (1) with the rounded edge facing the cap, Figure 475V.
- Tighten the sealing plate bolts (10), Figure 474V to 5.4 N·m {0.55 kgf·m} and check the spool for smooth operation.



Snap Ring Installation

- 1 Snap Ring
- 2 Cap
- 3 Holder

475V

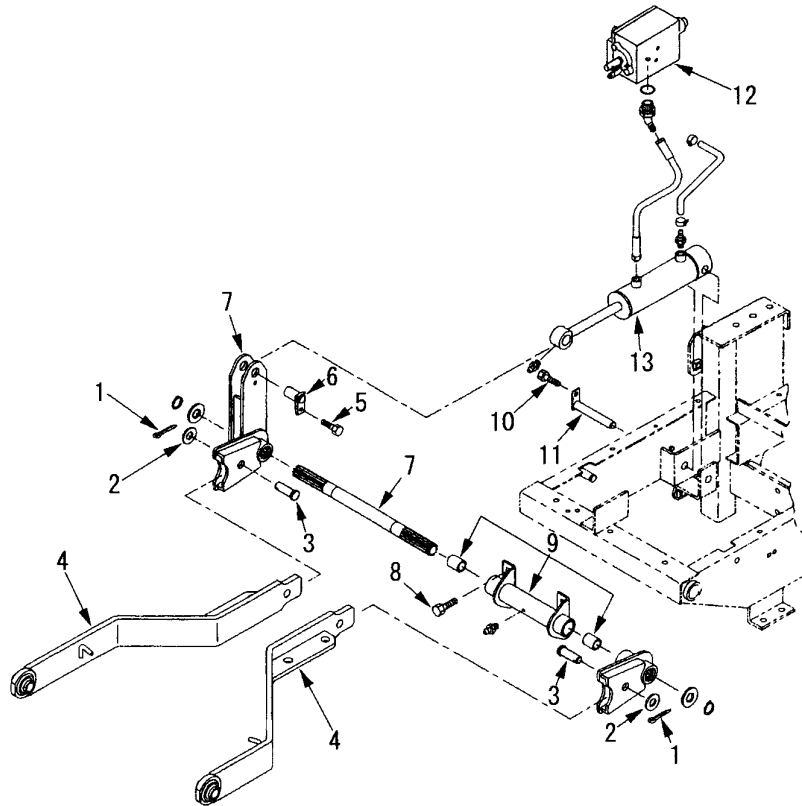
3-5 Lift Linkages

1) Removal

- a. Remove the split pins (1), washers (2) and pins (3).
- b. Remove the L.H. and R.H. lift arms (4).
- c. Remove the bolt (5) and pin (6) from the bracket (7).
- d. Remove the bolts (8) and bracket (9) from the transmission housing.
- e. Remove the bolt (10) and pin (11) from the frame.
- f. Disconnect the oil hoses from the control valve (12) and remove the cylinder (13).
- g. If necessary remove the oil hose from the cylinder.

2) Installation

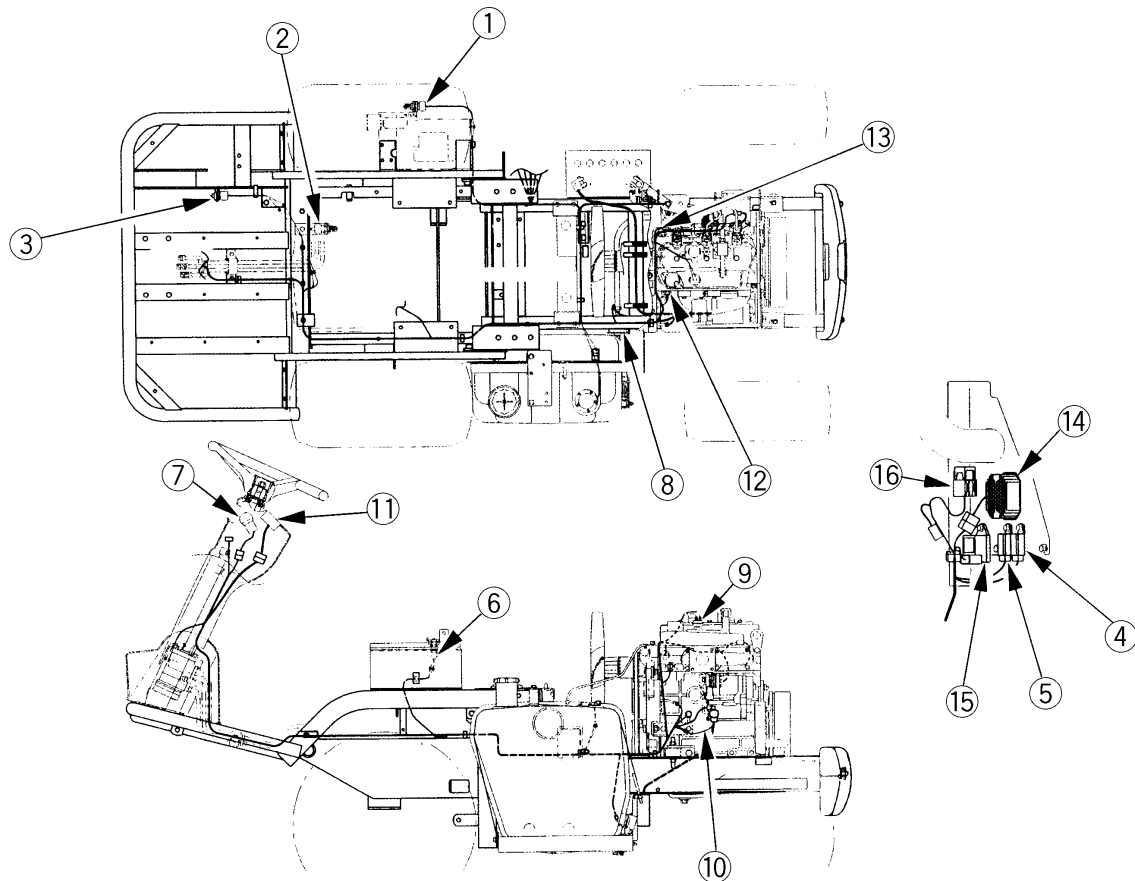
Install the lift linkage generally follows the disassembly procedure in reverse order. On assembly wind the seal tape and tighten the oil hose to 24.5 N·m {2.5 kgf·m}.



