YANMAR SERVICE MANUAL

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DIESEL TRACTOR

MODEL **YM276**
YM276D

(Rev. Jun. '89)

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YANMAR DIESEL ENGINE CO.,LTD.

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SME2760(2)-8705
Kinomoto, Printed in Japan

HOW TO USE THIS MANUAL

This manual consists of two groups of Chapter. The Chapter 10 to 80 is classified with Cream Color and the Chapter 220 to 270 are classified with blue color.

Each system of tractor is instructed by both cream Chapter and Blue Chapter. The Cream Chapter instructs how to disassemble, repair, inspect, assemble or install for pure repairing works.

The blue Chapter instructs the general operation of the system and test before disassembling the faulty area.

To know the system operation and basic functions of composed parts is very important for decrease the time for diagnosis, and permit you to shorten repairing time.

Also, the blue Chapter is good for sales peoples to know the general functions, and to use the knowledge as their sales promotion aids.

This safety alert symbol indicates important safety messages in this manual. When you see this symbol, be alert to the possibility of personal injury and carefully read the message that follows.

This stop symbol indicates important proper operation messages in this manual. When you see this symbol, carefully read the message that follows.

"Right-hand" and the "Left-hand" sides of this tractor are determined by fauling in the direction of tractor forward travel.

This tractor is of metric design. Most hardware is therefore metric (ISO). Make sure you use the specified metric hard-ware when replacement becomes necessary.

For your convenience most specifications are given in customary U.S. measurement with the metric measurement following.

All information, illustrations and specifications contained in this service manual are based on the latest information available at the time of publication. The right is reserved to make changes at any time without notice.

Safety equipments and protectors may not shown in the pictures or illustrations for emphasize the specific part or a visual point of shoot.

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TO ENSURE SAFETY IN SERVICE

1) Refer to operation manual for safety operation of tractor.

2) Make sure that dependable jacks of adequate capacity AND suitable stands (or wooden blocking) are used to securely block up the machine when removing any of the wheels, or axles.

3) If it becomes necessary to go under raised equipment (i.e.: to perform adjustments, etc), make certain that safety stands are used.

4) Do not modify or alter this tractor or any of its components or any tractor function.

5) Never modify structural member of ROPS (Roll-over protective structure) by welding, bending, grinding or cutting, as this may weaken the structure.
If any component is damaged, replace it. Do not attempt repair.

6) If ROPS is loosened or removed for any reason, make certain all parts are installed correctly. Tighten mounting bolts to proper torque.

7) Use correct tools and equipment. Before servicing the tractor: locate the tractor on a firm level surface; lower implement; set the parking brake; place the gear in neutral; stop the engine and block wheels.

8) Service or check the tractor after it has completely cooled off. Avoid touching the muffler, radiator and other high temperatured parts until they have cooled off.

9) Under normal circumstances, radiator cap should not be removed. Add coolant to cooling system through coolant sub tank.

   If radiator cap must be removed, do not remove it when engine is hot. Shut the engine off and wait until it cools. Then turn the cap slowly to the first stop to relieve pressure before removing it completely.

10) Wait for all moving parts to stop COMPLETELY before attempting servicing.

11) Keep hands, feet and clothing a safe distance away from moving belts, pulleys and any other moving part that may cause injury. Make sure that all safety shields are installed.

12) Be extra careful when performing any checks, inspections, adjustments or tests that require operating the engine, operating the hydraulic controls, or with the machine in motion. DO NOT make any check, adjustment, inspection or test under these stated conditions... UNLESS the procedures *specifically* recommend this practice, and THEN ONLY WITH STRICT ADHERENCE TO RECOMMENDED PROCEDURES AND SAFETY RULES.

13) Before any attempt is made to remove any hydraulic component, make certain that the hydraulic pressure within the system is relieved even if the engine is not running.

14) Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Keep hands and body away from pin holes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

   If any fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result.

15) Disconnect the battery ground cable before working on the electrical system or working in any area where you might come in contact with electrical components. Disconnect ground cable first and install last. Never put tools or metals on a battery.

   Be sure there is plenty of ventilation before charging the battery. Gas of battery is dangerous.

   If electrolyte is contact the skin, eye or clothing, flush with water and call physician immediately.

16) Failure to follow proper procedures when mounting a tire on a wheel or rim can produce an explosion which may result in serious injury or death. Do not attempt to mount a tire unless you have the proper equipment and experience to perform the job have it done by your YANMAR dealer or a qualified tire repair service.

When changing the wheel tread width, securely support tractor while raised. Always retighten wheel bolts to the specified torque and check regularly.

17) Never pour cold water into a hot engine, since it could crack cylinder block or head. Never operate engine without coolant for even a few minutes.

18) Always display the caution tag or board until tractor has completely serviced.

19) Keep working floor clean and dry to avoid slippage.

20) Let other worker know what you are doing when servicing in cooperation with the tractor.

21) Safety shields are usually removed for access to assemblies being serviced. All safety shields must be replaced after servicing if they were removed. Also replace any CAUTION, WARNING, or INSTRUCTION decal that is not readable, or missing. Refer to "Parts Catalog" for decal locations.

CAUTION: Personal injure may result if these safety instructions are not followed.
Carefully read the cautions and messages that follow when you see this symbol.

GENERAL 10

10

GENERAL TRACTOR SPECIFICATION

MODELS		YM276	YM276D
DIMENSIONS			
Overall length			
with 3-point hitch		2986 mm (117.6 in.)	2986 mm (117.6 in.)
without 3-point hitch		2714 mm (106.9 in.)	2695 mm (106.1 in.)
Overall width		1432 mm (55.3 in.)	1404 mm (55.3 in.)
Overall height			
to muffler end		1865 mm (73.4 in.)	1878 mm (73.9 in.)
to steering wheel		1469 mm (57.8 in.)	1486 mm (58.5 in.)
Wheel base		1625 mm (64.0 in.)	1625 mm (64.0 in.)
Standard tread			
front		1015 mm (39.9 in.)	1000 mm (39.4 in.)
rear		1114 mm (43.9 in.)	1114 mm (43.9 in.)
Turning radius	Without brake	2600 mm (102.4 in.)	2600 mm (102.4 in.)
	With brake	2400 mm (94.5 in.)	2400 mm (94.5 in.)
GROUND CLEARANCE			
		329 mm (12.9 in.) (at drawbar)	309 mm (12.2 in.) (at front axle case)
SHIPPING WEIGHT			
Tire			
front	rear		
5.00–15(F1)	12.4–24(R1)	996 kg (2196 lbs.)	X
7–14(R1)	11.2–24(R1)	X	1035 kg (2282 lbs.)
27x8.50–15(Turf)	11.2/10–24(R3)	910 kg (2006 lbs.)	999 kg (2202 lbs.)
5.50–16(F1)	12.4–24(R1)	1018 kg (2244 lbs.)	X
7–16(R1)	12.4–24(R1)	X	1115 kg (2458 lbs.)
6.00–14(F2)	12.4–24(R1)	1000 kg (2205 lbs.)	X
25x7.50–15(Turf)	16.5L–16.1 (R3)	910 kg (2006 lbs.)	999 kg (2202 lbs.)
ENGINE			
Type		3-cylinder, in-line diesel	3-cylinder, in-line diesel
Model		3T84HA	3T84HA
Slow idle speed		900 rpm	900 rpm
Working speed range		1800 to 2600 rpm	1800 to 2600 rpm
Bore and stroke		84 x 85 mm (3.31 x 3.35 in.)	84 x 85 mm (3.31 x 3.35 in.)
Displacement		1.413 ℓ (86.2 Cu. in.)	1.413 ℓ (86.2 Cu. in.)
Compression ratio		20 : 1	20 : 1
Firing order (No. 1 in. rear)		1–3–2	1–3–2
Valve clearance			
intake		0.20 mm (0.008 in.)	0.20 mm (0.008 in.)
exhaust		0.20 mm (0.008 in.)	0.20 mm (0.008 in.)
Injection timing		21°BTDC	21°BTDC
Lubrication system		Force-feed, pressurized with full-flow filter	Force-feed, pressurized with full-flow filter
Max. gross horsepower (factory-observed)		27HP (20.1 KW) at 2600 rpm	27HP (20.1 KW) at 2600 rpm
FUEL SYSTEM			
Type		Swirl-precombustion chamber	Swirl-precombustion chamber
Injection pump type		Plunger/bosch type	Plunger/bosch type
Air cleaner		Dry type with pre-cleaner	Dry type with pre-cleaner

GENERAL TRACTOR SPECIFICATIONS

MODELS	YM276	YM276D
COOLING SYSTEM		
Type	Pressurized with centrifugal pump	Pressurized with centrifugal pump
Temperature control	Thermostat	Thermostat
CAPACITIES		
Fuel tank	32 ℓ (8.4 U.S. gallons)	32 ℓ (8.4 U.S. gallons)
Cooling system (without subtank)	4.4 ℓ (1.2 U.S. gallons)	4.4 ℓ (1.2 U.S. gallons)
Crankcase (with filter)	4.3 ℓ (4.5 U.S. quarts)	4.3 ℓ (4.5 U.S. quarts)
Transmission hydraulic system	17.5 ℓ (4.6 U.S. gallons)	18 ℓ (4.8 U.S. gallons)
Front drive gear case	X	6 ℓ (6.3 U.S. quarts)
TRANSMISSION		
Type	Power shift and sliding gear 4-speed range shift, and 3-forward and 1-reverse power shift	Power shift and sliding gear 4-speed range shift, and 3-forward and 1-reverse power shift
Gear selection	12 forward and 4 reverse	12 forward and 4 reverse
Clutch	Single-disk, dry	Single-disk, dry
POWER TAKE-OFF		
Type	2-speed, transmission driven with overrunning clutch	2-speed, transmission driven with overrunning clutch
Speed	540 rpm (2258 engine rpm) 1000 rpm (2294 engine rpm)	540 rpm (2258 engine rpm) 1000 rpm (2294 engine rpm)
Size	35 mm (1-3/8 in.)	35 mm (1-3/8 in.)
Clutch	Uses transmission clutch	Uses transmission clutch
HYDRAULIC SYSTEM		
Type	Open center, constant flow	Open center, constant flow
Max. Lift capacity (@ 24 in. behind points)	650 kg (1433 lbs) 630 kg (1389 lbs)	650 kg (1433 lbs) 630 kg (1389 lbs)
Relief pressure	155 kg/cm^2 (2204 psi.)	155 kg/cm^2 (2204 psi.)
Pump	Gear pump, driven by engine	Gear pump, driven by engine
Pump rated output	31.2 ℓ/min. (8.2 U.S. GPM)	31.2 ℓ/min. (8.2 U.S. GPM)
BRAKES		
Type	Mechanical dry, internal expanding shoe	Mechanical dry, internal expanding shoe
ELECTRICAL SYSTEM		
Type	12-volt, negative ground	12-volt, negative ground
Battery	One, 12-volt, 70 Ah	One 12-volt, 70 Ah
Alternator	15 amp (or 35 amp)	15 amp (or 35 amp)
TIRE AND TREAD		
Tire Front	5.00–15 (F1) 5.50–16 (F1) 27 x 8.50–15	7–14 (R1) 7–16 (R1) 27 x 8.50–15
Rear	11.2–24 (R1) 12.4–24 (R1) 11.2–24 (R3)	11.2–24 (R1) 12.4–24 (R1) 11.2–24 (R3)
Tread Front (w/STD AG Tire) (standard)	355/80D20 (Turf) 1094 mm (43.1 in.)	355/80D20 (Turf) 1000 mm (39.4 in.)
Rear (w/STD AG Tire) (standard)	1094 mm (43.1 in.)	1094 mm (43.1 in.)

TRAVEL SPEEDS

With 11.2 – 24 (AG) tire

Gear	Rated Engine Speed (2600 rpm)		STD. PTO Speed (2258 rpm)	
	km/h	mph	km/h	mph
C1	0.27	0.17	0.23	0.15
C2	0.35	0.22	0.30	0.19
C3	0.47	0.29	0.41	0.25
1	1.34	0.83	1.16	0.72
2	1.77	1.10	1.53	0.96
3	2.34	1.45	2.03	1.26
4	4.25	2.64	3.69	2.29
5	5.62	3.49	4.88	3.03
6	7.42	4.61	6.44	4.00
7	10.51	6.54	9.13	5.68
8	13.93	8.65	12.10	7.51
9	18.36	11.48	15.94	9.97
Max.	19.6 km/h (12.2 mph) at 2775 rpm			
CR	0.34	0.21	0.30	0.18
1R	1.72	1.07	1.49	0.93
2R	5.46	3.39	4.74	2.94
3R	13.54	8.41	11.76	7.30

With 12.4 – 24 (AG) tire

Gear	Rated Engine Speed (2600 rpm)		STD. PTO Speed (2258 rpm)	
	km/h	mph	km/h	mph
C1	0.28	0.18	0.24	0.16
C2	0.37	0.23	0.32	0.20
C3	0.49	0.31	0.43	0.27
1	1.41	0.88	1.22	0.76
2	1.87	1.16	1.62	1.01
3	2.47	1.53	2.15	1.33
4	4.48	2.78	3.89	2.41
5	5.93	3.68	5.15	3.20
6	7.82	4.86	6.79	4.22
7	11.09	6.90	9.63	5.99
8	14.69	9.12	12.76	7.92
9	19.37	12.10	16.82	10.50
Max.	20.7 km/h (19.9 mph) at 2775 rpm			
CR	0.36	0.23	0.31	0.20
1R	1.82	1.13	1.58	0.98
2R	5.76	3.58	5.00	3.11
3R	14.30	8.87	12.42	7.70

With 355/80D20 (Turf) tire

Gear	Rated Engine Speed (2600 rpm)		STD. PTO Speed (2258 rpm)	
	km/h	mph	km/h	mph
C1	0.26	0.16	0.23	0.14
C2	0.34	0.21	0.30	0.18
C3	0.45	0.28	0.38	0.24
1	1.28	0.80	1.11	0.70
2	1.70	1.06	1.45	0.91
3	2.24	1.40	1.94	1.21
4	4.06	2.54	3.53	2.21
5	5.38	3.36	4.67	2.92
6	7.09	4.43	6.16	3.85
7	10.05	6.28	8.73	5.46
8	13.32	8.33	11.56	7.23
9	17.58	10.99	15.27	9.54
Max.	18.74 km/h (11.7 mph) at 2775 rpm			
CR	0.33	0.21	0.29	0.18
1R	1.65	1.03	1.43	0.89
2R	5.22	3.26	4.53	2.83
3R	12.92	8.08	11.26	7.04

PREDELIVERY SERVICE

Tune-Up

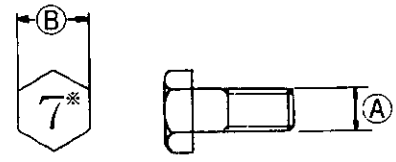
PTO Horsepower (Factory estimate)	23.0 HP (17.1 kw) at 2600 rpm
Compression	3.92 to 4.41 MPa (40 to 45 kg/cm^2) (568 to 639 psi) at 300 rpm
Thermostat opening temperature	71°C (160°F)
Radiator cap pressure release	76 to 103 kPa (0.76 to 1.73 kg/cm^2) (11 to 15 psi)
Engine Speeds	
Slow idle	900 rpm
Fast idle	2775 ± 25 rpm
Rated speed at full load	2600 rpm
Toe-In	4 to 8 mm (1/8 to 3/8 in.)
Fan belt deflection (at 89 N [20 lbs.] push)	10 to 15 mm (3/8 to 5/8 in.)

Torques

Front Axle to Knee	196 Nm (20 kgm) (147 ft-lbs)
Front Wheel to Hub	137 Nm (14 kgm) (103 ft-lbs)
Rear Wheel to Hub	294 Nm (30 kgm) (221 ft-lbs)
Rear Wheel to Rim	196 Nm (20 kgm) (147 ft-lbs)
Drag Rod to Pitman Arm	60 Nm (6 kgm) (43 ft-lbs)

TORQUE CHART

Refer to the following charts for tightening torque specifications. Note, however, that torque specifications for the more important nuts and bolts will be provided in the sections on their assembly.



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A	B	TORQUE					
Bolt effective diameter	With across flats of nuts and bolts	GRADE 7T*			GRADE 11T (10.9T)*		
		Nm	kgm	ft-lbs	Nm	kgm	ft-lbs
M6	10 mm (0.3937 in.)	8 ~ 12	0.8 ~ 1.2	5.8 ~ 8.7	—	—	—
M8	12 (0.5118)	23 ~ 30	2.3 ~ 3.0	17 ~ 22	30 ~ 34	3.0 ~ 3.5	22 ~ 25
M10	17 (0.6693)	45 ~ 60	4.5 ~ 6.0	33 ~ 43	60 ~ 70	6.2 ~ 7.2	45 ~ 52
M12	19 (0.7480)	80 ~ 100	8 ~ 10	58 ~ 72	103 ~ 118	10.5 ~ 12	76 ~ 86
M14	22 (0.8661)	118 ~ 147	12 ~ 15	87 ~ 108	170 ~ 200	17 ~ 20	123 ~ 145
M16	24 (0.9449)	170 ~ 210	17 ~ 21	123 ~ 152	260 ~ 300	26.5 ~ 31	192 ~ 224
M18	27 (1.0630)	235 ~ 284	24 ~ 29	174 ~ 210	340 ~ 400	35 ~ 41	253 ~ 297
M20	30 (1.1811)	324 ~ 402	33 ~ 41	238 ~ 297	490 ~ 570	50 ~ 58	362 ~ 420

* Grade is embossed on screw head

PERIODIC SERVICE

Service Interval

Engine crankcase oil capacity	4.3 ℓ (1.14 US gallons)
Transmission-hydraulic system oil capacity	17.5 ℓ (4.6 US gallons) (2WD) 18 ℓ (4.8 US gallons) (4WD)

Service intervals

Check engine oil level	Every 10 hours
Change engine oil	Every 100 hours
Replace engine oil filter	Every 200 hours
Clean crankcase breather tube	Every 600 hours
Check transmission-hydraulic oil level	Every 50 hours
Change transmission-hydraulic oil	Every 300 hours
Clean transmission-hydraulic oil filter (Mesh Type)	Every 300 hours
Replace transmission-hydraulic oil filter (Cartridge Type)	Every 300 hours
Clean and repack front wheel bearings	Every 600 hours
Check front axle gear oil level (Front Drive Model)	Every 50 hours
Change front axle gear oil (Front Drive Model)	Every 300 hours
Lubricate grease fittings	
Front axle center pin	Every 10 hours
All others	Every 50 hours

SEPARATION

Torque

Fender-to-Axle housing		98 Nm (10 kgm) (72 ft-lbs)
Fender-to-Step		30 Nm (3 kgm) (22 ft-lbs)
Step-to-Transmission case		60 Nm (6 kgm) (43 ft-lbs)
Differential housing-to - Transmission case		98 Nm (10 kgm) (72 ft-lbs)
Drag-rod-to-Pitman arm		60 Nm (6 kgm) (43 ft-lbs)
Clutch housing-to-Engine		98 Nm (10 kgm) (72 ft-lbs)
Front axle bracket-to-Engine		98 Nm (10 kgm) (72 ft-lbs)
Hydraulic lines-to-Pump		8 Nm (0.8 kgm) (5.8 ft-lbs)
Hood mounting bracket cap screws		60 Nm (6 kgm) (43 ft-lbs)
Center pin bracket cap screws		150 Nm (15 kgm) (108 ft-lbs)
Axle housing-to-Differential housing	7T	60 Nm (6 kgm) (43 ft-lbs)
	10.9T	70 Nm (7 kgm) (52 ft-lbs)
Hydraulic cylinder case-to-Differential housing		60 Nm (6 kgm) (43 ft-lbs)
Clutch housing-to-Transmission case	M12	137 Nm (14 kgm) (101 ft-lbs)
	M14	196 Nm (20 kgm) (145 ft-lbs)

PREDELIVERY SERVICE

YANMAR tractors require set-up and assembly per instructions in shipping crates. Perform these operations prior to predelivery which follows.

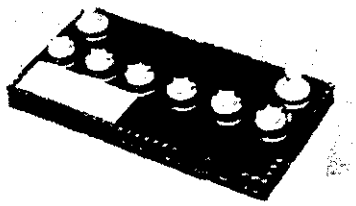
The Warranty and Delivery Report when properly filled out and signed by the dealer and customer verifies that the predelivery service was satisfactory performed. When delivering this machine, give the customer his copy of the Warranty and Delivery Report and the operation manual. Explain their purpose to him.

After completing the Warranty and Delivery Report, file it. It will certify that the tractor has received the proper predelivery service.

Because of the shipping factors involved, plus extra finishing touches that are necessary to promote customer satisfaction, proper predelivery service is of prime importance to the dealer.

BATTERY

CHARGING "DRY-CHARGED" BATTERY



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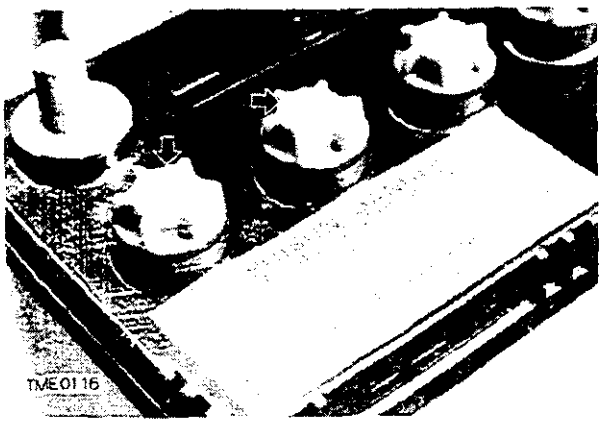
The vent plugs and sealing tape on the vent holes should not be removed nor allowed to loosen until just before filling with electrolyte. This precaution will maintain the battery in its dry charged condition while in storage.

In case of the accidentaly removal of the vent plugs or sealing tape on vent holes, charge the battery immediately, otherwise the battery will be dead.



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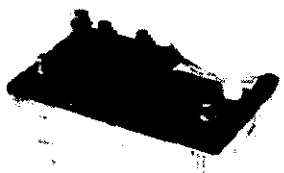
Filling of Electrolyte

CAUTION: Sulfuric acid in battery electrolyte is poisonous. It can destroy clothing and burn the skin. Wear eye protection and rubber gloves when filling battery. If you spill acid on yourself, flush your skin with water and apply baking soda or lime to neutralize the acid. Get medical attention immediately.

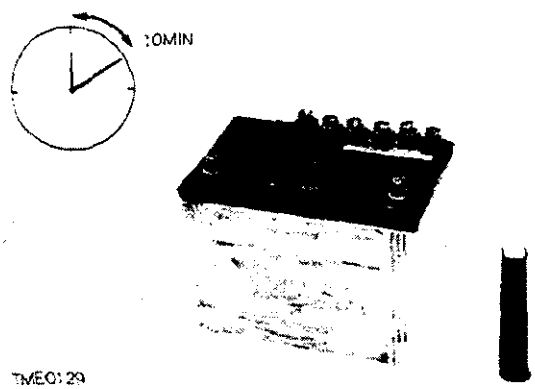
1. Take off sealing tape on vent-hole and remove vent plugs before filling with electrolyte.
2. Fill with electrolyte up to the bottom of the vent well, or up to the UPPER LEVEL indicated on the battery container.
3. For filling, use battery electrolyte of specific gravity (use only dilute sulfuric acid prepared as standard battery electrolyte) given below.



TME0135

	In temperate climates	In tropical climates
Filling Sp. Gr.	1.260 at 20°C (58°F)	1.240 at 20°C (58°F)
Final Sp. Gr.	1.270 – 1.285 at 20°C (58°F)	1.230 – 1.245 at 20°C (58°F)

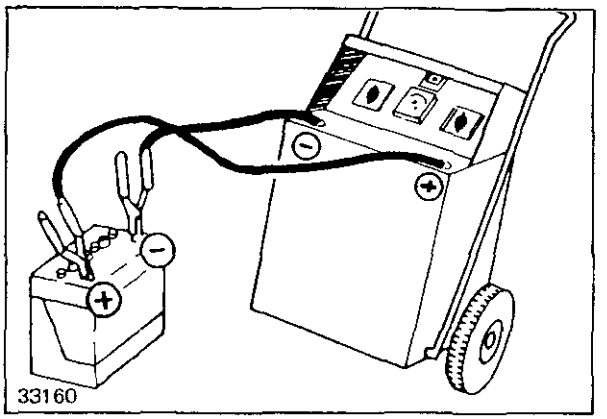
Standing



TME0129

4. This will permit the electrolyte to soak into battery plates.
5. As the electrolyte level will fall after standing, refil with electrolyte of the same specific gravity, to restore the same electrolyte level in each cell.

Initial Charge



6. Connect positive (+) battery terminal to positive of current source and negative (–) battery terminal to negative of current source.

7. After the temperature of electrolyte has fallen or has been adjusted to below 32°C (90°F), charge the battery at the rate given below.

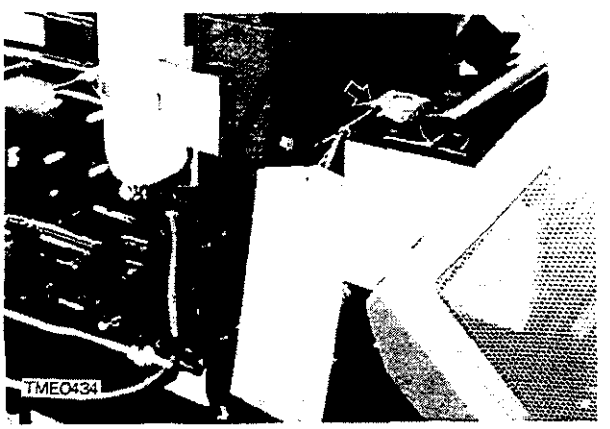
   The maximum charging current is 1/10 of 20 hour rate of battery.

Tractor Model	Battery Type	Voltage V	Amp. Hrs (20 Hr. Rate) Ah	Charging Current A	Volume of Acid ℓ (US Gal)	BCI Group
YM276 YM276D	N70Z	12	70	7	5.5 (1.45)	27

8. Continue charging until all cells gas freely and the voltage and the specific gravity show no further rise for 3 successive reading taken at 1-hour intervals.

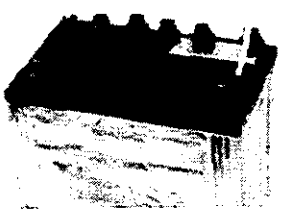
   The charging time is very according to the storage period of battery as follows:

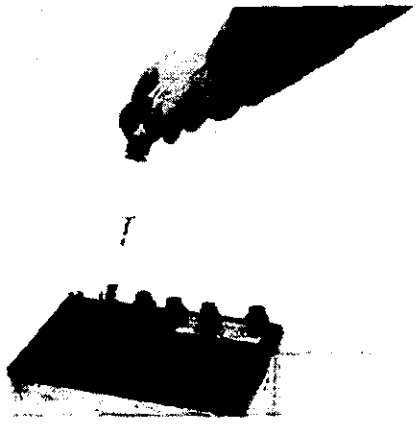
Storage Period (Month)	0 to 12	12 to 18	18 to 24
Charging Time (Hour)	3	5	10



Battery that has been stored for a long time may have partly lost its dry-charged performance. This, however, does not mean any deterioration in battery characteristics. Just give a full initial charge at the charge rate for specified in the above table.

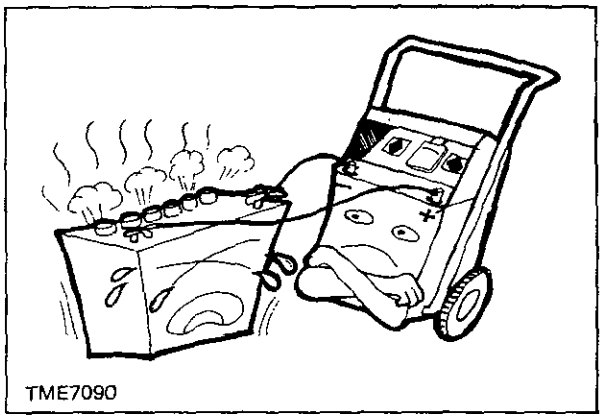
9. Temperature of the electrolyte during charge should not exceed 45°C (115°F). If it rises higher, suspend charging allow the electrolyte temperature to fall or cool it to lower than 45°C (115°F).





TME0127

10. After charging, adjust specific gravity of electrolyte to the specified value.



TME7090

When charging battery on a tractor, disconnect positive battery cable to starter to avoid damage to the diodes of alternator.

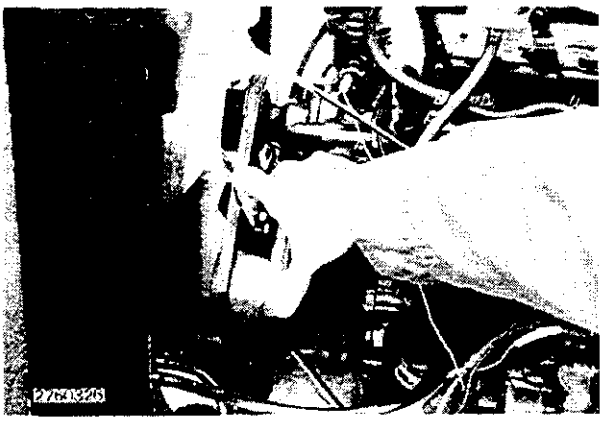
Never apply FAST CHARGE so as not to lose performance of battery.

ELECTRICAL SYSTEM

ELECTRICAL SYSTEM

BELT TENSION

Check tension of fan belt and adjust if necessary. Fan belt should deflect 10 to 15 mm (3/8 to 5/8 inch) when a 89 N (20 lbs.) force is applied.

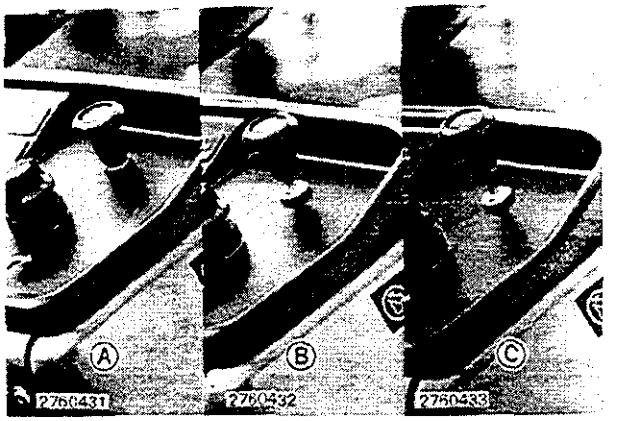


LIGHTING

Headlight Switch

The light switch has two positions. The first pulled position gives High-beam of headlights and the second pulled position gives Dim headlights. Dim lights in case of on coming traffic or when driving through populated areas.

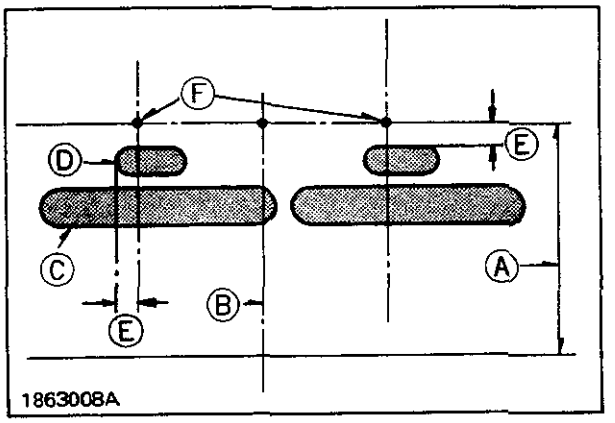
A – Off
B – High Beam/Work Light
C – Dim



Headlight Adjustment

Park tractor on level ground, 8 m (25 ft.) from a wall.
Check headlight adjustment. Direct headlight beams slightly downward and to the right. See that no lights will blind the operators of other vehicles.
See page 40-20-1 for adjustment.

A – Height of Lamp
B – Centerline of Tractor
C – Lower Light Zone
D – Upper Light Zone
E – 130 mm (5 in.)
F – Points Directly in Front of Lights

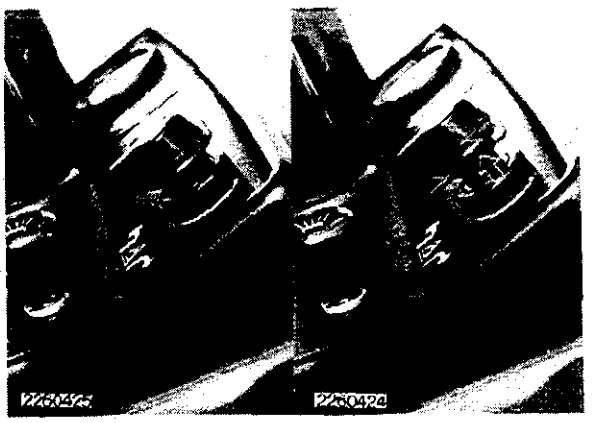


Flashing Warning Lights

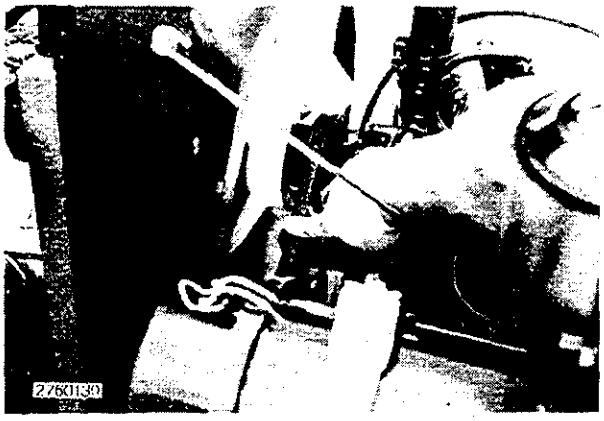
Turn signal light switch works for flashing warning. Pull the switch for both lights flashing.

Turn Signal Light

Check switch function. Turn the switch to the right for left turning. To the left for right turning.

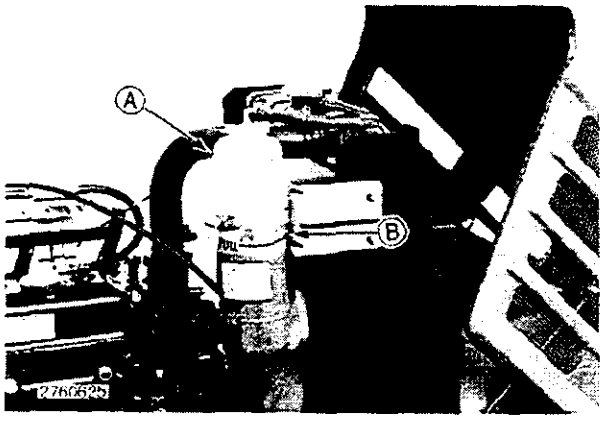


COOLING SYSTEM



BELT TENSION

Check tension of fan belt and adjust if necessary. Fan belt should deflect 10 to 15 mm (3/8 to 5/8 in.) When a 89 N (9 kg) (20 lbs.) force is applied.



COOLANT LEVEL

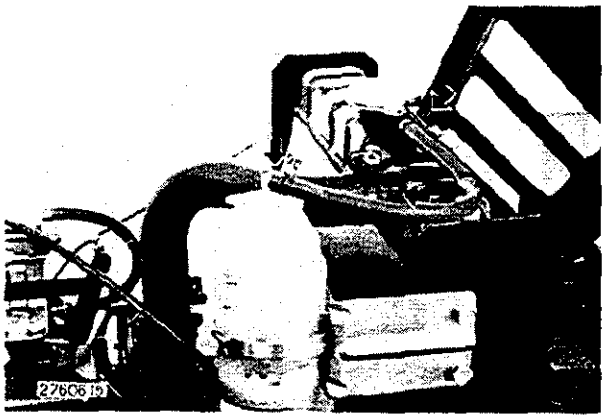
Remove radiator cap to see if the radiator is full of coolant. The sub-tank (A) should have coolant up to the full mark.

A – Sub-Tank
B – Full mark

If coolant level is low, fill to proper level and determine where coolant was lost.

ANTI-FREEZE PROTECTION

Use a dependable, temperature-correcting hydrometer to check anti-freeze protection of coolant. If more is needed, use permanent type, ethylene glycol anti-freeze which contains a rust inhibitor but does not contain a stopleak additive.

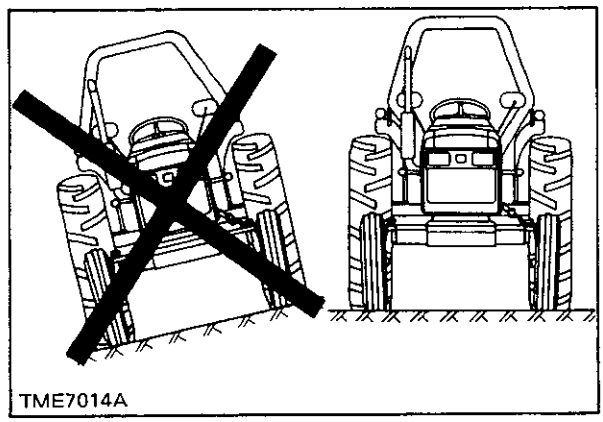


LEAKS

Check any coolant leakage from cooling system connections.

LUBRICANT

Before starting engine, make a few checks for lubricant level.

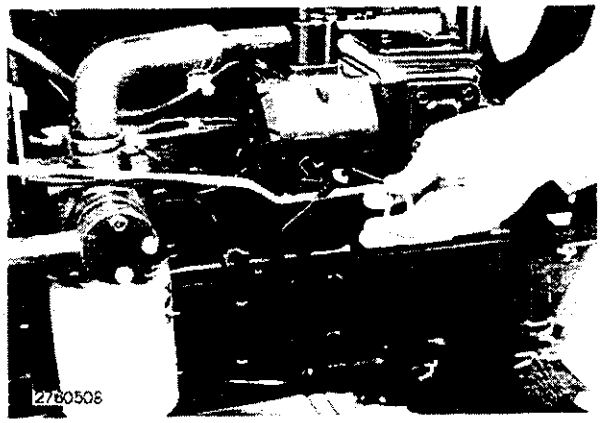

TME7014A

Tractor should be on a level surface when oil level is checked. If it is not, check only to make sure the transmission case is not dry. Recheck oil level later, when tractor is on level ground.

CAUTION: Store lubricants out of reach of children.

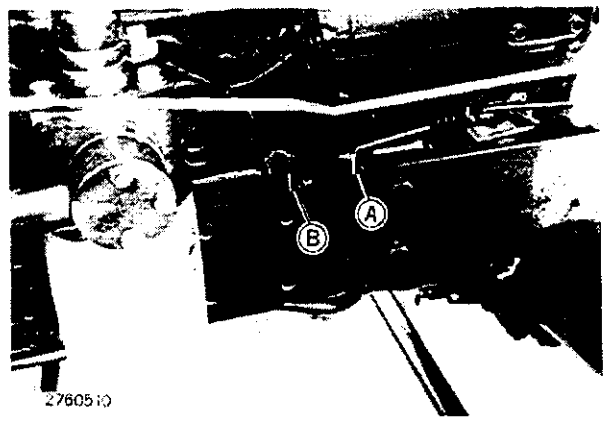
ENGINE OIL

1. Remove engine oil dipstick located on the right-hand side of cylinder block.


2760508

2. Check oil level. The oil level should be between upper and lower lines.

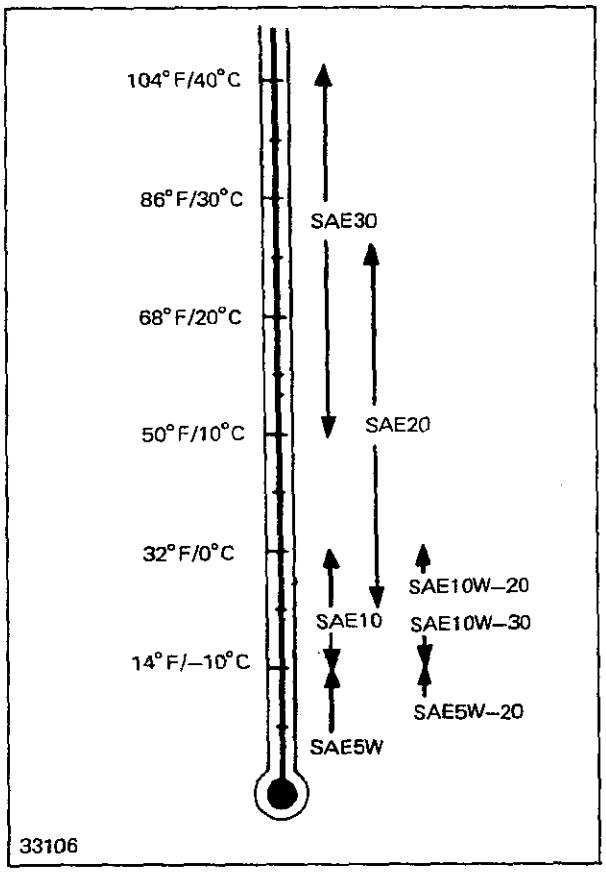
A – Upper Indicator Line
B – Lower Indicator Line



2760510

3. If necessary, add enough oil with the following specifications.
4. Depending upon the operating conditions, use the correct grade of oil specified as shown.

	Single-Viscosity Oil	Multi-Viscosity Oil
API	CD	CC or CD
MIL	MIL-L-2104C	MIL-L-46152



ENGINE OIL (Continued)

5. Depending upon the expected ambient temperature for the fill period, use oil of viscosity as shown in the illustration.

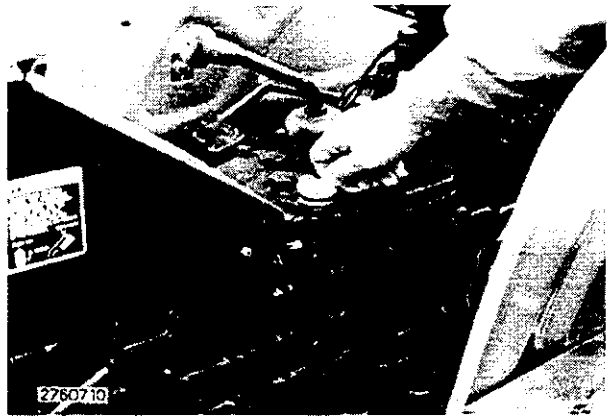
6. The engine oil capacities of models are as follows:

MODEL	ENGINE OIL ℓ (US gal)
YM276	4.3 (1.14)
YM276D	4.3 (1.14)

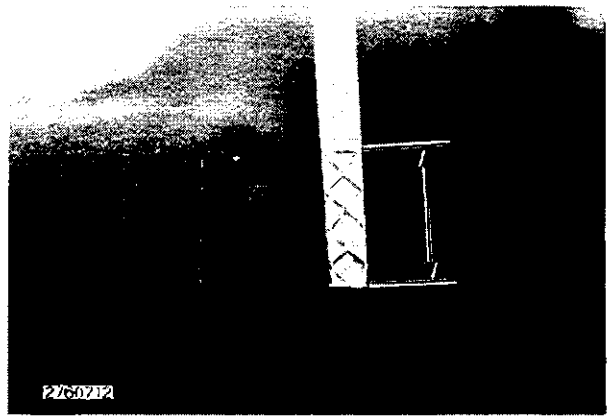
TRANSMISSION-HYDRAULIC OIL

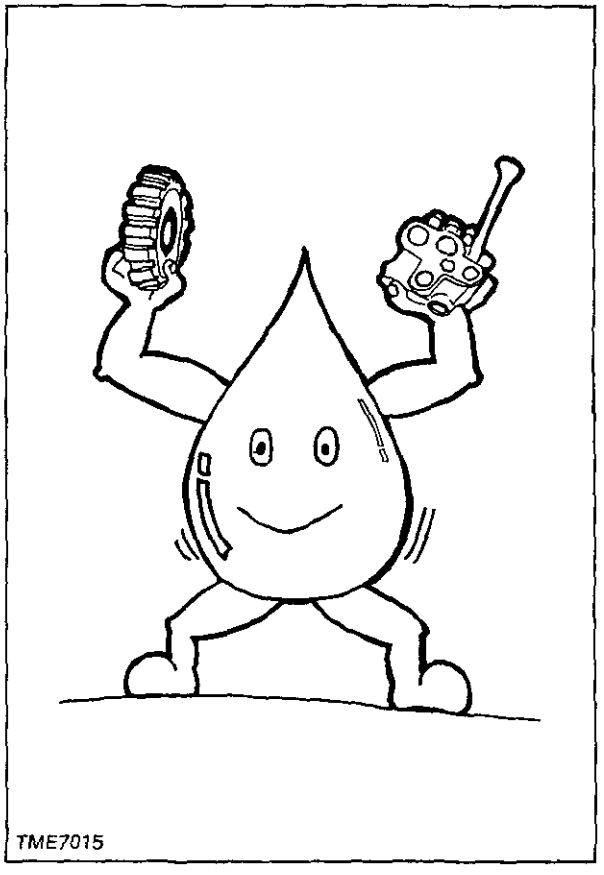
1. Remove oil filler cap with dipstick and wipe it clean.

2. Insert dipstick to rest on threads, but do not screw it in.



3. Oil level should be within cross-hatchings.





TME7015

TRANSMISSION-HYDRAULIC OIL (Continued)

4. If necessary, add transmission-hydraulic oil.

   Use only a multi-functional fluid for use in the transmission and hydraulic system. The equivalent oils are the followings:

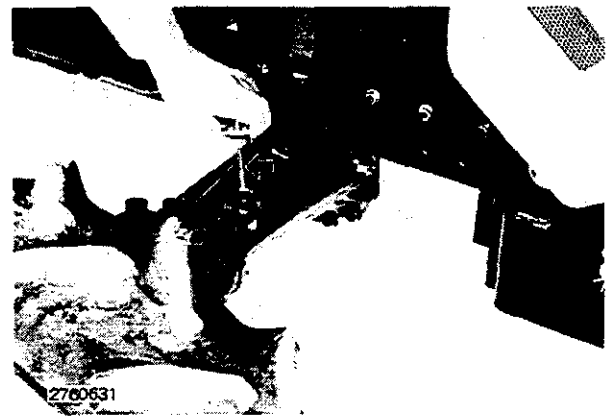
CALTEX	RPM Tractor Hydraulic Fluid
SUN OIL	ALTRAM #303 Fluid Oil
JOHN DEERE	303 (J14B)
CASE	CASE TCH Oil (JIC143, JIC144 or JIC145)
ALLIS-CHALMERS	ALLIS-CHALMERS Gear, Hydraulic and Wet Brake Oil (ACM-7201)
FORD	M2C41-A, M2C53-A or M2C86A
INTERNATIONAL HARVESTER	Hy-Tran B-6 Fluid INTERNATIONAL HARVESTER

5. The transmission-hydraulic oil capacities of models are as follows:

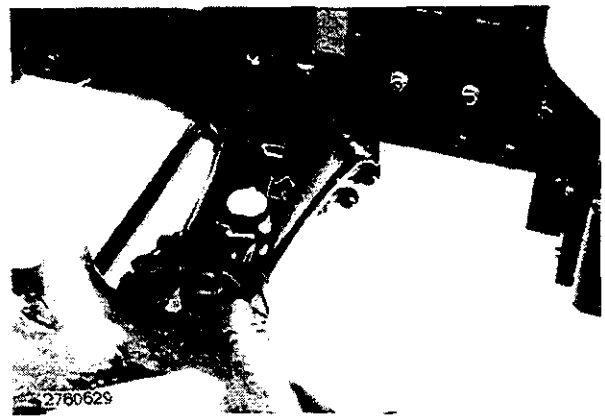
MODEL	TRANSMISSION-HYDRAULIC OIL ℓ (US Gal)
YM276 YM276D	17.5 (4.6) 18.0 (4.8)

FRONT AXLE OIL (4WD)

1. Remove oil filler cap (Yellow) with dipstick and wipe clean.

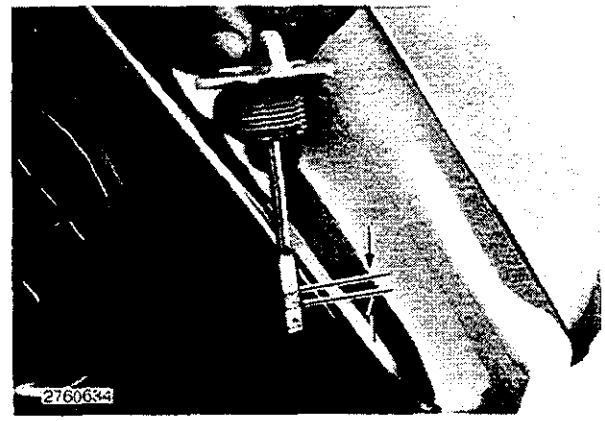


2. Insert dipstick to rest on threads, but do not screw it in.



3. Remove the dipstick again and check oil level. Oil level should be within cross-hatchings.

   If necessary, add SAE 90 gear oil to the front axle housing.



4. The front axle oil capacity is as follows:

MODEL	FRONT AXLE OIL ℓ (US gal)
YM276D	6.0 (1.6)

FUEL AND AIR INTAKE

2760333

CHECKING FUEL LEVEL

Check fuel gauge to make sure tractor has enough fuel for driving around the lot, if not, add some. Try to never run a diesel engine out of fuel.

Fuel Specification

Use either Grade No. 1-D or Grade No. 2-D fuel, as defined by ASTM Designation D975 for diesel fuels. Use the chart below to determine correct grade of fuel.

As further insurance of satisfactory operation, use fuel having less than 1.0 percent sulfur — preferably less than 0.5 percent.

For maximum filter life, sediment and water should not exceed 0.10 percent.

To maintain proper fuel delivery during cold weather operation, use Grade No. 1-D diesel fuel with a pour point at least 5.6°C (10°F) below lowest ambient air temperature.

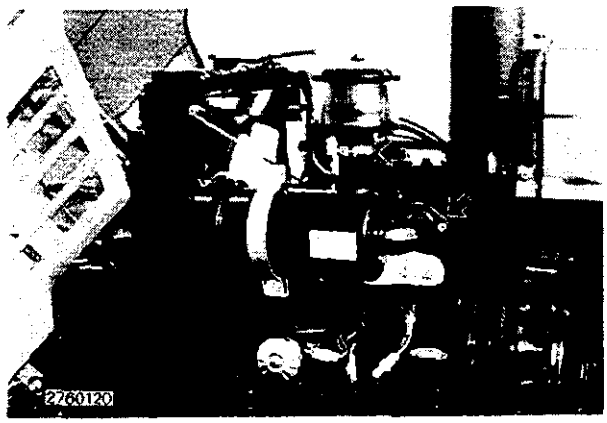
The cetane number should be 40 minimum. Operation under low ambient temperature as well as rarefied air, may require use of a fuel with a higher cetane number.

DIESEL FUELS

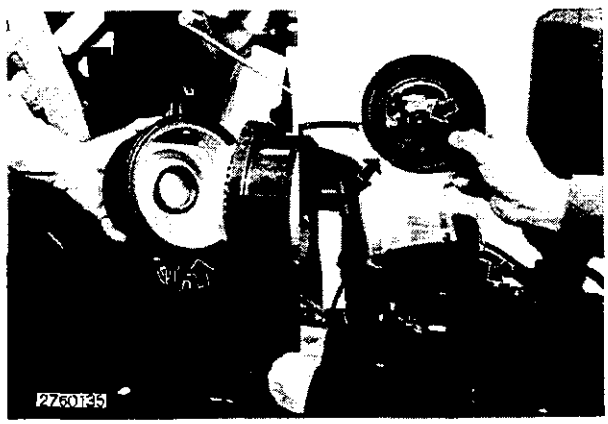
Type of Engine Service	Air Temperature	Diesel Fuel Grade No.
Wide variation in load and speed, considerable idling.	Below 25°C (80°F) Above 25°C (80°F)	1-D 2-D
Heavy load and high speed, minimum idling	Below 5°C (40°F) Above 5°C (40°F)	1-D 2-D

CHECKING AIR INTAKE CONNECTIONS

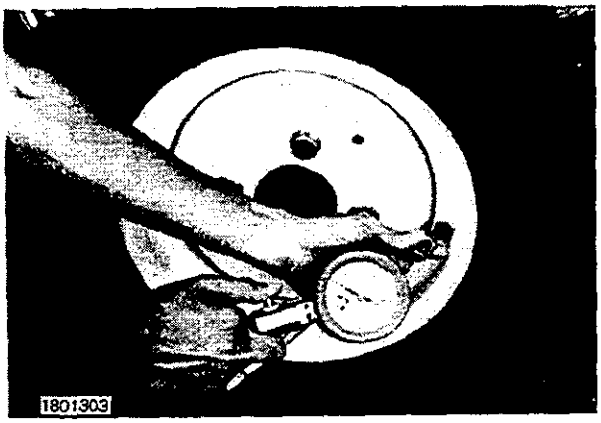
1. Check all connections in air intake system for possible leaks. Tighten any loose clamps.



2. Be sure rubber gasket between canister and end cover is in good conditon. If gasket is damaged or missing, replace gasket.
3. Be sure seal washer on the pre-cleaner cover is in good condition. If the washer is damaged or missing, install new seal washer.
4. Be sure rubber gasket on the precleaner bowl is in good condition. Replace as necessary.



TIRES, WHEELS AND WEIGHTS



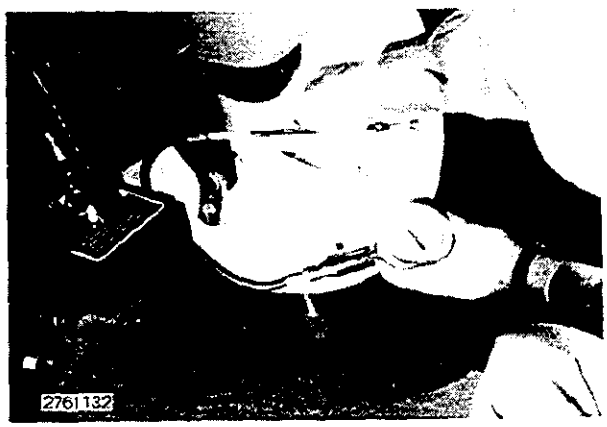
CHECKING TIRE INFLATION PRESSURE

Check the inflation pressure to be sure it is not above the maximum pressures listed in the following chart.

Front Tires

Tire Size	Ply Rating	Inflation Pressure	
		Min kPa (kg/cm²) (psi)	Max kPa (kg/cm²) (psi)
5.00–15	4	118 (1.2) (18)	255 (2.6) (37)
7–14	4	118 (1.2) (18)	176 (1.8) (26)
7–16	4	118 (1.2) (18)	176 (1.8) (26)
27 x 8.50–15 (Turf)	2	69 (0.7) (10)	69 (0.7) (10)

⚠ CAUTION: When inflating tire, do so from a distance. Use long hose with self-attaching air chuck and safe cage. Do not inflate tire beyond maximum recommended pressurer.



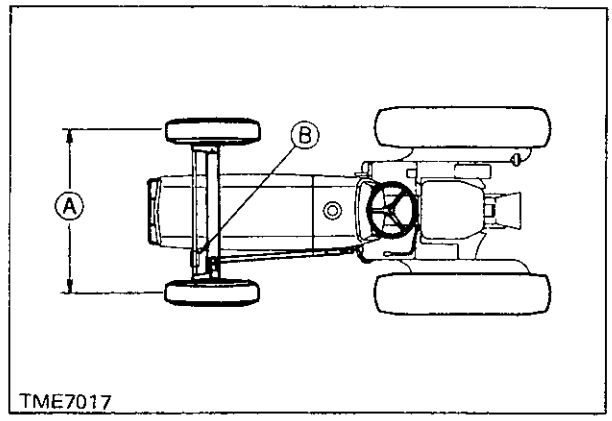
Rear Tires

Tire Size	Ply Rating	Inflation Pressure	
		Min kPa (kg/cm²) (psi)	Max kPa (kg/cm²) (psi)
11.2–24	4	78 (0.8) (11)	118 (1.2) (18)
12.4–24	4	78 (0.8) (11)	98 (1.0) (14)
11.2/10–24	4	78 (0.8) (11)	118 (1.2) (18)
355/80D20	4	78 (0.8) (11)	98 (1.0) (14)

FRONT TREAD

Front tread is the distance between left and right tires. It is measured at the center contact points to the ground of both tires.

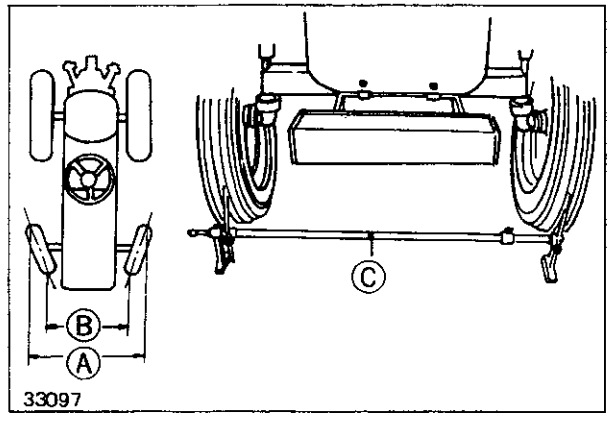
A – Front Tread
B – Turnbuckle



Checking toe-in

1. Steer front wheels straight ahead.
2. Measure distance between tires at hub level, both in front and in back.
   Proper toe-in is 4 to 8 mm (0.16 to 0.32 in.) less in front than in rear.

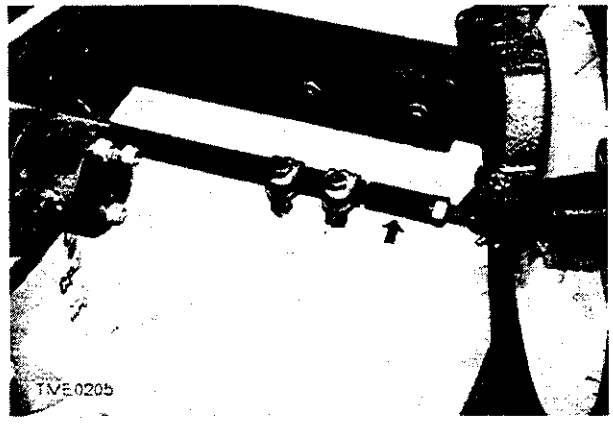
A – B = 4 to 8 mm
(0.16 to 0.32 in.)
C – Toe-in Gauge

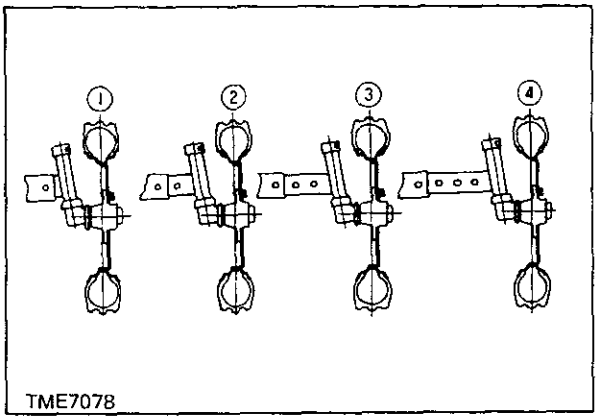


Adjusting Toe-in

1. Loosen lock nut(s) on the end of turnbuckle.

2. Rotate turnbuckle to lengthen or shorten it. Adjust toe-in to 6 mm (0.25 in.).
3. Tighten lock nuts.





TME7078

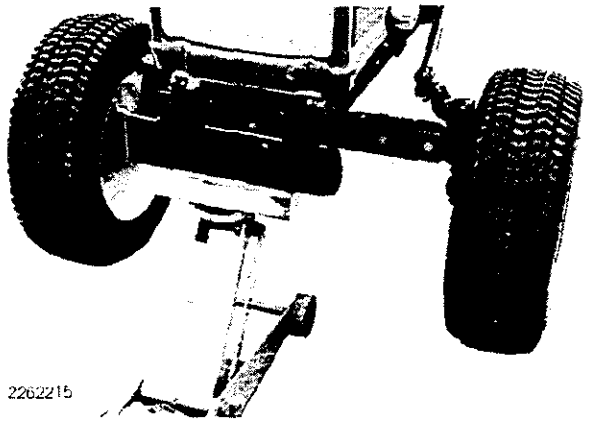
FRONT TREAD (Continued)

Spreading Adjustable Front Axle

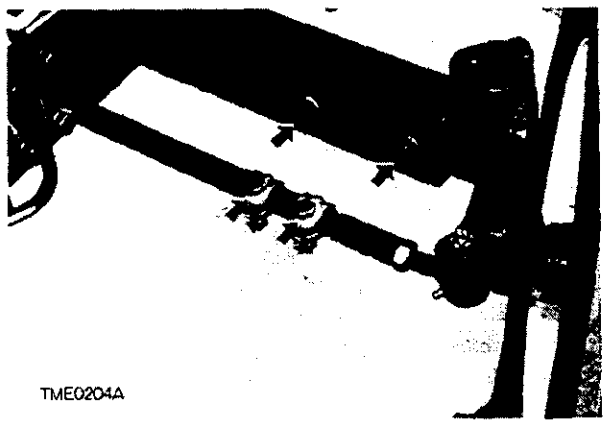
Adjustable front axle is equipped on YM276 (2-wheel drive). The front tread is adjustable in 100 mm (4 in.) steps.

The front tread of 4-wheel drive model is not adjustable.

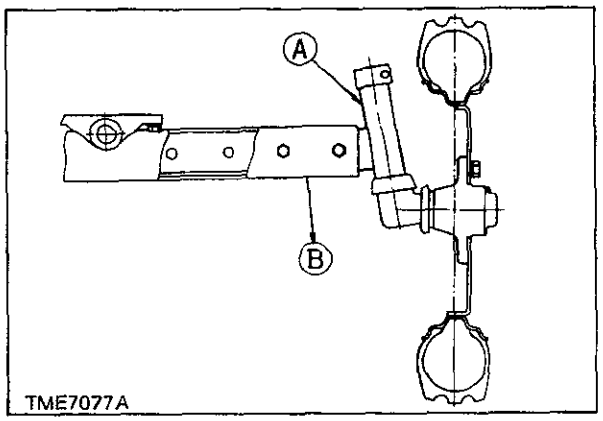
STOP Reversing front wheels to extend wheel tread is not recommended.


2262215

1. With jack under front weight support, jack up tractor just enough to take weight off tires.


TME0204A

2. Remove bolts from tie rod clamps.
3. Remove bolts from front axle.

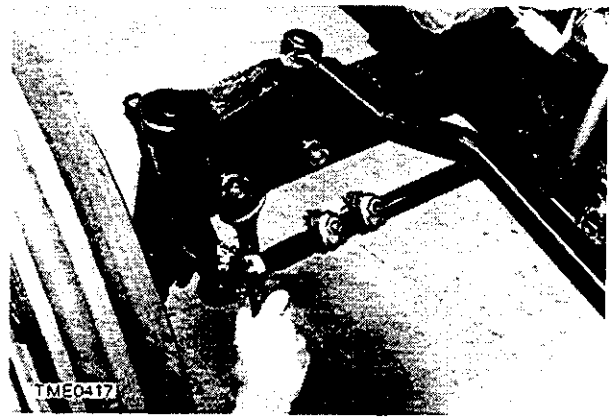


TME7077A

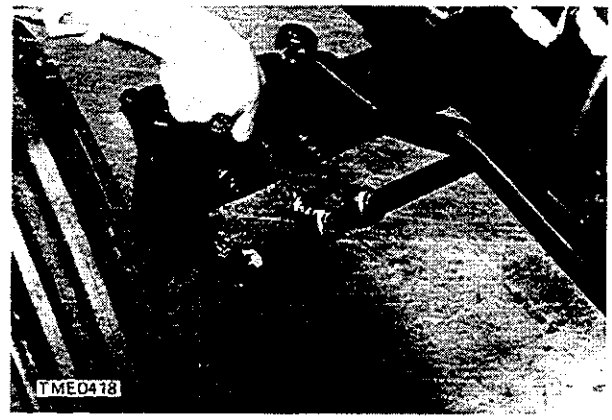
4. Slide axle knee to desired position.

A – Axle Knee
B – Axle

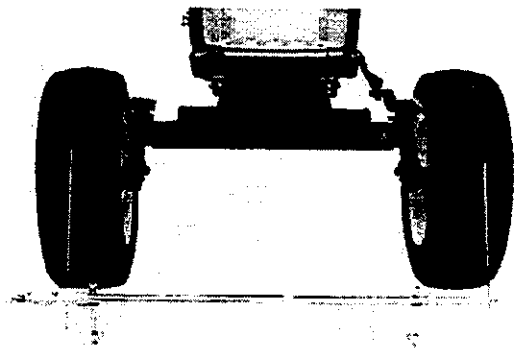
5. Install axle bolts. Tighten to 196 Nm (20 kgm) (147 ft-lbs) torque.



6. Install bolts in tie rod, making sure tie rod is changed same amount as axle.
7. Adjust other side in same manner. Both sides should normally be adjusted to same spacing.



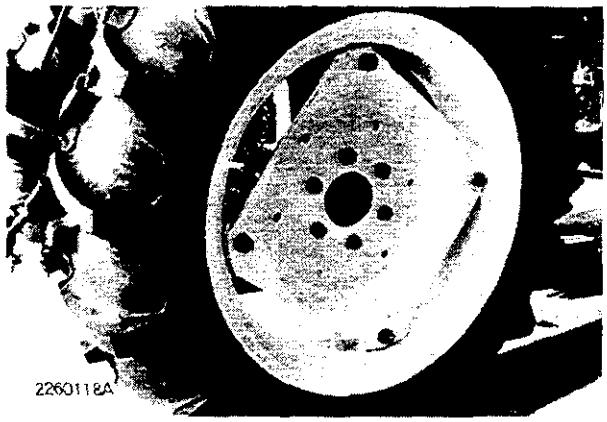
8. Check toe-in each time tread is adjusted. See instructions on page 10-05-15.



2262212

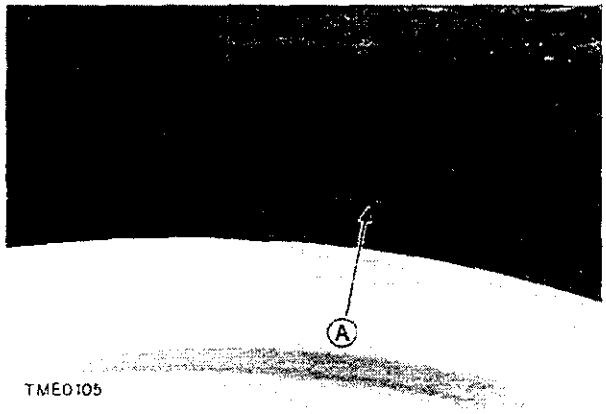
9. The following chart shows front treads at every axle positions.

TRACTOR MODEL	TREAD AT AXLE POSITIONS					mm (in.)
	1st	2nd	3rd	4th		
YM276	1015 (40.0)	1115 (43.9)	1215 (47.8)	1315 (51.8)		



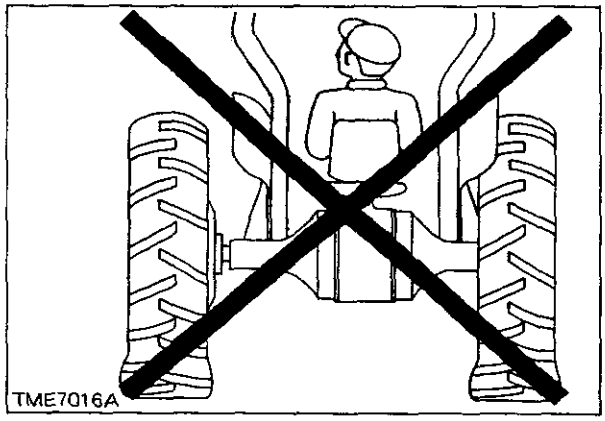
REAR TREAD

Rear wheel tread can be adjusted by repositioning or reversing the rims and disks.



When reversing the wheels, they must be changed from one side to the other so that arrow (Circuled) on side of tire points in the direction of forward rotation of tire.

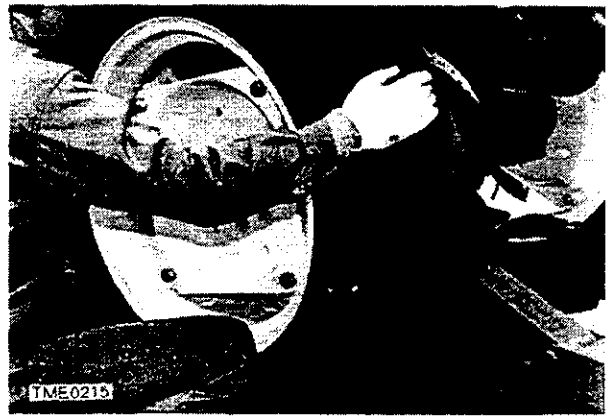
A – Rotational Direction



Adjust other side in same manner. Both sides must be adjusted to same position.

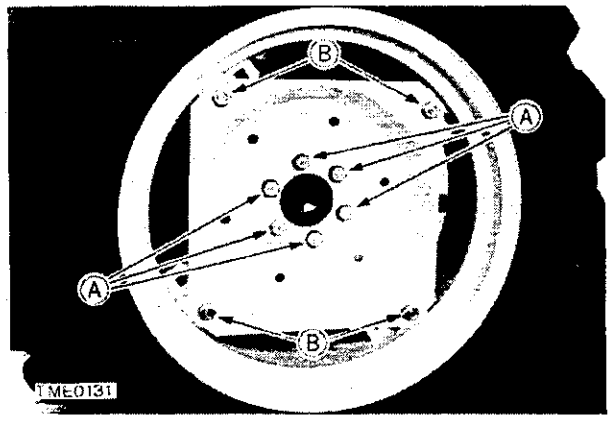
Adjusting Rear Tread

1. To adjust tread, jack up tractor enough to take weight off tires.



WARNING: Support tractor securely on stands before removing a rim or wheel.

2. Remove hub bolts (A) or wheel-to-rim retaining screws (B).

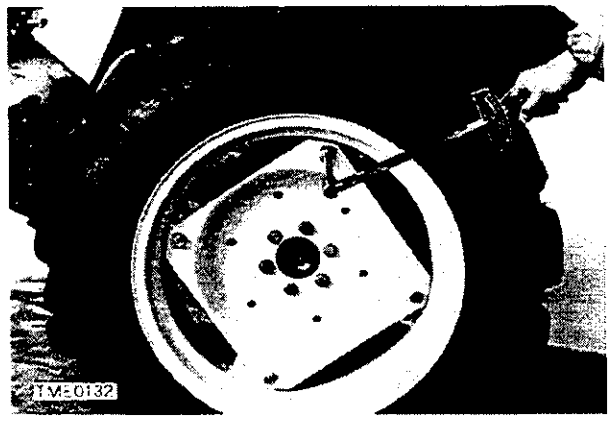


A – Hub Bolts
B – Wheel-to-Rim Retaining Screws

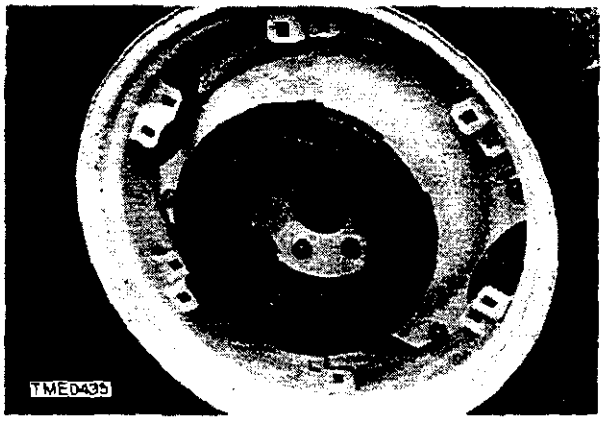
3. Reverse wheels or reposition the wheels and rims to get the desired tread.

TRACTOR MODEL	REAR TREAD AT RIM/DISK POSITIONS mm (in.)					
	1st	2nd	3rd	4th	5th	6th
YM276 YM276D	1190 (46.8)	1094 (43.0)	1288 (50.7)	1296 (51.0)	1394 (54.9)	—

4. Tighten all retaining bolts and screws as follows.

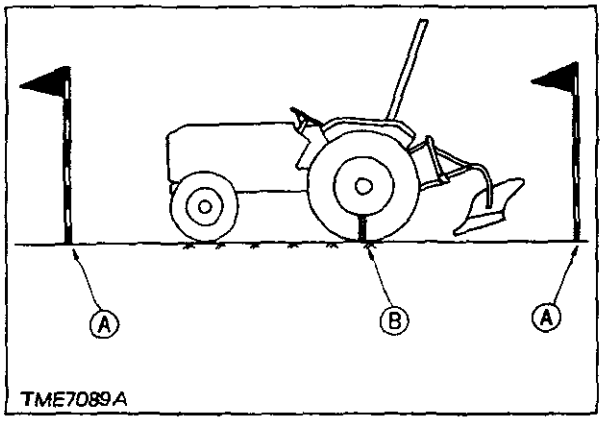


Screws	Torques
Hub Bolts	294Nm (30kgm) (221ft-lbs)
Wheel-to-Rim Retaining Screws	196Nm (20kgm) (147ft-lbs)



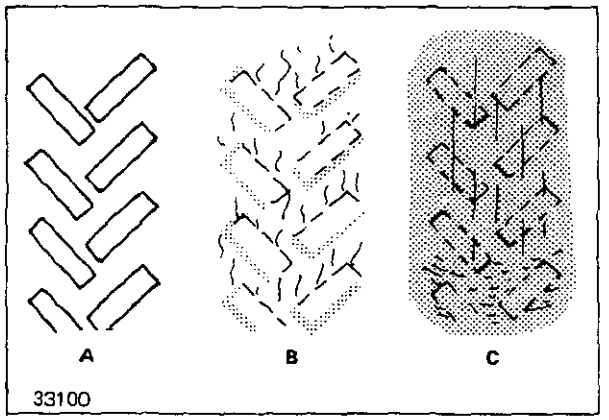
REAR BALLAST

The amount of rear ballast should permit operation with approximately 10 to 15 percent slip of rear wheels. Maximum drawbar horsepower is available when operating in this range. Check slippage as follows:



1. While tractor is working, count revolutions of rear wheel between two marks.
2. Go back with implement raised and count rear wheel revolutions between same two marks.
3. Compare the two counts. The first should be 10 to 15 percent larger.

A — Mark on ground
B — Mark on wheel



4. Check tire tracks often. With too much ballast, tread marks will be clear and distinct, showing no slippage. With too little ballast, tread marks will be wiped out by slippage.

A — Too much ballast
B — Correct ballast
C — Too little ballast

Maximum added ballast varies depending upon tire size, ply rating and tractor weight.

Total rear axle weight including tractor weight, liquid ballast, cast iron weights, and mounted equipment must not exceed the maximum indicated in the chart below.

Maximum Total Rear Axle Weight		
Tire Size	Ply Rating	Capacity per a tractor
11.2–24 (R1)	4	1210kg (2668lbs)
12.4–24 (R1)	4	1210kg (2668lbs)
11.2–24 (R3)	4	1210kg (2668lbs)
355/80D20 (Turf)	4	1210kg (2668lbs)

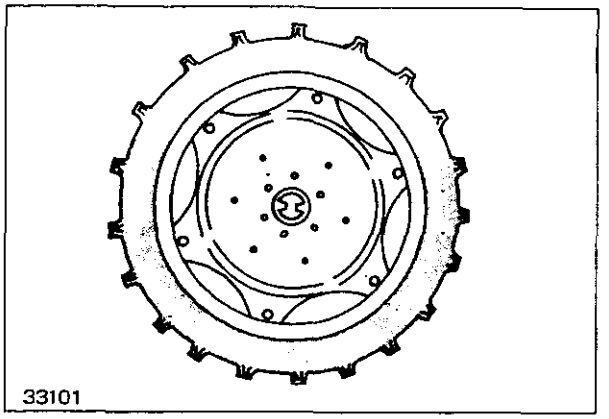
Liquid Ballast

A solution of water and calcium chloride provides safe and economical ballast. Used properly, it will not damage tires, tubes, or rims.

Use calcium chloride to prevent water from freezing. A mixture of 0.4 kg of calcium chloride per liter (3.5 lbs. per gal.) will not freeze solid above –45°C (–50°F).

Valve stem must be replaced with anti-corrosive stem by tire shop if calcium choloride is used.

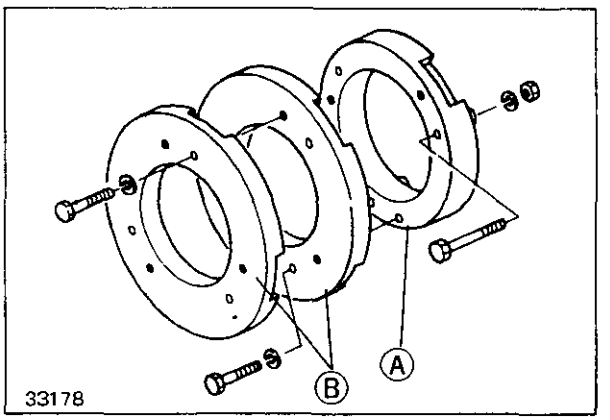
Tire Size	*Liquid Weight per tire 75% fill with 0.4 kg (3.5 lbs)* per liter (US gallon) $CaCl_2$
11.2–24	106 kg (235 lbs)
12.4–24	140 kg (308 lbs)



Cast iron weights (Rear wheel weights)

Cast iron weights are available from your YANMAR.

When installing cast iron weights, install a weight (A) (20 kg) on wheel disk, then install additional weight (B) (25 kg). Each tractor has a limit of rear ballast. See operation manual for the limitation.



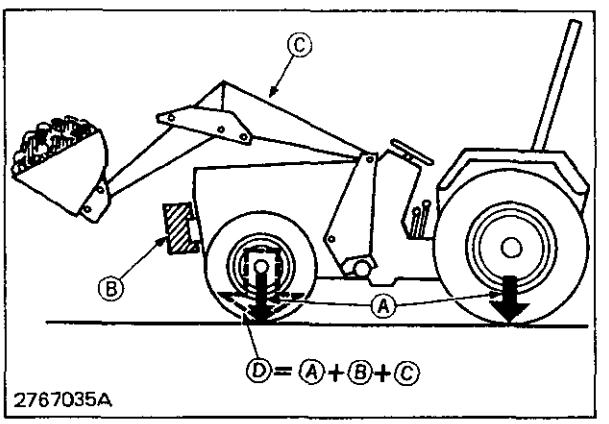
A — Base Weight — 20kg (45 lbs)
B — Additional weight — 25 kg (55 lbs)

FRONT BALLAST

Front ballast may be required for stability and steering control when weight on the front wheels is transferred to the rear wheels by implement action through the hitch.

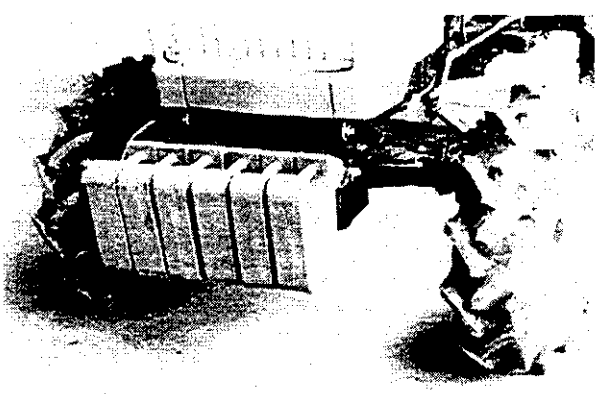
Total front axle weight, (D) including tractor weight (A), bumper weights (B) and mounted equipment (C) must not exceed the maximum indicated in the chart below.

Maximum Total Front Axle Weight		
Tire Size	Ply Rating	Capacity per a tractor
5.00–15/5.50–15	4	700 kg (1543 lbs)
7–14/7–16	4	700 kg (1543 lbs)
27 x 8.50–15	2	700 kg (1543 lbs)



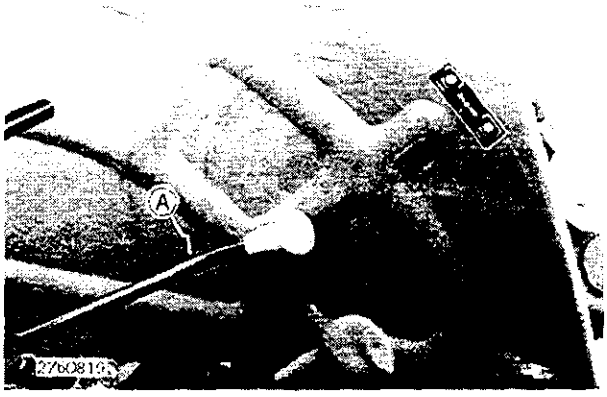
Front Bumper Weights

Up to six bumper weights can be installed. Each weight approximately 20 kg (45 lbs).



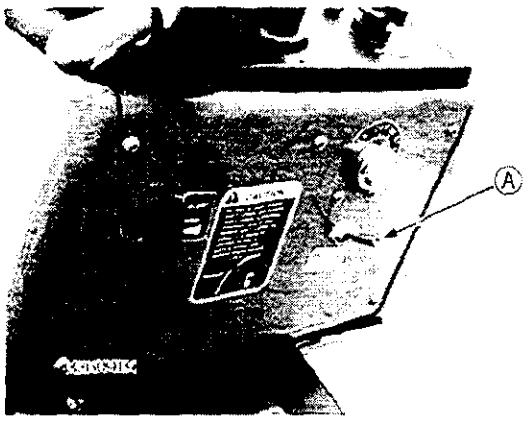
OPERATION

STARTING ENGINE



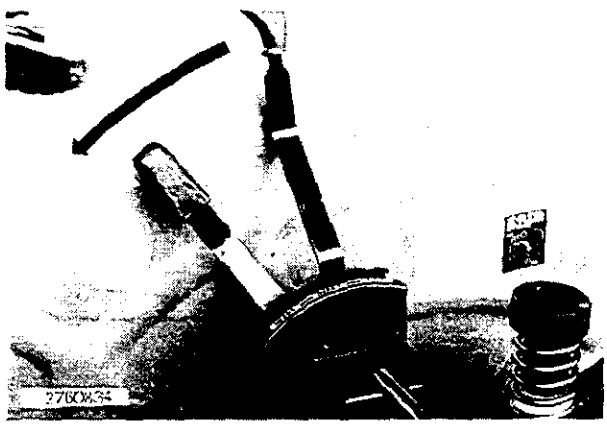
1. Open fuel shut-off valve.
2. Place power shift lever, range shift lever in neutral position.
3. Place PTO shift lever in neutral position to close start safety switch.

A – PTO shift lever



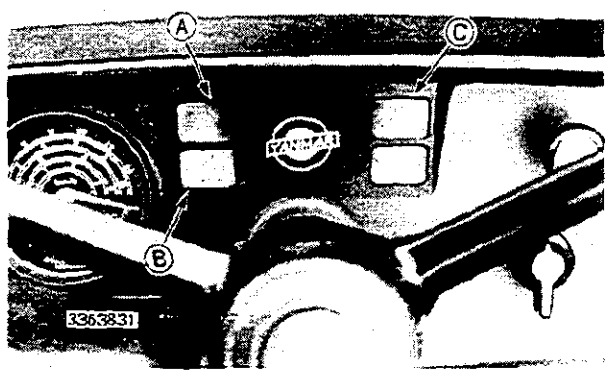
4. Turn off front P.T.O. switch if it is equipped. Move switch down to disengage front P.T.O.
   If it is switched on, starter can not be run.

A – Front PTO. switch



5. Place hydraulic control lever in lower position.
6. Push throttle lever to the maximum speed position.

As soon as engine starts, pull throttle about halfway back. Do not run a cold engine at full throttle.



7. Turn key clockwise to first position (ON). Check indicator lamps. Oil pressure indicator lamp should glow.

A – Temperature
B – Charge
C – Oil

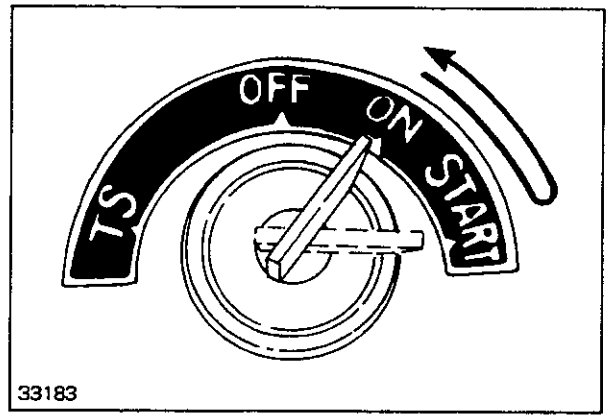
8. Depress clutch pedal.

WARNING: Start engine only from operator's seat NEVER start engine while standing on ground.

9. Turn key further clockwise against spring pressure to engage starter. When starter gives enough rotation to start engine. Release key immediately when engine starts.
   Check the coolant temperature indicator lamp glows when running starter.

Do not operate starter more than 10 seconds at a time. If engine does not start, wait at least one minute before trying again.

10. Check indicator lamps as soon as engine starts. If lamps do not go out, stop the engine and determin the cause.
11. Operate engine at approximately 1500 rpm for five minutes. Do not accelerate or apply a load until engine warms up.



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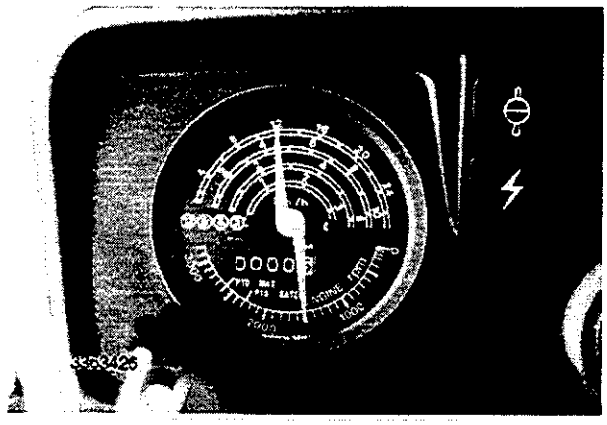


COLD WEATHER STARTING ENGINE

Do not use starting fluid (ether) in this engine.

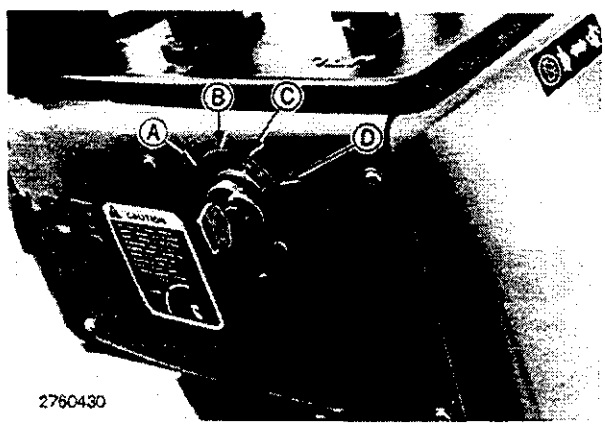
Thermostart Device

With a cold engine and at ambient temperatures below 0°C (32°F), operate the thermostart device as follows:

1. Pull throttle lever fully rearward (stop position).
2. Crank engine 5 to 10 seconds until oil pressure indicator lamp stop glowing. If the lamp does not stop glowing for first attempt, try again after waiting one minute.
3. Place throttle lever in fully forward position.
4. Turn key counterclockwise and hold it there 10 to 15 seconds. An electric thermostart plug ignites a small mount of fuel in the intake manifold.

   A – Thermostart
   B – Off
   C – On
   D – Start

5. Depress clutch pedal. Quickly turn key clockwise and start engine.



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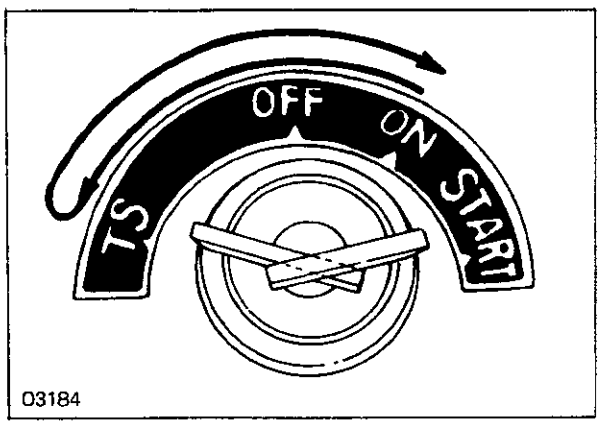

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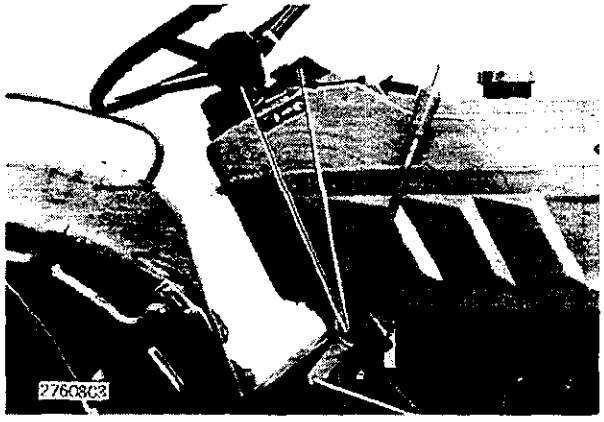
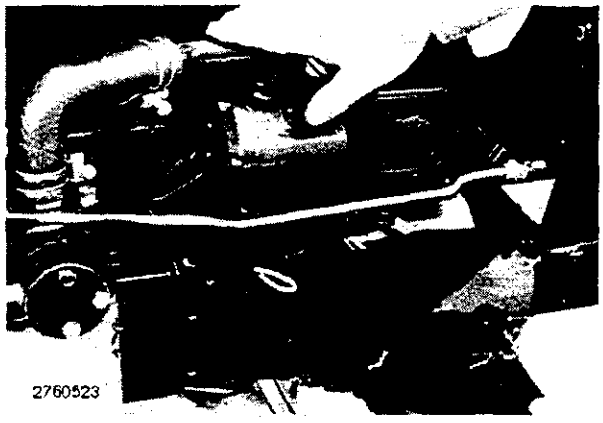


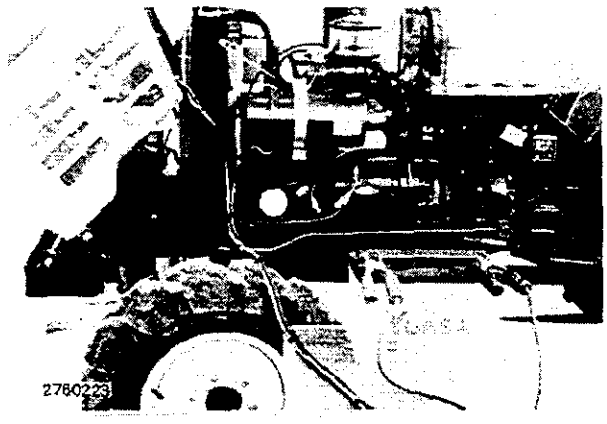
6. As soon as engine starts, turn key back to thermostart position and pull throttle lever about halfway back. Hold key in this position until engine runs smoothly and then turn to "ON" position.

   If engine does not start within 10 seconds, turn key to "OFF" position and wait at least one minute before trying again.



7. Allow hydraulic system to warm up for 5 to 10 minutes in cold weather condition.

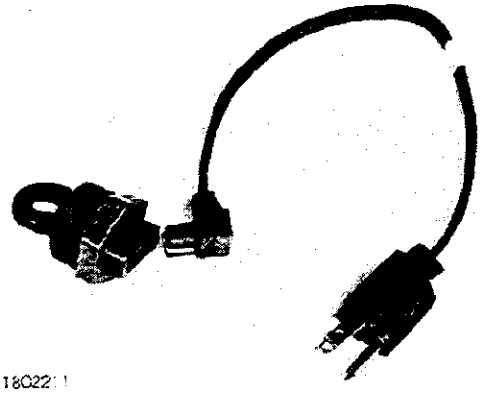
8. When inlet line to pump becomes uncomfortable to hold, the oil temperature will be 30–40°C (100–110°F).



Using Booster Battery

A 12-volt battery can be connected in parallel with the tractor battery. Use heavy duty jumper cables.

1. Attach one cable to positive terminal of booster battery and to starter terminal where positive battery cable is attached.
2. Attach one end of second cable to negative terminal of booster battery.
3. Attach other end of second cable to a good ground on tractor frame.



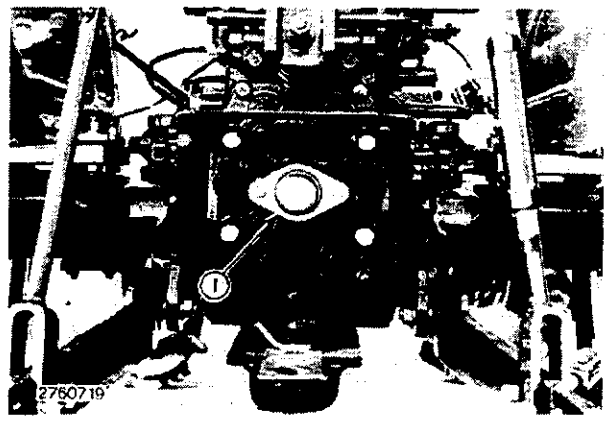
Electric Coolant Heater (Optional)

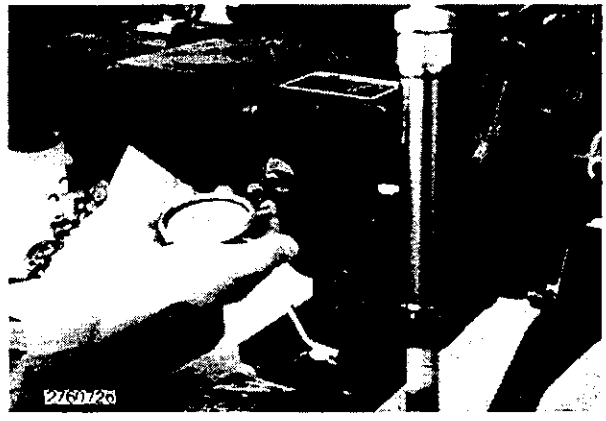
With a cold engine, and at ambient temperatures below +10°F (−12°C), use a electric coolant heater.

1. Remove a plug from the left side of cylinder block.
2. Install the coolant heater to the cylinder block.
3. Connect coolant heater to 115-volt electric outlet. In extremely cold weather, it may take five to eight hours to heat engine. Coolant heater has a 400-watt heating element.

CHECKING ENGINE SPEEDS

1. Remove PTO guard.
2. Start engine.
3. Engage PTO.
4. Pull throttle back to slow idle detent.
5. Measure PTO speed using hand tachometer.
6. Refer to chart below to get engine speed.
7. Push throttle all the way forward and measure PTO speed.
8. Refer the chart below to get engine speed.



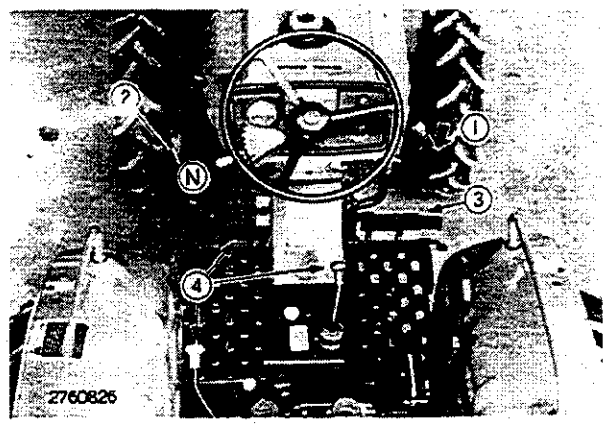


ENGINE–PTO SPEED RELATIONSHIP

	Engine rpm	PTO rpm
Fast Idle	2775±25	664±6
Slow Idle	800	119
Rated Speed	2600	622
PTO Speed	2258	540

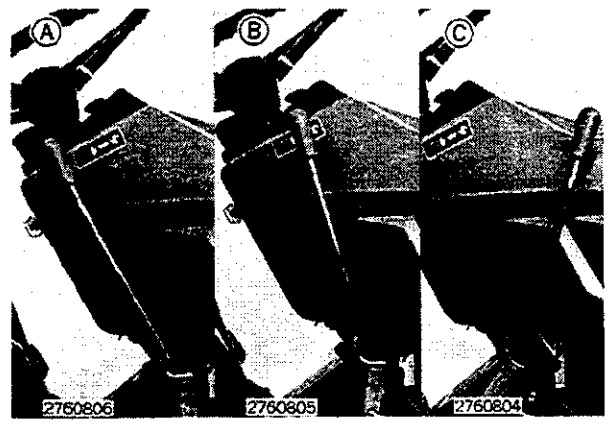
STOPPING THE ENGINE

1. Pull throttle lever back to slow idle position.
2. Move power shift lever to "N" position.
3. Depress both brake pedals.
4. After tractor is stopped, place range shift lever and PTO lever in neutral position with depressing clutch pedal.
5. If an implement is attached on three point hich, move hydraulic control lever forward "LOWER".
6. Pull parking brake lever back and firmly depress brake pedals.