476V

3-6 Electric Units and Accessories

1. Location



477V

- | | | |
|-----------------------|--|--------------------------------|
| 1. PTO safety switch | 7. Key switch assembly | 13. Engine oil pressure switch |
| 2. HST Neutral switch | 8. Fuel pump | 14. Regulator |
| 3. Brake switch | 9. Air cleaner clogging warning switch | 15. Glow timer |
| 4. Safety relay | 10. Fusible link | 16. Fuse box |
| 5. Safety start relay | 11. Instrument panel | |
| 6. Seat switch | 12. Coolant temperature sensor | |

2. Safety Start and Stop System

1) Safety Start System

Engine can be started when the three switches (HST switch, PTO switch and brake switch) are “ON” position, and then engine start relay and safety relay are energized.

(1) Safety Start Circuit

Safety start circuit consists safety start relay and three switches.

The safety start relay is energized and current flows to starting motor “S” terminal when the PTO switch, HST switch and brake switch are “ON” position at the key switch is “START” position. At the same time, current flows safety relay and fuel cut-off solenoid.

(2) Fuel Cut-off Circuit

The fuel cut-off circuit consists safety relay for fuel cut-off solenoid, three switches and seat switch. The three switches circuit and seat switch circuit are parallel circuits, then current can flow to safety relay and fuel cut-off solenoid at one circuit is closed.

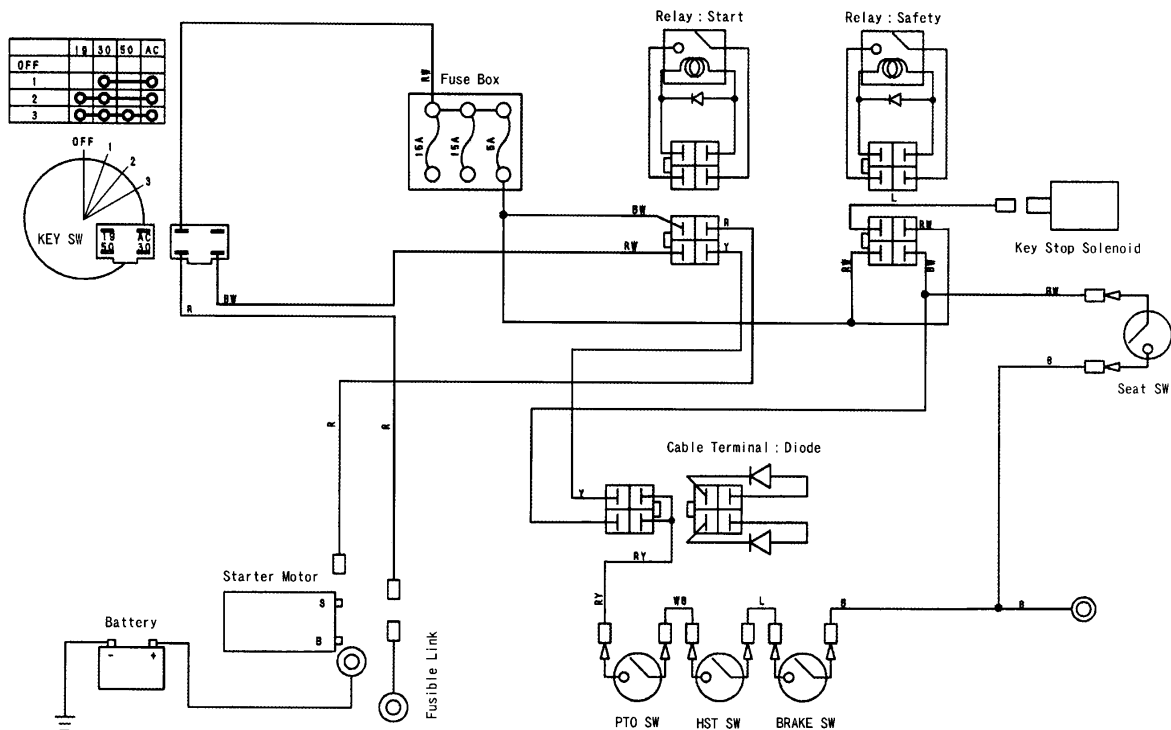
(3) Three Switches (PTO switch, HST switch and brake switch)

Three switches are “ON” position at as follows:

The PTO switch is “ON” position at the PTO control lever at the “DISENGAGED” position.

The HST switch is “ON” position at the HST pedal is at the “NEUTRAL” position.

The brake switch is “ON” position when the brake pedal is at the “DEPRESSED” position.



478V

SAFETY START AND STOP CIRCUIT

2) Safety Stop System

The engine is automatically stopped for safety with the driver is unseated.

(1) Safety Stop Circuit

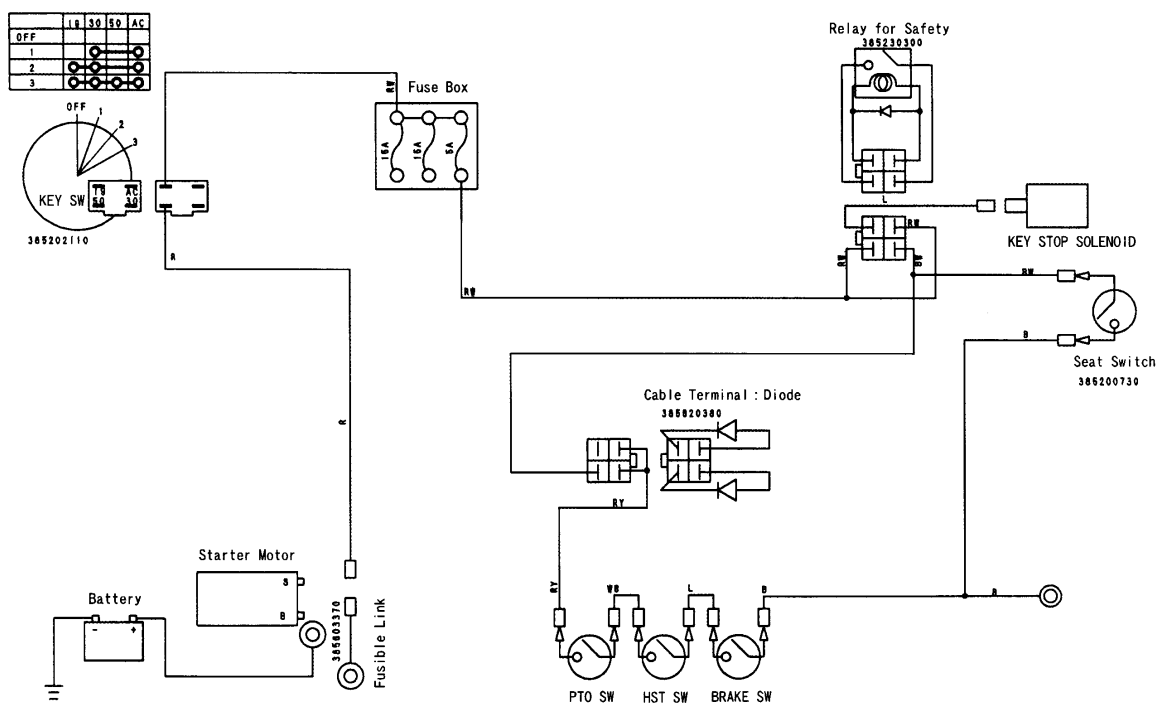
The safety relay and fuel cut-off solenoid are in series, and seat switch and three switches are parallel circuit.

Engine can be stopped when driver is unseated with one of three switches (PTO, HST and BRAKE switches) are "OFF" position.

Engine can not stop when driver is unseated with three switches are "ON" position because the seat switch and three switches are parallel circuit.

(2) Seat Switch

The seat switch is "ON" position at "SEATED" and then fuel cut-off solenoid and safety relay are energized.



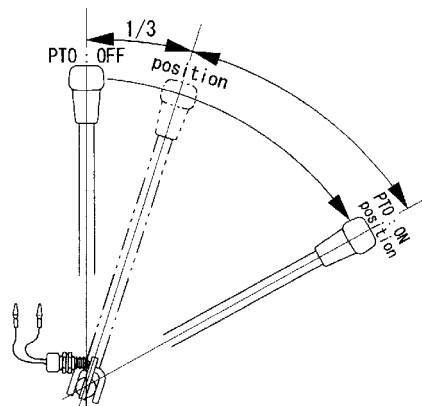
FUEL CUT-OFF SOLENOID CIRCUIT

479V

3) Adjustment

(1) PTO Switch

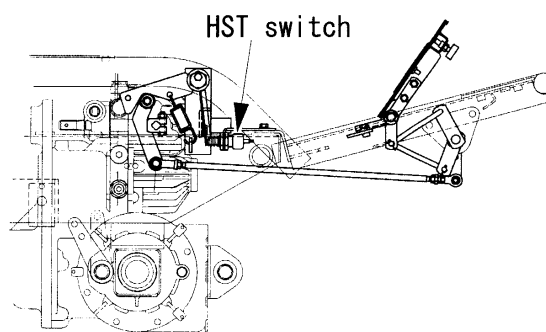
Install the PTO switch and adjust the plunger no contact to PTO lever plate when PTO lever moves to 1/3 of the travel, and tighten to lock nut.



480V

(2) HST Switch

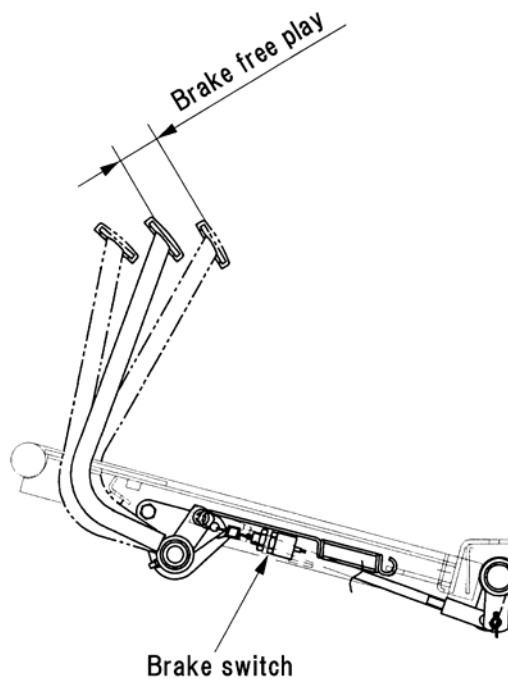
Adjust the HST switch position after HST neutral position adjustment.
Install the HST switch and adjust the switch by turn until the plunger 2~3 mm pushed in to body when HST neutral position.



481V

(3) Brake Switch

Place the brake pedal to free play finished position and adjust the switch at the "ON" position (plunger is fully pulled out position), and tighten the lock nut.



482V

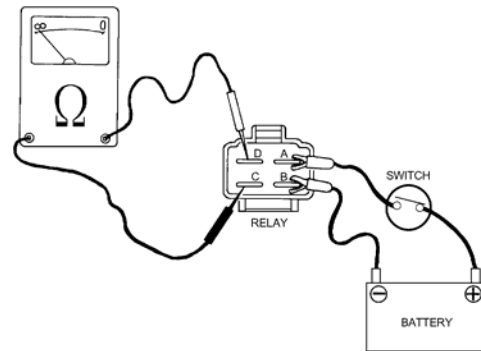
4) Inspection

(1) Engine start relay and safety relay.

To test a relay, disconnect it from the circuit.
Connect the battery, switch, relay and ohmmeter as illustration.

- The switch is "OFF" position, the ohmmeter reading no continuity.
- The switch is "ON" position, the ohmmeter reading continuity.

If test results are not as outlined above, replace the safety start relay.



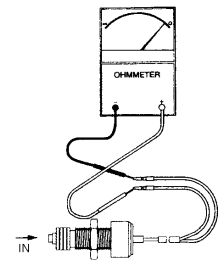
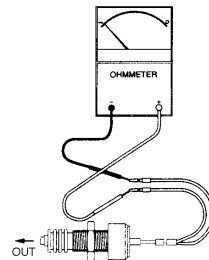
483V

(2) PTO switch, HST switch and Seat Switch

To test a switch, disconnect it from the circuit.
Connect the ohmmeter leads to switch terminals.