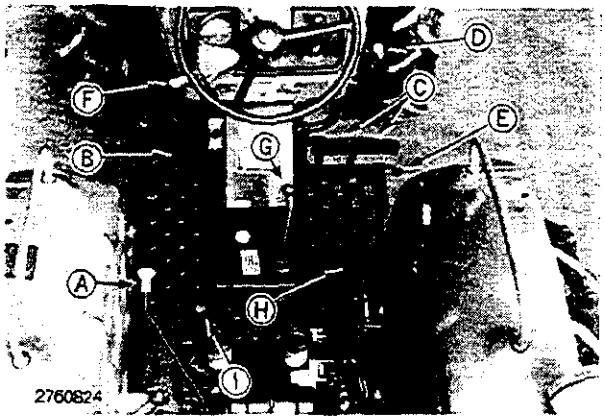
Stopping a hot engine suddenly could cause damage to certain engine parts by over heating.

7. Allow engine to idle one to two minutes to stabilize engine temperature.
8. Pull throttle lever fully rearward to stop engine.
9. Turn key switch off and remove key.



A – Stop Position
B – Slow Idle Position
C – Maximum Speed Position

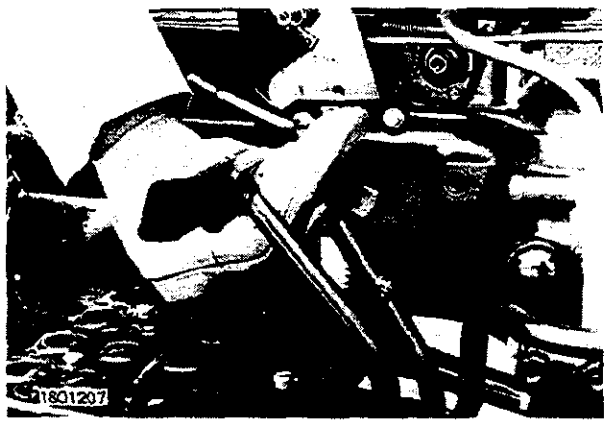
OPERATING CHECKS



DRIVING TESTS

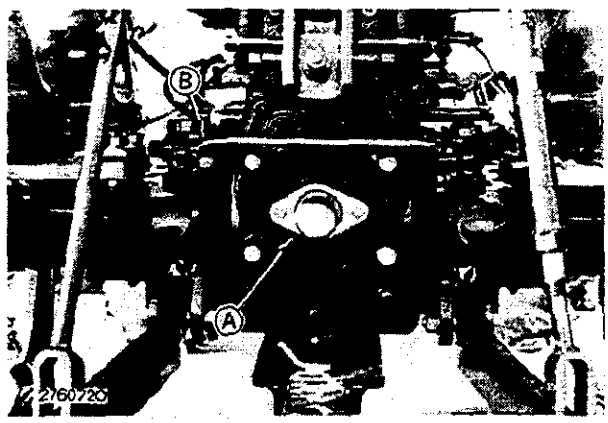
1. Shift transmission through all gears, driving tractor in each gear. If you find any problem in transmission, linkage, shift levers, clutch, or any part of power train, refer to Chapter 250 and 50 in this service manual.
2. Check for smooth operation of all controls. If you find any problem, refer to the appropriate area in this manual.
3. Check operation of front wheel drive, if equiped. While driving tractor with front wheel drive engaged, check steering force. If it hard, check inflation pressures of front and rear tires.

A – PTO Shift Lever
B – Clutch Pedal
C – Brake Pedals
D – Throttle Lever
E – Foot Throttle
F – Power Shift Lever
G – Range Shift Lever
H – Differential Lock Pedal
I – Front Wheel Drive Shift Lever



BRAKES

Be sure that brakes are properly adjusted and the both sides brake equally.



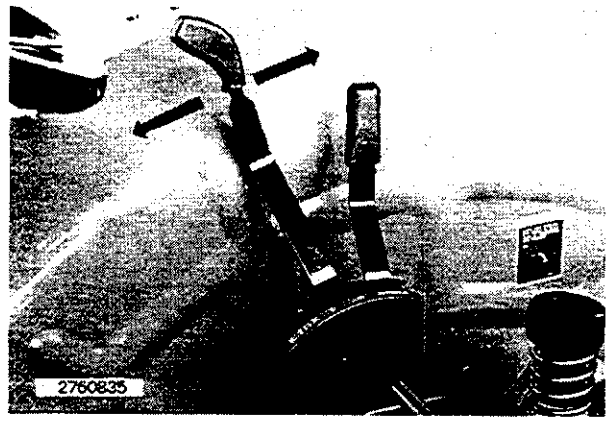
POWER TAKE-OFF

1. Check PTO guard (A) and master shield (B) for correct installation.
2. With PTO guard removed and engine running, make sure PTO shaft rotated when PTO shift lever is engaged and stops within a few minutes after PTO shift lever is disengaged.

A – PTO Guard
B – Master Shield

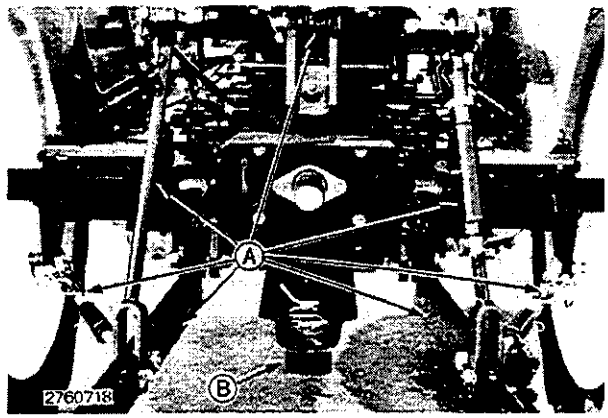
HYDRAULIC LIFT AND 3-POINT HITCH

1. Raise and lower hydraulic lift several times to make sure it functions smoothly.



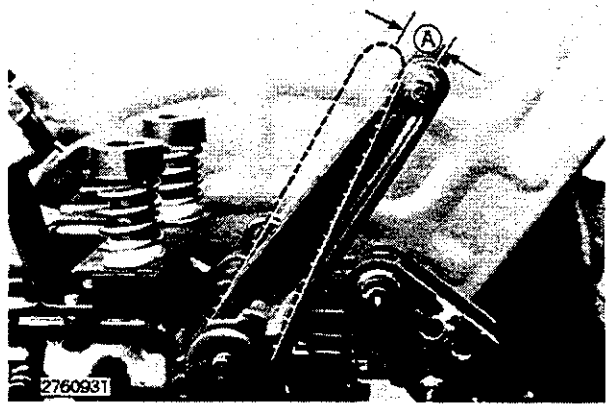
2. Inspect all components of 3-point hitch (A) and drawbar (B). Check for missing parts, damage, or anything which might lead to problem.

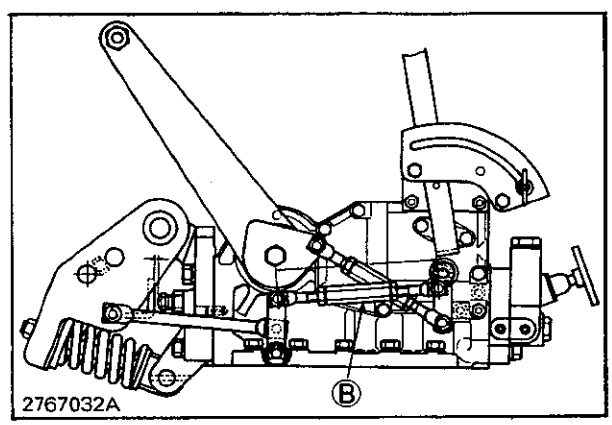
A – 3-Point Hitch
B – Drawbar



3. Check the lift arm free play at the top of the stroke of the lift arms. The play should be 7 to 10 mm (0.3 to 0.4 in.). Adjust lower feedback rod (B) to obtain the correct play.

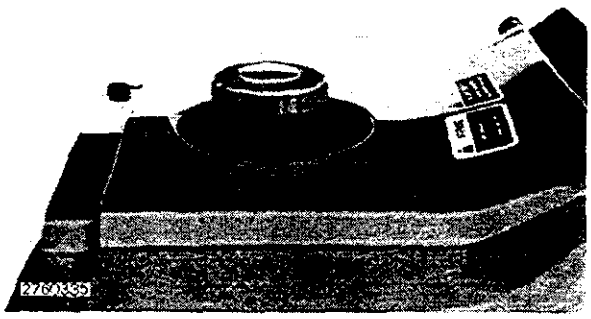
A – Lift Arm Free Play
B – Lower Feedback Rod





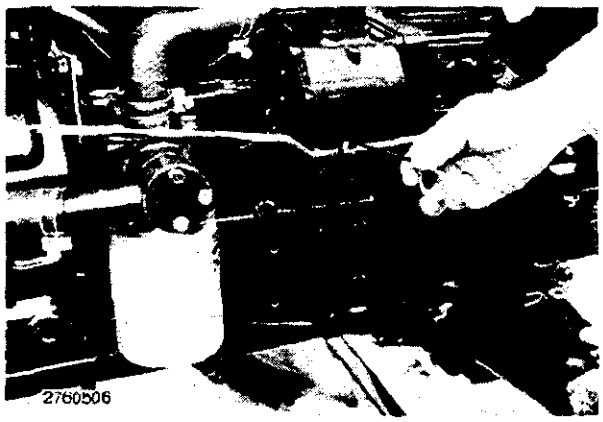
STORAGE A NEW TRACTOR

To prevent deterioration of tractor during storage, do the following to properly prepare it.

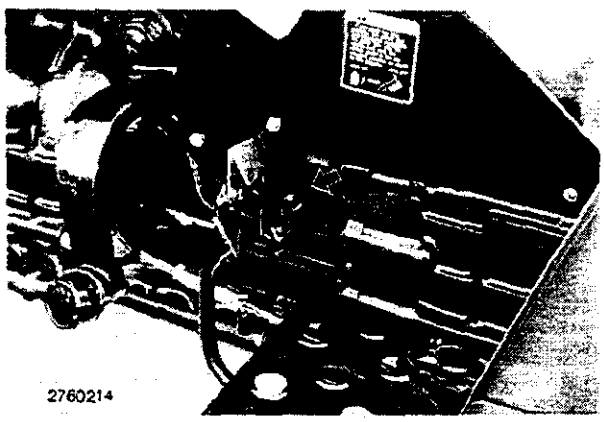


SHORT-TERM (UNDER 30 DAYS)

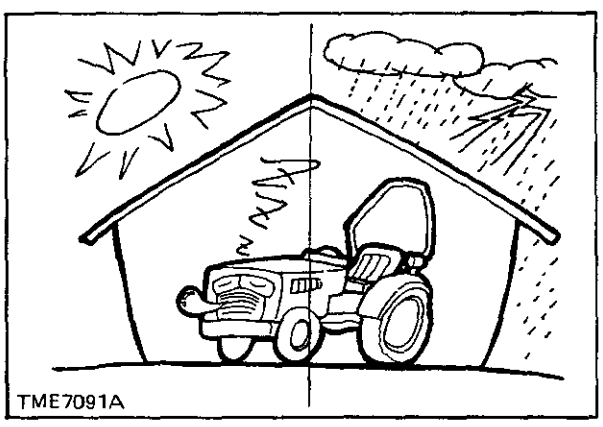
1. Fill fuel tank to prevent condensation of moisture in tank.



2. Check engine oil level, transmission-hydraulic oil level, and coolant level. Add oil or coolant if necessary. During cold weather, be sure coolant contains sufficient anti-freeze.
3. Check electrolyte level in battery. If electrolyte does not cover plates, add distilled water. Make sure battery is fully charged.



4. Look clutch pedal in a depressed position to prevent it from sticking.

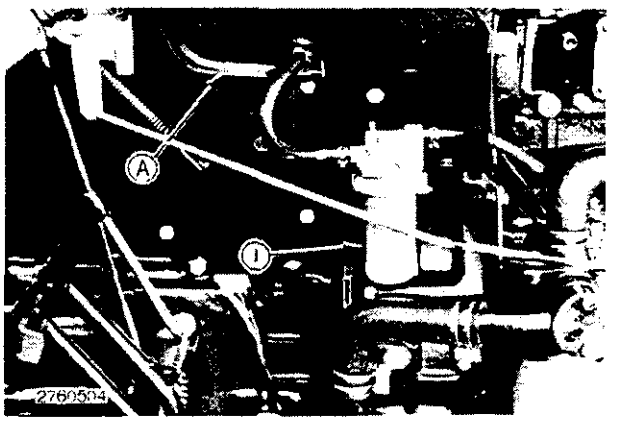


5. Store tractor in a dry, protected place. If necessary to store tractor outside, cover it with a protective material. Protect tires from sunlight, heat and petroleum products.
6. Squirt penetrating lubricant on the exposed ends of the clutch release shaft at the housing.

LONG TERM (OVER 30 DAYS)

1. Drain fuel tank and add then 4 ℓ (1 US gal.) of fuel. Add 0.4 ℓ (0.1 US gal.) of corrosion inhabitor.

A – Fuel tank

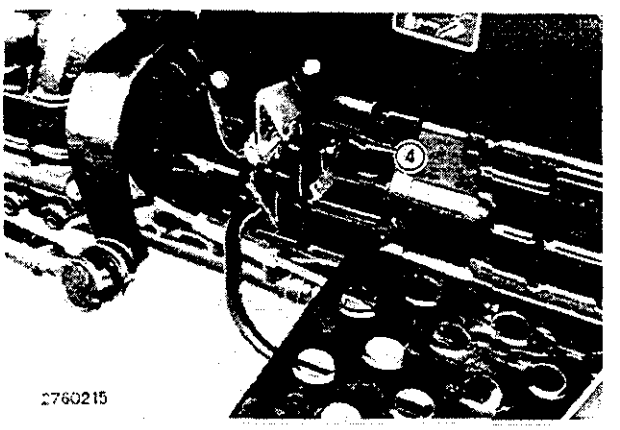


2. Remove and clean battery. Store it in a cool, dry place, and keep it charged every one month.

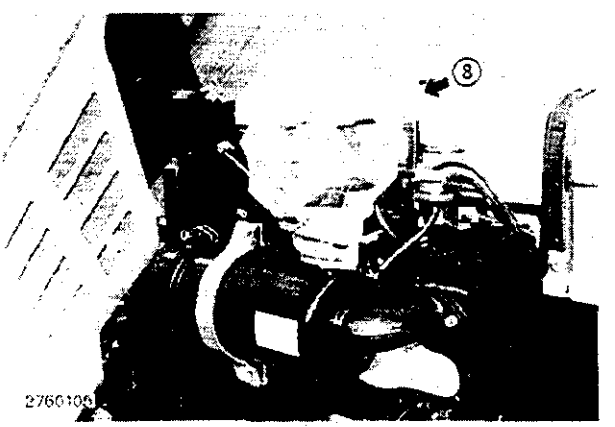
⚠ CAUTION: Store battery out of reach of children.

3. Loosen alternator belt after it has cooled.

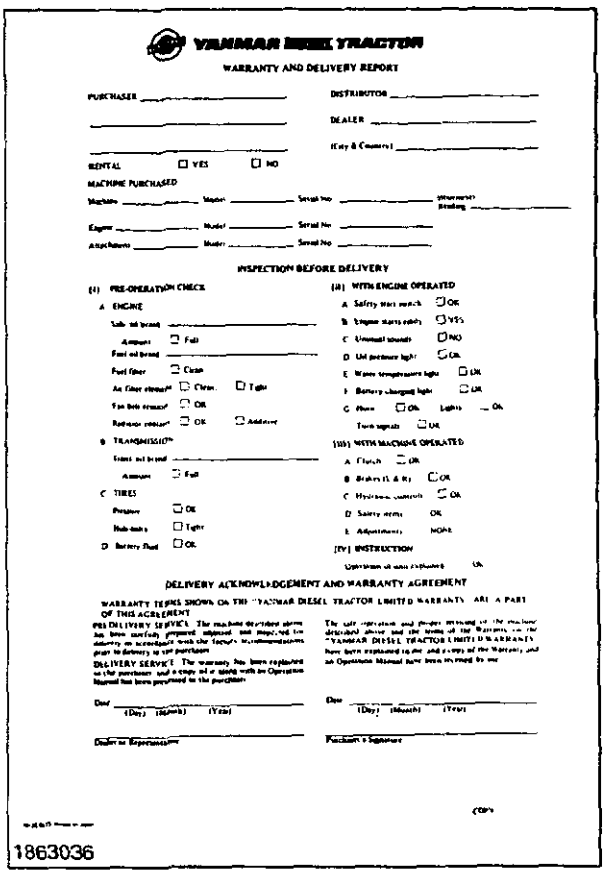
4. Block clutch pedal down in the disengaged position.
5. Clean the tractor. Touch up any painted surfaces which are scratched or chipped.
6. Coat exposed metal surfaces with grease or corrosion preventative.
7. Store tractor in a dry protective place. If necessary to store tractor outside, cover it with a protective material. Protect tires from heat, sunlight and petroleum products.



8. Seal end of air intake pipe, crankcase breather pipe, hydraulic system breather pipe, muffler, and engine oil filler with plastic bags and tape.
9. Start engine once a month to supply engine oil to bearings.
10. When removing tractor from storage, remove protective cover and unseal all openings. Check engine oil level, transmission-hydraulic oil level, coolant level and inflation pressure. Install battery. Adjust belt tension and fill fuel tank.



WARRANTY AND DELIVERY REPORT



YANMAR DIESEL TRACTOR

WARRANTY AND DELIVERY REPORT

PURCHASER _____ DISTRIBUTOR _____

_____ DEALER _____

_____ (City & Country) _____

RENTAL ☐ YES ☐ NO

MACHINE PURCHASED

Machine _____ Model _____ Serial No. _____ Engine No. _____

Engine _____ Model _____ Serial No. _____

Attachment _____ Model _____ Serial No. _____

INSPECTION BEFORE DELIVERY

(I) PRE-OPERATION CHECK

A ENGINE

Lub. oil level ☐ OK

Amount ☐ Full

Fuel oil level

Fuel filter ☐ Clean

Air filter element ☐ Clean ☐ Tight

Fan belt tension ☐ OK

Radiator coolant ☐ OK ☐ Additional

B TRANSMISSION

Trans. oil level

Amount ☐ Full

C TIRES

Pressure ☐ OK

Bolts & nuts ☐ Tight

D Battery fluid ☐ OK

(II) WITH ENGINE OPERATED

A Safety start switch ☐ OK

B Engine starts easily ☐ YES

C Unusual sounds ☐ NO

D Oil pressure light ☐ OK

E Water temperature light ☐ OK

F Battery charging light ☐ OK

G Horn ☐ OK Lights ☐ OK

Turn signals ☐ OK

(III) WITH MACHINE OPERATED

A Clutch ☐ OK

B Brakes (L & R) ☐ OK

C Hydraulic controls ☐ OK

D Safety items OK

E Adjustments NONE

(IV) INSTRUCTION

Operation of each implement OK

DELIVERY ACKNOWLEDGEMENT AND WARRANTY AGREEMENT

WARRANTY TERMS SHOWN ON THE "YANMAR DIESEL TRACTOR LIMITED WARRANTY" ARE A PART OF THIS AGREEMENT

PRE DELIVERY SERVICE: The machine described above has been carefully prepared, adjusted and inspected for delivery in accordance with the factory recommendations prior to delivery to the purchaser.

DELIVERY SERVICE: The warranty has been explained to the purchaser and a copy of it along with an Operation Manual has been presented to the purchaser.

Date _____ (Day) (Month) (Year)

Dealer or Representative _____

The safe operation and proper servicing of the machine described above and the terms of the Warranty on the "YANMAR DIESEL TRACTOR LIMITED WARRANTY" have been explained to me and a copy of the Warranty and an Operation Manual have been received by me.

Date _____ (Day) (Month) (Year)

Purchaser's Signature _____

(COPY)

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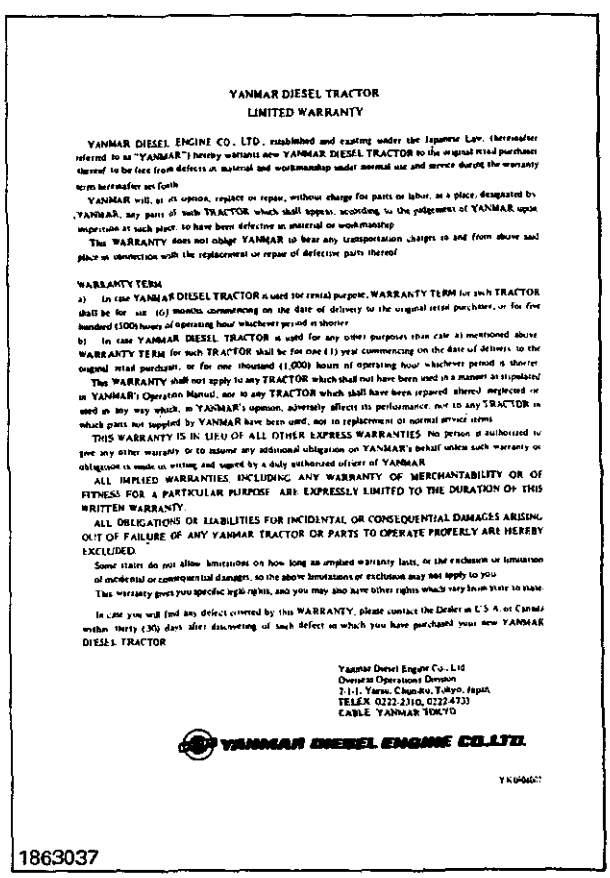

YANMAR DIESEL TRACTOR
LIMITED WARRANTY

YANMAR DIESEL ENGINE CO., LTD., established and existing under the Japanese Law, (hereinafter referred to as "YANMAR") hereby warrants new YANMAR DIESEL TRACTOR to the original retail purchaser thereof to be free from defects in material and workmanship under normal use and service during the warranty term hereinafter set forth.

YANMAR will, at its option, replace or repair, without charge for parts or labor, at a place designated by YANMAR, any parts of such TRACTOR which shall appear, according to the judgement of YANMAR upon inspection at such place, to have been defective in material or workmanship.

This WARRANTY does not oblige YANMAR to bear any transportation charges to and from above said place in connection with the replacement or repair of defective parts thereof.

WARRANTY TERM

a) In case YANMAR DIESEL TRACTOR is used for rental purpose, WARRANTY TERM for such TRACTOR shall be for six (6) months commencing on the date of delivery to the original retail purchaser, or for five hundred (500) hours of operating hour whichever period is shorter.

b) In case YANMAR DIESEL TRACTOR is used for any other purposes than one as mentioned above, WARRANTY TERM for such TRACTOR shall be for one (1) year commencing on the date of delivery to the original retail purchaser, or for one thousand (1,000) hours of operating hour whichever period is shorter.

This WARRANTY shall not apply to any TRACTOR which shall not have been used in a manner as stipulated in YANMAR's Operation Manual, nor to any TRACTOR which shall have been repaired altered neglected or used in any way which, in YANMAR's opinion, adversely affects its performance, nor to any TRACTOR in which parts not supplied by YANMAR have been used, nor to replacement or normal service items.

THIS WARRANTY IS IN LIEU OF ALL OTHER EXPRESS WARRANTIES. No person is authorized to give any other warranty or to assume any additional obligation on YANMAR's behalf unless such warranty or obligation is made in writing and signed by a duly authorized officer of YANMAR.

ALL IMPLIED WARRANTIES, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE ARE EXPRESSLY LIMITED TO THE DURATION OF THIS WRITTEN WARRANTY.

ALL OBLIGATIONS OR LIABILITIES FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF FAILURE OF ANY YANMAR TRACTOR OR PARTS TO OPERATE PROPERLY ARE HEREBY EXCLUDED.

Some states do not allow limitations on how long an implied warranty lasts, or the exclusion or limitation of incidental or consequential damages, so the above limitations or exclusion may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

In case you will find any defect covered by this WARRANTY, please contact the Dealer in U.S.A. or Canada within thirty (30) days after discovering of such defect on which you have purchased your new YANMAR DIESEL TRACTOR.

Yanmar Diesel Engine Co., Ltd.
Overseas Operations Division
2-1-1, Yaesu, Chuo-ku, Tokyo, Japan
TELEX 0222-2310, 0222-4733
CABLE YANMAR TOKYO

YANMAR DIESEL ENGINE CO.,LTD.

YK0404E7

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The following procedure is recommended before the serviceman and owner complete the delivery acknowledgements portion of the "WARRANTY AND DELIVERY REPORT".

Using the tractor operation manual as a guide, be sure the owner understands these points thoroughly.

1. The importance of safety
2. Controls and instruments
3. How to start and stop engine
4. The importance of the break-in period
5. All functions of the hydraulic system
6. Using the power take-off
7. How to use ballast
8. The importance of the lubrication and periodic service.

Give particular emphasis to the importance of Power shift lever safety-lock, Clutch pedal free travel check and Cold start instruction.

After explaining and demonstrating the above features, have the owner sign the warranty agreement portion of the "WARRANTY AND DELIVERY REPORT" and give him the operation manual.

INTRODUCTION

Periodic inspection and servicing are necessary to keep the tractor in top condition at all times.

Proper maintenance also assures economical, efficient, and safe operation of the tractor.

Use the operation manual for the machine to determine specific maintenance intervals, location of service points, and instructions for maintenance and service adjustment.

Recommended service intervals are for average conditions. Service MORE OFTEN if tractor is operated under severe conditions.

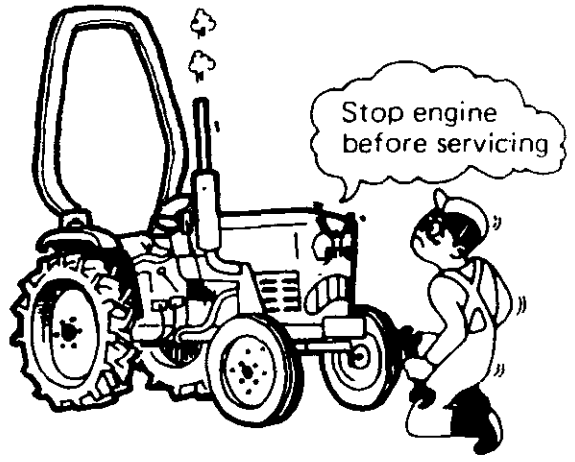
When servicing each item which is required at the time, note the date in each column of list.

Effective lubrication is the most important step toward low upkeep cost, long life, and satisfactory service. Without oil and grease you can ruin important working parts of your tractor in a very short time.

The intervals at which the various working parts should be checked, lubricated, serviced, or adjusted are based on hours of operation as shown on the hourmeter.

⚠ WARNING

Do not service tractor while engine is running.



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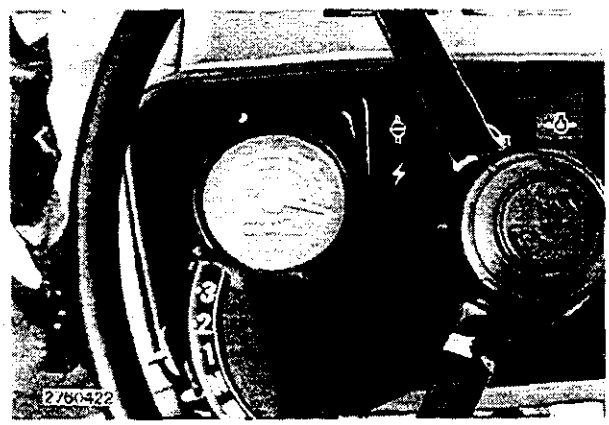
HOURMETER

Use the hourmeter on the instrument panel to determine when periodic services are required. The meter operates whenever the engine is running and shows engine rpm, and accumulated hours of operation. Always check to make sure hourmeter is operating correctly.



PERIODIC SERVICE TIMETABLE

The following intervals are based on operation under normal conditions. When operating under unusual conditions, such as excessive heat, cold, or dust, the tractor should be checked and serviced at more frequent intervals.

AS REQUIRED

Item No.	Component	Description of service	Capacity and procedure	Description of lubricant
AR-1	Brakes	Adjust pedal free travel.		
AR-2	Clutch	Adjust pedal free travel.		

DAILY OR EVERY 10 HOURS

10-1	Diesel fuel	Check fuel level to supply for one-day operation.		
10-2	Engine oil	Check oil level with dipstick fully inserted.		
10-3	Transmission-Hydraulic oil	Check oil level.		
10-4	Coolant	Check coolant level at sub-tank.		Use clean soft water
10-5	Bolts and nuts	Check tightness of front axle bracket bolts and wheel bolts.		
10-6	Tires	Check air pressure, inspect for damage.		
10-7	All grease fittings	Lubricate grease fittings.	Several strokes of grease gun.	Multipurpose type grease.
10-8	Reflectors, horn and headlights	Make sure they are in good working condition.		
10-9	Pre-cleaner	Clean pre-cleaner.		
10-10	Radiator	Clean front grille and radiator screen.		
10-11	Filter screen in the fuel tank (Fuel strainer)	Clean screen before filling the tank.		
10-12	Indicator lamps	Check indicator lamps are good conditions.		
10-13	Brakes	Check pedal free travel. Adjust it if necessary.	30 mm (1 -½ in.)	
10-14	Clutch	Check pedal free travel. Adjust it if necessary.	25 mm (1 in.)	

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Kinomoto, Printed in Japan

EVERY 50 HOURS

Item No.	Component	Description of service	Capacity and procedure	Description of lubricant
50-1	Battery	Check level of electrolyte in each cell. Check for terminal corrosion. Clean exterior of battery.		Distilled water
50-2	Front axle gear oil	Check oil level.		

EVERY 100 HOURS

100-1	Air cleaner	Clean element.	Install new element after five cleanings or annually, whichever occurs first.	
100-2	Fuel filter	Clean element.		
100-3	Engine oil	Change oil		See page 10-05-7 for recommended engine oil.
100-4	Steering system	Check tightness of steering system.		
100-5	Fan belt	Check fan belt tension. Replace belt if worn or damaged.		
100-6	Coolant temperature indicator lamp	Check the bulb by removing from the lamp holder.		

EVERY 200 HOURS

200-1	Engine oil filter	Replace filter element.	Replace with a YANMAR element.	
200-2	Fuel filter	Replace filter element.	Replace with a YANMAR element.	

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Kinomoto, Printed in Japan

EVERY 300 HOURS

Item No.	Component	Description of service	Capacity and procedure	Description of lubricant
300-1	Battery	Check electrolyte specific gravity. Charge battery.		
300-2	Fan blade and Radiator	Clean fan blade and radiator core.		
300-3	Transmission and Hydraulic oil	Replace oil.		
300-4	Hydraulic oil filter (cartridge)	Replace filter element.		
300-5	Transmission oil filter (Suction screen)	Clean suction screen		
300-6	Front axle gear oil (4WD ONLY)	Replace gear oil.		SAE 90 gear oil

EVERY 600 HOURS

600-1	Air intake system	Check air intake system for leaks. Correct as necessary.		
600-2	Front wheel hubs (2WD ONLY)	Renew front wheel hub grease.		
600-3	Radiator	Flush radiator.		
600-4	Engine valve clearance	Adjust valve clearance.		
600-5	Engine valve clearance	Adjust valve clearance.		
600-6	Injection nozzle	Check infection nozzle.		
600-7	Steering wheel	Check steering wheel free travel.		The free travel should within 40 mm (1.6 in.)
600-8	Transmission oil filter (suction screen)	Clean suction screen.		
600-9	Air cleaner	Replace element.		

ANNUAL

Item No.	Component	Description of service	Capacity and procedure	Description of lubricant
A-1	Air cleaner	Replace element annualy (or after five cleanings, whichever occurs first).		
A-2	Transmission and Hydraulic oil	Replace oil and filter element annually.		
A-3	Radiator	Flush radiator annually.		
A-4	Engine crankcase	Flush crankcase interior.		
A-5	Hydraulic rubber hoses (if equipped)	Check for cracks.	Replace as necessary.	

DAILY CHECK LIST

	No.	Item	Description	Reference
Inspections before starting engine	1	Diesel Fuel	1. Check fuel level 2. Check leakage 3. Make sure one-day supply of fuel is available.	
	2	Lubricating oil	1. Confirm each component using lubricating oil is filled to the level indicated on the dipsticks. (Engine & Transmission) 2. Check engine oil leakage.	
	3	Coolant	Confirm radiator is filled by the specified amount of coolant.	Use clean soft water
	4	Bolts and nuts	1. Check tightness of bolts and nuts for mounting between engine and front axle support, and clutch housing. 2. Check tightness of bolts and nuts for front and rear wheels.	
	5	Tires	1. Check tire inflation. 2. Check excessive wear on the lugs of wheels.	
	6	Greasing	Lubricate 3 point hitch and other moving components.	
	7	Reflectors, horn	Check conditions.	
	8	Pre-cleaner	Clean pre-cleaner	
	9	Fan belt and fan	Check fan belt tension and clean fan blade.	
	10	Radiator	Clean front lower grille, radiator screen and core.	
	11	Battery	1. Keep clean and dry the top surface of battery. 2. Check electrolyte level.	Use only distilled water to refill to the upper level.
	12	Brakes & Clutch	Check pedal free travels of brake and clutch.	

	No.	Item	Description	Reference
Check when engine is started	13	Oil pressure lamp	Confirm that lamp glows when main switch is turned one step (ON) position.	
	14	Hourmeter	Confirm that needle moves along with increase in engine speed.	
	15	Engine	1. Confirm that color of exhaust gas is not black. 2. Check any usual noises.	
	16	Oil pressure and coolant temperature	Confirm that all lamps stop glowing when engine runs at more than 1000 rpm.	
Check when operating tractor	17	Clutch	1. Check clutch pedal free travel. 2. Confirm that clutch is to be disengaged completely.	
	18	Steering wheel	1. Check steering wheel for excessive play. 2. Confirm that steering wheel is not too heavy to turn, and does not vibrate.	
	19	Brakes	1. Confirm that both left and right brake pedals are adjusted evenly. 2. Check brake pedal free travel. 3. Check effectiveness of parking brake.	
Re-check	20	Brakes & Clutch	Check overheat of brakes and clutch.	
Inspection after operation	21	Greasing	1. Grease 3-point hitch and other moving components. 2. Grease all components that are susceptible to corrosion.	
	22	Fuel	Refill fuel fully.	

PERIODIC CHECK LIST

(● : Checking ★ : Changing)

Items	Hour meter 50	100	150	200	250	300	350	400	450	500
Front wheel hub, renewing grease						●				
DATE										
Fuel injection nozzle, checking						●				
DATE										
Valve clearance, checking						●				
DATE										
Air cleaner element, cleaning or changing		●		●		●		●		●
DATE										
Air intake system, checking if leaking										
DATE										
Battery electrolyte level, checking	●	●	●	●	●	●	●	●	●	●
DATE										
Battery electrolyte, checking specific gravity & charging						●				
DATE										
Engine oil, changing	★	★		★		★		★		★
DATE										
Engine oil, filter, changing	★			★				★		
DATE										
Engine crank case interior, washing										
DATE										
Fan belt, checking	●	●		●		●		●		●
DATE										
Fan blade/radiator core, cleaning	●	●	●	●	●	●	●	●	●	●
DATE										
Front axle, gear oil, checking level and changing	●	●	●	●	●	★	●	●	●	●
DATE										
Fuel filter element, washing and changing		●		★		●		★		●
DATE										
Transmission oil, checking level and changing		●	●	●	●	★	●	●	●	●
DATE										
Transmission oil filter (cartridge type) changing	★					★				
DATE										
Transmission oil filter (suction screen) cleaning	●					●				
DATE										
Radiator, flushing										
DATE										

STOP This chart excludes daily or every to hours check and service.
Use "DAILY CHECK LIST" on preceding page every day.

550	600	650	700	750	800	850	900	950	1000	1050	1100	1150	1200	Remarks
	●												●	
	●												●	
	●												●	
	★		●		●		●		●		●		★	
	●												●	
●	●	●	●	●	●	●	●	●	●	●	●	●	●	
	●						●						●	
	★		★		★		★		★		★		★	
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●	★	●	●	●	●	●	★	●	●	●	●	●	★	
	★		●		★		●		★		●		★	
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	★						★						★	
	●						●						●	
	●												●	

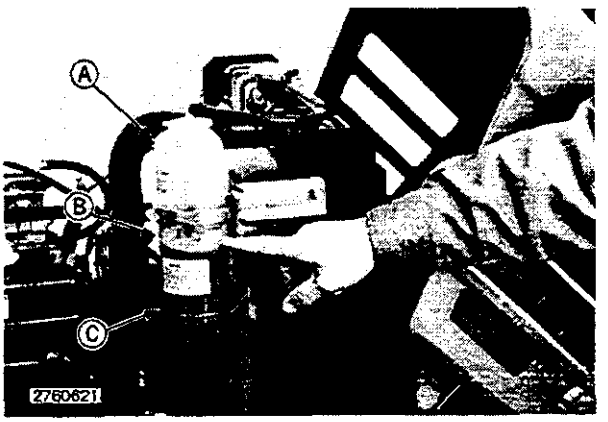
AFTER-SALE INSPECTION

The purpose of this inspection is to make sure that the customer is receiveing satisfactory performance from his tractor. At the same time, the inspection should reveal whether the tractor is being operated, lubricated, and serviced properly.
If the recommended after-sale service inspection is followed, the dealer can eliminate a needless volume of service work by preventing miner irregularities from developing into serious problems later on. This will promote strong dealer-customer relations and present the dealer an opportunity to answer questions that may have arisen during the first few days of operation.
The following inspection program is recommended within the first 100 hours of tractor operation.

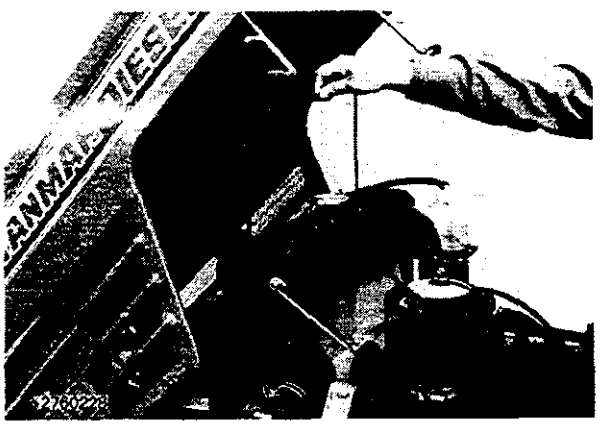
COOLING SYSTEM

1. Check radiator sub-tank (Overflow Tank). Coolant should be between the marks on the tank. If not, fill to the full mark and determine where the coolant was lost.

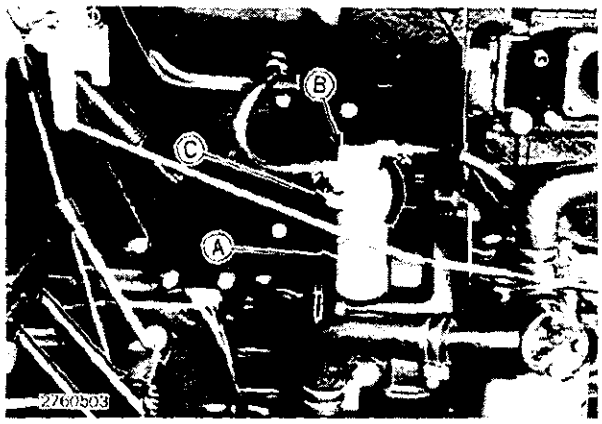
A – Sub-tank
B – Full Mark
C – Lower Mark



2. Remove any trash which has collected on the radiator screen, and front and side grille.



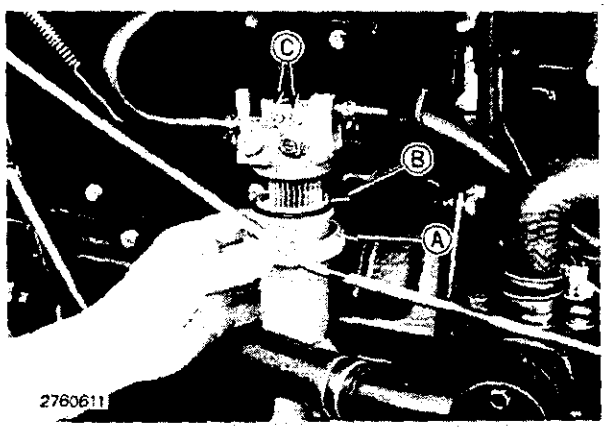
3. Check all hoses and connections for leaks. Correct if any leaks are found.



AIR AND FUEL SYSTEM

1. Check sediment bowl (A) for dirt or water. Empty if necessary. To empty, close the valve on a filter housing (B), then turn the retaining nut (C) loose and remove sediment bowl.

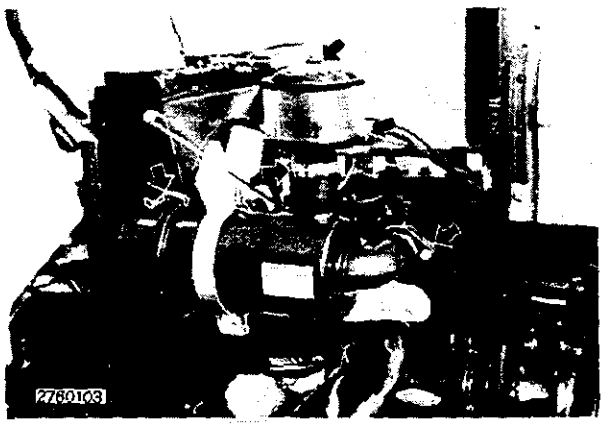
A – Sediment Bowl
B – Filter Housing
C – Retaining Nut



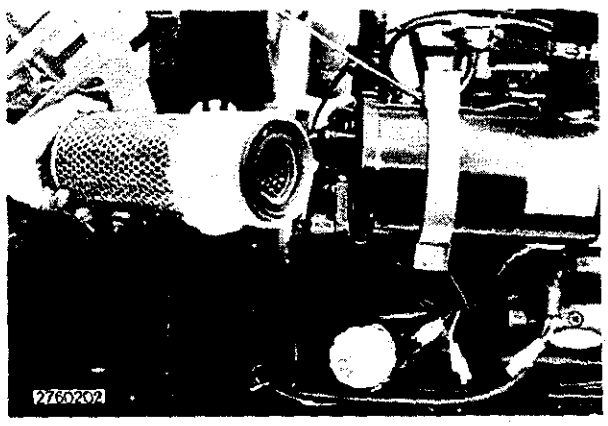
When reinstalling sediment bowl, be sure the O-ring (B) is in the groove in the retaining nut (A).

After reinstalling sediment bowl, bleed air from the sediment bowl. To bleed, loose bleed plugs (C) on the filter housing until air bubble is gone and fuel flows out bleed hole.

A – Retaining Nut
B – O-Ring
C – Bleed Plugs



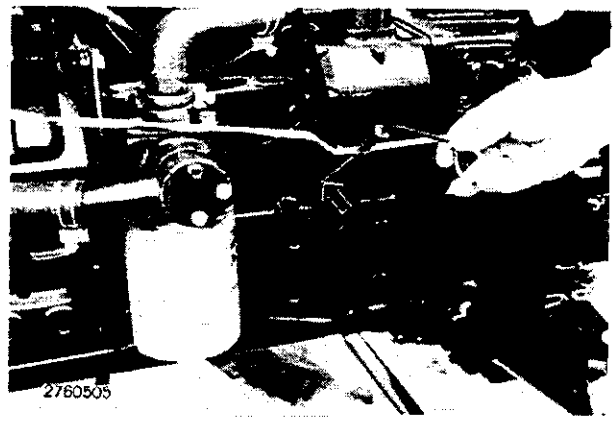
2. Check entire air intake system for leaks.



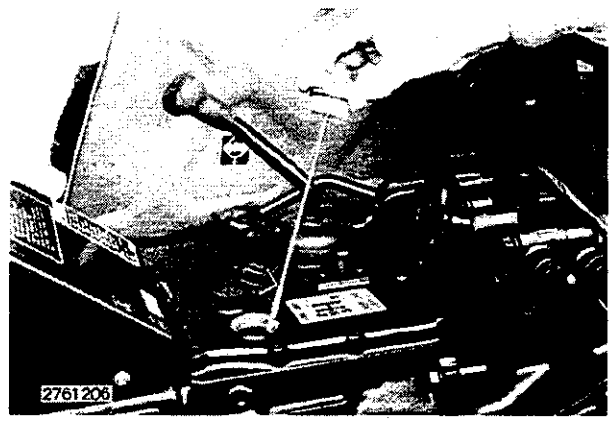
3. Inspect air filter and clean if necessary.

LUBRICATION

1. With the tractor on level ground and stopped for ten minutes or more, loosen engine dipstick and remove it. If the oil level is low, add enough oil to bring it up to the top of indicator line.



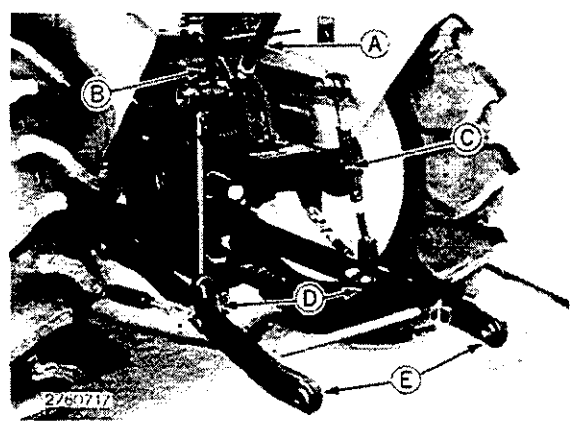
2. With the tractor on level ground, loosen the transmission dipstick and see if the oil level is in the safe range. If not, add enough oil to bring it up to the top of cross-hatching.

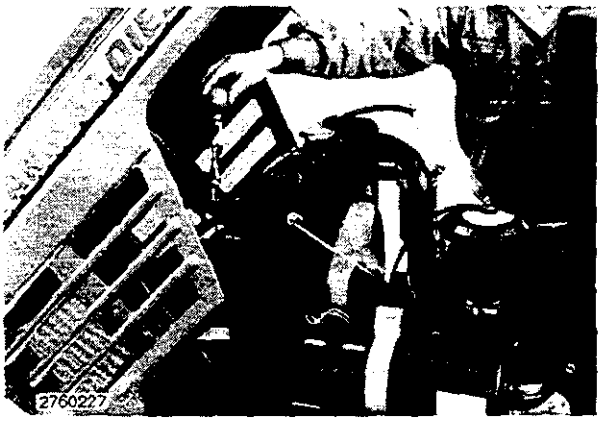


3. With the tractor front axle on level ground, loosen the front axle oil dipstick and check the oil level is in the safe range. If not, add enough gear oil to bring it up to the top of cross-hatching.
(4WD Model Only)

4. Lubricate 3-point hitch.

A — Upper link
B — Upper Link Hinge
C — Leveling Turnbuckle
D — Lift Links
E — Lower Links





ELECTRICAL SYSTEM

1. The specific gravity of electrolyte is to be checked by using an accurate hydrometer.
   Charge battery if reading is below 1.260 at 20°C (68°F).

   If battery is not near full charge, determine the reason.

2. Check level of electrolyte in each cell. Level should be to bottom of filter neck. If water is needed, use clean mineral-free water.

3. Check tension of fan belt. Belt should deflect 10 to 15 mm (3/8 to 5/8 in.) when a 89N (20 lbs) force is applied.

4. Check operation of all lights. If there is a problem, refer to Section 20 of Chapter 240 in the service manual.

5. Follow engine starting instructions beginning on 10-05-22. Check operation of starter and warning lights.

OPERATION

Perform all checks as instructed under "OPERATING CHECKS" beginning on page 10-05-26.

1. Driving tests.
2. Brake adjustment.
3. Power take-off.
4. Hydraulic lift and 3-point hitch.

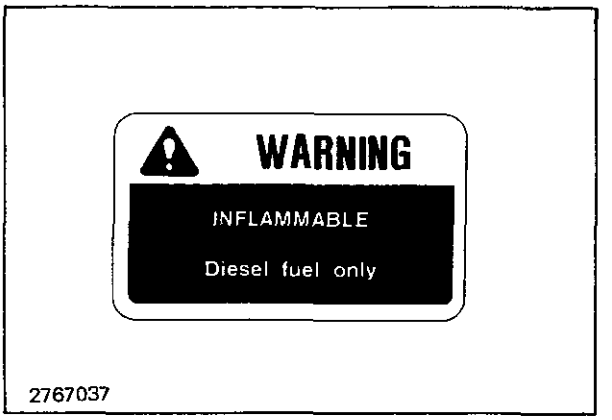
ENGINE

Check engine speeds as instructed on page 10-05-25.

FUEL

Use Diesel Fuel Only

The quality of fuel used is an important factor in obtaining dependable performance and satisfactory engine life. Suitable fuels must be clean, completely distilled, wellrefined, and non-corrosive to the fuel system parts. Be sure to use fuel of a known quality from a reputable supplier.



Fuel Specifications

Use either Grade No. 1-D or Grade No. 2-D fuel, as defined by ASTM Designation D975 for diesel fuels. Use the chart below to determine correct grade of fuel.

As further insurance of satisfactory operation, use fuel having less than 1.0 percent sulfur – preferably less than 0.5 percent.

For maximum filter life, sediment and water should not exceed 0.10 percent.

To maintain proper fuel delivery during cold weather operation, use Grade No. 1-D diesel fuel with a pour point at least 5.6°C (10°F) below lowest ambient air temperature.

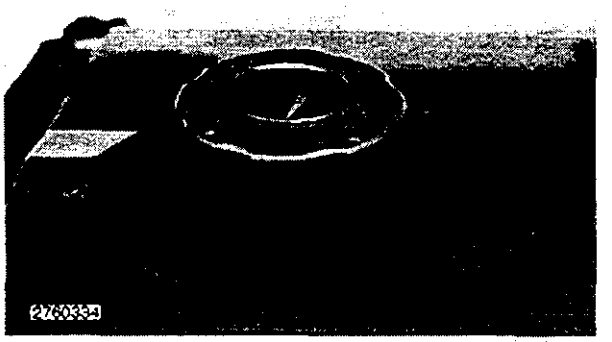
The cetane number should be 40 minumum. Operation under low ambient temperature as well as rarefied air, may required use of a fuel with a higher cetane number.

DIESEL FUELS

Type of Engine Service	Air Temperature	Diesel Fuel Grade No.
Wide variation in load and speed, considerable idling.	Below 25°C (80°F) Above 25°C (80°F)	1-D 2-D
Heavy load and high speed, minimum idling.	Below 5°C (40°F) Above 5°C (40°F)	1-D 2-D

CHECKING FUEL LEVEL

Check fuel gauge to make sure tractor has enough fuel for driving around the lot. If not, add some. Try to never run a diesel engine out of fuel.



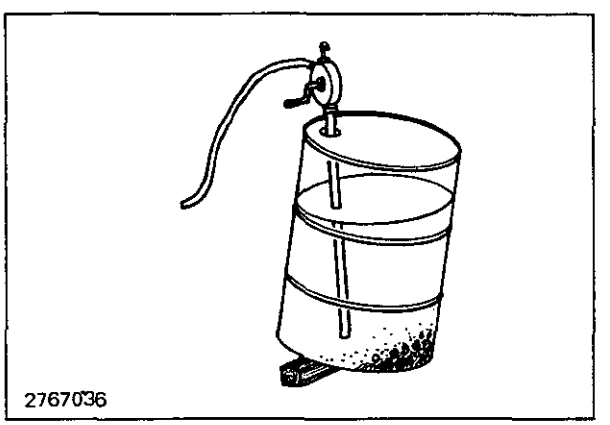
FILLING FUEL TANK

Fill fuel tank at end of each day's operation. This prevents condensation in tank from moist air cooling.

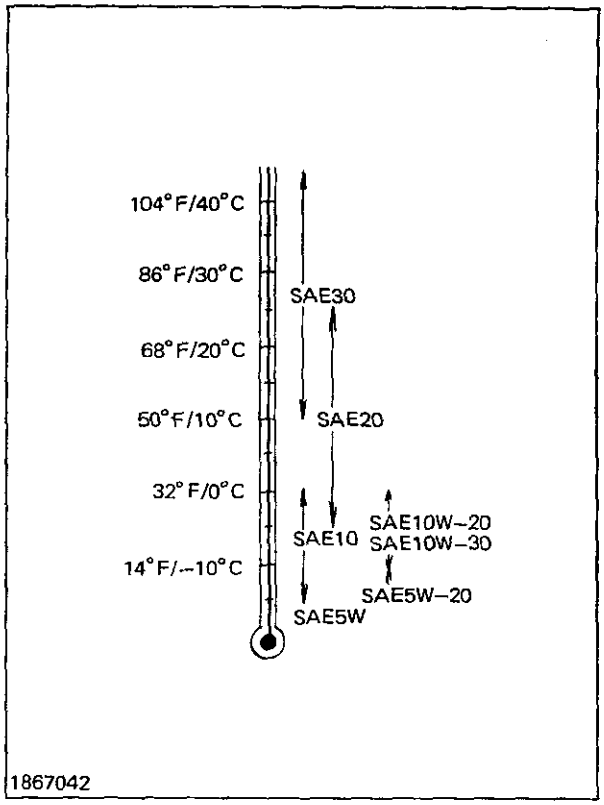
STORING FUEL

Proper fuel storage is critically important. Keep all dirt, water, and other contaminants out of fuel. Avoid storing fuel over long periods of time.

Store fuel in a convenient place away from buildings.



LUBRICANTS



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ENGINE OILS

It is important to use the correct type of oil conforming to the ambient temperature and conditions under which the tractor is used.

The oil must conform to one of the following specifications:

1. Single-viscosity oils
   API Service CD
   MIL-L-2104C
2. Multi-viscosity oils
   API Service CC or CD
   MIL-L-46152

Some increase in oil consumption may be expected when SAE 5W-20 or SAE 5W oils are used. Check oil level more frequently.
If ambient temperature is below –12°C (10°F), use a coolant heater (Engine block heater).

Depending upon the expected ambient temperature for the fill period, use oil of viscosity as shown in the chart below.

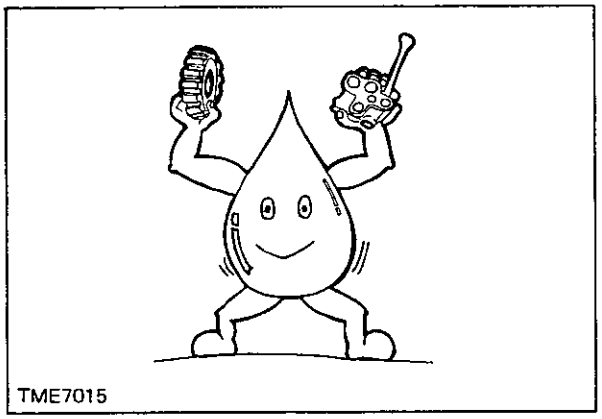
List of Engine Lubricating Oils

Supplier	Brand name	Below 10°C (50°F)	10–20°C (50–68°F)	20–35°C (68–95°F)	35°C (Over 95°F)
SHELL	Shell Rotella Oil	10W 20/20W	20/20W	30 40	50
	Shell Talona Oil	10W	20	30 40	50
	Shell Rimula Oil	20/20W	20/20W	30 40	
CALTEX	RPM Delo Marine Oil	10W	20	30 40	50
	RPM Delo Multi-Service Oil	20/20W 10W	20	30 40	50
MOBIL	Delvac Special	10W	20	30 40	
	Delvac 20W–40	20W–40	20W–40		
	Delvac 1100 Series	10W 20–20W	20–20W	30 40	50
	Delvac 1200 Series	10W 20–20W	20–20W	30 40	50
ESSO	Estor HD	10	20	30 40	
	Esso Lube HD		20	30 40	50
	Standard Diesel Oil	10W	20	30 40	50
BP	BP Vanellus M	20W		30 40	50
	BP Vanellus C3			30 40	
MOTUL	DS	DS 0		DS 1	DS 2

TRANSMISSION-HYDRAULIC OILS

Use only a multi-functional fluid for use in the transmission and hydraulic system. The equivalent oils are listed here.

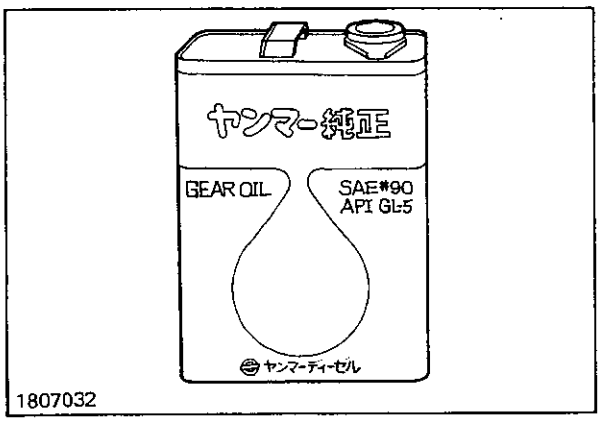
CALTEX	RPM Tractor Hydraulic Fluid
SUN OIL	ALTRAM #303 Fluid Oil
JOHN DEERE	303 (J14B)
CASE	CASE TCH Oil (JIC143, JIC144, or JIC145)
ALLIS-CHALMERS	ALLIS-CHALMERS Gear, Hydraulic and Wet Brake Oil (ACM-7201)
FORD	M2C41-A, M2C53-A, or M2C86A
INTER-NATIONAL	INTERNATIONAL HARVESTER Hy-Tran B-6 Fluid


TME7015

GEAR OILS

Use SAE #90 and API service classification GL-5 gear oil for front axle of four wheel drive model.

API GL-5 gear oil is suitable for conditions encountered in hypoid gears and other equipment operated under high-speed, high-torque conditions.



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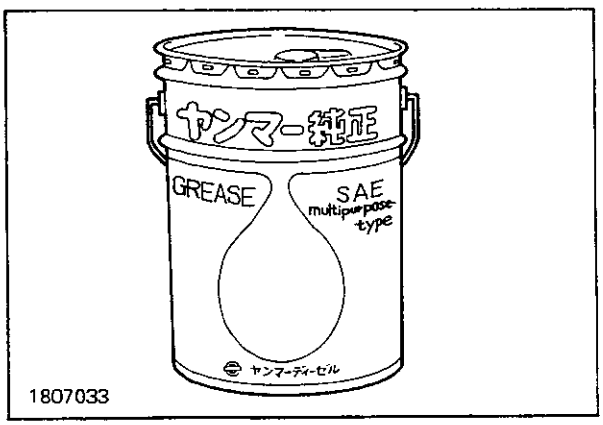
GREASES

Use SAE multipurpose-type grease for all grease fittings. Wheel bearing grease is recommended for front wheel bearings.

STORING LUBRICANTS

Your tractor can operate at top efficiency only if clean lubricants are used. Use clean containers to handle all lubricants. Store them in an area protected from dust, moisture, and other contamination.



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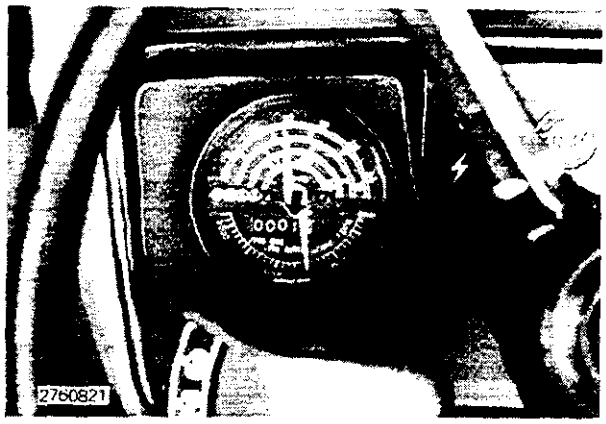
SERVICE INTERVAL

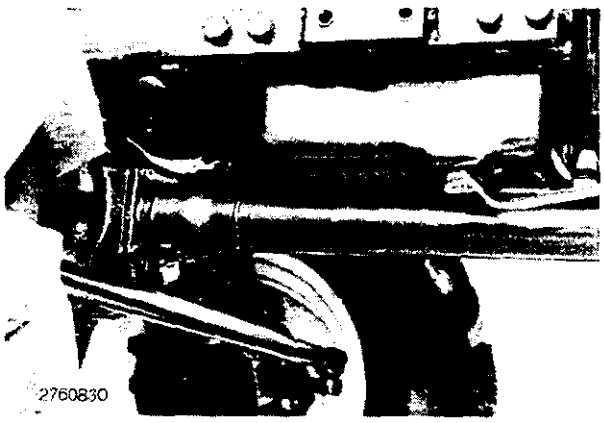


Use the hourmeter on the instrument panel to determine when periodic services are required.

The meter reading below needle indicated the total hours the engine has been running at engine speed 2600 rpm. If engine is running at less than 2600 rpm, the meter indicates total running hours less than actual total running hours.

Periodic service should be performed by using the time indicated on the hourmeter.

Carefully written and illustrated instructions are included in the tractor operation manual. Remind your customer to follow the recommendations in these instructions.



Be sure to change the engine oil with which the crankcase was filled at factory and filter element after the 50 hours of operation.

Change the Transmission-Hydraulic oil and filter element (Cartridge type), and clean suction screen after the first 50 hours operation.

LUBRICANT MAINTENANCE CHART

COMPONENT	CAPACITY	TYPE OF LUBRICANT	INTERVAL OF SERVICE	
Engine Oil	4.3 ℓ (4.5 U.S. gallons)	See page 10-15-2.	10 Hrs. 100 Hrs. 200 Hrs. 300 Hrs. 300Hrs.	Check level Change oil Change filter Wash crankcase interior Clean vent tube
Transmission and Hydraulic Oil	17.5 ℓ (4.6 U.S. gallons)	Multi-functional fluid for both transmission hydraulic system.	50 Hrs. 300 Hrs. 300 Hrs. 300 Hrs.	Check level Change oil and Change filter Clean suction screen.
Front Axle Gear Oil	6.0 ℓ (6.3 U.S. quarts)	Use SAE 90 Gear Oil.	50 Hrs. 300 Hrs.	Check level Change oil
Front Wheel Bearings	....	Wheel Bearing Grease	300 Hrs.	Repack bearings
Grease Fittings	.....	Multipurpose Grease	See Pages	

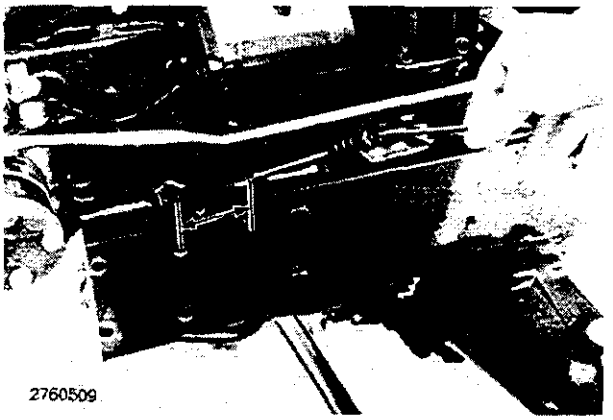
ENGINE CRANKCASE

CHECKING ENGINE OIL LEVEL

Checking Oil Level

Remove engine oil dipstick. Observe engine oil level. If necessary, and enough oil to bring oil level to full mark on dipstick. See page 10-15-2 for specifications.

Tractor should be on a level surface when oil level is checked. If it is not, check only to make sure the crankcase is not dry. Recheck oil level later, when tractor is on level ground.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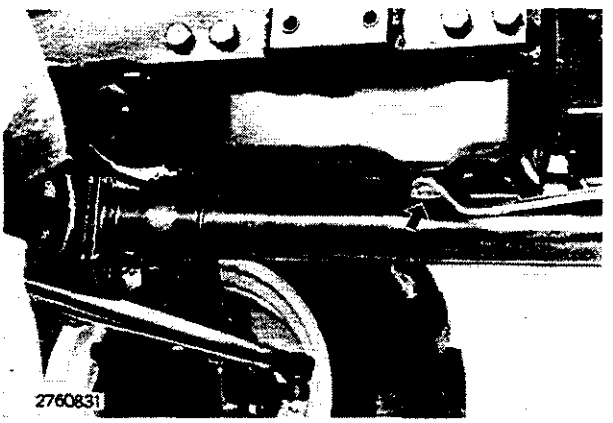
Draining and Filling Engine Crankcase

Every 100 hours of engine operation, replace oil in the engine crankcase. Drain crankcase at the end of day's operation, at which time the oil is hot and all foreign material is in suspection.

During cold weather operation with temperatures below 0°C (32°F), change oil at any seasonal change in temperature when oil of a new viscosity is required.

1. Remove engine oil drain plug, and drain oil.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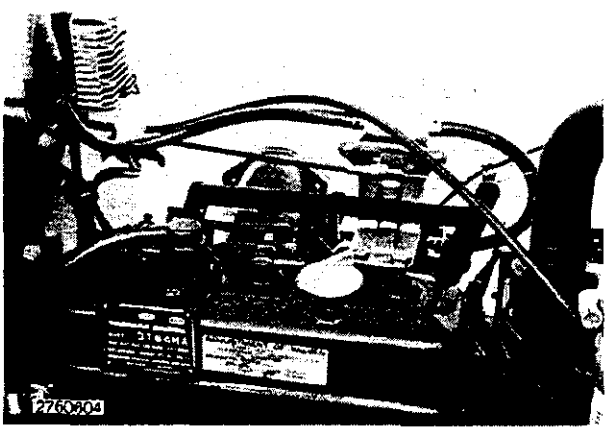
2. Install drain plug, and add engine oil as specified on page 10-15-2. Capacity is 4.3 ℓ (1.14 U.S. gallons).

   Oil level on the dipstick should be at the upper mark.

3. Start engine, run a short time and check for oil leaks, especially around the filter body and drain plug.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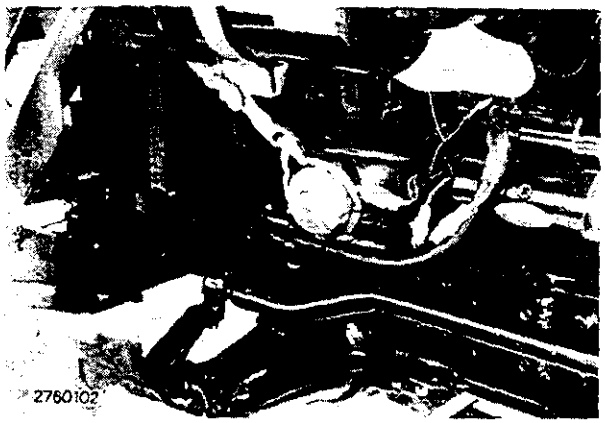
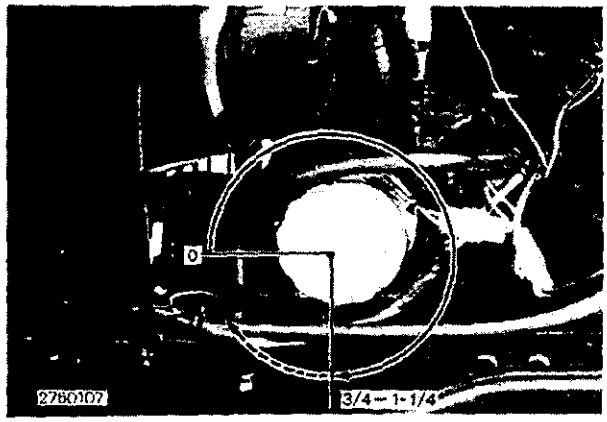


Engine Oil Filter

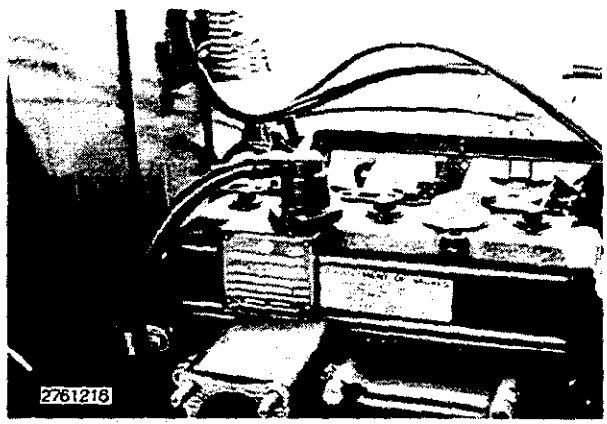
The engine oil filter is full-flow type, and should be replaced every 200 hours or once for every two oil changes.

1. Screw off engine oil filter.



2. Clean filter mounting pad and make sure lock nut on filter mounting stud is tight.
3. Install new filter element, applying a thin film of oil to the sealing ring.
4. Screw filter element down by hand until sealing ring just touches mounting pad. Then turn down an additional 3/4 to 1-1/4 turns. Do not overtighten.
5. Start engine and check for leaks.

The filter element has a special bypass valve. Replace only with a genuine YANMAR filter element.



CLEANING CRANKCASE VENT TUBE

Remove crankcase vent tube and clean in a safe solvent. Reinstall tube on tractor, making sure it is not kinked or pinched.

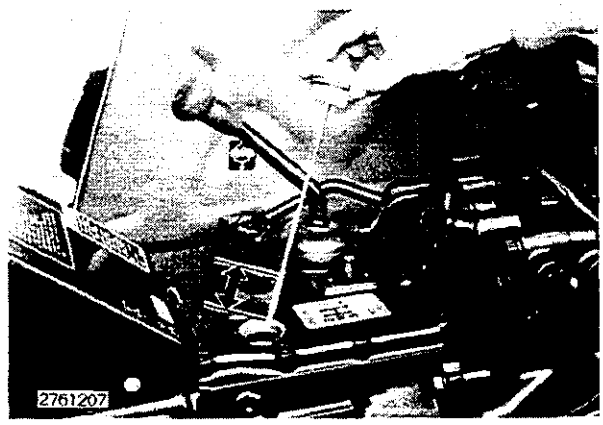
SERVICE INTERVAL: Every 300 hours.

TRANSMISSION AND HYDRAULIC SYSTEM

CHECKING TRANSMISSION-HYDRAULIC OIL LEVEL

Checking Oil Level

Remove dipstick and wipe it clean. Insert dipstick to the end. Oil level should be within cross-hatching.
If low, add oil as specified on page 10-15-3.

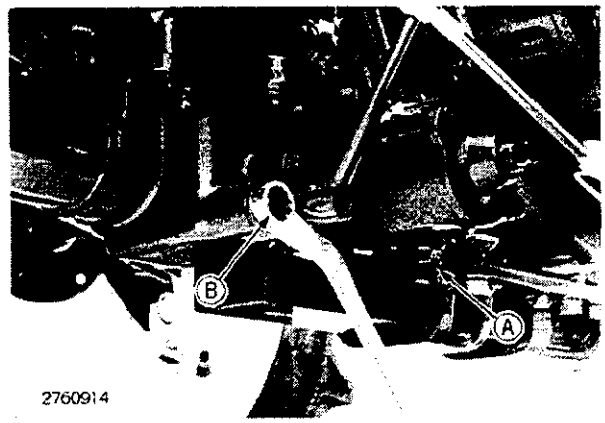


STOP Be sure to use Transmission-Hydraulic oil, or its equivalent. Never use light viscosity hydraulic fluid.

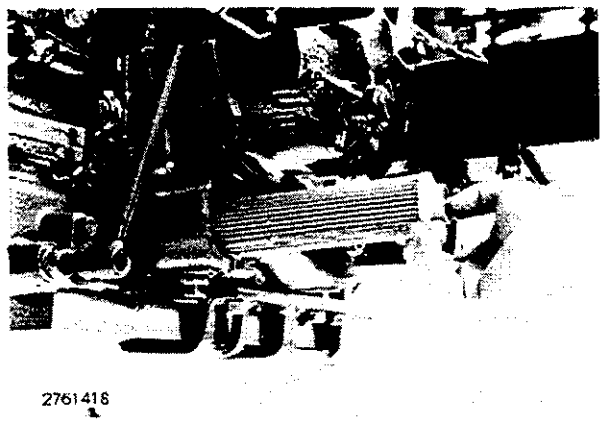
Draining and Filling Transmission Case

Every 300 hours of engine operation or annually, whichever occurs first, replace oil in the transmission case. Drain transmission case at the end of a day's operation, at which time the oil is hot and all foreign material is in suspention.

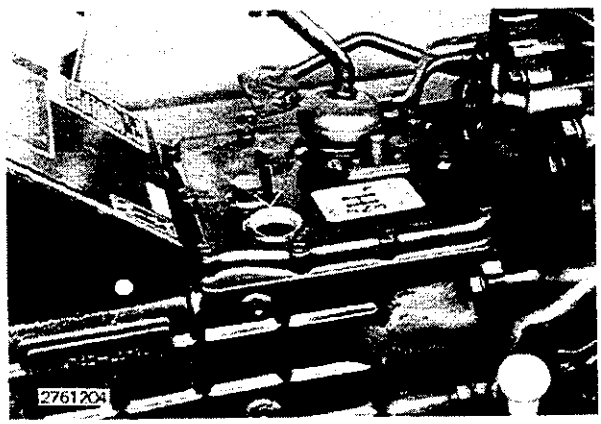
1. Remove drain plug (A) from transmission case, plug (B) from front drive case, and drain oil. Lower hydraulic lift to remove trapped oil.

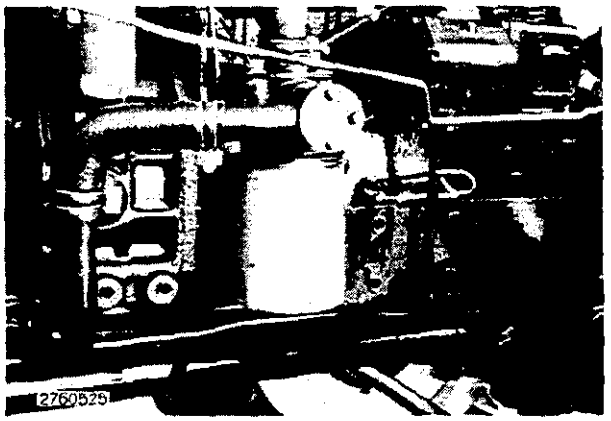


2. Clean or replace transmission oil filter.



3. After installing new (or clean) filter, refill system with Transmission-Hydraulic oil, or its equivalent. Capacity is 17.5 ℓ (4.6 U.S. gallons) for YM276, and 18.0ℓ (4.8 U.S. gallons) for YM276D.



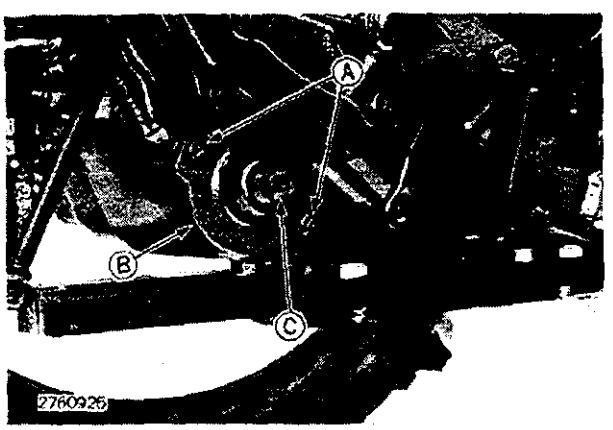


Hydraulic Oil Filter

Hydraulic oil filter is located at the hydraulic suction (low pressure) line.

Replace every 300 hours or annually at the same time which the transmission-hydraulic oil is changed.

1. Screw off hydraulic oil filter.
2. Clean filter mounting pad.
3. Install new filter element, applying a thin film of oil to the sealing ring.
4. Screw filter element down by hand until seal ring just touches mounting pad. Then turn down an additional 3/4 to 1-1/4 turns. Do not overtighten.
5. Start engine and check for leaks.



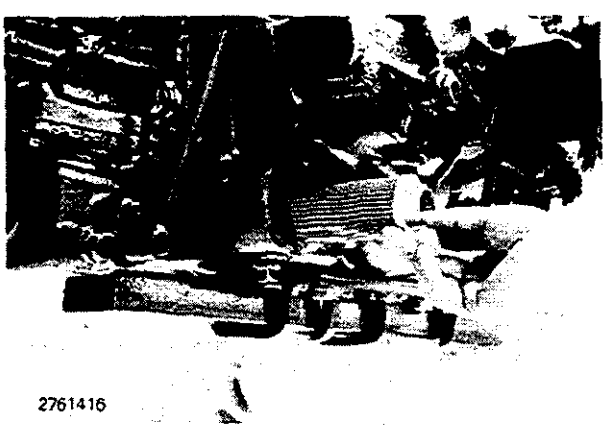
Transmission Oil Filter (Suction Screen)

Transmission oil filter cover is located at the left side of transmission case.

Clean filter element every 300 hours or annually at the same time which the transmission oil is changed.

1. Remove two cap screw (A) and pry off filter cover (B).

A – Cap Screws
B – Cover
C – Oil Heater Plug



2. Carefully clean filter in solvent and blow dry with compressed air.

Replace the transmission oil filter if damaged.

3. Install cleaned filter element.
4. Fill system with Transmission-Hydraulic oil.

FRONT WHEEL DRIVE

CHECKING FRONT AXLE GEAR OIL LEVEL

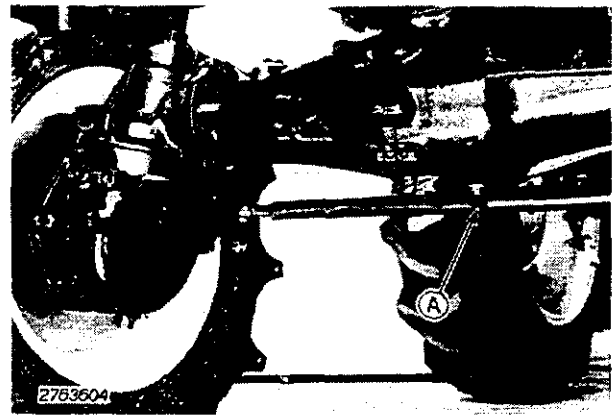
Check front axle gear oil level every 50 hours and change oil every 300 hours.

Remove dipstick and wipe it clean. Insert dipstick to rest on threads, but do not screw it in. Oil level should be within cross-hatching. If low, add SAE 90# gear oil.
Capacity is 6.0 ℓ (6.3 U.S. quarts).

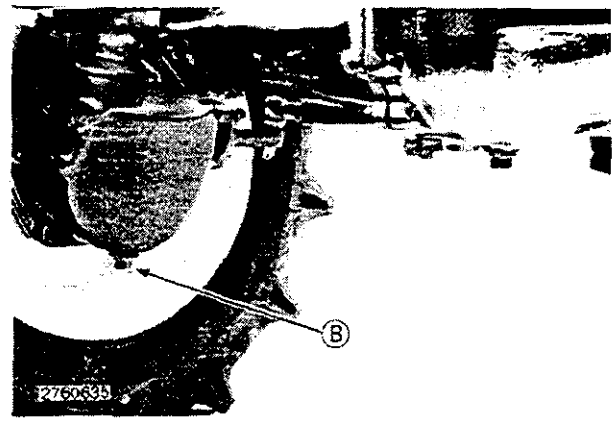
Changing Oil

1. Remove a drain plug (A) on the differential housing and two drain plugs (B) on both right and left final gear case.

A – Drain Plug



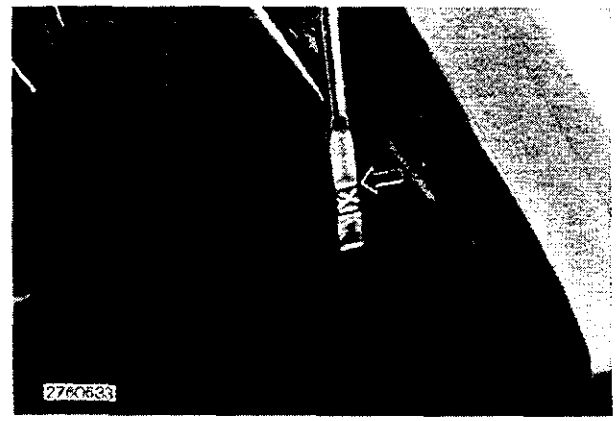
B – Drain Plugs on Final Gear Case



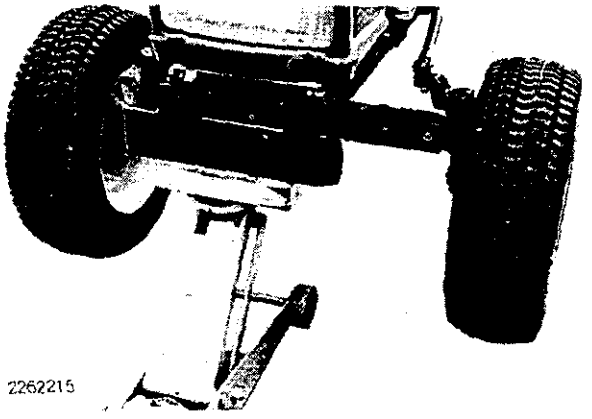
2. Install drain plugs.
3. Refill with 6.0 ℓ (6.3 U.S. quarts) of SAE 90# gear oil.
4. After having carried out the oil change check oil level by the dipstick.

When checking oil level after refilling, wait at least one hour to obtain even level for both bevel gear housing.

5. Recheck oil level after a few hours operation.



FRONT WHEEL BEARINGS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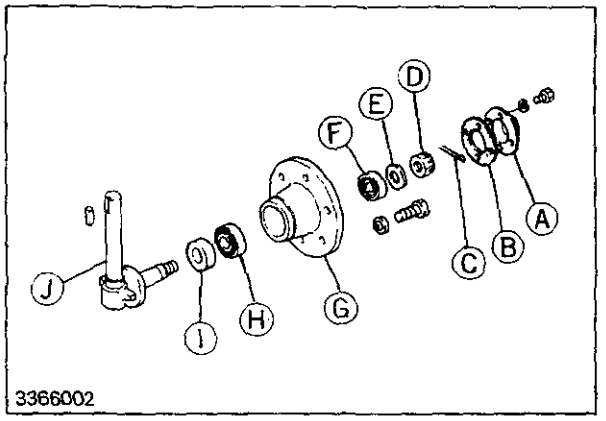
CLEANING AND PACKING BEARINGS

1. Jack up front axle.



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2. Remove hub cap. Remove cotter pin and adjusting nut.
3. Disassemble parts. Clean parts in solvent and blow them dry with compressed air.
4. Inspect parts carefully for damage. Replace any which are worn.
5. Pack bearings with wheel bearing grease. Coat seal with multi-purpose grease.
6. Reassemble parts. Tighten adjusting nut until a slight drag is felt when wheel is turned. Back nut off just enough to insert cotter pin in first hole.
7. Reinstall hub cap.

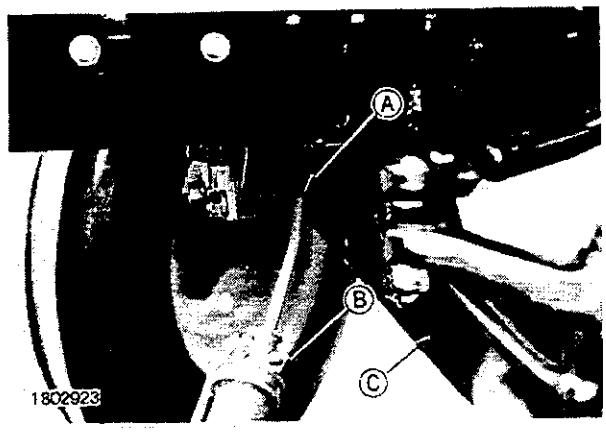
SERVICE INTERVAL: Every 300 hours.

A – Hub Cab
B – Packing
C – Cotter Pin
D – Slotted Nut
E – Washer
F – Bearing
G – Hub
H – Bearing
I – Oil Seal
J – King Pin

GREASING

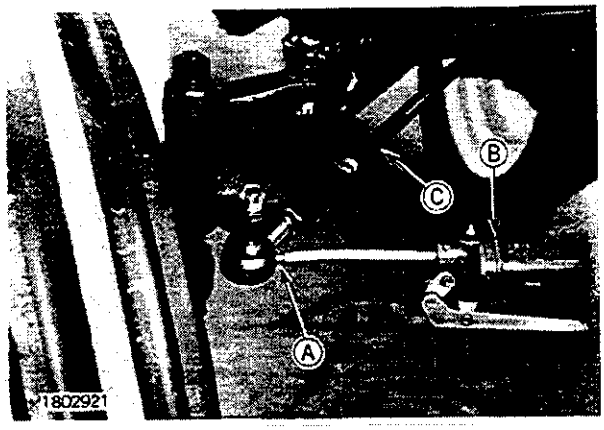
Front Axle Center Pin (Every 10Hrs.)

A – Grease Fitting
B – Grease Pump
C – Front Axle (2WD)



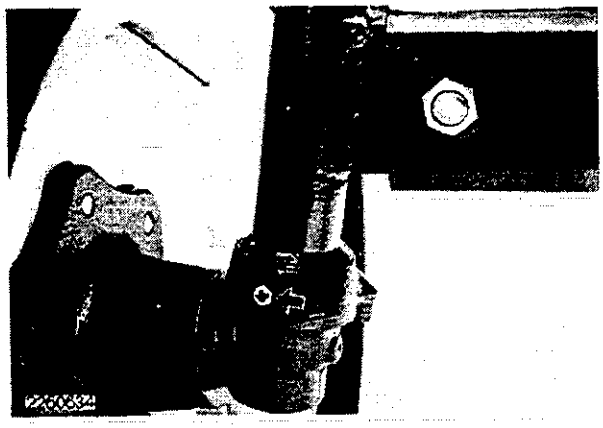
Tie Rod Ends (Every 50Hrs.)

A – Grease Fitting
B – Grease Pump
C – Tie Rod



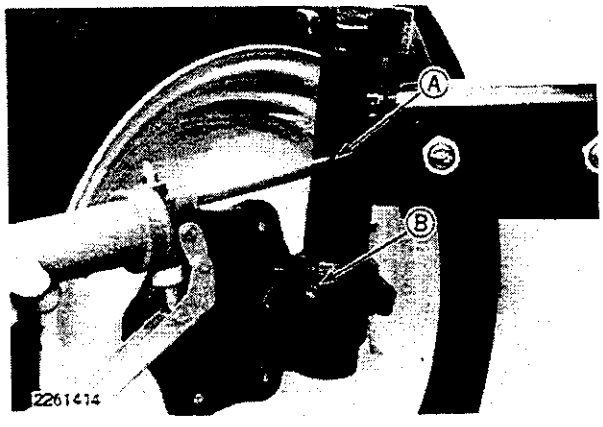
King Pins (Every 50Hrs.)

1. Remove plugs from front axle king pins.

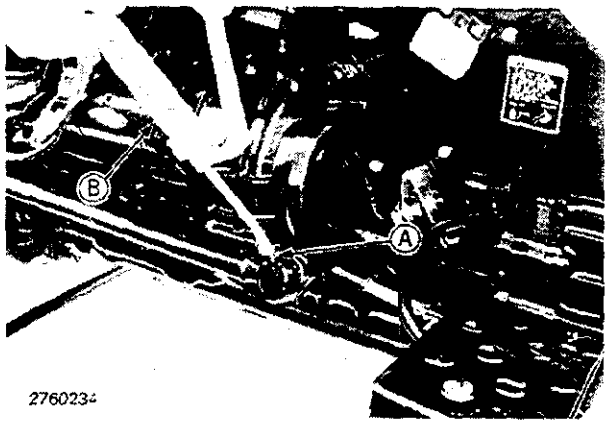


2. Apply several shots of grease to fitting (A), until clean grease comes from opening.

A – Grease Fitting
B – Drain Opening

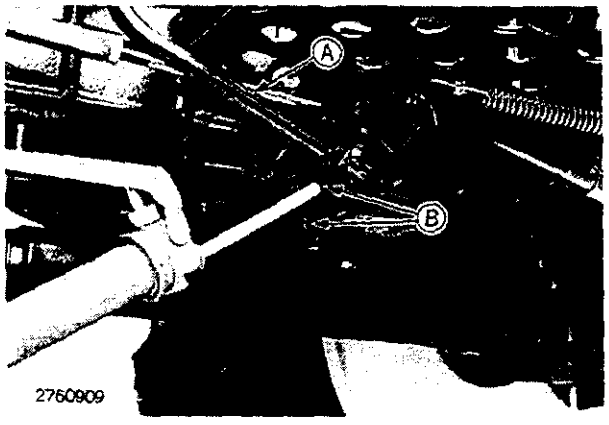


GREASING (Continued)



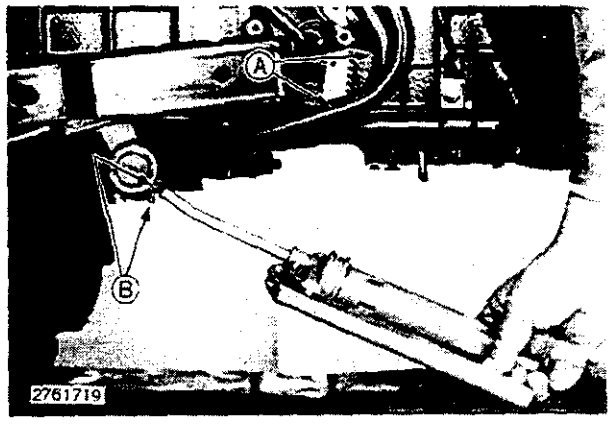
Drag-Rod Ends (Every 50Hrs.)

A — Grease Fitting Rear
B — Grease Pump



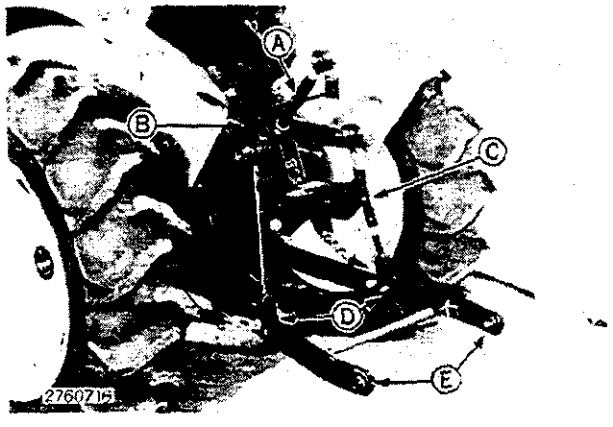
Clutch Pedal Shaft (Every 50 Hrs.)

A — Clutch Pedal
B — Grease Fitting



Brake Pedal Shaft (Every 50Hrs.)

A — Breake Pedals
B — Grease Fittings



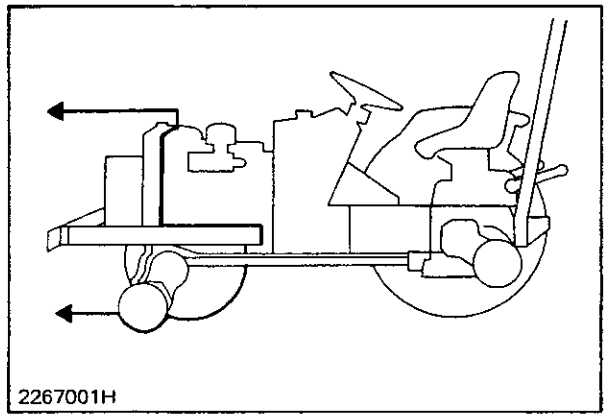
3-Point Hich (Every 10Hrs.)

A — Upper Link
B — Upper Link Hinge
C — Leveling Turnbuckle
D — Lift Links
E — Lower Links

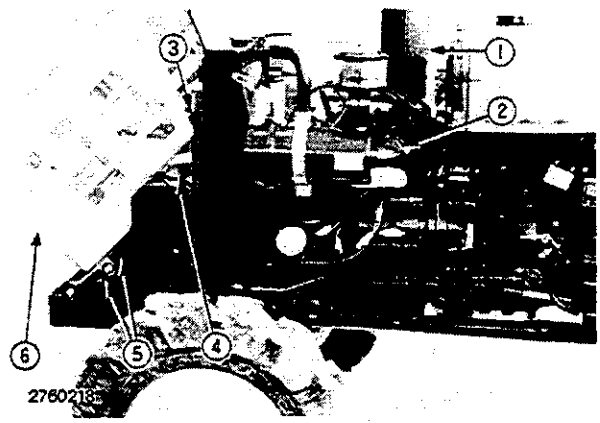
FRONT END FROM ENGINE

REMOVAL

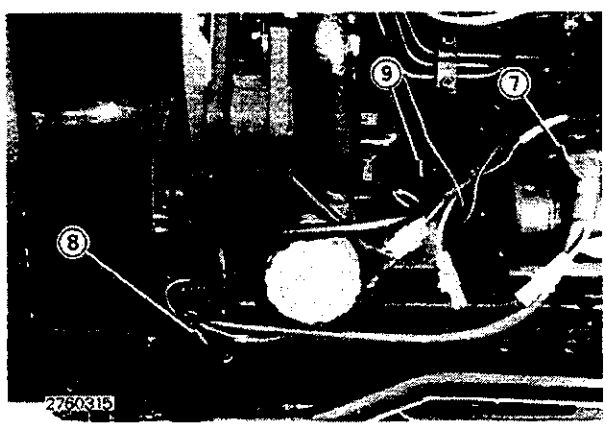
Remove tractor front end from engine.



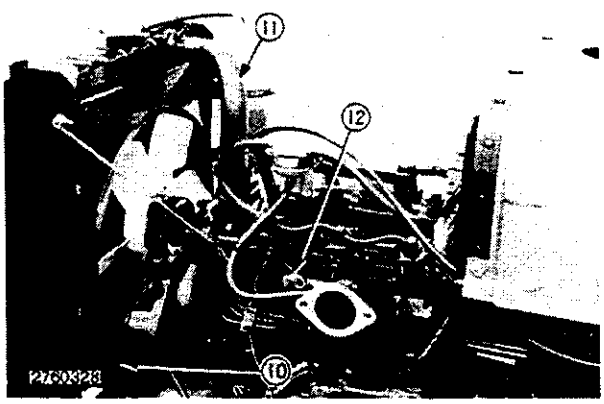
1. Remove muffler.
2. Remove air cleaner.
3. Disconnect ground cable from frame or battery.
4. Disconnect headlight wire.
5. Remove hood mount bracket cap screws.
6. Remove hood.

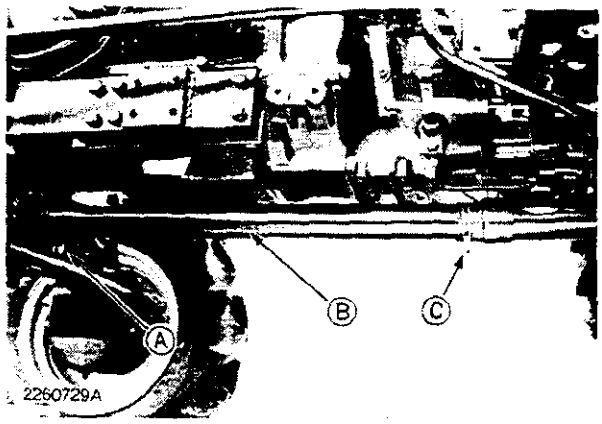


7. Disconnect cable from starter.
8. Drain cooling system.
9. Disconnect drain hose from engine block.



10. Disconnect radiator lower hose from engine block.
11. Disconnect radiator upper hose from radiator.
12. Remove cap screw.

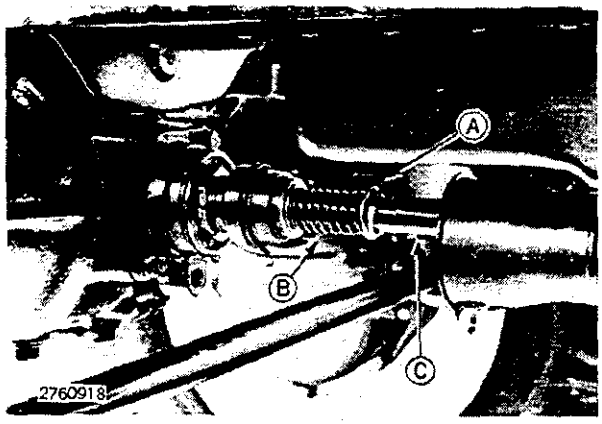




REMOVAL (Continued)

13. Remove cap screw (A) from propeller shaft cover (B). Loosen cap screw of hose clamp (C) and slide the cover back.

A – Cap Screw
B – Propeller Shaft Cover
C – Hose Clamp

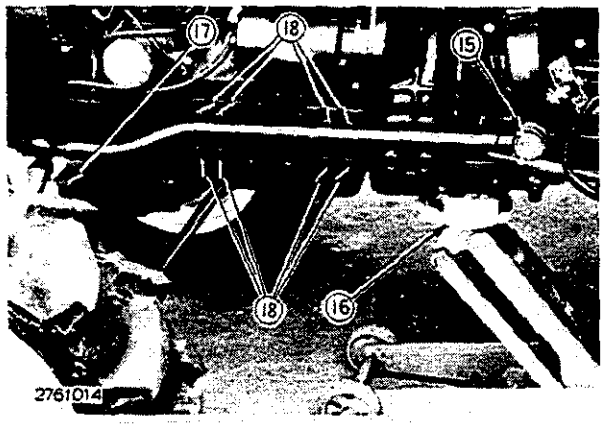


14. Remove cotter pin (A) which supports spring (B) from the rear end of propeller shaft.

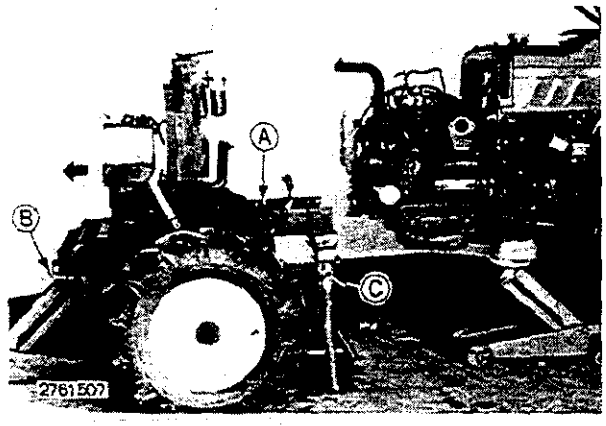
    Remove propeller shaft (C) with careful attention to the steel balls in the front and rear cups of propeller shaft.