- With the button in the "OUT" position, continuity will not exist across terminals.
- With the button in the "IN" position, continuity will exist across terminals.

If test results are not as outlined above, replace the switch.



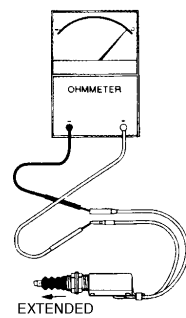
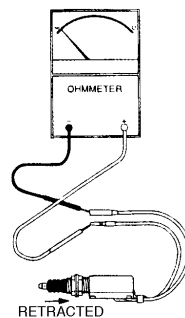
484V

(3) Brake switch

To test a switch, disconnect it from the circuit.
Connect the ohmmeter leads to switch terminals.

- With the button in the "Extended" position, continuity will exist across terminals.
- With the button in the "Retracted" position, continuity will not exist across terminals.

If test results are not as outlined above, replace the switch.

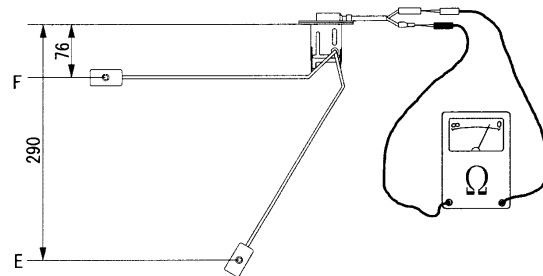


485V

(4) Fuel Sensor

Use an ohmmeter to test the fuel gauge sensor. Disconnect the wiring from the sensor and connect the ohmmeter leads to the sensor terminals.

- When the float at “F” position, the ohmmeter reading of 3 ± 2 ohms is normal.
- When the float at “E” position, the ohmmeter reading of 110 ± 7 ohms is normal.

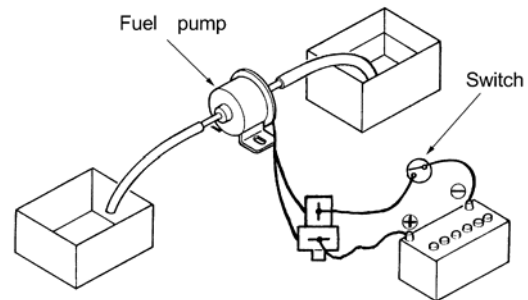


486V

(5) Fuel Pump

Disconnect the fuel hoses from the fuel filter and injection pump, and stop the fuel leaking from the fuel tank.

- Place one liter water in the container and put the inlet hose in the water.
 - Place the container and put the outlet hose in the container.
 - Inspect the water delivery time by starting switch is “ON” position.
- The delivery time about three minutes is normal.



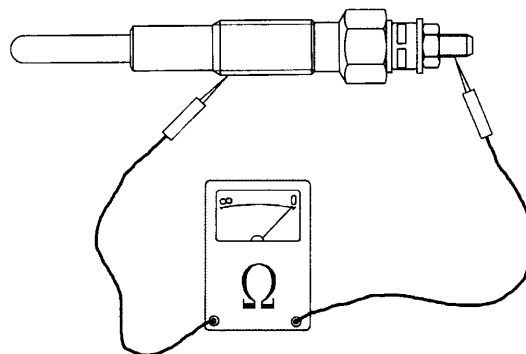
487V

(6) Glow Plug

Use and ohmmeter to test glow plugs. Place one lead on the center electrode and the other lead on the glow plug body.

- A resistance reading of 1.0 ohms maximum is normal.

If test result is not outlined as above, replace the faulty glow plugs.

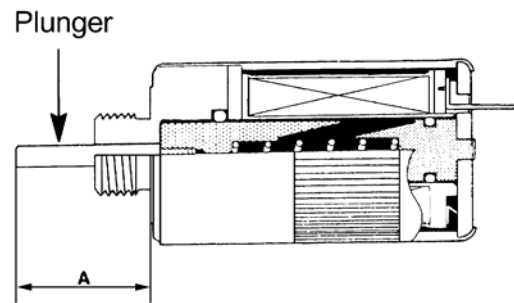


488V

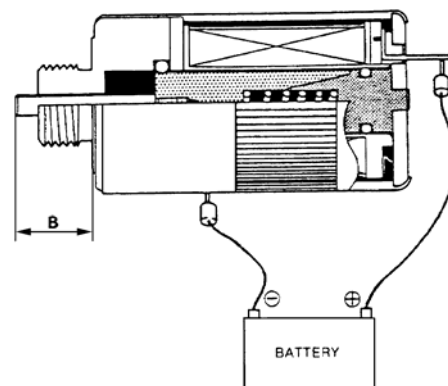
(7) Fuel Shut-off Solenoid

1. With the solenoid de-energized, measure the protrusion distance "A" of the plunger as shown at right.
- In the shut-off position, the plunger protrusion distance should measure 25.5 mm – 26.5 mm.
2. Connect a jumper wire from the solenoid terminal to the battery positive (+) terminal. Connect a second jumper wire from the battery negative (-) terminal to the solenoid body. The solenoid plunger will retract. Measure the protrusion distance "B" of the plunger as shown at right.
- In the retracted position, the plunger protrusion distance should measure 12 mm – 14 mm.

If the measurements are not within the limits specified above, replace the solenoid.



489V

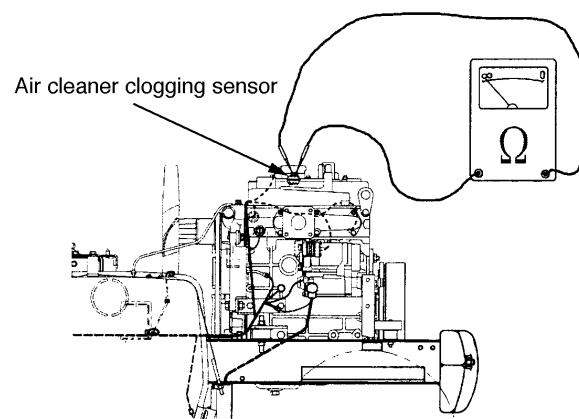


490V

(8) Air Cleaner Clogging Sensor

The air cleaner sensor is normally open and is actuated by vacuumed air in the intake manifold. Connect the ohmmeter leads to switch terminals.