Be careful when removing the shaft.
The steel balls may fall and be lost unless the shaft is handled with care.

A – Cotter Pin
B – Spring
C – Propeller Shaft



15. Disconnect drag rod from pitman arm.
16. Support tractor under clutch housing.
17. Insert blocks both sides between front axle bracket and axle housing.
18. Remove front axle bracket bolts.



19. Roll front end away from tractor.

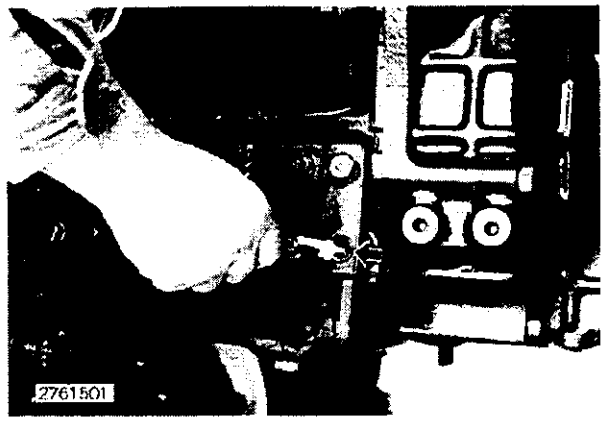
A – Front Axle Bracket
B – Jack
C – Jack Stand

CAUTION: Support the both ends of front axle bracket (A) by using jack stand (C).

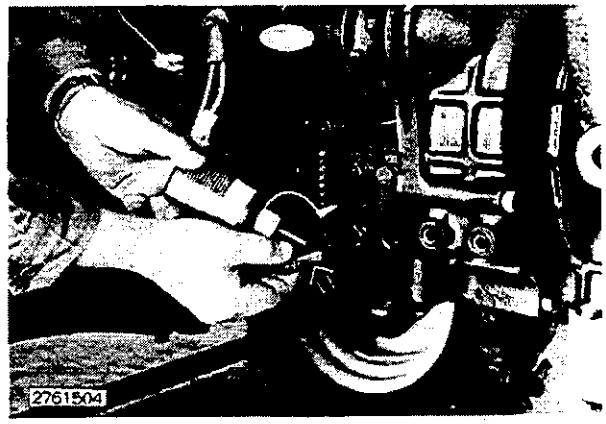
INSTALLATION

Reverse the removal steps given preceding page and note the installation instructions that follow.

1. Clean bolts and threaded holes of engine block with solvent.

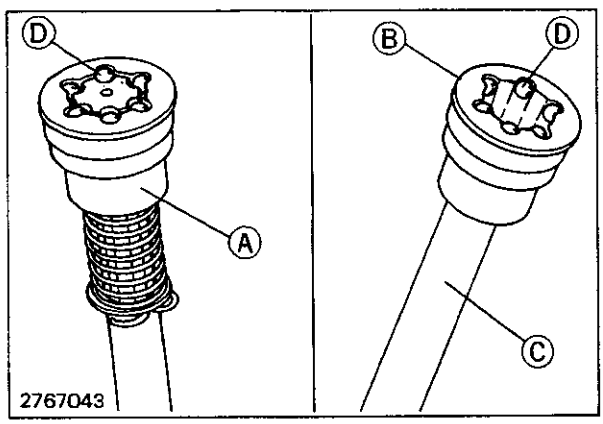


2. Apply a thin film of Lock-tite to the thread of front axle bracket bolts.
3. Tighten front axle bracket-to-engine bolts to 98 Nm (10 kgm) (72 ft-lbs).



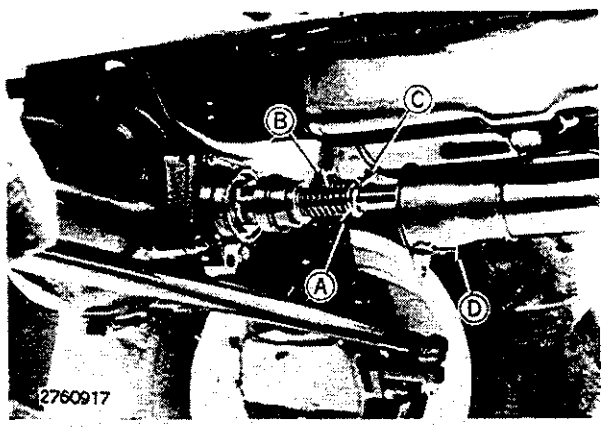
4. Fill both cups (A) and (B) with grease and put in six steel balls (D) in each cup.

A – Front Cup
B – Rear Cup
C – Propeller Shaft
D – Steel Ball (12 used)



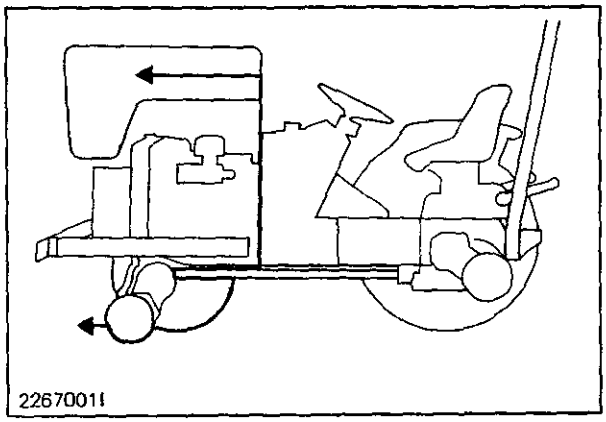
5. Carefully hold the propeller shaft and front cup with steel balls. Install the shaft between front differential drive shaft and front drive shaft.
6. Push plain washer (A) to compress spring (B), and install cotter pin (C). Install propeller shaft cover (D).

A – Plain Washer
B – Spring
C – Cotter Pin
D – Propeller Shaft Cover

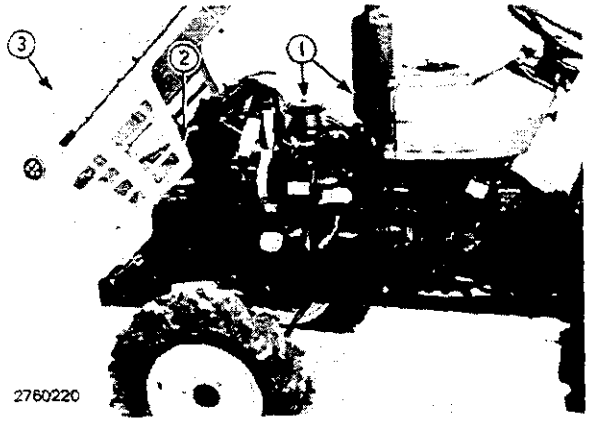


FRONT END FROM CLUTCH HOUSING

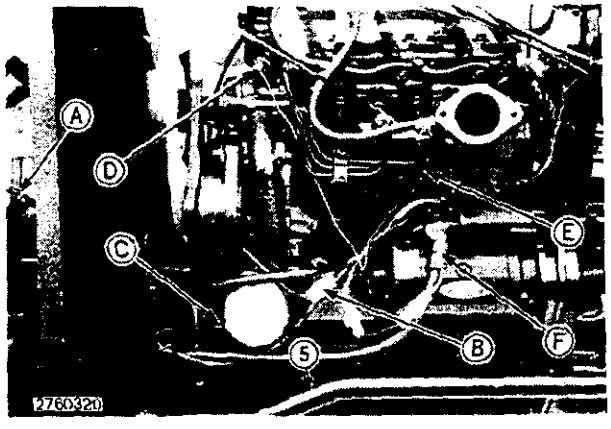
REMOVAL



Remove tractor front end from clutch housing.



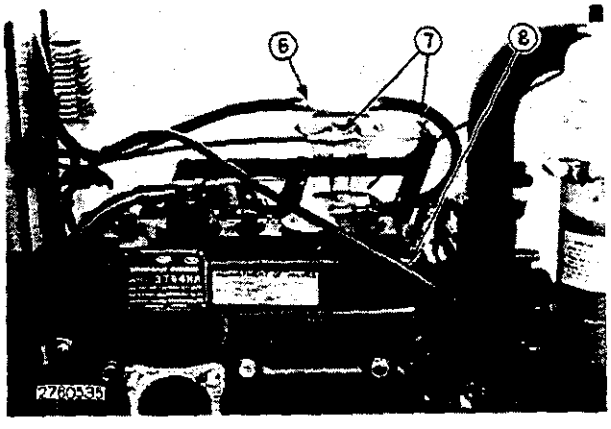
1. Remove muffler and air cleaner.
2. Disconnect ground cable from battery.
3. Remove hood.



4. Disconnect wires from:

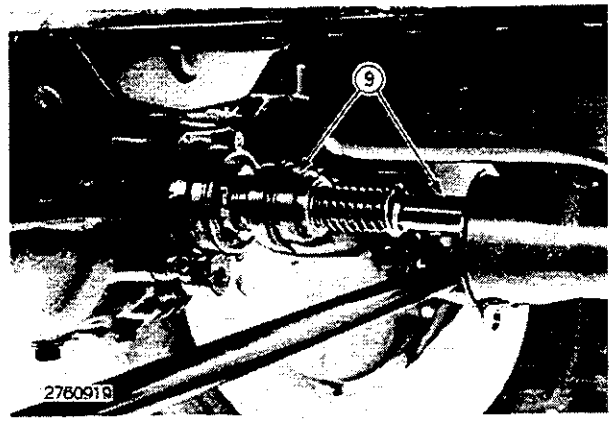
A – Headlights
B – Alternator
C – Oil Pressure Sender
D – Coolant Temperature Sender
E – Thermostart Heater Plug
F – Starter

5. Disconnect drag rod from pitman arm.



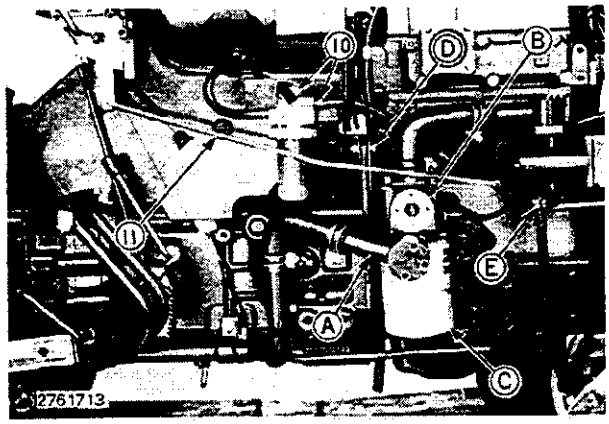
6. Disconnect line from thermostart cup.
7. Disconnect decompression cable.
8. Disconnect hourmeter cable from the drive unit.

9. Remove front wheel drive propeller shaft.
   See page 10-20-2 for detail procedure.

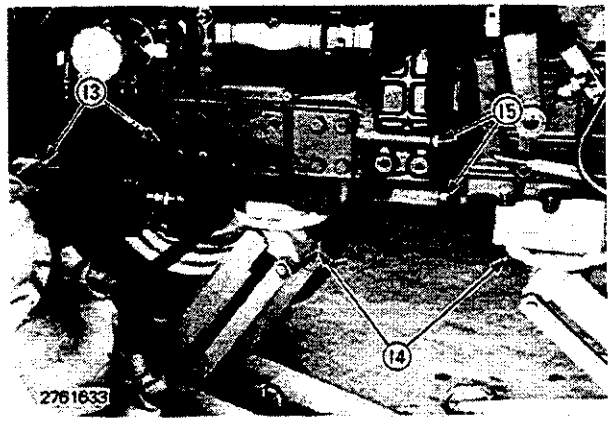


10. Close shut-off valve on fuel filter housing and disconnect fuel line at the housing.
11. Disconnect throttle linkage from pump and lever.
12. Disconnect hydraulic lines (A), (E) and filter housing (B) retaining bolt and nut (D).

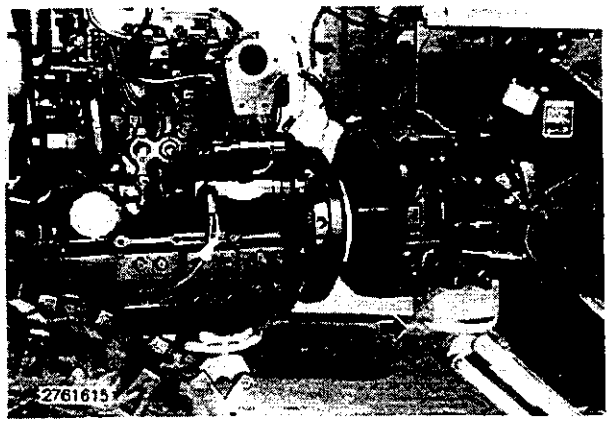
A — Hydraulic Line (Suction)
B — Filter Housing
C — Hydraulic Oil Filter
D — Retaining Bolt and Nut
E — Hydraulic Line (Pressure)

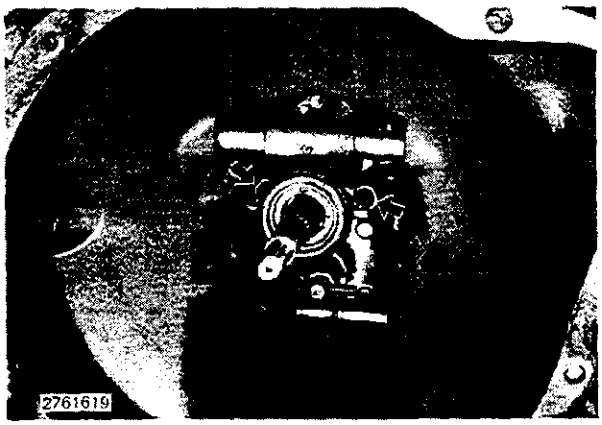


13. Insert blocks both sides between front axle bracket and axle housing.
14. Support tractor under clutch housing and oil pan.
15. Remove seven cap screws from clutch housing.



16. Slowly roll rear portion of tractor away.



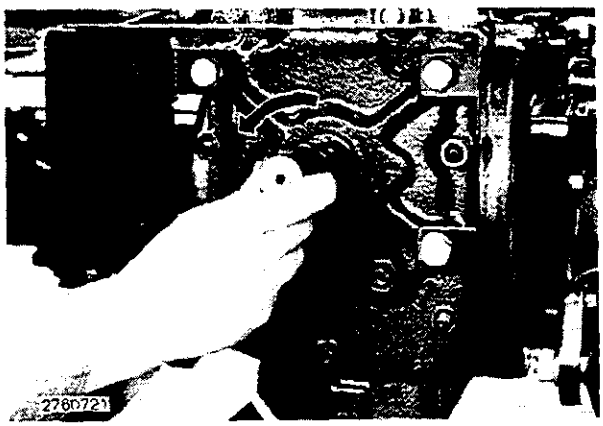


INSTALLATION

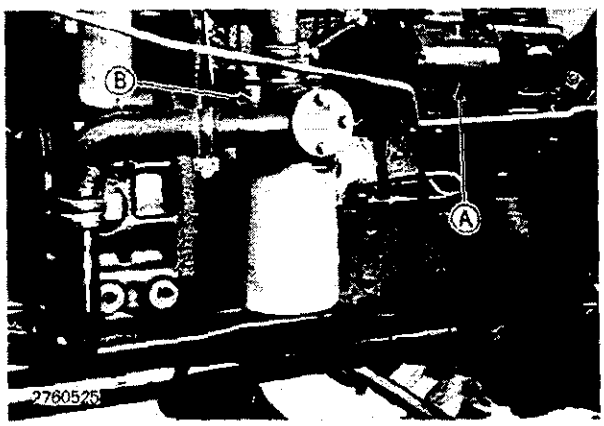
Reverse the removal steps on the preceding pages and note the installation instructions that follow.

1. Insure that both clutch release springs are properly attached.

▼ **Grease main drive shaft at bushing surface before installing. Apply liquid sealant to the sealing surface between clutch housing and mounting flange.**



2. Engage PTO shift lever and turn shaft counter-clockwisely to align splines pushing tractor together.

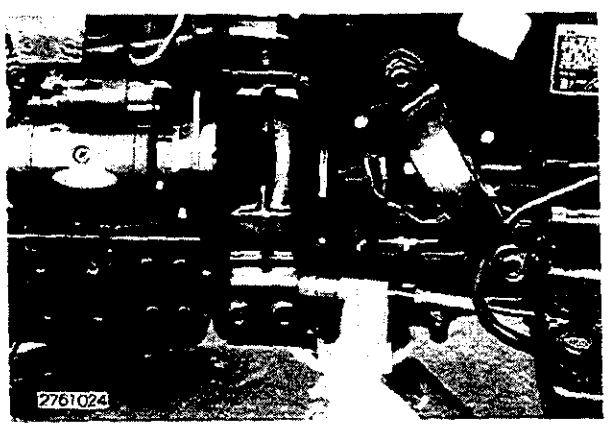


3. Tighten cap screws for mounting hydraulic lines to pump (A) and hydraulic oil filter housing (B) to 10 Nm (1 kgm) (7.2 ft-lbs).

▼ **Do not install incorrect length of screws. The length of inlet line screws longer than outlet's.**

Be sure length and specified torque for line cap screws to avoid brakage of thread in pump housing.

A — Hydraulic Pump
B — Filter Housing

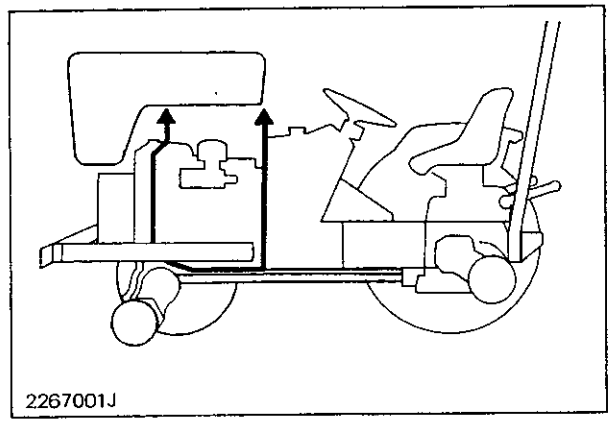


4. Tighten clutch housing-to-engine cap screws to 98 Nm (10 kgm) (72 ft-lbs).

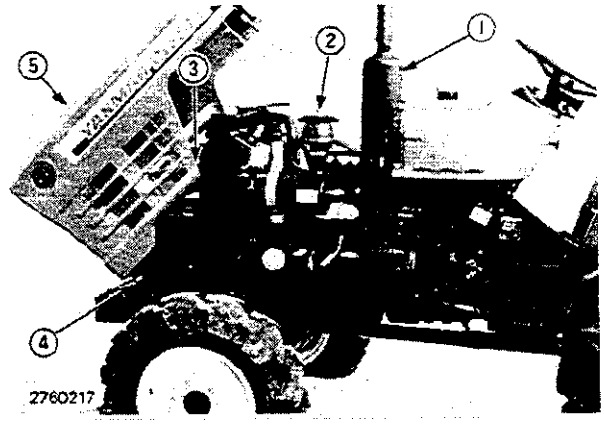
ENGINE REMOVAL

REMOVAL

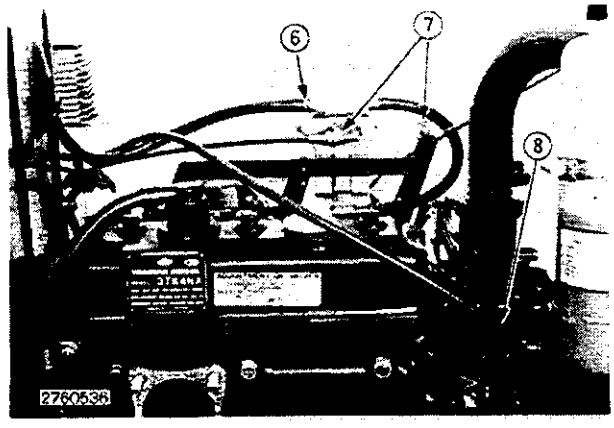
Remove engine from tractor.



1. Remove muffler.
2. Remove air cleaner.
3. Disconnect ground cable from frame or battery.
4. Remove hood mount bracket cap screws.
5. Remove hood.



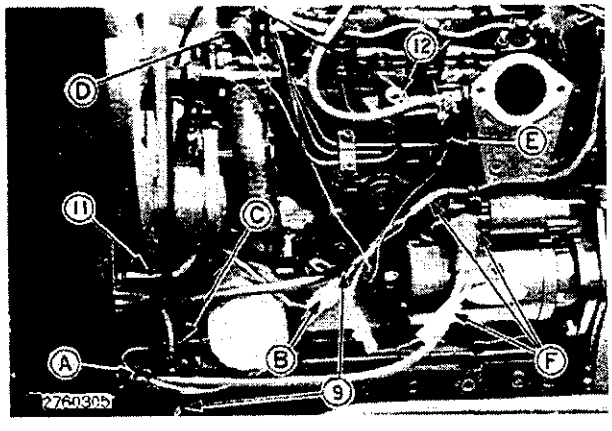
6. Disconnect line from thermostart cup.
7. Disconnect decompression cable.
8. Disconnect hourmeter cable from the drive unit.

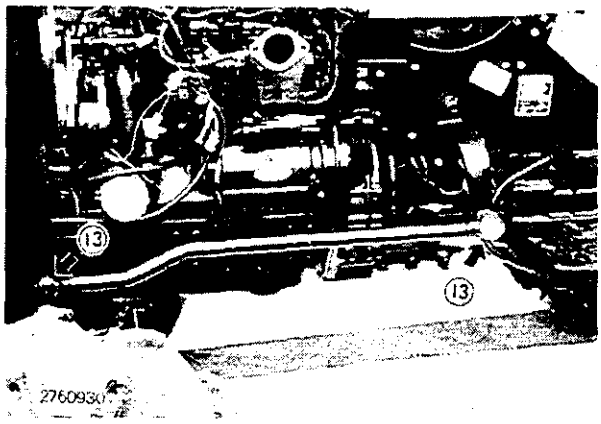


9. Drain cooling system and disconnect drain tube from engine block.
10. Disconnect wires from:

    A — Headlights
    B — Alternator
    C — Oil Pressure Sender
    D — Coolant Temperature Sender
    E — Thermostart Heater Plug
    F — Starter

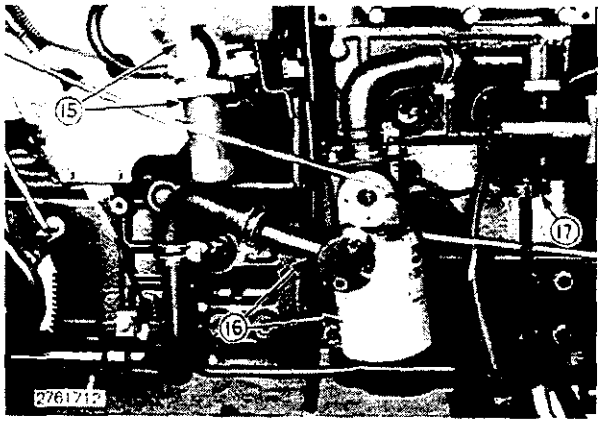
11. Disconnect radiator upper and lower hoses from radiator.
12. Remove cap screw.



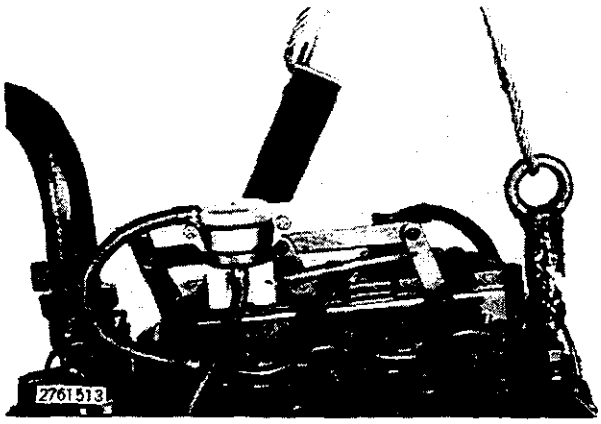


REMOVAL (Continued)

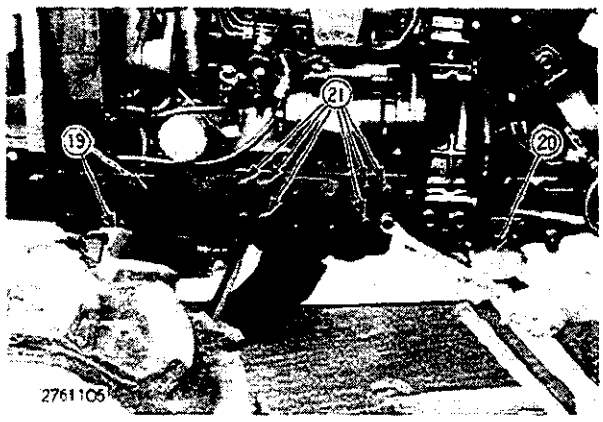
13. Remove drag rod from steering arm and pitman arm.
14. Remove front wheel drive propeller shaft as described on page 10-20-2.



15. Close fuel shut-off valve and remove fuel filter assembly from engine mounting flange.
16. Disconnect hydraulic low pressure line from filter housing and remove filter assembly from engine mounting flange.
17. Disconnect hydraulic high pressure line from hydraulic pump.

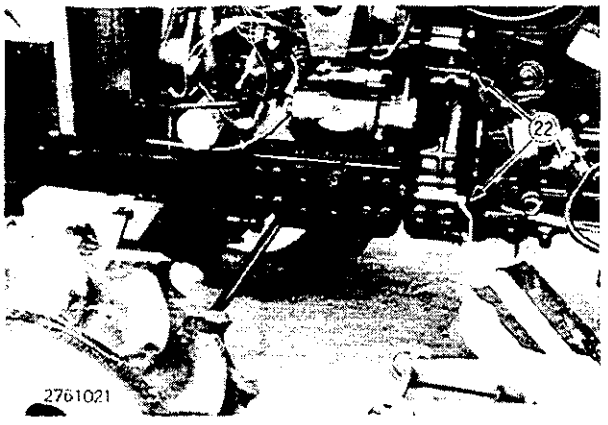


18. Attach lift eyes to engine for chain hoist.

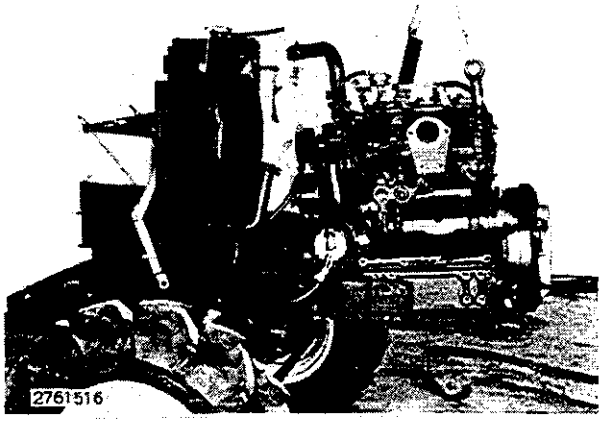


19. Insert blocks both sides between front axle bracket and axle housing.
20. Support tractor under clutch housing with hydraulic jack.
21. Loosen front axle bracket bolts before separating between engine and clutch housing. These bolts were applied with "Lock-tite" when assembled.

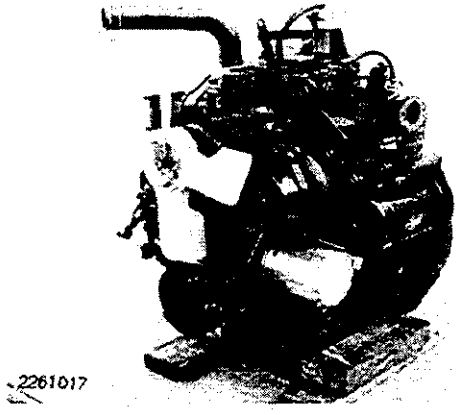
22. Remove clutch housing-to-engine cap screws (7 used).
23. Slowly roll back.



24. Remove all front axle bracket bolts (16 used).
25. Slowly lift engine straight up from front axle bracket.



26. When setting the engine down, support it at the edges of the oil pan. Be sure that no weight is put on the center of the oil pan.

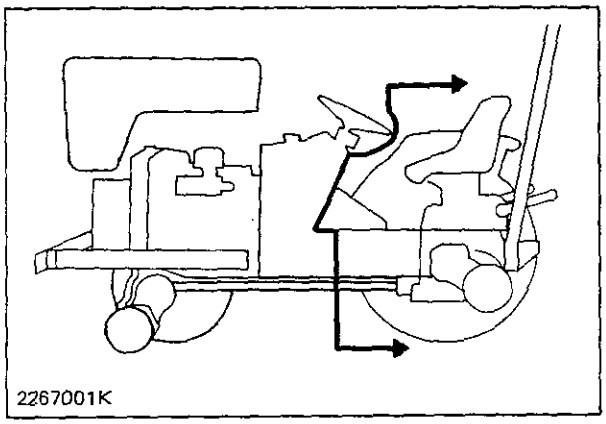


INSTALLATION

Reverse the removal steps on the preceding pages and refer the page 10-20-3 for front end installation to engine, page 10-20-6 for engine installation to clutch housing.

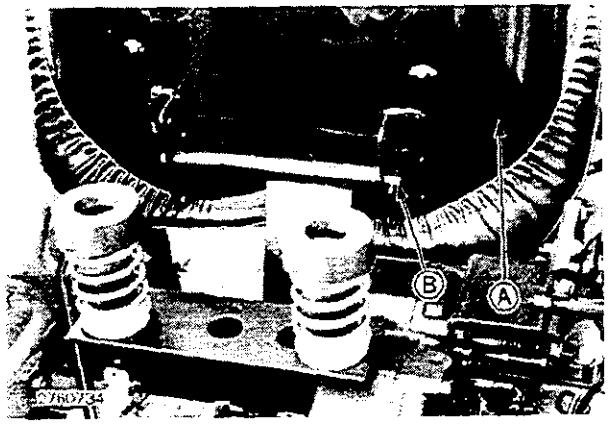
▼ **Apply liquid sealant to the sealing surface between clutch *housing and mounting flange.***

TRANSMISSION CASE FROM CLUTCH HOUSING


2267001K

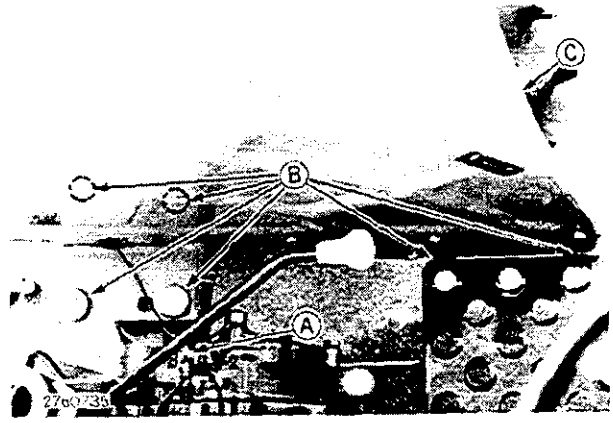
REMOVAL

Remove transmission case from clutch housing.



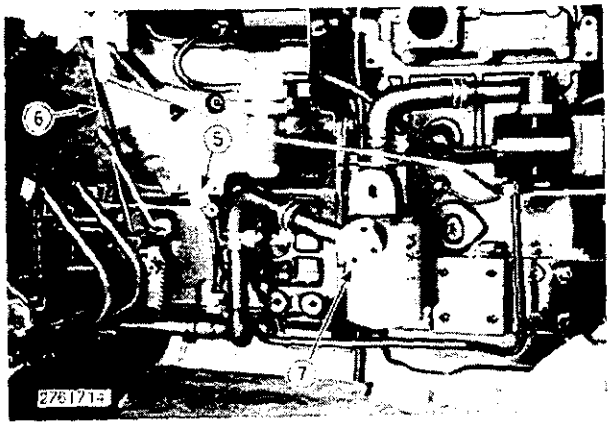
1. Remove seat (A) by pulling out seat hinge pin (B).

A – Seat
B – Seat Hinge Pin



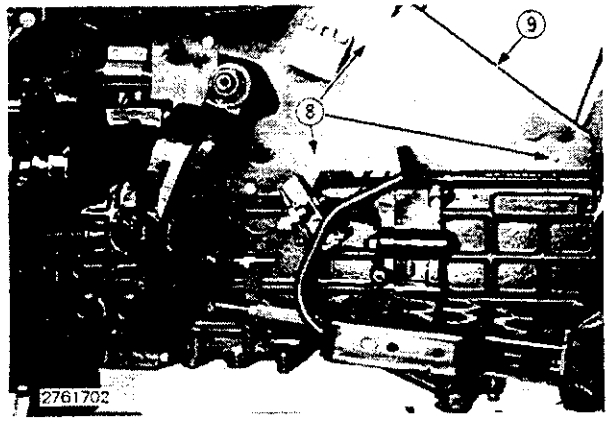
2. Disconnect ground cable of battery, then wire harness connector (A).
3. Remove cap screws (B) and fenders (C) from steps and rear axle housings.

A – Wire Harness Connector
B – Cap Screws
C – Fenders

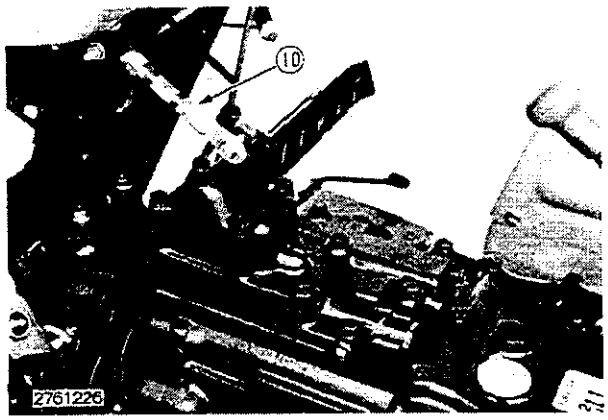


4. Remove front drive propeller shaft as described on page 10-20-2. (4WD only)
5. Disconnect wire harness connector.
6. Disconnect foot throttle linkage.
7. Disconnect hydraulic inlet head from cartridge filter.

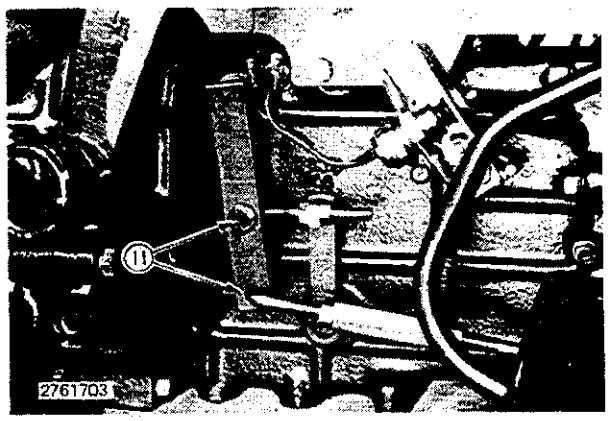
8. Remove cap screws.
9. Remove regulator cover.



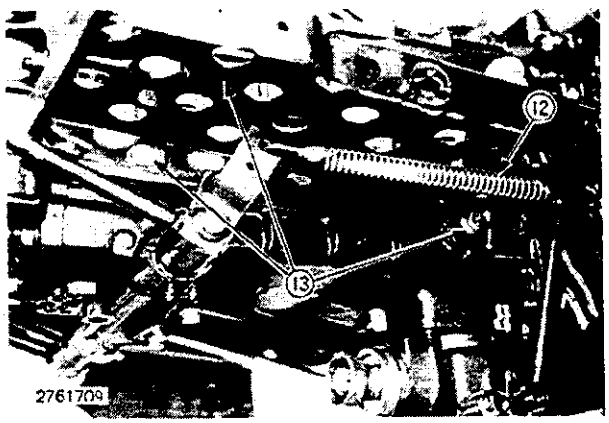
10. Disconnect shuttle shift linkage.

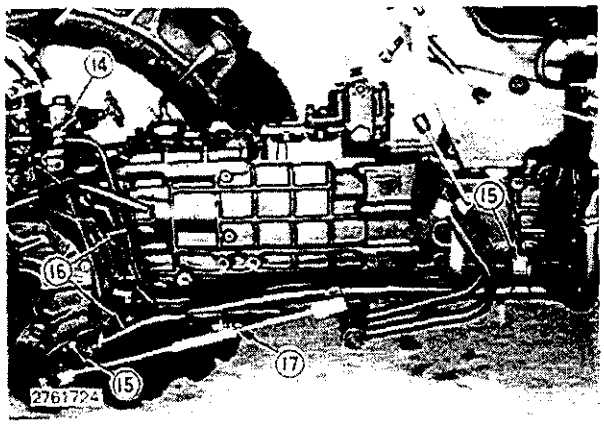


11. Disconnect clutch linkage at front.



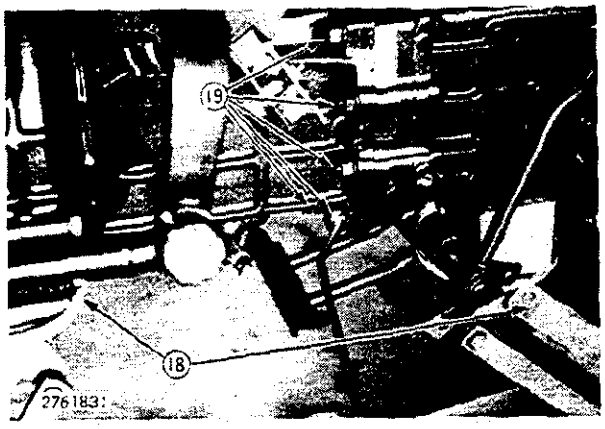
12. Remove brake return springs.
13. Remove cap screws and steps.



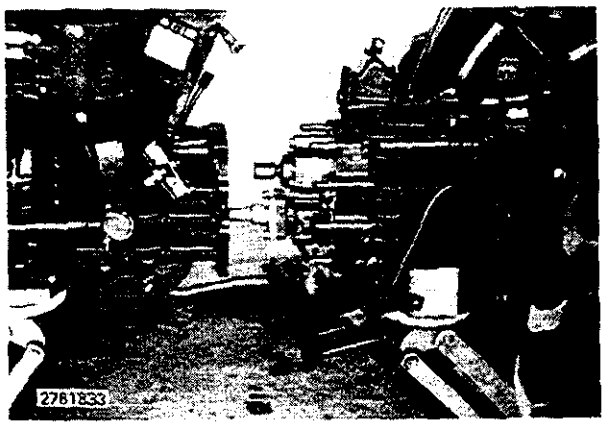


REMOVAL (Continued)

14. Remove hollow screw on cylinder head.
15. Remove cap screws.
16. Remove inlet and outlet hydraulic lines.
17. Remove brake rods.

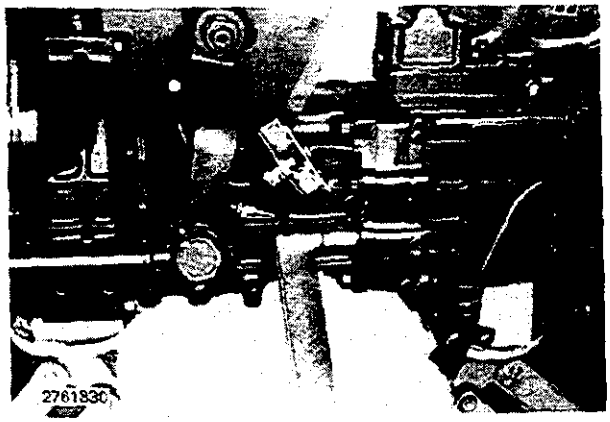


18. Support the tractor at clutch housing and apply garage jack to transmission to support.
19. Remove clutch housing-to-transmission case connecting nuts. There are nine nuts and underneath nut is easy to forget removing.



20. Roll the rear part of tractor back.

STOP **Separating about 4 inches, check if main drive shaft in front of power shift pump stays with clutch or not. If the shaft comes out completely from clutch section, SEPARATION AT ENGINE-TO-CLUTCH HOUSING is required to correct.**



INSTALLATION

Reverse the removal steps on the preceding pages.

Be sure that clutch disk stays correctly and spline shaft connectors are properly installed.

STOP **As mating front and rear part of tractor, pay attention to assemble clutch linkages.**

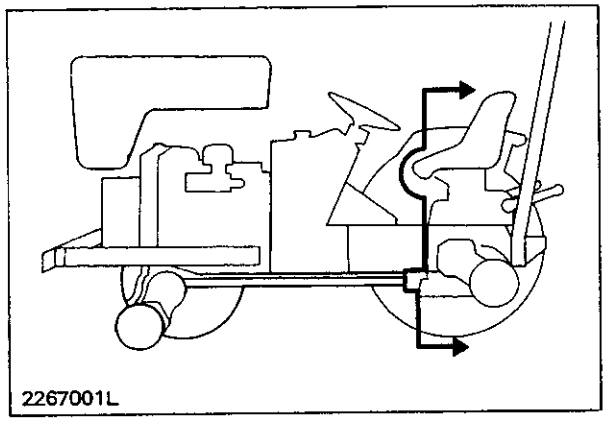
STOP **Before tightening nuts, check the clutch pedal operation correctly.**

Tighten clutch housing-to-transmission connecting nuts to
M14: 167 to 196 Nm (17 to 20 kgm) (123 to 145 ft-lbs)
M12: 118 to 137 Nm (12 to 14 kgm) (87 to 101 ft-lbs)

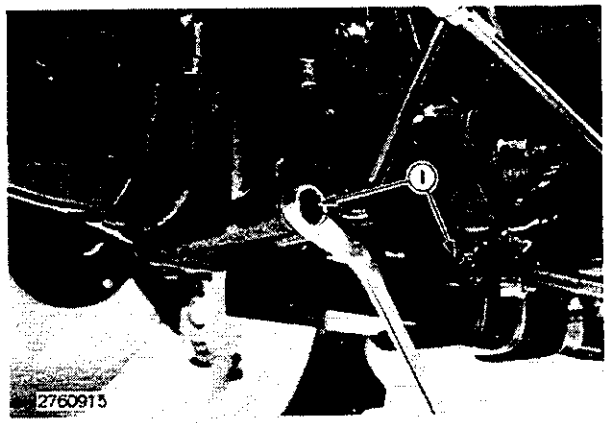
DIFFERENTIAL HOUSING FROM TRANSMISSION CASE

REMOVAL

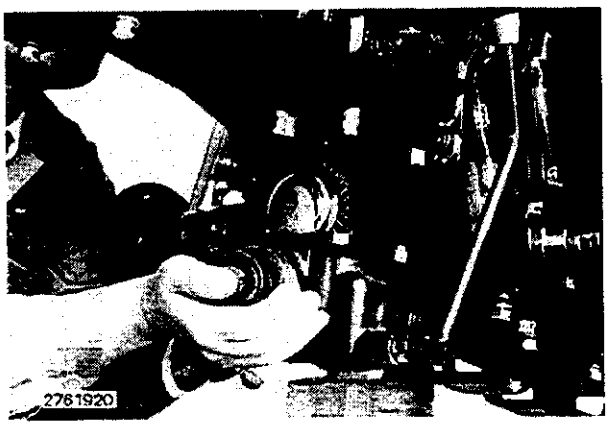
Remove differential housing from transmission case.


2267001L

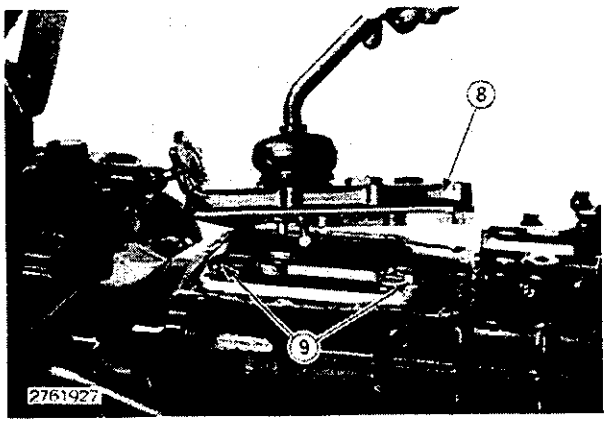
1. Drain transmission.
2. Remove three point hitches and drawbar.
3. Remove seat and fenders as described on page 10-20-10.
4. Remove front drive propeller shaft as described on page 10-20-2. (4WD only)
5. Remove brake return springs, foot throttle linkage, brake connecting rods, steps and hydraulic lines as described on 10-20-10, 10-20-11, 10-20-12.

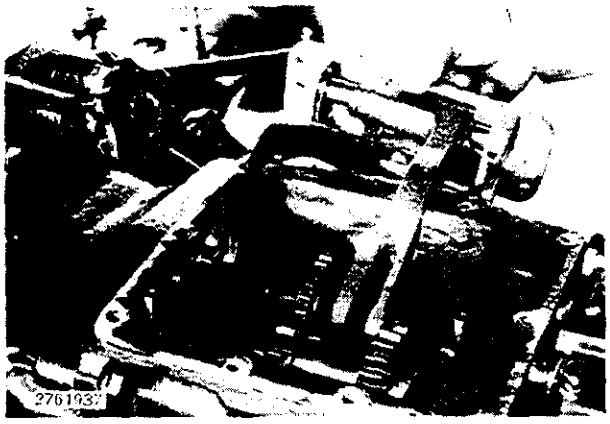


6. Remove front drive housing-to-transmission case cap screws and front drive assembly. Be free snap rings from counter shaft and move front drive gear and both sides snap rings forward as possible.


2761920

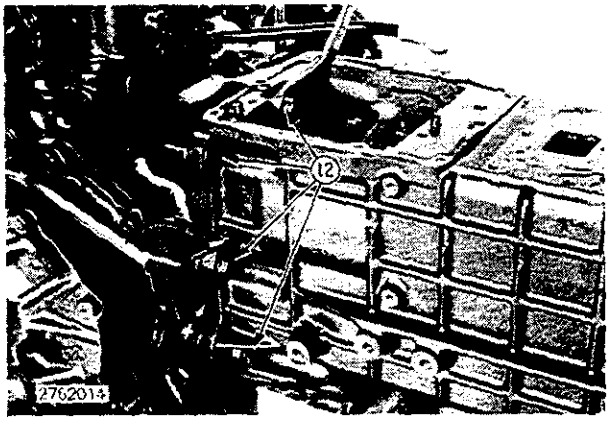
7. Remove transmission shift cover-to-transmission case cap screws.
8. Remove transmission shift cover assembly.
9. Remove cap screws.





REMOVAL (Continued)

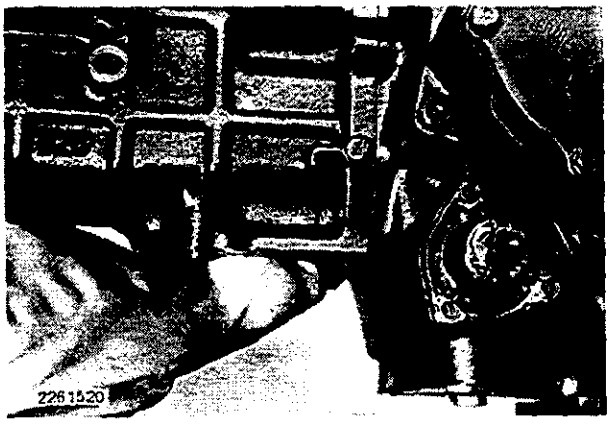
10. Remove shift fork assembly.



11. Support the tractor at transmission case and apply garage jack to differential housing to support.
12. Remove transmission case-to-differential housing cap screws.
13. Roll the rear part of tractor back.

Hold range shift gear from the window where lower cover (2WD)/front drive case (4WD) is removed, preventing from damage when the counter gear falling down.

Do not fall PTO connecting joint into differential housing.



INSTALLATION

Reverse the removal steps on the preceding page and note the installation instructions that follow.

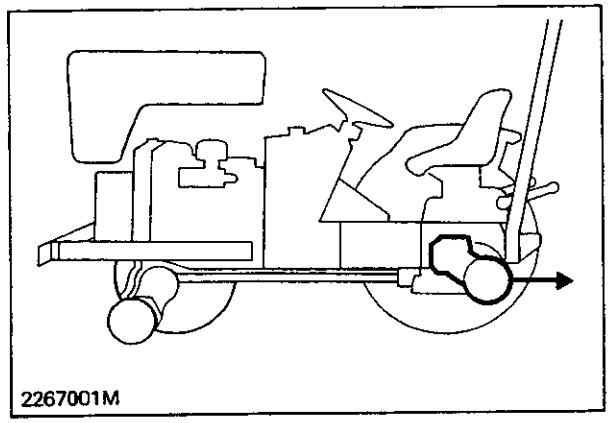
1. When docking transmission case and differential housing, mesh range shift gear and differential drive shaft by turning the range gear with hand from window of transmission bottom.
2. There are two length of cap screws for transmission case-to-differential housing. Two cap screws of bottom are M12 x 45, and others M12 x 35.

Item	Specification
Torque	98 Nm (10 kgm) (72 ft-lbs)

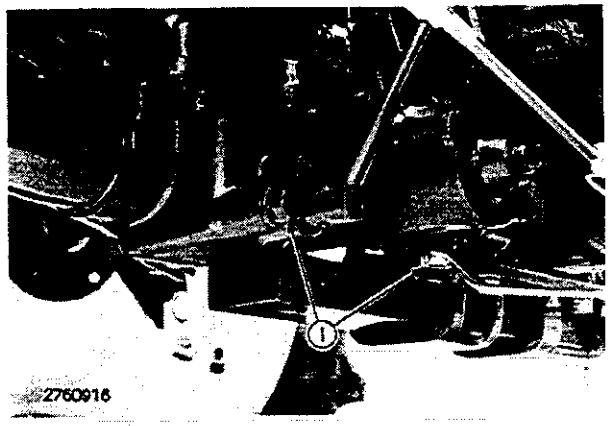
REAR AXLE HOUSING FROM DIFFERENTIAL HOUSING

REMOVAL

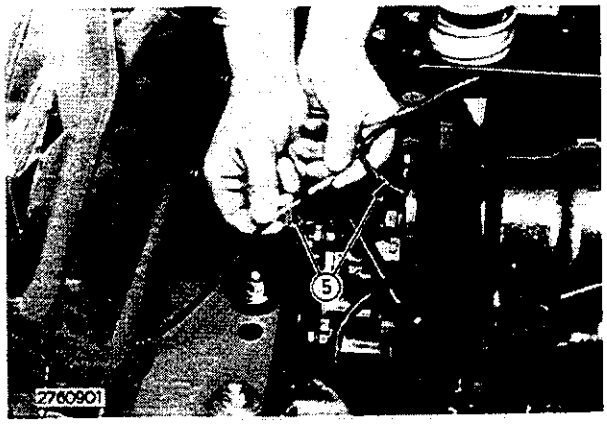
Remove rear axle housing from differential housing.


2267001M

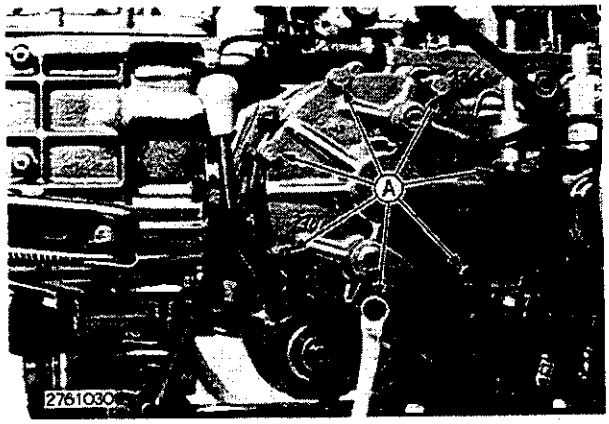
1. Drain transmission case.
2. Remove three point hitches and drawbar.

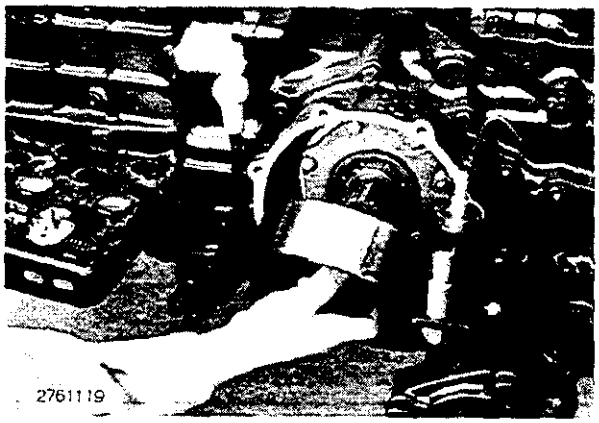


3. Support the tractor at drawbar bracket.
4. Remove rear tire.
5. Disconnect ground cable of battery, then flashing light cable and safety start cable at PTO shifting lever.
6. Remove fenders as described on page 10-20-10.



7. Disconnect brake rod.
8. Remove cap screws (A) and brake cover.

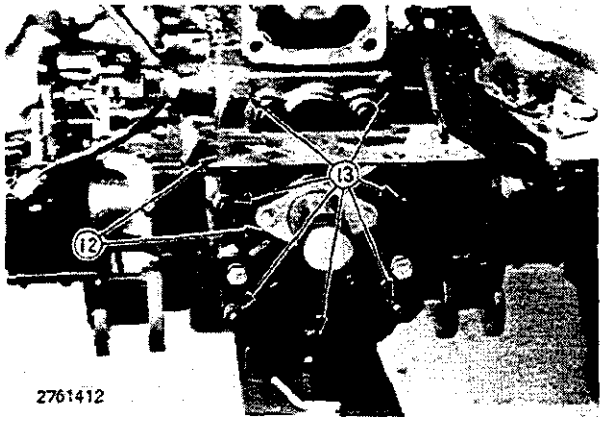




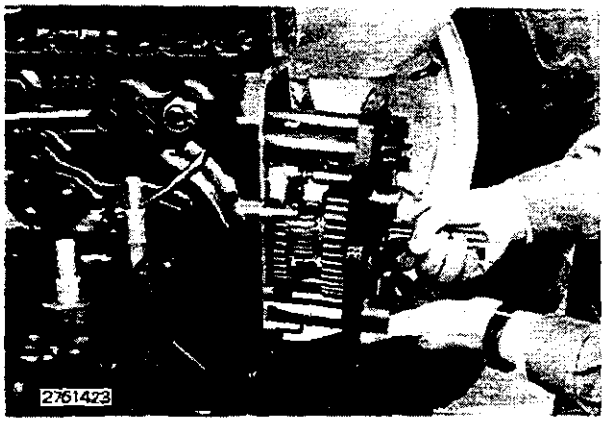
REMOVAL (Continued)

9. Flatten lock washer and remove cap screw, plate washer and brake drum.

10. Disconnect hydraulic control linkage.
11. Remove upper link hinge assembly.

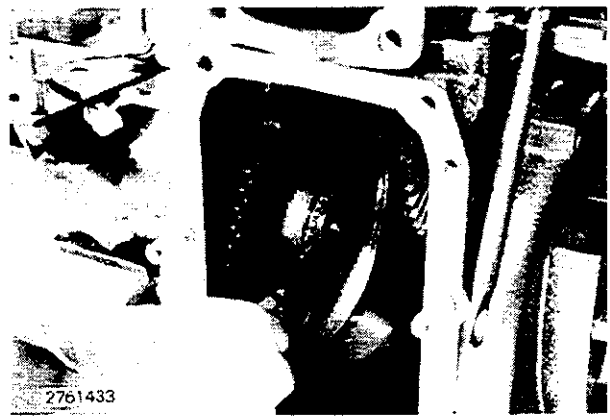


12. Remove PTO safety guard and PTO shield.
13. Remove three cap screws and four nuts.



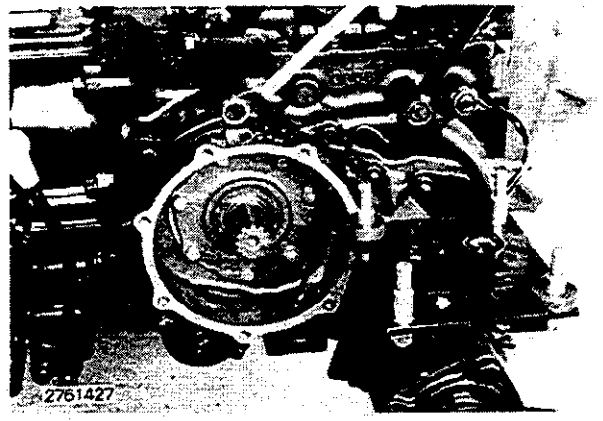
14. Pull PTO assembly out.

15. Remove snap ring on rear axle shaft to make final gear free from shaft.

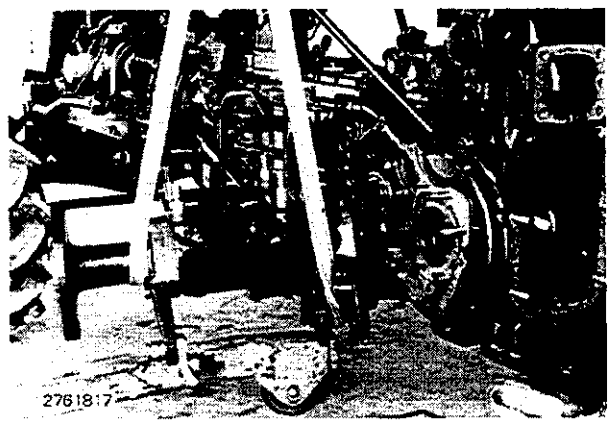


16. Support the axle housing with chain hoist.

17. Remove two nuts, eight cap screws and two cap screws on lower link hinge bracket of rear axle housing-to-differential case.



18. Remove rear axle housing.



INSTALLATION

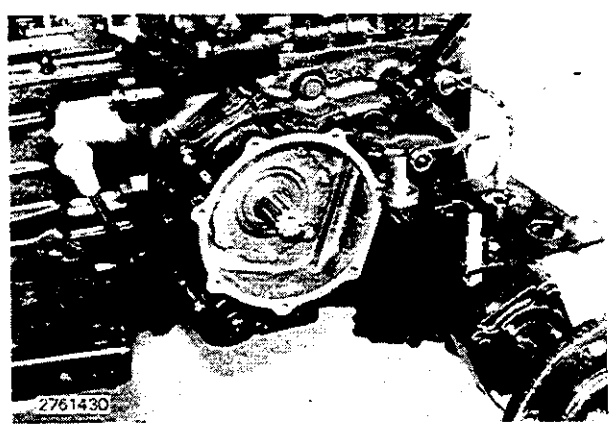
1. Reverse the removal steps on the preceding page.

2. Find out M10 x 58 cap screws which have "10.9T" mark on head. They are for lower link hinge bracket-to-axle housing-to-differential housing and apply with "LOCK-TITE".

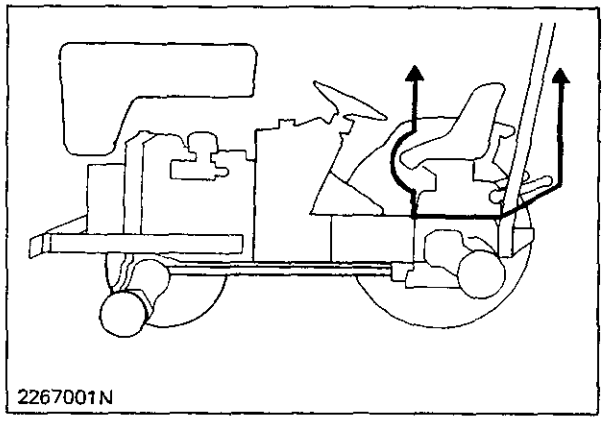
3. Reinstall ROPS and seat belt.

Tightening torque;

M10 x 58 (10.9T)	70 Nm (7 kgm) (52 ft-lbs)
All other nuts and cap screws	60 Nm (6 kgm) (43 ft-lbs)

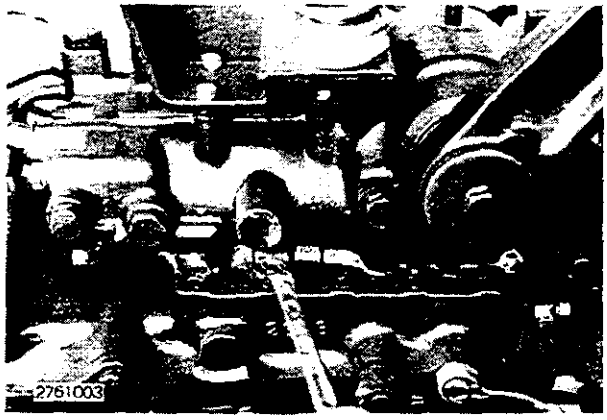


HYDRAULIC CYLINDER CASE FROM DIFFERENTIAL HOUSING

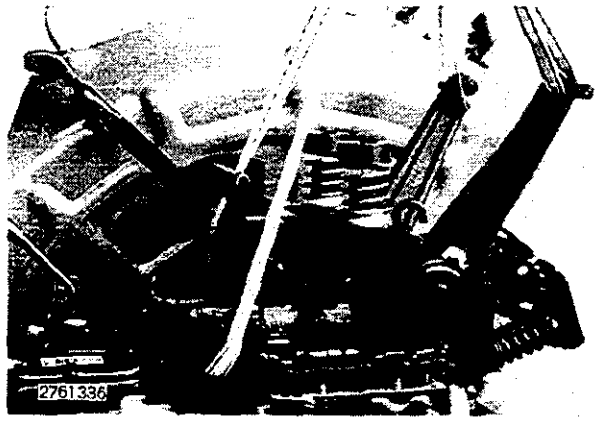

2267001N

REMOVAL

Remove hydraulic cylinder case from differential housing.


2761003

1. Remove seat for convenience of future works.
2. Remove pressure line from hydraulic cylinder head.
3. Remove three cap screws and seven nuts of hydraulic cylinder case-to-differential housing.


2761336

4. Remove hydraulic lift assembly with chain hoist.
5. Place the assembly on clean stand.

INSTALLATION

Reverse the removal step on the preceding page.

1. Replace the gasket.
2. Tighten hydraulic cylinder case-to-differential housing cap screws and nuts to 60 Nm (6 kgm) (43 ft-lbs).

CAUTION: Reinstall ROPS and seat belt if removed.

ENGINE REPAIR 20

SPECIFICATIONS SPECIAL TOOLS

Cylinder Head, Valves and Camshaft

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Rocker Arm Assembly		
Shaft O.D.	13.98 to 14.00 mm (0.5504 to 0.5512 in.)	13.90 mm (0.5472 in.)
Bushing I.D.	14.02 to 14.03 mm (0.5520 to 0.5524 in.)	14.10 mm (0.5512 in.)
Bushing-to-shaft clearance	0.016 to 0.052 mm (0.0006 to 0.002 in.)	0.15 mm (0.006 in.)
Valve Springs		
Free Hength	40.0 mm (1.57 in.)	39.5 mm (1.55 in.)
Spring tilt	----------	1.40 mm (0.055 in.)
Spring compression	37.4 kg at 23.50 mm (89.45 lbs. at 0.92 in.)	36.00 kg at 23.50 mm (79.36 lbs. at 0.92 in.)
Valve Face Angle	45°	
Valve Face O.D.		
Intake	35.0 mm (1.37 in.)	
Exhaust	29.0 mm (1.14 in.)	
Valve Stem O.D.	7.96 to 7.97 mm (0.3133 to 0.3137 in.)	6.90 mm (0.271 in.)
Valve Guide I.D.	8.01 to 8.025 mm (0.3153 to 0.3159 in.)	8.08 mm (0.318 in.)
Guide-to-Stem Clearance	0.04 to 0.06 mm (0.002 to 0.003 in.)	0.15 mm (0.006 in.)
Valve Seat Angle	45°	
Valve Seat Width		
Exhaust valve	1.77 mm (0.070 in.)	
Intake valve	1.77 mm (0.070 in.)	
Valve Height (recessed)	1.00 mm (0.039 in.)	1.500 mm (0.059 in.)
Cylinder Head Distorition	0.03 mm (0.0012 in.)	0.1 mm (0.004 in.)
Camshaft Gear Backlash	0.08 to 0.16 mm (0.003 to 0.006 in.)	0.30 mm (0.012 in.)
Camshaft Journal O.D.		
Flywheel side journal	29.939 to 29.960 mm (1.179 to 1.180 in.)	29.84 mm (1.175 in.)
Between No. 1 & No. 2 cyl.	41.425 to 41.450 mm (1.631 to 1.632 in.)	41.28 mm (1.625 in.)
Between No. 2 & No. 3 cyl.	42.425 to 42.450 mm (1.670 to 1.671 in.)	42.28 mm (1.665 in.)
Camshaft Bearing Bore I.D.		
Flywheel side	30.000 to 30.021 mm (1.181 to 1.182 in.)	30.07 mm (1.184 in.)
Between No. 1 & No. 2 cyl.	41.500 to 41.525 mm (1.634 to 1.635 in.)	41.58 mm (1.637 in.)
Between No. 2 & No. 2	42.500 to 42.525 mm (1.673 to 1.674 in.)	42.58 mm (1.676 in.)
Valve Clearance		
Intake and Exhaust Valves	0.2 mm (0.008 in.) (cold condition)	

Cylinder Head, Valves and Camshaft (Continued)

ITEM	NEW PART SPECIFICATIONS	WEAR LIMT
Camshaft Bearing-to-journal Oil Clearance		
Flywheel side	0.04 to 0.08 mm (0.001 to 0.003 in.)	0.12 mm (0.004 in.)
Others	0.05 to 0.10 mm (0.002 to 0.004 in.)	0.15 mm (0.006 in.)
Camshaft Lobe O.D.		
Intake exhaust valve	35.00 mm (1.378 in.)	34.50 mm (1.358 in.)
Fuel pump	45.00 mm (1.772 in.)	44.90 mm (1.768 in.)
Tappet O.D.	9.98 to 9.99 mm (0.393 to 0.394 in.)	9.95 mm (0.392 in.)
Tappet Bore I.D.	10.005 to 10.020 mm (0.394 to 0.395 in.)	10.07 mm (0.396 in.)
Oil Clearance	0.01 to 0.04 mm (0.0004 to 0.0016 in.)	0.10 mm (0.004 in.)
Push Rod Bend	0.03 mm (0.0012 in.)	0.3 mm (0.012 in.)
Push Rod Length	188.0 mm (7.401 in.)	187.5 mm (7.382 in.)

TORQUES

Cylinder Head Bolts and Nuts	
Initial	39 Nm (4.0 kgm) (29 ft-lbs)
Second	78 Nm (8.0 kgm) (58 ft-lbs)
Final	127 Nm (13.0 kgm) (94 ft-lbs)
Cylinder Head Assist Bolts and Nuts	29 Nm (3.0 kgm) (22 ft-lbs)
Rocker Arm Shaft Support Nuts	54 Nm (4.5 to 5.6 kgm) (40 ft-lbs)
Timing Gear Cover Cap Screws	25 to 27 Nm (2.5 to 2.7 kgm) (18 to 19.5 ft-lbs)
Governor Weight Support	
Securing Nut	74 Nm (7.0 to 7.5 kgm) (54 ft-lbs)
Camshaft Ball Bearing	
Retainer Screw	20 Nm (2.0 kgm) (15 ft-lbs)
Cam Gear & F.I. Cam Nut	68 Nm (7.0 kgm) (50 ft-lbs)

Cylinder Block, Liners, Pistons and Rods

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Piston Ring-Groove Clearance		
Top ring	0.065 to 0.1000 mm (0.0015 to 0.004 in.)	0.30 mm (0.012 in.)
Second ring	0.035 to 0.070 mm (0.0014 to 0.003 in.)	0.25 mm (0.010 in.)
Oil ring	0.020 to 0.055 mm (0.0008 to 0.0022 in.)	0.25 mm (0.010 in.)
Piston Ring Gap		
Top ring	0.25 to 0.45 mm (0.009 to 0.017 in.)	1.5 mm (0.06 in.)
Second ring	0.20 to 0.40 mm (0.008 to 0.016 in.)	1.5 mm (0.06 in.)
Oil ring	0.25 to 0.45 mm (0.009 to 0.017 in.)	1.5 mm (0.06 in.)
Piston O.D.	83.902 to 83.932 mm (3.303 to 3.304 in.)	83.800 mm (3.299 in.)
Piston Pin O.D.	25.991 to 26.000 mm (1.023 to 1.024 in.)	25.900 mm (1.019 in.)
Piston Pin Bushing I.D.	26.025 to 26.038 mm (1.024 to 1.025 in.)	26.100 mm (1.027 in.)
Pin-to-Bushing		
Oil Clearance	0.025 to 0.047 mm (0.0009 to 0.001 in.)	0.15 mm (0.006 in.)
Connecting Rod Bearing		
I.D.	47.000 to 47.042 mm (1.850 to 1.852 in.)	47.100 mm (1.854 in.)
Connecting Rod Journal		
O.D.	46.950 to 46.964 mm (1.848 to 1.849 in.)	46.920 mm (1.847 in.)
Bearing-to-Journal		
Clearance	0.036 to 0.092 mm (0.0014 to 0.0036 in.)	0.15 mm (0.006 in.)
Cylinder Liner Height Above		
Block	0.005 to 0.075 mm (0.0002 to 0.003 in.)	
Cylinder Liner I.D.	84.008 to 84.035 mm (3.307 to 3.308 in.)	84.180 mm (3.314 in.)
Cylinder Liner-to-Piston		
Clearance	0.068 to 0.133 mm (0.002 to 0.005 in.)	0.280 mm (0.011 in.)

TORQUES

Connecting Rod Caps	44 to 49 Nm (4.5 to 5.0 kgm) (33 to 36 ft-lbs)
Cylinder Block Mounting Flange-to-Cylinder Block Cap Screws	39 to 49 Nm (4.0 to 5.0 kgm) (29 to 36 ft-lbs)

Crankshaft, Main Bearings and Flywheel

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Crankshaft end play	0.09 to 0.19 mm (0.0035 to 0.0075 in.)	0.33 mm (0.013 in.)
Main bearing I.D.		
Rear (Flywheel side)	65.000 to 65.045 mm (2.559 to 2.560 in.)	65.10 mm (2.563 in.)
Others	60.00 to 60.045 mm (2.362 to 2.364 in.)	60.10 mm (2.366 in.)
Bearing-to-journal oil clearance	0.036 to 0.095 mm (0.0014 to 0.0037 in.)	0.15 mm (0.006 in.)
Main bearing journal O.D.		
Rear (Flywheel side)	64.950 to 64.964 mm (2.5571 to 2.5576 in.)	64.920 mm (2.556 in.)
Others	59.950 to 59.964 mm (2.360 to 2.361 in.)	59.92 mm (2.359 in.)
Flywheel clutch surface Flatness	14.935 to 14.953 mm (0.588 to 0.588 in.)	
Clutch shaft-to-bushing oil clearance		0.3 mm (0.012 in.)

TORQUES

Main bearing housing half cap screws	44.1 to 49.0 Nm (4.5 to 5.0 kgm) (32.5 to 36.1 ft-lbs)
Intermediate bearing housing set screws	68.6 to 73.5 Nm (7.0 to 7.5 kgm) (50.6 to 54.2 ft-lbs)
Rear main bearing housing-to-block cap screws	24.5 to 26.5 Nm (2.5 to 2.7 kgm) (18.5 to 19.5 ft-lbs)
Flywheel-to-crankshaft cap screws	68.6 to 73.5 Nm (7.0 to 7.5 kgm) (50.6 to 54.2 ft-lbs)
Crankshaft Gear-to-crankshaft	69 to 73 Nm (7.0 to 7.5 kgm) (51 to 54 ft-lbs)
Crankshaft pulley-to-crankshaft	*17.6 to 19.6 Nm (18.0 to 20.0 kgm) (13.0 to 14.4 ft-lbs)*

Lubrication System

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Engine oil pressure	245 to 392 Kpa (2.5 to 4.0 kg/cm^2) (36 to 57 psi)	
Oil pump-crankshaft gear backlash	0.08 to 0.16 mm (0.003 to 0.006 in.)	0.3 mm (0.012 in.)
Oil pump rotor recess	0.03 to 0.09 mm (0.0012 to 0.0035 in.)	0.15 mm (0.006 in.)
Outer rotor-to-pump body clearance	0.10 to 0.16 mm (0.004 to 0.006 in.)	0.25 mm (0.01 in.)
Inner rotor-to-outer rotor clearance	0.10 to 0.16 mm (0.004 to 0.006 in.)	0.25 mm (0.01 in.)
TORQUES		
Oil pan cap screws	7.8 to 9.8 Nm (0.8 to 1.0 kgm) (5.8 to 7.2 ft-lbs)	

Cooling System

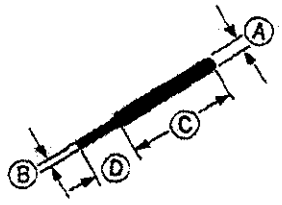
ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Radiator leakage test	147 Kpa (0.99 kg/cm^2) (21 psi)	
Radiator cap pressure	74 to 103 Kpa (0.75 to 1.05 kg/cm^2) (11 to 15 psi)	
Fan belt deflection	10 to 15 mm (3/8 to 5/8 in.) at 98.1 N (10 kg) (22 lbs.) force	
Thermostat opening temperature	69.5 to 72.5°C (157 to 163°F)	
Temperature Sending Units	110°C (230°F)	

Gasket and Bonding Materials

AREA	APPLICATION LOCATION	GASKET BONDING MATERIAL
Cylinder Head	Cylinder head gasket	NO NEED
Injection Pump	Injection Timing Adjusting Shims	Silicon Gasket
Timing Gear Cover	Timing gear cover gasket (both sides)	NO NEED
Cylinder Block	Oil pan gasket (both sides)	NO NEED
	Threaded part of lube oil intake pipe	LOC-TITE

SPECIAL TOOLS

Valve Guide Tool (121420-92300)

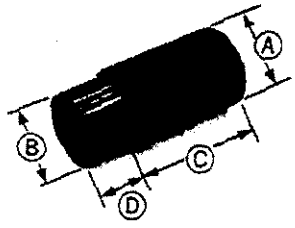


3364810

Removing and installing valve guide

A – 11 mm (0.43 in.)
B – 8.5 mm (0.31 in.)
C – 100 mm (4.00 in.)
D – 40 mm (1.60 in.)

Piston Pin Bushing Tool



3361335

Removing and installing piston pin bushing

A – 27.8 to 28.00 mm (1.094 to 1.102 in.)
B – 26.975 to 26.000 mm (1.062 to 1.023 in.)
C – 50.0 mm (1.97 in.)
D – 20 mm (0.8 in.)

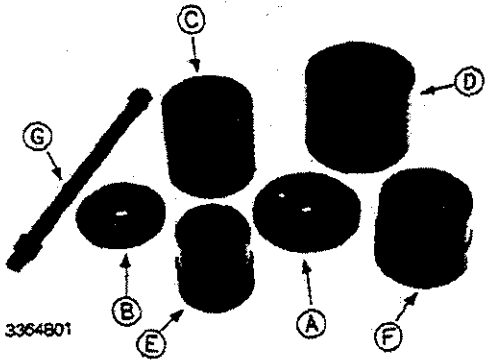
Flywheel, Crankshaft Gear and Pulley Puller (TOL-92000000)

336T132

Removing flywheel, crankshaft gear and pulley.

Use M10 x 40 mm bolts to remove Crankshaft pulley

Crankshaft Main Bearing Removal and Installation Tools



3364801

Removing and installing front and rear main bearings.

A – Metal Piece (A)
B – Metal Piece (B)
C – Spacer
F – Guide (Large)
G – Bolt and Nuts

Dimensions of each piece are shown next pages.

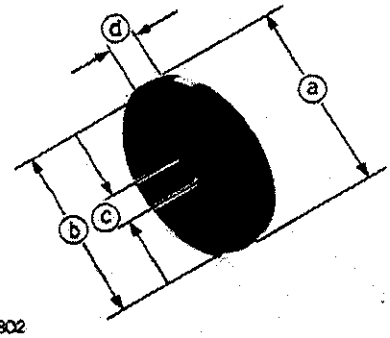
SPECIAL TOOLS (Continued)

Crankshaft Main Bearing Removal and Installation Tools (Continued)

METAL PIECE (A) (124460 – 92420)

Dimentions:

a – 89 mm (3.50 in.)
b – 79.9 to 80 mm (3.146 to 3.15 in.)
c – (Center hole) – 17 mm (0.669 in.)
d – 13 mm (0.512 in.)

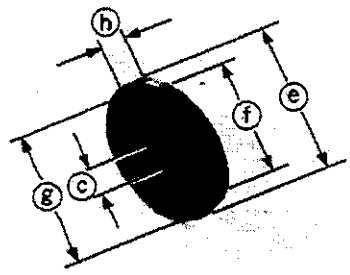


3364802

METAL PIECE (B) (124460 – 92430)

Dimensions:

c – (Center hole) – 17 mm (0.669 in.)
e – 79 mm (3.11 in.)
f – 59.8 to 59.9 mm (2.35 to 2.36 in.)
g – 69.8 to 69.9 mm (2.748 to 2.752 in.)
h – 16 mm (0.630 in.)

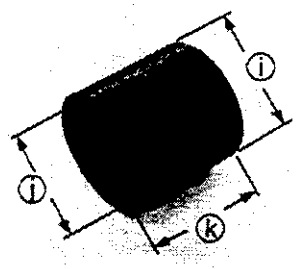


3364803

SPACER (124460 – 92440)

Dimensions:

i – 96 mm (3.78 in.)
j – 80.0 to 80.1 mm (3.149 to 3.153 in.)
k – 90 mm (3.54 in.)

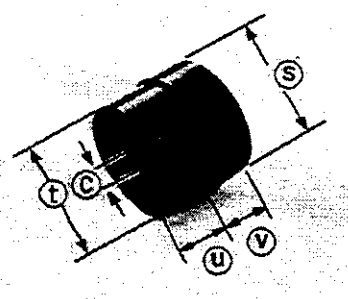


3364806

(124060 – 92410)

Dimensions:

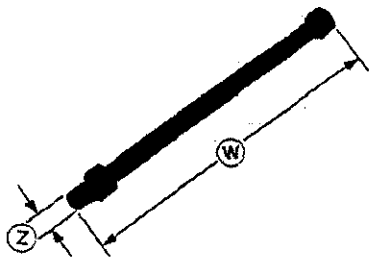
c – (Center hole) – 17 mm (0.669 in.)
s –
t – 64.96 to 64.97 mm (2.556 to 2.557 in.)
u – 24 mm (0.94 in.)
v – 25 mm (0.98 in.)



3364805

SPECIAL TOOLS (Continued)

Bolt and Nuts (124460 – 92450)



3364808

Dimensions:

w – 275 mm (10.8 in.)
z – 16 mm (0.63 in.) Diameter

Pilot Bushing Removal Tool

Removing pilot bushing from crankshaft.

3361031

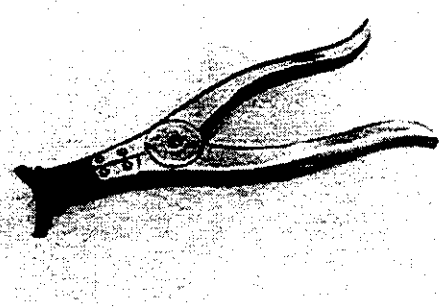
Piston Ring Compressor

Installing piston into cylinder liner.

3361037

Piston Ring Expander

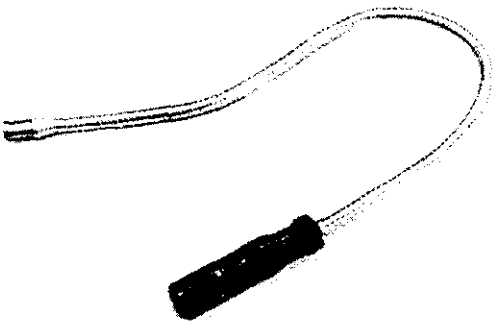
Removing and installing Piston Ring.



3361332

Magnetic Finger

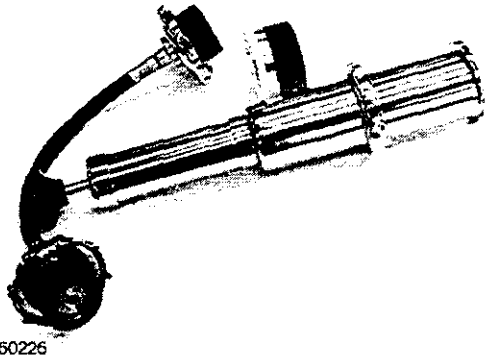
Holding tappet up when installing camshaft.



3361128

Radiator Tester

Checking radiator cap and system leakage.



3360226

DIAGNOSING MALFUNCTIONS

Sticking Valves

- Carbon deposits on valve stem
- Worn valve guides
- Warped valve stems
- Cocked or broken valve springs
- Worn or distorted valve seats
- Insufficient lubrication

Warped, Worn, or Distorted Valve Guides

- Lack of lubrication
- Cylinder head distortion
- Excessive heat
- Unevenly tightened cylinder head cap screws

Distorted Cylinder Head and Cylinder Head Gasket Leakage

- Improperly tightened cylinder head cap screws
- Faulty gasket installation
- Excessive oil pressure
- Improper cylinder liner height above cylinder block

Worn Valve Seats

- Misaligned valves
- Distorted cylinder head
- Carbon deposits on seats due to incomplete combustion
- Valve spring tension too weak
- Excessive heat
- Improper valve clearance
- Improper valve timing

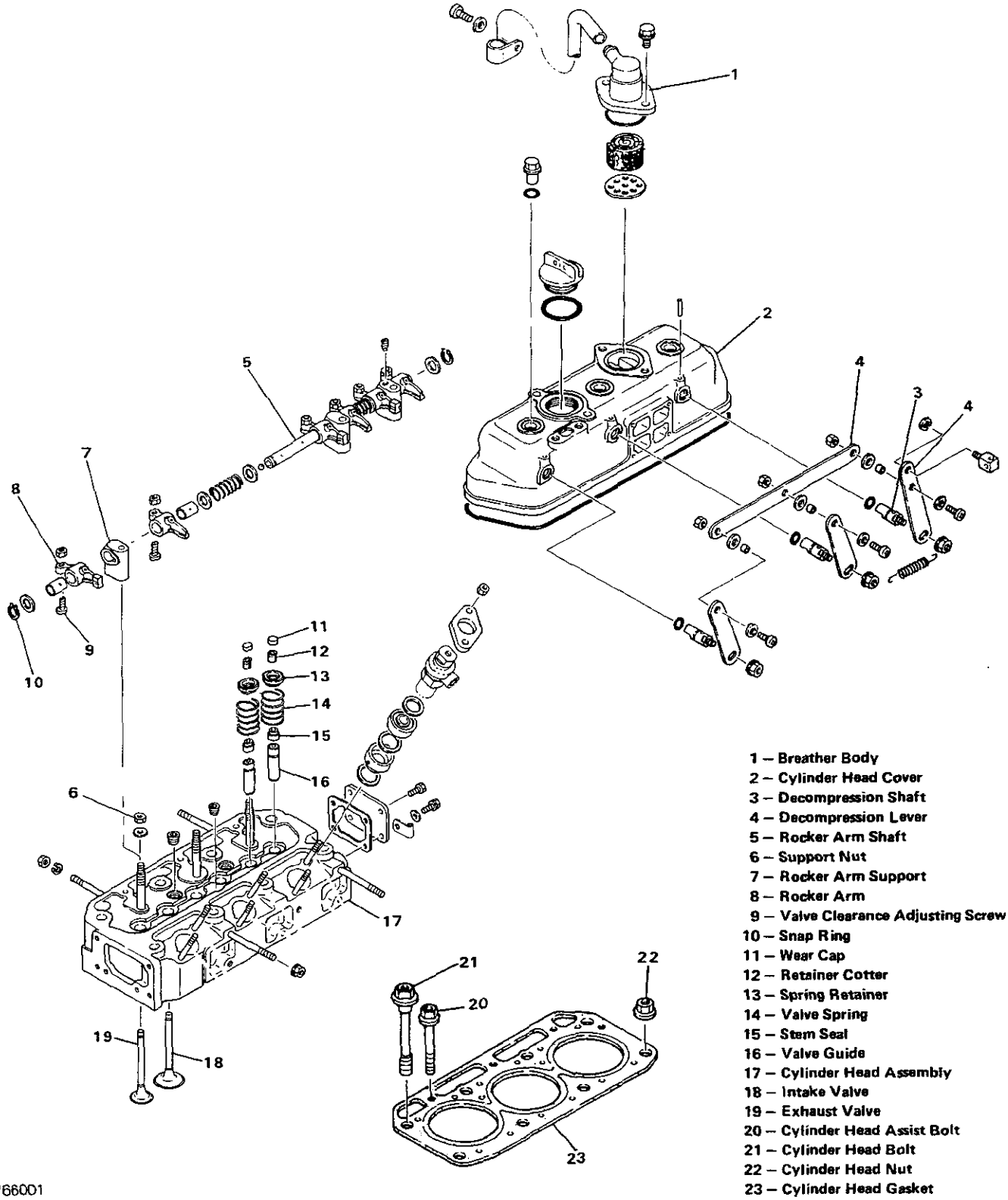
Burned, Pitted, Worn, or Broken Valves

- Worn or distorted valve seats
- Worn valve guides
- Insufficient cooling
- Insufficient lubrication
- Cocked or broken valve springs
- Improper engine operation
- Improper valve train timing
- Warped or distorted valve stems
- Distorted cylinder head
- Bent push rods
- Carbon build-up valve seats
- Rocker arm failure

Camshaft Failure

- Scored camshaft lobes due to inadequate lubrication
- Excessive end play due to bearing failure.
- Broken or warped camshaft due to improper valve timing or scored camshaft lobes.

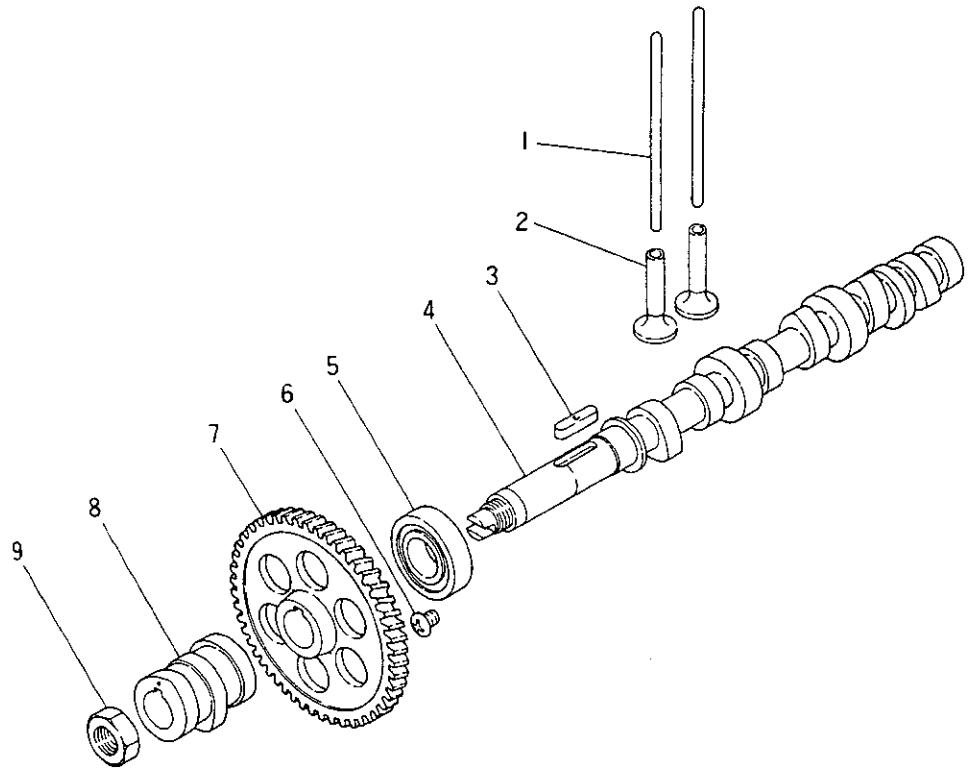
CYLINDER HEAD & HEAD COVER



1 – Breather Body
2 – Cylinder Head Cover
3 – Decompression Shaft
4 – Decompression Lever
5 – Rocker Arm Shaft
6 – Support Nut
7 – Rocker Arm Support
8 – Rocker Arm
9 – Valve Clearance Adjusting Screw
10 – Snap Ring
11 – Wear Cap
12 – Retainer Cotter
13 – Spring Retainer
14 – Valve Spring
15 – Stem Seal
16 – Valve Guide
17 – Cylinder Head Assembly
18 – Intake Valve
19 – Exhaust Valve
20 – Cylinder Head Assist Bolt
21 – Cylinder Head Bolt
22 – Cylinder Head Nut
23 – Cylinder Head Gasket

2766001

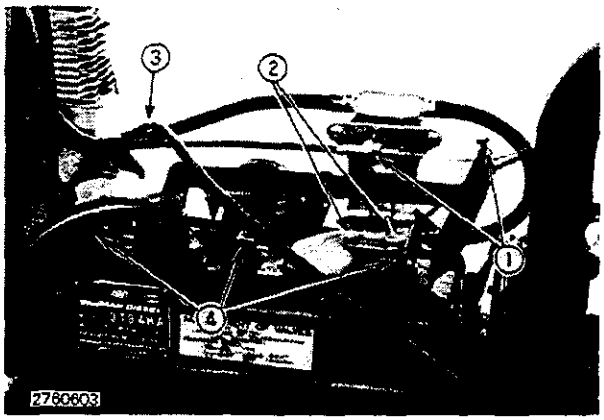
CAMSHAFT



1866002

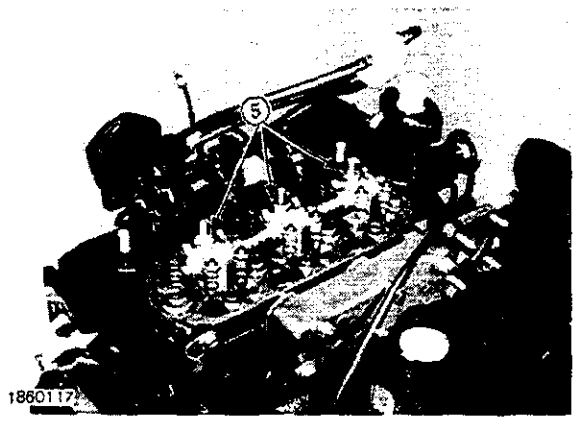
1 – Push Rod
2 – Tappet
3 – Key
4 – Camshaft
5 – Bearing
6 – Bearing Retainer Screw
7 – Camshaft Gear
8 – Fuel Injection Pump Cam
9 – Nut

ROCKER ARM ASSEMBLY



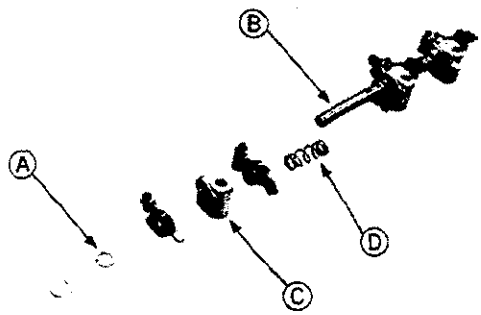
REMOVAL

1. Disconnect decompression linkage.
2. Remove thermostart fuel cup support mounting screws.
3. Push hourmeter cable further to lift the cylinder head cover.
4. Remove cylinder head cover cap screws, and remove cylinder head cover.



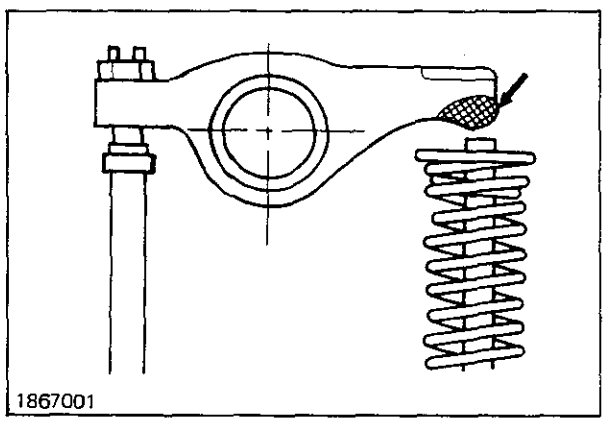
5. Remove rocker arm support nuts, and remove rocker arm assembly

STOP When removing rocker arm shaft components, identify for reassembly into original position.



6. Remove rocker arm shaft end snap rings and slide components from shaft.

A – Snap Ring
B – Shaft
C – Rocker Arm Support
D – Spacer Spring



INSPECTION AND REPAIR

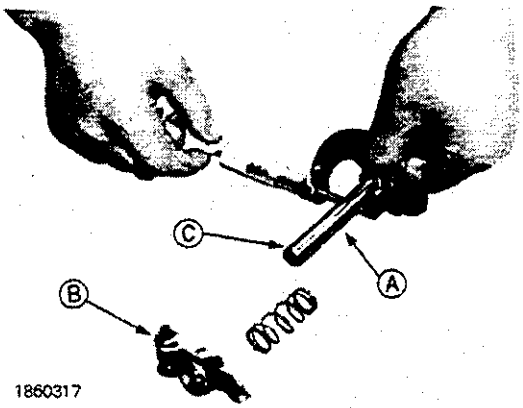
1. Inspect rocker arm shaft for scratches, scores, or excessive wear at points of rocker arm contact.
2. Check for wear on ends of rocker arms where they contact valve tip caps.

3. Be sure that all oil holes are open and clean (A).

4. Check valve clearance adjusting screws and nuts for damage (B).

5. Measuring O.D. of rocker arm shaft (C) as shown. Replace rocker arm shaft if the measurement exceeds the following wear limit.

Item	New Part	Wear Limit
Shaft O.D.	13.98 to 14.00 mm (0.5504 to 0.5512 in.)	13,90 mm (0.5472 in.)

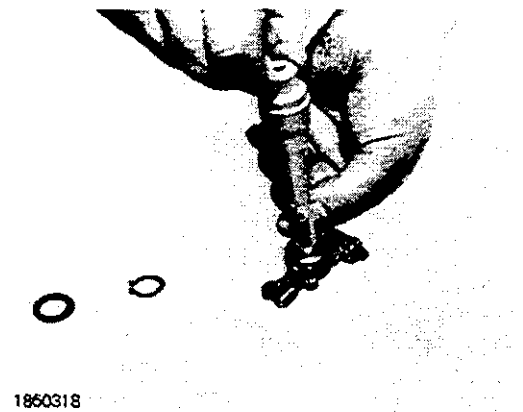


1860317

A – Oil Holes
B – Adjusting Screw
C – Rocker Arm Shaft

6. Measuring I.D. of bushings in the rocker arm. Replace bushings if the measurement exceeds the following wear limit.

Item	New Part	Wear Limit
Bushing I.D.	14.02 to 14.03 mm (0.5520 to 0.5524 in.)	14.10 mm (0.555 in.)
Bushing-to-Shaft Clearance	0.016 to 0.052 mm (0.0006 to 0.002 in.)	0.15 mm (0.006 in.)


1860318

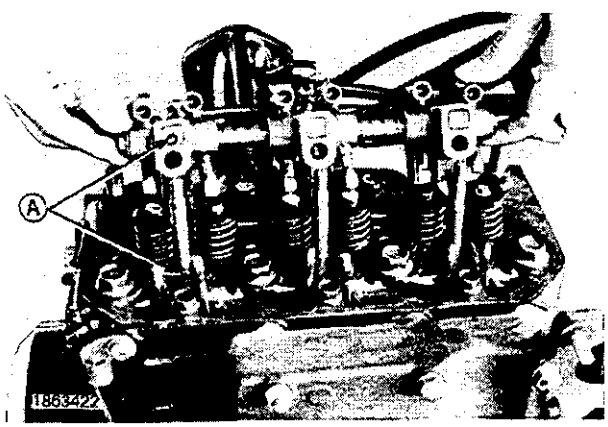
ASSEMBLY AND INSTALLATION

1. Assemble parts on rocker arm shaft in reverse of sequence removed.

2. Make sure rocker arm shaft end snap rings are firmly inserted into prooves of shaft.

3. Position rocker arm shaft on head, insuring that spring pin and lubricating oil hole in rocker arm support line up.

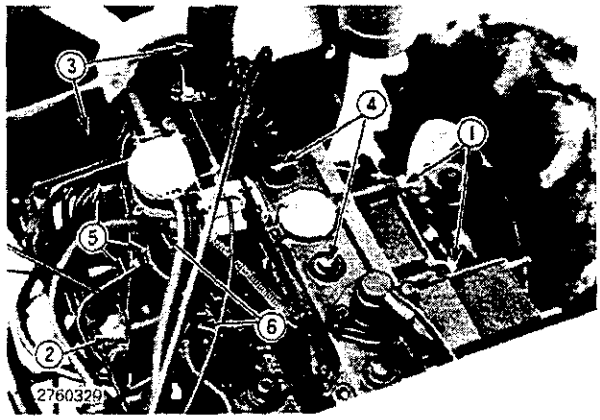
4. Tighten rocker arm support nuts to 54 Nm (5.6 kgm, 40 ft-lbs).