- With the air cleaner element is no clogged, continuity will not exist across terminals.
- When engine is running with the air cleaner element is clogged, continuity will exist across terminals.



491V

(9) Engine Coolant Temperature Sensor

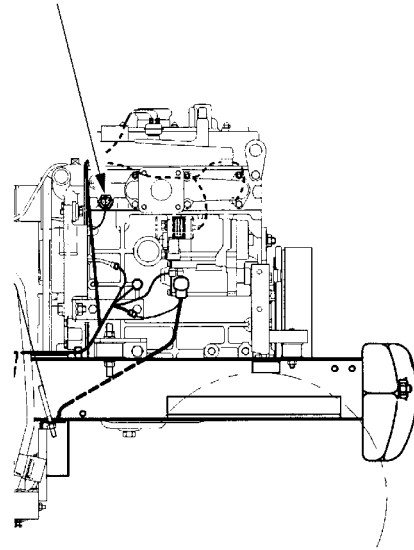
The sensor is located at the left side cylinder head. This sensor regulates a variable resistance to ground, which translates into the movement of the temperature gauge.

(10) Engine Oil Pressure Sensor

The engine oil pressure switch is located on the cylinder head. The switch closes when oil pressure is less than 29.4 kPa {0.3 kgf/cm²}.

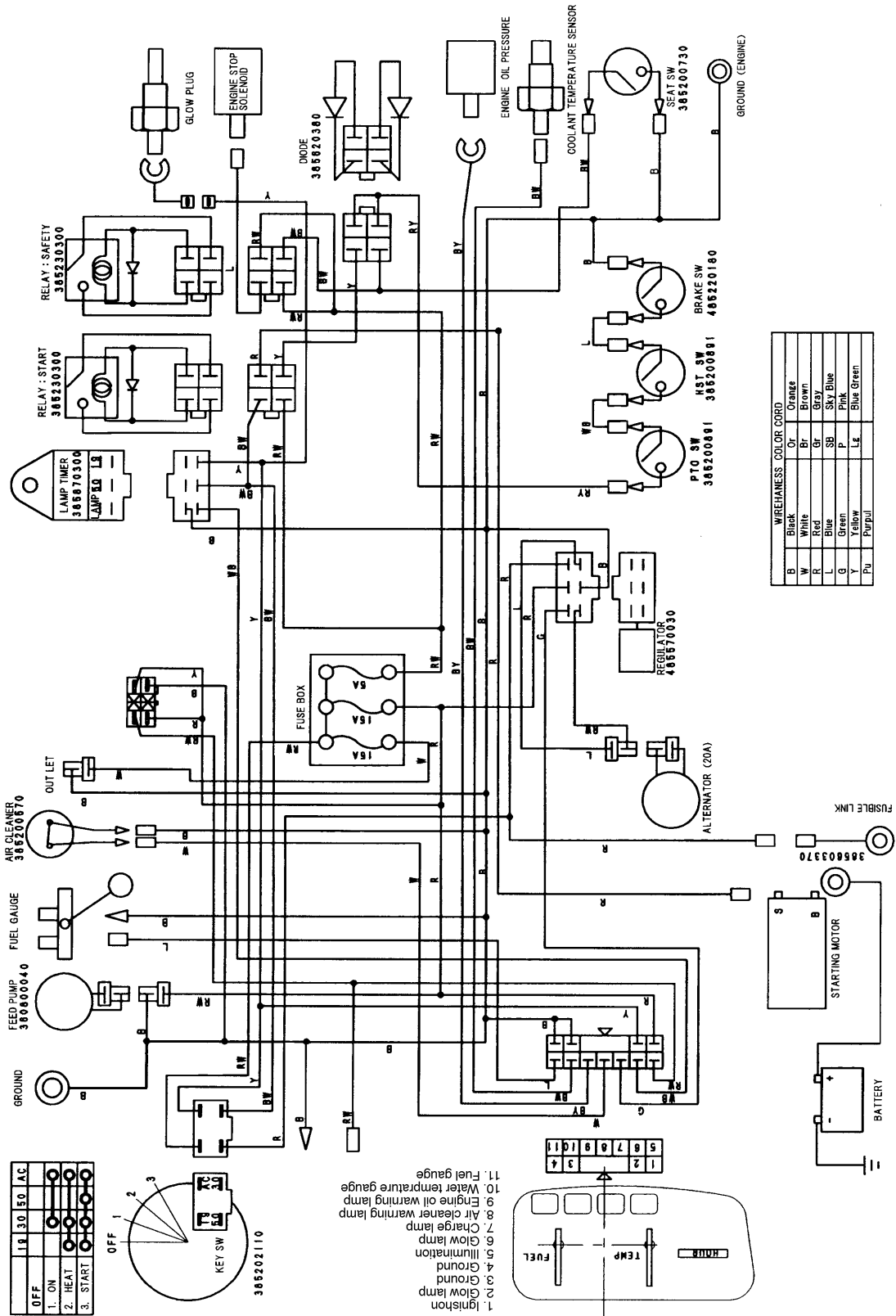
If the oil pressure warning light does not go out after engine has started, first check the engine oil level.