1860322

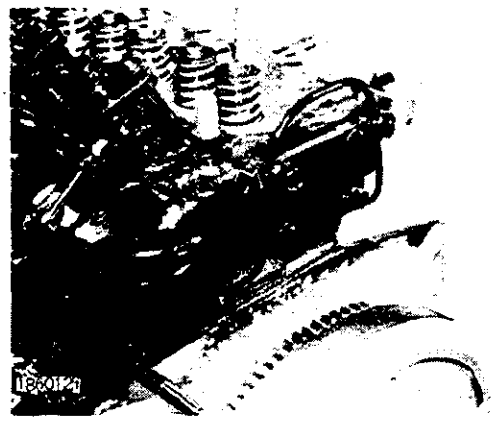
A – Lubricating oil hole

VALVES, VALVE SPRINGS, AND WEAR CAPS

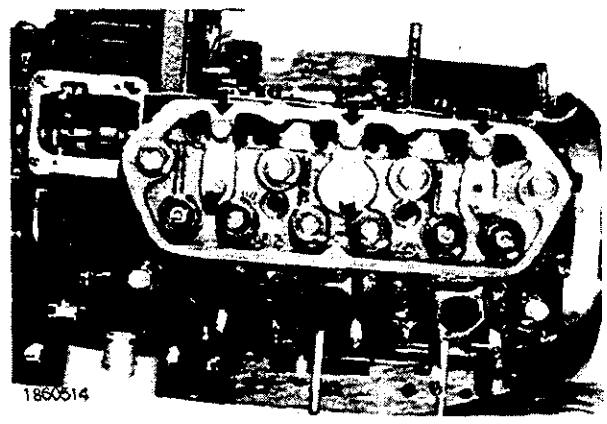


REMOVAL

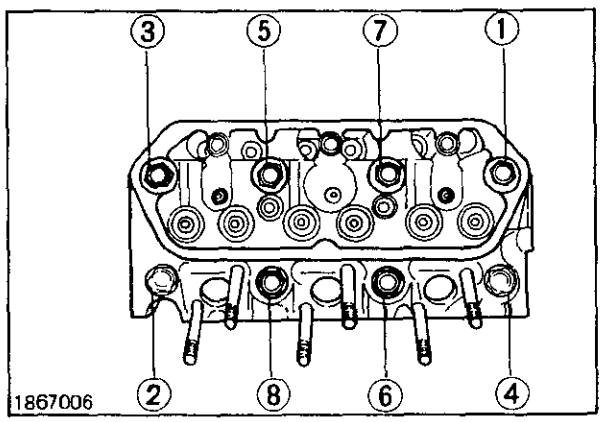
1. Remove exhaust manifold with muffler.
2. Remove intake manifold with air cleaner.
3. Remove fan belt and radiator hoses.
4. Remove cylinder head cover as previously described.
5. Remove excess fuel (fuel leak-off) and injection lines.
6. Remove injection nozzles.



7. Remove cylinder head lubricating oil line connecting screws.



8. Remove three cylinder head assist bolts.

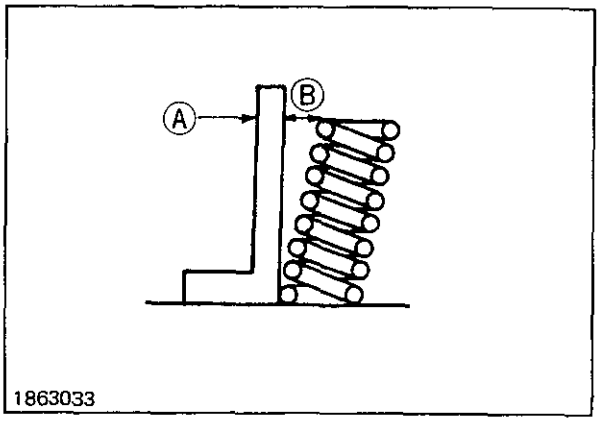


9. Remove cylinder head bolts by following loosening sequence as shown.
10. Use a valve spring compressor to remove valves from head.

INSPECTION AND REPAIR

Valve Springs

1. Inspect valve springs for alignment, wear, and damage.
2. Place the spring on a flat surface, and use a square (A) to check if spring is cocked. If spring is out of square, measure tilt (B) and compare to the following specifications.

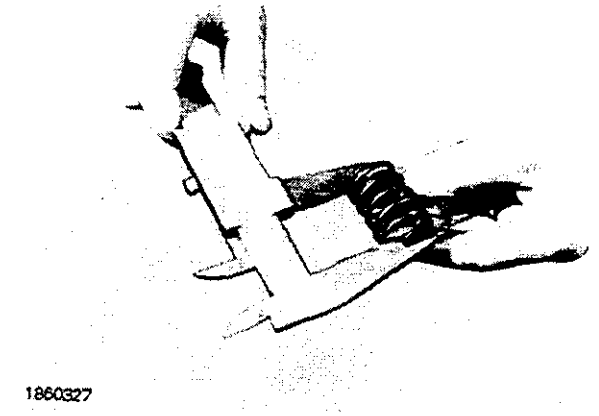


Item	New Part	Wear Limit
Spring Tilt	0	1.40 mm (0.055 in.)

A – Square
B – Spring Tilt

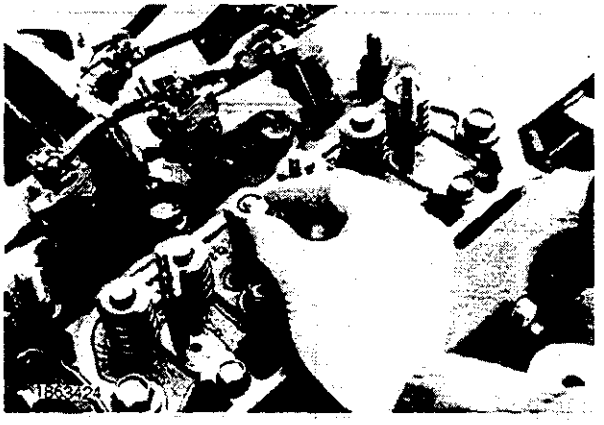
3. Measure spring free length, and replace the spring if the measurement exceeds the following wear limit.
4. Check valve spring tension on a spring tester.

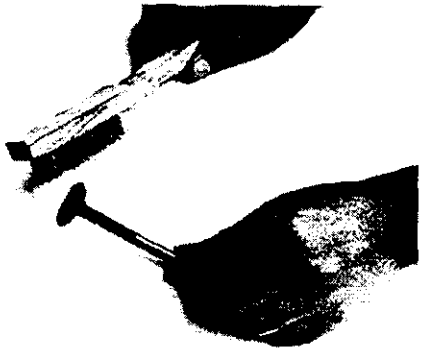
Item	New Part	Wear Limit
Spring Free Length	40.0 mm (1.57 in.)	39.5 mm (1.55 in.)
Spring compression	37.4 kg at 23.5 mm (89.5 lbs. at 0.92 in.)	36.0 kg at 23.5 mm (79.4 lbs. at 0.92 in.)



Valve Wear Caps

1. Check valve wear cap. Replace valve wear caps if pitted or worn.





3364135

INSPECTION AND REPAIR (Continued)

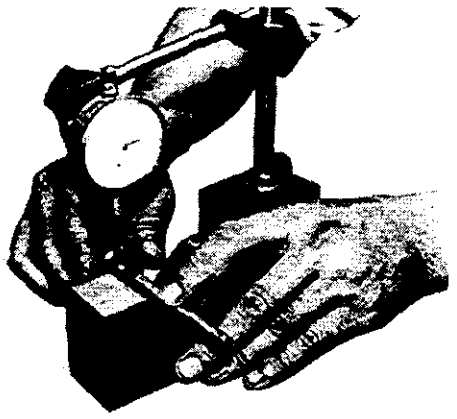
Cleaning Valves, Guides Seats

Perform the following cleaning procedure before measuring or repairing valves, guides and seats.

1. Hold each valve firmly against a wire wheel on a bench grinder.
2. Make sure all carbon is removed from the valve face, head and stem.
3. Polish the valve stems with steel wool or fine emery cloth to remove any scratch marks.
4. Use a valve guide cleaning brush to clean valve guide before inspection or repair.
5. Use an electric drill with wire cleaning brush to remove all carbon from valve seats.

Any carbon left on the stem will affect alignment in valve refacer if valves need to the refaces.

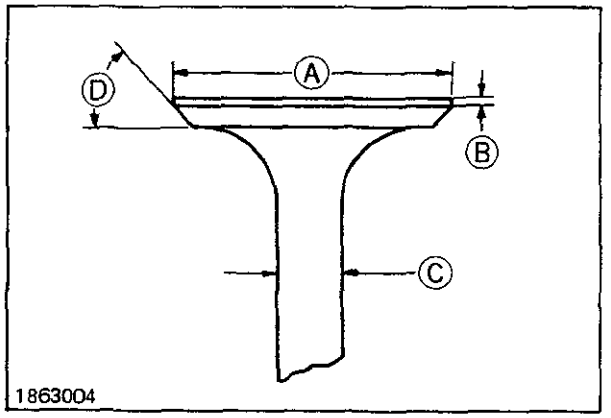
A few drops of light oil or kerosene will help to fully clean the valve guides.



1862116

Valves

1. Visually check valve face and stem for damage or wear.
2. Inspect valves as shown in picture to determine if valves are out of round, bent or wapped.



1863004

3. If necessary, grind valves to the following specifications.

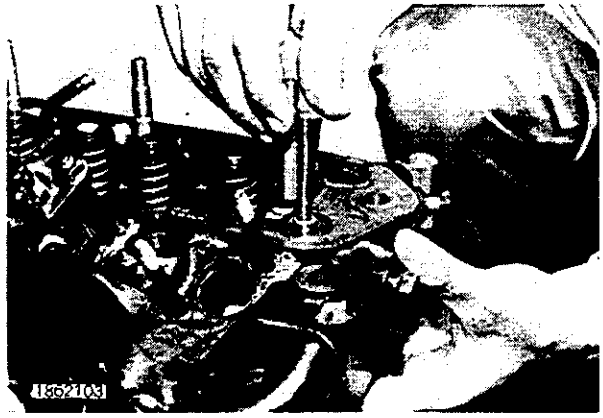
VALVE SPECIFICATIONS

	New Part	Minimum Acceptable
A –	(Intake) 32.0 mm (1.26 in.) (Exhaust) 26.0 mm (1.02 in.)	— —
B –	0.75 mm (0.03 in.)	0.5 mm (0.02 in.)
C –	7.96 to 7.97 mm (0.3133 to 0.3137 in.)	6.9 mm (0.271 in.)
D –	45°	—

Valve Guides

1. Measure valve guides and compare to the following specifications.
2. Replace the guide as shown in the following Cylinder head assembly section if wear exceeds the wear limit.

Item	New Part	Wear Tolerance
Guide I.D.		
	8.01 to 8.025 mm (0.3153 to 0.3159 in.)	8.08 mm (0.318 in.)
Guide-to-stem clearance		
	0.04 to 0.06 mm (0.002 to 0.003 in.)	0.15 mm (0.006 in.)

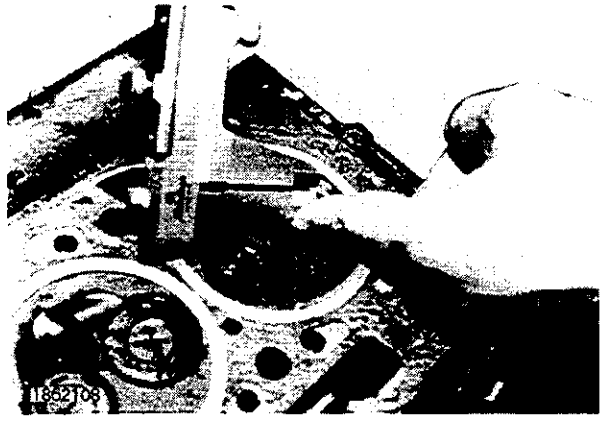


Valve Seats

1. Measure valve seats with a vernier calipers and compare measurement taken to the following specifications.

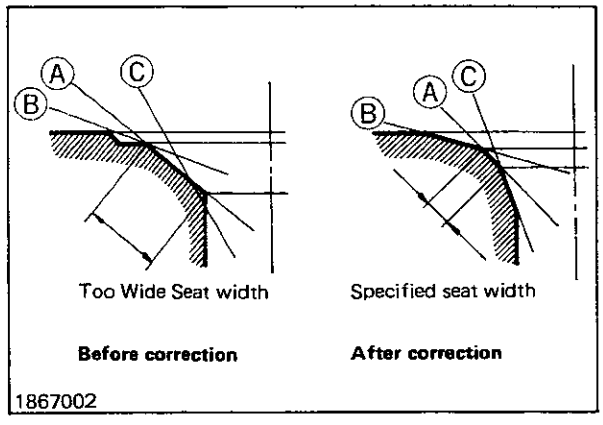
VALVE SEAT SPECIFICATIONS

Seat Width	
Intake Valve	1.77 mm (0.070 in.)
Exhaust Valve	1.77 mm (0.070 in.)
Seat Angle	45°



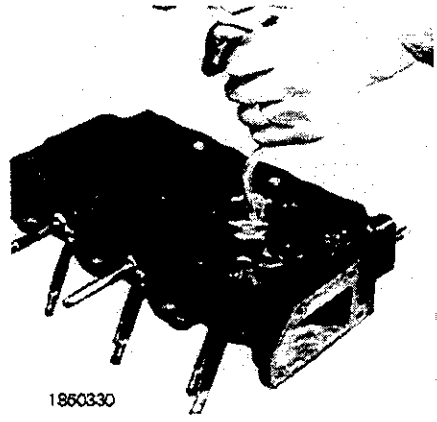
2. If the Valve seat width is too wide grind the seat by the sequence (A → B → C).

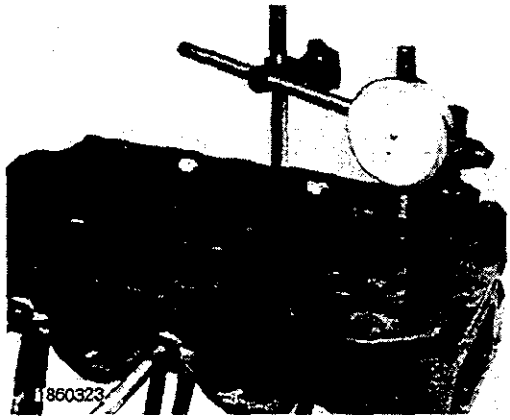
A — Grind with a 45° grinder
B — Grind with a 15° grinder
C — Grind with a 65° ~ 75° grinder



When the valve seat has been corrected with a seat grinder, insert an adjusting shim between the valve spring and cylinder head.

3. Lap each valve onto its seat using lapping compound.





CHECKING VALVE HEIGHT

Width repeated valve seating, the valves will sink into the head. Use the following procedure to check valve height. If measurement taken exceeds specifications replace valves, cylinder head, or both.

1. Install each valve in its guide.
2. Check each valve with a micrometer and compare measurements taken with the following specification.

VALVE HEIGHT SPECIFICATIONS

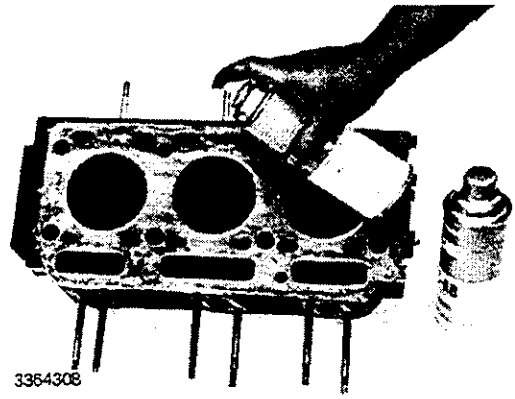
New Part	Wear Tolerence
1.00 mm (0.039 in.)	1.50 mm (0.059 in.)

CYLINDER HEAD

INSPECTION

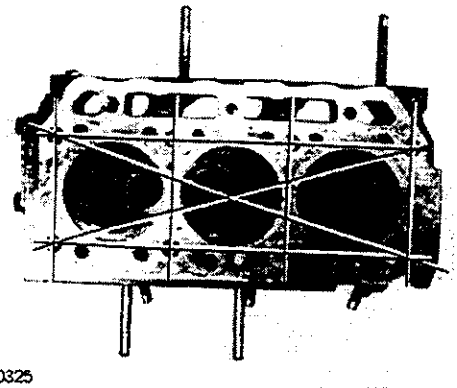
Inspection for crack

Check the combustion surface for crack by color check, and replace cylinder head if any crack is detected.

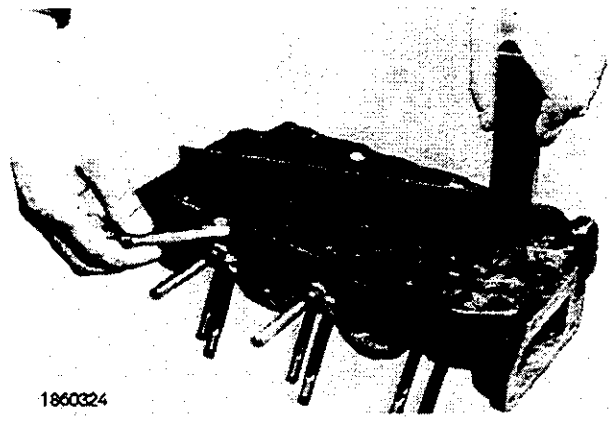


Checking Head Distortion

1. Thoroughly clean the cylinder head.



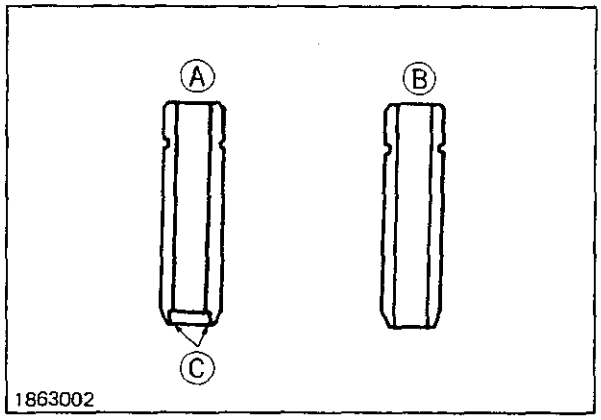
2. Use a straight edge for checking cylinder head flatness by placing it in the indicated positions.
3. Measure gap with a feeler gauge. Compare measurement taken with the following specifications.



CYLINDER HEAD DISTORTION

New Part	Maximum Distortion
0.03 mm (0.0012 in.)	0.1 mm (0.004 in.)

CYLINDER HEAD (Continued)



1863002

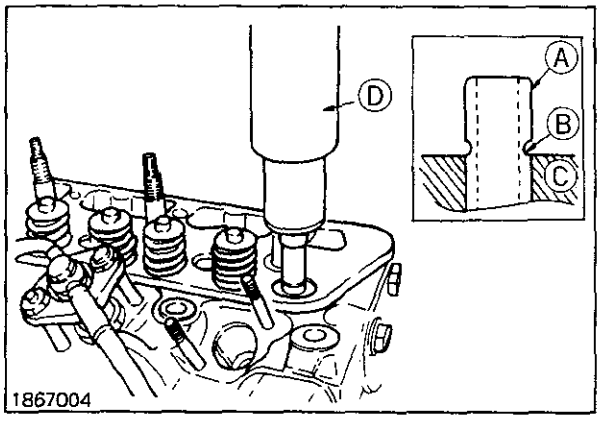
ASSEMBLY

Valve Stem Guides

Worn or loosen valve guides must be replaced with new guides by the following procedure.

1. The valve guide is different for the intake valve and exhaust valve in that the inner face of the exhaust valve has a recess (Gas Cut).
2. Make sure intake and exhaust guides are installed in their correct bores.

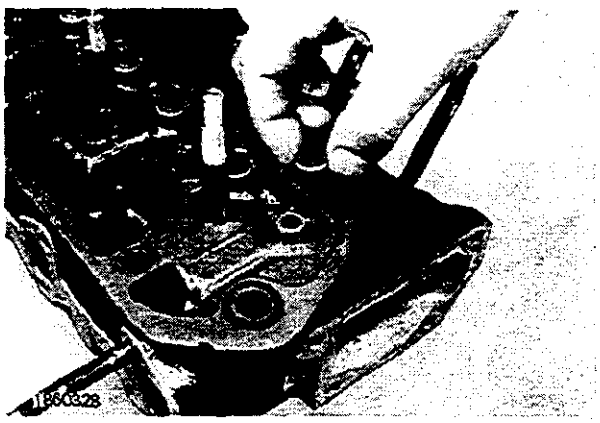
A – Exhaust Valve Guide
B – Intake Valve Guide
C – Recess (Gas Cut)



1867004

3. Install guides with a press and press in until groove in O.D. of guide reaches cylinder head face.

A – Valve Guide
B – Groove
C – Cylinder Head
D – Installation Tool


1866328

Valve Stem Seal

The valve stem seal must always be replaced whenever it has been removed.

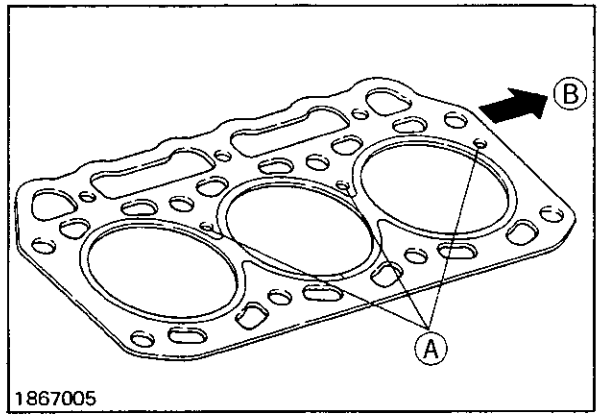
Assembling Procedure

1. Apply engine lubricating oil to valve stems and guides, and install valves in guides from which they were removed.
2. Install valve springs and spring retainers.
3. Compress valve springs and install retainer cotters.
4. Strike the end of each valve three or four times with a soft mallet to insure proper positioning of the retainer cotters.

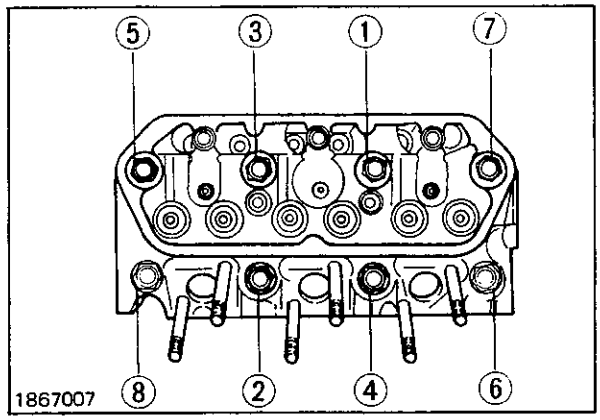
INSTALLATION

1. Check cylinder head stud bolts for loosing.
2. Confirm correct alignment of the coolant passaged for cylinder head and gasket, and install on cylinder block without sealant.

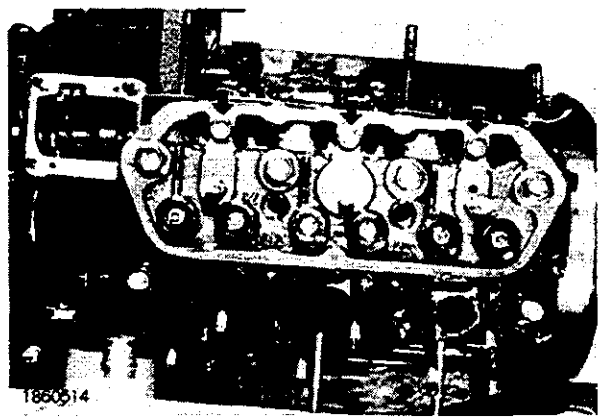
A – Lubricating Oil
B – Flywheel Side

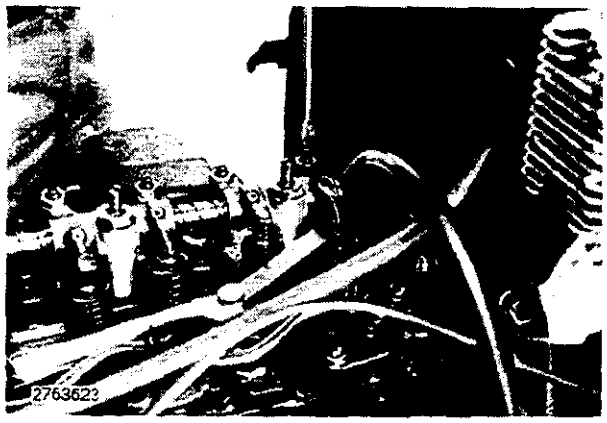


3. Coat studs, cylinder head bolts and nuts with clean engine oil, and tighten in sequence in Fig. to 39 Nm (4.0 kgm) (29 ft-lbs).
4. Retighten head bolts and nuts in sequence in Fig. to 78 Nm (8.0 kgm) (58 ft-lbs) and finally tighten to 127 Nm (13 kgm) (94 ft-lbs).



5. Tighten three cylinder head assist bolts to 29 Nm (3.0 kgm) (22 ft-lbs).
6. Install wear caps on valves.
7. Install push rods on valve tappets. Be careful for not falling them into cylinder block.
8. Install rocker arm assembly on head.
9. Tighten rocker arm support nuts to 54 Nm (5.6 kgm) (40 ft-lbs).
10. Set valve clearance using procedure on page 20-05-14.
11. Install rocker arm cover.





CHECKING VALVE CLEARANCE

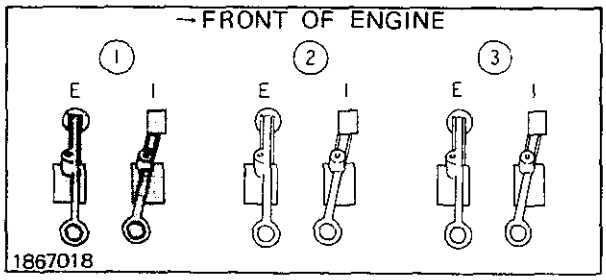
Check and adjust the valve clearance after assembly and after every 300 hours of operation. Check the engine when cold as follows:

1. Disconnect decompression linkage.
2. Remove thermo-start reservoir support cap screws.
3. Remove expansion tank bracket cap screws.
4. Remove cylinder head cover cap screws, and remove cylinder head cover.
5. Crank engine until No. 1 cylinder is at TDC of its compression stroke. Both valves should be in the up position (rocker arms loose).
6. Check the intake and exhaust valve clearances of the No. 1 cylinder. **No. 1 CYLINDER IS AT REAR OF ENGINE.**

   Adjust to the following specifications.

INTAKE AND EXHAUST VALVE CLEARANCE SPECIFICATIONS

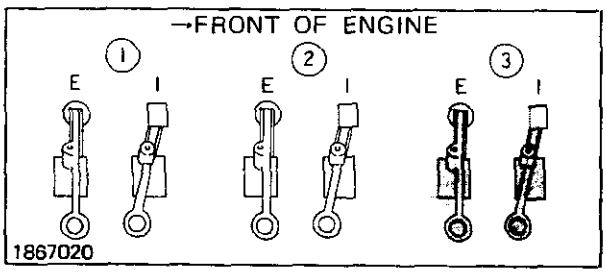
. . . . . 0.2 mm (0.008 in.)



7. Turn the crankshaft clockwise 240° to align the TDC mark of the No. 3 cylinder.

INTAKE AND EXHAUST VALVE CLEARANCE SPECIFICATIONS

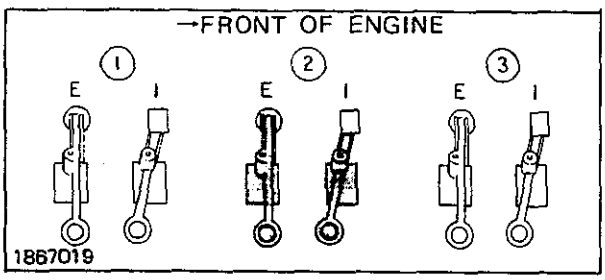
. . . . . 0.2 mm (0.008 in.)



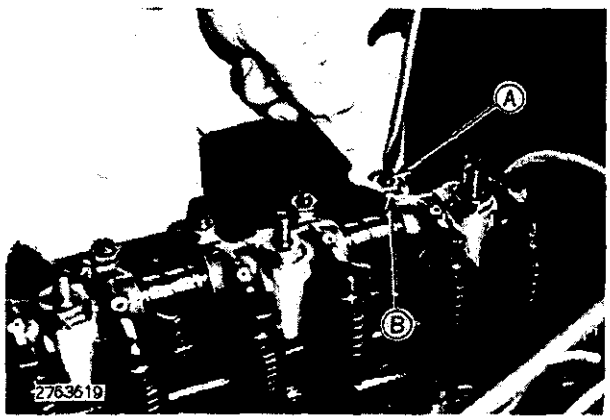
8. Check the valve clearance of the intake and exhaust valves of the No. 3 cylinder, and adjust to proper specification.
9. Turn the crankshaft another 240° clockwise to align the TDC mark of the No. 2 cylinder.

INTAKE AND EXHAUST VALVE CLEARANCE SPECIFICATIONS

. . . . . 0.2 mm (0.008 in.)



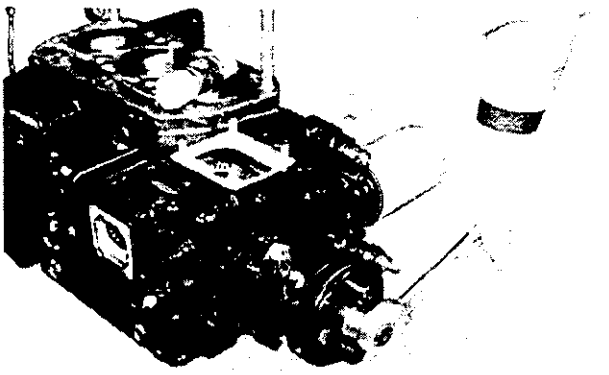
10. Check the valve clearance of the intake and exhaust valves of the No. 2 cylinder, and adjust to proper specification.



When tightening the lock nut (B), be sure not turning the adjusting screw (A). Hold the screw with screw driver as shown in figure.

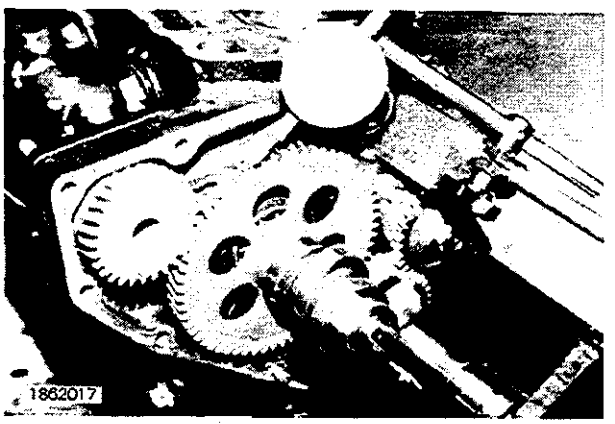
CAMSHAFT

CHECKING CAMSHAFT GEAR BACKLASH



1860214

1. Separate tractor front end from engine.
2. Remove radiator fan and fan belt.
3. Disconnect hourmeter drive cable from housing.
4. Remove nut on crankshaft pully, and remove timing gear pulley.
5. Remove injection pump chamber cover.
6. Remove timing gear cover cap screws and remove timing gear cover.
7. Mount a dial gauge on cylinder block as shown.
8. Rotate camshaft gear back and forth slightly, while making sure crankshaft gear does not move. Check backlash on indicator while moving gear, and compare to the following specifications:



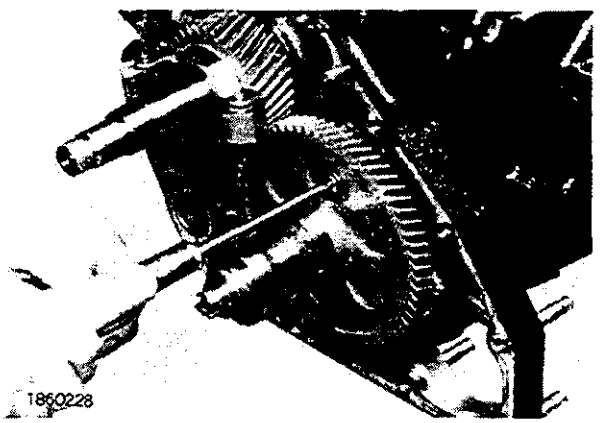
1862017

CAMSHAFT GEAR BACKLASH SPECIFICATIONS

New Part	Wear Tolerance
0.08 to 0.13 mm (0.003 to 0.005 in.)	0.30 mm (0.012 in.)

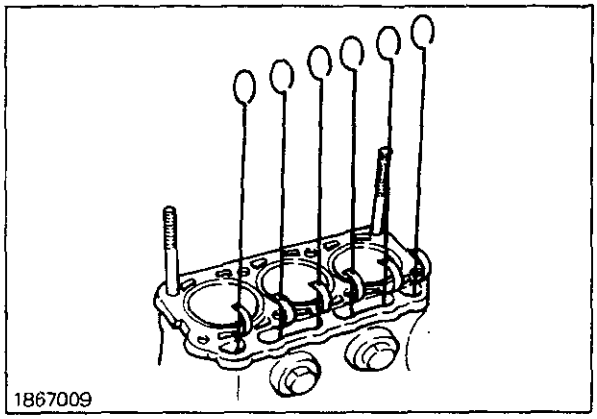
9. If backlash exceeds wear tolerance, replace either or both gears. A step wear pattern on gear teeth indicates wear.

CAMSHAFT REMOVAL



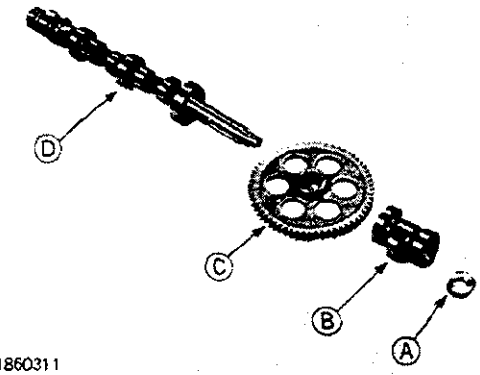
1860228

1. Remove tractor front end and timing gear cover as previously indicated.
2. Remove rocker arm cover as indicated on p. 20-05-4.
3. Remove cylinder head by loosening sequence on p.20-05-6.
4. Remove camshaft bearing retainer screw.


1867009

CAMSHAFT REMOVAL (Continued)

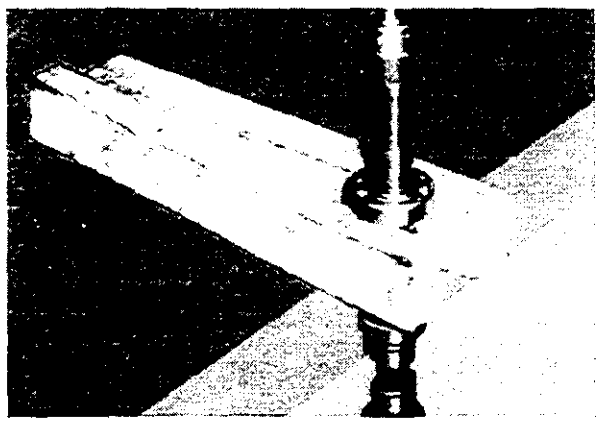
5. Use Magnetic Holding Tool or its equivalent to hold tappets away from camshaft lobes during removal.
6. Carefully remove camshaft from cylinder block so that camshaft lobes do not drag in bores.



1860311

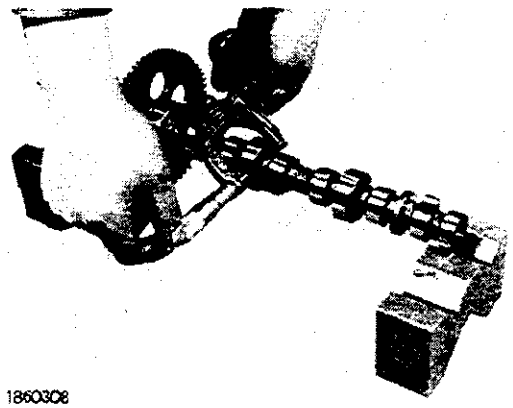
7. Loosen Nut (A) and remove injection pump drive cam (B) and camshaft gear (C). **Nut (A) has left-hand threads.**

A – Nut
B – Injection Pump Cam
C – Drive Gear
D – Camshaft



8. Support camshaft bearings in a press.
9. Press camshaft from bearings.

Prevent camshaft from striking floor when pressing camshaft from gear.


1860308

INSPECTION

Camshaft

1. Measure bearing journals and bearing surface in block and compare to the following specifications.

CAMSHAFT BEARING AND JOURNAL SPECIFICATIONS

Flywheel Side Journal

	New Part	Wear Limit
Journal O.D.	29.939 to 29.960 mm (1.179 to 1.180 in.)	29.84 mm (1.175 in.)
Bearing I.D.	30.00 to 30.021 mm (1.181 to 1.182 in.)	30.07 mm (1.184 in.)
Oil Clearance	0.04 to 0.08 mm (0.001 to 0.003 in.)	0.12 mm (0.004 in.)

Intermediate Journal (Between No. 1 & No. 2 Cyl.)

Journal O.D.	41.425 to 41.450 mm (1.631 to 1.632 in.)	41.28 mm (1.625 in.)
Bearing I.D.	41.500 to 41.525 mm (1.634 to 1.635 in.)	41.58 mm (1.637 in.)
Oil Clearance	0.05 to 0.10 mm (0.002 to 0.004 in.)	0.15 mm (0.006 in.)

Intermediate Journal (Between No. 2 & No. 3 Cyl.)

Journal O.D.	42.425 to 42.450 mm (1.670 to 1.671 in.)	42.28 mm (1.665 in.)
Bearing I.D.	42.500 to 42.525 mm (1.673 to 1.674 in.)	42.58 mm (1.676 in.)
Oil Clearance	0.05 to 0.10 mm (0.002 to 0.004 in.)	0.15 mm (0.006 in.)

CAMSHAFT LOBE SPECIFICATIONS

	New Part	Wear Limit
Intake and exhaust Valve (A)	35.00 mm (1.378 in.)	34.50 mm (1.358 in.)
Injection Pump (B)	45.00 mm (1.772 in.)	44.90 mm (1.768 in.)

Tappets

1. *Remove camshaft tappets from block.*

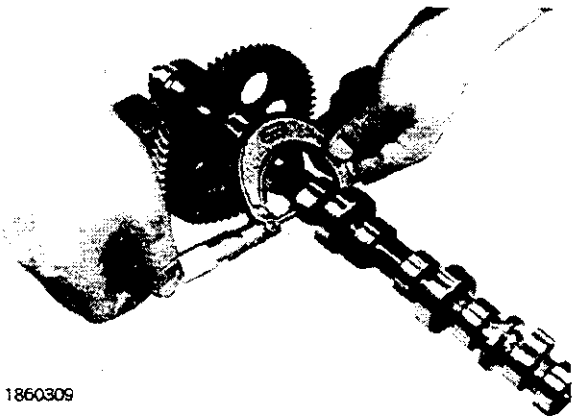
   Tappet centers are out of alignment with the camshaft lobe centers. This causes the tappet to rotate, preventing uneven wear.
   Inspect the tappet wear surface for uneven wear, and replace if excessive.

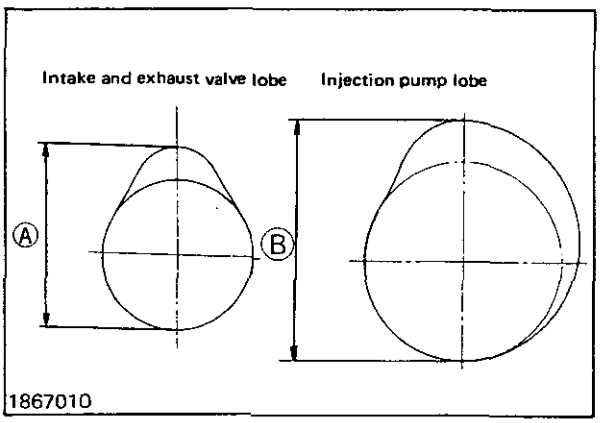
   A – Offset
   B – Tappet
   C – Camshaft

2. Measure tappets and tappet bore in block and compare measurements taken with the following specifications:

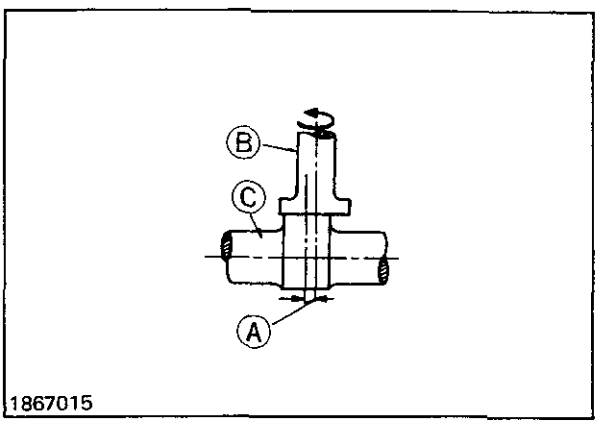
VALVE TAPPET SPECIFICATIONS

	New Part	Wear Tolerance
O.D. of Tappet	9.98 to 9.99 mm (0.393 to 0.394 in.)	9.95 mm (0.392 in.)
Oil Clearance	0.01 to 0.04 mm (0.0004 to 0.0016 in.)	0.10 mm (0.004 in.)

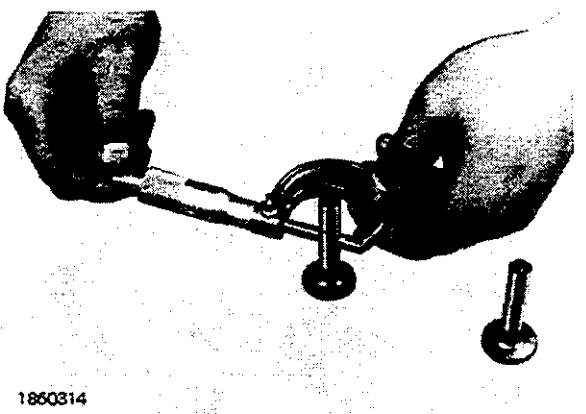

1860309



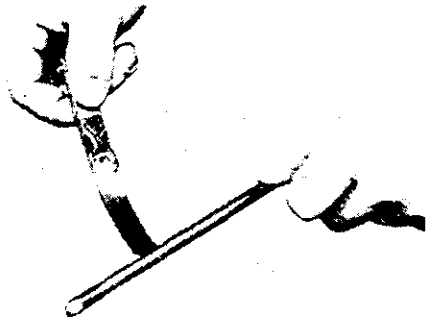
1867010



1867015


1860314

CAMSHAFT (Continued)



1860315

INSPECTION (Continued)

Push Rods

1. Lay the push rods on a flat surface. Use a feeler gauge to check for bent push rods. Compare measurement taken with the following specifications:

PUSH ROD BEND SPECIFICATIONS

New Part	Maximum Acceptable
0.03 mm (0.0012 in.)	0.3 mm (0.012 in.)

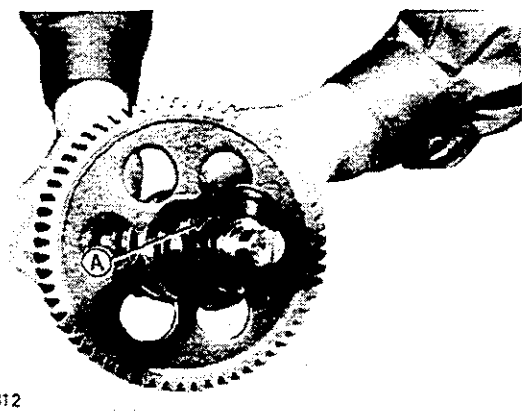
2. Inspect the push rod for wear on each end. Measure the push rod length and compare to the following specifications:

PUSH ROD LENGTH SPECIFICATIONS

New Part	Minimum Acceptable
188.0 mm (7.401 in.)	187.5 mm (7.382 in.)

ASSEMBLY

1. Support camshaft in a press, and press or bearing with a Installation Tool. Bearing should be pressed on until it bottoms on shoulder of camshaft.
2. Make sure key is in place before installing gear and injection pump cam.
3. Install camshaft gear and injection pump cam.
4. When installing injection cam to camshaft, make sure the mark "O" on the cam faces to front. Tighten nut. **The nut has left-hand thread.**



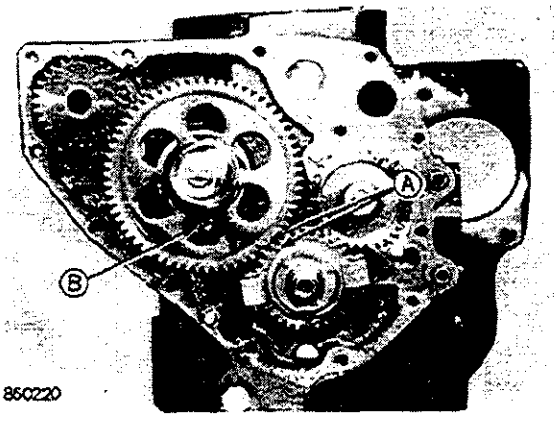
1860312

A – "O" Mark (outside)

STOP **The injection pump cam has a installing direction. If installed with a wrong direction, the engine cannot be started.**

INSTALLATION

1. Hold tappets away from camshaft bore until camshaft is installed.
2. Coat camshaft journals and bearing bores with clean engine oil.
3. When installing camshaft, make sure lobes do not drag in bores.
4. Align timing marks on camshaft gears and crarkshaft gears during installation (A).
5. Install bearing retaining scrw (B).



1860220

A – Timing Marks
B – Bearing Retaining Screw

DIAGNOSING MALFUNCTIONS

Scuffed or Scored Pistons

- Insufficient lubrication
- Insufficient cooling
- Improper piston-liner clearance
- Preignition or postignition
- Coolant leakage in crankcase
- Misaligned or bent connecting rod
- Low oil level
- Improper operation
- Incorrect connecting rod bearing clearance
- Carbon build up in ring groove
- Improper break-in
- Worn piston
- Contaminated oil
- Distorted cylinder liner

Worn or Broken Compression Rings

- Insufficient lubrication
- Insufficient cooling
- Improper ring installation
- Improper combustion
- Improper timing
- Abrasives in combustion chamber

Clogged Oil Ring

- Improper oil
- Excessive blow-by
- Contaminated Oil
- Improper periodic service
- Low operating temperature

Stuck Rings

- Improper oil classification
- Improper periodic service
- Poor operating conditions
- Coolant leakage in crankcase

Cylinder Liner Wear and Distortion

- Incorrectly installed compression rings
- Insufficient lubrication
- Uneven cooling around liner
- Improper piston-liner clearance
- Liner bore damage

Warped Cylinder Block

- Insufficient cooling

Broken Connecting Rod

- Loose connecting rod cap screws
- Inadequate piston-liner clearance
- Worn connecting rod bushing
- Distorted cylinder liner
- Piston pin failure

Piston Pin and Snap Ring Failure

- Misaligned connecting rod
- Excessive crankshaft end play

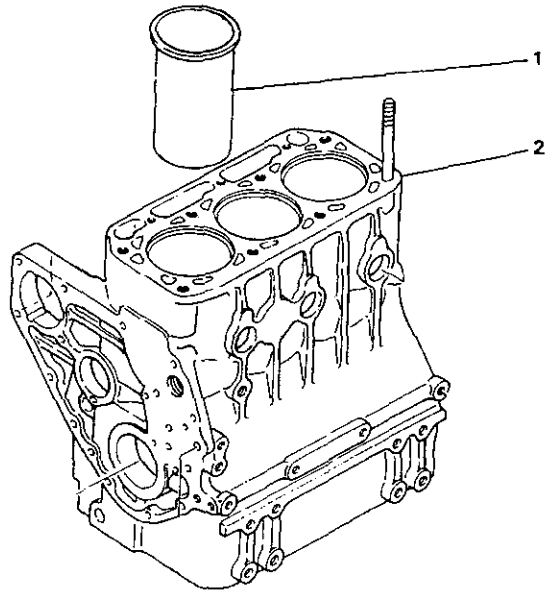
Mottled, Grayish or Pitted Compression Rings

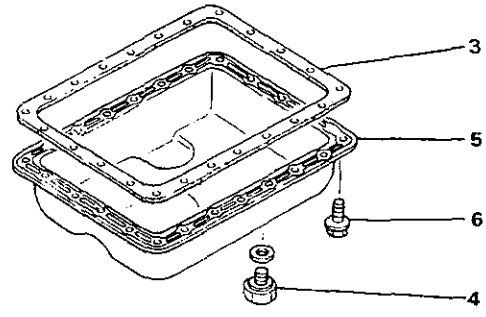
- Internal coolant leaks

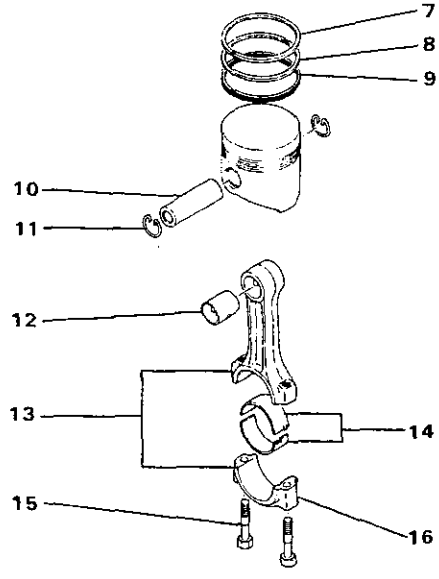
Dull Stain Finish and Fine Vertical Scratches on Rings

- Dirt and abrasive in air intake system

CYLINDER BLOCK, LINERS, PISTONS, AND RODS







1 – Liner
2 – Cylinder Block
3 – Oil Pan Packing
4 – Drain Plug
5 – Oil Pan
6 – Oil Pan Cap Screws
7 – Piston Ring (Top)
8 – Piston Ring (2nd)
9 – Oil Control Ring
10 – Piston Pin
11 – Snap Ring
12 – Pin Bushing
13 – Connecting Rod
14 – Rod Bearing Inserts
15 – Connecting Rod Bolts
16 – Cap

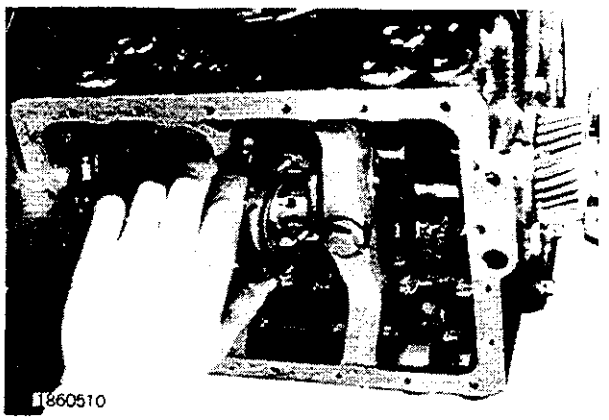
2766002

PISTONS

REMOVAL

It is not necessary to remove the engine to service pistons, rods and liners. If engine removal is desireable see Chapter 10, Section 20.

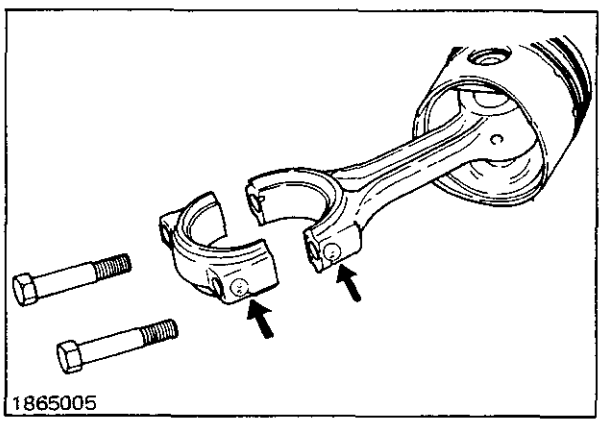
1. Remove cylinder head as described in Section 5.
2. Remove oil pan.
   It is not necessary to remove the front drive propeller shaft to remove piston.


1860510

3. Remove connecting rod bolts and rod caps.

STOP Keep bearing inserts with their respective rods and caps. Each rod and cap assembly have identify numbers on their side faces to the camshaft side of cylinder block.

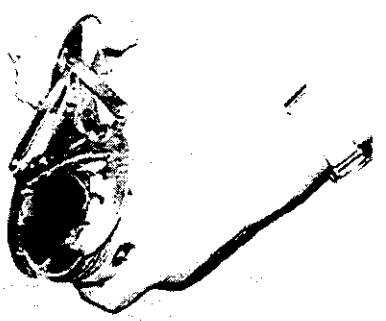
4. Gently tap piston and connecting rod out of cylinder top.


1865005

INSPECTION AND REPAIR

Piston Rings and Ring Grooves

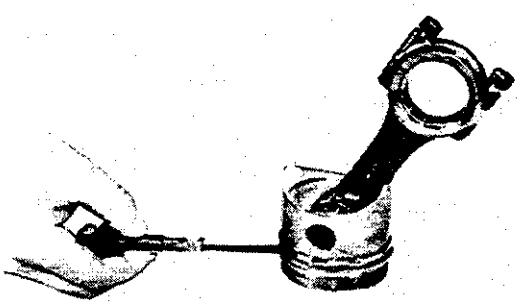
1. Examine piston rings for damage, wear, and scratched or scored conditions.
2. Use tools from Ring Expander to remove piston rings.


1862028

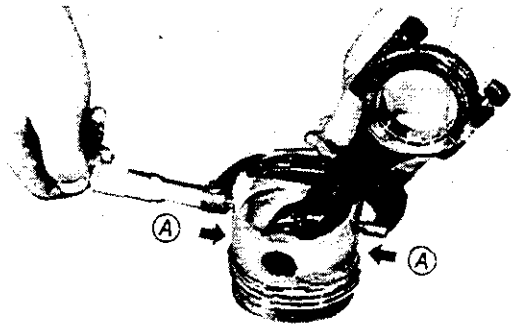
3. Measure clearance between piston ring and ring groove with a feeler gauge. If clearance exceeds the following wear limits replace rings.

RING-GROOVE CLEARANCE WEAR LIMIT

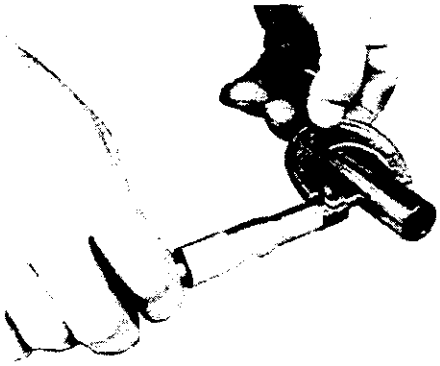
Top Ring	0.30 mm (0.012 in.)
Second Ring	0.25 mm (0.010 in.)
Oil Ring	0.25 mm (0.010 in.)


1860424

PISTONS (Continued)



1860423



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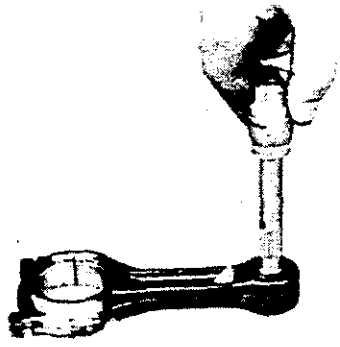

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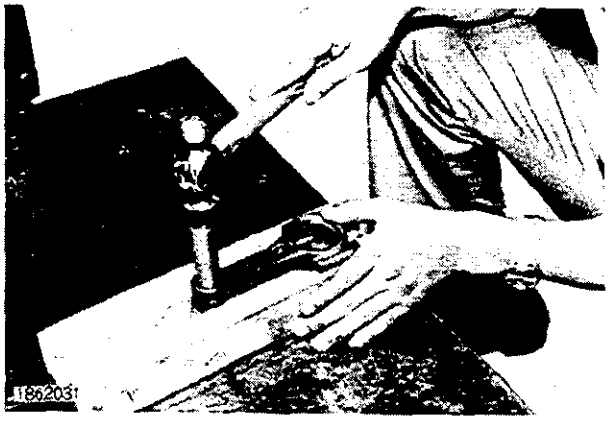


1862031

INSPECTION AND REPAIR (Continued)

Piston Head, Ring Grooves, and Piston Skirt

1. Check pistons for scuffing, scoring, or sings of over-heating.
2. Carefully examine piston head, ring grooves, and skirt for sign of fatigue such as fine cracks in the head, or around piston pin bore.
3. Measure piston diameter near bottom of skirt and perpendicular to piston pin direction (A). Compare measurement taken with the following specifications.

PISTON DIAMETER SPECIFICATIONS

New Part	Wear Tolerance
71.89 to 71.92 mm (2.8303 to 2.8315 in.)	71.81 mm (2.827 in.)

Piston Pins and Bushings

1. Measure piston pin O.D. and compare measurement taken with the following specifications.
2. Measure piston pin bushing I.D. and compare measurement taken with the following specifications.

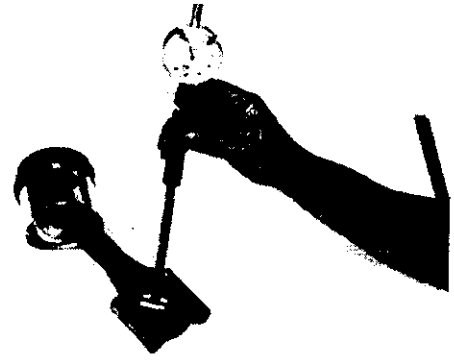
PISTON PIN AND BUSHING SPECIFICATIONS

	New Part	Wear Tolerance
Pin O.D.	19.991 to 20.00 mm (0.7870 to 0.7874 in.)	19.90 mm (0.783 in.)
Bushing I.D.	20.025 to 20.038 mm (0.788 to 0.789 in.)	20.10 mm (0.791 in.)
Pin-to-Bushing Oil Clearance	0.02 to 0.05 mm (0.0008 to 0.002 in.)	0.15 mm (0.006 in.)

3. Remove pin bushing using Removal and Installation Tool.

Connecting Rod Bearings

Rod bearings can be checked by measuring assembled I.D. of connecting rod bearings if rod is out of the engine, or with "Plastigage" if rod is connected to crankshaft.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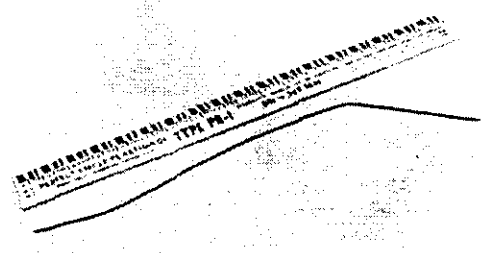
When rod is out of the engine:

1. Thoroughly clean connecting rod bearings.
2. Install connecting rod cap on rod with bearing in correct position.
3. Tighten rod bolts to 22.5 to 27.4 Nm (2.3 to 2.8 kgm) (16.6 to 20.2 ft-lbs).
4. Use an inside micrometer or cylinder gauge to measure inside diameter of bearing.
5. Measure connecting rod journal O.D. on crankshaft at several points around journal.
6. Subtract I.D. of rod bearings from O.D. of crankshaft journal to obtain oil clearance.
7. Compare the measurements with the following specifications.

ROD BEARING AND JOURNAL SPECIFICATIONS

	New Part	Wear Tolerance
O.D. of Bearing Journal	39.95 to 39.96 mm (1.573 to 1.574 in.)	39.92 mm (1.572 in.)
I.D. of Assembled Rod Bearing	40.00 to 40.04 mm (1.575 to 1.576 in.)	40.10 mm (1.579 in.)
Oil Clearance	0.04 to 0.09 mm (0.002 to 0.004 in.)	0.15 mm (0.006 in.)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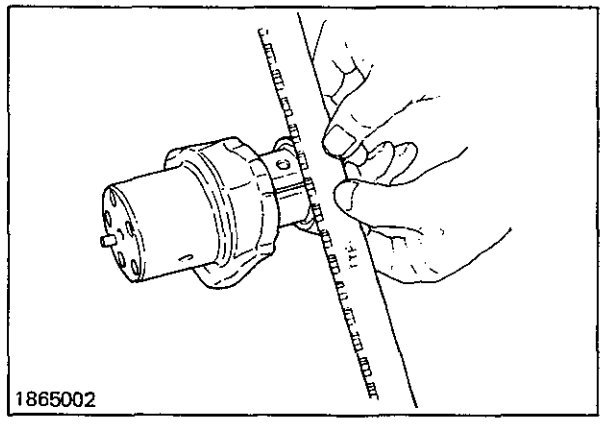
When rod is connected to crankshaft,

1. Thoroughly clean inside surface of bearings and connecting rod journal of crankshaft.
2. Insert a "Plastigauge" between connecting rod journal of crankshaft and bearing in rod end.
3. Tighten rod bolts to 22.5 to 27.4 Nm (2.3 to 2.8 kgm) (16.6 to 20.2 ft-lbs).
4. Loosen rod bolts and slowly remove cap and read the crushed width of plastigage on the packaging.
5. Compare the measurement with the oil clearance specification.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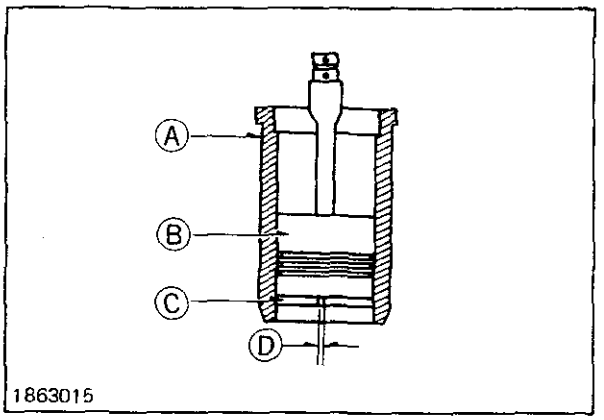

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INSPECTION AND REPAIR (Continued)

Piston Rings

1. Push each piston ring (one at a time) into the cylinder using the piston head. Remove piston.
2. Measure the ring gap with a feeler gauge and compare measurement taken with the following specifications.

   Push ring into liner approximately 150 mm (6 in.) before measuring gap.
3. If there is excessive gap, replace rings. If gap is too small, fill to meet specifications.

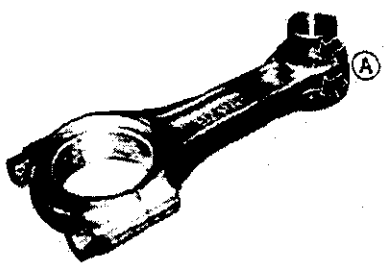
A — Liner
B — Piston Head
C — Piston Ring
D — Ring Gap

PISTON RING GAP SPECIFICATIONS

	New Part	Wear Tolerance
Top Ring	0.25 to 0.45 mm (0.009 to 0.017 in.)	1.5 mm (0.06 in.)
Second Ring	0.20 to 0.40 mm (0.008 to 0.016 in.)	1.5 mm (0.06 in.)
Oil Ring	0.25 to 0.45 mm (0.009 to 0.017 in.)	1.5 mm (0.06 in.)

ASSEMBLY AND INSTALLATION

The method of piston pin fastering is a called a free floating type. The pin is free to turn in the bosses and in the rod.



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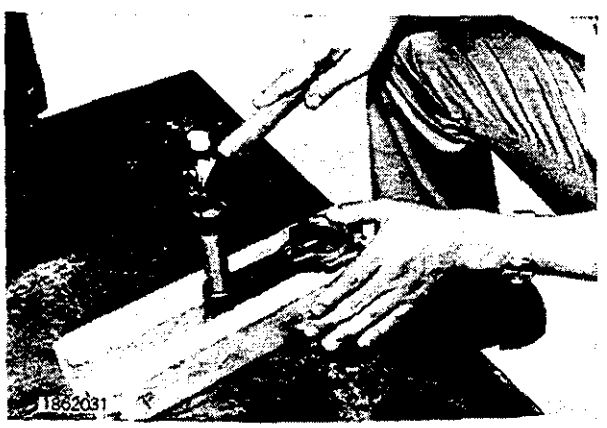
A — Oil Holes

Before installing pin bushing, make sure oil holes in bushing and *rod end are aligned* (A).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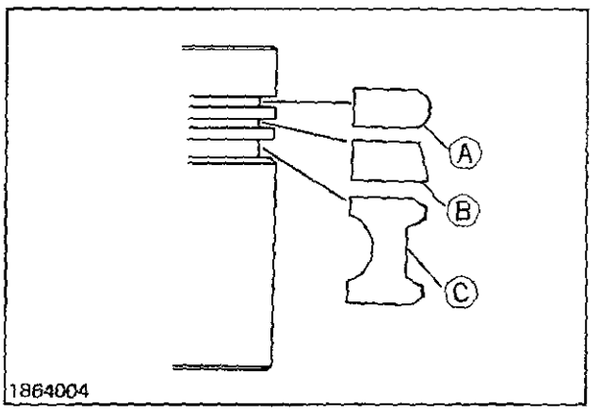
1. Install pin bushing using Removal and Installation Tool.
2. Install one pin retaining snap ring in each piston.
3. Coat piston pins with engine oil.
4. Install piston connecting rod and piston pin.
5. Install remaining snap rings.

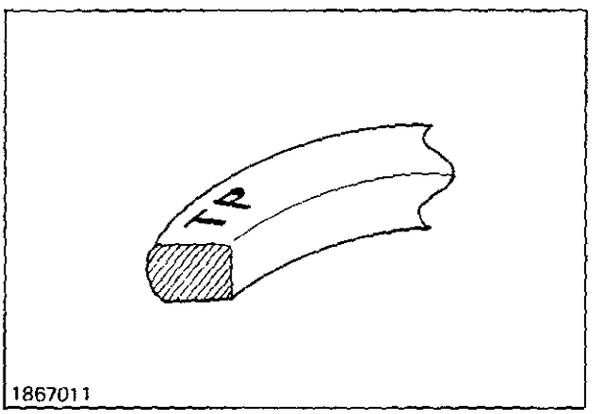
STOP Make sure connecting rod moves smoothly with piston.

6. Each piston ring has a different shape. Make sure to install correctly.

A – First Compression Ring (Barrel Face) Coated with Chrome.
B – Second Compression Ring
C – Oil Ring

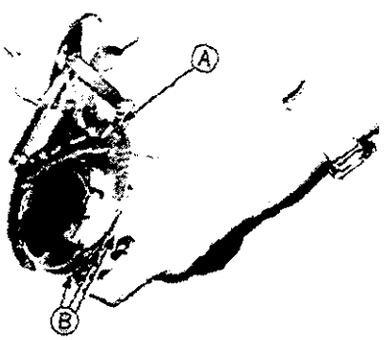


7. Manufacture's mark near the ring gap must face the top of piston when assembled.



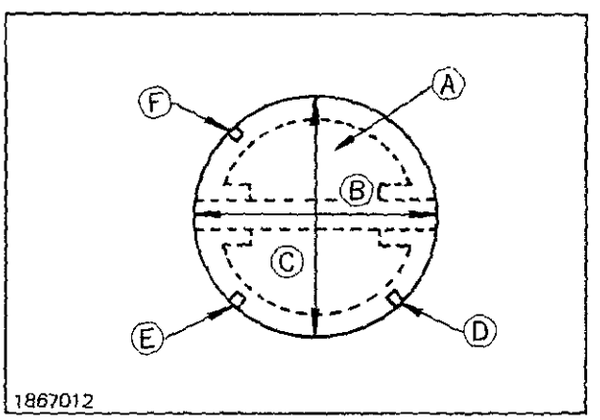
8. Install rings on piston using Ring expander.

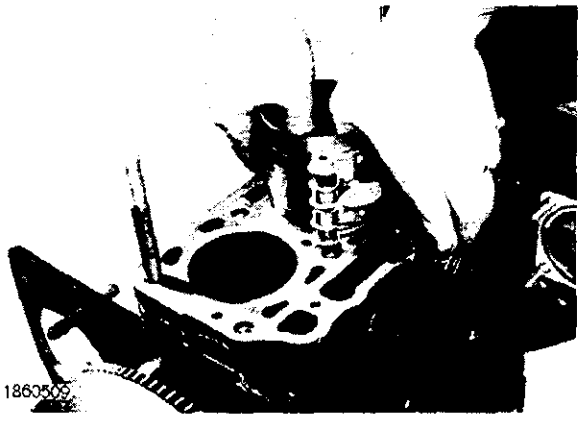
A – Expander
B – Piston rings



9. Before installing pistons, make sure ring gaps are between piston pin direction (A) and piston thrust direction (B).

A – Piston Head
B – Piston Pin Direction
C – Piston Thrust Direction
D – Top Ring
E – Second Ring
F – Oil Ring



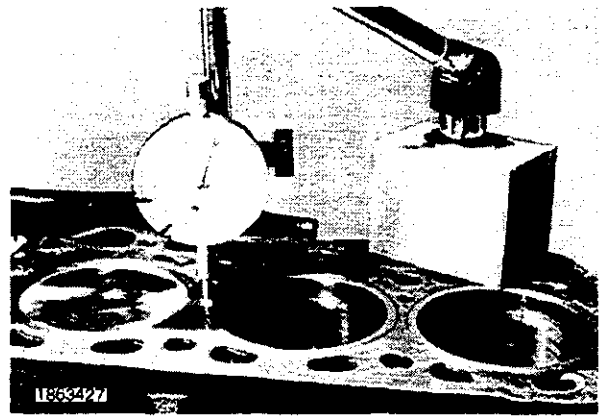


10. Coat pistons, liners and inside of ring compressor with clean engine oil. Use ring compressor.
11. Carefully place piston in ring compressor.
12. Carefully place ring compressor with piston and rod over liner.
13. Position piston and rod so identification on rod faces toward flywheel side of engine.
14. With piston centered in installing tool and rings staggered correctly, push piston into liner.
15. Install connecting rod caps, and tighten to 44 to 49 Nm (4.5 to 5.0 kgm) (29 to 36 ft-lbs).

CYLINDER LINERS

REMOVAL, INSPECTION AND REPAIR

1. Use a dial indicator to measure the height of liners before removal from block.

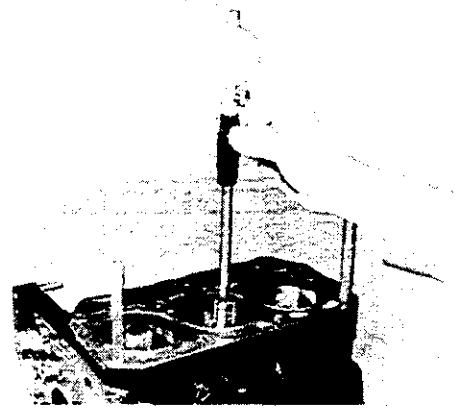


LINER HEIGHT SPECIFICATION

Liner Height . . . . . 0.05 to 0.075 mm (0.002 to 0.003 in.)

2. Measure cylinder liner inside diameter. Using Cylinder Bore Gange, and compare the reading taken with the following specifications.

   Measure the liner bore parallel and at right angle to piston pin at the both top and bottom of ring travel.



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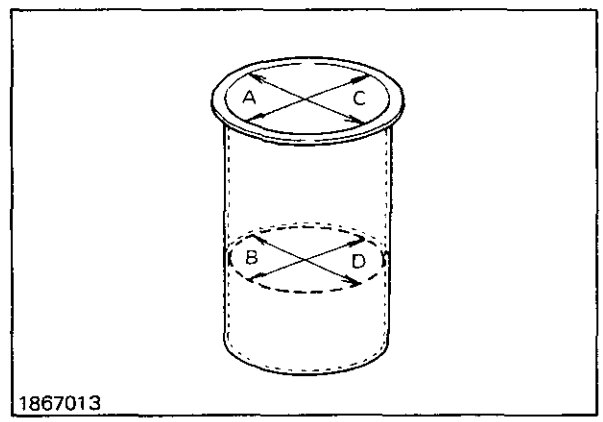
CYLINDER LINER I.D. SPECIFICATIONS

New Part	Wear Tolerance
84.000 to 84.035 mm (3.307 to 3.308 in.)	84.18 mm (3.314 in.)



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3. Compare liner I.D. measurements to piston skirt measurements. See specifications below.

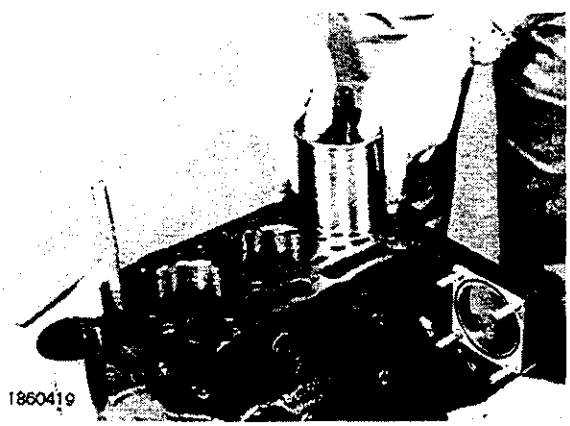
LINER-TO-PISTON CLEARANCE

New Part	Wear Tolerance
0.068 to 0.133 mm (0.002 to 0.005 in.)	0.28 mm (0.011 in.)

When removing liners, identify for reassembly into original bores of cylinder block.

4. Remove cylinder liner by hands. This engine has "HAND PRESS FIT-DRY LINER".

   It is a flarge type liner, and can be removed and installed using no special tool.



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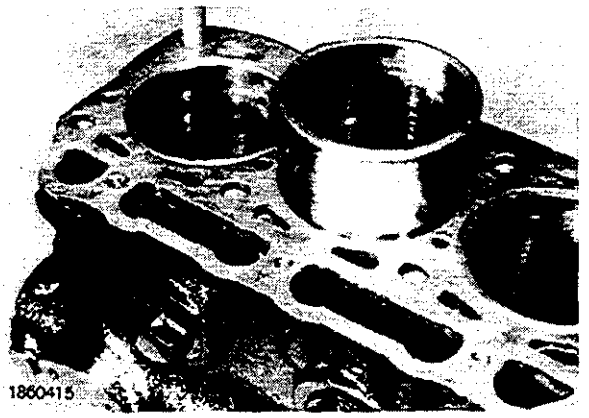
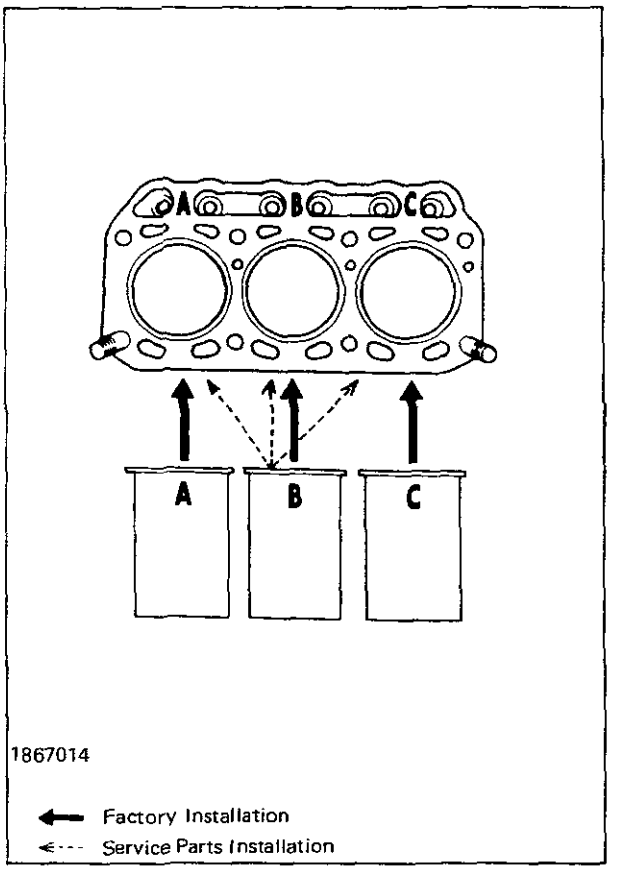




INSTALLATION

1. Clean cylinder linders with solvent.
2. Thoroughtly clean inside of bores for liners with solvent. Especially, be careful to clean liner flange seating area of cylinder block.
3. Install cylinder liners into their original bores.
4. Measure liner hights shown by which the sealing face of the cylinder liner protrudes over the cylinder block sealing face.

   Measure at several places around the circumference and compare measurements. See specifications on page 20-10-9.

Each liner bore of cylinder block is punched mark (A, B or C) on the camshaft side of cylinder block top sealing face according to its range of finishing dimension.

Cylinder liner is also marked (A, B or C) on its side face.

CYLINDER LINER O.D. SPECIFICATIONS

A – 88.00 to 88.01 mm (3.4646 to 3.4650 in.)
B – 87.98 to 87.99 mm (3.4638 to 3.4642 in.)
C – 87.99 to 88.00 mm (3.4642 to 3.4646 in.)

CYLINDER BLOCK BORE I.D. SPECIFICATIONS

A – 88.02 to 88.03 mm (3.4654 to 3.4657 in.)
B – 88.01 to 88.02 mm (3.4650 to 2.4654 in.)
C – 88.00 to 88.01 (3.4646 to 3.4650 in.)

The liner must be installed into the bore has the same mark as it. That is the liner marked (A) must be installed into the bore marked (A).

(A) is bigger than (B), and (C) is smaller than (B).

YANMAR supply only liner having (B) dimension as service parts.

The liner (B) can be installed into both cylinder bores (A) and (C). But this is allowed to only for replacing worn liner with new one.

INSPECTION AND REPAIR

1. Clean block thoroughtly with clearing solvent.
2. Make sure all passages and cleaned of sludge, rust, and grease.
3. Make sure all coolant passages are cleaned of lime deposits and scale.
4. Clean counter bore for liner flange.

DIAGNOSING MALFUNCTIONS

Scored Main Bearings (Diagnosis applies to Connecting Rod Bearings, also — See Section 10, this Chapter)

- Oil starvation
- Contaminated oil
- Engine parts failure
- Excessive heat
- Poor periodic service

Galled or "Wiped" Bearings

- Fuel in lubricating oil (incomplete combustion)
- Coolant in lubrication system
- Insufficient bearing oil clearance
- Parts not lubricated prior to engine operation
- Wrong bearing size

Uneven Wear Pattern

- Misaligned or bent connecting rod
- Warped or bowed crankshaft
- Distorted cylinder block

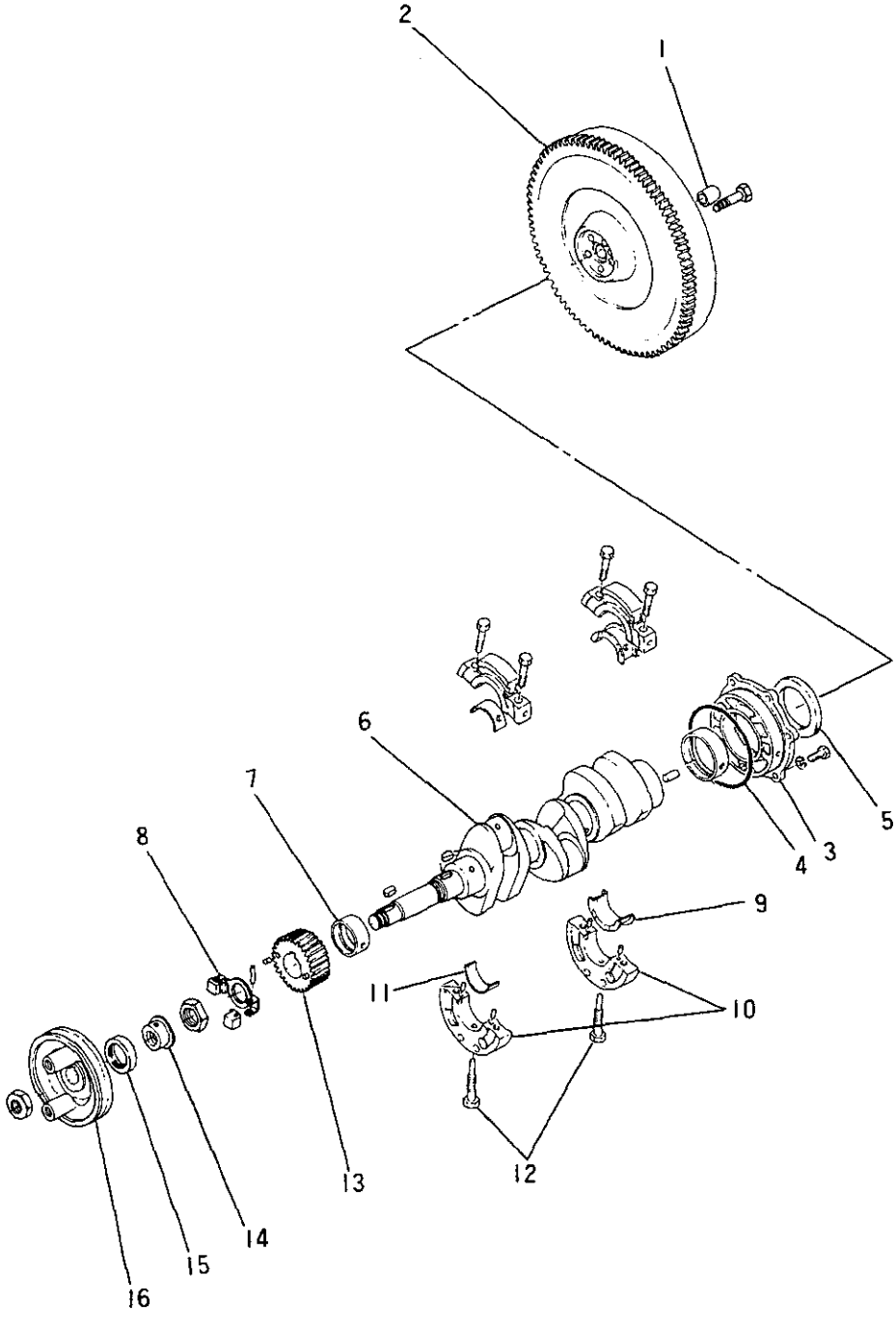
Broken Main Bearing Caps

- Improper installation
- Dirt between bearing and crankshaft journal
- Low oil pressure
- Oil pump failure

Cracked, Chipped or Broken Bearings

- Overspeeding
- Excessive idling
- Lugging
- Excissive oil clearance
- Improper installation

CRANKSHAFT, MAIN BEARINGS, AND FLYWHEEL



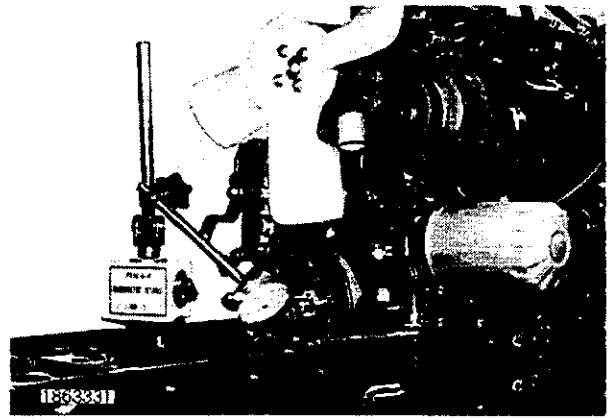
1 – Pilot Bushing
2 – Flywheel
3 – Rear Main Bearing Housing
4 – Rear Main Bearing
5 – Rear Oil Seal
6 – Crankshaft
7 – Front Main Bearing
8 – Governor Weights
9 – Thrust Bearing
10 – Intermediate Main Bearing Housing Halves
11 – Plain Bearing
12 – Set Screws
13 – Crankshaft Gear
14 – Governor Sleeve
15 – Front Oil Seal
16 – Pulley

1866004

CHEKING CRANKSHAFT END PLAY

Use the following procedure to check crankshaft end play before removing crankshaft.

1. Place a dial gauge on crankshaft pulley.
2. Pry between the pulley and timing gear cover to find end play.
3. Compare reading taken to the following specifications.



CRANKSHAFT END PLAY SPECIFICATIONS

New Part	Maximum Acceptable
0.09 to 0.10 mm (0.0035 to 0.0039 in.)	0.33mm (0.013 in.)

Use care not to distort the timing gear cover or pulley when prying.

BEFORE REMOVING

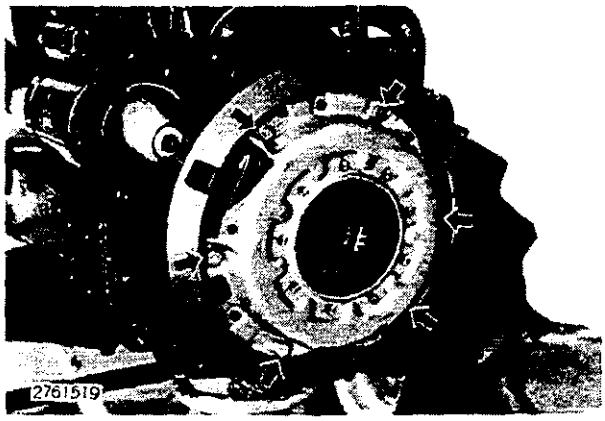
To inspect and repair the followings, engine must be removed from the tractor. See "Engine Removal" on page 10-20-7, "Cylinder head Removal" on page 20-05-6 and "Piston Removal" on page 20-10-3.

1. Crankshaft
2. Intermediate main bearings
3. Rear oil seal
4. Rear main bearing
5. Flywheel and Pilot bushing

To inspect and repair the followings, engine do not have to be removed from the tractor.

1. Front oil seal
2. Front main bearing

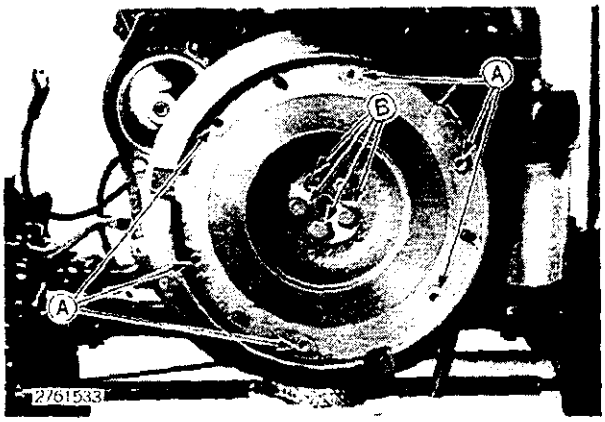
FLYWHEEL



REMOVAL, INSPECTION AND REPAIR

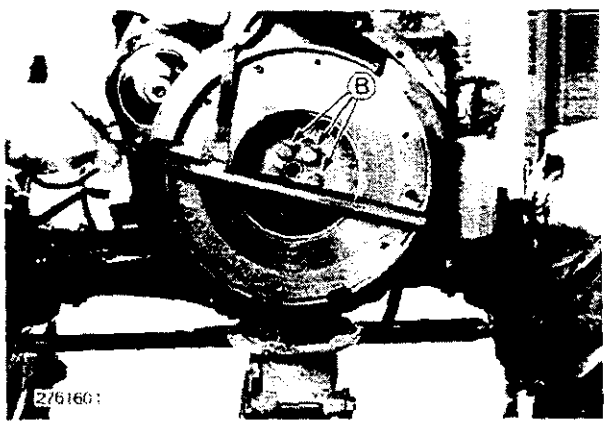
1. Separate the engine from the clutch housing.
2. Remove clutch assembly retaining cap screws and remove clutch assembly from flywheel.

STOP **Before removing clutch assembly from the flywheel, mark on the clutch assembly to be reinstalled at the original position.**



3. Check flywheel for cracks or damage, particularly around clutch mounting (A) and flywheel mounting cap screw holes (B).

A – Clutch Mounting Holes
B – Flywheel Mounting Cap Screws



4. Place a straight edge on the clutch disk friction surface, and use a feeler gauge to check for flatness.

FRICTION SURFACE FLATNESS SPECIFICATIONS

New Part	Maximum Warpage
0.07 mm (0.003 in.)	0.20 mm (0.008 in.)

5. Remove flywheel loosing cap screws (B) if necessary.

Ring Gear

1. Examine flywheel ring gear for chipped or broken teeth.
2. Remove ring gear by placing the flywheel on a flat surface, and driving off ring gear with a punch.
3. Install new ring gear by heating gear to 148°C (300°F) using either heated oil, oven heat, or flame heat.

STOP If flame heat is used, be sure gear is heated uniformly around circumference. DO NOT OVERHEAT. SEE CAUSION. Overheating may also destroy original heat treatment of gear.

4. Make sure the ring gear direction to the flywheel. The side grinded at the bottoms of teeth must be faced towards starter pinion gear.

⚠ Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer and do not exceed 182°C (360°F). Do not allow a flame or heating element to be in direct contact with the oil Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

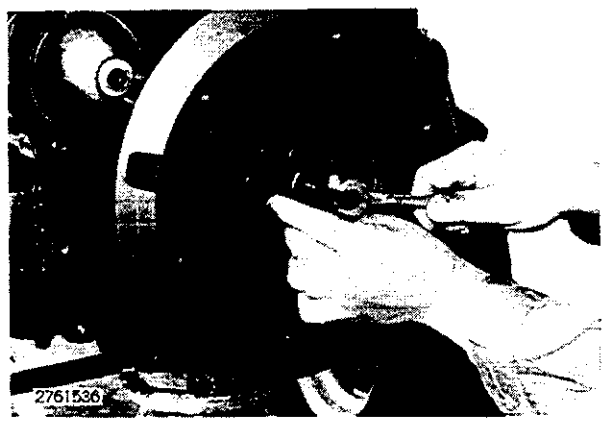
5. Tap heated gear into place against flywheel shoulder.

Clutch Shaft (Main Drive Shaft) Pilot Bushing

1. Measure I.D. of clutch shaft bushing, and O.D. of clutch shaft.
2. Compare measurements taken with the following specifications.

PILOT BUSHING SPECIFICATIONS

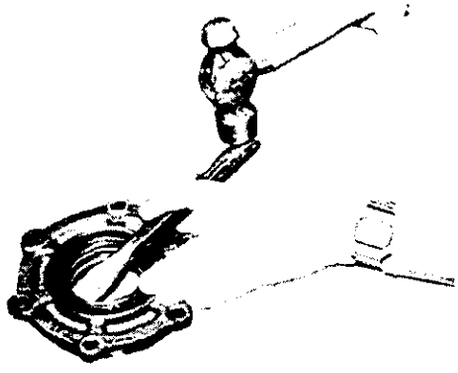
	New Parts
Bushing I.D.	12.016 to 12.034 mm (0.4731 to 0.4738 in.)
Clutch shaft O.D.	11.935 to 11.953 mm (0.4699 to 0.4706 in.)
Bushing-to-shaft Clearance	0.3 mm (0.012 in.)



3. Remove bushing by using Pilot Busing puller.
4. When installing pilot bushing, drive in until flush with clutch side of flywheel.

STOP Make sure tangs on bearings fit in recesses in bearing housing.

REAR OIL SEAL AND REAR MAIN BEARING



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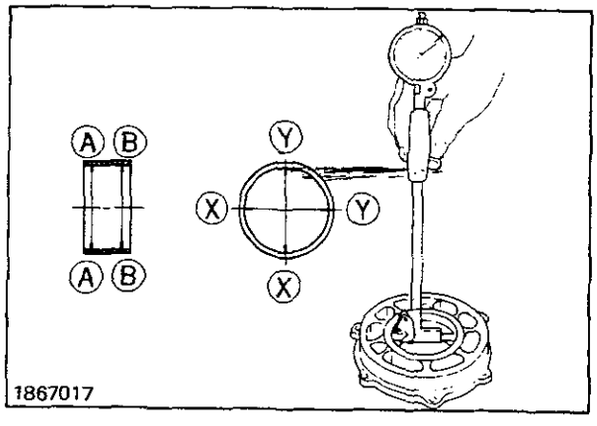
REMOVAL AND INSPECTION

1. Separate the engine from clutch housing. See page 10-20-3.
2. Remove flywheel as explained on page 20-15-4.
3. Remove rear main bearing housing from cylinder block.
4. Use a pry bar to remove oil seal.



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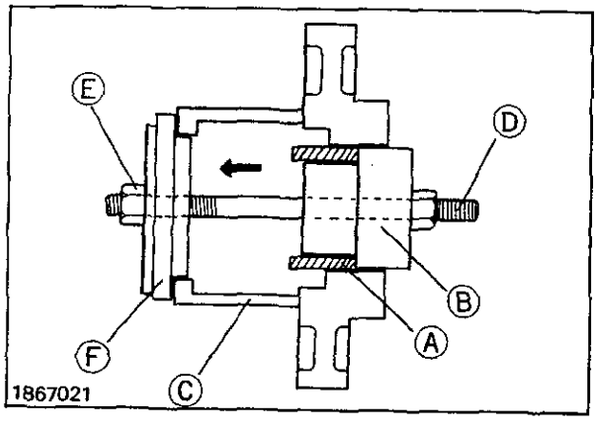
5. Measure I.D. of rear main bearing at the four points shown. Compare measurements taken with the following specifications.

REAR MAIN BEARING SPECIFICATIONS

	New Part	Wear Limit
I.D.	65.000 to 65.045 mm	65.10 mm



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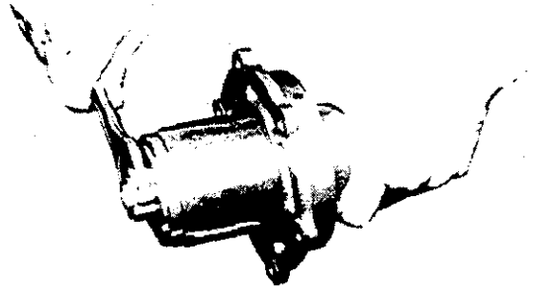
6. Remove bearing by using "Crank Shaft Main Bearing Removal and Installation Tool Kit".

A – Bearing
B – Guide (Large)
C – Spacer
D – Bolt
E – Nut
F – Metal Piece (A)



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7. To remove bearing, tighten nut.

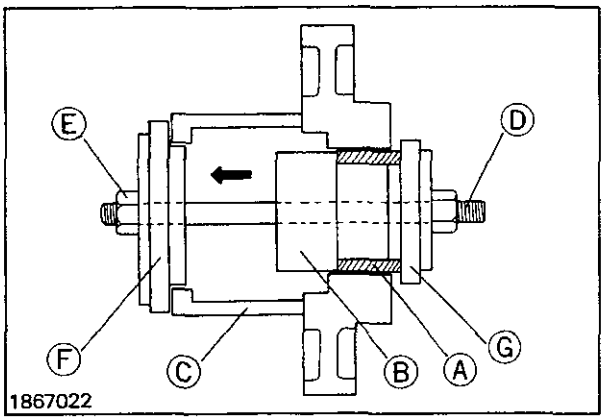
SME2760(1)-8304
Kinomoto, Printed in Japan
YM276 and 276D

ASSEMBLY

Rear Main Bearing

1. Clean the bores of housing before installing new bearing and seal.
2. Apply oil to the outside of bearing, and place it on guide (B).

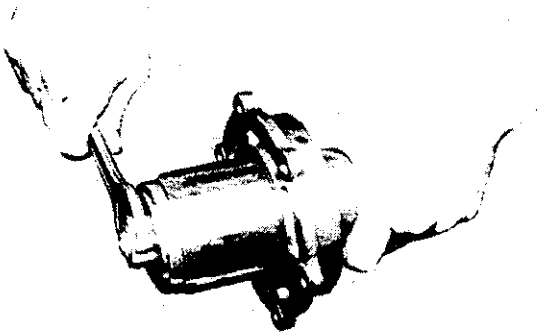
A – Bearing
B – Guide (Large)
C – Spacer
D – Bolt
E – Nut
F – Metal Piece (A)
G – Metal Piece (B)



1867022

3. Place the guide with bearing on the housing bore, and assemble installation tool as shown.

STOP When installing bearing, make sure lubricating oil hole on bearing align to the oil hole of bearing housing.
The oil hole location in bearing housing is offset. Also make sure of the installing direction. The chamfered edge of bearing must face oil seal side.


1862024

4. Tighten nut to install bearing.
5. After installing a new bearing, measure I.D., and check for distortion.

ASSEMBLY (Continued)

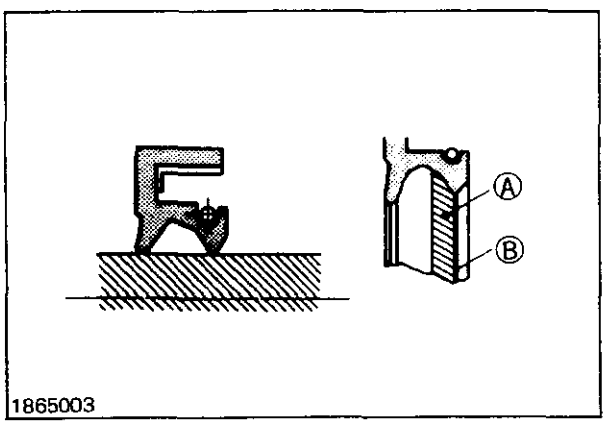
Rear Oil Seal

The crankshaft oil seals are spiral oil seals (Pumping seales). A lip design in the seal prevents oil from leaking during crankshaft operation.

DO NOT apply grease to the lip of seal. This would destroy seal pumping ability.

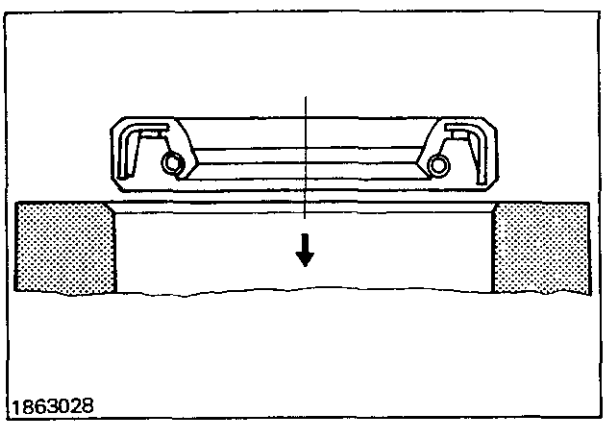
1. Clean the oil seal seating area of bearing housing.

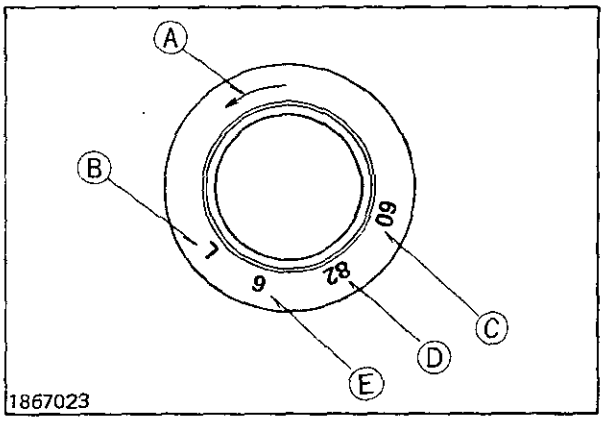
A – Lip
B – Lip End



1865003

2. Be sure the installation direction of oil seal is correct. The open side faces cylinder block side of housing.


1863028

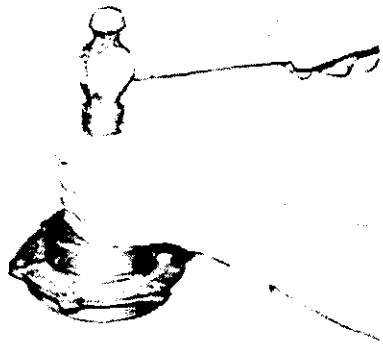


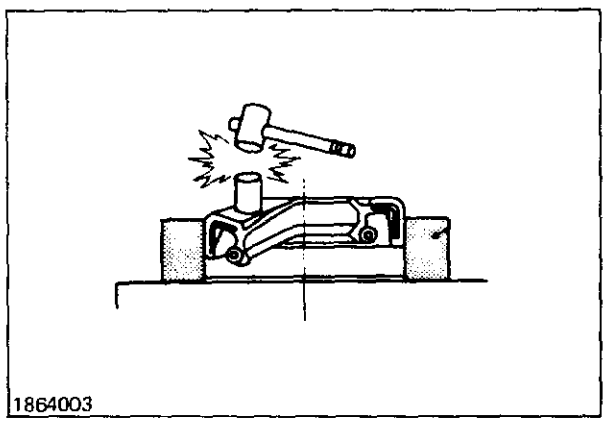
1867023

3. Make sure the arrow on the oil seal shows same direction as crankshaft rotation.

A – Rotation Arrow
B – Rotation Mark
C – Oil Seal Inside Diameter
D – Oil Seal Outside Diameter
E – Oil Seal Thickness

4. Install seal into bearing housing by using an installation tool.


1862023

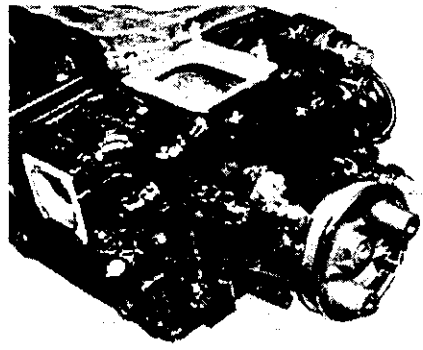

1864003

Never tap oil seal directly as shown.

CRANKSHAFT AND, FRONT AND INTERMEDIATE MAIN BEARINGS

To inspect and repair crankshaft, intermediate main bearings, must be removed engine from tractor.

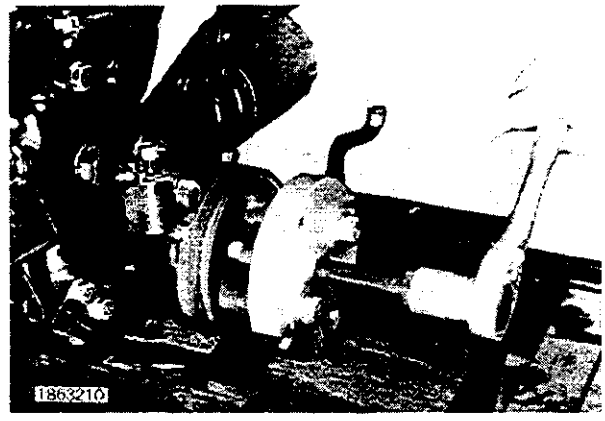
1. Remove engine (See page 10-20-7).
2. Remove cylinder head and pistons (See page 20-05-6 and 20-10-3).
3. Remove flywheel (See page 20-15-4).



1860213

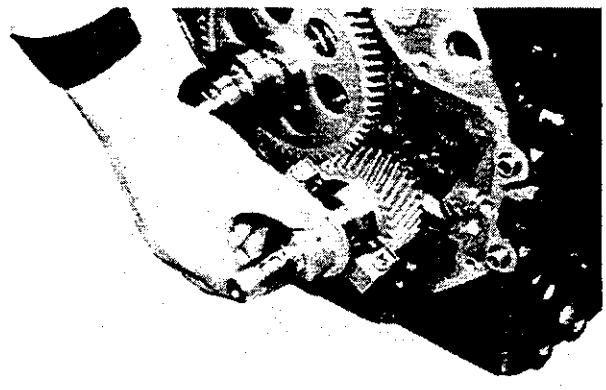
REMOVAL

1. Remove crankshaft pulley retaining nut.
2. Use a puller to remove pulley.
3. Remove timing gear cover.



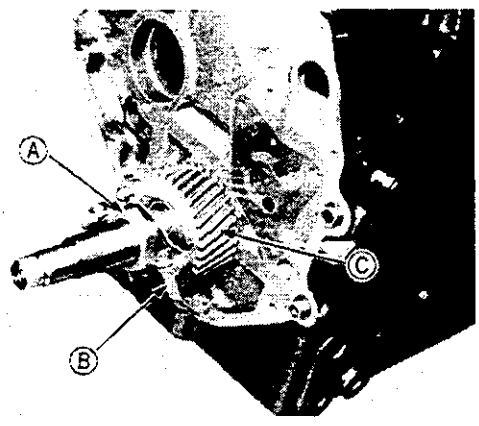
1863210

4. Remove governor sleeve from crankshaft.

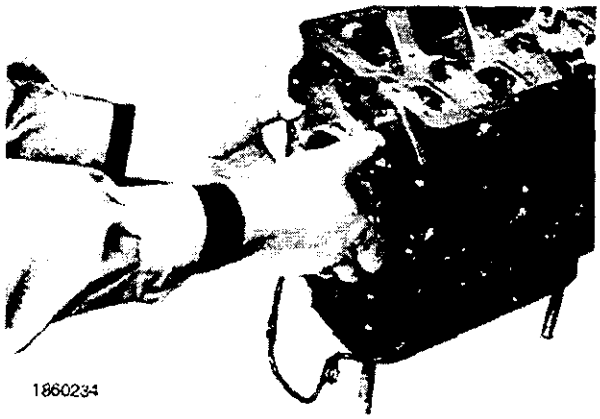


1860225

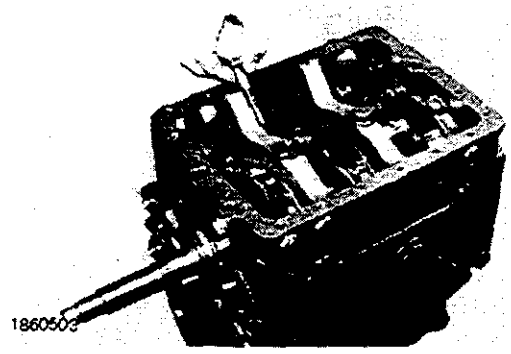
5. Remove nut (A) and governor weight assembly (B) to remove crankshaft gear (C).
6. Remove crankshaft gear (C).



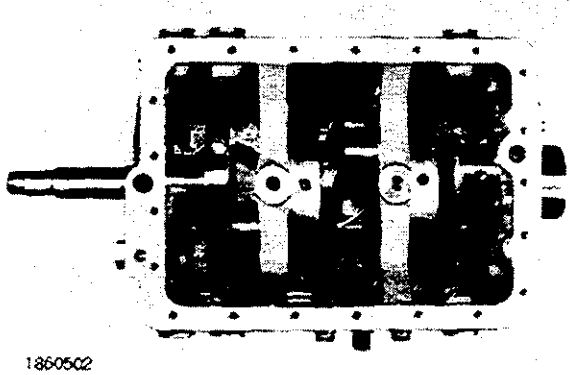
1860236


1860234

7. Invert cylinder block and remove the rear main bearing housing and mounting flonge.

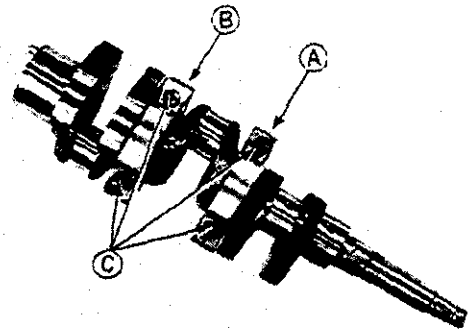

1860503

8. Secure a chain hoist to crankshaft.
9. Remove the two set bolts from intermediate main bearing housings.
10. Carefully lift crankshaft from block.


1860502

10. Carefully pull crankshaft out of cylinder block.

Be careful not to damage the outer surfaces of the intermediate main bearing bodies during crankshaft removal.



1860429

11. Remove intermediate main bearing housing cap screws (C) and remove housings (A, B) from crankshaft.

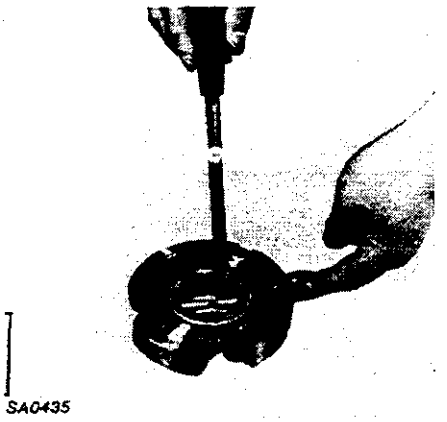
A — Bearing housing
B — Bearing Housing
C — Housing Cap Screws

INSPECTION

Intermediate Main Bearings

1. Inspect intermediate, front and rear main bearings for excessive wear, scoring or damage.

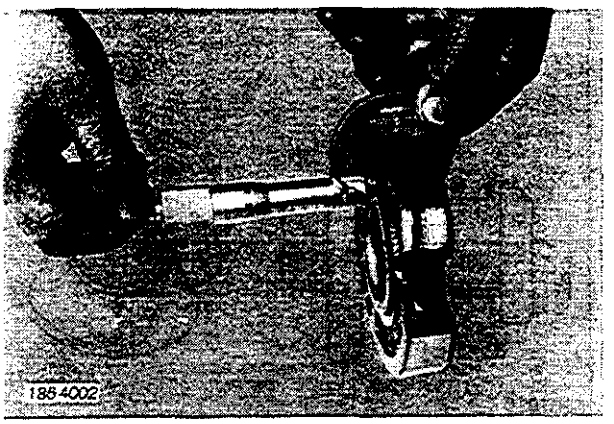
2. Measure the inside diameter of intermediate bearings in both the A-A and B-B directions, at the front and rear of bearing. Compare reading taken with the following specifications.


SA0435

INTERMEDIATE BEARING SPECIFICATIONS

	New Part	Wear Limit
I.D.	60.00 to 60.045 mm (2.362 to 2.364 in.)	60.10 mm (2.366 in.)
Intermediate Oil Clearance	0.036 to 0.095 mm (0.0014 to 0.0037 in.)	0.15 mm (0.006 in.)

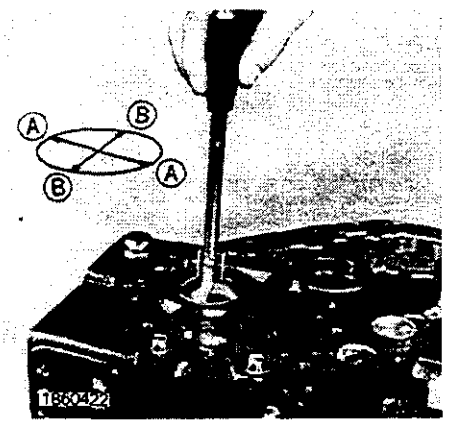
3. Measure the width of rear intermediate bearing. Compare the measurement taken with the following specifications.


1884002

REAR INTERMEDIATE BEARING SPECIFICATIONS

	New Part	Wear Limit
Width	29.83 to 29.91 mm (1.1744 to 1.1776 in.)	29.80 mm (1.1722 in.)

4. Measure the inside diameter of front main bearing in both the A-A and B-B directions. Compare the measurement taken with the following specifications.



1860422

FRONT MAIN BEARING SPECIFICATIONS

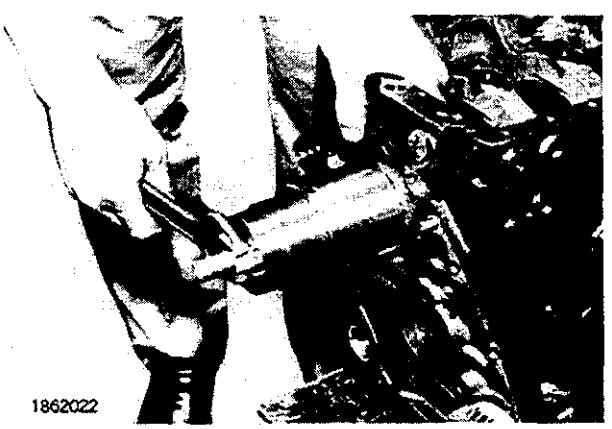
	New Part	Wear Limit
I.D.	60.000 to 60.045 mm (2.362 to 2.364 in.)	60.10 mm (2.366 in.)
Intermediate Oil Clearance	0.036 to 0.095 mm (0.0014 to 0.0037 in.)	0.15 mm (0.006 in.)

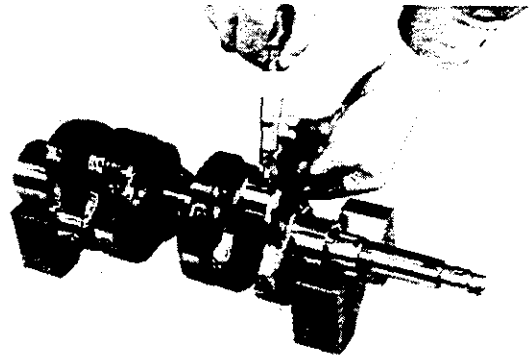
REAR MAIN BEARING SPECIFICATION

Rear Main Bearing I.D.	65.000 to 65.045 mm (2.559 to 2.560 in.)	65.10 mm (2.563 in.)
Rear Oil Clearance	0.036 to 0.095 mm (0.0014 to 0.0037 in.)	0.15 mm (0.006 in.)

5. If the measurement exceeds the wear limit, Replace the bearing by using a main bearing installation and removal tool.

See page 20-15-13 to install new bearing.

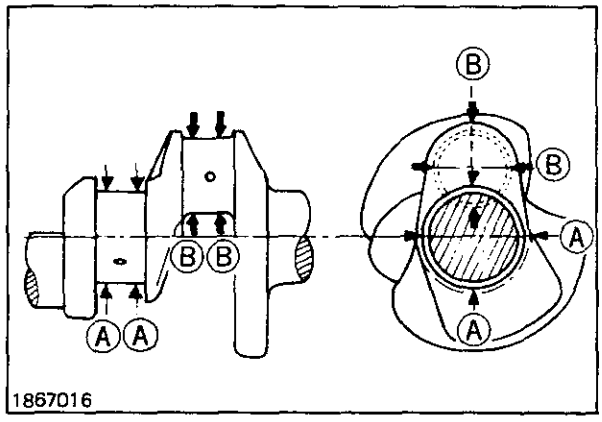

1862022



1860427

Crankshaft

1. Check crankshaft for cracks or signs of load stress.

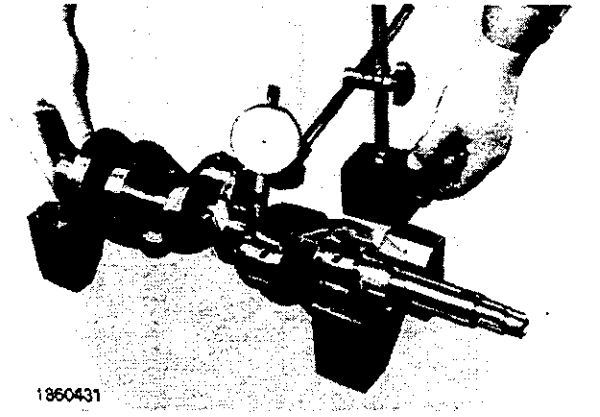


1867016

2. Measure each main journal O.D. (A) – (A) and Rod bearing journal O.D. (B) – (B) at points shown and compare measurement taken with the following specfications. Also, compare bearing I.D. with journal O.D. to determine oil clearance.

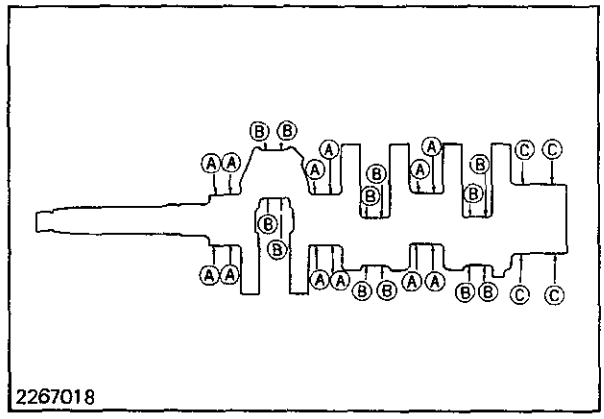
CRANKSHAFT ROD BEARING JOURNAL SPECIFICATIONS

	New Part	Wear Limit
O.D. of bearing journal	46.950 to 46.964 mm (1.848 to 1.849 in.)	46.92 mm (1.847 in.)
I.D. of Assembled Rod Bearing	47.000 to 47.042 mm (1.850 to 1.852 in.)	47.10 mm (1.854 in.)
Oil Clearance	0.036 to 0.092 mm (0.0014 to 0.0036 in.)	0.15 mm (0.006 in.)



1860431

3. Inspect crankshaft bent or warp by using dial gauge while rotating the crankshaft on V-blocks .



2267018

CRANKSHAFT MAIN BEARING JOURNAL SPECIFICATIONS

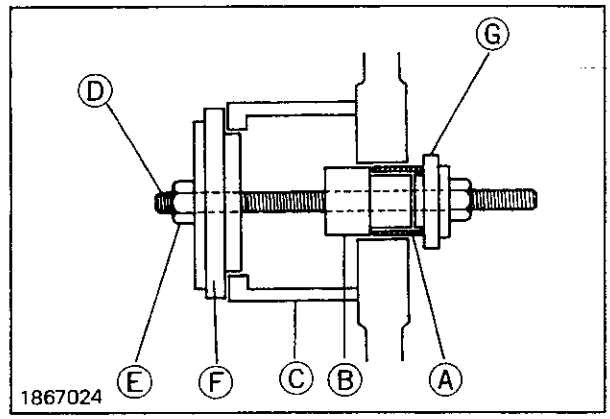
	New Part	Wear Limit
Front (O.D.)	59.950 to 59.964 mm (2.360 to 2.364 in.)	59.92 mm (2.359 in.)
Inter mediate (O.D.)	59.950 to 59.964 mm (2.360 to 2.364 in.)	59.92 mm (2.359 in.)
Rear (O.D.)	64.950 to 64.964 mm (2.5571 to 2.5576 in.)	64.92 mm (2.556 in.)

A — Front & Intermediate Main Bearing Journal
B — Connection Lod Bearing Journal.
C — Rear Bearing Journal

ASSEMBLY

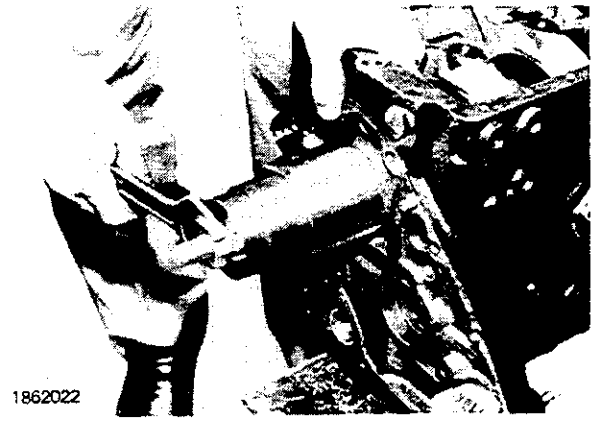
Front Main Bearing

1. Clean the bore of cylinder block before installing new bearing.
2. Apply oil the outside of bearing, and place it on guide (A).
3. Insert the guide with bearing in the cylinder block bore from its inside and assemble intallation tool as shown.
4. When installing bearing, make sure lubricating oil hole to bearing align to the oil hole of cylinder block.



A – Bearing
B – Guide (Small)
C – Spacer
D – Bolt
E – Nut
F – Metal Piece (A)
G – Metal Piece (C)

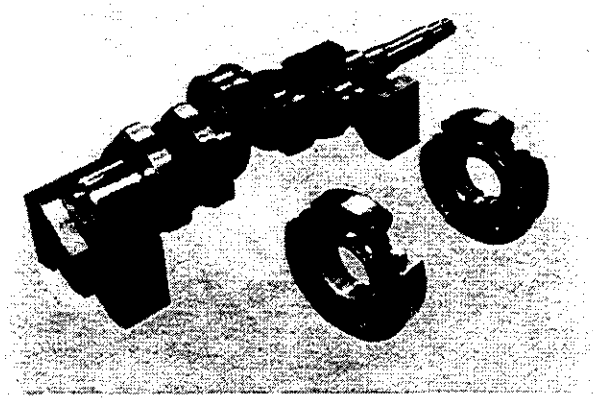
5. Tighten nut to install bearing.
6. After installing a new bearing, measure I.D. and check for distortion.



Intermediate Main Bearings and Crankshaft

1. Coat intermediate bearings with engine oil and install in bearing housing halves. Make sure the bearing halves with a oil hole is installed in the upper bearing halves, and the oil hole of bearing align the oil hole of bearing housing.

Make sure tangs on bearings fit in recesses in bearing housing.

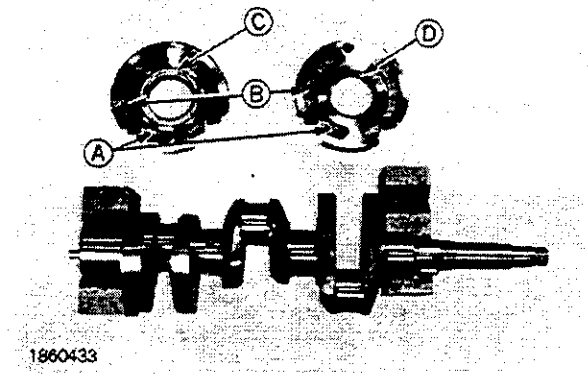


2. Assembly bearing housing with bearings on crankshaft with the following important instructions.

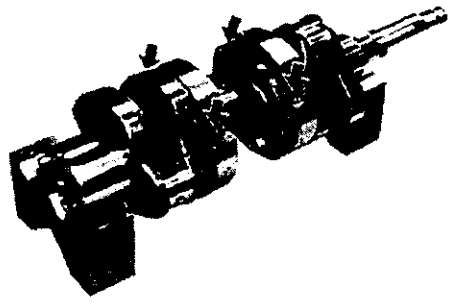
   A – "F" mark faces toward flywheel side of crankshaft.

   B – "Arrows" align each other.

   C – Bearing with thrust surface must be installed flywheel side journal of crankshaft (Between No. 1 and No. 2 Cylinders).



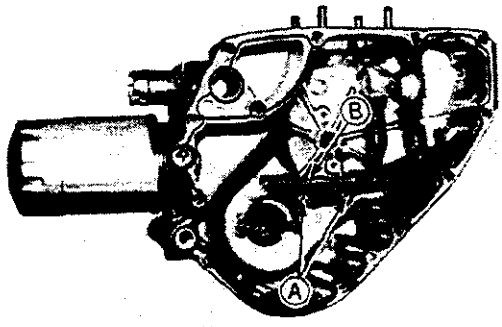
A – "F" Mark
B – Align Arrow
C – Thrust Bearing
D – Plain Bearing



1860428

3. Tighten intermediate main bearing housing cap screws to 44.1 to 49.0 Nm (4.5 to 5.0 kgm) (32.5 to 36.1 ft-lbs).

4. After tightening, check if the bearing nousings rotate smoothly.



1860405

FRONT OIL SEAL

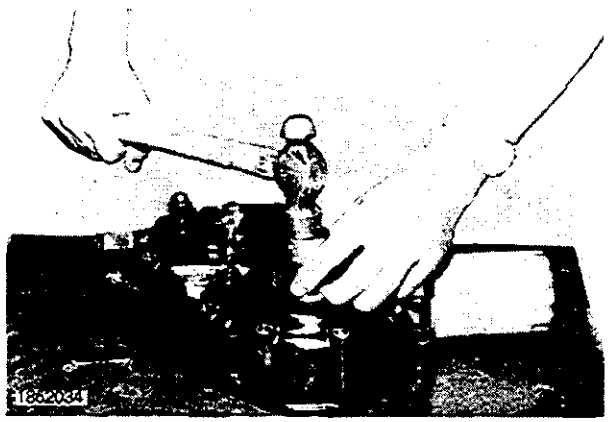
REMOVAL

1. Remove timing gear cover (See page 20-05-15).

2. Remove cap screws (A) and governor linkage assembly (B).

3. Check oil seal for wear or deterioration.

A – Cap Screws
B – Governor Linkage



1862034

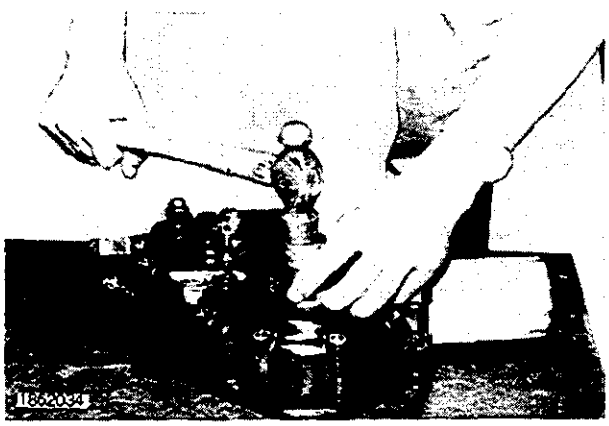
4. Use punch to remove oil seal from timing gear cover.

   Replace oil seal with new one if it was removed from the cover.

ASSEMBLY

The crankshaft oil seals are spiral oil seals (Pumping seals). A lip design in the seal prevents oil from leaking during crankshaft operation.

DO NOT apply grease to the lip of seal. This would eliminate seal pumping ability.



1862034

1. Clean the oil seal seating area of timing gear cover.

2. Be sure the installation direction of oil seal is correct. The open side faces cylinder block side of cover.

3. Make sure an arrow on the oil seal shows same direction as crankshaft rotation.

4. Install seal to timing gear cover by using a installation tool.

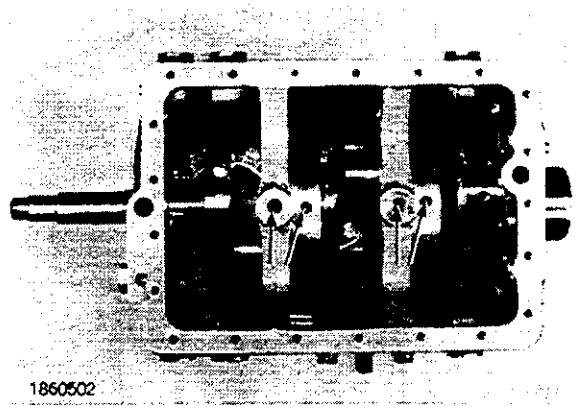
   Never tap oil seal directly.

See Rear Oil Seal assembly on page 20-15-8 for detail illustrations of spiral oil seal.

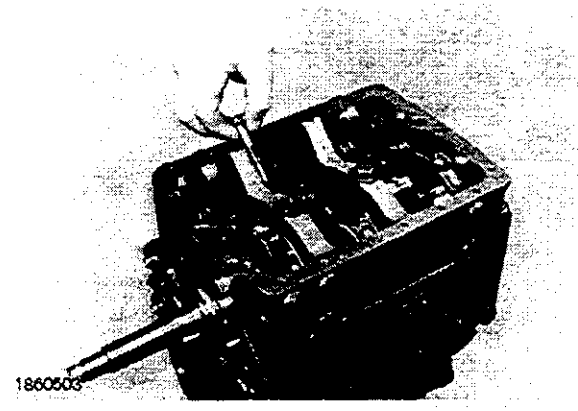
CRANKSHAFT INSTALLATION TO BLOCK

Before installing crankshaft, clean each assembled component, and prepare all cap screws.

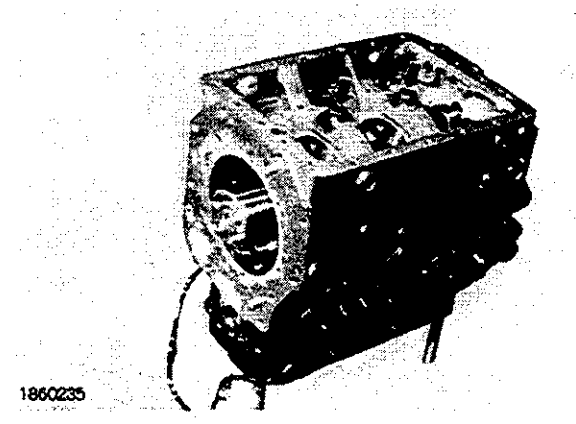
1. Stand cylinder block upright, and lower crankshaft into block.
2. Before completely installing, align set screw holes between intermediate main bearing housing and block.


1860502

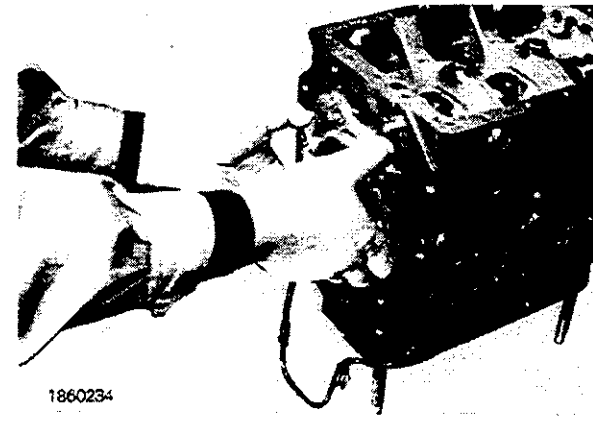
3. Lightly oil set screws.
4. Complete lower crankshaft into position and install intermediate bearing housing set screws. Do not tighten yet.

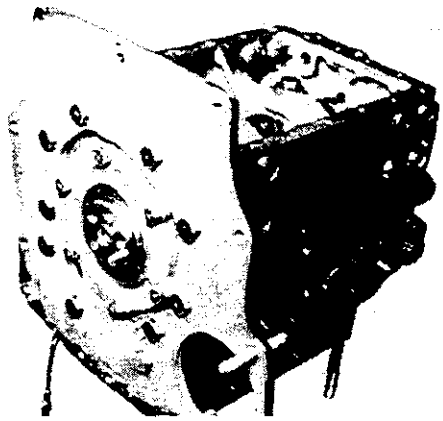

1860503

5. Tighten set screw in bearing housing nearest flywheel first (Thrust bearing housing) to 73.5 Nm (7.5 kgm) (54.2 ft-lbs).
6. Tighten the remaining set screw to 73.5 Nm (7.5 kgm) (54.2 ft-lbs).
7. After tightening set screws, make sure the crankshaft rotates smoothly.

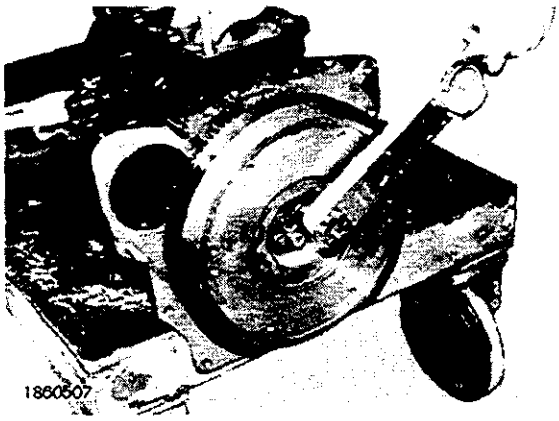

1860235

8. When installing rear main bearing housing, make sure oil hole in bearing housing and oil hole in block are aligned. The bolt pattern in bearing housing in not divided equally so that it prevents incorrect installation.
9. Carefully place rear main bearing housing on block and tighten cap screws to 24.5 to 26.5 Nm (2.5 to 2.7 kgm) (18.5 to 19.5 ft-lbs).

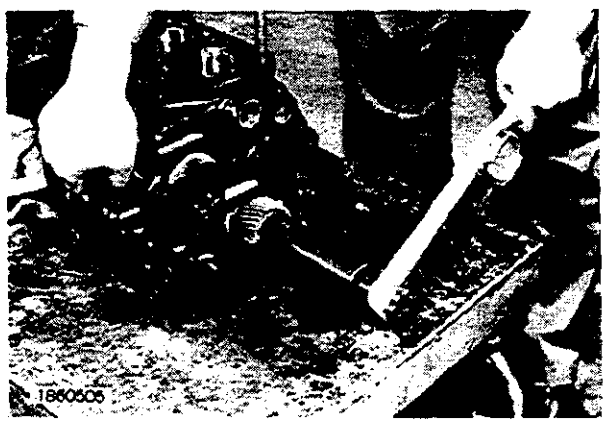

1860234


1860232

10. Install mounting flange and tighten can screws to 45 to 60 Nm (4.5 to 6.0 kgm) (33 to 43 ft-lbs).


1860507

11. Install flywheel and tighten cap screws to 64 Nm (7 kgm) (50 ft-lbs). Do not damage pilot bushing when tightening cap screws.
12. Install key in groove in crankshaft before installing crankshaft gear.
13. Align key groove in gear with key on crankshaft.
14. Install governor weight assembly on the gear.


1860505

15. Use special deep socket to tighten and drive crankshaft gear onto crankshaft. Tighten on gear until it is tight against shoulder on crankshaft to 69 to 73 Nm (7.0 to 7.5 kgm) (51 to 54 ft-lbs).

DIAGNOSING MALFUNCTIONS

Low Oil Level

- Low oil level
- Excessive oil temperature
- Incorrect oil
- Oil pressure regulating valve failure
- Excessive main bearing clearance
- Clogged suction tube screen
- Excessive clearance between oil pump rotors and pump body

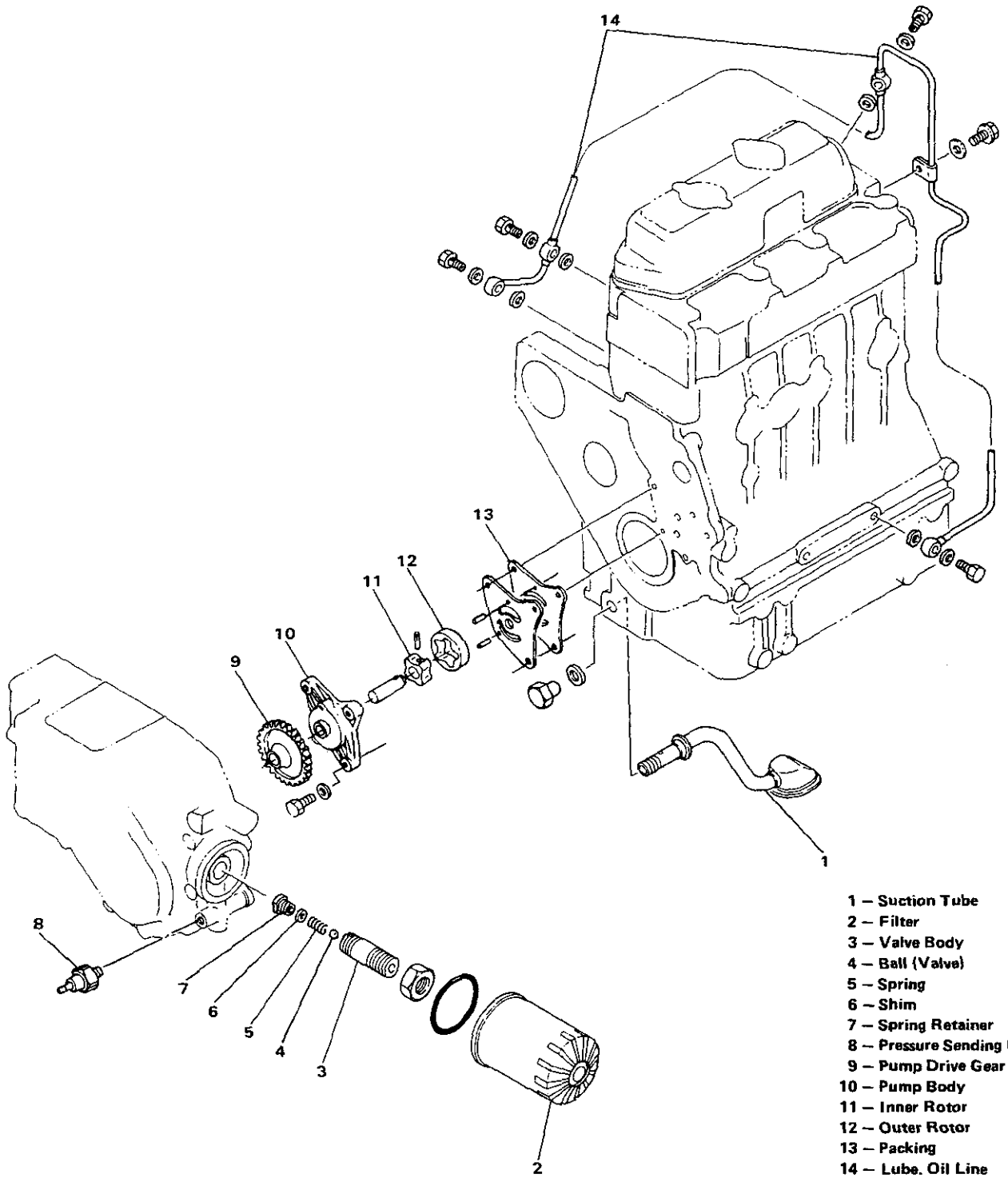
High Oil Pressure

- Improper oil type
- Clogged oil lines
- Oil pressure regulating valve failure

Oil Sludge and Dilution

- Improper operation and servicing
- Coolant leakage into lubrication system
- Incomplete combusion
- Excessive oil temperature

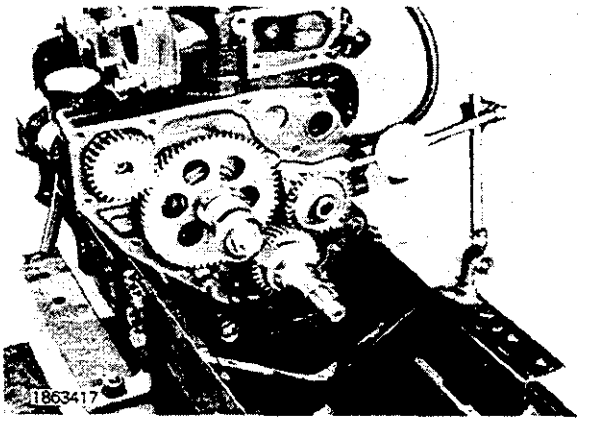
LUBRICATION SYSTEM



1 – Suction Tube
2 – Filter
3 – Valve Body
4 – Ball (Valve)
5 – Spring
6 – Shim
7 – Spring Retainer
8 – Pressure Sending Unit
9 – Pump Drive Gear
10 – Pump Body
11 – Inner Rotor
12 – Outer Rotor
13 – Packing
14 – Lube. Oil Line

2766003

CHECKING OIL PUMP GEAR BACKLASH



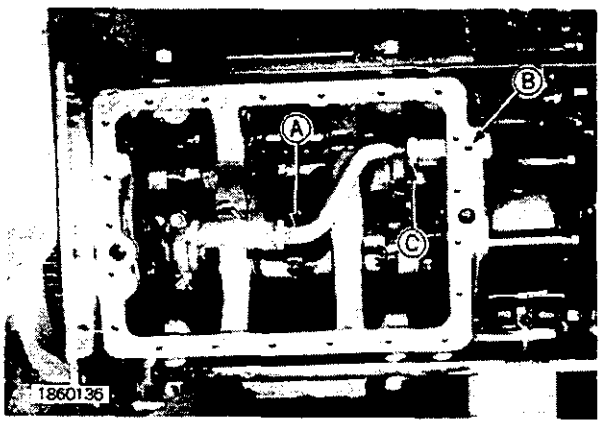
1. Remove timing gear cover as instructed on page 20-05-15.
2. Install a dial indicator on block as shown.
3. More oil pump gear back and forth and observe reading. While moving oil pump gear make sure crankshaft gear does not move. Compare reading taken with the following specifications:

OIL PUMP-CRANKSHAFT GEAR BACKLASH SPECIFICATIONS

New Part	Wear Tolerance
0.08 to 0.16 mm (0.003 to 0.006 in.)	0.3 mm (0.0012 in.)

4. If wear exceeds wear tolerance, replace oil pump gear.
5. When replacing gear, pump assembly must be replaced. Because the gear is prossed on the pump shaft.

LUBE OIL SUCTION TUBE AND SCREEN



INSPECTION AND REMOVAL

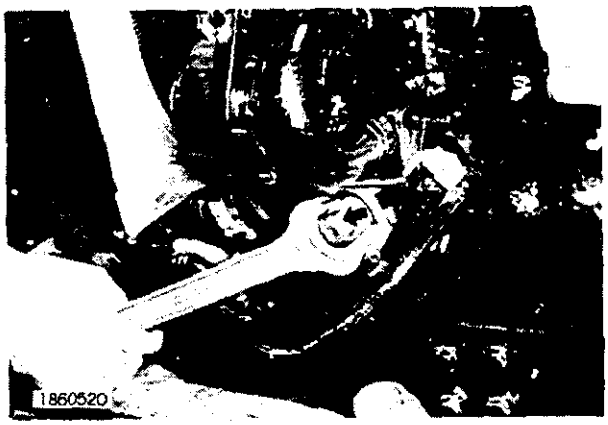
1. Inspect suction screen for clogged condition.
2. Loosen locknut and remove suction tube.

A – Suction Tube
B – Oil Prassage
C – Lock Nut

INSTALLATION

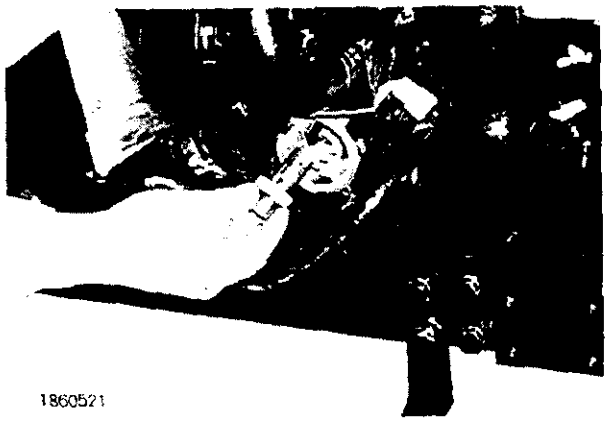
1. Clean thread of tube and cylinder block with solvent.
2. Coat threads of tube with lock tite.
3. Screw tube in 8 to 10 mm (0.3 to 0.4 in.) or 6 to 7-1/2 turns.
4. Make sure threads on tube do not enter drilled oil passage (B).
5. Tighten lock nut (C).

OIL PRESSURE REGULATING VALVE

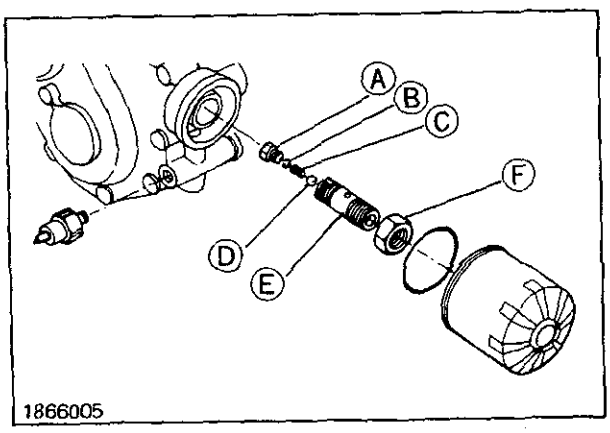


REMOVAL, DISASSEMBLY AND INSPECTION

1. Remove oil filter.
2. Remove oil pressure regulating valve body.



3. Remove spring retainer from valve body.
4. Remove shim(s), spring and check ball from valve body.
5. Add shim(s) to increase oil pressure and subtract shims to decrease oil pressure. Addition of one shim increases oil pressure 17 Kpa (0.18 kg/cm^2) (2.6 psi).



INSTALLATION

1. Install ball (D) spring (C), shim(s) (B), and spring retainer (A) in valve body (E).
2. Install valve body in timing gear cover and screw completely in by hand.
3. Install locking nut (F) on valve body.
4. Install oil filter.

A – Spring Retainer
B – Shim(s)
C – Spring
D – Ball
E – Valve Body
F – Lock Nut

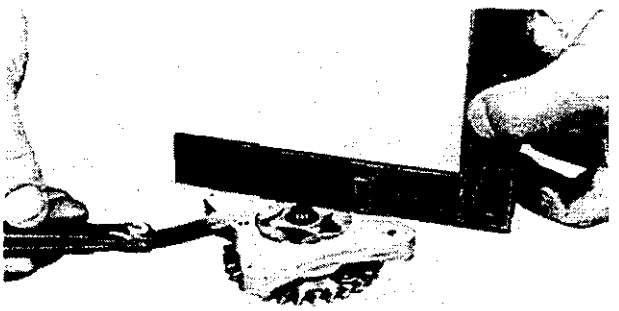
OIL PUMP

REMOVAL

1. Remove timing gear cover as instructed on P. 20-05-15.
2. Remove the three cap screws securing pump body to block and remove pump.

INSPECTION

1. Place a straightedge across machined surface on pump body.
2. Use a feeler gauge to check recess of pump rotors in pump body. Compare measurement taken with the following specifications.

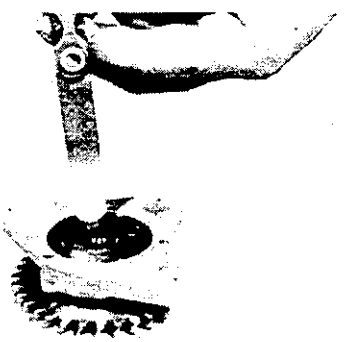


1860334

PUMP ROTOR RECESS SPECIFICATIONS

New Part	Wear Tolerance
0.03 to 0.09 mm (0.0012 to 0.0035 in.)	0.15 mm (0.006 in.)

3. Use a feeler gauge to check clearances between outer rotor and pump body. Compare measurement taken with the following specifications.

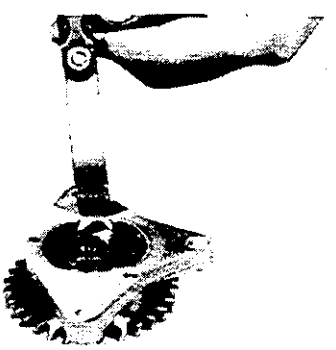


1860335

OUTER ROTOR-TO-PUMP BODY CLEARANCE

New Part	Wear Tolerance
0.10 to 0.16 mm (0.004 to 0.006 in.)	0.25 mm (0.01 in.)

4. Check inner rotor-to-outer rotor clearance between a high point on inner rotor, and high point on outer rotor. Compare measurement taken with the following specifications.



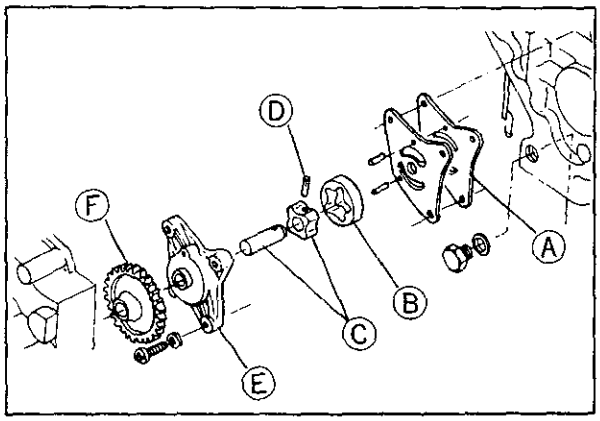
1860336

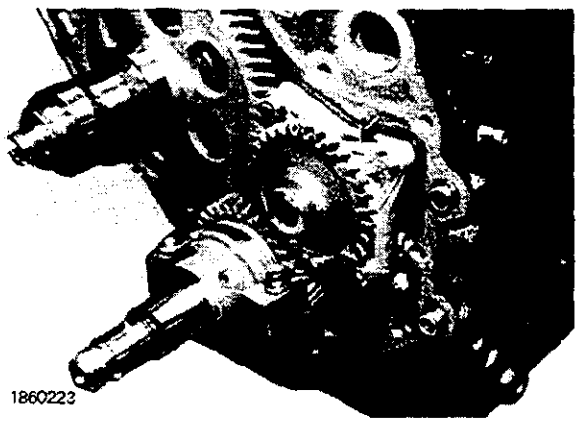
INNER ROTOR-TO-OUTER ROTOR SPECIFICATIONS

New Part	Wear Tolerance
0.10 to 0.16 mm (0.004 to 0.006 in.)	0.25 mm (0.01 in.)

If measurement exceeds wear tolerance, replace pump.

OIL PUMP (Continued)




1860223

ASSEMBLY AND INSTALLATION

1. Install inner rotor-shaft assembly (C) pump body (E).
2. Install outer rotor (B) in pump body.
3. Install key in inner rotor-shaft assembly.
4. Install cap screws in pump body.
5. Install gear on shaft.

A – Packing
B – Outer Rotor
C – Inner Rotor-Shaft assembly
D – Pin
E – Pump Body
F – Gear

6. Install packing (A) on pump body.
7. Install pump so spring pin (B) enters hole in block.
8. Tighten cap screws to 8 to 12 Nm (0.8 to 1.2 kgm) (6 to 8 ft-lbs).

DIAGNOSING MALFUNCTIONS

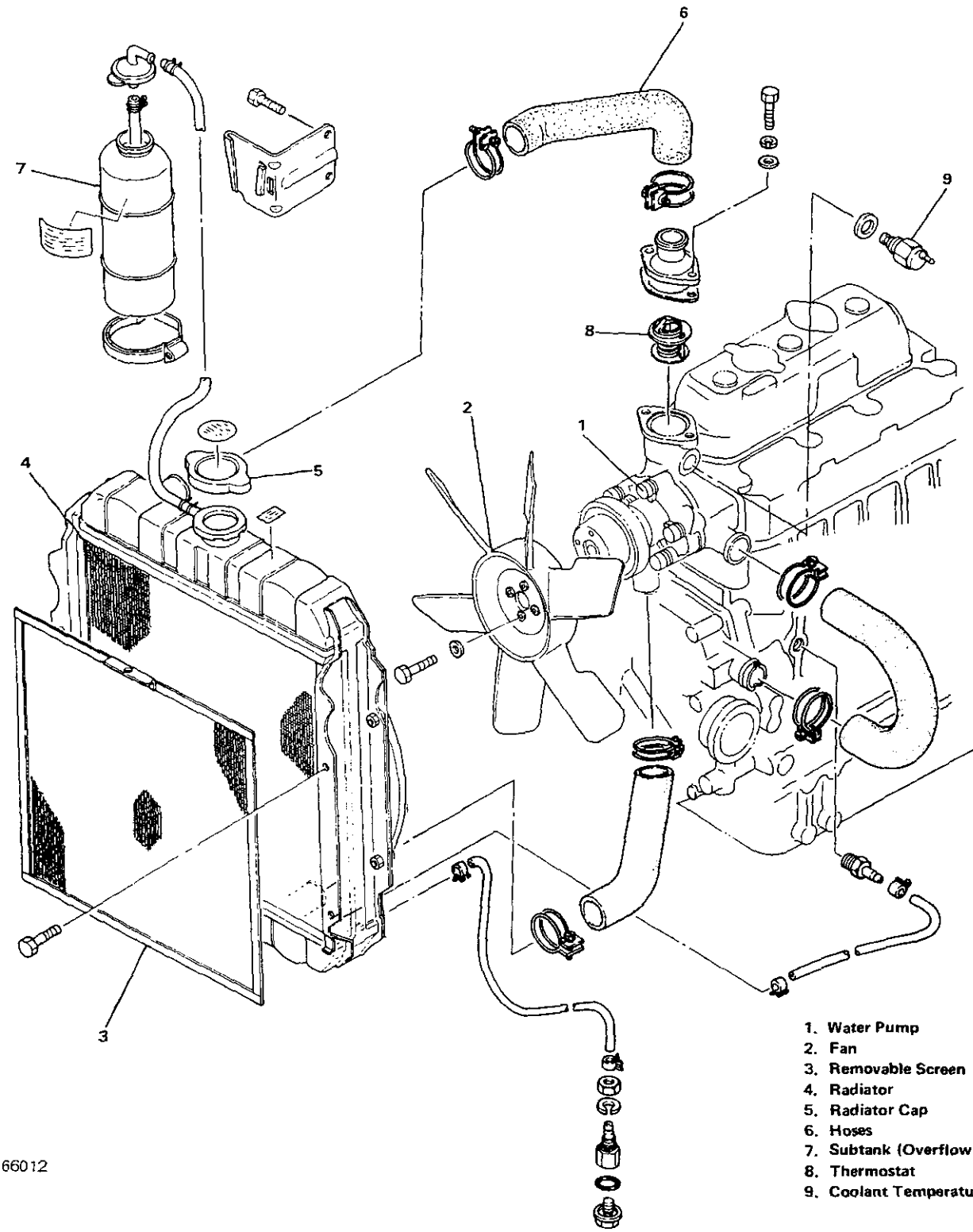
Engine Overheats

- Loose fan belt
- Dirty radiator or grille screen
- Low coolant level
- Low oil level
- Improper operation
- Defective head gasket
- Incorrect timing
- Faulty thermostat
- Faulty radiator cap
- Faulty water pump
- Corroded coolant passages

Low Coolant Level

- Improper maintenance
- Improper operation
- Damaged radiator
- Water pump seal leakage
- Leakage
- Faulty radiator cap

COOLING SYSTEM

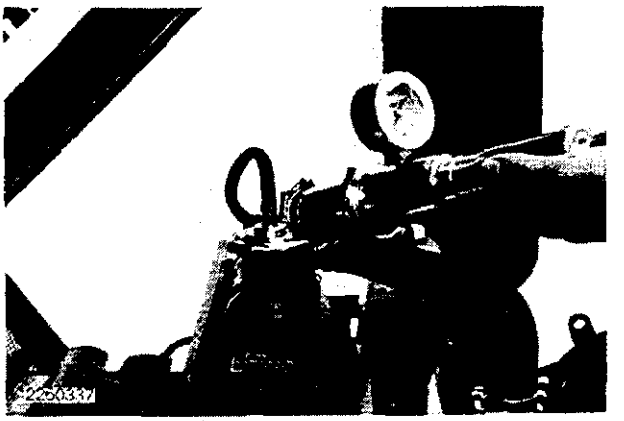


2766012

1. Water Pump
2. Fan
3. Removable Screen
4. Radiator
5. Radiator Cap
6. Hoses
7. Subtank (Overflow Tank)
8. Thermostat
9. Coolant Temperature Sender

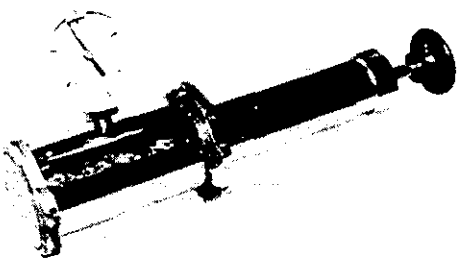
TESTING COOLING SYSTEM

CHECKING COOLING SYSTEM



1. Tilt hood forward.
2. Visually check the radiator for leaks or damage.
3. Remove radiator cap.
4. Attach Pressure Pump to filler neck.
5. Use pump to apply 147 Kpa (1.50 kg/cm^2) (21 psi) compressed air to system.
6. Check radiator, hoses, water pump and engine for leaks.

CHECKING RADIATOR CAP



1. Remove cap and attach to Pressure Pump.
2. When pressurized, cap should maintain 73 to 103 Kpa (0.74 to 1.05 kg/cm^2) (11 to 15 psi).

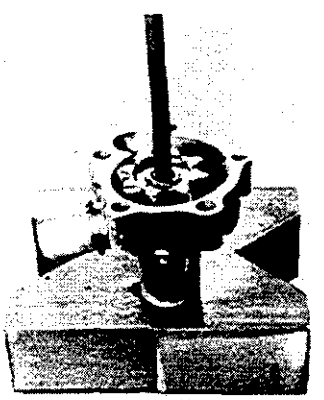
1860925

CHECKING BELT TENSION

Check tension of fan belt and adjust if necessary. Fan belt should deflect 10 to 15 mm (3/8 to 5/8 inch) when 98N (10 kg) (22 lbs.) force is applied.

WATER PUMP

REMOVAL AND DISASSEMBLY

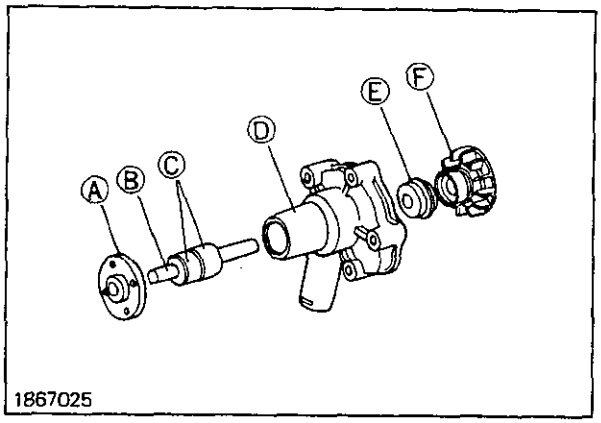


1. Drain cooling system.
2. Remove fan belt, and water pump hoses from water pump.
3. Remove water pump-to-thermostat housing cap screws and remove water pump.
4. Use a press to push bearing shaft from fan hub.
5. *Remove bearing retainer snap ring from water pump housing.*
6. Support water pump in a press as shown. Press bearing from impeller and water pump housing.

1863409

WATER PUMP (Continued)

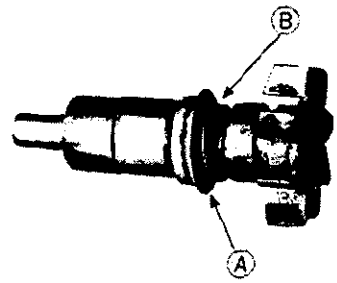
ASSEMBLY AND INSTALLATION



1867025

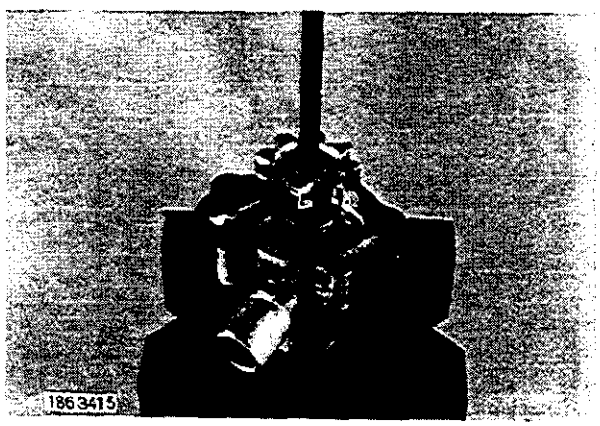
A — Hub
B — Shaft
C — Bearings
D — Housing
E — Seal
F — Impeller

1. Inspect seal (A) and ceramic insert in impeller (B) for wear.

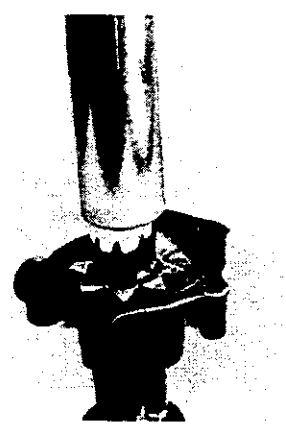


1863412

A — Seal
B — Ceramic Insert

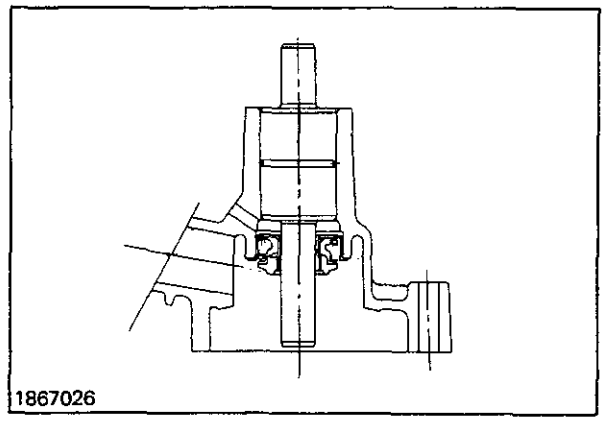

1863415

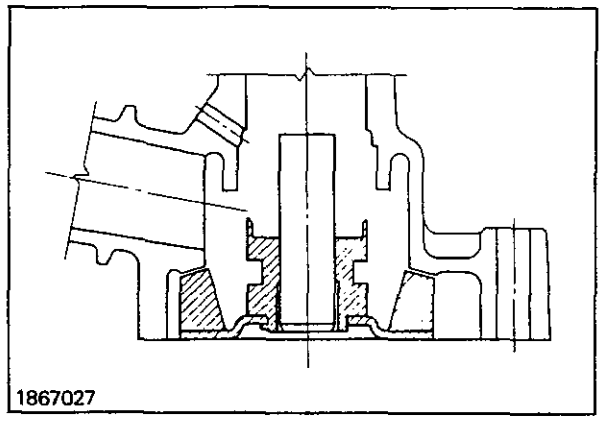
2. If seal was removed, use hydraulic press to reinstall.


1863402

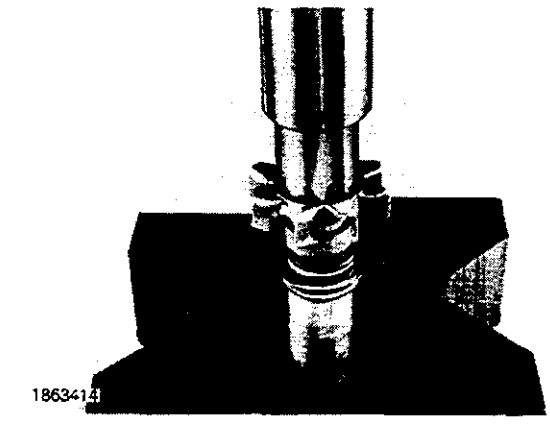
3. Installing bearing .

4. Use a tube to press in water pump bearing. Press in bearing until bearing is flush with end of housing.

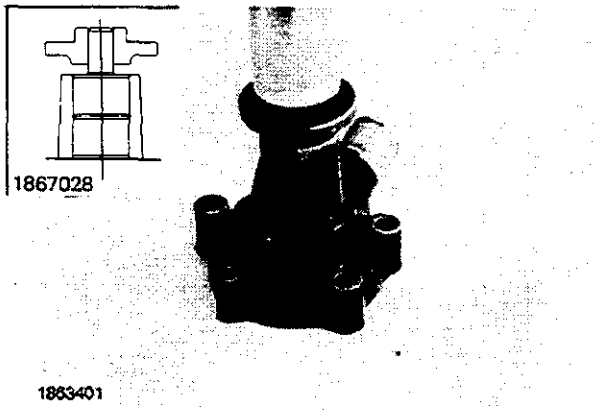

1867026


1867027

5. Support water pump in a press as shown. Press in impeller until impeller flushes with end of bearing shaft.

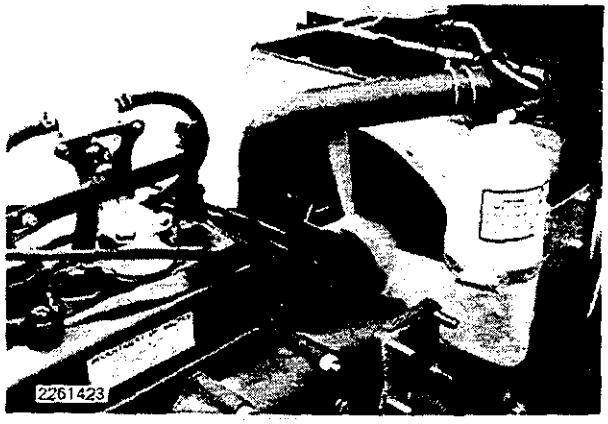

1863414

6. Press on hub until hub is flush with end of bearing shaft.


1867028

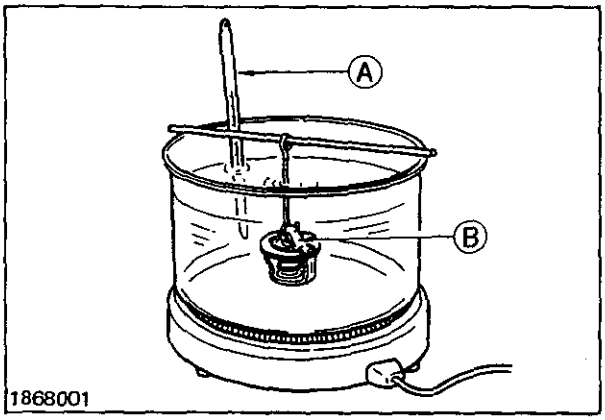
1863401

THERMOSTAT



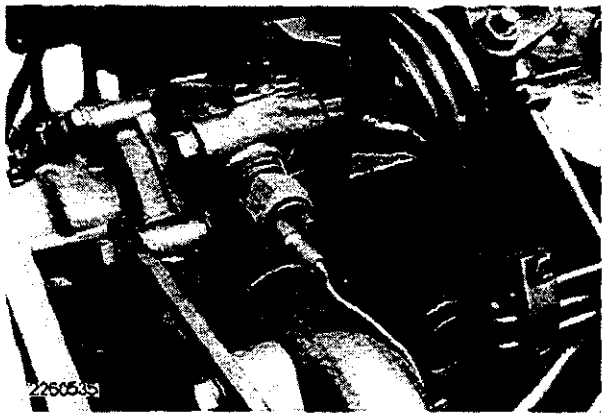
1. Visually check area around thermostat housing for leaks.
2. Remove radiator hose from thermostat cover.
3. Remove thermostat cover.

4. Remove thermostat.



5. Check thermostat in a thermostat tester. Thermostat should open at 69.5 to 72.5°C (157 to 163°F).

A – Thermometer
B – Thermostat



6. Check temperature sender in thermostat tester with circuit terster. Current should flow at 110°C (230°F).

FUEL AND AIR REPAIR 30

SPECIFICATIONS

Air Intake System

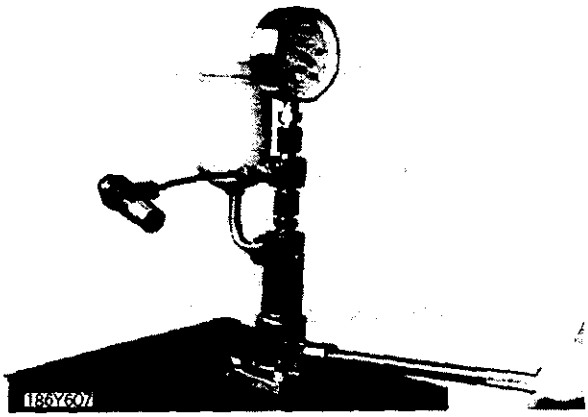
ITEM	SPECIFICATIONS
Intake Manifold	
Intake manifold-to-cylinder head screws	25 Nm (2.5 kgm) (18 ft-lbs)

Diesel Fuel System

ITEM	SPECIFICATIONS
Fuel Tank	
Capacity	32 ℓ (8.4 US gallons)
Fuel Injection Pump	
Timing to engine	21° ± 2° before TDC
Fuel Injection Nozzles	
Model YDN	
Nozzle Opening Pressure	15.68 Mpa (160 kg/cm^2) (2275 psi)
Nozzle Retaining nut	88 to 98 Nm (9 – 10 kgm) (65 – 72 ft-lbs)
Upper Holder nut	69 – 80 Nm (7 – 8 kgm) (51 – 58 ft-lbs)
Fuel Delivery Valve Holders	44 Nm (4.5 kgm) (33 ft-lbs)
Governor	
Limiter Spring Dimension Adjustment	0.8 ± 0.1 mm (0.031 ± 0.004 in.)

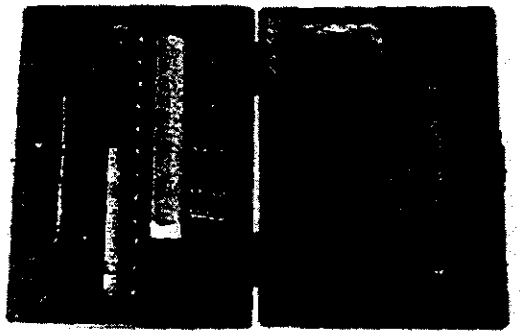
	NEW PARTS SPECIFICATIONS	WEAR LIMIT
Limiter Spring Free Lenth	18.0 mm (0.7087 in.)	19.6 mm (0.7717 in.)
Spring Compression	160 g at 17.9 mm (0.352 lbs at 0.7047 in.)	110 g at 19.85 mm (0.242 lbs at 0.7815 in.)

SPECIAL TOOLS



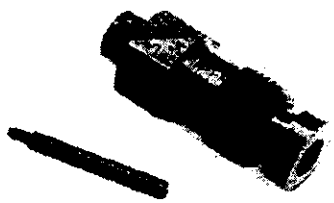
Nozzle Tester D-50

Checking nozzle opening pressure.



Nozzle Cleaning Kit

Cleaning YDN injection nozzles.



Injection Pump Adjusting Adapter TOL–92060000

Measuring Pumps plunger top clearance with a dial gauge.

DIAGNOSING MALFUNCTIONS

Lack of Power

- Clogged air cleaner
- Broken Air cleaner filter or system leakage near liner and piston rings.

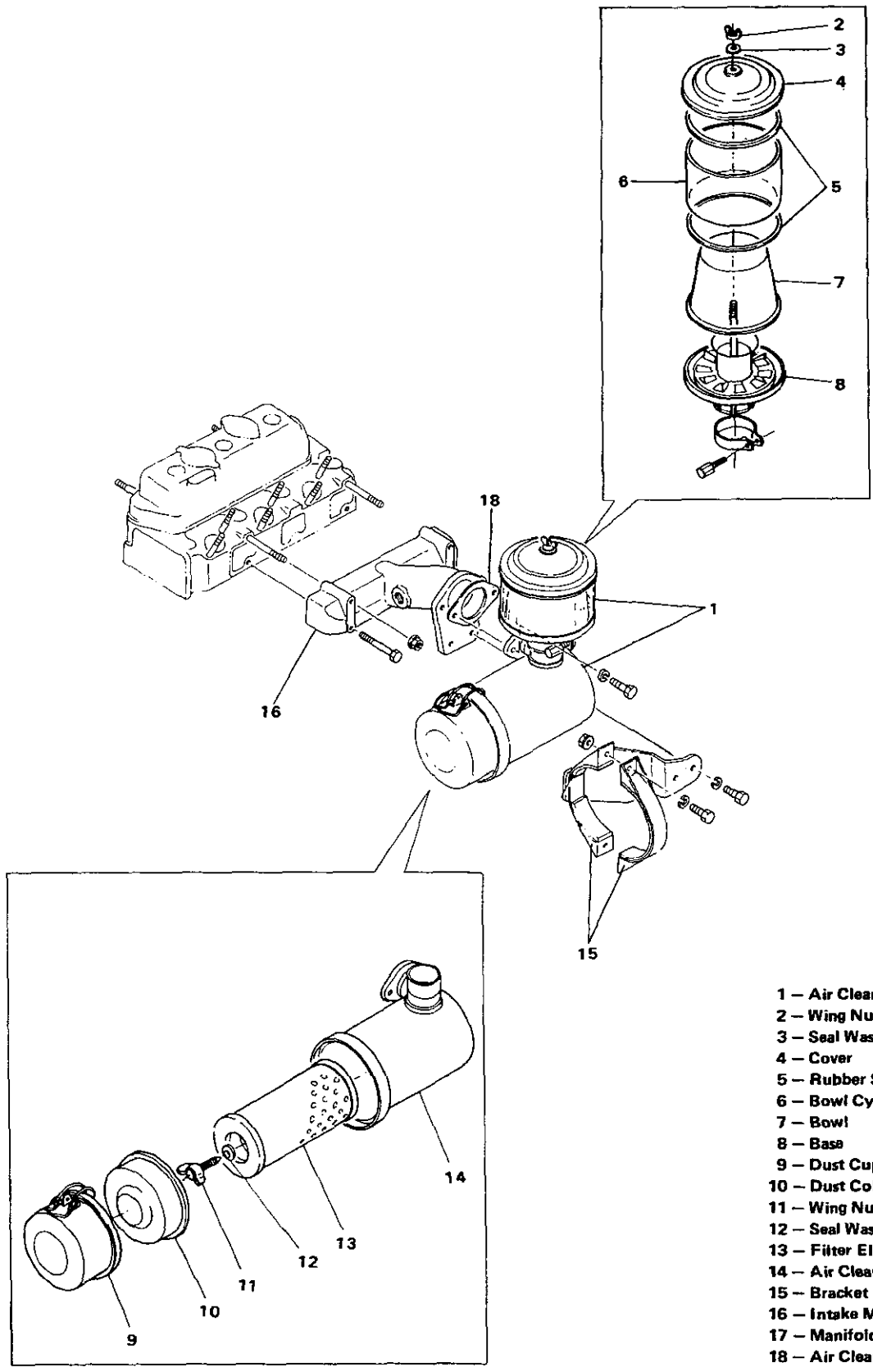
Black Exhaust Smoke

- Clogged air cleaner

Dust deposit in air cleaner

- Dust is sucked through broken packings
- Overload pre-cleaner

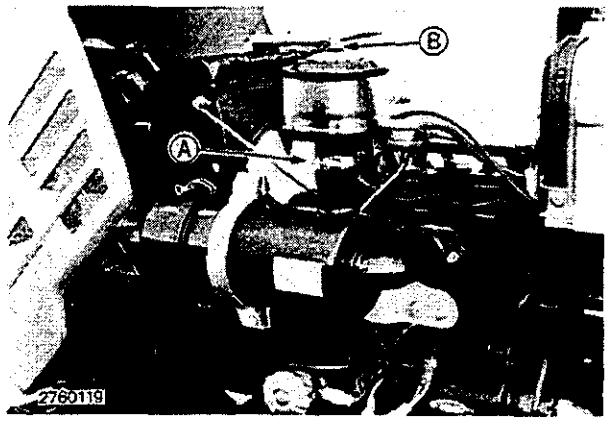
AIR INTAKE SYSTEM



2766004

1 – Air Cleaner Assembly
2 – Wing Nut
3 – Seal Washer
4 – Cover
5 – Rubber Seal
6 – Bowl Cylinder
7 – Bowl
8 – Base
9 – Dust Cup
10 – Dust Collector
11 – Wing Nut
12 – Seal Washer
13 – Filter Element
14 – Air Cleaner Canister
15 – Bracket
16 – Intake Manifold
17 – Manifold Packing
18 – Air Cleaner Packing

Removal of air cleaner system assembly is not normally requied unless necessary to gain access to an adjacent components, or to make a repair on the air cleaner canister.



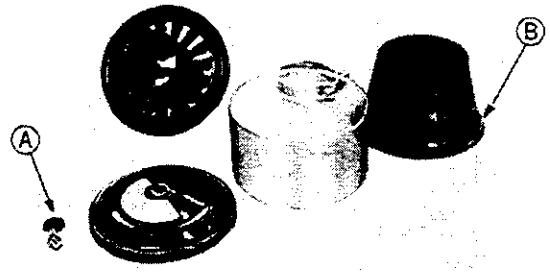
PRE CLEANER

REMOVAL

1. Loosen pipe clamp (A) and pull out precleaner assembly.
2. Remove wing nut (B) to disassemble precleaner bowl.

INSPECTION AND SERVICE

1. Inspect seal washer (A) and rubber seals (B) for cracks or deterioration. Replace if required.
2. Dump any chafs or dust collected in a bowl.
3. Clean all pre cleaner components.

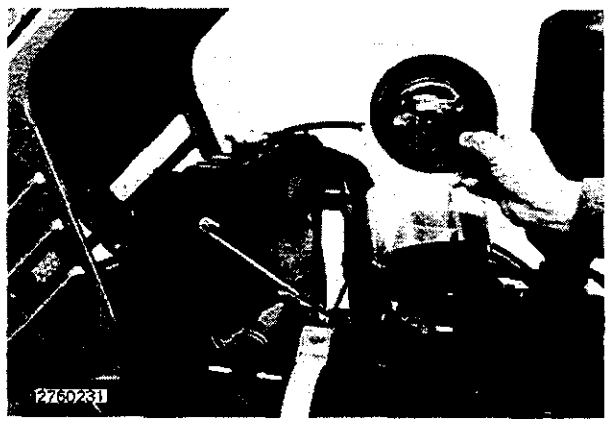


A — Seal Washer
B — Rubber Seals

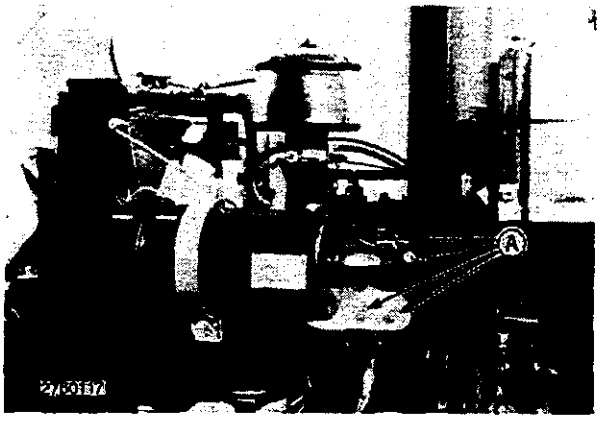
1863337

INSTALLATION

1. *Install pre cleaner base on air cleaner intake pipe.*
2. Tighten pipe clamp nut.
3. Assemble pre cleaner bowl, and tighten wing nut. Make sure the seal washer is correctly installed.



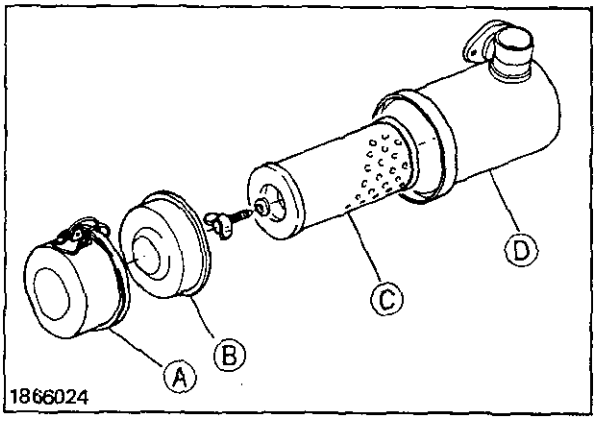
AIR CLEANER



REMOVAL

1. Remove pre cleaner.
2. Remove air cleaner mounting cap screws (A).
3. Remove air cleaner assembly.

A – Cap Screws



INSPECTION AND SERVICE

1. Disassemble air cleaner assembly. Remove dust cup (A), dust collector (B) and element (C).
2. Carefully inspect air cleaner canister (D) for cracks and holes which would permit dust to enter.

   Repair as required.
3. Service filter element whenever a overhaul or tune-up is to be performed on the engine. See tractor operation manual for element service instructions.

A – Dust Cup
B – Dust Collector
C – Element
D – Canister

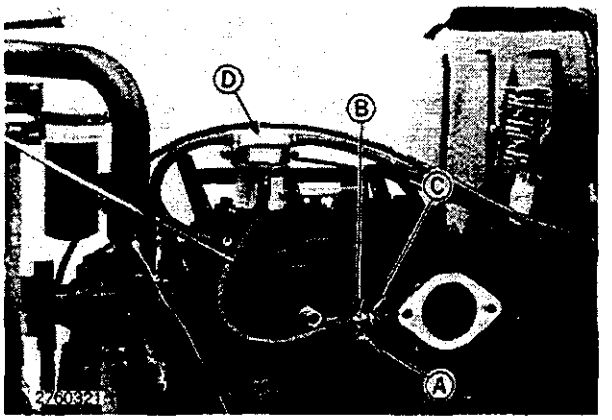
INSTALLATION

1. Mount air cleaner canister on tractor.
2. Install element into the canister, and tighten wing nut.
3. Install dust collector and cup on air cleaner canistor. Recheck element sealing area before installing.
4. Install pre cleaner.

THERMOSTART SYSTEM

REMOVAL

1. Disconnect battery ground cable.
2. Disconnect wire at the thermostart plug (A).
3. Remove fuel hose clamp. (B).
4. Remove thermostart plug. (C).



A – Wiring Lead
B – Hose Clamp
C – Thermostart Plug
D – Fuel Cup

INSPECTION

Inspect the thermostart plug, fuel reservoir, and hoses for evidence of flaws, cracks, or other deficiencies which would cause the system to not work properly.

Check thermostart plug bad check value for leak. Too much carbon deposit or wet on the plug head mean fuel leaks from valve. Replace it.

If a visual inspection does not reveal the cause for the thermostart plug not working, the plug should be tested for ball check valve operation and heater coil/igniter continuity.

Check Valve Test

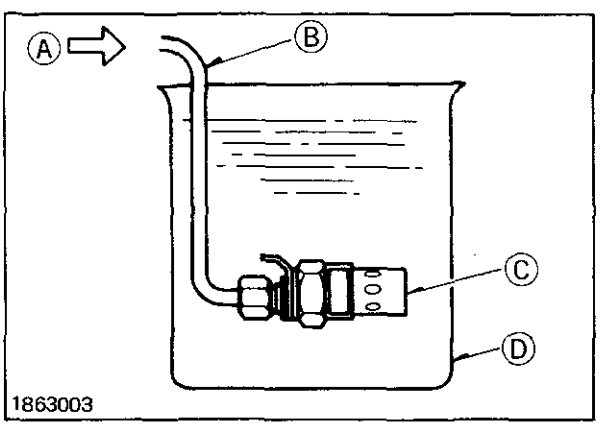
Perform the check valve test to make sure that the ball check valve works correctly.

Use the following procedure:

1. Connect shop air supply (A) to inlet line (B) and to thermostart plug (C). Regulate pressure to 137 Kpa (1.4 kg/cm^2) (20 psi).

STOP Use any suitable line as a means to connect air hose to the thermostart plug. A piece of copper tubing bent in the shape shown in Fig. works well.

2. Immerse the thermostart plug in a container of diesel fuel (D) for 10 seconds.
3. Watch for air bubbles coming out from body of plug as a result of the ball check valve unseating. If bubbles appear, replace the thermostart plug.

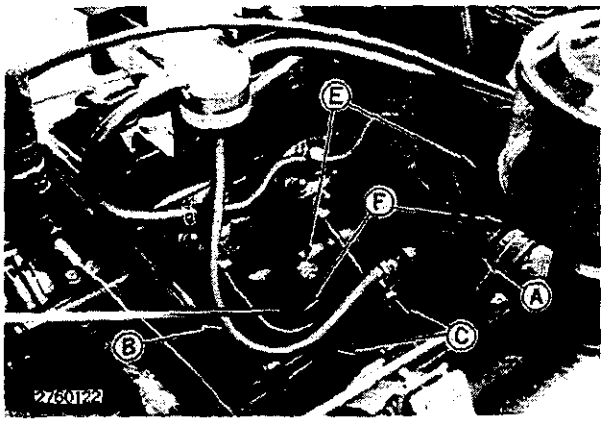


A – Shop Air Supply
B – Inlet Line
C – Thermostart Plug
D – Container

INSTALLATION

Install thermostart plug in the intake manifold. Connect wiring lead to therminal, and connect supply hose to plug.

INTAKE MANIFOLD



REMOVAL

1. Thoroughly clean area around intake manifold (A) before removing parts.
2. Remove air cleaner, thermostart fuel supply hose (B), and wiring lead (C).
3. Remove fuel injection lines (D).
4. Remove two nuts (E) which secure manifold to cylinder head, and carefully remove manifold.

A –
B – Supply Hose
C – Wiring Lead
D – Injection Pipes
E – Stud Nuts
F – Cap Screws

REPAIR

Inspect the intake manifold to see that it is not cracked, or have any other defects which would permit unfiltered air to enter the combustion chamber.

Repace the intake manifold, should it be defective.

INSTALLATION

If gasket is not in good condition, remove all the old gasket material from cylinder head and intake manifold, and replace with a new one.

1. Install manifold using a new gasket. Tighten stud nuts to 25 Nm (2.5 kgm) (18 ft-lbs).
2. Install fuel injection lines.
3. Connect thermostart hose and wiring lead.
4. Bleed the fuel system (Section 10, Chapter 230).
5. Start engine and check operation.

DIAGNOSING MALFANCTIONS

Engine Will Not Start

- Air in fuel pump
- Air in fuel lines
- Clogged filter
- Sticking plunger or delivery valve
- Injection pump roller guide stuck
- Excessive wear on injection lobes
- High pressure fuel line connector loose
- Nozzle valve stuck
- Improper nozzle spray pattern

Lack of Power

- Injection pump out of adjustment
- Faulty injection nozzle
- Faulty injection timing
- Low fuel injection rate
- Faulty injection pressure
- Clogged fuel system line
- Clogged air filter element
- Air in fuel
- Water in fuel
- Clogged fuel filter

Engine Runs Irregularly or Misses

- Air in fuel (injection pump and lines)
- Injection pump contains air
- *Defective nozzle*
- Faulty injection pump

Engine Stalls Frequently

- Clogged fuel line
- Clogged fuel filter
- Air in fuel
- Clogged fuel tank air vent

Excessive Fuel Consumption

- Improper injection pump timing
- Excessive fuel delivery

Engine Knocks

- Improper injection pump timing

Black Exhaust Smoke

- Improper injection timing
- Excessive injection rate
- Faulty nozzle spray

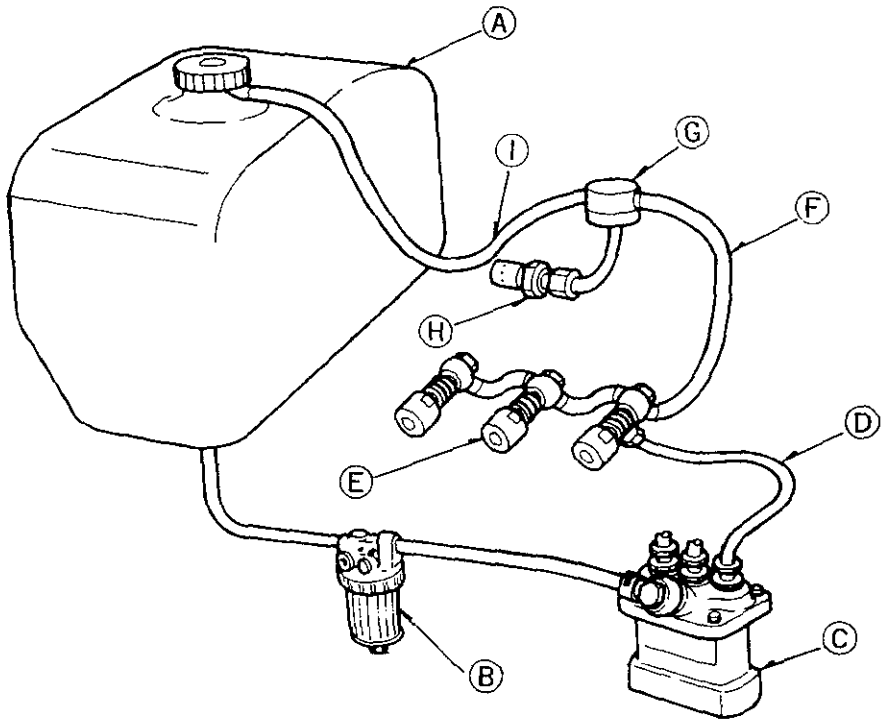
White Exhaust Smoke

- Improper injection timing

Engine Overheats

- Excess fuel delivery
- Improper injection timing

DIESEL FUEL SYSTEM



A — Fuel Tank
B — Fuel Filter
C — Fuel Injection Pump
D — Fuel Injection Pipe
E — Injection Nozzle
F — Excess Fuel Line
G — Thermostart Fuel Cup
H — Thermostart Plug
I — Fuel Return Line

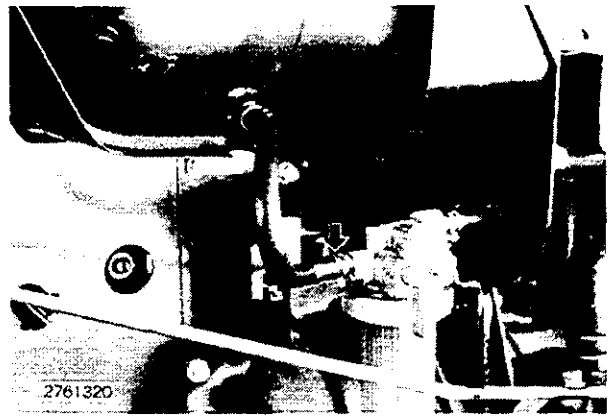
1863038

FUEL TANK

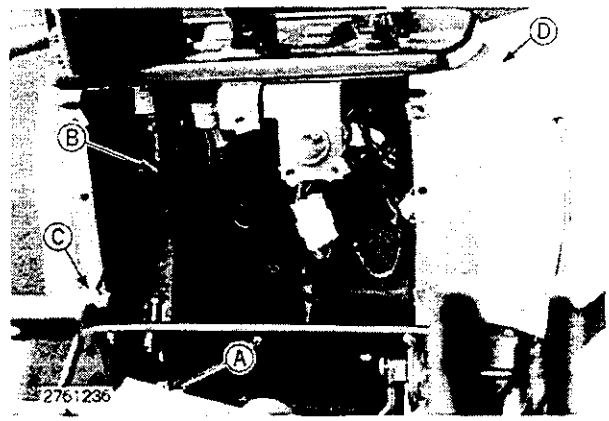
REMOVAL

Use the following procedure to remove the fuel tank.

1. Disconnect the fuel tank-to-fuel filter line (rubber hose) at the fuel filter. Drain the fuel tank. Capacity is 32ℓ (8.4 U.S. gal.).
2. Disconnect the battery ground cable.
3. Remove the steering wheel.

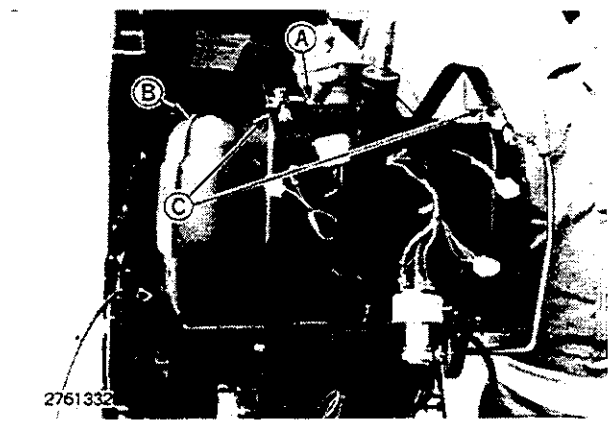


4. Remove cowl and instrument panel.
   a) Remove panel (A).
   b) Disconnect wiring harness leads from all electrical components (switches, lights, etc.).
   c) Disconnect tachometer drive cable from tachometer (B) or engine and decompression device control cable (C), at engine end.
   d) Remove instrument panel and panel box (D) from tractor.

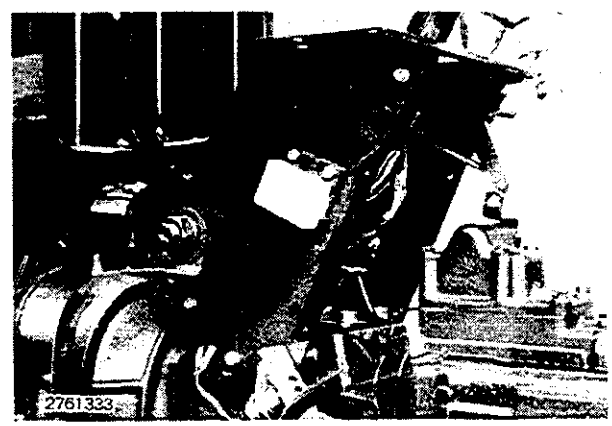


   e) Disconnect the fuel return hose (A) from tank (B).
   f) Disconnect and remove tank mounting straps (C).

A – Fuel Return Hose
B – Fuel Tank
C – Straps



5. Remove fuel tank.



FUEL TANK (Continued)

CLEANING AND INSPECTION

Cleaning

Before beginning service work on the fuel tank, remove the fuel gauge from tank. This will prevent damage to unit and also provide a hole for cleaning.

Flush the tank for 15 minutes with water. Run in at the bottom and allow it to overflow at the top.

Inspecting For Leaks

Use one of these two methods to test the tank for leaks:

1. Wet Method
   Plug or cap tank fuel outlet and fuel return. Dry entire outer surface of tank thoroughly with compressor air and a clean, dry rag. Place tank so that all surfaces may be easily seen such as setting it on top of blocks. Then fill tank with water. Insert end of air hose in filler neck and apply approximately 20 Kpa (0.2 kg/cm^2) (3 psi) air pressure against water. Examine tank surfaces for moist spots where water may have been forced through.

2. Air Pressure Method
   Plug or cap filler neck, and fuel outlet holes. Attach an air hose to the fuel return hole. Submerge tank in clean water and apply approximately 20 Kpa (0.2 kg/cm^2) (3 psi) air pressure. Look for air bubbles in water coming from a source of leak.

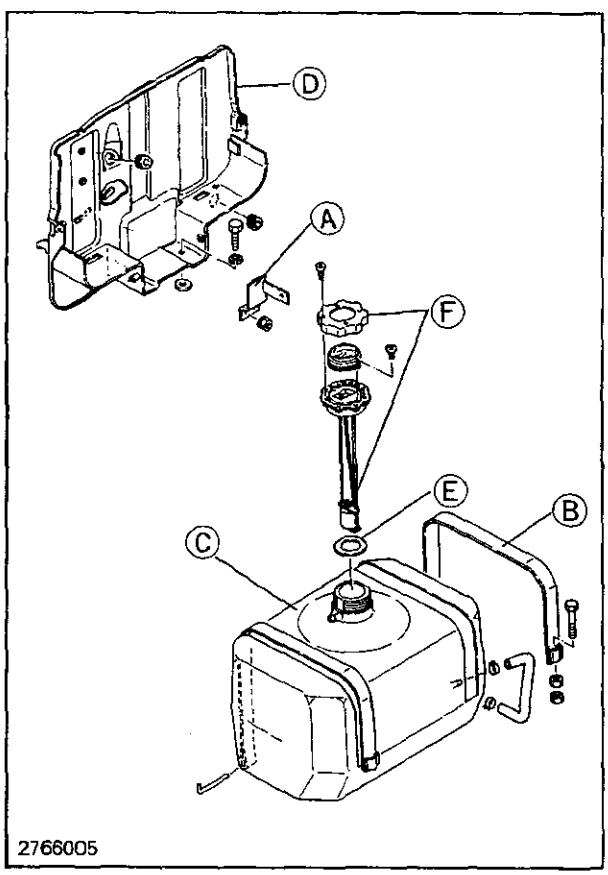
REPAIR

The fuel tank is not repairable. If tank leaks, replace with a new one.

INSTALLATION

Make sure that the fuel tank is thoroughly clean and dry inside before installing on tractor.

1. Position fuel tank on (A) and locate the rear pads under end of both mounting straps (B). Tighten mounting strap screws.
2. Reverse the removal procedures given on the preceeding page.
3. Install steering wheel, and tighten nut to 44 to 59 Nm (4.5 to 6.0 kgm) (33 to 43 ft-lbs), being careful not to over righten nut.
4. Fill fuel tank with the correct grade of clean diesel fuel.
5. Bleed the fuel system.



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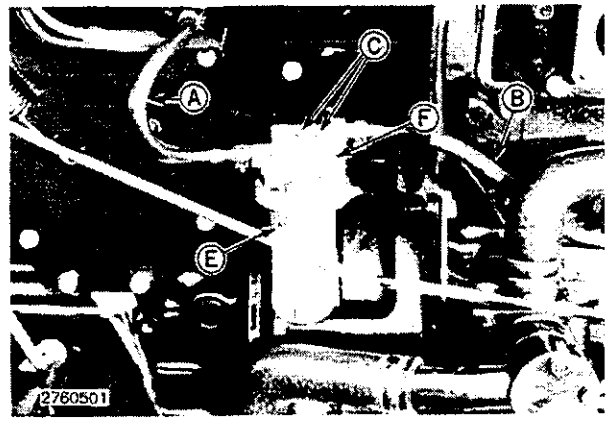
A — Fuel Tank Bracket
B — Strap
C — Fuel Tank
D — Heat Baffle Plate
E — Packing
F — Fuel Gauge/Cap

FUEL FILTER

GENERAL INFORMATION

A fuel filter is used to prevent dirty fuel from reaching the injection pump and injection nozzles.