Engine Coolant Temperature Sensor



492V

3. Wiring



3-7 Maintenance Standards Table

* Unit for values without unit in the column of inspection item is mm

Unit	Part	Inspection Item	Standard Dimensions	Standard Assembling Value	Repair Value	Service Limit	Remarks
Main body	Transmission	Backlash of each gear		0.04 – 0.2		0.5	
	Front differential	Differential pinion thrust washer thickness	1.2	1.1 – 1.2		0.9	
		Differential gear thrust washer thickness	1.2	1.1 – 1.2		0.9	
		Backlash of differential gear and differential pinion		0.1 – 0.2		0.4	
		Rign gear tightening torque N·m {kgf·m}		22.6 – 28.4 {2.3 – 2.9}			
		Differential carrier tightening torque N·m {kgf·m}		22.6 – 28.4 {2.3 – 2.9}			
		Drive pinion preload N {kgf}		196 {20}			
		Backlash of drive pinion and ring gear		0.1 – 0.2	0.4		
	Brake	Brake disc thickness		2.8		2.5	
		Brake stater level height difference		0		0.1	
		Brake pedal free play		19 – 30	40		
		Clearance between pedal shaft and bush		0.05 – 0.35		0.8	
	Front wheel	Rim run-out		0 – 5		10	
		Lug height	8.9				
		Tire size	20 × 10.0 – 8 2 ply				
		Disk tightening torque N·m {kgf·m}		65.5 – 83.5 {6.7 – 8.5}			
	Rear axle	King pin inclination angle	8°				Fixed type
		Toe-in		0 – 5			
		Caster	0°				Fixed type
		Camber	3°				Fixed type
		Wheel shaft case longitudinal play		0 – 0.3	0.5		
		Disk tightening torque N·m {kgf·m}		65.5 – 83.5 {6.7 – 8.5}			
		Rim run-out		0 – 3		5	
		Lug height	4.3				
		Tire size	16 × 6.5 – 8				
		Tie-rod castle nut tightening torque N·m {kgf·m}		74.5 – 94 {7.6 – 9.6}			
	Rear differential	Differential pinion thrust washer thickness	1.2	1.1 – 1.2		0.9	
		Differential gear thrust washer thickness	1.2	1.1 – 1.2		0.9	
		Backlash of drive pinion and ring gear		0.2 – 0.3			

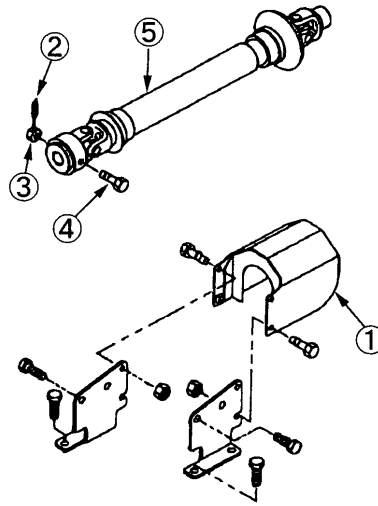
Unit	Part	Inspection Item	Standard Dimensions	Standard Assembling Value	Repair Value	Service Limit	Remarks
Main body	Hydraulic unit	Relief valve working pressure MPa {kgf/cm ² }		6.37 {65}			Steering box
		High-pressure relief set pressure MPa {kgf/cm ² }		17.64 {180}			HST
		Charge circuit relief set pressure MPa {kgf/cm ² }		0.49 {5}			HST
		Eye bolt PF 3/8 tightening torque N·m {kgf·m}		44.1 – 53.9 {4.5 – 5.5}			
		Eye bolt PF 1/2 tightening torque N·m {kgf·m}		58.8 – 68.6 {6.0 – 7.0}			
		Flare nut M14 tightening torque N·m {kgf·m}		29.4 – 39.2 {3.0 – 4.0}			
		Flare nut M16 tightening torque N·m {kgf·m}		39.2 – 49.0 {4.0 – 5.0}			

Chapter 4. MOWER

4-1 Mower (Models FM48 and FM 60CJ)

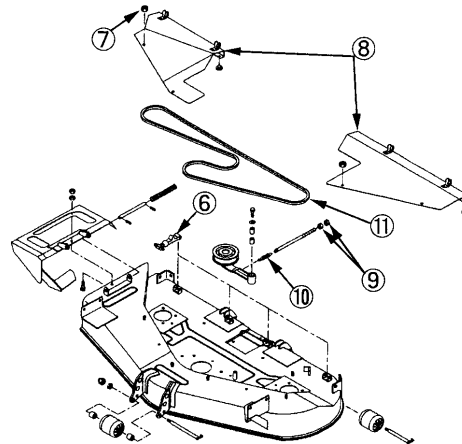
1. Gear Box Unit Removal

- (1) Remove the joint cover ①, sprit pin ②, nut ③ and bolt ④.
- (2) Remove the universal joint ⑤.



900V

- (3) Unhook the hangers ⑥ and remove the nuts ⑦ and belt covers ⑧.
- (4) Untighten the lock nut ⑨ and release the tension spring ⑩, and remove the V-belt ⑪.

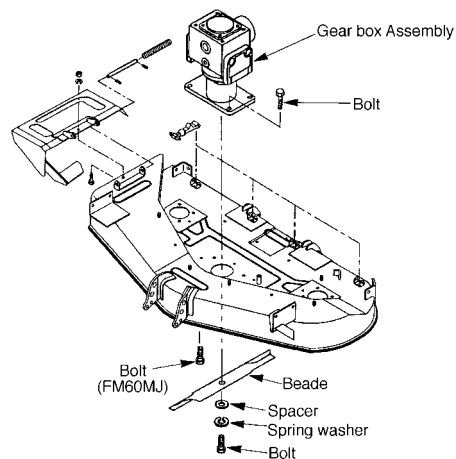


901V

- (5) Remove the bolt, spring washer, spacer and blade from under the mower deck.

- (6) Remove the gear box assembly as follows:

- On model FM 48, remove the four bolts and gear box assembly.
- On model FM60 CJ, remove two long bolts (M12×40) from top of the mower deck, and remove the four bolts (fine thread M12×20) from under the mower deck, and then remove the gear box unit.

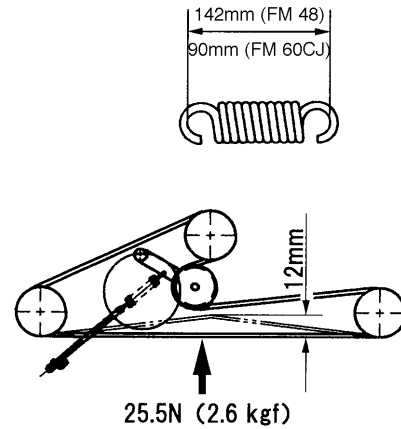


902V

2. Adjustment

Adjust the V-belt tension as follows:

- Install the V-belt on the pulleys, spring, tension rod and tension nut.
- Tighten the tension nut until the V-belt deflection is 12 mm by push the V-belt of two driven pulleys center at 25.5 N {2.6 kgf}.
- On model FM 48, tension spring length is 142 mm and FM60CJ tension spring length is 90 mm.