The filter element will require occasional replacement to maintain an adequate flow of fuel to the injection pump. The frequency of this service will vary according to the cleanliness of available fuel and the care used in storage.



A – Inlet House
B – Outlet Hose
C – Air Vent Screws
D – Filter Element
E – Shut-Off Lever
F – Attaching Screw

REMOVAL

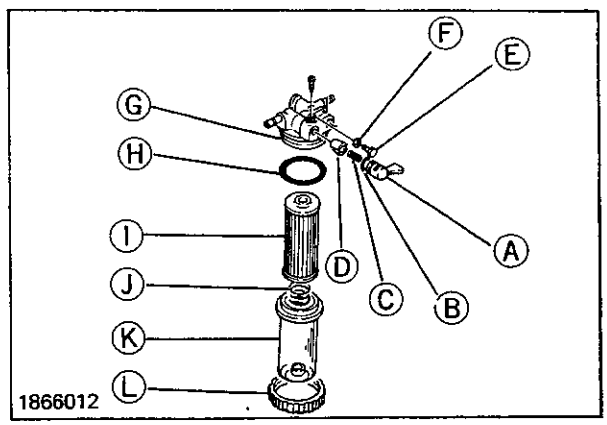
1. Disconnect inlet hose (A) and plug the disconnected end to prevent the loss of fuel.
2. Disconnect the outlet hose (B) at filter.
3. Remove the filter housing attaching screw (F).

It may be necessary at some time to repair the filter housing because of fuel leakage from around the shut-off level or bleed screws.

INSTALLATION

To install the filter assembly, reverse the removal steps given above.

Refer to page 230-10-6 for instructions on how to bleed air from the fuel system.

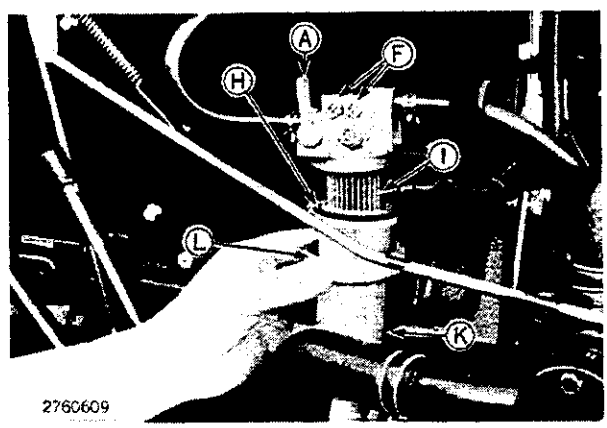


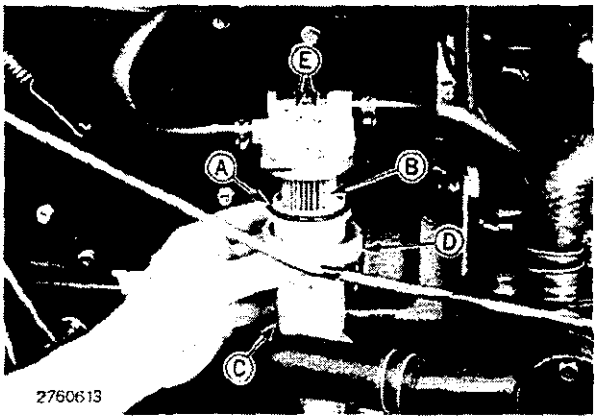
A – Valve Handle
B – O-ring
C – Valve Spring
D – Valve
E – Bleed Screws
F – Washers
G – Filter Housing
H – O-ring Seal
I – Filter Element
J – Spring
K – Sediment Bowl
L – Nut

REPLACEING FILTER ELEMENT

Before replacing the filter element, shut-off the fuel supply to the filter by turning the fuel shut-off lever straight up; then, do the following:

1. Unscrew large nut (L) which retains the sediment bowl from filter housing.
2. Remove nut and sediment bowl (K) from filter housing.
3. Remove filter element (I), and install a new element in its place.





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4. Thoroughly clean sediment bowl. Be sure that O-ring seal (A) is in good condition and install on sediment bowl. Also, be sure spring (C) is position in bowl.

5. Install sediment bowl, being careful not to over-tighten nut.

6. Turn on fuel supply.

7. Open both air vent screws (E) on filter and vent screw on injection pump to bleed air from fuel. Tighten screws when fuel flows free of bubbles.

A – O-ring Seal
B – Filter Element
C – Sediment Bowl
D – Retaining Nut
E – Vent Screw

FUEL INJECTION PUMP

REMOVAL

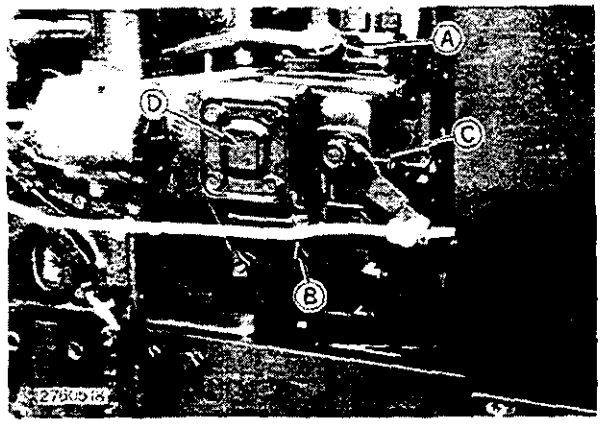
Clean the injection pump, pipes, and area around the pump with cleaning solvent or a steam cleaner.

STOP Never steam clean or pour cold water on an injection pump while the pump is running or while it is warm. To do so may cause seizure of pump parts.

Use the following method to remove the fuel injection pump.

1. Close the fuel shut-off valve at fuel filter.

2. Remove attaching screw from fuel inlet banjo fitting (A).



2760618

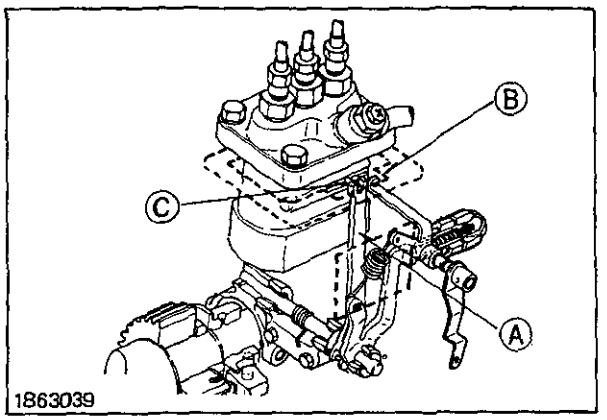
3. Disconnect the speed control rod and swivel (B) from pump regulator handle (C).

4. Disconnect and remove the fuel pipes. Be sure to plug or cap both ends of each pipe to keep contaminants out.

5. Remove cover plate (D) from timing gear cover.

A – Banjo Fitting
B – Control Rod
C – Regulator Handle
D – Cover Plate

6. Move 2nd governor lever (A) and pump control rack (C) forward to clear opening (B) in timing gear cover as pump is removed.



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7. Remove the injection pump-to-timing gear cover nuts. Be careful not to damage shims as pump is separated from timing gear cover.

   After pump flange is free from dowels, make sure pump control rack to clear opening in timing gear cover.

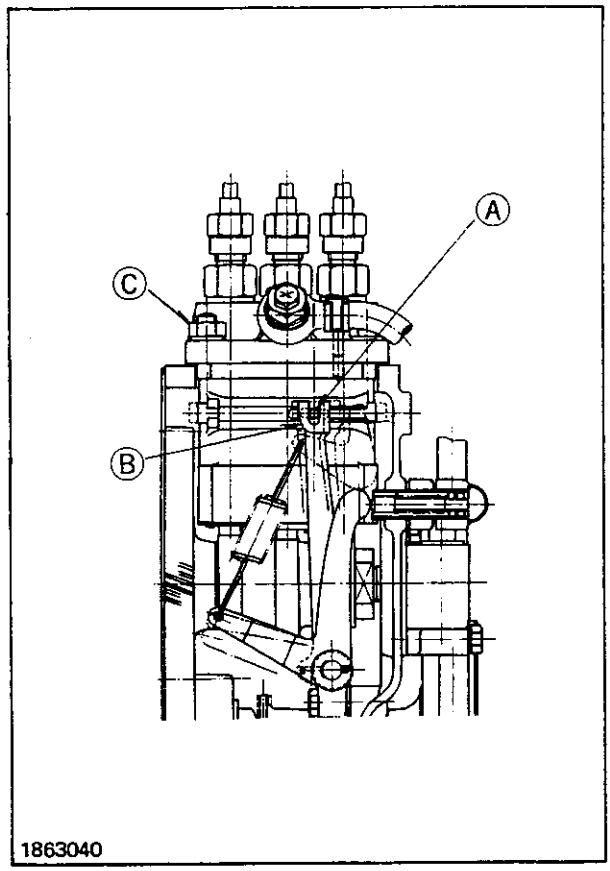
8. Note nimber and thickness of shims under mounting flange of pump to facilitate pump installation.

A – 2nd Governor Lever
B – Opening
C – Pump Control Rack

FUEL INJECTION PUMP (Continued)

INSTALLATION

1. Coat shims with silicon gasket.
2. Place the same number and thickness of shims on pump mounting flange as when removed. Shims should be clean and not deformed.
3. Install injection pump using new sealing washers under mounting nuts.
4. Make sure pump control rack pin (A) is placed in the yoke of 2nd governor lever (B).
5. Tighten nuts to 20 to 29 Nm (2 to 3 kgm) (15 to 22 ft-lbs) (C).
6. Install cover plates.
7. Install fuel injection pipes and connect fuel inlet hose to pump.
8. Connect speed control rod to pump regulator lever.
9. Open fuel shut-off valve on filter.
10. Open both bleed screws on filter housing and one bleed screw on pump. When fuel flows without air, close bleed screws.



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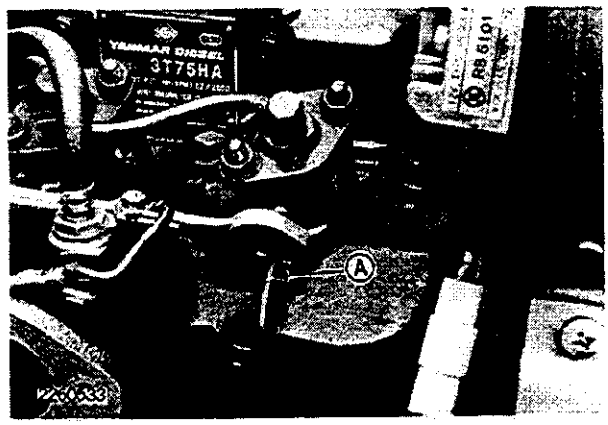
A — Control Rack Pin
B — 2nd Governor Lever
C — Nut

PUMP TIMING ADJUSTMENT

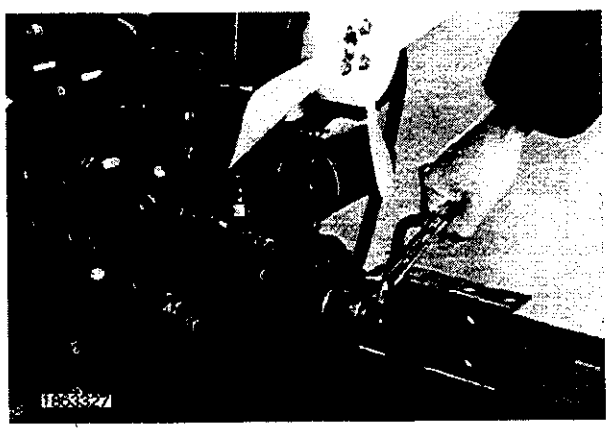
1. Disconnect No. 1 fuel injection pipe. (A).

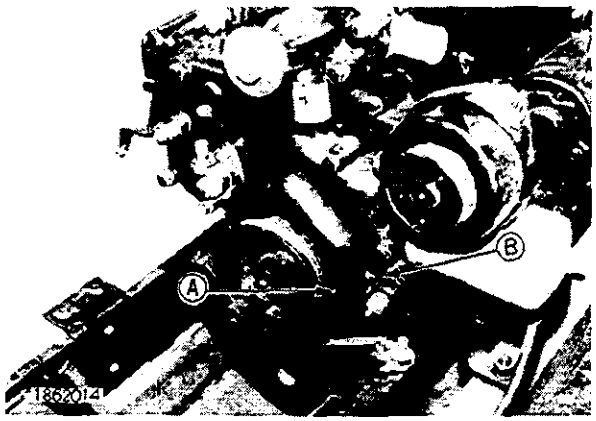
   Remove that No. 1 cylinder or injection pump plunger is the one closest to the engine flywheel.

2. Place throttle lever at maximum speed position and fuel shu-off valve should be opened.



3. Assemble a 27 mm (or 1-1/16 in.) socket and a ratchet handle together and place socket on crankshaft pulley nut.
   Ratchet handle should be long enough to come out between radiator and engine as shown.
4. Pull out the engine decompression lever on dash.
5. Rotate engine in normal clockwise rotation (as viewed from front of tractor) until No. 1 piston is coming up on the compression stroke.
6. Wipe out leak fuel in the delivery by clean rag.
7. Rotate engine untile fuel comes up in the delivery valve of No. 1 cylinder.
   Stop rotation of engine as soon as coming up fuel from the delivery valve.





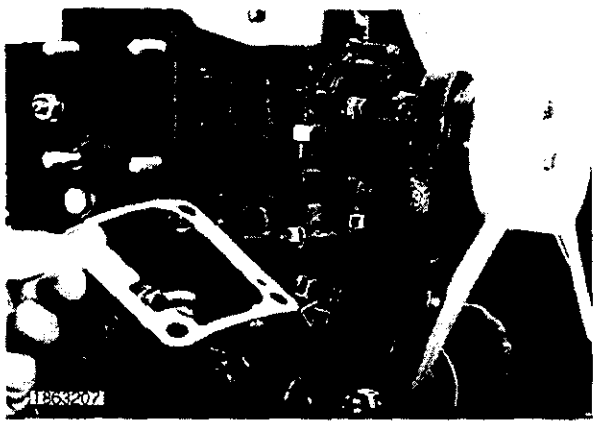
8. Observe injection timing mark (A) on crankshaft pulley. Mark will be aligned with pointer (B) when correct thickness of shims is under pump flange.
   If mark has gone past pointer — Remove shims.

   If mark has not reached pointer — Add shims.

   A 0.1 mm (0.004 in.) shim change corresponds to a 1 degree difference in crankshaft position.

STOP The injection mark is at 21 degree B.T.D.

A — Timing Mark
B — Pointer

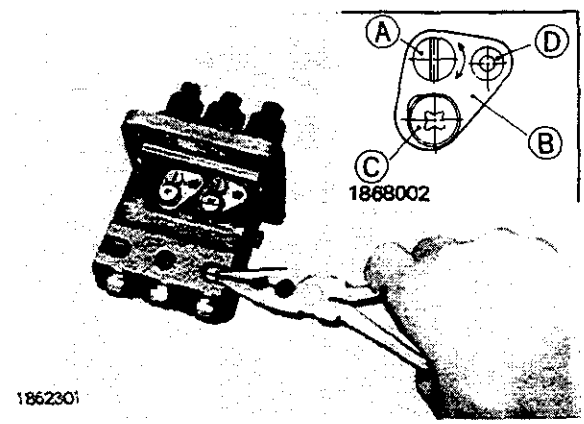


9. Connect fuel injection pipe to pump. Tighten connector to 27 Nm (2.7 kgm) (20 ft-lbs).
10. Bleed air from fuel system (Chapter 230). Start engine and check for leaks.

DISASSEMBLY

STOP Never loosen or remove barrel adjust screw (A), adjust plate (B) and adjust plate retaining screw (C).

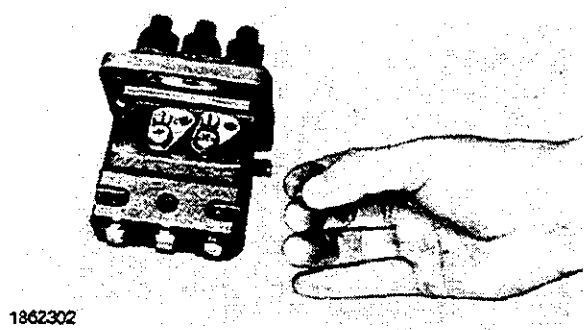
If they had been removed, the pump must be adjusted for injection valume by pump tester.



1. Remove plunger guide stopper pin.

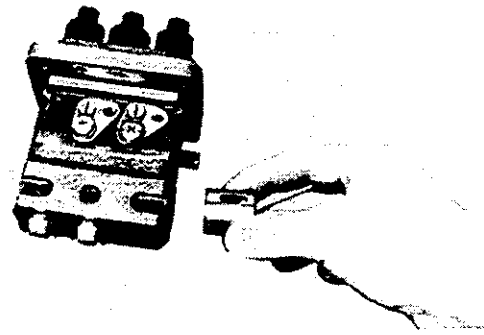
A — Adjust Screw
B — Adjust Plate
C — Retaining Screw
D — Pin

2. Remove the plunger guide stopper of No. 1 cylinder.



3. Remove plunger guide of No. 1 cylinder.

When removing plunger guide, be careful plunger stroke adjusting shims in the plunger guides from missing or mixing them with other cylinders.



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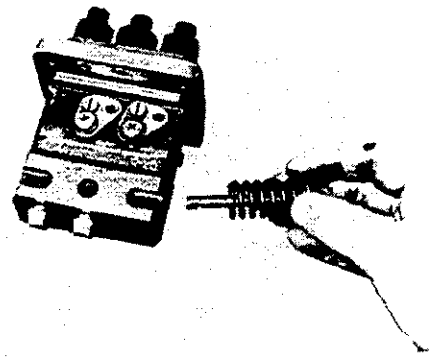
4. Remove plunger, plunger spring, spring lower retainer of No. 1 cylinder.

When removing plunger, never touch the plunger with fingers for rust prevention.



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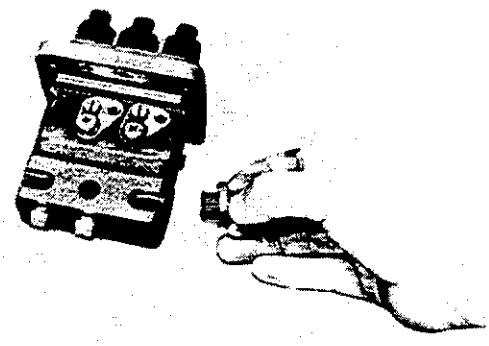
5. Remove the plunger spring upper retainer and control sleeve of No. 1 cylinder.



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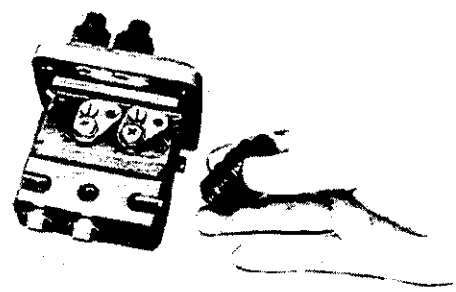
6. Remove the delivery valve holder and spring of No. 1 cylinder.

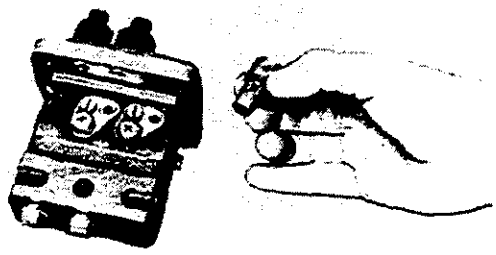


1862307

7. Remove the delivery valve, delivery valve seat and gasket of No. 1 cylinder together.

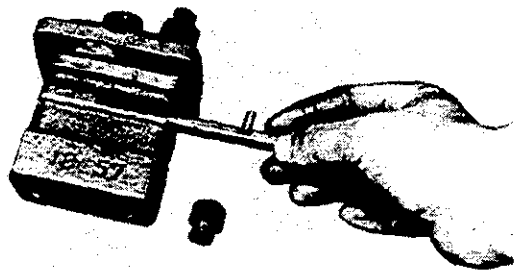
1862308

8. Remove the right plunger barrel of No. 1 cylinder.



1862309

9. Repeat the same procedure (1 to 8) to remove the center plunger and related parts (No. 2 cylinder).
10. Repeat the same procedure (1 to 8) to remove the left plunger and related parts (No. 3 cylinder).
11. Remove the fuel control rack.



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FUEL INJECTION PUMP (Continued)

INSPECTION OF MAJOR COMPONENTS

Inspection of the Plunger and Barrel

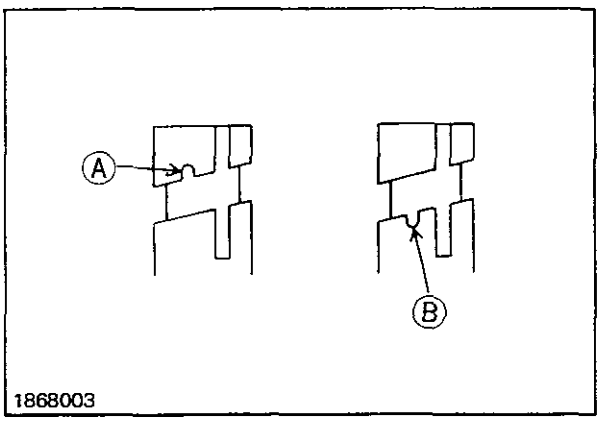
The plunger and barrel assembly is one of the most important and precisely built parts of the fuel system. Due to the close tolerance (0.001 mm), make sure it is free from excessive scratches, wear, chips and foreign material. Also the free fall of the plunger should be smooth.

The plunger should be checked visually, under a magnifying glass, for excessive wear or possible chips on the helix.

If there is any chipped area on the lead helix, it will not be indicated in any of the tests.

1. Inspect the plunger. If the plunger is chipped replace the plunger and barrel assembly.
2. Inspect the outside diameter of the plunger. Examine the surface with a magnifying glass; even the slightest imperfection will prevent the plunger from operating properly. Check for burrs, nicks, corrosion, cracks, chipping and excessive wear.

   If necessary, replace the plunger and barrel assembly.

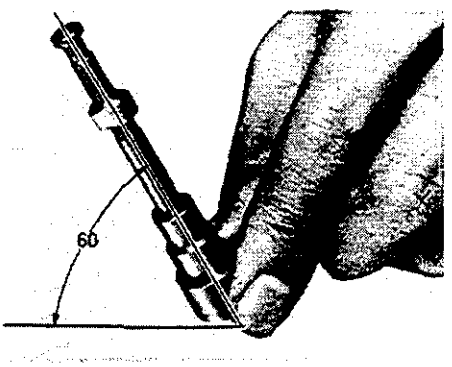


A – Chip on Upper Lead Edge
B – Chip on Lower Lead Edge

Free Fall of the Plunger and Barrel

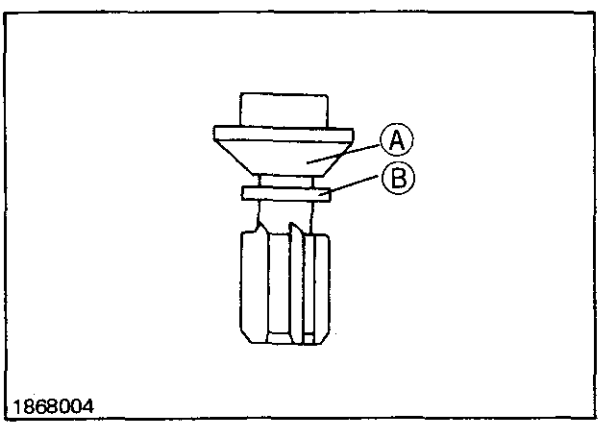
After thoroughly cheaning the plunger and the barrel, tilt them about 60°, as shown in the figure. Plunger should slide down slowly.

Repeat this test sevral times while rotating the plunger. If it slides down too fast, or if it sticks halfway, correct (lap or clean) or replace it.



Delivery Valve Inspection

1. Inspect the delivery valve, and replace it if the suction collar or seat is scratched, dented, or shows signs of wear.

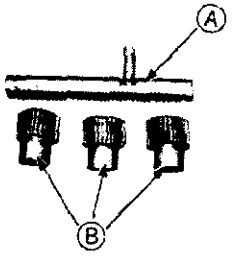


A – Delivery Valve Seating Surface
B – Suction Collar

186Y809

2. Thoroughly clean the delivery valve. After cleaning, press the lower end down with your finger to close it. Remove your finger, and it should spring back. If it does not spring back, it should be replaced because the section collar section is probably badly worn.

Inspection of the Control Sleeve and Control Rack

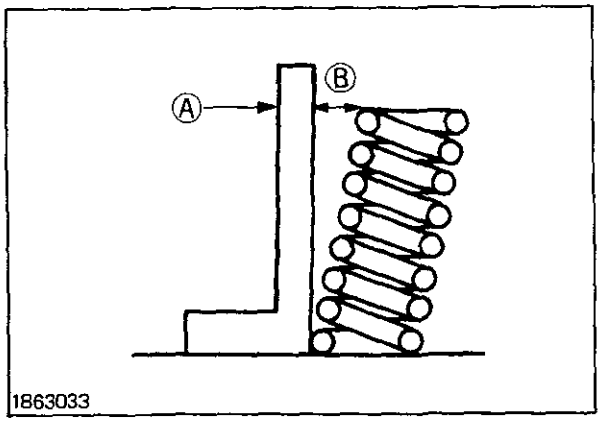


1862315

Check that the control sleeve and control rack do not have any abnormal gear contact, scratches, or foreign matter on them. Any abnormal gear engagement will increase the friction resistance of the control rack and may cause engine trouble.

A – Control Rack
B – Sleeves

Inspection of the Delivery Spring and Plunger Spring



1863033

Check for any abnormal contact/damage and deformation of the springs.

Place the spring on a flat surface, and use a square (A) to check if spring is "cocked". If spring is "out of square", measure distortion (B) and compare to the following specifications.

SPRING TILT SPECIFICATIONS

	New Part	Wear Limit
Delivery spring	—	0.55 mm (0.022 in.)
Plunger spring	—	0.70 mm (0.028 in.)

A – Square
B – Spring Tilt

186Y812

Plunger Guide Inspection

There should not be any "play" between the pin and the inside/outside roller pin. Also be sure there is no "pitching" on the surface of the outside wheel of the roller.

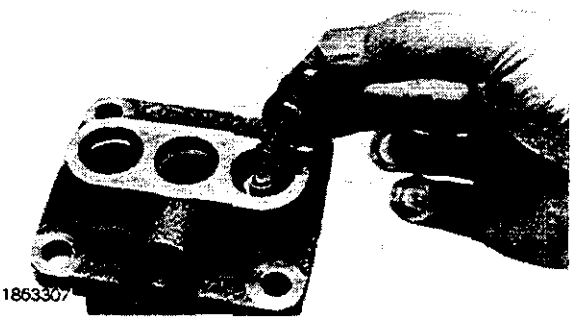
FUEL INJECTION PUMP

ASSEMBLY

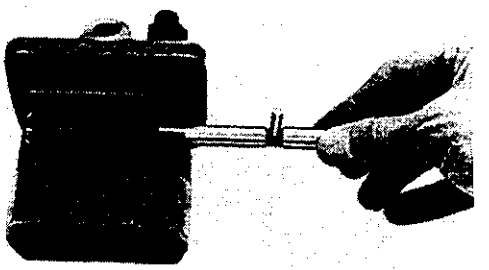
Do not mix the various parts of each valve. If one valve part is defective, replace all the valves. During assembly, clean the parts in clean fuel oil and align the "matching parts".

1. Place the plunger barrel packing in position.
2. Install the plunger barrel.

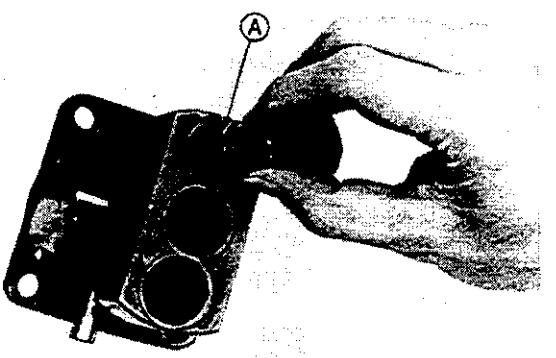
3. Install the delivery valve assembly and the delivery spring.
4. Install the delivery valve holder, then tighten it tentatively. The specific torque is 45 Nm (4.5 kgm) (30 ft-lbs).

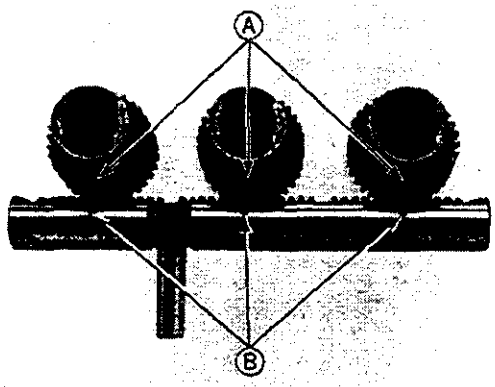


5. Install the control rack.



6. Install control sleeve (A) in the plunger guide bore of pump housing.

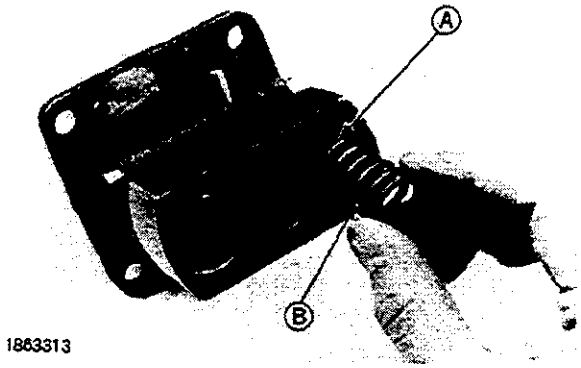




1863312

7. When installing the sleeve, align the punch mark on sleeve gear (A) to the mark (Painted Red) on control rack (B).

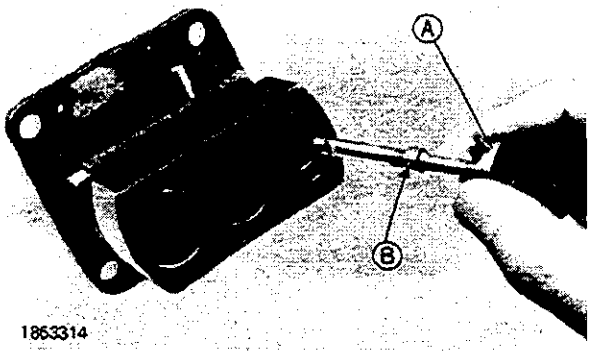
A – Mark on Sleeve Gear
B – Mark on Control Rack



1863313

8. Install upper spring retainer (A) and plunger spring (B).

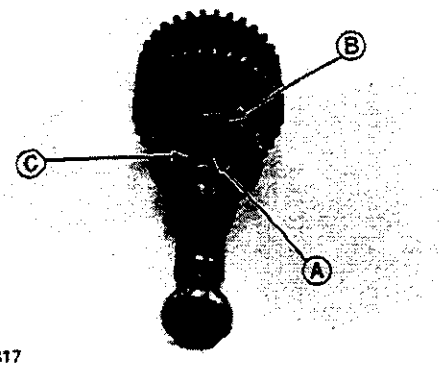
A – Upper Spring Retainer
B – Plunger Spring



1863314

9. Install the lower plunger retainer (A) to the plunger (B), and install them in the plunger guide bore.

A – Plunger Retainer
B – Plunger



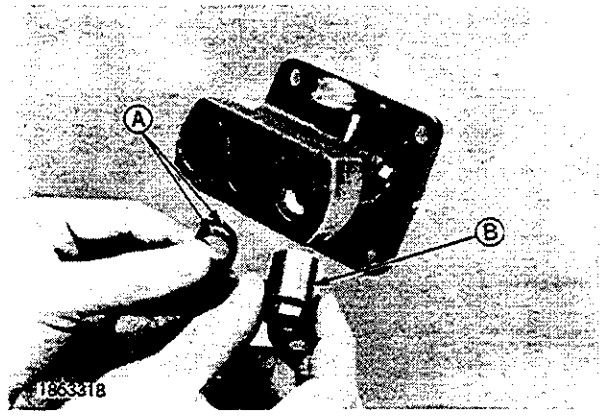
1863317

10. When installing plunger align the punch mark (A) to the mark on control sleeve (B).

A – Punch Mark on Planger
B – Mark on Control Sleeve
C – Planger

11. Place the plunger height adjusting shim (A), then install the plunger guide (B).

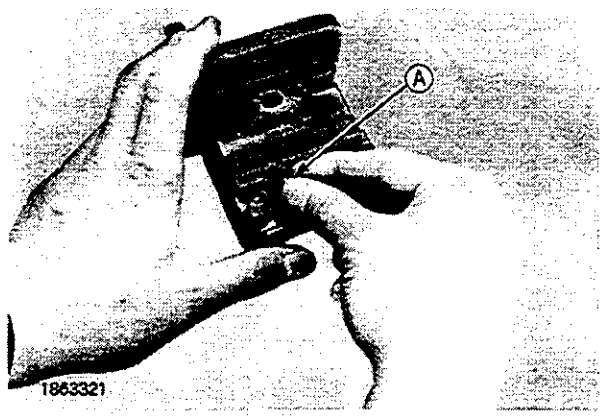
A – Shims
B – Plunger Guide



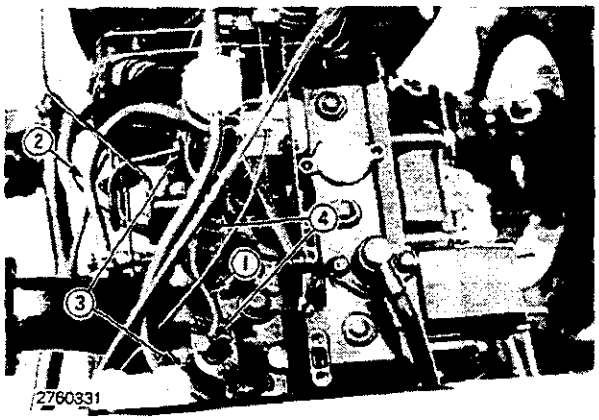
12. Install the plunger guide stopper. Set the stopper by pressing the plunger by hand.
(Press the plunger guide with moving the rack slightly so that the plunger shoulder can be fixed into the groove of sleeve.)

13. Set the plunger guide stopper pin.

A – Stopper Pin



FUEL INJECTION NOZZLES



REMOVAL

1. Disconnect excess fuel lines (leak-off houses) from injection nozzle and remove banjo fitting from top of each nozzle.
2. Disconnect thermostart system fuel hoses.
3. Disconnect fuel injection pipes from injection nozzles.
4. Remove retainer from top of each injection nozzle.

5. Remove injection nozzle from cylinder head. Note cylinder location of each nozzle to permit nozzle to be installed back in the same bore from which it was removed.

TESTING

Test the injection nozzle before disassembling to determine its condition. Test for: Opening Pressure, Leakage, Chatter and Spray Pattern.

CAUTION: The nozzle tip should always be directed away from the operator. Fuel spray can penetrate clothing and skin, causing serious personal injury. It is recommended that the spray be collected in a container as shown.

Before applying pressure to the nozzle tester, be sure that all connections are tight, and that the fittings are not damaged. Fuel escaping from a very small hole can be almost invisible. Use a piece of cardboard or wood, rather than hands, to search for suspected leaks.

If injured by escaping fuel, see a doctor at once. Serious infection or reaction can develop if proper medical treatment is not administered immediately.

Always use clean, filtered fuel when testing injection nozzle performance. Testing nozzles with dirty fuel will severely damage the precision parts of the nozzle.

Opening Pressure Test

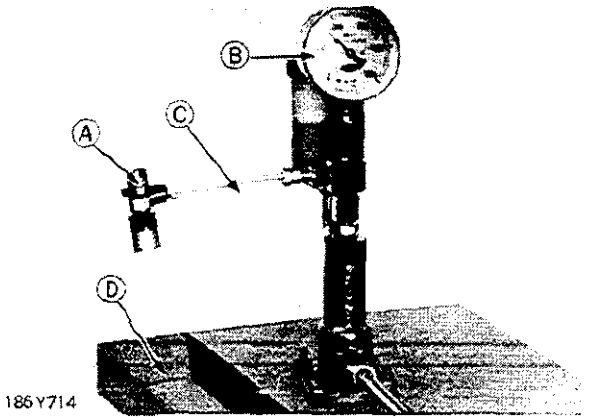
To make the opening pressure test, connect injection nozzle (A) to the Nozzle Tester (B), using the fuel line in the kit (C). Place a container (D) under injection nozzle to catch fuel.

Pump the handle several times to flush out nozzle fittings. Tighten the fitting.

Expel air from the nozzle by operating the pump handle for several strokes. Then raise the pressure slowly and steadily. Observe the gauge pressure at which the valve opens. Recheck by completely releasing the pressure, and gradually building pressure until the valve opens.

The nozzle should open at approximately 15.68 Mpa (160 kg/cm^2) (2275 psi). If the opening pressure is not correct, disassembre the injection nozzle and change shims until nozzle opens at the proper pressure.

Each 0.1 mm (0.004 in.) shim changes the opening pressure approximately 686 – 980 Kpa (7 – 10 kg/cm^2) (100 – 142 psi).



186Y714

A – Nozzle
B – Nozzle Tester
C – Fuel Line
D – Container

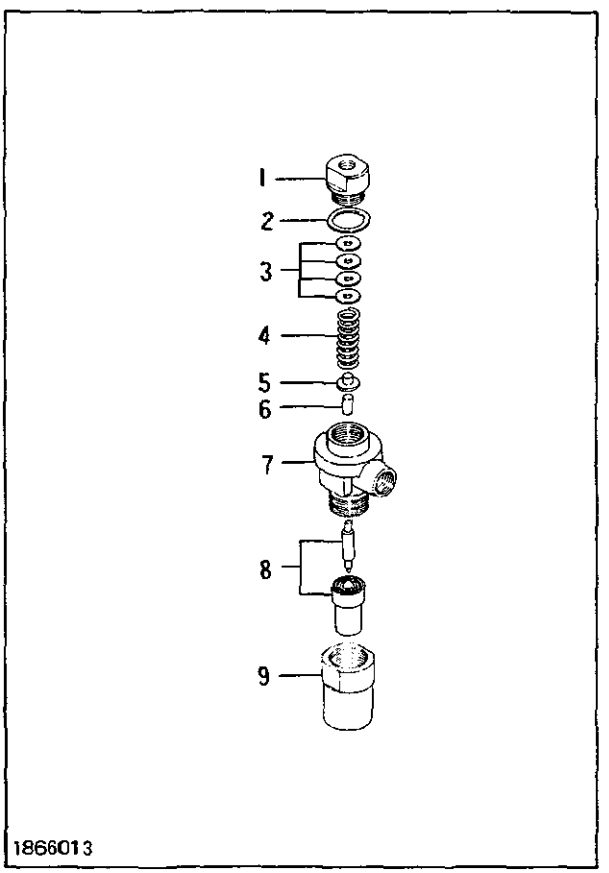
Leakage Test

To check for a leaking nozzle, wipe the nozzle dry. Bring the pressure up slowly to 13.72 Mpa (140 kg/cm^2) (1990 psi), and watch for an accumulation of fuel from the spray orifice, indicating a bad seat. If the nozzle drips within 10 seconds, replace the nozzle assembly.

Check for leakage around the nozzle nut (9) thread connection with nozzle holder (7). Leakage indicates a bad seat between nozzle assembly (8) and nozzle holder.

Be sure that the nozzle retaining nut is tight on the nozzle holder before disassembling or replacing parts.

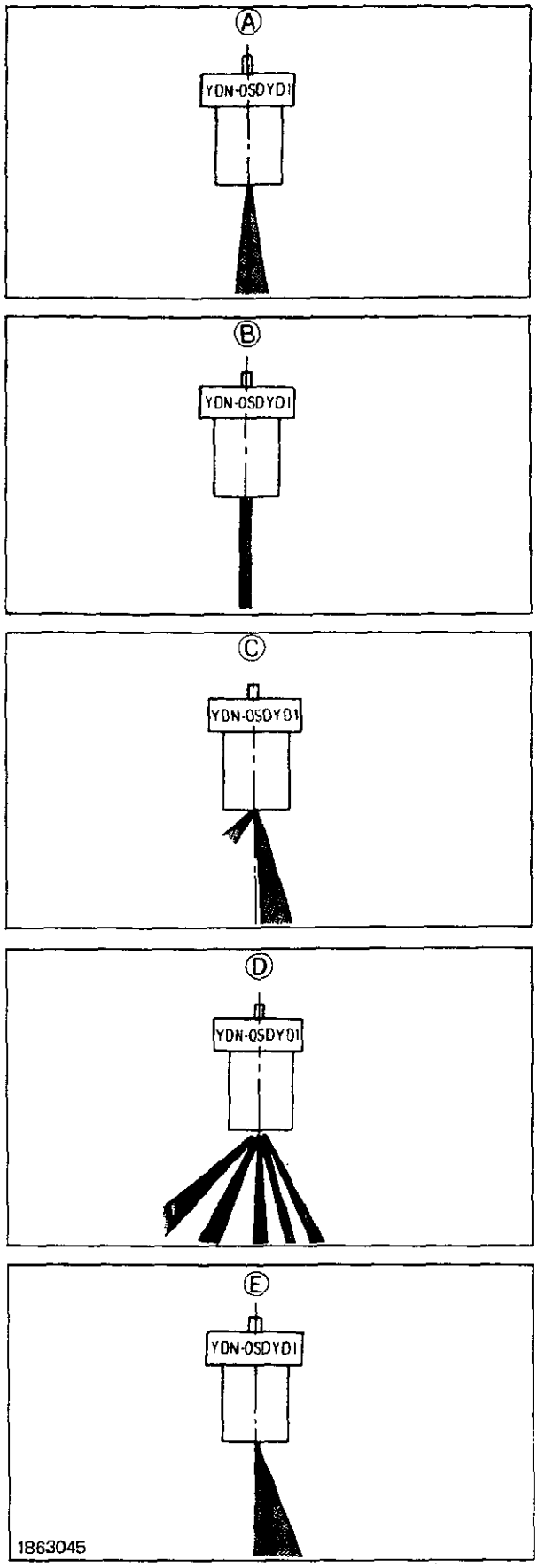
Lightly lap nozzle body-nozzle holder seating surfaces to insure a good seal. If leakage persists, replace nozzle body and holder.



1866013

1 – Upper Holder Nut
2 – Copper Washer
3 – Shims
4 – Spring
5 – Lower Spring Seat
6 – Inter Spindle
7 – Nozzle Holder
8 – Nozzle Assembly
9 – Nozzle Nut

FUEL INJECTION NOZZLES (Continued)



TESTING (Continued)

Chatter and Spray Pattern Test

The injection nozzle should chatter very softly, and only when the hand lever movement is slow (1–2 downward movements per second). Failure to chatter may be caused by a binding or bent nozzle valve.

Until the chattering range is reached, the test oil emerges as non-atomized streams. When the lever movement is accelerated, (4–6 times per second) the spray should be very broad and finely atomized.

A partially clogged or eroded throttling valve will usually cause the spray to deviate from the correct angle. The spray will also be streaky rather than finely atomized.

Disassemble the nozzle for cleaning or reconditioning if it fails to chatter or spray properly.

	CONDITION	CAUSE:
A	Good	
B	Incorrect	1 – Low injection pressure 2 – Valve sticking 3 – Nozzle spring bent
C	Incorrect	1 – Scratch or dirt in the nozzle hole 2 – Carbon deposit in the hole
D	Incorrect	1 – Injection hole worn 2 – Carbon deposit in the hole
E	Incorrect	1 – Improperly sealed injection valve 2 – Damaged or worn injection hole 3 – Carbon deposit in the hole

DISASSEMBLY

General Information

Since dirt and water are the worst contaminants in the fuel injection system, the working area, tools, and cleaning materials must be kept spotlessly clean. Whenever possible, work in an isolated, dust-free area.

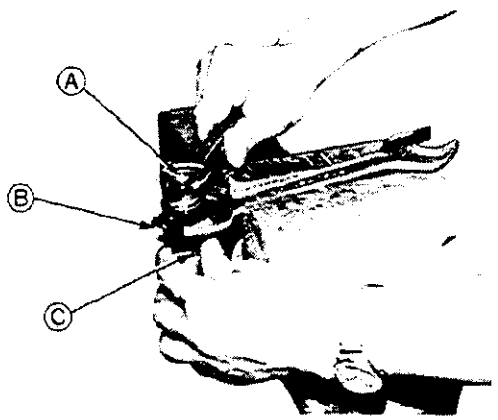
Cover the work bench with clean paper before beginning disassembly of injection nozzle.

As parts are disassembled, place them in a pan of clean diesel fuel and leave them there until needed. Do not permit these parts to strike each other.

Use a separate pan of clean diesel fuel for washing parts just before assembly.

Disassembling Procedure

1. Clamp handle of open-end wrench (use correct size to fit flats on nozzle holder) in a vise.
2. Insert nozzle holder (B) into wrench with leak-off end facing up. Remove upper holder nut (A) and copper washer.

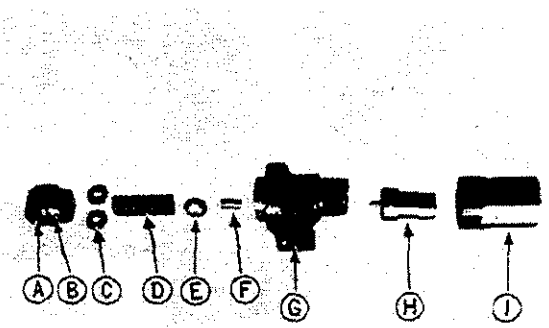


1862118

A — Upper Holder Nut
B — Nozzle Holder
C — Nozzle Nut

3. Remove nozzle holder from wrench and withdraw shims (3), spring (4), lower spring seat (5), and inter spindle (6) from holder.
4. Insert nozzle holder upside down in wrench. Loosen and remove the nozzle retaining nut (C). Remove nozzle from holder.
5. Withdraw nozzle valve from nozzle. If valve is stuck, it may be necessary to soak the nozzle assembly in Bendix cleaner, acetone, or other commercial cleaners sold especially for freeing stuck valves.

A — Upper Holder Nut
B — Copper Washer
C — Shims
D — Spring
E — Lower Spring Seat
F — Inter Spindle
G — Nozzle Holder
H — Nozzle Assembly
I — Nozzle Nut

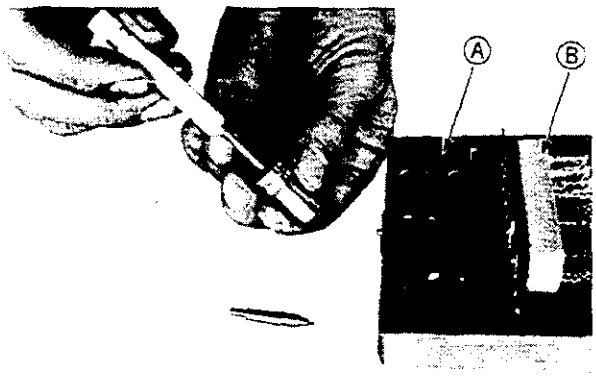


186Y602

CAUTION: Use these nozzle cleaning fluids in accordance with the manufacturer's instructions.

The valve and nozzle are individually fitted and hand lapped. Keep these mated parts together, and do not permit the lapped surfaces to come in contact with any hard substance. Do not touch the valve unless hands are wet with fuel.

FUEL INJECTION NOZZLES (Continued)



186Y605

CLEANING AND INSPECTION

Nozzle Assembly

1. Remove anti-corrosive grease from new or recorditioned nozzles by washing them thoroughly in diesel fuel.
2. Remove carbon from used nozzles, using Cleaning Kit and clean by washing in diesel fuel. If parts are coated with hardened carbon or lacquer, it may be necessary to use a brass wire brush (B).

A — Cleaning Kit
B — Brass Wire Brush

Never use a steel brush to clean nozzles as this will distort the spray hole.

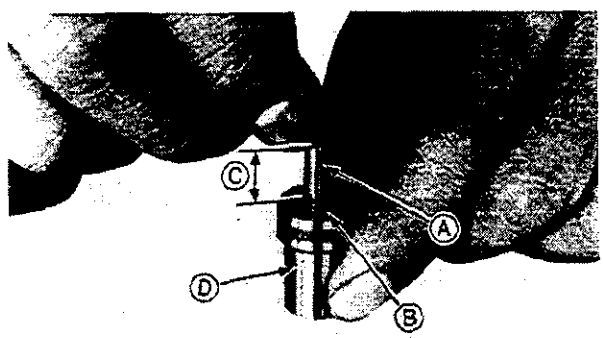
3. After removing carbon or lacquer from the exterior of nozzle, inspect the lapped machined surface (B) for nicks or scratches.
4. Inspect the piston (large) part of nozzle valve to see that it is not scratched or scored and that lower (tip) end of valve is not broken. If any of these conditions are present, replace the nozzle assembly.
5. Inspect condition of seat for nozzle valve and nozzle. Contact area of seat (both parts) must not be scored or pitted. Use an inspection magnifier to aid making the inspection.

A bad nozzle valve seat will cause fuel to drip from the nozzle. This condition usually will be noted when making "Leakage Test" described on page 30-10-17.

Further inspect the nozzle assembly by performing a slide test. Use the following procedure:

1. Dip the nozzle valve (A) in clean diesel fuel. Insert valve in nozzle (D).
2. Hold nozzle vertical, and pull valve out about 1/3 of its engaged length (C).
3. Release valve. Valve should slide smoothly down to its seat by its own weight.

Always replace a nozzle assembly if the valve does not slide freely to its seat.



186Y604

A — Nozzle Valve
B — Lapped Surface
C — Free-Fall Distance
D — Nozzle Housing

CLEANING AND INSPECTION (Continued)

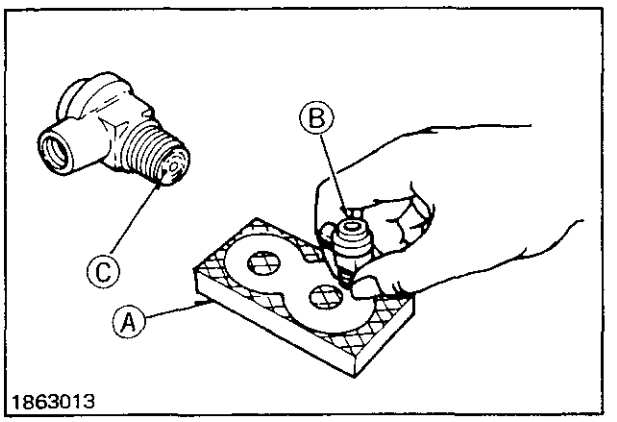
Nozzle Holder

Inspect the lapped machined surface on bottom end of nozzle holder (B) for nicks or scratches. Minor defects may be removed by lapping machined surface of nozzle holder on lapping plate (A) with lapping compound. When lapping holder, use a figure-8 pattern as shown in the illustration. Replace holder if it can not be restored to a good, serviceable condition.

Inspect threads on nozzle holder for general condition. Threads that are nicked slightly may be "dressed-up". Replace holder if threads can not be restored to a serviceable condition.

Check fuel passage (C) in nozzle holder to make sure that it is open. Clean with compressed air.

A — Lapping Plate
B — Nozzle Holder
C — Fuel Passage



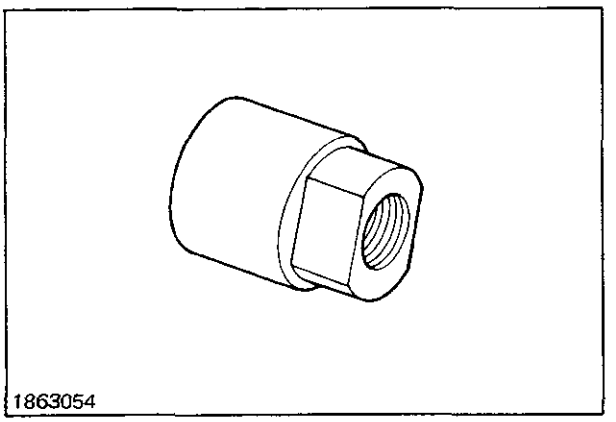
1863013

Nozzle Retaining Nut

Remove carbon deposits on both inner and outer surfaces of the nozzle retaining nut.

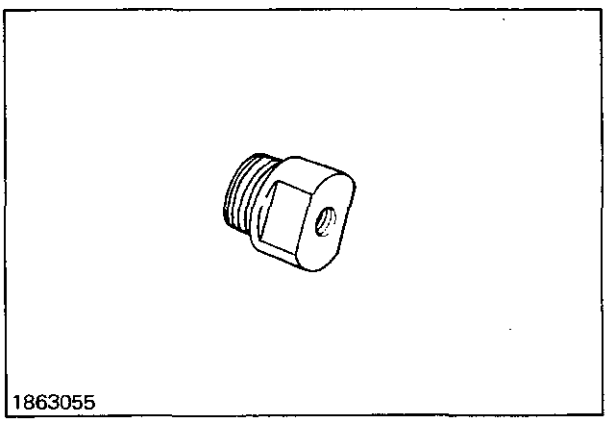
Inspect the retaining nut for a damaged lower seating surface (seats against head insultating packing on precombustion chamber). A seating surface may be restored by rubbing the surface on emery cloth.

Any nozzle retaining nut which cannot be reconditioned, must be replaced with a new one.


1863054

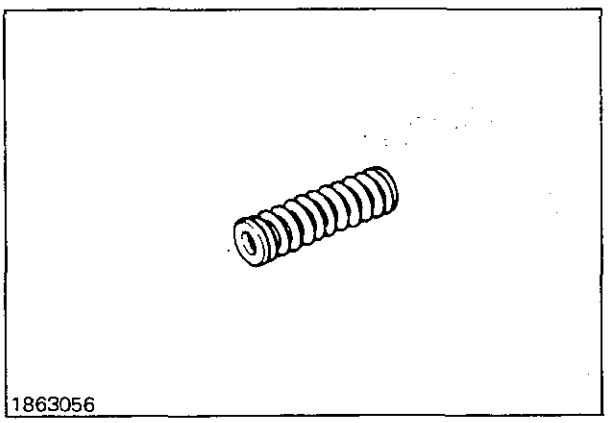
Upper Holder Nut

Inspect upper holder nut for condition of threads and spring seating surface. Thread sizes are shown in the above illustration. Replace nut if it can not be restored to a serviceable condition.

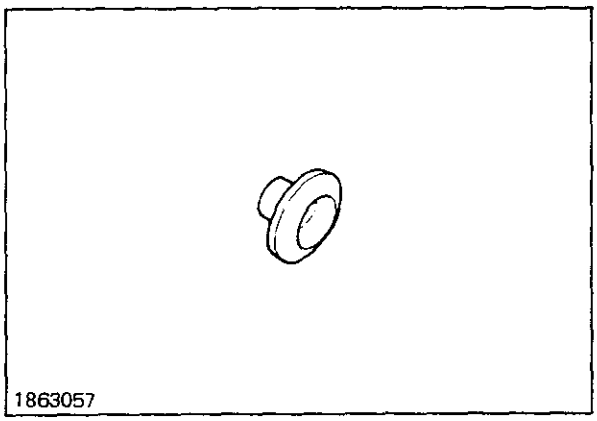

1863055

Nozzle Valve Spring

Examine spring and shims for pitting or excessive wear. Replace, if not in good condition.


1863056

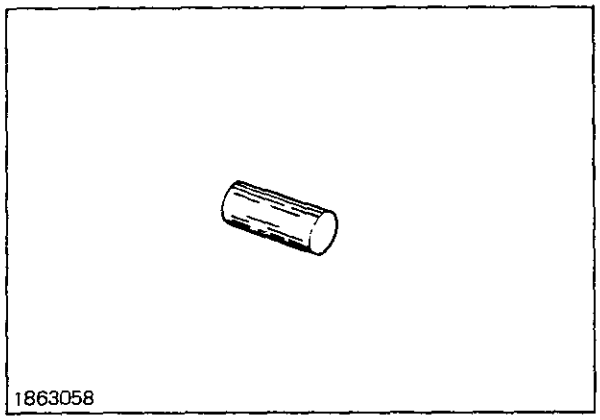
FUEL INJECTION NOZZLE (Continued)


1863057

CLEANING AND INSPECTION (Continued)

Spring Seat

Inspect the spring seat for splitting, cracking, or excessive wear. Replace seat if any of these conditions are evident.


1863058

Inter Spindle

Spindle must not be worn appreciably or bent. Replace spindle if either one, or both, conditions exist.

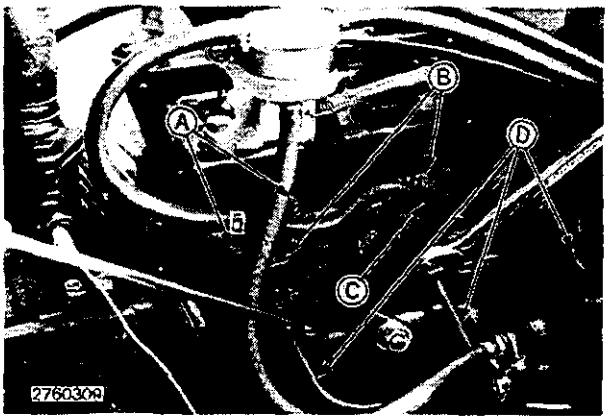
Assembly

1. Insert the nozzle valve into the nozzle while holding parts below the fuel level in pan.
2. Install the nozzle assembly on holder and secure with the nozzle retaining nut (9). Tighten nut 90–100 Nm (9–10 kgm) (67–73 ft-lbs) torque.
3. Place inter spindle (6), spring seat (5), spring (4) and shims (3) in nozzle holder while still wet with fuel.
4. Install upper holder nut (1) with copper washer (2) and tighten 70–80 Nm (7–8 kgm) (52–58 ft-lbs) torque.

INSTALLATION

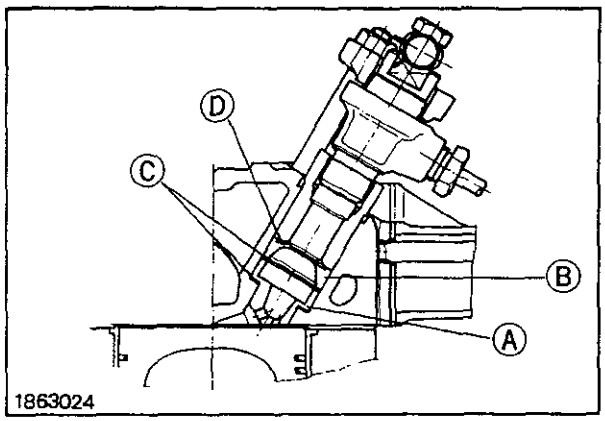
Before installing the YDN injection nozzle, check outer part of percombustion chamber for condition of the heat insulting packing. The packing must be in good condition in order to reduce heat transfer from the precombustion chamber to the injection nozzle, and thereby extending life of the injection nozzle.

1. Insert the injection nozzles into cylinder head. To insure correct positioning of nozzle for each cylinder, connect fuel pipes to injection nozzles before installing retainers.
2. Install retainer (B) on injection nozzle with side of retainer having two "V"-type protrusions resting on injection nozzle.
3. Tighten the injection nozzle retainer stud nuts(A) to 20 Nm (2 kgm) (15 ft-lbs) torque. Be sure to keep retainer even as nuts are tightened.
4. Install the leak-off banjo connectors (C) and washers on injection nozzles. Connect rubber hoses.
5. Tighten the fuel injection pipe connectors (D) to 27 Nm (2.7 kgm) (20 ft-lbs) torque.
6. Connect thermostart system fuel hoses.
7. Bleed the fuel system (page 10-6).
8. Start the engine and check for leaks.



A — Retainer Nuts
B — Retainer
C — Banjo Connectors
D — Fuel Injection Pipe

PRECOMBUSTION CHAMBER



REMOVAL

To remove the precombustion chamber, first remove the injection nozzle (page 30-10-16). Then, using any suitable tool with a hook on one end, withdraw rear chamber (B), rear copper washer (C), front chamber (A), and front copper washer (C).

A – Front Chamber
B – Reak Chamber
C – Copper Packings
D – Insulating Packing

The front chamber has a tang (A) which fits into a slot (B) in cylinder head. Its purpose is to maintain alignment of the chamber with cylinder to insure that the fuel is injected into the cylinder at the correct angle.

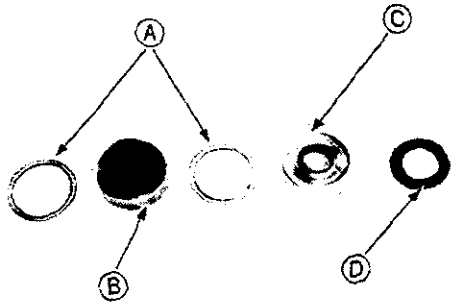
If the precombustion chamber can not be removed as described above, it will be necessary to remove the cylinder head (See page 20-05-6) and drive out the chambers using a suitable and drive out the chambers using a suitable soft driver. NEVER USE STEEL DRIVER.

A – Tang

Repair

The heat insulating packing improves the durability of the injection nozzle by preventing combustion heat from being transferred to the nozzle valve.

When the heat insulating packing becomes defective, pry out the old packing and replace with new.



Installation

Reverse the removal instructions given on the previous page.

Install the injection nozzles as described on the previous page.

A – Copper Packing
B – Front Chamber
C – Rear Chamber
D – Insulation Packing

GOVERNOR

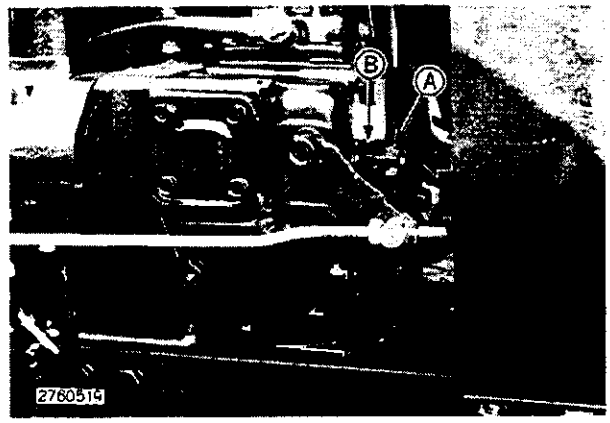
GENERAL INFORMATION

The governor mechanism affects the engine performance such as power, speed, smoke and fuel consumption.

It is desirable not to disassembel governor system if not necessary when disassembling or repairing the other components.

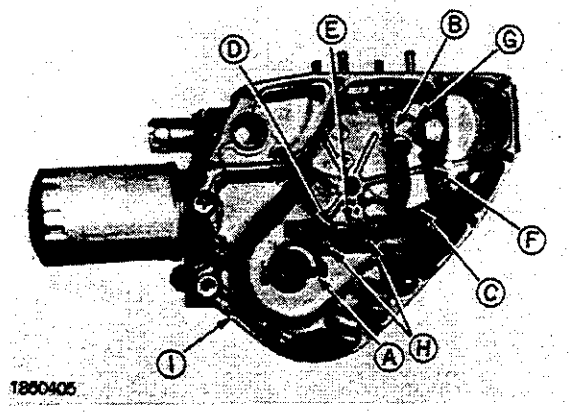
Do not loosen cap nut (A) lock nut (B) and limiter screw.

If they were accidentally removed or loosened, they must be adjusted.



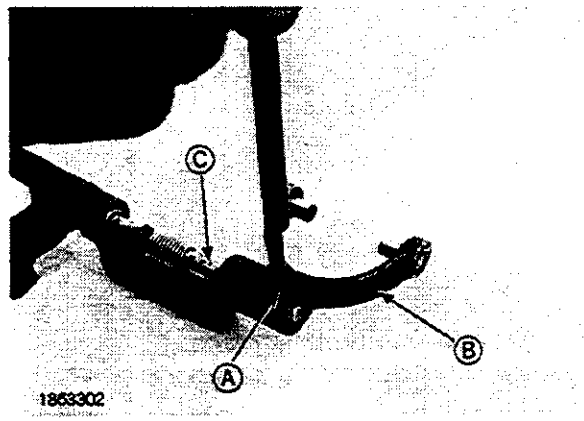
REMOVAL

1. Remove fuel injection pump as shown on page 30-10-7.
2. Remove timing gear cover as shown on page 20-05-15.
3. Remove regulator spring (F).
4. Remove cap screws (H), and remove Governor Lever Assembly.



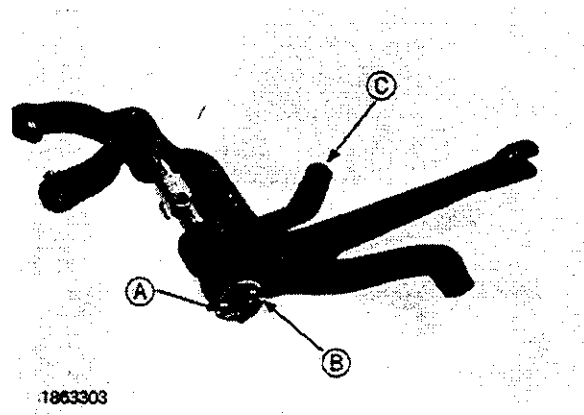
A – 1st Governor Lever
B – 2nd Governor Lever
C – Control Lever
D – Governor Shaft
E – Governor Spring
F – Regulator Spring
G – Regulator Lever
H – Cap Screws
I – Timing Gear Cover

5. Punch Taper pin (A) out, and remove 1st Governor lever (B) from governor shaft.



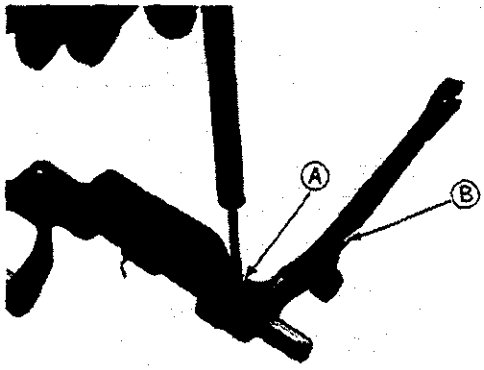
A – Taper Pin
B – 1st Governe lever
C – Shaft

6. Remove cotter pin (A) and washer (B), and remove control lever (C).



A – Cotter Pin
B – Washer
C – Control Lever

GOVERNOR

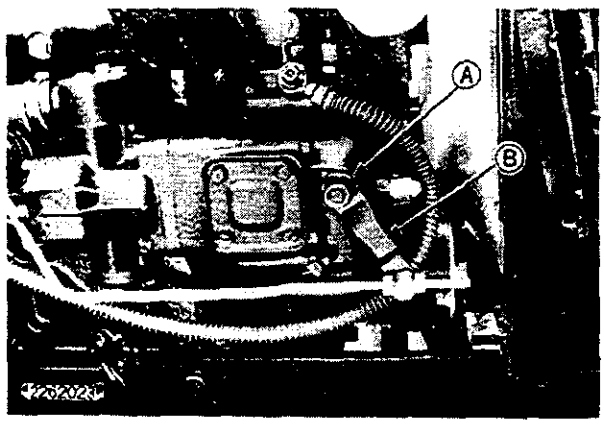


1863304

REMOVAL (Continued)

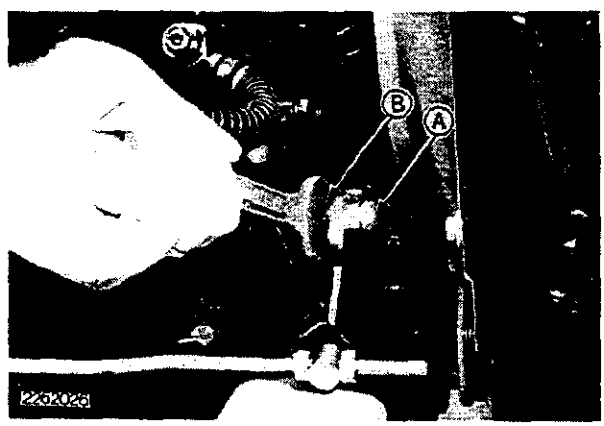
7. Punch out taper pin (A) and remove 2nd governor lever (B) from governor shaft.

A – Tapper Pin
B – 2nd Governor Lever



8. Remove Pin (A) and Regulator handle, (B) and pull out regulator lever (Not shown).

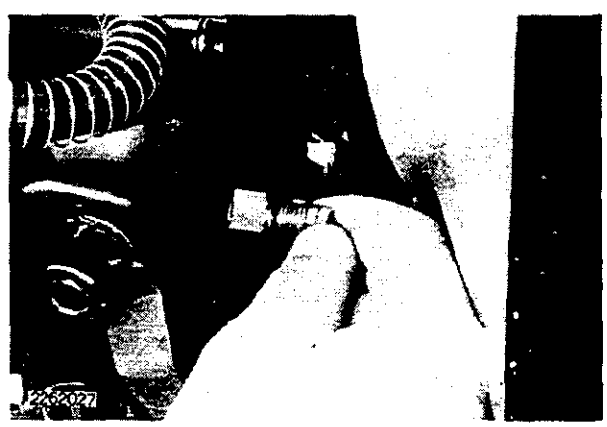
A – Pin
B – Regulator Handle



9. Remove governor sleeve and governor weight assembly. See page 20-15-09.

10. Remove cap nut (A), and loosen lock nut (B).

A – Cap Nut
B – Lock Nut



11. Remove injection limiter.

Do not have to remove timing gear cover to repair or replace only injection limiter.

INSPECTION

Regulator Spring

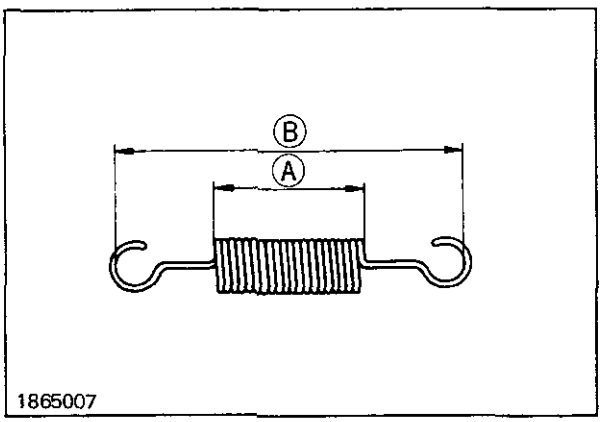
Inspect the spring for damage, corrosion and hock deformation, and replace if faulty.

Measure the spring dimensions and tension, and compare measurement taken with the following specifications.

REGULATOR SPRING SPECIFICATIONS

	New Part	Wear Limit
Wire O.D.	1.6 mm (0.06 in.)	——
Coil O.D.	13.6 mm (0.535 in.)	——
Free Length		
A	22 mm (0.866 in.)	
B	68 mm (2.677 in.)	68.1 mm (2.68 in.)
Tensile Length	78.5 mm at 4.536 kg (3.091 in. at 10 lbs)	

A – Spring Length
B – Coil Length



1865007

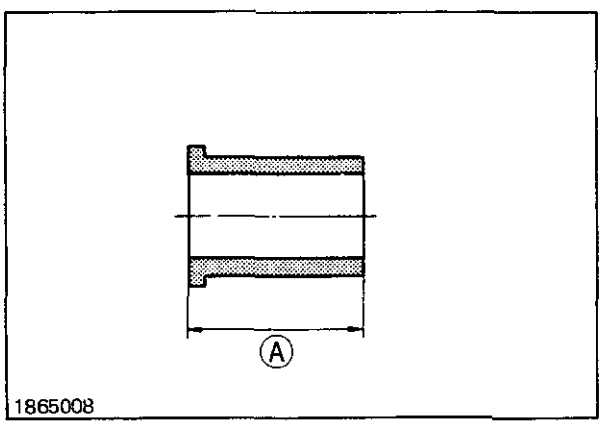
Governor Sleeve

Slide the sleeve on crankshaft to check if it move smoothly.

Measure I.D. of sleeve and O.D. of crankshaft. Compare measurement taken with the following specifications.

GOVERNOR SLEEVE SPECIFICATIONS

	New Part	Wear Limit
Sleeve I.D.	25.117 to 25.138 mm (0.989 to 0.990 in.)	——
Crankshaft		
O.D.	24.939 to 24.960 mm (0.982 to 0.983 in.)	——
Clearance	0.06 to 0.1 mm (0.002 to 0.004 in.)	0.2 mm (0.008 in.)
Sleeve length		
A	24.9 to 25.1 mm (0.980 to 0.988 in.)	24.75 mm (0.974 in.)

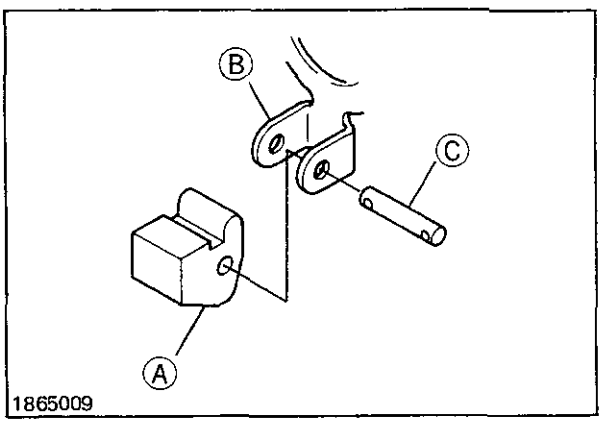


1865008

Governor Weight

Check contact with the sleeve and for wear. Replace assembly if necessary.

A – Weight
B – Support
C – Pin



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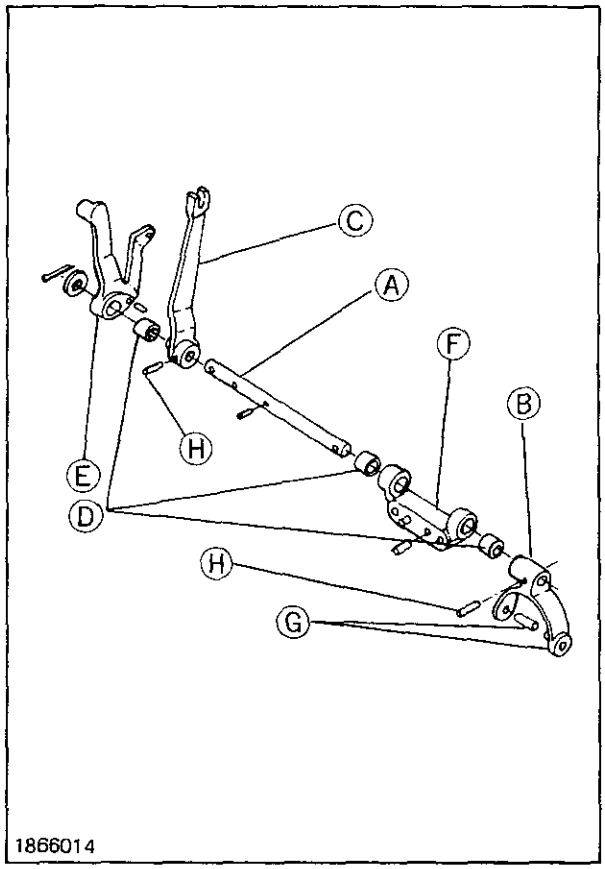


1866014

Governor Lever and Shaft

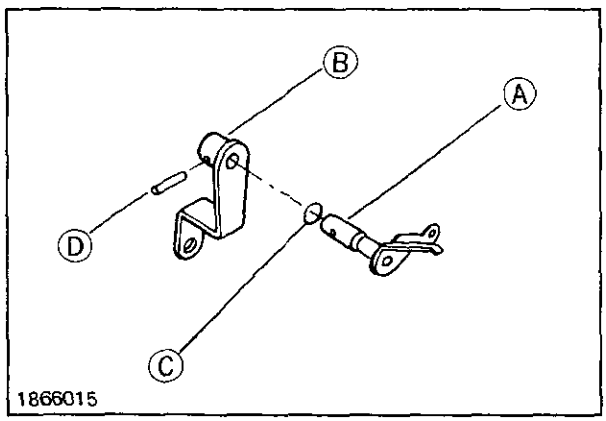
Replace the governor lever and shaft together if there is play between the shaft (A) and (B,C).

The 1st governor lever (B) has a specified angle to the 2nd governor lever. So the 1st and 2nd levers and shaft must be replaced together with a new kit parts.

Replace the bearings (D) in control lever (E) and shaft bracket (F) if there is play between the shaft and needle bearings, or if the shaft does not move smoothly.

Inspect the contact and wear of the pins (G) at the end of 1st governor lever (B).

A – Shaft
B – 1st Governor Lever
C – 2nd Governor Lever
D – Bearings
E – Control Lever
F – Shaft Bracket
G – Pins
H – Taper Pin



1866015

Regulator Lever and Handle

Replace the regulator lever and handle together if there is play between the lever (A) and handle (B).

The lever and handle are drilled hole for taper pin together to get specified angle. So they must replaced together with a new kit parts.

Inspect O-ring (C) for wear or crack.
Replace it if necessary.

A – Regulator Lever
B – Regualtor Handle
C – O-ring
D – Taper Pin

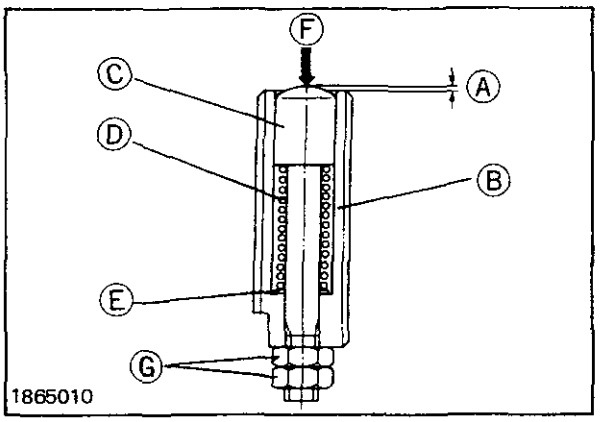
INSPECTION (Continued)

Fuel Injection Limiter

Measure the dimension A and compare to the following specifications.

FUEL INJECTION LIMITER SPECIFICATION

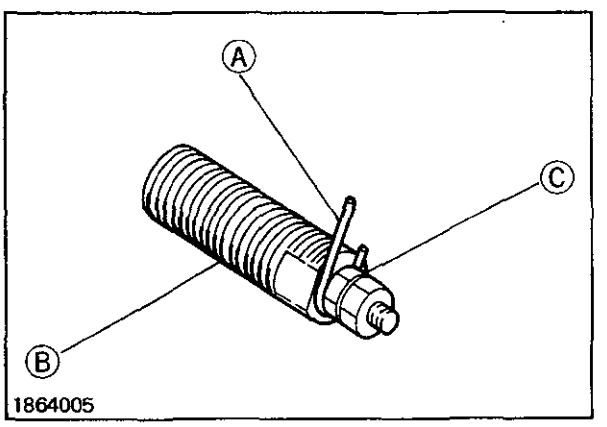
Dimension A . . . . . 0.8 to 0.9 mm (0.031 to 0.035 in.)
Load F . . . . . 150 to 160 kg (5.906 to 6.299 lbs)



Adjust the spring force with a shim so that the dimension A is specified value while pressing the limiter pin with specified load F. Then, lock the limiter pin with double lock nut.

If it is impossible to adjust, replace the assembly with a new one.

A – Protrusion
B – Limiter Screw
C – Limiter Pin
D – Spring
E – Shim
F – Checking Load
G – Lock Nuts



INSTALLATION AND ADJUSTMENT

Reverse the removal steps to install on the preceding pages. But the fuel injection limiter should be installed after installing timing gear cover.
When assembling, reffer to the following tightening torques.

TORQUE SPECIFICATIONS

Governor shaft bracket
cap screws . . . . . 7.9 to 11.7 Nm (0.8 to 1.2 kgm) (6 to 9 ft-lbs)

Timing gear cover
cap screws . . . . . 23 to 30 Nm (2.3 to 3.0 kgm) (17 to 22 ft-lbs)

Injection Pump
Retaining Nuts . . . . . 20 to 29 Nm (2 to 3 kgm) (15 to 22 ft-lbs)

To adjust fuel injection limiter.

1. Check governor levers for smooth movement rotaing the regulator handle.

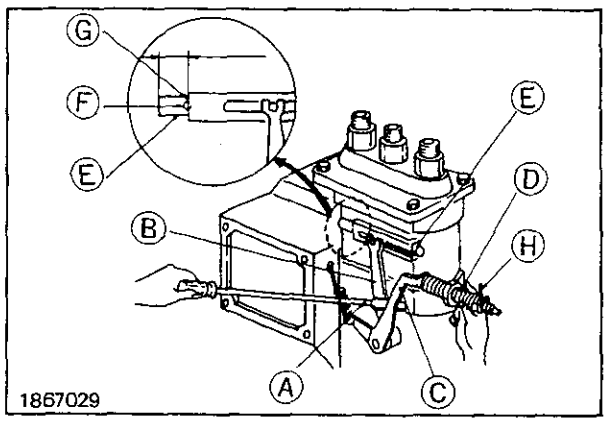
2. (FOR LIMITER WITH WHITE PAINT MARK)

   Insert spacer (A) which has the thickness of 1.4 to 2.0 mm (0.055 to 0.078 in.) nut (C), and screw into the timing gear cover.

   (FOR LIMITER WITHOUT MARK)

   Insert spacer (A) which has the thickness of 0.8 to 1.0 mm (0.032 to 0.039 in.) between limiter screw (B) and lock nut (C), and screw into the timing gear cover.

A – Spacer
B – Limit Screw
C – Lock Nut



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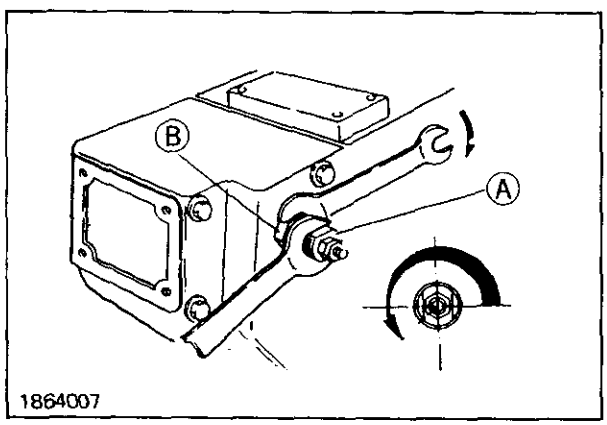
3. Insert screw drive (A) between governor lever (B) and Control lever (C) to keep away from each other.

   Then, turn the limiter screw (D) clockwise to push the governor and regulator levers an fuel control rack (E) until the punch mark (F) on control rack (E) is centered on reference face (G) of pump housing.

A – Screw Drive
B – Governor Lever
C – Regulator Lever
D – Limiter Screw
E – Control Rack
F – Punch Mark
G – Reference Surface
H – Spacer



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4. (FOR LIMITER WITH WHITE PAINT MARK)

   Remove the screw drive (A) and the spacer (B), and screw limiter 220° to 230° (5/8 turn) out of timing gear cover.

   (FOR LIMITER WITHOUT MARK)

   Remove the screw drive (A) and the spacer (B) and screw limiter 375° to 400° (1-1/8 turns) out of timing gear cover.

5. Secure adjustment with lock nut (B) and install cap nut.

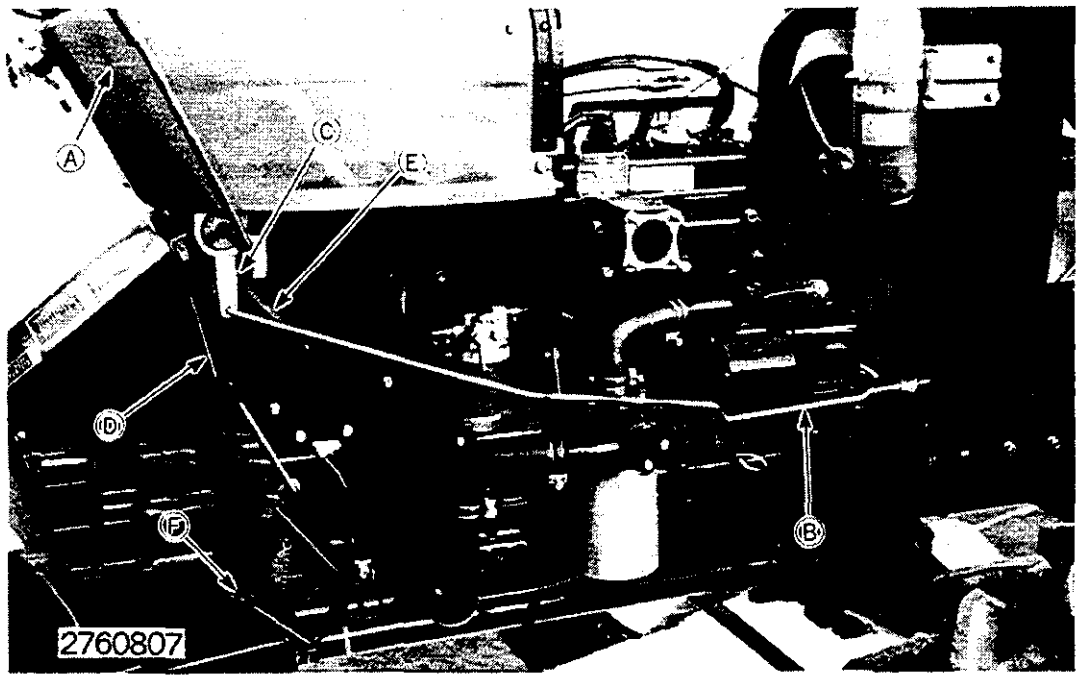
STOP Be sure for limiter (A) not to be turned when tightening lock nut (B).

6. Install cover plate to the timing gear cover.

7. Check engine fast idle speed after adjustment.

   The fast idle speed should be 2725 to 2775 rpm.

A – Fuel Limiter
B – Lock Nut



A – Throttle Lever
B – Link Rod
C – Link Lever
D – Foot Throttle Rod
E – Return Spring
F – Foot Throttle Pedal

DIAGNOSING MALFUNCTIONS

Engine can not be shut off

- Improperly adjusted link rod
- Broken, weaken or missing return spring
- Rust on throttle lever bracket

Engine runs irregularly

- Weaken return spring
- Worn friction disc

Engine can not keep a certain speed

- Worn friction disc
- Improper preload adjustment of throttle lever

SPEED CONTROL LINKAGE

REMOVAL

1. Disconnect spring (E) and two rods (B and D).
2. Take off two nuts which fasten the throttle lever assembly (A) to bracket. Remove lever assembly.

   Be careful not to lose detent ball and spring.

INSPECTION AND REPAIR

Inspect condition of friction disk. If disk is glazed or worn excessively, the speed control lever will not stay where it is placed. Replace disk when required.

Inspect condition of detent ball and spring. Spring must not be weak or broken. Replace parts if their condition is not satisfactory.

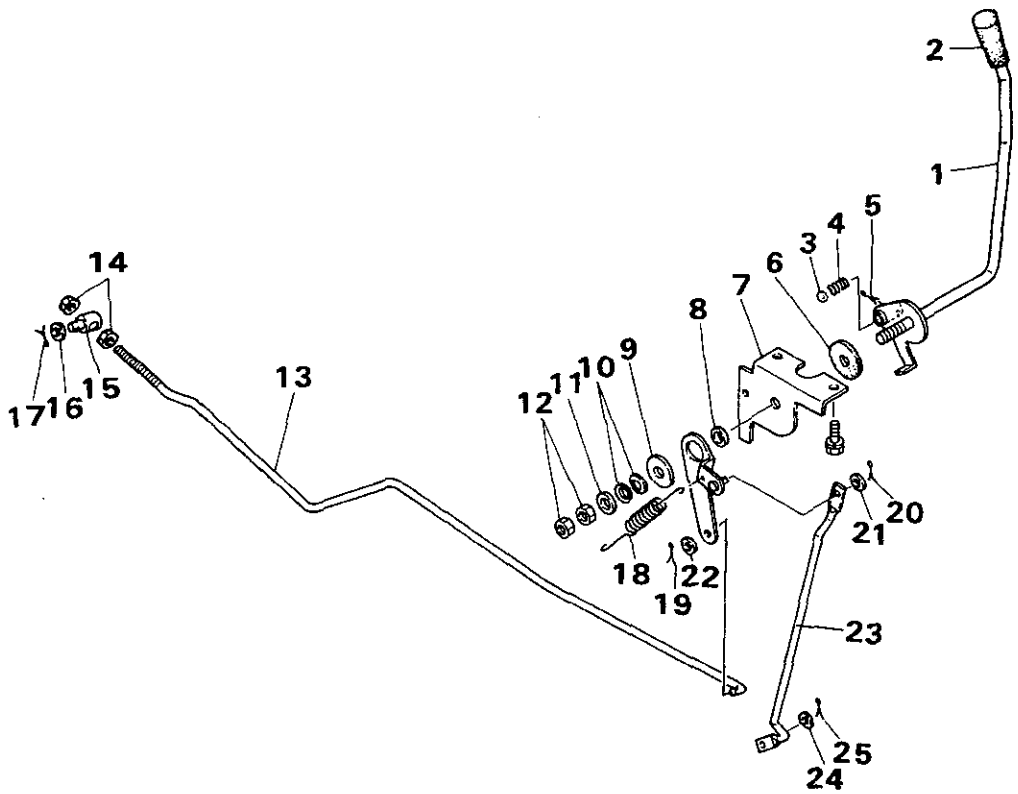
Inspect condition of linkage connections where control rods connect with control levers. Excessively loose linkage connections will give poor response to selecting engine speed.

Worn linkage connections can usually be repaired by welding. Use brass welding rod to fill worn holes and worn control rod ends. Restore repaired areas to the original size and shape. If unable to repair worn part satisfactorily, replace with a new one.

INSTALLATION

Reverse the removal procedures to install speed control linkage.

Refer to for information on adjusting the speed control linkage.



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1 – Throttle, Lever
2 – Lever Grip
3 – Detent Ball
4 – Lock Spring
5 – Cotter Pin
6 – Friction Plate
7 – Throttle Lever, Bracket
8 – Spacer
9 – Whasher
10 – Spring
11 – Washer
12 – Nut M 10
13 – Link Rod
14 – Nut M 8
15 – Adjuster
16 – Wahser M 6
17 – Cotter Pin
18 – Spring
19 – Cotter Pin
20 – Wahser M 6
21 – Cotter Pin
22 – Washer M 6
23 – Foot Throttle
24 – Wahser 8
25 – Cotter Pin

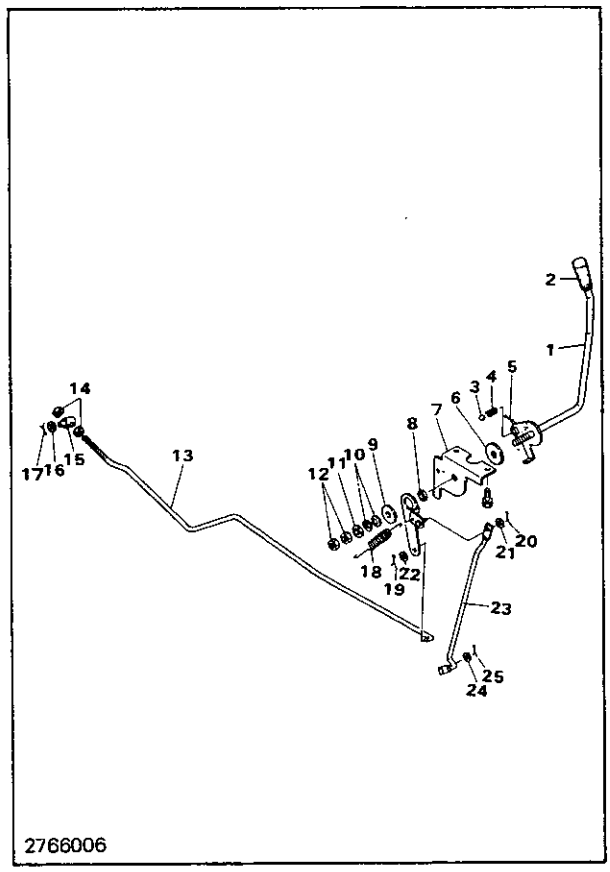
INSPECTION AND REPAIR

Inspect condition of friction disk. If disk is glazed or worn excessively, the speed control lever will not stay where it is placed. Replace disk when required.

Inspect condition of detent ball and spring. Spring must not be weak or broken. Replace parts if their condition is not satisfactory.

Inspect condition of linkage connections where control rods connect with control levers. Excessively loose linkage connections will give poor response to selecting engine speed.

Worn linkage connections can usually be repaired by welding. Use brass welding rod to fill worn holes and worn control rod ends. Restore repaired areas to the original size and shape. If unable to repair worn part satisfactorily, replace with a new one.



INSTALLATION

Reverse the removal procedures to install speed control linkage.

Refer to for information on adjusting the speed control linkage.

ELECTRICAL REPAIR 40

SPECIFICATIONS

General Information

		SPECIFICATIONS
Battery	Battery Ground	Negative
	BCI Group	27
	Battery Volts	12.4 to 12.8
	Cold cranking amps at −18° (0°F)	390A
	Reserve capacity (minutes at 25 amps)	115 min.
	Full charge specific gravity	1.260
		FUSE USED
Fuses	Headlights	15 amp
	Horn/Front PTO	10 amp
	Flashing/Warning Lights	10 amp
	Indicator Lamps	5 amp

Changing Circuit 15A

	SPECIFICATIONS
Alternator Model	GP9150
Alternator output (minimum at 1400 rpm)	15 amps
Pulley nut torque	54 Nm (5.4 kgm) (40 ft-lbs)
Belt deflection with 89 Nm (9 kg) (20 lbs.) force applied	10 to 16 mm (3/8 to 5/8 in.)
Regulator Model	RS1105

Changing Circuit 35A (Optional for Northern Europe)

Alternator Model	LT135 −54
Alternator output (minimum at 2600 rpm)	35A
Pulley nut torque	54 Nm (5.4 kgm) (40 ft-lbs)
Belt deflection with 89 Nm (9 kg) (20 lbs.) force applied	10 to 16 mm (3/8 to 5/8 in.)
Regulator Model	TL1Z − 86E

Starting Circuit

	NEW PART SPECIFICATIONS	WEAR LIMIT
No-Load Current Draw	70 amps max. @6000 rpm	
Brush Length	22 mm (0.866 in.)	14 mm (0.55 in.)
Commutator O.D.	43 mm (1.69 in.)	40 mm (1.57 in.)
Insulator Undercut Depth	0.5 − 0.8 mm (0.02 − 0.003 in.)	0.2 mm (0.006 in.)
Pinion Clearance	0.3 − 1.5 mm (0.008 − 0.060 in.)	1.5 mm (0.006 in.)
Pinion Mesh Clearance to Ring Gear	3 − 5 mm (0.12 − 0.19 in.)	5 mm (0.2 in.)
Brush Spring Tension	850 g (30 oz)	

SPECIFICATIONS (Continued)

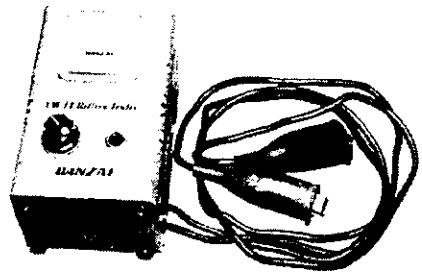
Lighting and Accessory Circuits

	SPECIFICATIONS	SAE Number
Bulbs		
Dual-beam headlight	12V–25W/25W	—
Warning Lamp	12V–23W	1156
Work Light	12V–20W	1034
Oil pressure, temperature, charge indicator and hourmeter lamps	12V–3W	53
Water temperature sender		
Closes (light on) at	110°C (230°F)	
Opens (light off) at	102°C (215°F)	
Oil pressure sender		
Closes (light on) below	1 kg/cm^2 (14.2 psi)	
Charge indicator light off	530 rpm (Engine)	

SPECIAL TOOLS

Battery Tester

Test battery.



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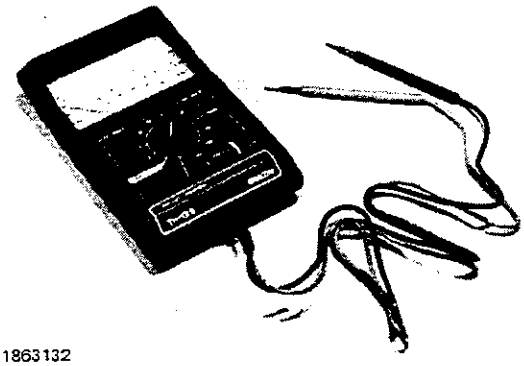
Circuit Tester (V-A-Ω Meter)

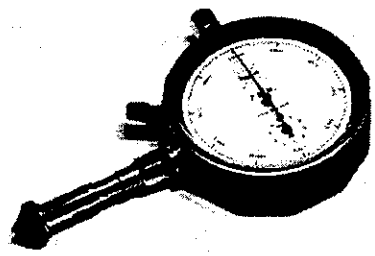
Test all electrical components for voltage, resistance, or current draw.



1863132

Hand-Held Tachometer

Measuring starter motor speed.



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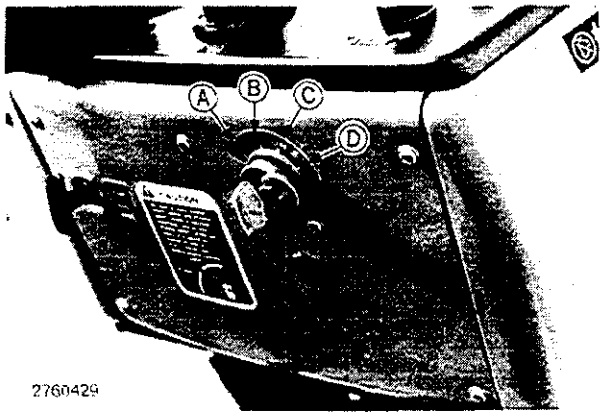
GENERAL INFORMATION

The electrical system consists of a battery, starting circuit, charging circuit, lighting circuit, instrument panel and interconnecting wiring. Refer to the appropriate Section within this Chapter and see Chapter 240 for theory of operation, diagnosis, tests, repair procedure and specifications.



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KEY SWITCH

The key switch is located on the panel box facing to the operator. It controls the starting circuit and the thermostart unit.

When the switch is in Position A, the glow plug unit is activated. This position is used to preheat the thermostart in extremely cold weather.

In Position B, all electrical circuits are off. The ignition key can be removed only in this position.

In Position C, all circuits except starting and thermostart are energized. The switch is in this position during normal operation.

In Position D, the starting circuit is energized and the starter turns. When the engine starts and the key is released, the key will spring back to Position C.

A – Thermostart
B – OFF
C – ON
D – START

FUSE HOLDER

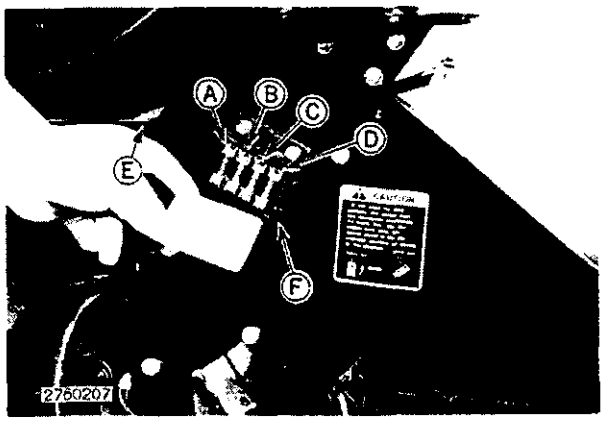
The fuse holder, mounted on the left side panel, holds four fuses used to protect the lighting system.

Fuse A is a 5-amp fuse that protects the indicator lamps.

Fuse B is a 10-amp fuse that protects the horn and the front PTO (Optional).

Fuse C is a 10-amp fuse that protects the flashing warning lights.

Fuse D is a 15-amp fuse that protects the headlights.



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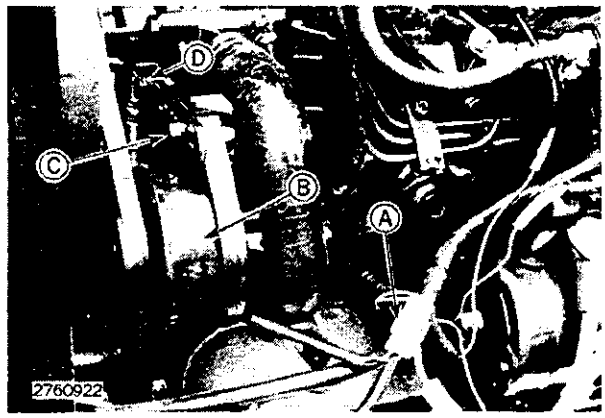
A – 5A Fuse (Red)
B – 10A Fuse (Yellow)
C – 10A Fuse (Yellow)
D – 15A Fuse (Blue)
E – Fuel Tank Bracket
F – Steering Column
G – Fuse Holder

ALTERNATOR

See chapter 240, Section 10 for charging circuit diagnosis and operation.



REMOVAL

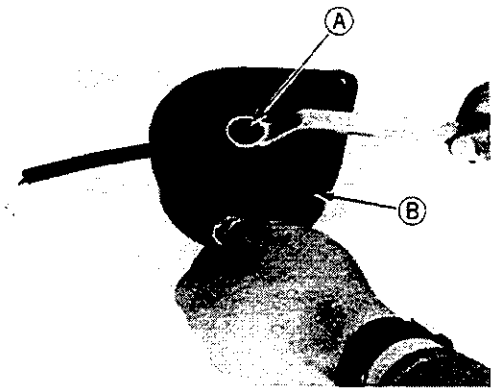
1. Disconnect battery ground cable at negative (—) battery terminal.
2. Disconnect harness connector.
3. Support alternator (B) and remove one mounting nut (D) and adjusting screw (C).
4. Lift off alternator.

A — Connector
B — Alternator
C — Adjusting Screw
D — Mounting Screw

DISASSEMBLY

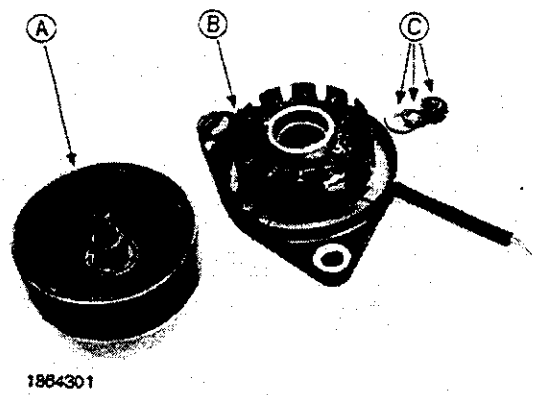
1. Remove nut (A) from end of shaft.

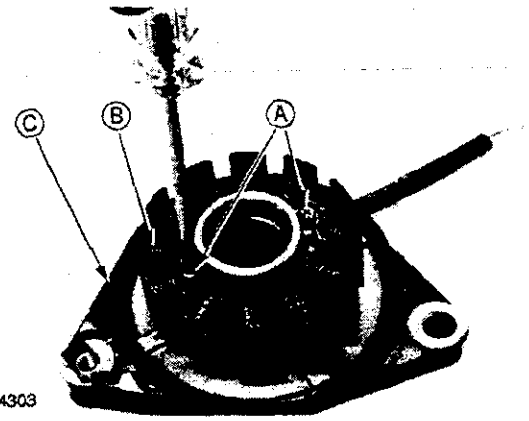
A — Nut
B — Alternator Body



2. Pull flywheel (A) with magnets from body of alternator (B).

A — Flywheel with Magnets
B — Alternator Body
C — Nut and Washers





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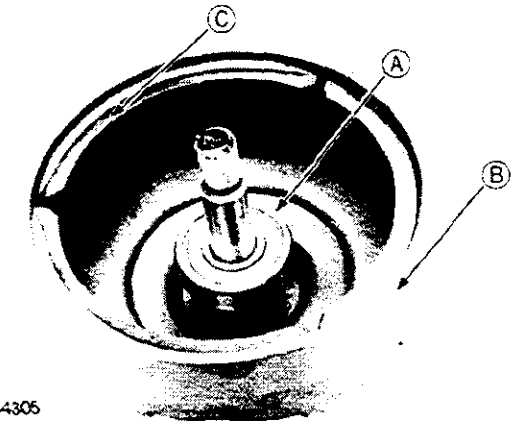
DISASSEMBLY (Continued)

3. Remove two coil retaining screws (A).

A – Screws
B – Stator Coils
C – Body



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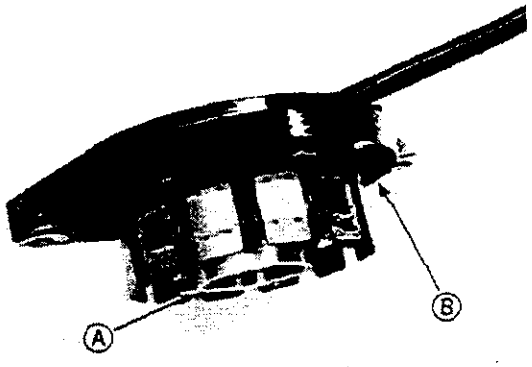
INSPECTION AND REPAIR

1. Inspect bearing (A) in flywheel (B) for damage or wear. Replace as necessary.

A – Outer Bearing
B – Flywheel
C – Magnets



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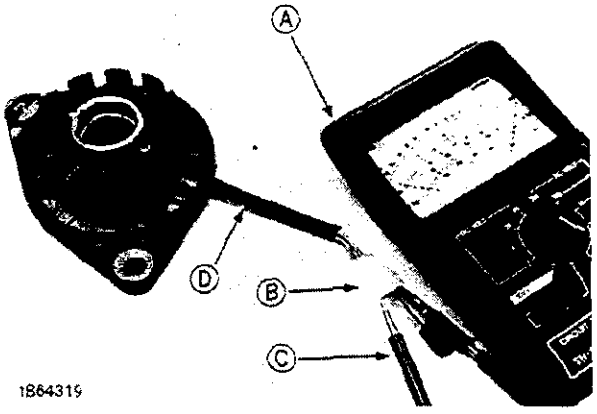
2. Inspect bearing (A) in alternator body (B) for damage or wear. Replace as necessary.

A – Inner Bearing
B – Alternator Body



1864319

3. To preform stator coil continuity test, use circuit tester (A).

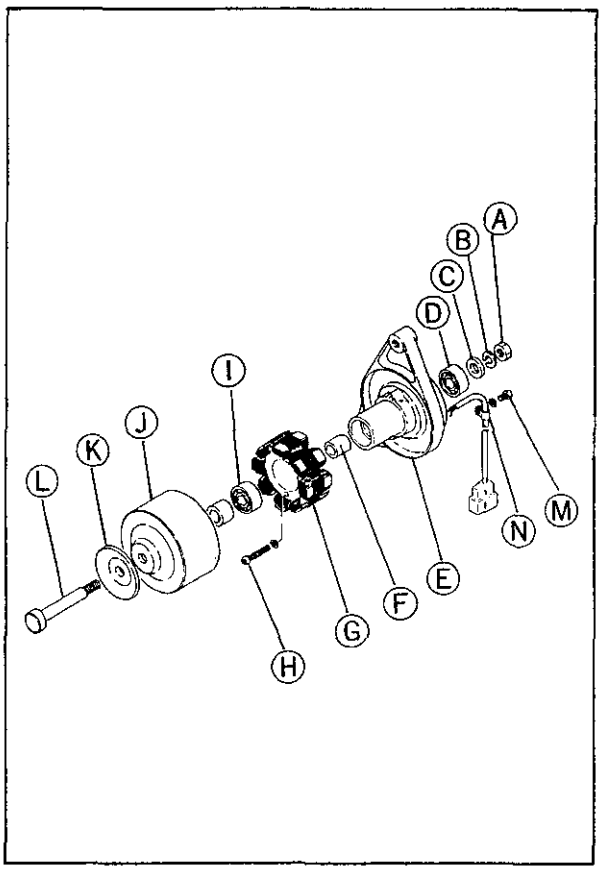
   Clip one terminal of connector (B) and touch the probe (C) of tester to other terminal of connector. Continuity should be observed.

   If no continuity is observed, replace coil assembly.

A – Circuit Tester
B – Connector
C – Probe
D – Lead

ASSEMBLY

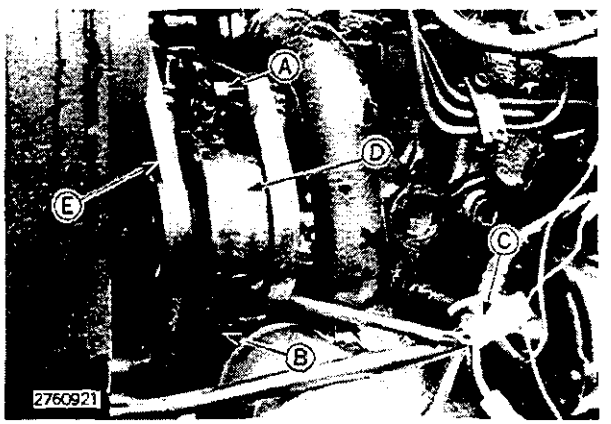
1. Install inner bearing (D) into alternator body against shoulder of the bearing bore.
2. Apply grease to the front face of inner bearing and insert bearing spacer (F) against bearing (D).
3. Install stator coil assembly (G) to alternator body (E) and tighten two retaining screws (H).
4. Insert shaft (L) though pulley half (K) to bore of flywheel (J).
5. Install outer bearing on shaft (H) in the flywheel bowl.
6. Fill space between outer bearing and inner bearing with new grease and install flywheel assembly to the alternator body assembly.
7. Install washers (C and B) and tighten nut (A) to 3 to 3.5 kgm (22 to 25 ft-lbs) torque.



A – Nut
B – Spring Washer
C – Washer
D – Inner Bearing
E – Alternator Body
F – Spacer
G – Stator Coil Assembly
H – Screw
I – Outer Bearing
J – Flywheel with Magnets
K – Pully Half
L – Shaft
M – Screw
N – Wire Lead with Connector

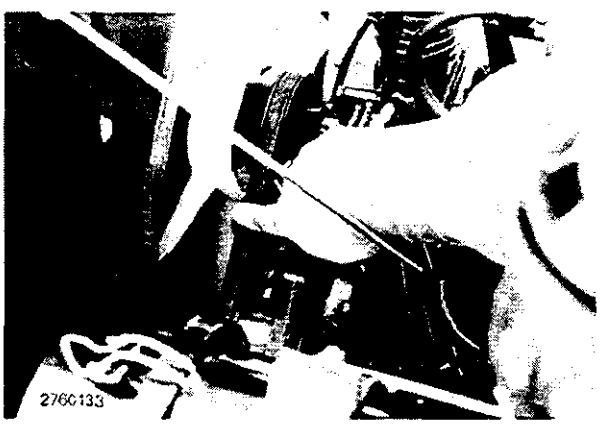
INSTALLATION

1. Install alternator on the engine and tighten cap screw (B) instantly.
2. Pry alternator (D) far from engine to give a tension on belt (E) and tighten adjusting cap screw (A).

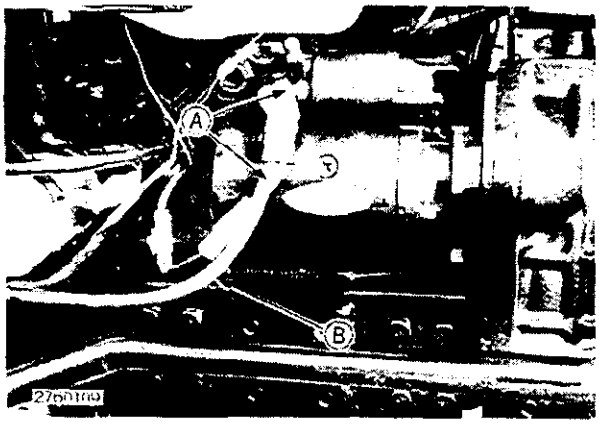


A – Adjusting Screw
B – Cap Screw
C – Connectors
D – Alternator
E – Belt

3. Inspect belt tension. Tighten nut (B) and adjusting screw (A) to 1.8 – 2.0 kgm (13 to 14 ft-lbs) if belt deflect 13 mm (1/2 in.) with around 9 kg (20 lbs.) force.
4. Connect harness connectors (C).



REGULATOR



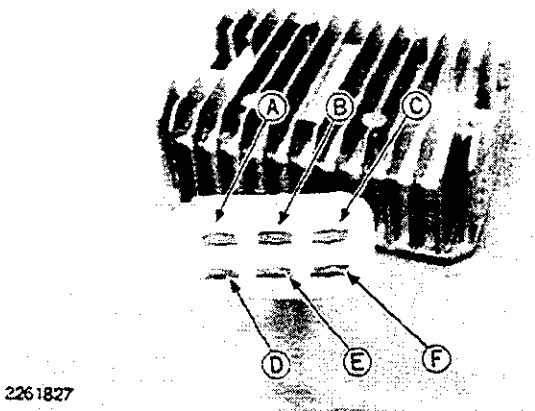
INSPECTION

1. Set selector switch to "30 VOLTS". Connect COM (–) probe to a suitable ground. Connect V-Ω-A (+) probe to "one' terminal on starter.
2. Start engine and run it several minutes at 1500 rpm to charge battery. Meter should read 13 to 15 volts.

A – Lead from Regulator (Red/white)
B – Battery Cable

If voltage is higher than 15 volts, voltage regulator is defective and must be replaced.

If voltage is lower than 13 volts, charge battery and repeat test. If voltage stays low, either alternator or voltage regulator is defective.



3. Check regulator for continuity for each terminal, and confirm continuity as shown in the following chart.

Terminal (A) – Blue
(B) – Black
(C) – Blue
(D) – Green
(E) – Yellow
(F) – Red

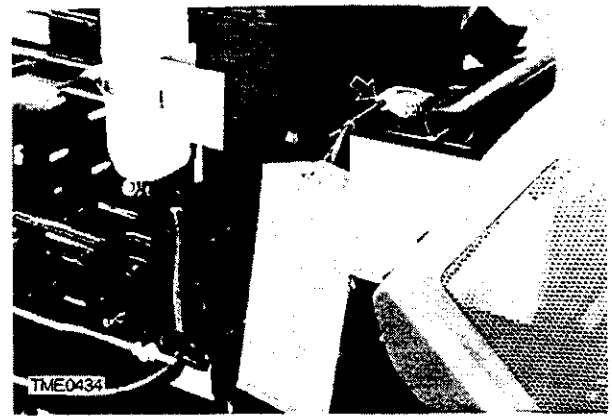
(+) Tester Probe

(–)	A	C	F	E	D	B
A		0	X	0	0	0
C	0		X	0	0	0
F	0	0		0	0	0
E	X	X	X		0	X
D	0	0	0	0		0
B	0	0	0	0	0	

"X" means continuity
"O" means no continuity

ALTERNATOR

See Chapter 240, Section 10 for charging circuit diagnosis and operation.



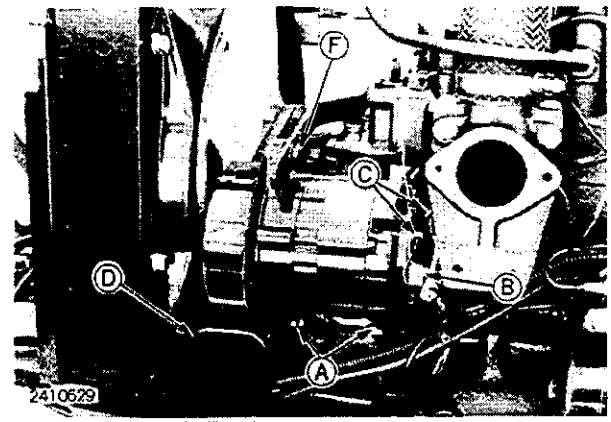
REMOVAL

1. Disconnect battery ground cable at negative (−) battery terminal.

2. Remove three screws and remove belt cover (D).

3. Disconnect harness connector (B) and terminal wire (C) and ground wire.

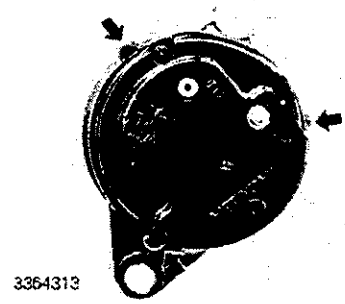
4. Support alternator and remove two mounting bolts (A) and adjusting screw (F). Lift off alternator and belt guard (E).



A — Mounting Bolts
B — Harness Connector
C — Terminal Wire
D — Belt Cover
E — Belt Guard
F — Adjusting Screw

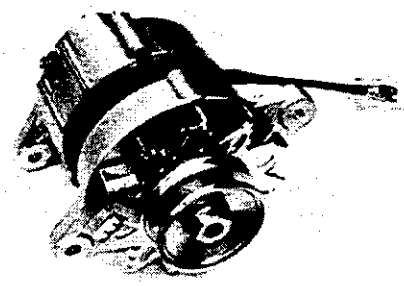
DISASSEMBLY

1. Remove three thru bolts

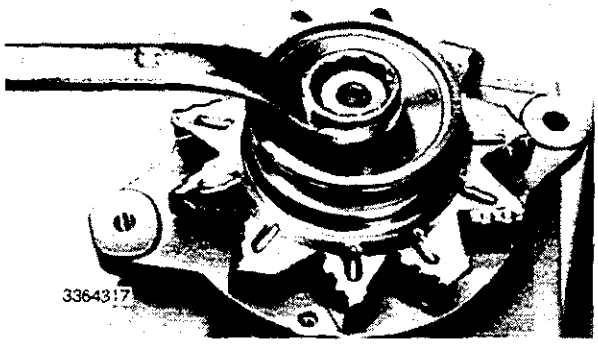


2. Using two screwdrivers, separate drive end-housing from stator.

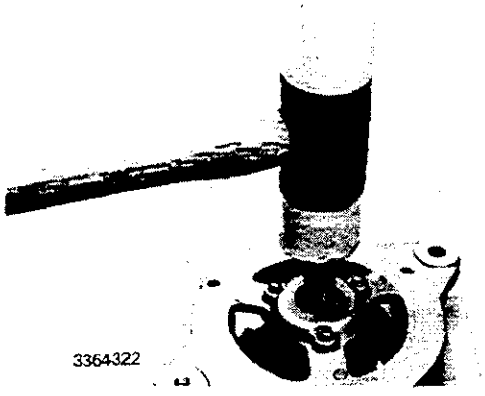
Do not pry against stator wires.



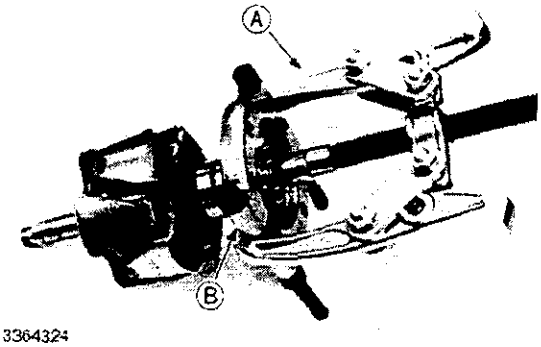
DISASSEMBLY (Continued)


3364317

3. Place rotor in a soft jaw vise. Remove pulley nut, pulley, fan and spacer.


3364322

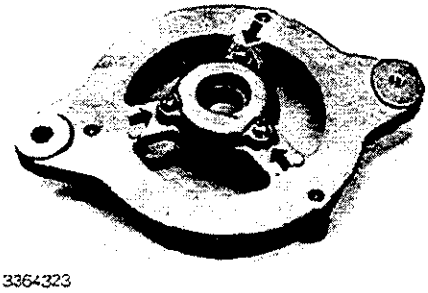
4. Loosen vise jaws. Remove rotor from drive end-housing using a plastic hammer.



3364324

5. Remove rotor shaft rear bearing using a bearing puller (A) and knife edge puller. It is not necessary to remove rear bearing unless it is defective.

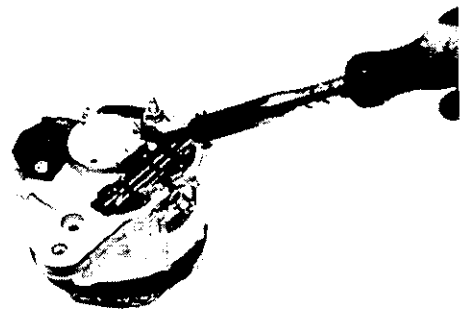
A — Bearing Puller
B — Knife Edge Puller


3364323

6. Remove three screws. Remove retainer plate, bearing and packing retainer from front cover.

7. Use a soldering iron to melt the three solder connections on rectifier assembly.

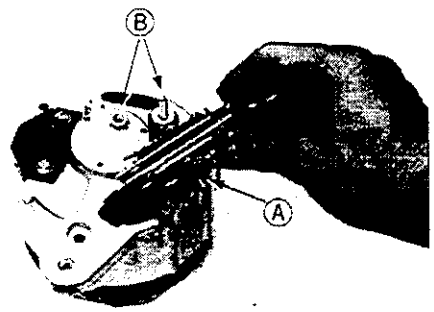
Do not heat plate longer than necessary to melt solder as excess heat will damage rectifier assembly.



3364316

8. Remove nut (B) from "A" terminal remove rectifier assembly (A).

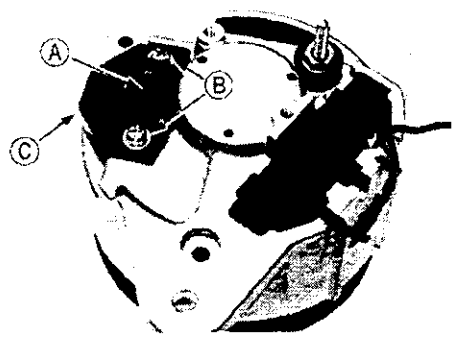
A – Rectifier Assembly
B – Nut on "A" Terminal



3364318

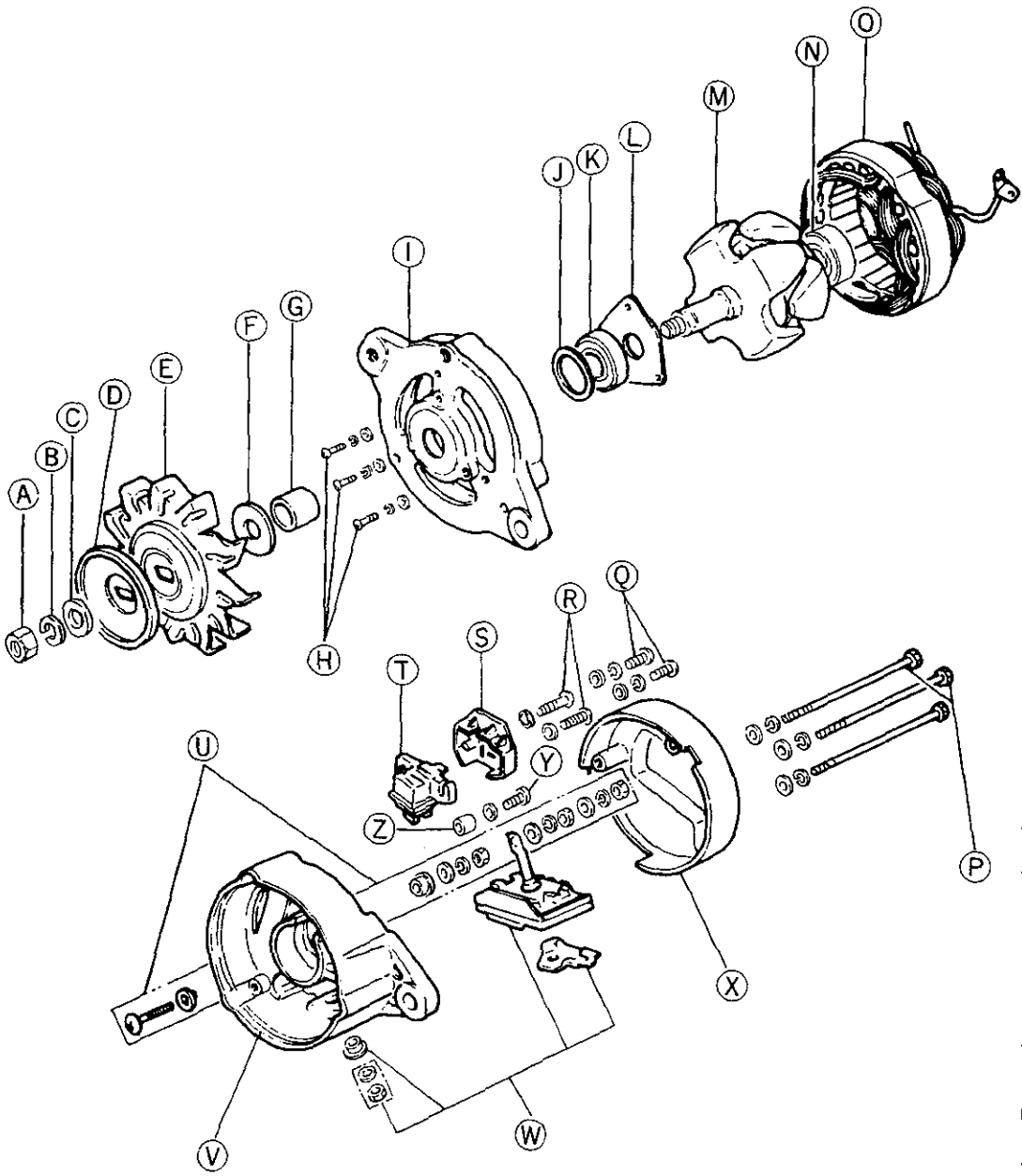
9. Remove two brush cover retaining screws (B). Remove brush holder assembly (A).

A – Brush Holder
B – Screws
C – Cover



3364319

INSPECTION, TESTING AND REPAIR



A – Nut
B – Spring Washer
C – Washer
D – Pulley
E – Fan
F – Washer
G – Spacer
H – Screw
I – Front Cover
J – Packing Retainer
K – Front Bearing
L – Bearing Retaining Plate
M – Rotor Assembly
N – Rear Bearing
O – Stator Assembly
P – Thru Bolts
Q – Screw
R – Screw
S – Brush Cover
T – Brush Holder
U – "A" Terminal
V – Stator Housing
W – Rectifier Assembly
X – Rear Cover
Y – Screw
Z – Spacer

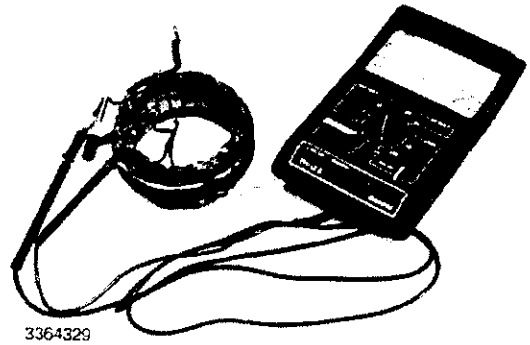
3366037

Testing Stator

Stator Coil Continuity Test

Touch the probes of ohmmeter to each pair of stator wires.

Equal continuity readings should be observed between each pair of leads. If readings are not equal, replace stator.

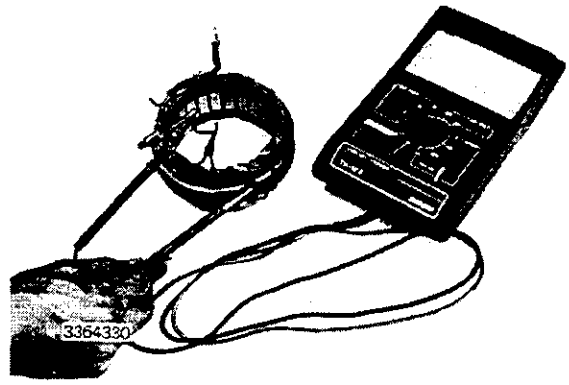

3364329

Stator Coil Ground Test

Touch one probe of ohmmeter to the bare metal surface of stator and the other probe to a bare stator lead wire.

The ohmmeter should register infinity (no needle movement).

If the meter indicates a reading (needle moves), the stator is grounded and must be replaced.


3364330

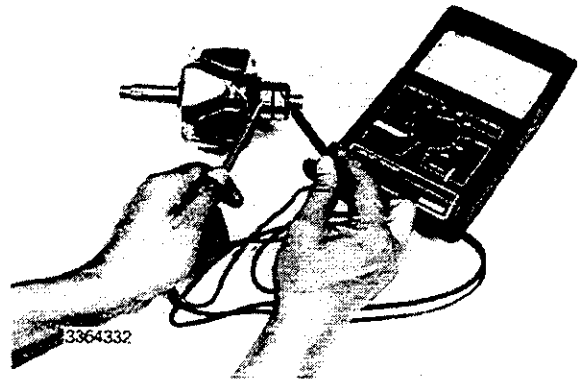
Testing Rotor

Rotor Coil Continuity Test

Touch the probes of an ohmmeter to slip rings to test rotor coil continuity.

Reading should be 8.2 – 9.8 ohms. If more than 9.8 ohms, check connection between lead wire and slip ring. If broken, repair and retest. If connections and wires are OK, rotor is defective and must be replaced.

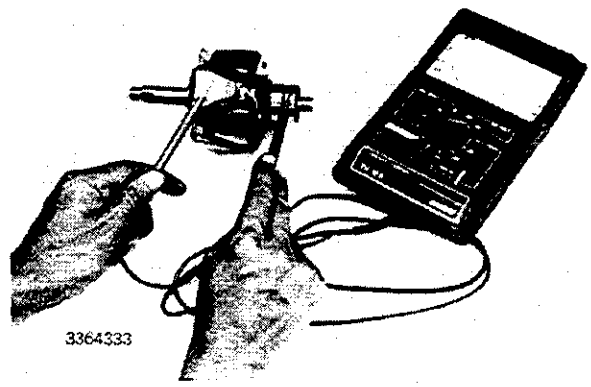
If reading is less than 8.2 ohms, rotor is shorted and must be replaced.


3364332

Rotor Coil Ground Test

Touch one probe to the rotor shaft and the other probe to one of the slip-rings and then the other.

The ohmmeter should register infinity (no needle movement). If the meter indicates a reading (needle moves), the rotor is grounded and must be replaced.


3364333

INSPECTION, TESTING AND REPAIR (Continued)

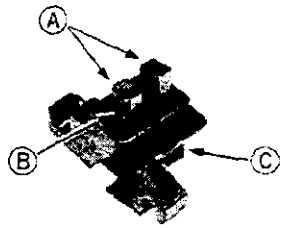
Inspecting Bearings

3364325

If the bearings are noisy during operation, they should be replaced.

Hold inner race and rotate outer race to check for roughness and pitted ball bearing.

Inspecting Brushes

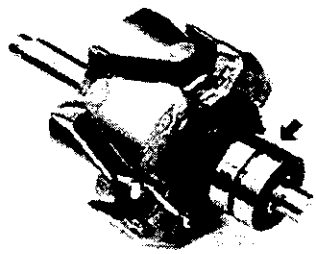


3364321

1. Check exposed length of brushes (A). The wear limit line is marked on the side of bush (B).
2. Check to be sure brushes move freely in brush holder (C) and brush spring are not broken or collapsed. Replace as necessary.

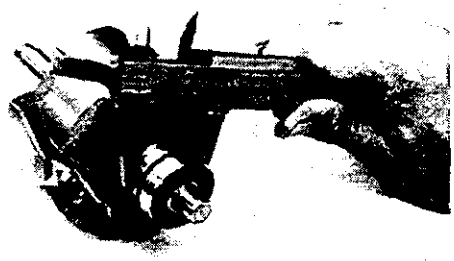
A — Brush
B — Wear Limit
C — Holder

Inspecting Slip Ring



3364326

1. Inspect slip rings (Arrow) for being dirty, rough, or out of round.
2. If necessary, polish the surface of slip rings using No. 500 emery paper or 500-grit silicon carbide paper.



3364327

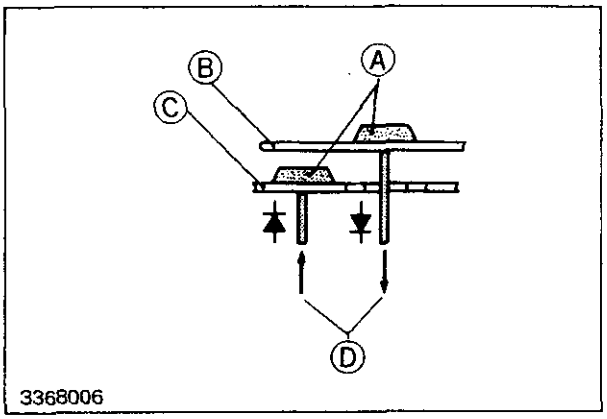
3. Measure O.D. of slip ring. O.D. should be 30 to 31 mm (1.18 to 1.22 in.). Replace if O.D. is less than 31 mm (1.22 in.)

Testing Rectifier

Rectifier assembly consists of two plates (B and C) and six diodes (A). The long lead of diode is for (–) positive, and the short lead is for (+) negative.

The plate (B) installed to long lead diode is (–) negative and the plate (C) installed to short lead diode is (+) positive and for "A" terminal.

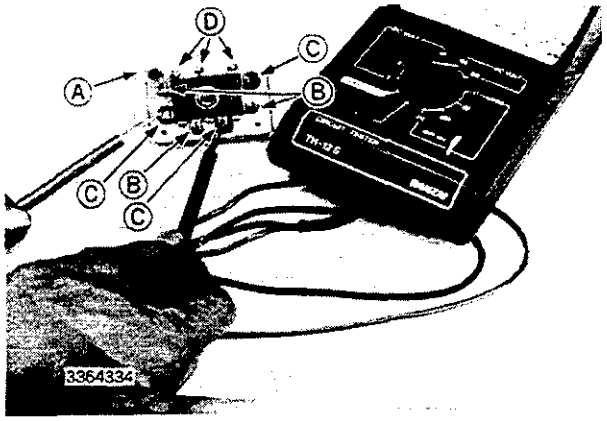
A – Diodes (6 used)
B – (–) Plate
C – (+) Plate, "A" Terminal
D – Direction of Conduction



Continuity Test

The three terminals (D) are connected by a printed circuit in rectifier. Use an ohmmeter to check for continuity between them. There should be no resistance from one to another. If test does not show continuity between terminals (D) rectifier is defective and must be replaced.

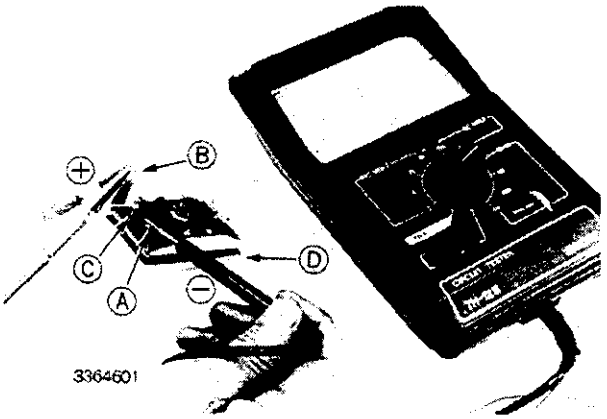
A – "A" Terminal
B – (–) Leads of Diodes
C – (+) Leads of Diodes
D – Terminals Connecting to Stator Coils



Short Lead Diodes "OPEN" Test

With (+) positive ohmmeter probe on (+) positive plate (B, "A" terminal), touch the (–) negative probe to each short lead of three diodes (A). There should be continuity in each touching. If not, the diode is "OPEN". Replace rectifier assembly.

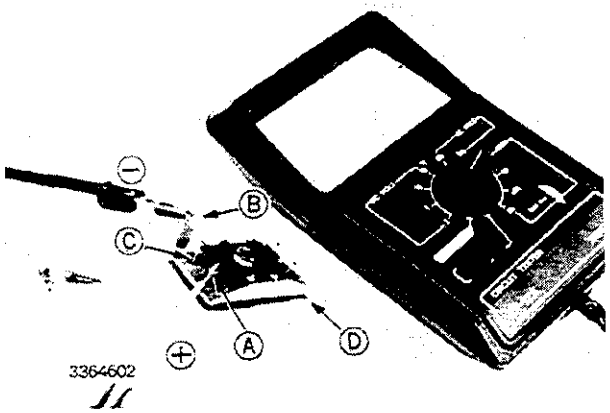
A – Short Leads on (+) Positive Plate
B – (+) Positive Plate
C – Long Leads on (–) Negative Plate
D – (–) Negative Plate

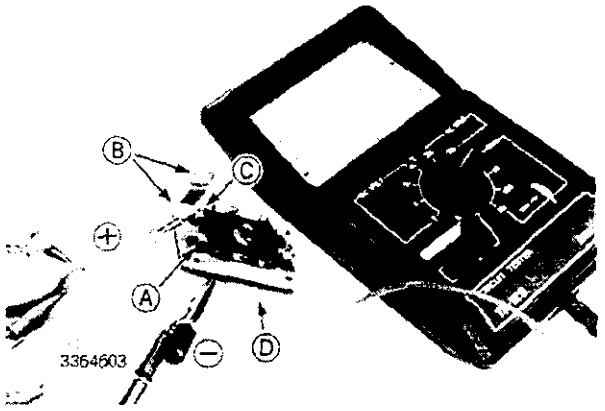


Short Lead Diodes "SHORT" Test

With (–) negative ohmmeter probe on (+) positive plate (B, "A" terminal), touch the (+) positive probe to each short lead of three diodes (A). There should no continuity in each touching. If there is continuity, the diode is "SHORT". Replace rectifier assembly.

A – Short Lead on (+) Positive Plate
B – (+) Positive Plate
C – Long Leads on (–) Negative Plate
D – (–) Negative Plate



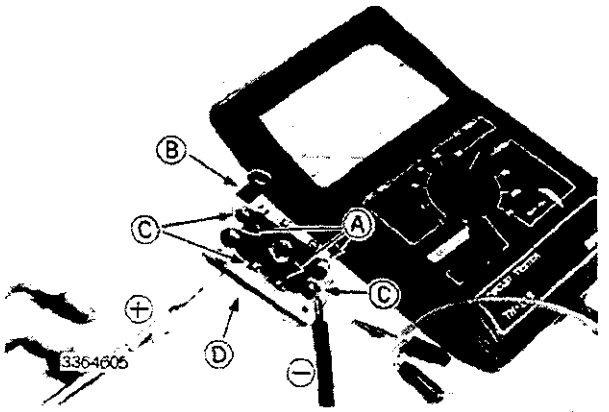


INSPECTION, TESTING AND REPAIR (Continued)

Long Lead Diodes "OPEN" Test

With (–) negative ohmmeter probe on (–) negative plate (D), touch the (+) positive probe to each long lead of three diodes (C). There should be continuity in each touching. If not, the diode is "OPEN". Replace rectifier assembly.

A – Short Leads on (+) Positive Plate
B – (+) Positive Plate
C – Long Leads on (–) Negative Plate
D – (–) Negative Plate



Long Lead Diodes "SHORT" Test

With (+) positive ohmmeter probe on (–) negative plate (D), touch the (–) negative probe to each long lead of three diodes (C). *There should no lead of three diodes* (C). *There should no* continuity in each touching. If there is continuity, the diode is "SHORT". Replace rectifier assembly.

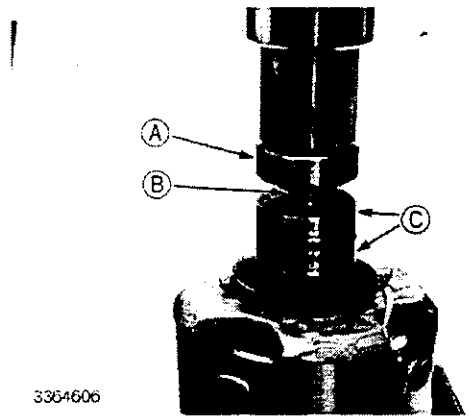
A – Short Lead on (+) Positive Plate
B – (+) Positive Plate
C – Long Leads on (–) Negative Plate
D – (–) Negative Plate

ASSEMBLY

1. Press bearing (A) on to rotor shaft (B) until flush with end of shaft.

   Drive only on inner race of bearing.

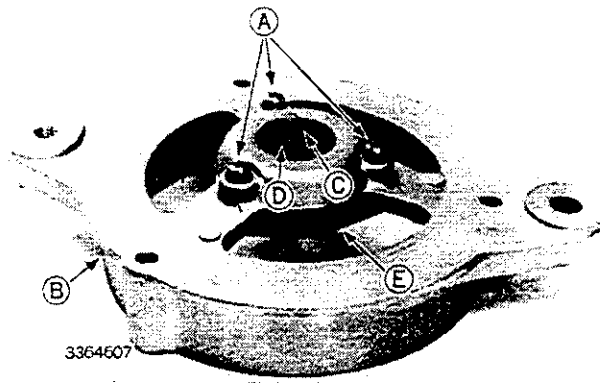
   A – Bearing
   B – Rotor Shaft
   C – Slip Rings



3364606

2. Install packing retainer (C) and bearing (D) into front cover (B).
3. Install bearing retaining plate (E) and tighten cap screws.

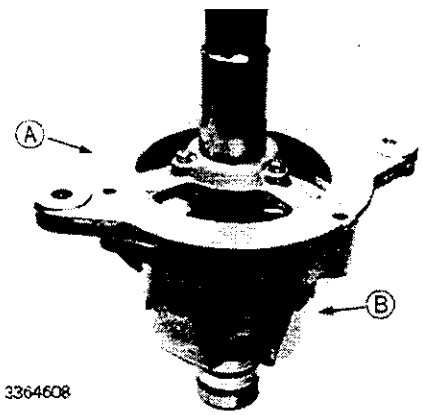
   A – Screw
   B – Front Cover
   C – Packing Retainer
   D – Front Bearing
   E – Bearing Retaining Plate



3364607

4. Install front cover assembly to rotor assembly.

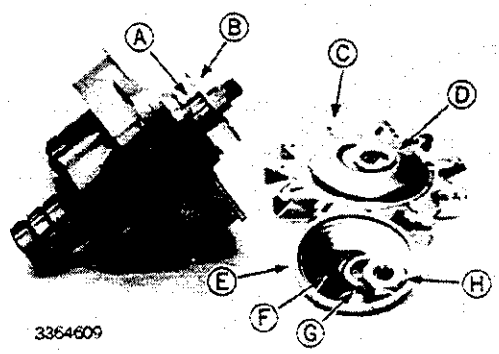
   A – Front Cover
   B – Rotor



3364608

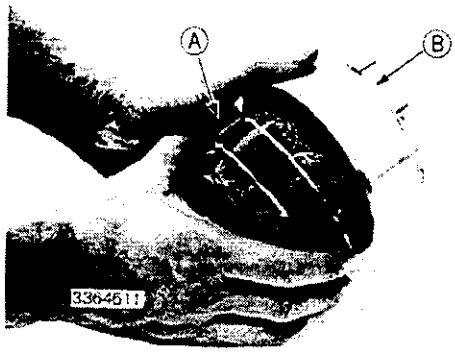
5. Install spacer (A) on rotor shaft and then washer (D), fan (C), washer (D).
   Install pulley half (E) against washer (D) and tighten nut (H) with washers to 25 to 33 Nm (2.5 to 3.5 kgm) (19 to 24 ft-lbs).

   A – Spacer
   B – Washer
   C – Fan
   D – Washer
   E – Pulley Half
   F – Washer
   G – Spring Washer
   H – Nut



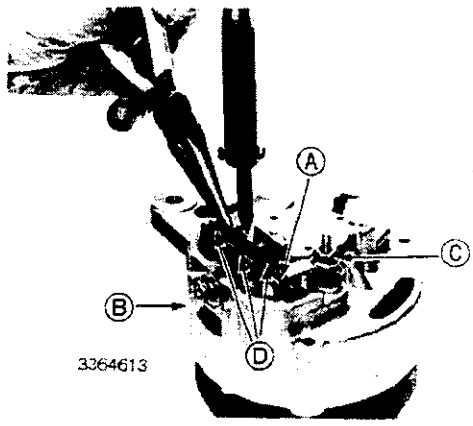
3364609

ASSEMBLY (Continued)



6. Install stator assembly (A) into stator housing (B).

A – Stator Coil Assembly
B – Stator Housing

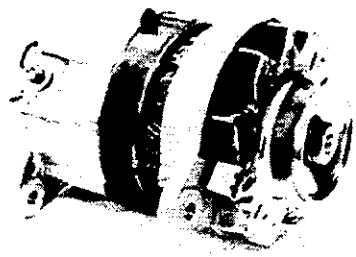


7. Place three terminal leads (D) from stator coil at the rectifier location.

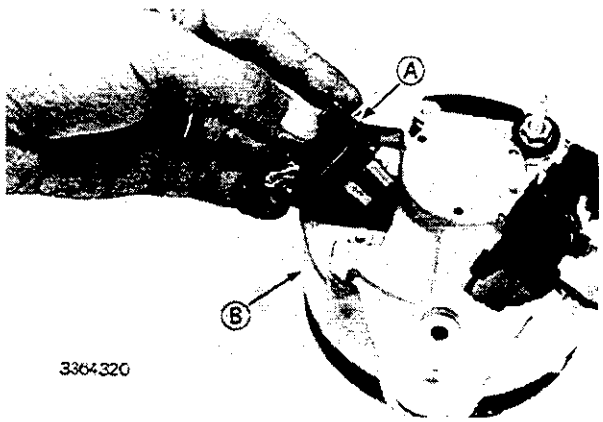
8. Use soldering iron to solder the stator lead wires (D) to rectifier assembly (A).

   If additional solder is needed, use ONLY 60 – 40, rosin core solder.

A – Rectifier Assembly
B – Stator Housing
C – "A" terminal
D – Leads from Stator



9. Install stator assembly to front cover and tighten three thru bolts.



10. Install brush holder (A) to stator housing so that two brushes are placed on slip rings.

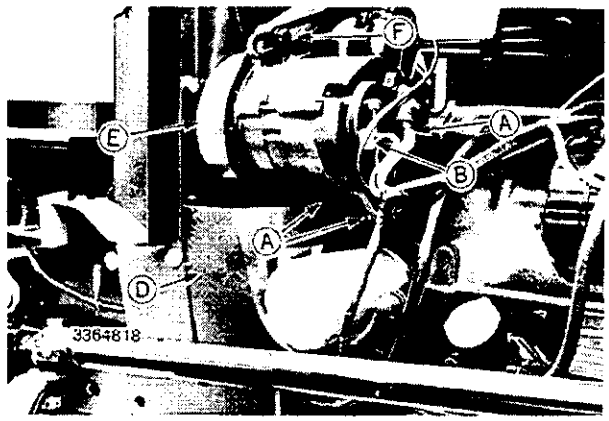
A – Brush Holder
B – Stator Housing

STOP Be sure not to brake brushes when installing.

11. Install rear cover to stator housing.

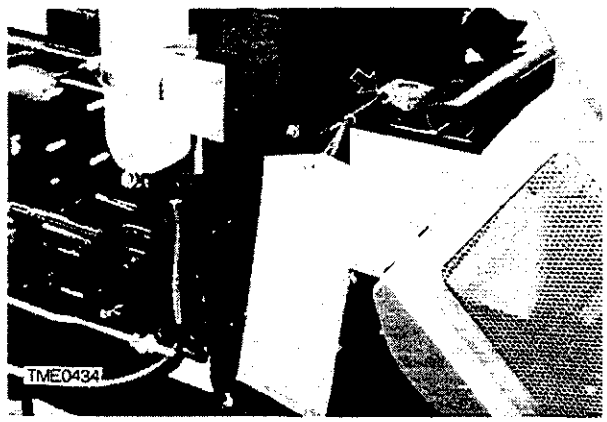
INSTALLATION

1. Position alternator and belt guard (E) and install mounting bolts (A) and adjusting bolt (F). Do not tighten bolts at this time.
2. Attach harness connector (B). Connect terminal wire (C) to "A" terminal and black ground wire to "E" terminal.
3. Install lower shield (D) with three screws.

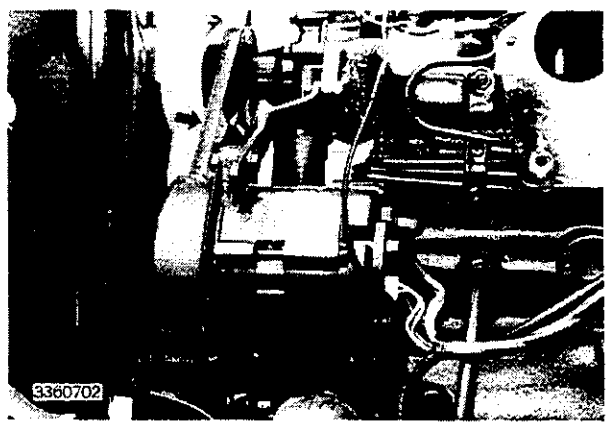


A – Mounting Bolts
B – Harness Connector
C – Terminal Wire
D – Belt Cover
E – Belt Guard
F – Adjusting Bolt

4. Attach battery ground cable to negative (–) terminal on battery.

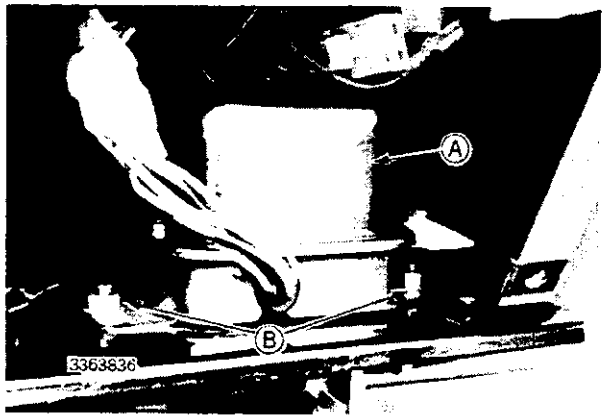


5. Adjust belt to have 10 to 16 mm (3/8 to 5/8 in.) deflection when a 89 N (9 kg) (20 lbs) force is applied midway between alternator and engine pulley (Arrow).



VOLTAGE REGULATOR

Refer to 240, 11 for charging system diagnosis.



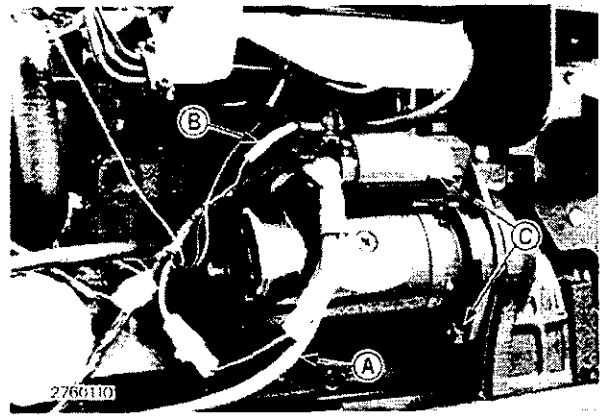
1. Remove voltage regulator by removing two screws. Disconnect wiring harness and lift out voltage regulator.
2. Install new regulator by reversing the above procedure.

A — Voltage Regulator
B — Mounting Screws

STARTING MOTOR

INSPECTION AND REMOVAL

1. Inspect starting motor for external defects before removal. Check for loose mounting bolts and pole shoe retaining screws. Operate motor and listen for rattling, squealing or grinding noises.
2. Disconnect battery ground cable.
3. Disconnect battery cable (A) and switch wiring (B).
4. Remove two nuts (C) and separate starter from engine.



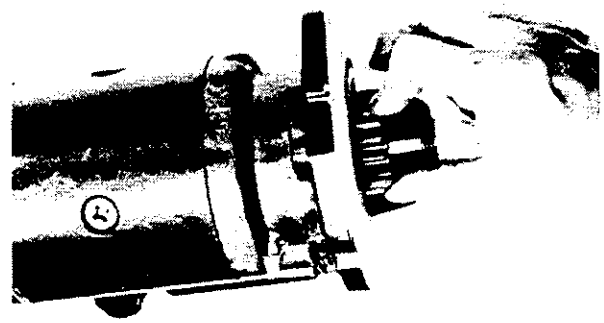
A – Battery Cable
B – Switch Wiring
C – Mounting Nuts

TEST BEFORE DISASSEMBLY

Overrunning Clutch Check

Grasp the pinion and turn. It should turn freely in a clockwise direction but not counterclockwise. If the clutch is defective the entire clutch assembly must be replaced.

Never operate starting motor longer than 20 seconds. Allow at least two minutes for cooling and battery recovery before operating again. Overheating, caused by excessive operation, will seriously damage starting motor.



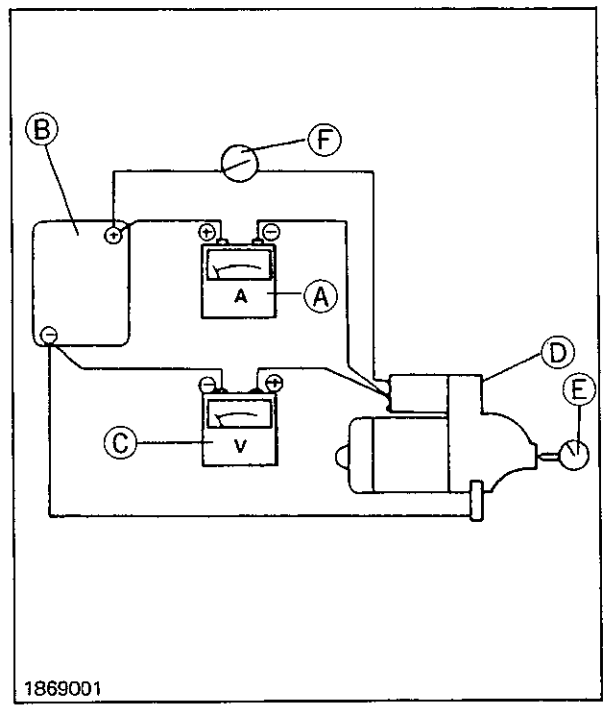
No-Load Test

1. Connect positive (+) terminal of ammeter (A) to the battery positive (+) terminal, and negative (–) terminal of ammeter to the starter "S" terminal.
2. Connect battery ground cable to the starter body (D).
3. Connect positive (+) terminal of voltmeter (C) to the starter "B" terminal, and negative (–) terminal of voltmeter to the starter body or battery ground terminal.
4. Prepare hand tachometer at the starter shaft.
5. Use a screwdriver to jump across from battery "B" terminal to switch "S" terminal. Starter should engage and run.

   If solenoid only chatters, hold-in winding is open-circuited. If nothing happens, either pull-in winding is open-circuited or mechanical parts are sticking. To check for sticking, remove end cover and push plunger by hand.

   If solenoid engages properly but motor does not run, check main contact points, bearings, brushes, reduction gears, armature, and field windings.

   Solenoid cannot be repaired. Just make sure all connections are good and clean the main contact points.
6. Measure current draw and shaft speed, and compare to the following specifications.



A – Ammeter
B – Battery
C – Volt Meter
D – Starter
E – Tachometer
F – Key Switch

TEST BEFORE DISASSEMBLY (Continued)

NO-LOAD TEST SPECIFICATIONS

	Current Draw	Voltage	RPM
YM276/276D	70 amps	12 volts	6000 rpm

If speed and current draw are slightly low, connect a voltmeter between "B" terminal and starter frame. Observe voltage during test. Voltage may be reduced because of high current draw on battery.

If speed or current draw is significantly different than specified, diagnose problem as follows.

Fails to operate, no current draw
- Open field circuit (All field windings)
- Open armature windings
- Defective brush contact with commutator
- Open solenoid windings
- Defective solenoid contacts

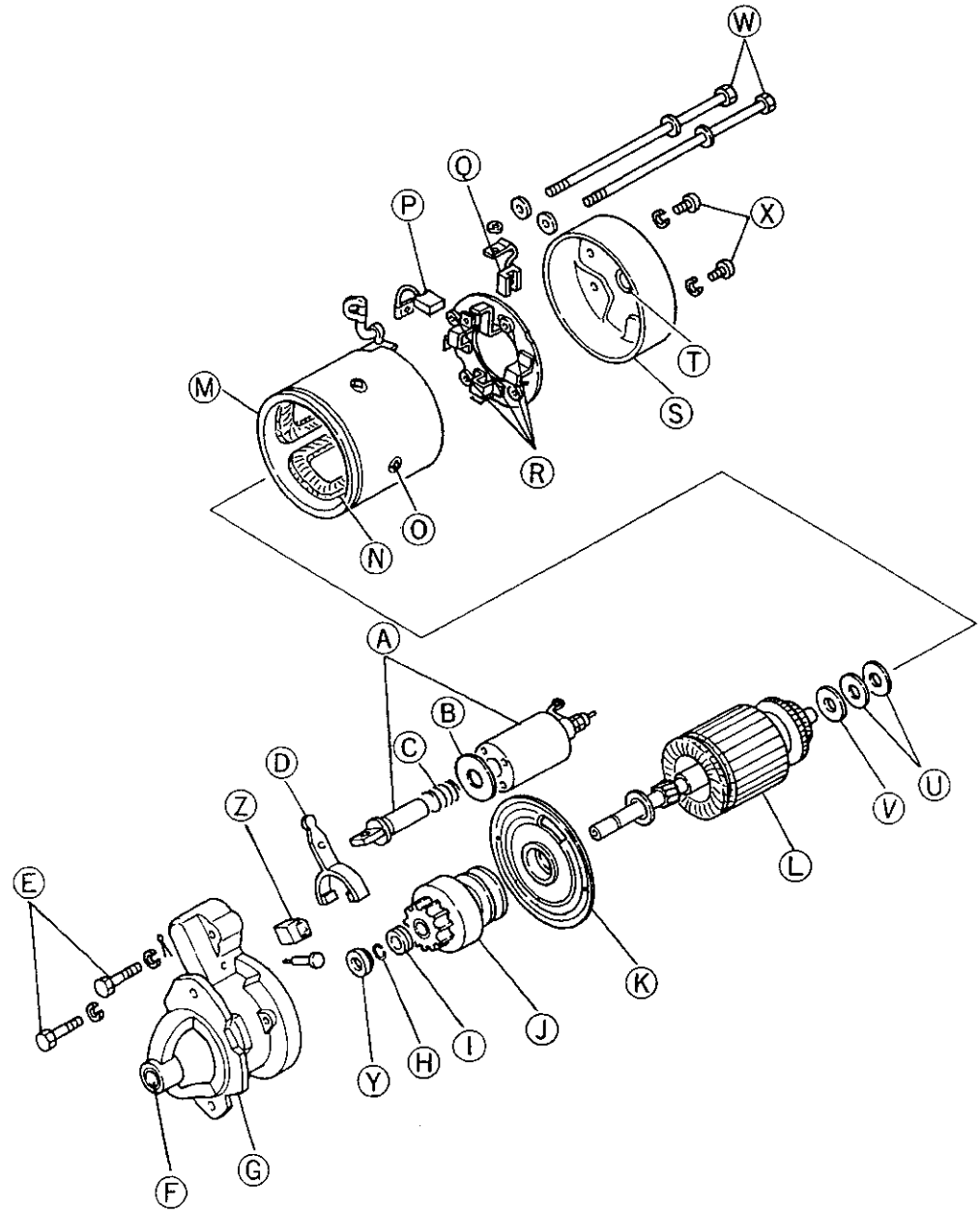
Fails to operate, high current draw
- Grounded field windings or armature windings
- Seized bearings

Low speed, low current draw
- High internal resistance
- Defective brush contact with commutator

Low speed, high current draw
- Excessive friction
- Shorted armature
- Grounded armature or field windings

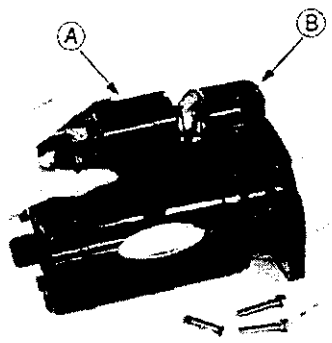
High speed, high current draw
- Shorted field windings

DISASSEMBLY



2766007

A – Solenoid Switch
B – Dust Cover
C – Spring
D – Shift Lever
E – Cap Screw (2 used)
F – Bushing
G – Front Cover
H – Snap Ring
I – Stop Ring
J – Drive Pinion
K – Center Plate
L – Armature
M – Starter Frame
N – Field Coil (Pole Shoe)
O – Pole Schoe Retaining Screw (4 used)
P – Brush (+) (2 used)
Q – Brush (–) (2 used)
R – Brush Spring (4 used)
S – Rear Cover
T – Bushing
U – Thrust Washer (0.2 mm)
V – Thrust Washer (1.0 mm)
W – Thru Bolt (2 used)
X – Screw (2 used)
Y – Stopper Washer
Z – Rubber Washer

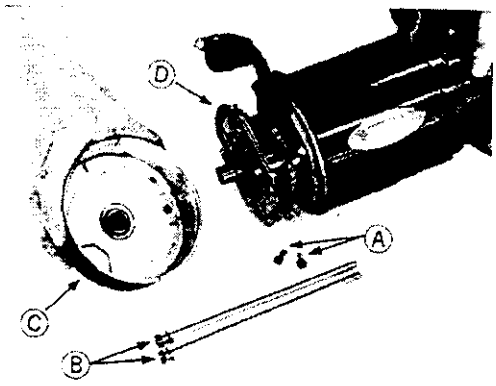


3300121

DISASSEMBLY (Continued)

1. Remove solenoid assembly (A) from front cover (B).

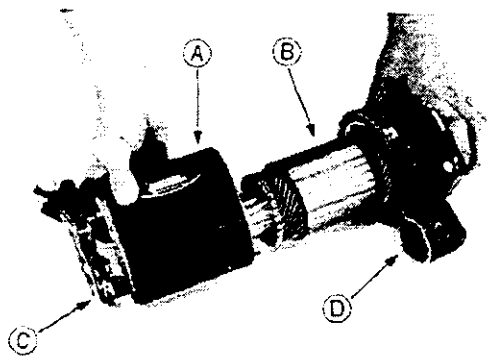
A — Solenoid
B — Front cover



3300122

2. Remove two brush holder retaining cap screws (A) and two thru bolts (B) from rear cover.

A — Cap Screw (2 used)
B — Thru Bolt (2 used)
C — Rear Cover
D — Brush Holder



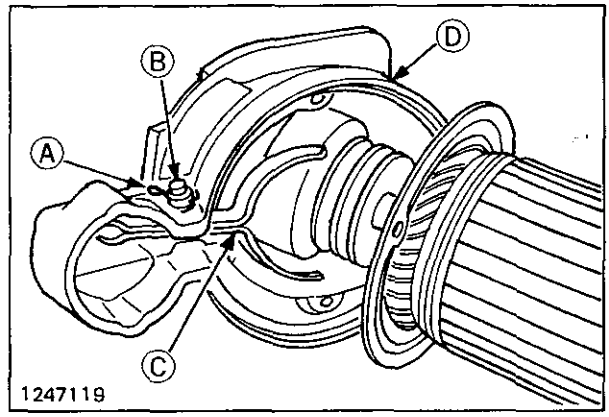
3300125

3 Remove field coil assembly (A) with brush holder (C).

A — Field Coil Assembly
B — Armature
C — Brush Holder
D — Front Cover

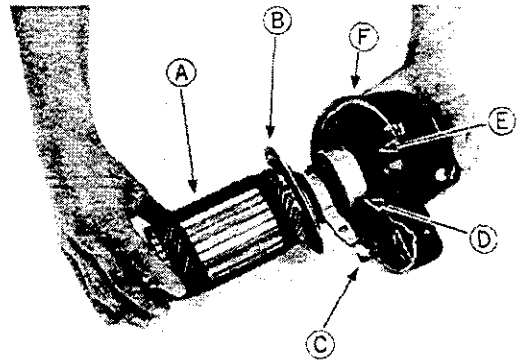
4. Remove pivot pin (B) from front cover (D).

A – Cotter Pin
B – Pivot Pin
C – Shift Lever
D – Front Cover



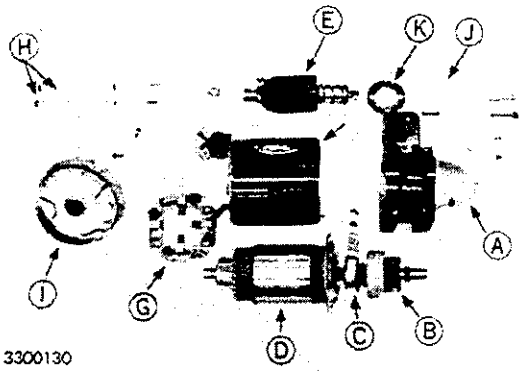
5. Removing armature (A) with pinion (E) from front cover (F).

A – Armature
B – Plate
C – Shift Lever
D – Overturning Clutch
E – Pinion Gear
F – Front Cover



6. Set all disassembled parts on a clean table.

A – Front Cover
B – Pinion Gear
C – Shift Lever
D – Armature
E – Solenoid Assembly
F – Field Coil Assembly
G – Brushes
H – Thru Bolts
I – Rear Cover
J – Washers
K – Rubber Washer
L – Snap Ring

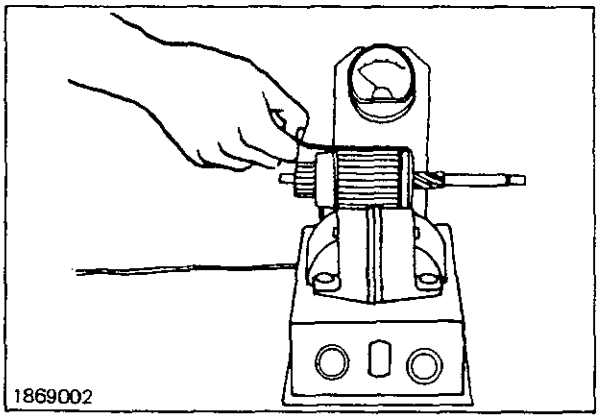


INSPECTION AND REPAIR

Armature

Do not clean armature with solvent. Solvent could damage insulation on windings. Use only mineral spirits and a brush.

Short Circuited Windings
Symptoms — Starting motor cranks engine too slowly. On no-load test, motor has low armature speed and high current draw.

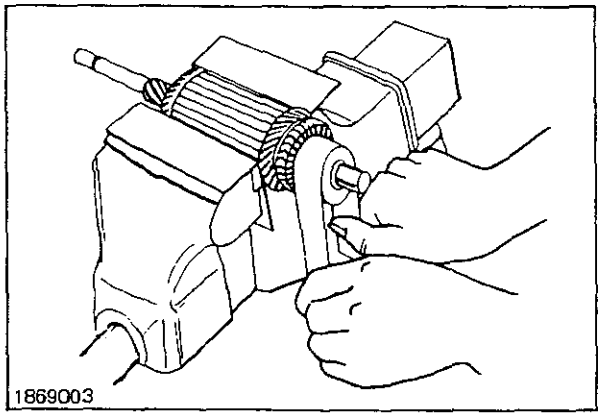


Use a growler to test armature for shorts. Follow the manufacturer's instructions. Replace armature if shorted.

Grounded Windings
Symptoms — Starting motor cranks engine too slowly or not at all. On no-load test, motor has low armature speed and high current or fails to operate and has high current draw.

Use an ohmmeter or test lamp to test for continuity between commutator bars and armature shaft. If test shows continuity, a winding is grounded. If fault cannot be corrected, replace armature.

All armature windings are connected in series, so you don't need to check more than one commutator bar.

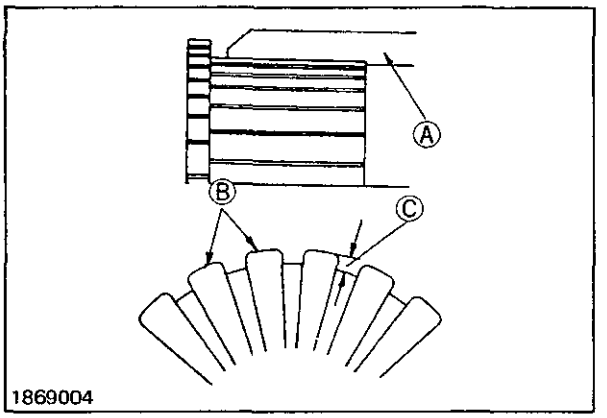


Commutator

1. Carefully check commutator. Look for roughness, burned commutator bars, or any material which might cause short circuits between bars.
2. If commutator is out of round, badly burned, or rough, it can be turned down slightly on a lathe. Remove only enough metal to eliminate problem.

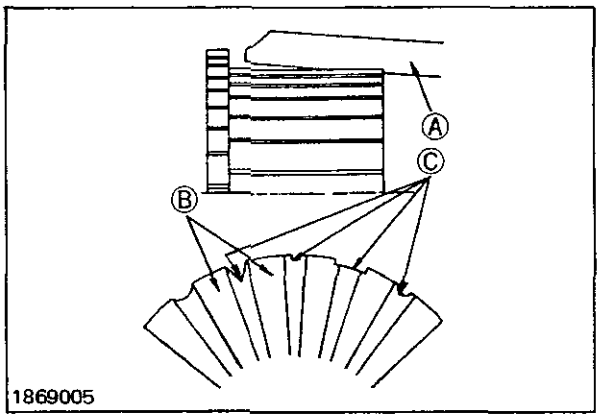
3. Inspect commutator depth. If the commutator is badly worn, make a light cut on the lathe with a sharp tool. After this, it should be polished with 400 emery paper.

A – Hacksaw Blade
B – Commutator Segment
C – Correct Depth of Undercut



4. Undercut insulation between commutator bars to 0.5 to 0.8 mm (0.0019 to 0.031 inch). Touch up commutator with 400 sandpaper after using lathe. Clean dust and metal chips from armature when finished.

If no-load test indicates possibility of grounding, short circuited, or open circuited windings, check armature for these defects. Windings are large, and defect might be easy to spot.



Do not cut as shown by (C).

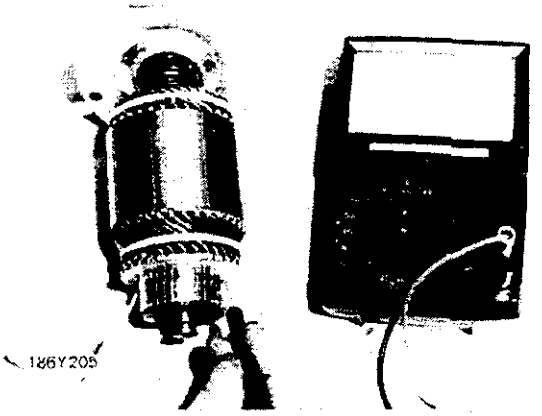
A – Hacksaw Blade
B – Commutator
C – Incorrect Cuttings

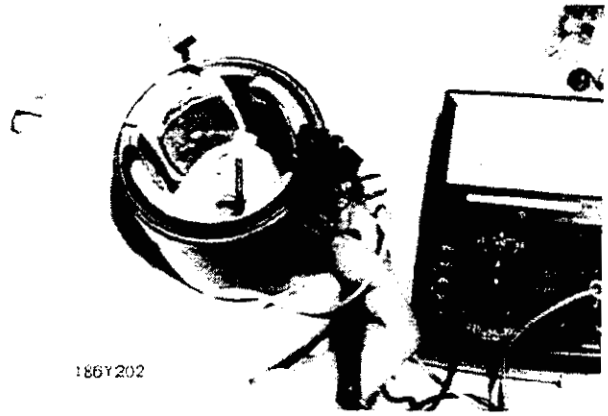
Opening-Circuited Windings

Symptoms — Starting motor cranks engine too slowly. On no-load test, motor has low armature speed and high current draw.

Use an ohmmeter or test light to test armature for an open circuit. Touch the probes to two commutator segments. There should be continuity. Replace armature if open-circuited.

Open circuits are usually due to overheating caused by excessive cranking. Check connections of windings to commutator bars. Also look for burned edges on commutator bars.




1867202

INSPECTION AND REPAIR (Continued)

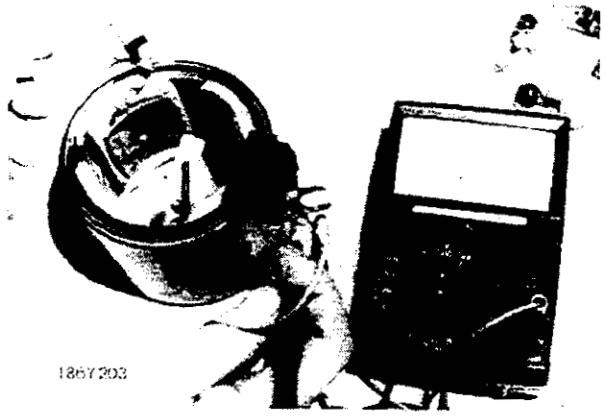
Field Coil

Grounded Field

Use an ohmmeter or test light to test for a grounded field winding.

Touch one lead to a field coil brush and the other lead to the field housing. Be sure the brush pigtail is not touching the housing. There should be no continuity.

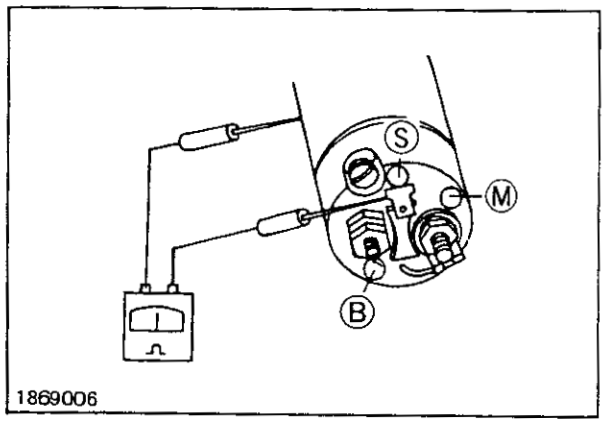
If there is continuity, the coil is grounded, and field coli assembly must be replaced.


1867203

Open Field

Using an ohmmeter or test light, touch one lead to each field coil brush. There should be continuity.

If there is no continuity, the field coil is open, and field coil assembly must be replaced.

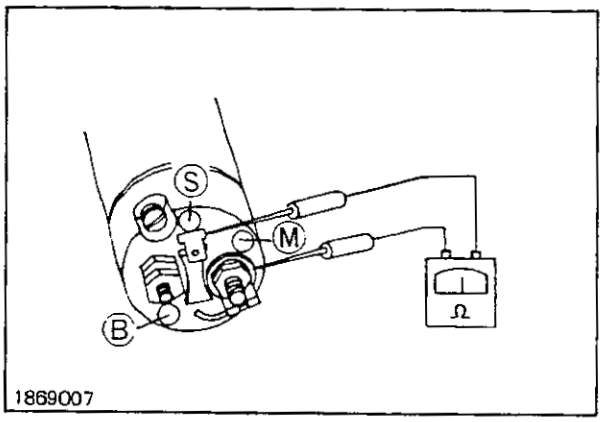


1869006

Solenoid Switch

Continuity Test of Shunt Coil

Place one test probe on the terminal S of the magnetic switch and the other on the metal section of the magnetic case. Check the hold-on windings (shunt coils) for continuity.



1869007

Continuity Test of Series Coil

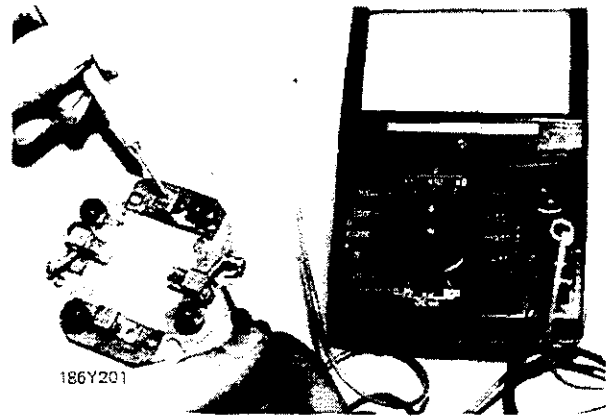
Place one test probe on the terminal S and the other on the terminal M. Check the operating windings (series coils) for continuity. No reading indicates that this coil opens.

Brushes

1. Measure brush length. Replace brushes if worn to less than 12 mm (0.472 in.).

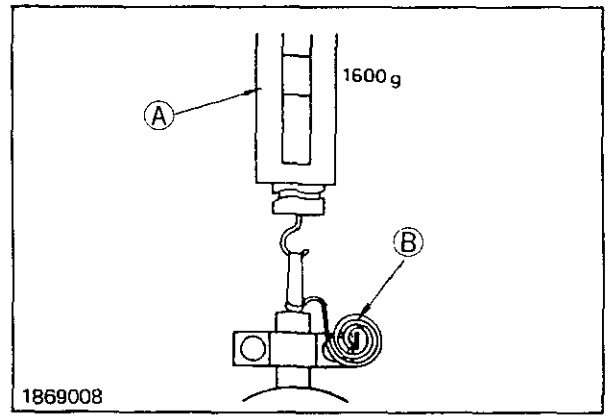
   If the negative side brushes mounted on the brush holder are worn, replace the entire brush holder. If the field coil brushes are worn, the entire field coil assembly must be replaced.

2. Using an ohmmeter or test light, check brush holder insulation. Touch one lead of the tester to the negative brush holder and the other lead to the field brush holder. There should be no continuity. Replace brush holder if defective.



3. Check brush spring tension with a spring scale. Tension should be about 1600 grams (56 ounces).

   Replace spring if tension is less than 1400 grams (49 ounces), or if spring is distorted.



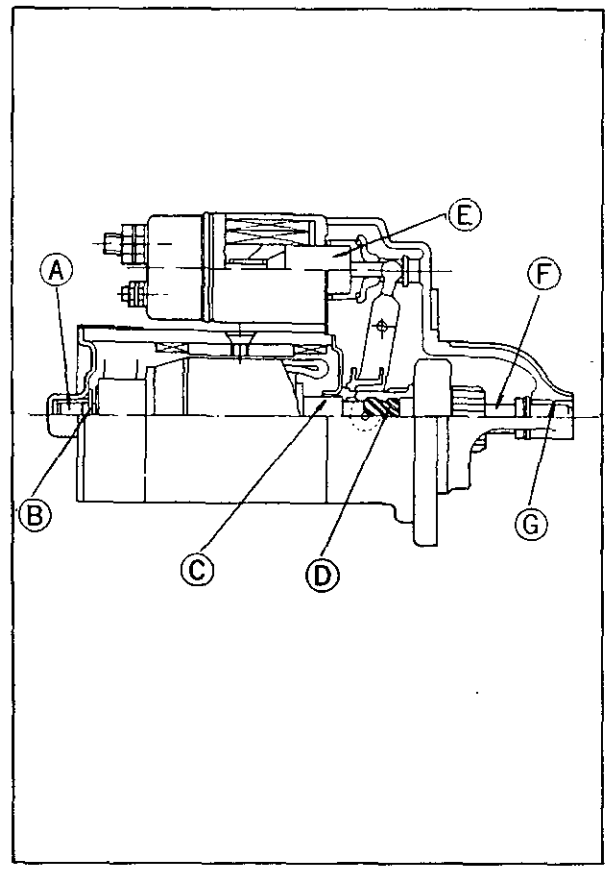
A – Spring Scale
B – Brush Spring

ASSEMBLY

1. Ensure that the parts indicated are lubricated with "Shell Alvania Grease No. 2", or the equivalent high melting point grease.

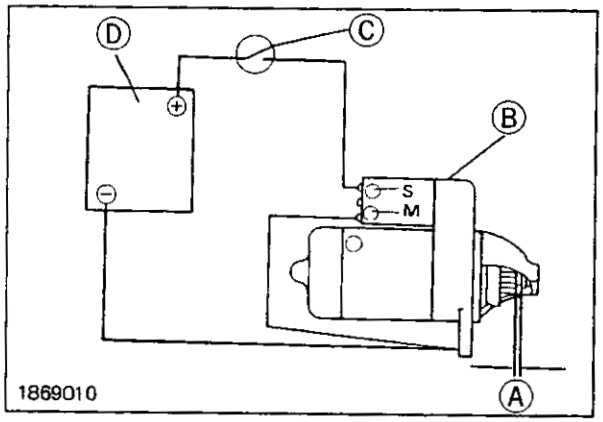
   *If specified grease is not available, substitute Esso Beacon 325 or Delco-Remy Lubricant No. 1960954.

2. Assemble starting motor in reverse order of disassembly. Refer to Figure for parts placement.



Be sure to insert the thrust washer between the rear cover and the armature. If the end play is more than 0.3 mm, more shims should be added.

A – Rear Cover Bushing
B – Thrust Washer
C – Center Plage
D – Helical Spline
E – Solenoid Plunger
F – Pinion Shaft
G – Front Cover Bushing

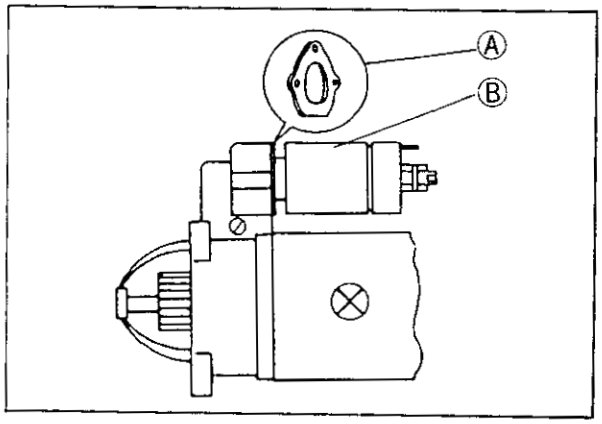


ADJUSTMENT AND PERFORMANCE TEST

Setting Pinion Clearance

1. After complete assembly of the starter motor, connect starter to battery as shown in the figure.
2. When the pinion is in the engaged position, measure the distance (A) between the pinion and the stopper. This check should be made with the pinion pressed back slightly to take up any play in the engagement linkage. The distance (A) should be 0.3 – 1.5 mm (0.012 to 0.059 in.).

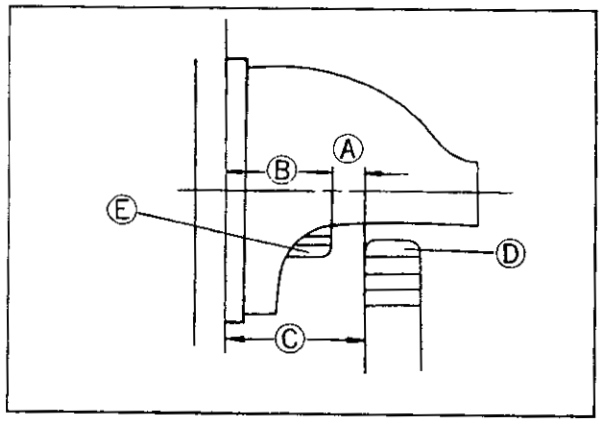
A – Pinion Clearance
B – Starter
C – Switch
D – Battery



Adjusting Pinion Clearance (Clearance)

3. If the gap between the pinion and pinion stopper cannot meet the specifications, insert shims (A) as shown in Fig. 0.4 and 0.8 mm (0.016 and 0.031 in.) thickness are available.

A – Adjusting Shim
B – Solenoid Assembly

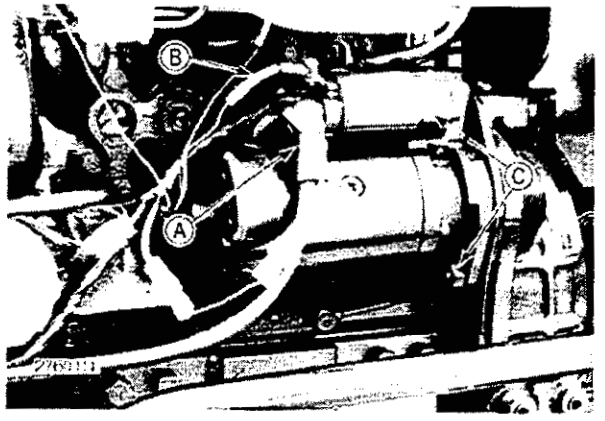


Adjusting Mesh Clearance

Mesh clearance (A) is the distance between flywheel ring gear and starter pinion in the rest position. This clearance should be between 3 mm to 5 mm.

Adjust with thicker packing under starter mounting if the measurement cannot meet specifications.

A – Mesh Clearance
B – Pinion Height
C – Ring Gear Height
D – Ring Gear
E – Pinion



INSTALLATION

1. Install starter using two nuts (C). Tighten securely.
2. Connect switch wiring (B) and battery cable (A).
3. Connect negative (–) battery cable to battery.

A – Battery Cable
B – Switch Wiring
C – Mounting Nuts

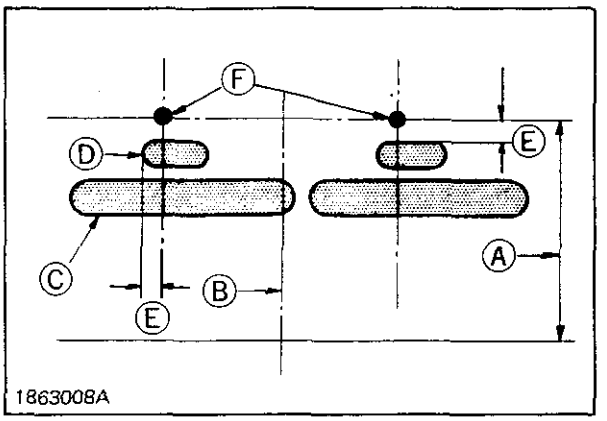
ADJUSTING HEADLIGHTS

Adjust headlights so they shine slightly down and to the right.

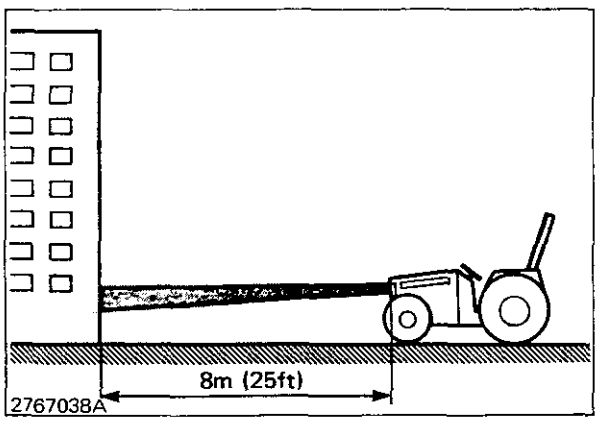
Use illustration as a guide for adjustment. Have lights on low beam. Sight across hood ornament and steering wheel to locate tractor centerline.

Adjusting screws are located behind bulbs. Open hood for access.

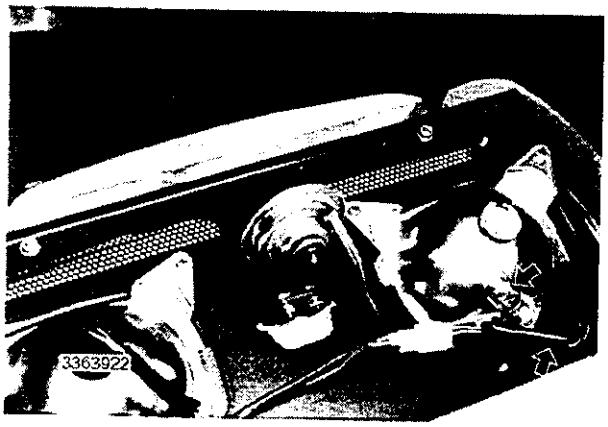
A – Height of Lamp
B – Centerline of Tractor
C – Lower Light Zone
D – Upper Light Zone
E – 130 mm (5 in.)
F – Points Directly in front of Lights



1. Park tractor on level ground, 8 m (25 feet) from a wall.
2. Measure height of lamps above ground, and place a strip of masking tape on wall at same height.
3. Slight across steering wheel and hood ornament to locate tractor centerline. Mark this spot, and measure out 130 mm (5 in.) in each direction. This locates a spot directly in front of each lamp.
4. Turn light switch to the second pulled position, which switches head lamps to low beam.
5. Locate small zone of bright light projected by each lamp. Top of bright zone should be 130 mm (5 in.) lower than lamp, and left edge of zone should be 130 mm (5 in.) to left of lamp. Cover other lamp if necessary.
6. Adjust lamp assemblies if necessary. Adjusting screws are behind bulbs. Open hood for access.



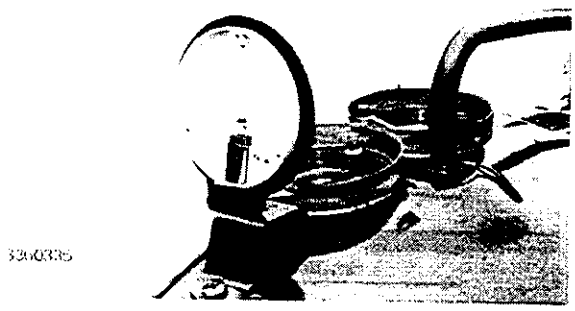
BULB REPLACEMENT



HEADLIGHTS

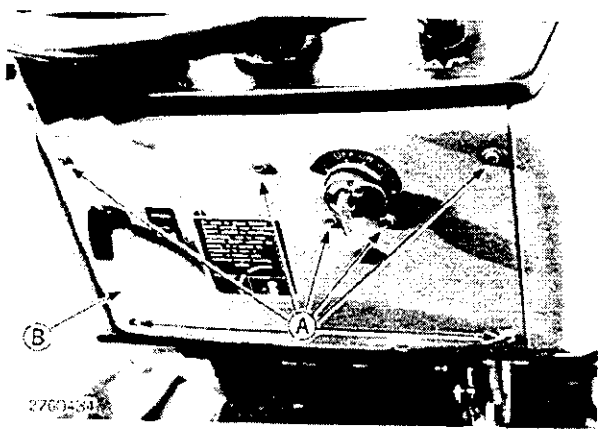
1. Remove bulb base by pressing down slightly and turning counterclockwise. Lift out bulb.
2. Insert new bulb. Press bulb base down slightly and turn clockwise.

TURN SIGNAL & FLASHING WARNING LAMPS



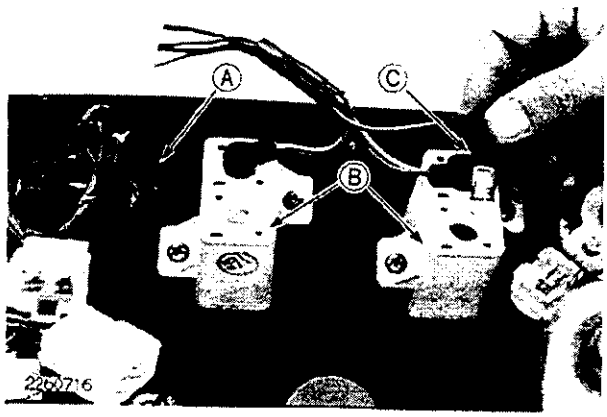
1. Remove lens by removing three screws.
2. Remove bulb by pressing down slightly and turning counterclockwise.
3. Press new bulb in, turning clockwise. Replace lens.

INDICATOR CLUSTER LAMPS



1. Remove access panel by removing seven screws (A).

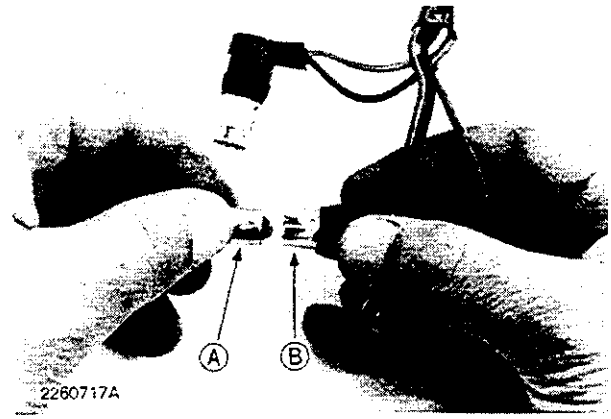
A – Screws
B – Access Panel



2. Turn 1/4 counterclockwise to remove holder with bulb (C) from lamp cluster (B).

A – Instrument Panel
B – Lamp Cluster
C – Lamp Holder

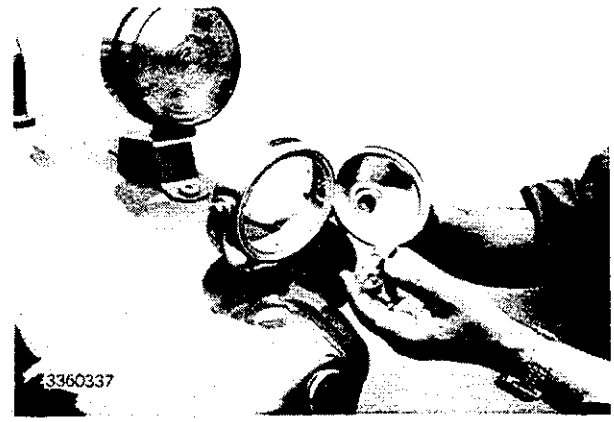
3. Remove bulb by pressing down and turning counterclockwise.
4. Press new bulb in, turning clockwise.
5. Insert lamp holder and turn clockwise to lock the holder on cluster.
6. Be sure bulbs are under correct lenses. "OIL" and "CHG" lamps should glow with key switch "ON". "TEMP" lamps should glow with key switch at "START" position.
7. Install access panel with five screws.



A – Bulb
B – Bulb Holder

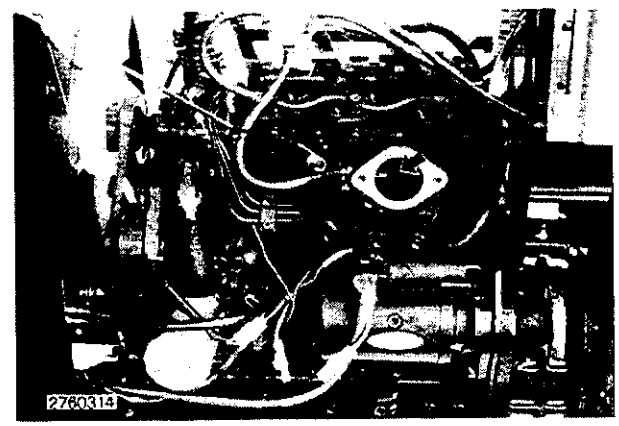
WORK LIGHT

1. Remove lens by removing two screws.
2. Press new bulb by pressing down and turning counterclockwise.
3. Press new bulb in, turning clockwise and reinstall lens.



THERMOSTART PLUG

⚠ **CAUTION: When testing thermostart plug, wear safety glasses and do not get too close to the burning fuel.**



1. Remove air cleaner-to-manifold pipe.
2. Holding key switch in thermostart position, look into manifold. After about five seconds, the inner coil in the thermostart plug should glow bright red. After about ten seconds, burning fuel should drip from the plug.
3. If the plug is not working, check wiring between plug and key switch for continuity and loose connections.