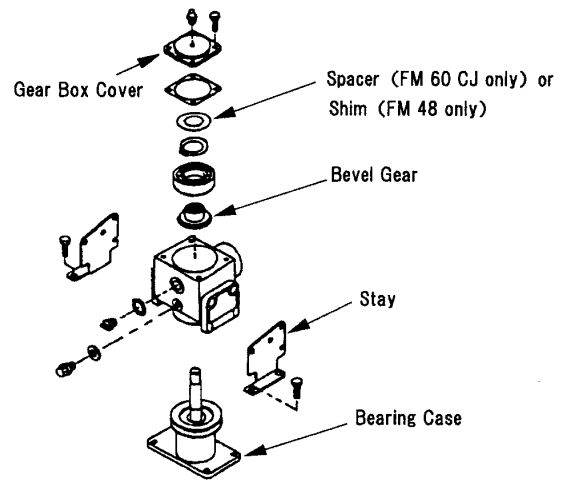


3. Gear Box Unit

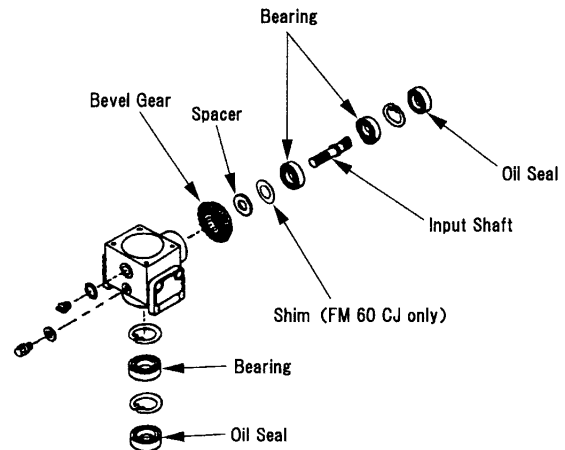
1) Disassembly

- (1) Inspect the bevel gear backlash with input shaft by hand feeling before disassemble the gear box unit. If backlash is larger than 0.2 mm, adjust by shims when reassembly.
- (2) Remove the gear box cover as follows:
 - On model FM48, remove the gear box cover with shims and note the quantity and thickness of shim.
 - On model FM60CJ, remove the gear box cover with spacer.
- (3) Remove the stays from the gear box.
- (4) Remove the snap ring from the rotor shaft.
- (5) Draw out the rotor shaft with bearing case.
- (6) Remove the bevel gear with bearing.
- (7) Remove the bevel gear and spacer.

On model FM60CJ, shim is installed between spacer and bearing, and then note the quantity and thickness of shims.
- (8) Remove the oil seal, snap ring, input shaft and bearings from in the gear box.
- (9) Remove the oil seal, snap ring and bearing from bottom of the gear box.



903V



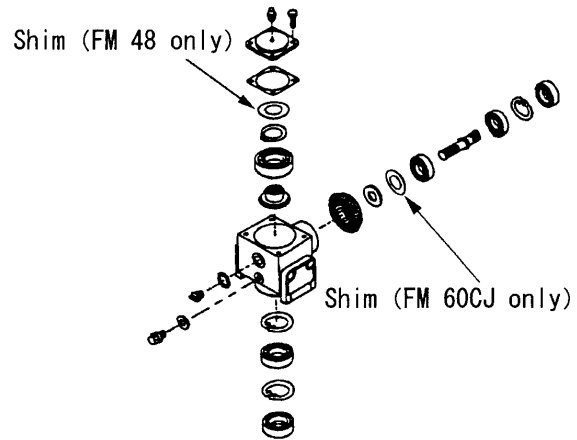
904V

905V

2) Assembly

Reassemble the gear box assembly generally follows the disassembly procedure in reverse order and observe as follows:

- If removed oil seals, replace the oil seal with new one.
- Adjust the bevel gear back lash to 0.08 – 0.2 mm by shims.



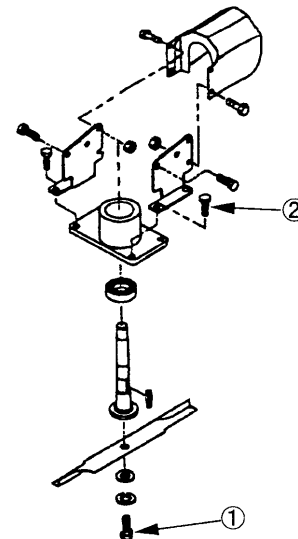
4. Gear Box Unit Installation

Install the gear box unit on the mower deck generally follows the removal procedure in reverse order and tightening torque as follows:

- On model FM48
 - ① Bolt (M14) for blade:
132.3 – 147 N·m {13.5 – 15.0 kgf·m}
 - ② Bolts (M12×40) for gear box to mower deck:
42.1 N·m {4.3 kgf·m}
- On model FM60CJ
 - ① Bolt (M14) for blade:
132.3 – 147 N·m {13.5 – 15.0 kgf·m}
 - ② Bolts (M12×40 and M12 20 Fine thread) for gear box to mower deck:
84.3 N·m {8.6 kgf·m}
 - ③ Bolts (M12×16 Fine thread) for stay to bearing case:
84.3 N·m {8.6 kgf·m}
 - ④ Bolts (M12×20 Coarse thread) for stay to gear box:
74.5 N·m {7.6 kgf·m}

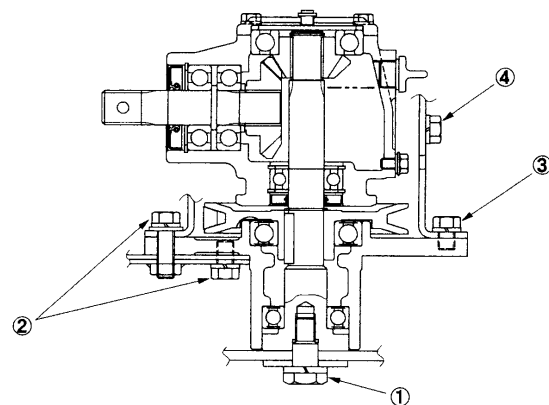
FM48

906V



FM60CJ

907V

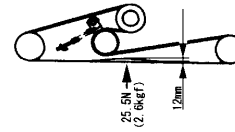
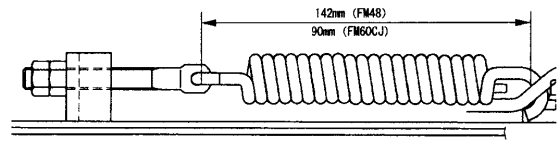


908V

5. Adjustment

Adjust the V-belt tension as follows:

- Install the V-belt on the pulleys, spring tension rod and tension nut.
- Tighten the tension nut until the V-belt deflection is 12 mm by push the V-belt of two driven pulleys center at 25.5 N {2.6 kgf}.
- On model FM 48, tension spring reference length is 142 mm.
- On model FM 60CJ, tension spring reference length is 90 mm.



909V

6. Bearing Case Unit

1) Disassembly

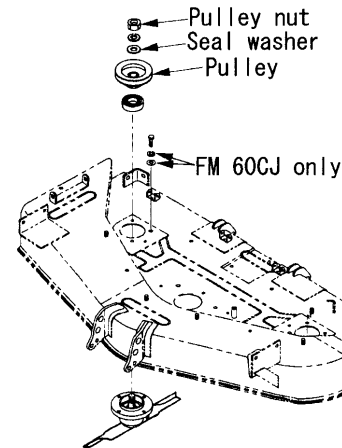
- (1) Remove the belt cover and V-belt.
See "GEAR BOX UNIT REMOVAL" in this section.
- (2) Remove the pulley nut, spring washer and seal washer.

NOTE: Pulley nut is a left-handed screw.

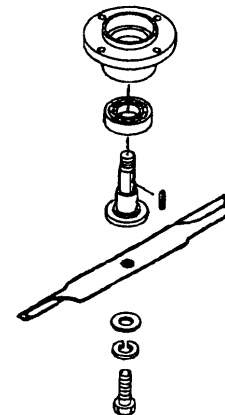
- (3) Remove the pulley with bearing by puller.
- (4) Remove the four case attaching bolts and bearing case assembly.

NOTE:

- On model FM 40 is coarse thread bolts (M10×25).
 - On model FM60CJ is fine thread bolt (M12×30) with spring washer and washer.
- (5) Remove the key, bearing, spring washer, spacer and blade from the shaft.



910V



911V

2) Assembly

Reassemble the bearing case generally follows the disassembly procedure in reverse order and refer to as follows:

(1) Tighten the bolt and nut as follows:

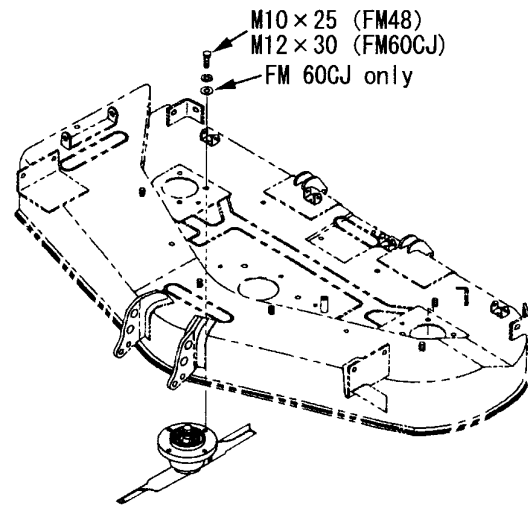
· On model FM48

- ① Bolts (M10×25 coarse thread) for bearing case:
29.4 N·m {3.0 kgf·m}
- ② Nut for pulley: 191 N·m {19.5 kgf·m}

· On model FM60CJ

- ① Bolts (M12×30 Fine thread) for bearing case:
84.3 N·m {8.6 kgf·m}
- ② Nut for pulley:
191 N·m {19.5 kgf·m}

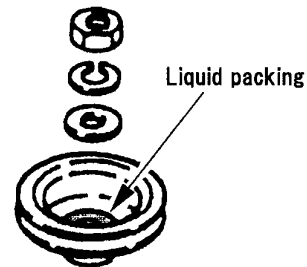
(2) Apply the liquid packing between pulley and seal washer when install the left handed thread nut.



912V

3) Adjustment

Adjust the V-belt tension.
See "4 ADJUSTMENT" of GEAR BOX UNIT.



913V

7. Blade

1) Inspection

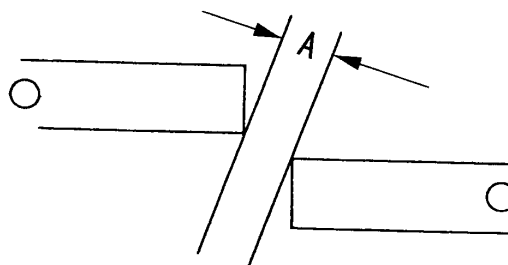
- (1) Before removing the blades, check the clearance between the blade tips as shown in figure.

Replace the blades if the clearance exceeds the specified wear limits.

Blade tip clearance

Standard 1.61 mm

Wear limit 10.0 mm



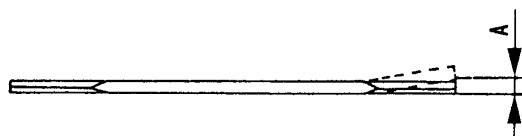
Blade Clearance

914V

- (2) Remove the blades and inspect the blades for straightness.

Blade straightness

Wear limit 0.3 mm

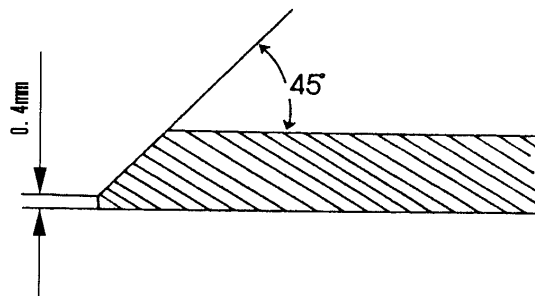


Blade Straightness

- (3) Blade sharpening and balance Sharpen the blade edge to 45 degree to the blade end dimension shown in figure.

WARNING:
USE PROTECTIVE EYES GOGGLES WHEN SHARPENING BLADES.

Using a suitable blade balancing tool, check the blade for balance. Level if necessary, by sharpening the heavier end until the blade balances evenly.



Blade Sharpening

915V

- (4) Blade tightening torque

132.3 – 147 N·m {13.5 – 15.0 kgf·m}

916V