   For additional tests of the thermostart plug, refer to Chapter 30, Section 20.

POWER TRAIN REPAIR 50

SME2760(1)-8304
Kinomoto, Printed in Japan

SPECIFICATIONS

Engine Clutch and Linkage

SPRING	FREE LENGTH	WORKING LOAD
Clutch Release	107 mm. (4.21 in.)	135 mm at 176N (5.3 mm at 39.7)

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Clutch Release York I.D.	20.01 – 20.07 mm (0.788 – 0.790 in.)	
Release Shaft O.D.	19.95 – 20.00 mm (0.785 – 0.787 in.)	
Yoke-to-Release Shaft Clearance	0.01 – 0.12 mm (0.004 – 0.005 in.)	0.5 mm (0.02 in.)
Pedal Bushings I.D.	25.12 – 25.14 mm (0.989 – 0.990 in.)	
Pedal Shaft O.D.	24.95 – 25.00 mm (0.982 – 0.984 in.)	
Pedal I.D.	25.07 – 25.12 mm (0.987 – 0.989 in.)	
Pedal Bushing-to-Shaft Clearance	0.12 – 0.19 mm (0.005 – 0.008 in.)	1 mm (0.04 in.)
Pedal-to-Shaft Clearance	0.07 – 0.17 mm (0.003 – 0.007 in.)	1 mm (0.04 in.)
Release Bearing I.D.	39.99 – 40.00 mm (1.574 – 1.575 in.)	
Release Sleeve Bushing O.D.	40.00 – 40.02 mm (1.575 – 1.576 in.)	
Release Sleeve Bushings I.D.	22.40 – 22.42 mm (0.882 – 0.883 in.)	
Main Drive Shaft O.D. (at Release Bearing)	21.92 – 22.00 (0.863 – 0.886 in.)	21.5 mm (0.846 in.)
Sleeve Bushings-to-Shaft Clearance	0.4 – 0.5 mm (0.016 – 0.020 in.)	0.5 mm (0.020 in.)
Main Drive Shaft Pilot O.D.	19.49 – 14.96 mm (0.588 – 0.589 in.)	
Pilot Bushing I.D.	15.00 – 15.03 mm (0.591 – 0.592 in.)	
Pilot Bushing-to-Shaft Clearance.	0.04 – 0.09 mm (0.00157 – 0.00354 in.)	0.3 mm
Clutch Disk Thickness	8.3 – 8.9 mm (0.3268 – 0.3504 in.)	6.6 mm (0.2598 in.)
Disk Facing Thickness	3.4 – 3.6 mm (0.1339 – 0.1417 in.)	

SPECIFICATIONS

Engine Clutch and Linkage (Continued)

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Disk Rivet Head Depth	1.2 mm (0.047 in.)	0.3 mm (0.012 in.)
Facing Warpage	----	0.4 mm (0.016 in.)
Pressure Plate Warpage	0.07 mm (0.0028 in.)	0.2 mm (0.0079 in.)
Flywheel Warpage	0.07 mm (0.0028 in.)	0.2 mm (0.0079 in.)
Clutch Disk Play		
Axial	----	0.7 mm (0.03 in.)
Radial	----	1 mm (0.04 in.)
Clutch Disk Spline Backlash	0.05 – 0.15 mm (0.002 – 0.006 in.)	0.3 mm (0.012 in.)
Diaphragm Spring Finger Height (with new disk)	30 – 32 mm (1.18 – 1.26 in.)	27 mm (1.06 in.)
Clutch Pedal Free Play	15 – 25 mm (0.59 – 0.98 in.)	
Clutch Pedal Stroke	110 mm (4.33 in.)	

CAP SCREW		TORQUE SPECIFICATION
Clutch Cover-to-Flywheel		30 Nm (3 kgm) (22 ft-lbs.)
Clutch Housing-to-Engine		98 Nm (10 kgm) (72 ft-lbs.)
Clutch Housing-to-Transmission Case	M12	137 Nm (14 kgm) (101 ft-lbs.)
	M14	196 Nm (20 kgm) (145 ft-lbs.)

Power Shift Transmission

SPRING	FREE LENGTH		WORKING LOAD
Detent (Range Shift Fork)	New Part	22.2 mm (0.874 in.)	15.7 mm at 118.8 N (12.12 kg) (0.618 in. at 26.72 lbs.)
	Wear Limit	21.83 mm (0.839 in.)	
Detent (Power Shift Fork)	New Part	13.6 mm (0.535 in.)	9.3 mm at 62.2 N (6.35 kg) (0.366 in. at 14.0 lbs.)
	Wear Limit	13.0 mm (0.512 in.)	
Power Shift Clutch Piston Return Spring	New Part	42.0 mm (1.65 in.)	19.6 mm at 654 N (66.7 kg) (0.77 in. at 147 lbs.)
	Wear Limit	44.0 mm (1.73 in.)	
Clutch Disk Separator	New Part	3.8 mm (0.15 in.)	2.6 mm at 10.2 N (1.04 kg) (0.102 in. at 2.29 lbs.)
	Wear Limit	3.6 mm (0.142 in.)	
DRV/Relief Valve Outer	New Part	64.5 – 65.5 mm (2.54 – 2.57 in.)	41.5 mm at 276 N (27.1 kg) (1.63 in. at 59.8 lbs.)
	Wear Limit	63 mm (2.46 in.)	
Inner	New Part	54 – 55 mm (2.13 – 2.16 in.)	38.5 mm at 142 N (14.5 kg) (1.52 in. at 32 lbs.)
	Wear Limit	52 mm (2.05 in.)	
2nd Relief Valve	New Part	16.3 mm (0.642 in.)	9.7 mm at 3.53 N (0.36 kg) (0.382 in. at 0.794 lbs.)
	Wear Limit	14.7 mm (0.60 in.)	
Inertia Brake Piston Spring	New Part	34 mm (1.34 in.)	26.4 mm at 0.96 KN (97.4 kg) (1.039 in. at 215 lbs.)

SPECIFICATIONS

Power Shift Transmission (Continued)

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Transmission Oil Capacity YM276	17.5 ℓ (4.6 US Gal)	
YM276D	18.0 ℓ (4.8 US Gal)	
Main Shaft		
O.D. at Front Bearing	19.9935 – 20.0065 mm (0.7871 – 0.7877 in.)	
O.D. at Center Bearings	30.002 – 30.015 mm (1.1812 – 1.1817 in.)	
O.D. at One-way Clutch	27.767 – 27.770 mm (1.0932 – 1.0933 in.)	
O.D. at Needle Bearing	21.991 – 22.000 mm (0.8658 – 0.8661 in.)	
O.D. at Rear Bearing	20.002 – 20.015 mm (0.7875 – 0.7880 in.)	
Axial Play	0.11 – 0.53 mm (0.00433 – 0.0224 in.)	0.8 mm (0.031 in.)
Clutch Shaft		
Clutch Shaft O.D. at Oil Manifold	29.925 – 29.95 mm (1.178 – 1.179 in.)	
Clutch Shaft O.D. at Cylinder	34.984 – 34.994 mm (1.377 – 1.378 in.)	
Clutch Shaft I.D. at Needle Bearing	24.007 – 24.020 mm (0.945 – 0.946 in.)	
Axial Play	0.23 – 0.61 mm (0.00906 – 0.0240 in.)	0.8 mm (0.031 in.)
Counter Gear I.D.		
at Front Bearing	62.000 – 62.030 mm (2.4409 – 2.4421 in.)	
at One-way Clutch	44.412 – 44.438 mm (1.7485 – 1.7495 in.)	
at Needle Bearing	26.007 – 26.020 mm (1.0239 – 1.0244 in.)	
Creep Gear I.D.		
at Needle Bearing	26.007 – 26.020 mm (1.0239 – 1.0244 in.)	
at Bearing	44.000 – 44.025 mm (1.7323 – 1.7333 in.)	
Reverse Idler Shaft		
O.D. at Needle Bearing	21.982 – 22.000 mm (0.8654 – 0.8661 in.)	
O.D. at Center Plate	17.982 – 18.000 mm (0.7080 – 0.7087 in.)	
Differential Drive Shaft		
O.D. at Rear Bearings	40.002 – 40.018 mm (1.5749 – 1.5755 in.)	
O.D. at Needle Bearing	17.994 – 17.983 mm (0.7084 – 0.7080 in.)	
Axial Play	0.11 – 0.57 mm (0.00433 – 0.0224 in.)	0.8 mm (0.031 in.)

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Creep Gear Shaft		
O.D. at Front Bearing	16.994 – 17.006 mm (0.6691 – 0.6695 in.)	
O.D. at Rear Bearing	16.994 – 17.006 mm (0.6691 – 0.6695 in.)	
Power Shift Pump		
Inner Gear (Drive Gear) O.D.	42.950 – 42.975 mm (1.691 – 1.692 in.)	
Inner Gear Counter Bore at Separator	43.040 – 43.060 mm (1.694 – 1.695 in.)	
Clearance between Inner Gear and Separator	0.065 – 0.110 mm (0.0026 – 0.0043 in.)	
Outer Ring Gear I.D.	50.600 – 50.630 mm (1.992 – 1.993 in.)	
Outer Ring Gear Counter Bore at Separator	50.510 – 50.540 mm (1.989 – 1.990 in.)	
Clearance between Outer Ring Gear and Separator	0.06 – 0.12 mm (0.0024 – 0.0047 in.)	
Outer Ring Gear O.D.	65.94 – 65.97 mm (2.596 – 2.597 in.)	
Outer Ring Gear Bore of Pump Case	66.00 – 66.03 mm (2.598 – 2.600 in.)	
Clearance between Outer Ring Gear and Pump Case	0.003 – 0.09 mm (0.0012 – 0.0035 in.)	
Width of Inner Gear	11.995 – 12.005 mm (0.4722 – 0.4726 in.)	
Width of Outer Gear	11.995 – 12.005 mm (0.4722 – 0.4726 in.)	
Depth of Pump Case	Gear Width +0.05 mm (Gear Width +0.002 in.)	
Power Shift Pump Output at Oil Temperature 70°C (158°F) and Engine 2600 rpm	12.48 ℓ/min (3.28 GPM)	9.36 ℓ/min (2.46 GPM)
Power Shift Pump Shaft		
O.D. at Bearings	19.955 – 20.005 mm (0.7872 – 0.7876 in.)	
O.D. at Oil Seal Collar	19.955 – 20.005 mm (0.7872 – 0.7876 in.)	
Power Shift Pump Cover		
I.D. at Bearing and Oil Seal	42.00 – 42.025 (1.6535 – 1.6545 in.)	

SPECIFICATIONS

Power Shift Transmission (Continued)

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Oil Manifold		
Clutch Shaft Bore I.D.	30.15 – 30.20 mm (1.187 – 1.189 in.)	
Inertia Brake		
Inertia Brake Disk Thickness	3.9 – 4.1 mm (0.154 – 0.161 in.)	3.5 mm (0.138 in.)
Inertia Brake Release Shaft O.D.	14.948 – 14.984 mm (0.589 – 0.590 in.)	
Release Shaft Bushing I.D.	15.000 – 15.027 mm (0.591 – 0.592 in.)	
Center Plate		
Flatness		0.2 mm (0.008 in.)
I.D. at Main Shaft Front Bearing	51.985 – 52.015 mm (2.0467 – 2.0478 in.)	
I.D. at Clutch Shaft Front Bearing	61.985 – 62.015 mm (2.4404 – 2.4415 in.)	
I.D. at Reverse Idler Shaft	18.000 – 18.021 mm (0.7087 – 0.7095 in.)	
Regulator Case		
DRV Sleeve I.D.	20.000 – 20.009 mm (0.7874 – 0.7878 in.)	
DRV Body O.D.	19.983 – 19.990 mm (0.7867 – 0.7870 in.)	
Clearance between DRV Sleeve and Body	0.010 – 0.026 mm (0.0004 – 0.0010 in.)	0.045 mm (0.008 in.)
DRV Sleeve O.D.	24.975 – 24.985 mm (0.9833 – 0.9837 in.)	
DRV Sleeve Bore of Regulator Case	25.00 – 25.02 mm (0.984 – 0.985 in.)	
Clearance between DRV sleeve and Regulator Case	0.015 – 0.045 mm (0.0006 – 0.0018 in.)	0.060 mm (0.0024 in.)
MRV (Main Relief Valve) Sleeve I.D.	18.500 – 18.513 mm (0.7283 – 0.7289 in.)	
MRV Body O.D.	18.470 – 18.480 mm (0.7272 – 0.7276 in.)	
Clearance between MRV Sleeve and Body	0.020 – 0.043 mm (0.0008 – 0.0017 in.)	0.060 mm (0.0024 in.)
MRV Sleeve O.D.	24.99 – 25.00 mm (0.9839 – 0.9843 in.)	
Sleeve Bore of Regulator Case	25.00 – 25.02 mm (0.9843 – 0.9850 in.)	

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Regulator Case (Continued)		
Clearance between MRV Sleeve and Regulator Case	0.00 – 0.03 mm (0 – 0.001 in.)	0.06 mm (0.024 in.)
Power Shift Valve Spool O.D.	15.975 – 15.987 mm (0.6289 – 0.6294 in.)	
Spool Bore of Regulator Case	16.007 – 16.025 mm (0.6302 – 0.6309 in.)	
Clearance between Spool and Regulator Case	0.025 – 0.045 mm (0.0001 – 0.0017 in.)	0.06 mm (0.0024 in.)
Fork Groove Width of Spool	7.1 – 7.3 mm (0.280 – 0.287 in.)	
Valve Spool Fork End Thickness	6.7 – 6.9 mm (0.264 – 0.272 in.)	
Valve Spool Fork I.D.	12.000 – 12.027 mm (0.472 – 0.474 in.)	
Fork Shaft O.D.	11.966 – 11.984 mm (0.471 – 0.472 in.)	
Fork Shaft Bore of Regulator Case Cover	12.000 – 12.027 mm (0.472 – 0.474 in.)	
P.S. Shifter Armshaft O.D.	13.957 – 14.000 mm (0.5495 – 0.5512 in.)	
P.S. Shifter Armshaft Holder Bore	14.016 – 14.043 mm (0.5518 – 0.5529 in.)	
Armshaft to Holder Clearance	0.016 – 0.086 mm (0.0006 – 0.0034 in.)	0.12 mm (0.005 in.)
Second Relief Valve Pressure at Engine 2600 rpm.	40 KPa ($0.4\ kg/cm^2$) (5.7 PSI)	19.6 KPa ($0.2\ kg/cm^2$) (2.84 PSI)
Main Relief Valve Pressure at Engine 2600 rpm.	1600 KPa. ($16.0\ kg/cm^2$) (227 PSI)	1450 KPa ($14.5\ kg/cm^2$) (207 PSI)
Clutch Engagement Delay Time (From Neutral to 1st)	1.0 – 1.4 sec.	0.7 or 2.5 second
Transmission Case		
I.D. at Main Shaft Rear Bearing	62.00 – 62.03 mm (2.441 – 2.442 in.)	
I.D. at Clutch Shaft Rear Bearing	72.00 – 72.03 mm (2.8346 – 2.8358 in.)	
I.D. at Creep Shaft Front Bearing	40.000 – 40.025 mm (1.5748 – 1.5758 in.)	
I.D. at Creep Shaft Rear Bearing.	40.000 – 40.025 mm (1.5748 – 1.5758 in.)	
I.D. at Differential Drive Shaft Bearing	80.000 – 80.030 mm (3.1496 – 3.1508 in.)	

SPECIFICATIONS

Power Shift Transmission (Continued)

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Clutch Pack		
Piston I.D.	100.072 – 100.107 mm (3.9398 – 3.9412 in.)	
Piston O.D.	99.729 – 99.764 mm (3.9263 – 3.9277 in.)	
Clearance between Inner Cylinder and Piston Inner Bore	0.308 – 0.378 mm (0.012 – 0.015 in.)	
Piston O-ring Sectional O.D.	3.0 – 3.2 mm (0.118 – 0.126 in.)	
Clutch Disk Thickness	2.5 – 2.7 mm (0.098 – 0.106 in.)	2.2 mm (0.0866 in.)
Clutch Disk Spline Backlash	0.35 mm (0.0137 in.)	0.80 mm (0.0314 in.)
Clutch Plate Thickness	1.55 – 1.65 mm (0.061 – 0.065 in.)	1.4 mm (0.055 in.)
Clutch Plate Warpage	less than 0.15 mm (less than 0.0059 in.)	0.3 mm (0.0118 in.)
Backing Plate Thickness	3.45 – 3.55 mm (0.136 – 0.140 in.)	3.30 mm (0.13 in.)
Backing Plate Warpage	0.2 mm (0.0079 in.)	0.35 mm (0.0137 in.)
Cylinder I.D. at Clutch Shaft	35.000 – 35.035 mm (1.3780 – 1.3793 in.)	
1st Clutch Gear Bearing I.D.	62.000 – 62.030 mm (2.4409 – 2.4421 in.)	
2nd Clutch Gear Bearing I.D.	62.000 – 62.030 mm (2.4409 – 2.4421 in.)	
3rd Clutch Gear Bearing I.D.	62.000 – 62.030 mm (2.4409 – 2.4421 in.)	
Rev. Clutch Gear Bearing I.D.	62.000 – 62.030 mm (2.4409 – 2.4421 in.)	
Seal Ring Thickness	1.85 – 2.00 mm (0.073 – 0.079 in.)	1.5 mm (0.059 in.)
Seal Ring Width	2.85 – 3.0 mm (0.112 – 0.118 in.)	2.3 mm (0.09 in.)
Range Shift Lever End O.D.	11.7 – 11.8 mm (0.461 – 0.465 mm)	
Range Shift Fork Groove Width	12.1 – 12.3 mm (0.476 – 0.484 in.)	
Clearnce between Shift Lever End and Fork Groove	0.3 – 0.6 mm (0.012 – 0.024 in.)	

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
For Shaft O.D.	14.966 – 14.984 mm (0.5892 – 0.5899 in.)	
Shaft Bore of Shaft Case	15.000 – 15.043 mm (0.5906 – 0.5922 in.)	
Clearance between Shaft and Bore	0.016 – 0.077 mm (0.0006 – 0.003 in.)	
Shift Fork I.D.	15.000 – 15.027 mm (0.5906 – 0.5916 in.)	
Clearance between Fork Shaft and Shift Fork	0.016 – 0.061 mm (0.0006 – 0.0024 in.)	
Shift Fork End Thickness	6.7 – 6.9 mm (0.2638 – 0.2717 in.)	
Sliding Gear Groove Width	7.1 – 7.3 mm (0.2795 – 0.2874 in.)	
Clearance between Fork End and Gear Groove	0.2 – 0.6 mm (0.008 – 0.024 in.)	1 mm (0.04 in.)
Backlash		
Main Gear 1st to Clutch Gear 1st (21T)	0.06 – 0.18 mm (0.0024 – 0.0071 in.)	0.3 mm (0.012 in.)
Main Gear 1st to Clutch Gear 2nd (25T)	0.06 – 0.18 mm (0.0024 – 0.0071 in.)	0.3 mm (0.012 in.)
Main Gear 3rd to Clutch Gear 3rd (33T)	0.05 – 0.17 mm (0.0020 – 0.0067 in.)	0.3 mm (0.012 in.)
Main Gear R to Clutch Gear R	0.05 – 0.17 mm (0.0020 – 0.0067 in.)	0.3 mm (0.012 in.)
Clutch Shaft Gear 19T to Counter Gear 51T	0.08 – 0.21 mm (0.031 – 0.0083 in.)	0.4 mm (0.016 in.)
Counter Gear 14T to Creep Shaft 24T	0.11 – 0.26 mm (0.0043 – 0.0102 in.)	0.5 mm (0.02 in.)
Creep Shaft 12T to Counter Gear 35T	0.09 – 0.24 mm (0.0035 – 0.0094 in.)	0.5 mm (0.02 in.)
Counter Gear 26T to Sliding Gear 24T	0.12 – 0.27 mm (0.0047 – 0.0106 in.)	0.5 mm (0.02 in.)
Clutch Shaft End	0.12 – 0.27 mm (0.0047 – 0.0106 in.)	0.5 mm (0.02 in.)
Counter Gear 14T to Sliding Gear 41T	0.11 – 0.26 mm (0.0043 – 0.0102 in.)	0.5 mm (0.02 in.)
Sliding Gear-to-Shaft Spline Rotational Backlash	0.05 – 0.15 mm (0.002 – 0.006 in.)	0.2 mm (0.008 in.)
Shaft (all) Deflection		0.002 in. (0.05 mm)
Differential Drive Shaft O.D. at Needle Bearing	17.983 to 17.994 mm (0.7079 to 0.7084 in.)	

CAP SCREWS (or NUT)		TORQUE SPECIFICATIONS
Oil Manifold-to-Transmission Case		30 Nm (3 kgm) (22 ft-lbs.)
Power Shift Pump-to-Transmission	M8	30 Nm (3 kgm) (22 ft-lbs.)
	M10	60 Nm (6 kgm) (43 ft-lbs.)
Reverse Gear Shaft-to-Center Plate		100 Nm (10 kgm) (72 ft-lbs.)
Regulator Case-to-Transmission Case		30 Nm (3 kgm) (22 ft-lbs.)
Differential Drive Shaft-to-Differential Housing		30 Nm (3 kgm) (22 ft-lbs.)
Range Shift Cover-to-Transmission Case		30 Nm (3 kgm) (22 ft-lbs.)

SPECIFICATIONS

PTO

SPRING	FREE LENGTH	WORKING LOAD
Detent	New Part 22.2 mm (0.874 in.) Wear Limit 21.83 mm (0.839 in.)	15.7 mm at 118.8 N (12.12 kg) (0.618 in. at 26.72 lbs.)
Over-Running Clutch	New Part 86 mm (3.386 in.) Wear Limit 83 mm (3.268 in.)	20 mm at 67 N (6.84 kg) (0.787 in. at 15 lbs.)

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
PTO Shaft		
O.D. at Front Bearing	30.002 – 30.018 mm (1.1812 – 1.1818 in.)	
O.D. at 540 rpm. Gear Bearing	34.992 – 35.008 mm (1.3776 – 1.3783 in.)	
O.D. at Rear Bearing	34.992 – 35.008 mm (1.3776 – 1.3783 in.)	
O.D. at Sliding Splined Sleeve	37.934 – 37.950 mm (1.4935 – 1.4941 in.)	
Sliding Splined Sleeve (Hollow Shaft) I.D.	38.000 – 38.025 mm (1.4961 – 1.4970 in.)	
PTO Shaft-to-Sliding Gear Sleeve (Hollow Shaft) Clearance	0.05 – 0.091 mm (0.0020 – 0.0036 in.)	0.2 mm (0.008 in.)
Shift Fork End Thickness	6.7 – 6.9 mm (0.263 – 0.272 in.)	
Fork Groove Width in Sliding Gear	7.1 – 7.3 mm (0.279 – 0.287 in.)	
Clearance between Fork and Sliding Gear	0.2 – 0.6 mm (0.008 – 0.024 in.)	1.0 mm (0.040 in.)
Shift Fork Groove Width	9.9 – 10.1 mm (0.390 – 0.398 in.)	
Shift Arm End Thickness	9.50 – 9.52 mm (0.379 – 0.375 in.)	
Clearance between Shift Fork Shaft Extension and Arm	0.38 – 0.60 mm (0.015 – 0.024 in.)	1 mm (0.040 in.)

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Shift Fork I.D.	15.000 – 15.027 mm (0.5906 – 0.5916 in.)	
Shift Fork Shaft O.D.	14.966 – 14.984 mm (0.5892 – 0.5899 in.)	
Clearance between Fork and Shaft	0.016 – 0.061 mm (0.0006 – 0.0024 in.)	0.2 mm (0.008 in.)
Pinion Shaft Axial Play	0.003 – 0.44 mm (0.00012 – 0.017 in.)	0.6 mm (0.024 in.)
Gear Backlash	0.11 – 0.26 mm (0.0043 – 0.0102 in.)	0.5 mm (0.02 in.)
Sliding Gear-to-Shaft Spline Rotational Backlash	0.05 – 0.15 mm (0.002 – 0.006 in.)	0.2 mm (0.08 in.)
540 rpm. PTO Gear I.D.	60.000 – 60.030 mm (2.3622 – 2.3634 in.)	
PTO Front Plate		
I.D. at Pinion Shaft Bearing	52.00 – 52.03 mm (2.0472 – 2.0484 in.)	
I.D. at PTO Shaft Bearing	72.00 – 72.03 mm (2.8346 – 2.8358 in.)	
PTO Rear Cover		
I.D. at Pinion Shaft Bearing	62.00 – 62.03 mm (2.441 – 2.442 in.)	
I.D. at PTO Shaft Bearing	72.00 – 72.03 mm (2.835 – 2.836 in.)	
I.D. at PTO Shaft Oil Seal	60.000 – 60.046 mm (2.362 – 2.364 in.)	

CAP SCREW (or NUT)	TORQUE SPECIFICATIONS
PTO Rear Cover-to-Differential Housing	100 Nm (10 kgm) (72 ft-lbs.)
PTO Rear Cover and Front Plate-to-Supporting Shaft	210 Nm (21 kgm) (152 ft-lbs.)

SPECIFICATIONS

Final Drive and Differential

SPRING	FREE LENGTH	WORKING LOAD
Differential Lock Return	115 mm. (4.528 in.)	79 mm at 489 N (48.9 kg) (3.11 in. at 110 lbs.)

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Differntial Lock		
Fork End Thickness	7.8 – 8.0 mm (0.307 – 0.315 in.)	
Differential Lock Slider Groove Width	8.1 – 8.3 mm (0.318 – 0.327 in.)	
Clearance between Fork and Lock Collar	0.1 – 0.5 mm (0.003 – 0.020 in.)	1.0 mm (0.040 in.)
Shaft Bore of Fork	20.040 – 20.073 mm (0.7890 – 0.7903 in.)	
Pedal Shaft O.D.	19.948 – 20.000 mm (0.7854 – 0.7874 in.)	
Sliding Collar I.D.	30.000 – 30.039 mm (1.1811 – 1.1826 in.)	
Differential		
Differential Case Bushing I.D.	48.000 – 48.039 mm (1.8898 – 1.8913 in.)	
Differential Ring Gear Bushing I.D.	48.000 – 48.039 mm (1.8898 – 1.8913 in.)	
Differential Side Gear O.D.	47.959 – 47.975 mm (1.8881 – 1.8888 in.)	
Bushing-to-Side Gear Clearance	0.025 – 0.080 mm (0.001 – 0.003 in.)	
Differential Pinion I.D.	18.032 – 18.050 mm (0.7099 – 0.7106 in.)	
Pinion Shaft O.D.	17.973 – 17.984 mm (0.7076 – 0.7080 in.)	
Differential Case Pinion Shaft I.D.	18.000 – 18.018 mm (0.7087 – 0.7094 in.)	
Clearance between Pinion Shaft and Case Bore	0.016 – 0.045 mm (0.0006 – 0.0018 in.)	
Clearance between Pinion Shaft and Pinion Gear	0.048 – 0.077 mm (0.0019 – 0.003 in.)	
Thrust Washers Thickness	0.95 – 1.05 mm (0.0374 – 0.0413 in.)	0.6 mm (0.0236 in.)
Differential Case O.D. at Bearing	65.002 – 65.021 mm (2.5591 – 2.5599 in.)	

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Differential (Continued)		
Ring Gear O.D. at Bearing	65.002 – 65.021 mm (2.5591 – 2.5599 in.)	
Ring Gear-to-Bevel Pinion Backlash	0.13 – 0.18 mm (0.005 – 0.007 in.)	0.3 mm (0.012 in.)
Bevel Pinion Gear-to-Bevel Side Gear Backlash	0.18 – 0.30 mm (0.007 – 0.012 in.)	0.5 mm (0.02 in.)
Bevel Side Gear-to-Final Reduction Pinion Backlash	0 – 0.088 mm (0 – 0.0035 in.)	0.3 mm (0.012 in.)
Differential Carrier		
I.D. at Inner Bearing	99.9825 – 100.0175 mm (3.9363 – 3.9377 in.)	
I.D. at Outer Bearing	79.985 – 80.015 mm (3.1490 – 3.1502 in.)	
I.D. at Oil Seal	68.000 – 68.046 mm (2.6772 – 2.6790 in.)	
Final Drive		
Final Pinion Shaft O.D. at Diff. Lock Slider	29.915 – 29.935 mm (1.1778 – 1.1785 in.)	
Final Pinion Shaft O.D. at Bearing	40.002 – 40.018 mm (1.5749 – 1.5755 in.)	
Final Pinion Shaft O.D. at Oil Seal Collar	40.002 – 40.018 mm (1.5749 – 1.5755 in.)	
Axle Shaft O.D. at Inner Bearing	49.992 – 50.008 mm (1.9682 – 1.9688 in.)	
Axle Shaft O.D. at Outer Bearing	49.992 – 50.008 mm (1.9682 – 1.9688 in.)	
Axle Shaft O.D. at Oil Seal	49.97 – 50.03 mm (1.9673 – 1.9697 in.)	
Bearing Case I.D. at Axle Shaft Outer Bearing	80.000 – 80.046 mm (3.1496 – 3.1514 in.)	
Rear Axle Housing I.D. at Axle Shaft Outer Bearing	89.9825 – 90.0175 mm (3.5426 – 3.5440 in.)	
Differential Housing I.D. at Axle Shaft Inner Bearing	90.000 – 90.035 mm (3.5433 – 3.5447 in.)	
Final Reduction Gear-to-Axle Spline Rotational Backlash on Spline	0 – 0.07 mm (0 – 0.0028 in.)	0.25 mm (0.0098 in.)
Final Reduction Gear-to-Pinion Gear Backlash on Reduction Gear Tooth	0.15 – 0.30 mm (0.006 – 0.012 in.)	0.5 mm (0.02 in.)
Final Reduction Gear Axial Play	0.15 – 0.59 mm (0.006 – 0.023 in.)	1 mm (0.039 in.)

SPECIFICATIONS

Final Drive and Differential (Continued)

CAP SCREWS	TORQUE SPECIFICATIONS
Differential Case-to-Ring Gear	60 Nm (6 kgm) (43 ft-lbs)
Differential Carrier-to-Differential Housing	30 Nm (3 kgm) (22 ft-lbs)
Seal Case-to-Rear Axle Housing	60 Nm (6 kgm) (42 ft-lbs)
Differential Housing-to-Transmission Case	98 Nm (10 kgm) (72 ft-lbs)
Brake Drum-to-Final Pinion Shaft Cap Screw	60 Nm (6 kgm) (43 ft-lbs)
Brake Cover-to-Rear Axle Housing	60 Nm (6 kgm) (43 ft-lbs)
Axle Housing-to-Differential Housing 7T	60 Nm (6 kgm) (52 ft-lbs)
10.9T (With Lock-Tite)	70 Nm (7 kgm) (43 ft-lbs)
Lower Link Bracket-to-Rear Axle Housing (With Lock-Tite)	60 Nm (6 kgm) (43 ft-lbs)

Front Wheel Drive

SPRING	FREE LENGTH	WORKING LOAD
Detent (Front Drive Shift Fork)	21.2 mm (0.835 in.)	18.4 mm at 43 N (4.4 kg) (0.724 in. at 9.7 lbs.)

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Front Drive Power Take-Off		
Shift Block Thickness	7.8 – 8.0 mm (0.307 – 0.315 in.)	
Sliding Gear Groove Width	8.1 – 8.3 mm (0.319 – 0.327 in.)	
Clearance between Shift Block and Sliding Gear Groove	0.1 – 0.5 mm (0.004 – 0.020 in.)	1.0 mm (0.04 in.)
Shift Arm O.D.	7.93 – 8.00 mm (0.312 – 0.315 in.)	
Shift Block I.D.	8.00 – 8.02 mm (0.312 – 0.315 in.)	
Shift Arm Shaft O.D.	14.93 – 15.00 mm (0.588 – 0.591 in.)	
Arm Shaft Bore of Drive Case	15.016 – 15.043 mm (0.5912 – 0.5922 in.)	
Clearance between Arm Shaft and Drive Case	0.016 – 0.113 mm (0.00063 – 0.0044 in.)	0.5 mm (0.02 in.)
Rotational Play of Sliding Gear	0.05 – 0.15 mm (0.002 – 0.006 in.)	0.5 mm (0.008 in.)
Front Drive Propeller Shaft Rotational Play	0.1 – 0.2 mm (0.004 – 0.008 in.)	1.0 mm (0.039 in.)
Idle Gear Shaft O.D. at Bearing	19.9935 – 20.0065 mm (0.7871 – 0.7877 in.)	
Idler Gear I.D.	47.000 – 47.025 mm (1.8504 – 1.8514 in.)	
Front Drive PTO Shaft O.D.		
at Front Bearing	24.9935 – 25.0065 mm (0.9840 – 0.9845 in.)	
at Rear Bearing	24.9935 – 25.0065 mm (0.9840 – 0.9845 in.)	
Drive Case I.D.		
at Idler Gear Shaft	20.020 – 20.041 mm (0.7882 – 0.7890 in.)	
at Bearings	52.000 – 52.030 mm (2.0472 – 2.0484 in.)	
at Oil Seal	52.000 – 52.030 mm (2.0472 – 2.0484 in.)	
Front Driven Gear I.D.	30.040 – 30.061 mm (1.1827 – 1.1835 in.)	

SPECIFICATIONS

Front Wheel Drive (Continued)

Front Drive System Oil Capacity . . . . . 6.0 ℓ (1.6 U.S Gal)

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Front Differential		
Bevel Pinion Shaft Bore of Differential Case	14.000 – 14.018 mm (0.55 – 0.552 in.)	
Bevel Pinion Shaft O.D.	13.97 – 13.98 mm (0.549 – 0.550 in.)	
Bevel Pinion I.D.	14.01 – 14.03 mm (0.551 – 0.552 in.)	
Bevel Pinion-to-Shaft Clearance	0.03 – 0.06 mm (0.0012 – 0.0024 in.)	0.4 mm (0.016 in.)
Thrust Washer Thickness	0.75 – 0.85 mm (0.029 – 0.033 in.)	0.65 mm (0.025 in.)
Bevel Side Gear O.D.	31.89 – 31.92 mm (1.255 – 1.256 in.)	
Ring Gear Bushing I.D.	32.00 – 32.04 mm (1.259 – 1.261 in.)	
Differential Case Bushing I.D.	32.00 – 32.04 mm (1.259 – 1.261 in.)	
Bushings-to-Side Gear O.D. Clearance	0.08 – 0.15 mm (0.003 – 0.006 in.)	0.15 mm (0.006 in.)
Differential Case O.D. at Bearing	45.002 – 45.018 mm (1.7717 – 1.7724 in.)	
Ring Gear O.D. at Bearing	45.002 – 45.018 mm (1.7717 – 1.7724 in.)	
Differential Drive Pinion Shaft		
Differential Drive Shaft O.D. at Bearing	29.987 – 30.000 mm (1.1015 – 1.1811 in.)	
Differential Drive Shaft O.D. at Seal Collar	27.979 – 28.000 mm (1.1015 – 1.1024 in.)	
Drive Shaft Taper Bearing Preload (Starting Drag Torque)	0.31 – 1.57 Nm (0.032 – 0.16 kgm) (0.23 – 1.15 ft-lbs.)	
Differential Drive Shaft-to-Ring Gear Backlash	0.17 – 0.23 mm (0.0066 – 0.0090 in.)	
Oil Seal Collar O.D.	39.961 – 40.000 mm (1.5733 – 1.5748 in.)	
Bearing Case I.D. at Taper Bearing	55.000 – 55.030 mm (2.1654 – 2.1665 in.)	
Center Pin Support		
Center Pin O.D. on Center Housing	29.95 – 30.00 mm (1.179 – 1.181 in.)	
Center Pin Bushing I.D.	30.02 – 30.08 mm (1.182 – 1.184 in.)	
Center Pin-to-Bushing Clearance	0.02 – 0.13 mm (0.001 – 0.005 in.)	0.4 mm (0.016 in.)
Center Pin Axial Play	0.05 – 0.3 mm (0.002 – 0.012 in.)	1 mm (0.04 in.)

ITEM	NEW PART SPECIFICATIONS
Bevel Gear and Final Gear Cases	
Drive Shaft Bevel Pinion O.D.	35.002 – 35.018 mm (1.378 – 1.379 in.)
Bevel Gear Case I.D.	
at Drive Shaft Bevel Pinion Bearing	72.000 – 72.030 mm (2.8346 – 2.8358 in.)
at Bevel Gear Bearing	100.000 – 100.035 mm (3.9370 – 3.984 in.)
at Spindle Upper Bearing	52.000 – 52.030 mm (2.0472 – 2.0484 in.)
at Spindle Oil Seal	40.000 – 40.039 mm (1.5748 – 1.5763 in.)
Bevel Gear Case O.D.	
at Lower Oil Seal	114.946 – 115.000 mm (4.5254 – 4.5276 in.)
Bevel Gear O.D. at Bearing	65.002 – 65.021 mm (2.5591 – 2.5599 in.)
Final Bevel Pinion I.D.	35.009 – 35.025 mm (1.3783 – 1.3789 in.)
Spindle O.D.	
at Steering Arm	23.987 – 24.000 mm (0.9444 – 0.9449 in.)
at Upper Bearing	24.987 – 25.000 mm (0.9837 – 0.9843 in.)
at Oil Seal	24.987 – 25.000 mm (0.9837 – 0.9843 in.)
at Needle Bearing	27.99 – 28.00 mm (1.1020 – 1.1024 in.)
at Final Gear Case	24.987 – 25.000 mm (0.9837 – 0.9843 in.)
Final Gear Case I.D.	
at Oil Seal	145.000 – 145.063 mm (5.709 – 5.711 in.)
at Spindle	25.000 – 25.021 mm (0.984 – 0.985 in.)
Bevel Pinion-to-Bevel Gear (All Straight Cut) Backlash	0.10 – 0.15 mm (0.004 – 0.006 in.)
Final Gear O.D. at Bearing	54.9905 – 55.0095 mm (2.1650 – 2.1657 in.)
Bearing Case I.D.	
at Inner Bearing	100.000 – 100.035 mm (3.9370 – 3.9384 in.)
at Outer Bearing	68.000 – 68.030 mm (2.6772 – 2.6783 in.)
at Oil Seal	68.000 – 68.030 mm (2.6772 – 2.6783 in.)

SPECIFICATIONS

Front Wheel Drive (Continued)

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Front Wheel Hub O.D.	40.002 – 40.018 mm (1.5749 – 1.5755 in.)	
Oil Seal Collar O.D.	49.961 – 50.000 mm (1.9670 – 1.9685 in.)	
Oil Seal Collar I.D.	40.025 – 40.064 mm (1.5758 – 1.5773 in.)	
Front Axle Case I.D. at Differential Bearings	75.000 – 75.030 mm (2.953 – 2.954 in.)	

CAP SCREW	TORQUE SPECIFICATIONS
Front Drive Case-to-Transmission Case	60 Nm (6 kgm) (43 ft-lbs)
Drive Shaft Bearing Housing-to-Axle Housing	30 Nm (3 kgm) (22 ft-lbs)
Front Drive Pinion Shaft Starting Drag Torque	0.31 – 1.57 Nm (0.032 – 0.16 kgm) (0.23 – 1.15 ft-lbs)
R.H. Axle Housing-to L.H. Axle Housing	60 Nm (6 kgm) (43 ft-lbs)
Ring Gear-to-Differential Case	34 Nm (3.4 kgm) (25 ft-lbs)
Axle Housing-to-Bevel Gear Case	60 Nm (6 kgm) (43 ft-lbs)
Spindle-to-Steering Arm	210 Nm (21 kgm) (152 ft-lbs)
Bearing Housing-to-Final Gear Case	100 Nm (10 kgm) (72 ft-lbs)
Steering Arm-to-Bearing Housing	60 Nm (6 kgm) (43 ft-lbs)
Tie-rod Bracket-to-Final Gear Case (with Lock-tite)	60 Nm (6 kgm) (43 ft-lbs)
Front Wheel Hub Nut	186 Nm (19 kgm) (137 ft-lbs)
Center Pin Plate-to-Axle Bracket	100 Nm (10 kgm) (72 ft-lbs)
Tie-rod Nut	45 – 60 Nm (4.5 – 6.0 kgm) (33 – 44 ft-lbs)
Drag-rod Nut	45 – 60 Nm (4.5 – 6.0 kgm) (33 – 44 ft-lbs)

DIAGNOSING MALFUNCTIONS

Worn disk prematurely

- Too small pedal free travel
- Too often "Inching" or "Slipping" clutch operation
- Broken diaphragm spring fingers
- Worn or distorted pressure plate

Disk facing burn or come off

- "Slipping" clutch operation
- Oily disk facing due to slipping
- Broken release bearing return spring or unhooked

Broken torsion spring on disk

- Abrupt clutch pedal operation

Scored pressure plate or flywheel

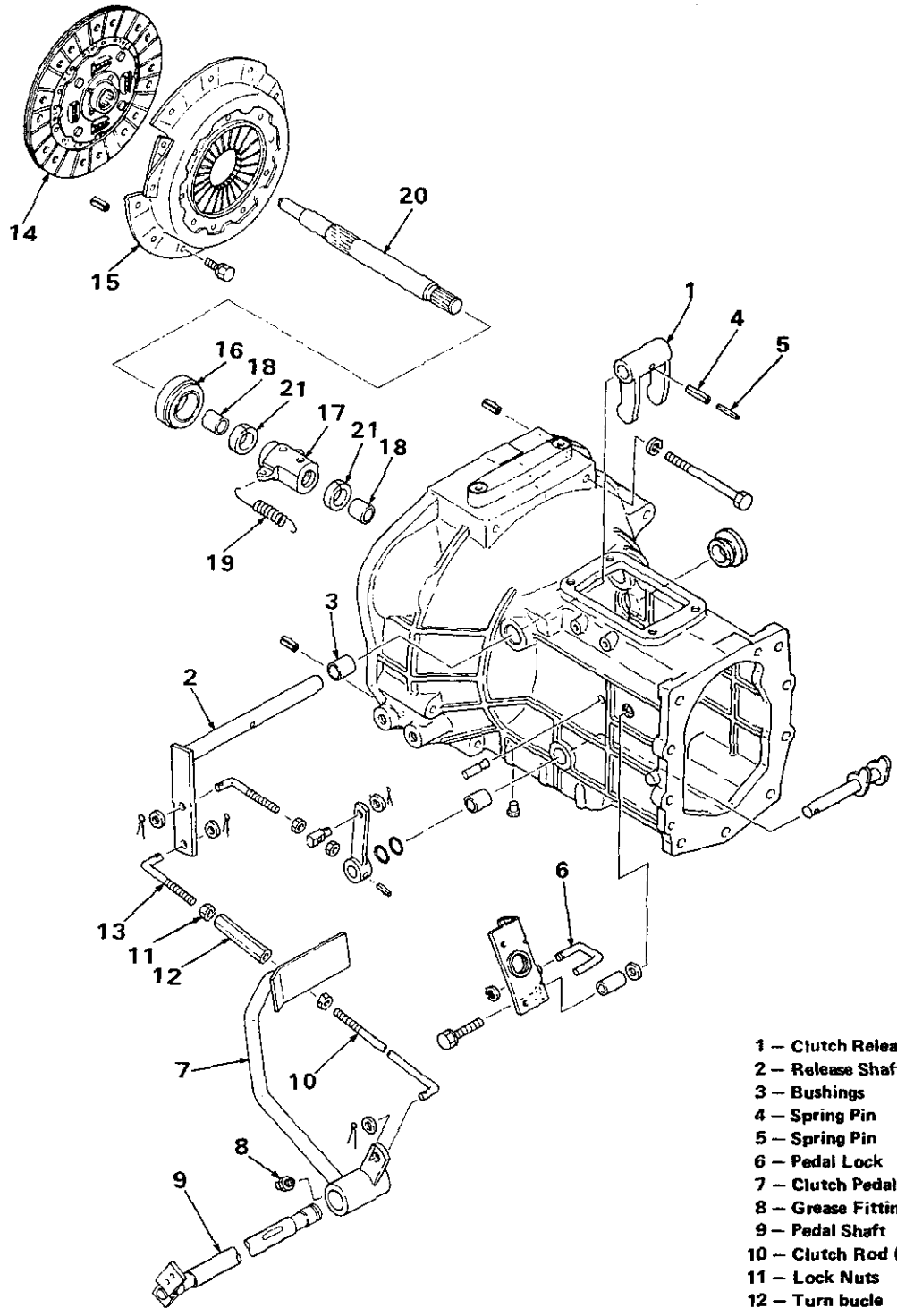
- Worn come off disk facing
- Broken torsion springs

Engine oil in clutch housing

- Oil leaks from crankshaft rear oil seal

Transmission oil in clutch housing

- Oil leaks from oil seal in the front side of transmission case.



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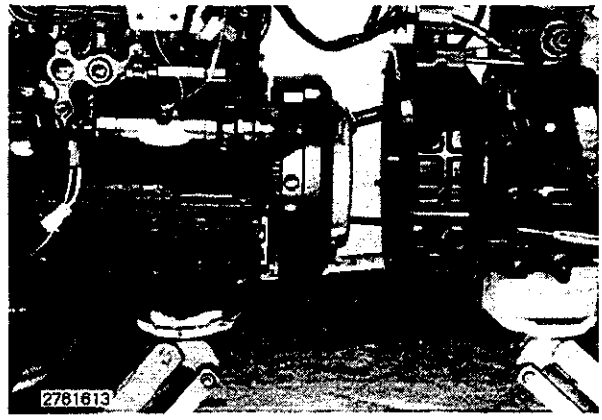
1 – Clutch Release Yoke
2 – Release Shaft
3 – Bushings
4 – Spring Pin
5 – Spring Pin
6 – Pedal Lock
7 – Clutch Pedal
8 – Grease Fittings
9 – Pedal Shaft
10 – Clutch Rod (R.H. Screw)
11 – Lock Nuts
12 – Turn bucle
13 – Clutch Rod (L.H. Screw)
14 – Clutch Disc
15 – Pressure Plate Assembly
16 – Release Bearing
17 – Release Bearing Sleeve
18 – Bushings
19 – Return Spring
20 – Main Drive Shaft (Clutch Shaft)
21 – Felt

REMOVAL

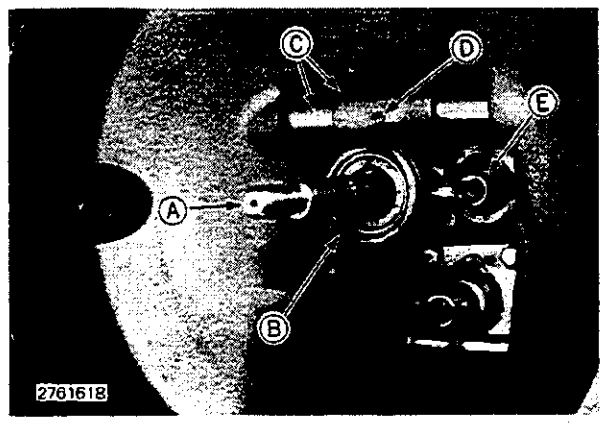
MAIN DRIVE SHAFT AND RELEASE MECHANISM

1. Separate the clutch housing from the engine.



2. Remove two release bearing return springs (E) from bearing sleeve. Remove springs from pins in clutch housing.

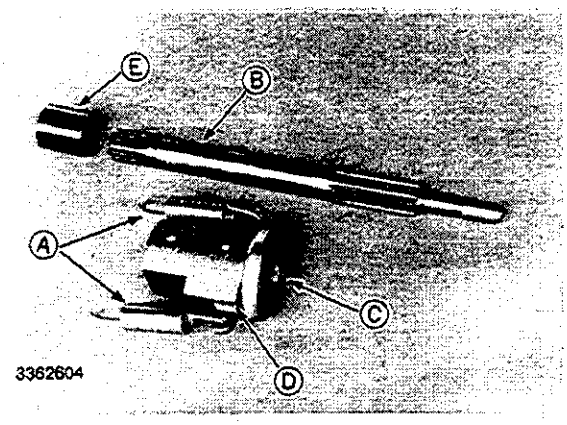
3. Separate clutch housing from transmission case as instructed section 10-20-10 and remove main drive shaft and release bearing assembly.



A — Main Drive Shaft
B — Release Bearing
C — Yoke and Release Shaft
D — Spring Pins
E — Return Spring

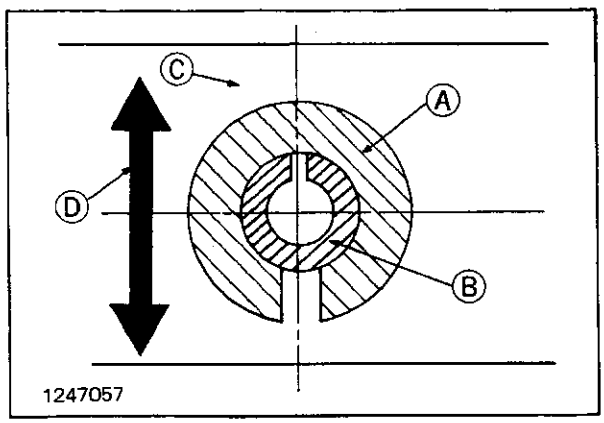
If splined coupler, connecting main drive shaft and main shaft, remains on main shaft, remove it for inspection. Coupler may have fallen to bottom of clutch housing.

4. To remove clutch release yoke and linkage, drive out spring pins, disconnect rod (on outside of clutch housing) from release shaft, and remove release shaft and yoke.

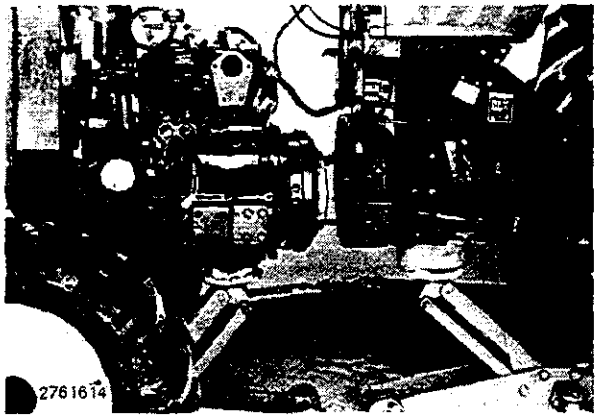


A — Bearing Return Spring
B — Main Drive Shaft
C — Release Bearing
D — Release Bearing Sleeve
E — Coupler

Spring pins consist of two pins, one inside the other. Note position of splits in pins for reassembly. They should face 180° from one another in a vertical plane as shown in the figure.

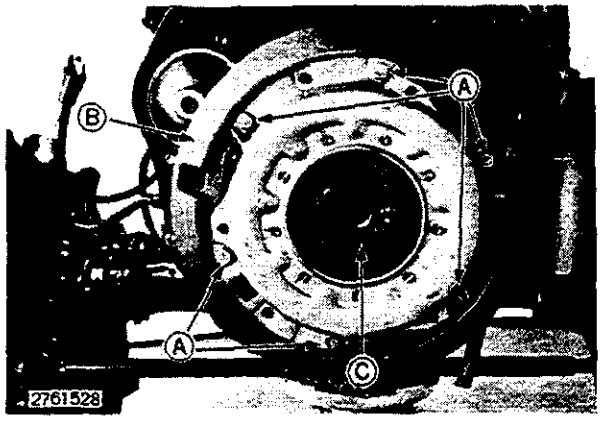


A — Lerger Pin
B — Smaller Pin
C — Sleeve
D — Direction of Sleeve Movement



ENGINE CLUTCH

1. Separate the clutch housing from the engine.

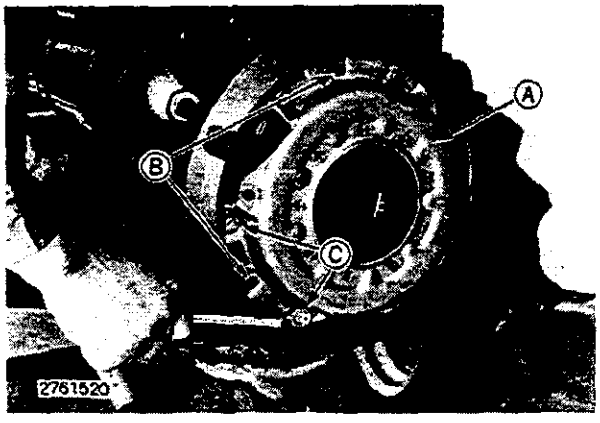


2. Remove six pressure plate assembly-to-flywheel cap screws (A).

A — Cap Screws
B — Flywheel
C — Diaphragm Spring Fingers

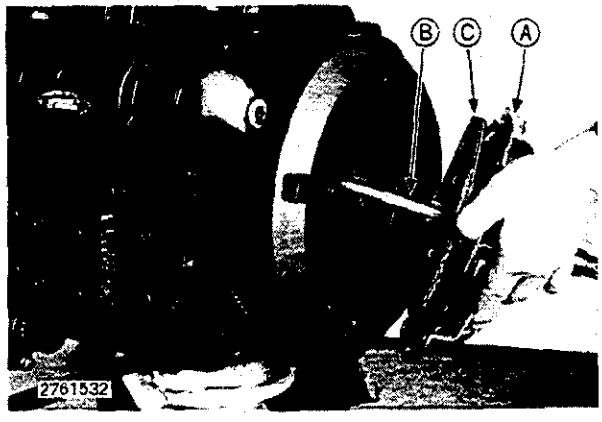
Before clutch removal, release plate height could be checked. See "Inspection and Repair".

If the clutch cover assembly is damaged or worn, the entire assembly must be replaced.



3. Pry pressure plate assembly off, arround three spring pins on flywheel, by using two screw drivers. Use care not to scratch flywheel or pressure plate.

A — Pressure Plate Cover
B — Alingning Pins
C — Cap Screws



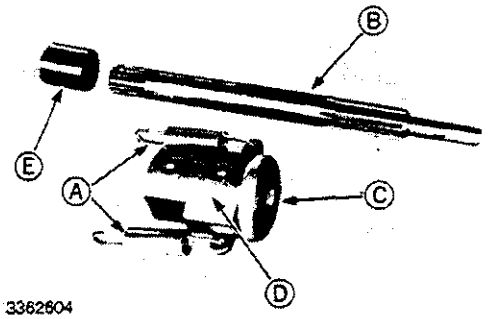
4. Use main drive shaft or installation tool not to drop disk which will be loose on flywheel.

A — Pressure Plate Cover
B — Main Drive Shaft
C — Clutch Disk

INSPECTION AND REPAIR

MAIN DRIVE SHAFT AND RELEASE MECHANISM

A – Bearing Return Springs
B – Main Drive Shaft
C – Release Bearing
D – Release Bearing Sleeve
E – Splined Coupler



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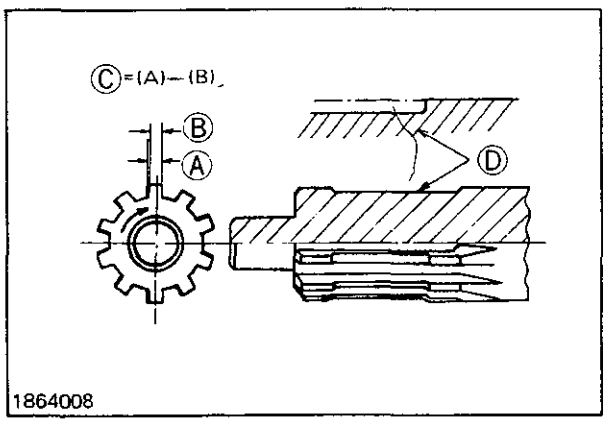
Main Drive Shaft

1. Inspect shaft splines are worn or damaged. If the backlash between disk and shaft splines exceeds the following limit, replace shaft.

A – Disk Spline Width
B – Shaft Spline Tooth Width
C – Backlash
D – Worn Area



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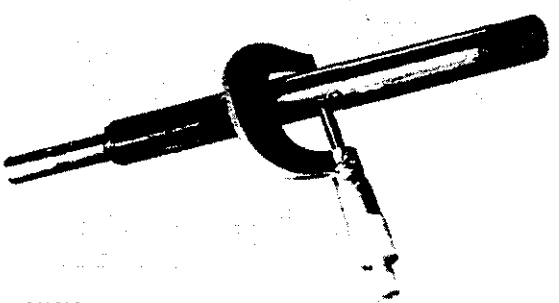
2. Replace shaft if diameter at release bearing is less than 21.5 mm (0.8465 in.).

3. If clearance between main drive shaft forward diameter and pilot bushing is 0.3 mm (0.012 in.) or greater, check to see which part(s) is excessively worn, and replace. Refer the following specifications.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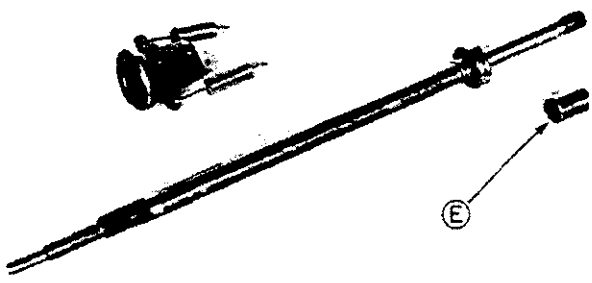
MAIN DRIVE SHAFT SPECIFICATIONS

Item	New Part	Wear Limit
Main Drive Shaft Spline Backlash (C)	0.05 to 0.15 mm (0.002 to 0.005 in.)	0.3 mm (0.012 in.)
Main Drive Shaft O.D.	21.92 to 22.00 mm (0.863 to 0.866 in.)	21.5 mm (0.8465 in.)
Main Drive Shaft Forward End O.D.	11.94 to 11.95 mm (0.4701 to 0.4704 in.)	
Pilot Bushing I.D.	12.02 to 12.03 mm (0.4732 to 0.4736 in.)	
Clearance between Pilot Bushing and Drive Shaft	0.04 to 0.09 mm (0.002 to 0.004 in.)	0.3 mm (0.012 in.)

INSPECTION AND REPAIR

Splined Coupler

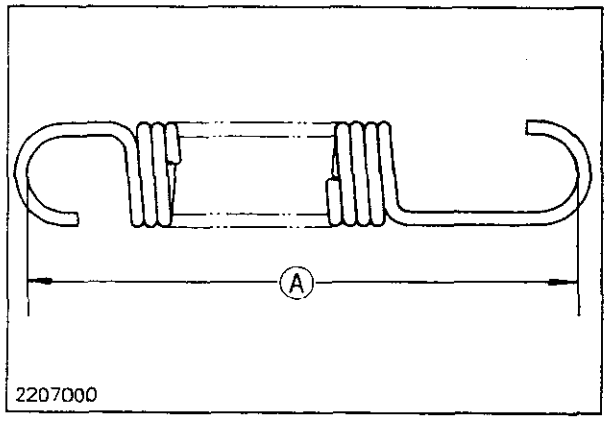


1800717

Inspect splined coupler is worn or damaged. Replace as required.

E — Splined Coupler

Return Spring



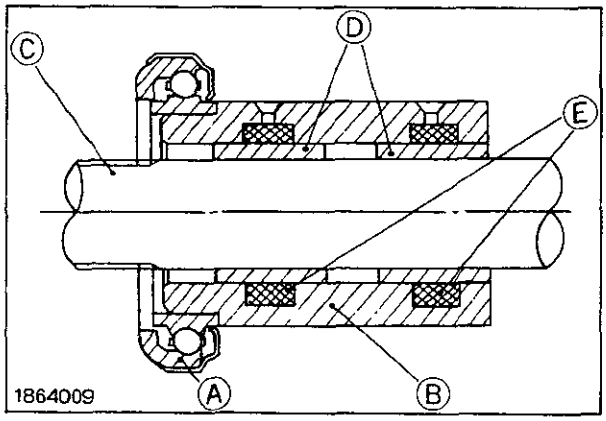
2207000

Compare measurement taken to the following specifications.

RETURN SPRING SPECIFICATIONS

Item	New Part
Free Length	107 mm (4.21 in.)
Working Load	135 mm at 176 N (5.3 in. at 39.7 lbs)

Release Bearing

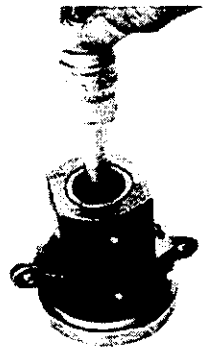


1864009

1. Check bearing (A) on sleeve (B), replace entire assembly. Clearance should not exceed 0.02 mm (0.001 in.)
2. If bearing (A) appears burned, remove using a press or bearing puller and replace.

A — Release Bearing
B — Bearing Sleeve
C — Main Drive Shaft
D — Oil Bushing
E — Felt

3. Measure the O.D. of bearing sleeve, I.D. of release bearing. Compare measurements taken with the following specifications.

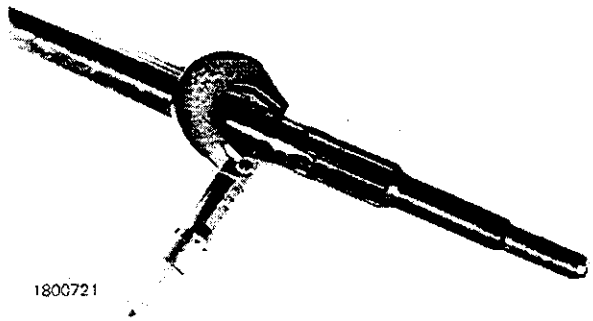


2413034

BEARING SLEEVE SPECIFICATIONS

Item	New Part
Release Bearing I.D.	39.98 to 40.00 mm (1.574 to 1.575 in.)
Release Bearing Sleeve O.D.	40.00 to 40.02 mm (1.575 to 1.576 in.)
Release Sleeve Bushings I.D.	22.4 to 22.421 mm (0.8818 to 0.8827 in.)

4. Measure the O.D. of main drive shaft and I.D. of oil bushings to obtain clearance. Compare measurement and replace if needed.



1800721

CLEARANCE SPECIFICATIONS

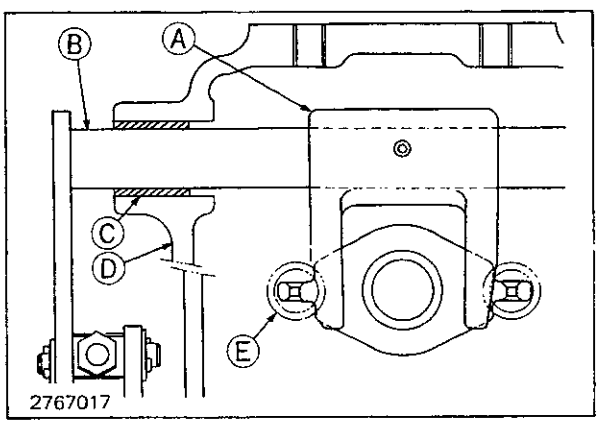
Item	New Part	Wear Limit
Clutch Shaft O.D.	21.92 to 22.00 mm (0.863 to 0.866 in.)	21.5 mm (0.8465 in.)
Clearance between Bushing and Clutch Shaft	0.068 to 0.172 mm (0.003 to 0.006 in.)	0.5 mm (0.020 in.)

5. Lubricate felt in release bearing sleeve before installing.

2413101

Clutch Yoke and Release Shaft

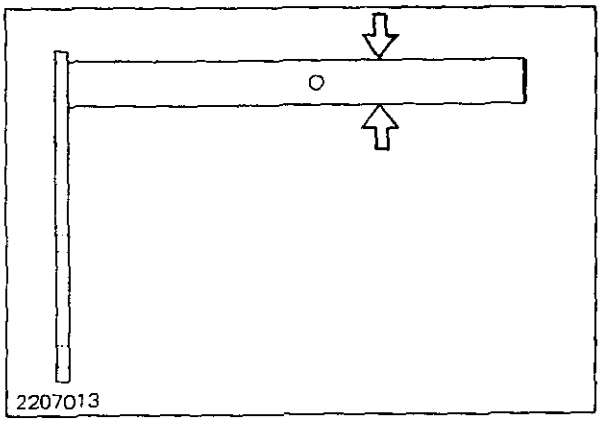
1. Check the ends of clutch yoke for wear. If the wear is too much to adjust clutch pedal rods, replace yoke.



2767017

A – Clutch Yoke
B – Release Shaft
C – Bushing
D – Clutch Housing
E – Return Spring

INSPECTION AND REPAIR



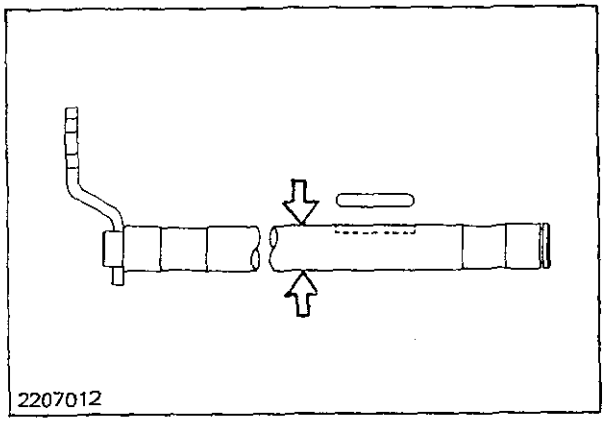
Clutch Yoke and Release Shaft (Continued)

2. Measure release shaft bore I.D. in the clutch housing and release shaft O.D. at clutch housing bearing area to get clearance between clutch housing and yoke shaft.

3. Compare measurement taken with the following specifications.

CLUTCH YOKE SPECIFICATIONS

Item	New Part	Wear Limit
Release Shaft O.D.	19.95 to 20.00 mm (0.785 to 0.787 in.)	
Bush I.D.	20.10 to 20.15 mm (0.791 to 0.793 in.)	
Clearance between Release Shaft and Bushing		0.5 mm (0.019 in.)



Pedal Assembly

Measure I.D. of pedal bushing, and O.D. of pedal shaft and I.D. of pedal to obtain clearances between pedal or pedal bushings and pedal shaft.

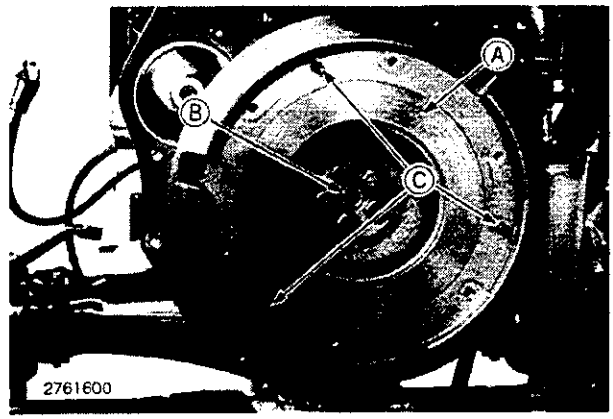
CLUTCH PEDAL SPECIFICATIONS

Item	New Part	Wear Limit
Pedal Bushing I.D.	25.12 to 25.14 mm (0.989 to 0.990 in.)	
Pedal Shaft O.D.	24.95 to 25.00 mm (0.982 to 0.984 in.)	
Pedal I.D.	25.07 to 25.12 mm (0.9868 to 0.9889 in.)	
Clearance between Pedal or Bushing and Shaft		1.0 mm (0.039 in.)

CLUTCH AND FLYWHEEL

Pilot Bushing

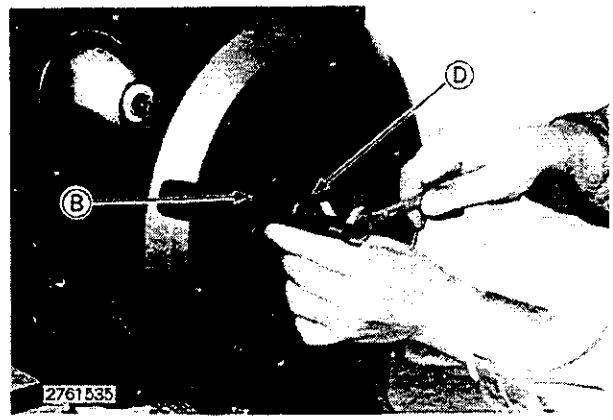
1. Inspect pilot bushing for wear, and measure I.D. of bushing and O.D. of main drive shaft (Clutch shaft) at pilot bushing.
2. Compare measurement taken with the following specifications.



A – Flywheel Friction Drive Surface
B – Pilot Bushing
C – Pin

PILOT BUSHING SPECIFICATIONS

Item	New Part	Wear Limit
Pilot Bushing I.D.	15.00 to 15.03 mm (0.590 to 0.592 in.)	
Main Drive Shaft Forward End O.D.	14.94 to 14.96 mm (0.588 to 0.589 in.)	
Clearance between Pilot Bushing and Drive Shaft	0.063 to 0.099 mm (0.003 to 0.004 in.)	0.3 mm (0.012 in.)

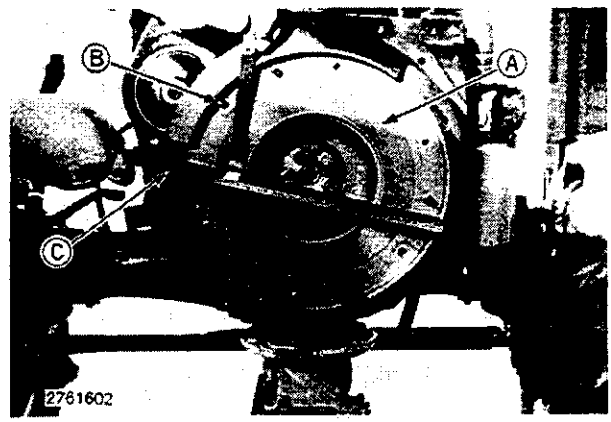


3. If bushing (B) is replaced, use a pilot bushing puller (D).

   Coat I.D. of new pilot bushing with a light clean grease.

Flywheel

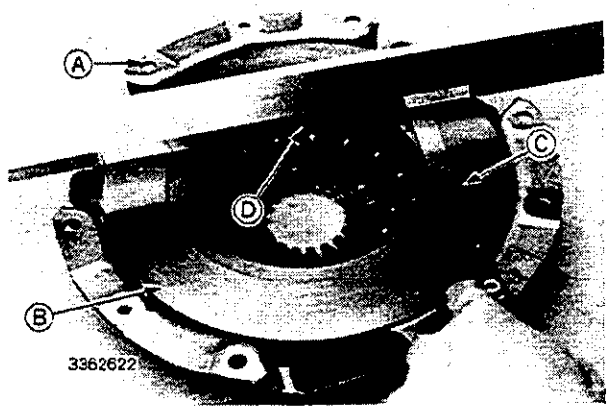
1. Inspect flywheel friction drive surface (A) for distortion and scratches.
2. Measure flatness of drive surface using straightedge (C) and feeler gauge (B). Replace flywheel if surface (A) is not flat to within 0.2 mm (0.008 in.).
3. Clean any rust or oil front drive surface using a light abrasive.



A – Drive Surface
B – Feeler Gauge
C – Straightedge

Pressure Plate

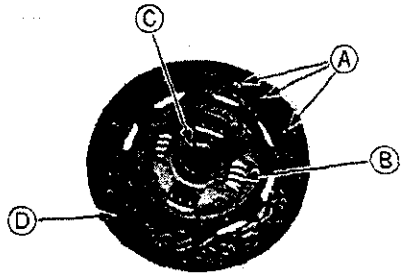
1. Inspect pressure plate drive surface (B) for distortion and scoring.
2. Measure flatness of drive surface using straightedge and feeler gauge.
   Replace entire clutch cover assembly if surface is not flat to within 0.2 mm (0.008 in.).
3. Clean any rust or oil from drive surface using a light abrasive.



A – Clutch Cover
B – Pressure Plate
C – Feeler Gauge
D – Straightedge

INSPECTION AND REPAIR

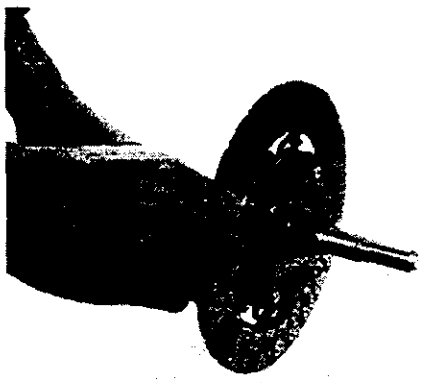
Clutch Disk



2761607

1. Inspect friction facings (D) for flatness. Replace disk if either facing (D) is not flat to with less than 0.4 mm (0.016 in.). (Use a straightedge and feeler gauge.)
2. Replace friction disk if scored or glazed. Check disk hub (C) splines for wear or damage.
3. Check condition of disk torsion springs (B). If any spring is loose or damaged, replace disk assembly.

A – Rivets **C – Hub**
B – Torsion Springs **D – Facings**

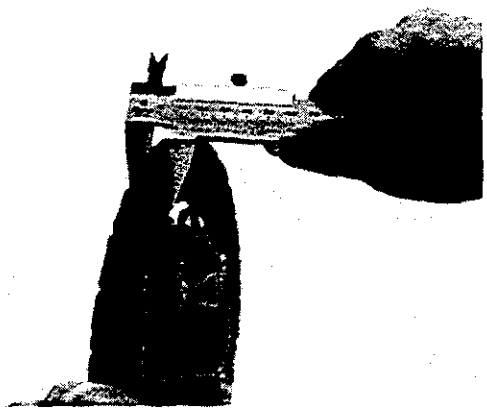


2260616

4. Check disk tilt at the disk outer edge on spline shaft using dial indicator.

CLUTCH DISK SPECIFICATIONS

Item	New Part	Wear Limit
Disk O.D.	180 mm (7.09 in.)	
Disk Tilt at Disk Edge		0.7 mm (0.027 in.)



2260612

5. Use a vernier caliper to measure clutch disk thickness. Disk should be replaced if thickness is 6.6 mm (0.260 in.) or less.

CLUTCH DISK SPECIFICATIONS

Item	New part	Wear Limit
Facing Thickness (One Side)	3.4 to 3.6 mm (0.13 to 0.14 in.)	
Facing Thickness (Both Sides)	7.8 to 8.6 mm (0.307 to 0.339 in.)	7.2 mm (0.284 in.)

2761609

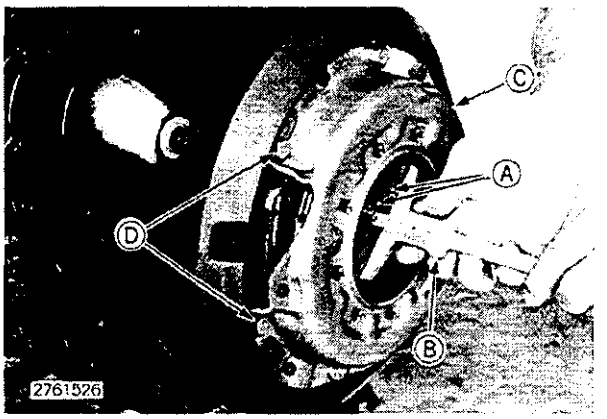
6. Measure disk rivet head depth. If any rivet heads is loose of if head depth is 0.3 mm (0.012 in.) or less, replace disk assembly.

CLUTCH DISK SPECIFICATIONS

Item	New part	Wear Limit
Rivet Head Depth	1.2 mm (0.05 in.)	0.3 mm (0.012 in.)

Clutch Release Lever Checking

1. Check condition of clutch cover and diaphragm spring fingers (A).
   Replace clutch pressure plate (Clutch cover) assembly if any of these parts is in questionable condition.



A – Diaphragm Spring
B – Depth Gauge
C – Clutch Cover
D – Cap Screws

2. Measure diaphragm spring finger height.

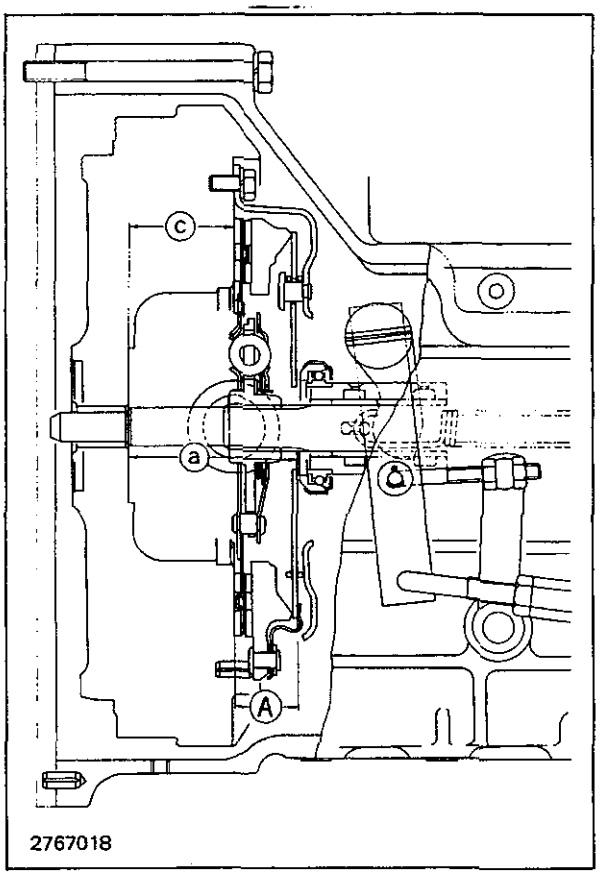
   a) Measure distance between flywheel drive surface and rear of pilot bushing.

   b) Install clutch disk and pressure plate assembly using clutch drive shaft as a pilot for the disk.
   Remove clutch drive shaft (Main drive shaft).

   c) With cover cap screws torqued to 27 Nm (2.7 kgm) (20 ft-lbs), measure distance between rear of flywheel pilot bushing and rear of diaphragm spring fingers.

   d) Subtract the dimension from step a) from the dimension measured in step c).

   e) The number calculated in "d" should be 31 to 33 mm (1.22 to 1.30 in.) with a new clutch disk installed. If the derived dimension is less than 27 mm (1.06 in.) the clutch pressure plate assembly should be replaced.



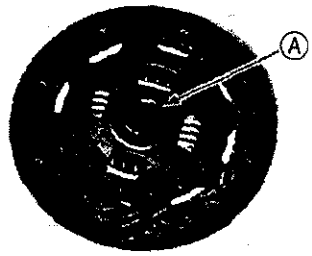
A – 30.0 to 32.0 mm (1.18 to 1.26 in.)

A = a – c

a: 68 mm (2.68 in.)
c: 36 ± 1 mm (1.38 to 1.46 in.)

ASSEMBLY AND INSTALLATION

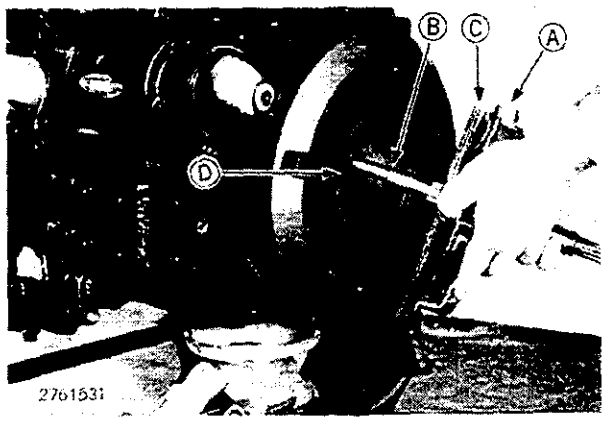
CLUTCH



2761608

1. Install clutch disk on the flywheel with the long end of the hub (A) rearward.
   Use clutch disk installation tool or (Clutch shaft) main drive shaft for giving disk center of rotation.

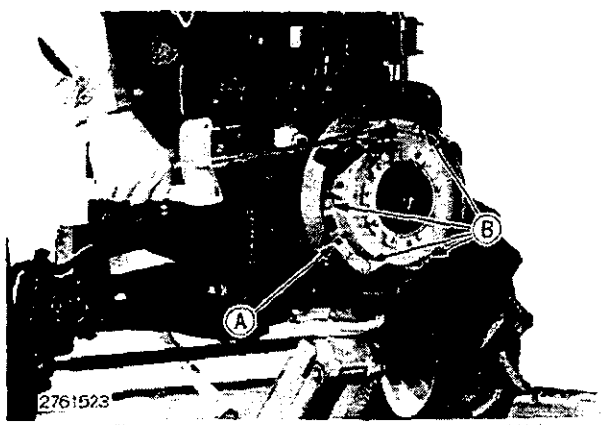
A – Hub



2761531

2. Install clutch pressure plate assembly (A) and clutch disk on the end spline of clutch shaft (B), and insert the shaft into pilot bushing in flywheel.

A – Pressure Plate Cover
B – Clutch Shaft (Main Drive Shaft)
C – Clutch Disk
D – Pilot Bushing



2761523

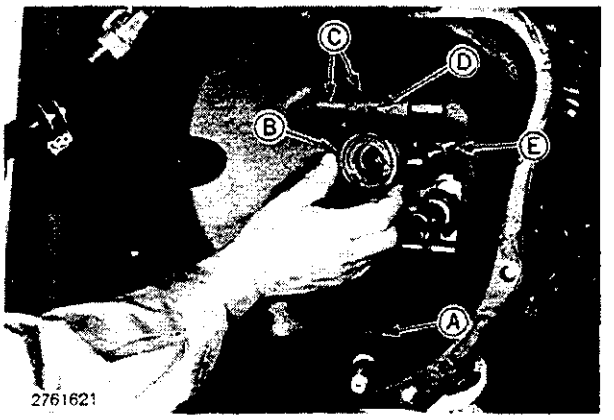
3. Align clutch pressure plate cover two aligning pins (A) on flywheel and install cap screws (B). Be sure to install clutch pressure plate assembly at the original position using the mark scratched when removing.

A – Aligning Pin (3 used)
B – Cap Screw (6 used)

4. Torque cap screws (B) to 27 Nm (2.7 kgm) (20 ft-lbs).
5. Remove clutch shaft (Main drive shaft) and install in clutch housing as described in following sequence.

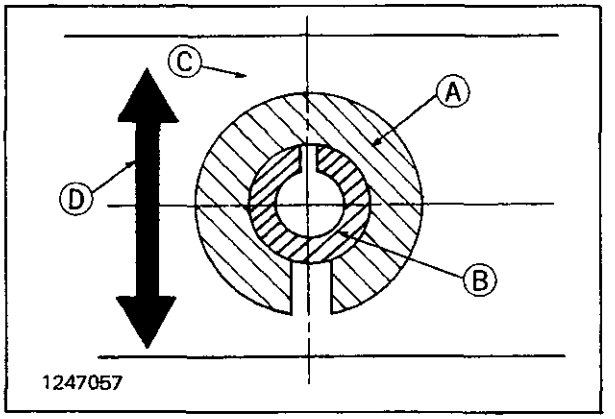
CLUTCH SHAFT AND RELEASE MECHANISM

1. Immerse clutch release bearing sleeve in transmission fluid.
2. Apply grease to the release shaft bores of clutch housing.
3. Install clutch yoke release shaft through clutch housing and through release shift yoke (C). Note that flat side of yoke faces to rear.
4. Rotate yoke shaft outer arm down so hole in shaft aligns with hole through yoke.



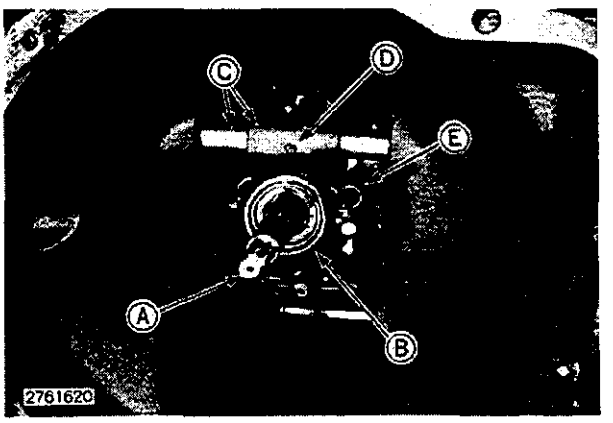
5. Install spring pins (D) through hole in yoke and release shaft (C). Note that one spring fits inside the other and be sure splits in pins are positioned 180° (opposite) one-another.

A – Larger Pin
B – Smaller Pin
C – Sleeve
D – Direction of Sleeve Movement

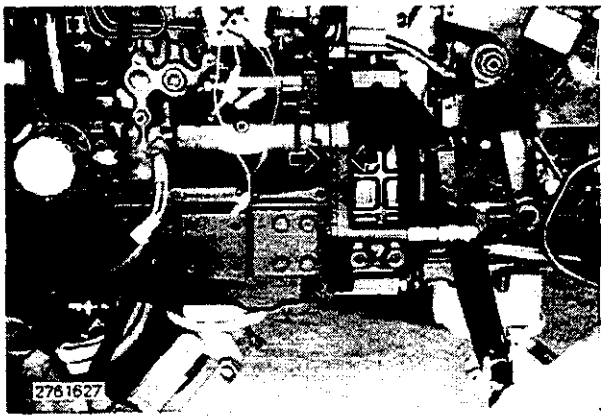


6. Install two release springs (E) in release sleeve (B) and over pins inside clutch housing. Open ends of springs should face down.
7. Install clutch shaft (A) through clutch housing into splined coupler at front of transmission drive shaft.
8. Wipe all excess oil from release bearing sleeve and install clutch shaft (A).

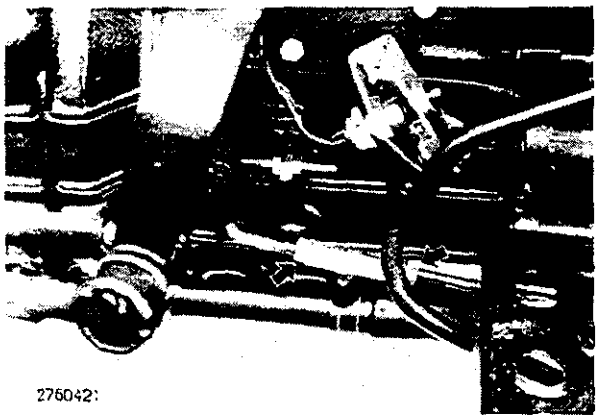
A – Clutch Drive Shaft
B – Release Bearing
C – Yoke and Release Shaft
D – Spring Pins
E – Release Springs



9. Join the clutch housing to the engine.
10. Install clutch and brake pedals and operating shaft.
11. Install and connect pedal linkage. Note that the longer rod has right-hand thread while the shorter rod has left-hand thread.
12. Install brake pedal linkage and spring.

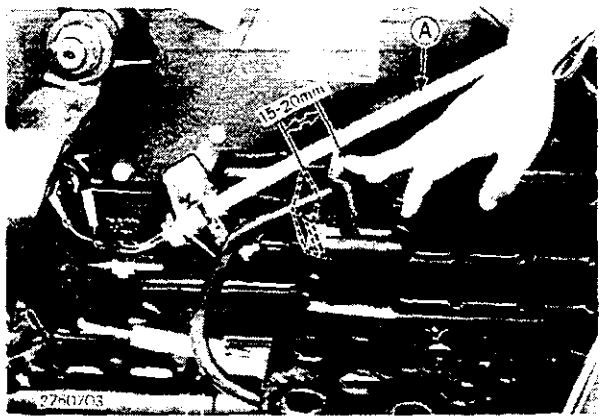


ADJUSTMENT



PEDAL FREE TRAVEL ADJUSTMENT

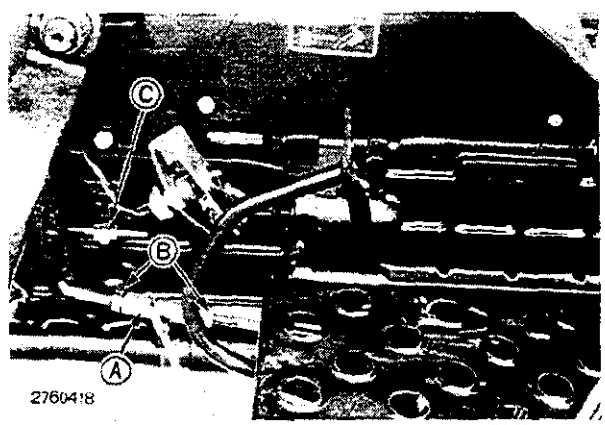
1. Loosen rod jam nuts. Note that front nut has left-hand thread while rear nut has right-hand thread.



2. With a scale (A) held in the line of clutch pedal travel, measure free travel of clutch pedal at the pedal footrest. Free travel should be 15—25 mm (9/16 to 1 inch).

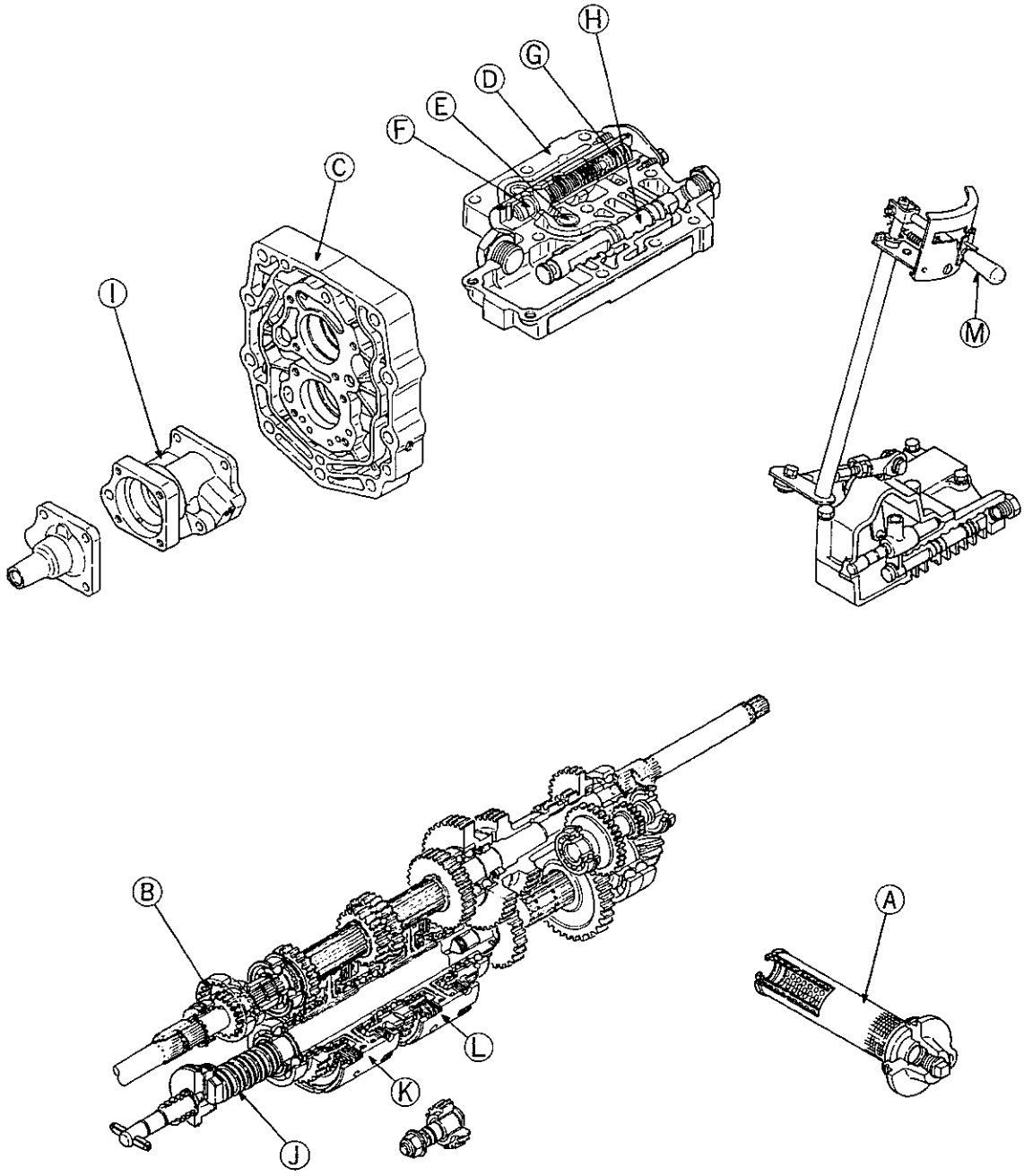
3. If free travel is excessive, turn turnbuckle counterclockwise (when viewed from front of tractor). If there is too little free play, turn turnbuckle clockwise (as viewed from front of tractor).

A — Scale



4. While holding turnbuckle, lock jam nuts.
   Adjust inertia brake release lever (C) if removed.

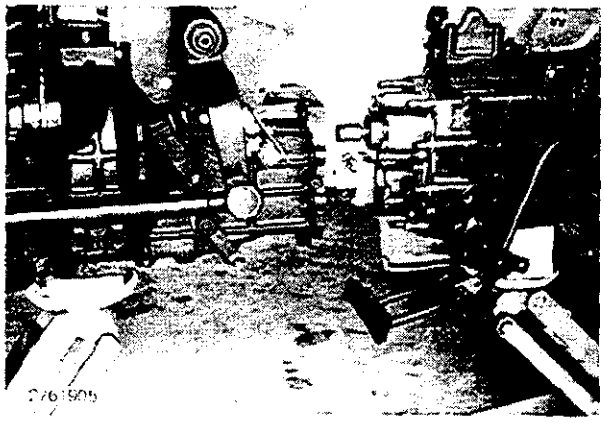
A — Turnbuckle
B — Lock Jam Nut
C — Inertia Brake Release Lever



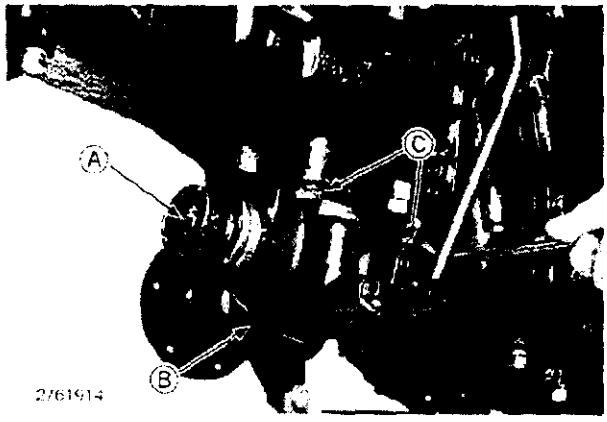
2767003

A – Suction Screen
B – Internal Gear Pump
C – Center Plate
D – Regulator Case
E – 2nd Relief Valve
F – Main Relief Valve
G – Delay Relief Valve
H – Valve Spool
I – Oil Manifold
J – Power Shift Clutch Shaft
K – Rev-1st Clutch Pack
L – 2nd-3rd Clutch Pack
M – Power Shift Lever

TRANSMISSION REMOVAL

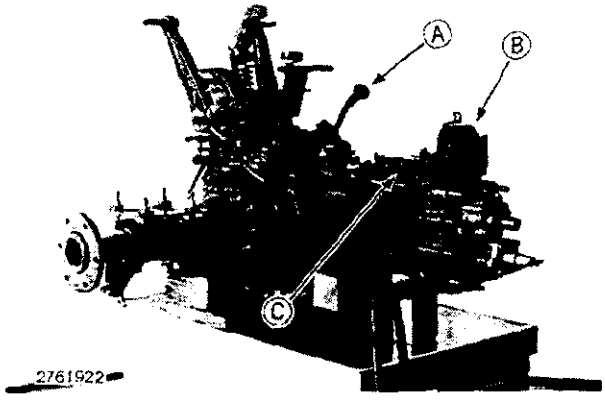


1. Drain transmission oil.
2. Separate the tractor between transmission case and clutch housing.



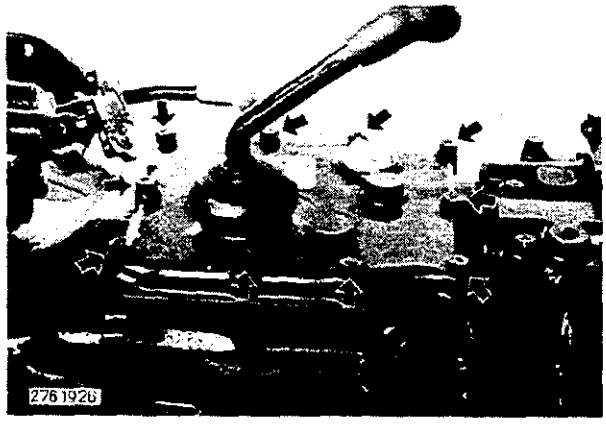
3. Remove four cap screws (C), and remove front drive case assembly (B) with front wheel drive shift lever.

A – Front Wheel Drive Power Take Off
B – Front Drive Case
C – Cap Screw (4 used)



4. Place the transmission and rear axle assembly on a steady stand.

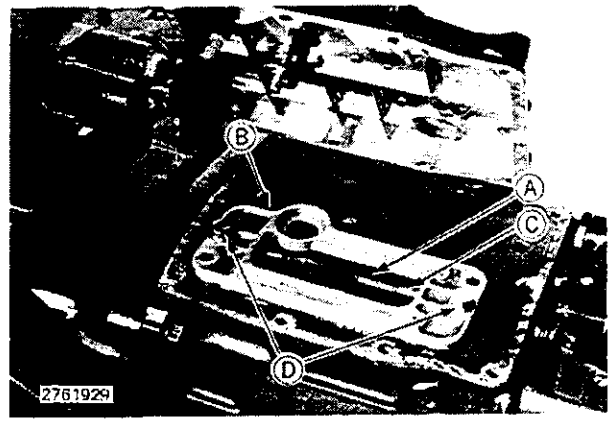
A – Range Shift Lever Assembly
B – Power Shift Shifter Cover
C – Regulator Case



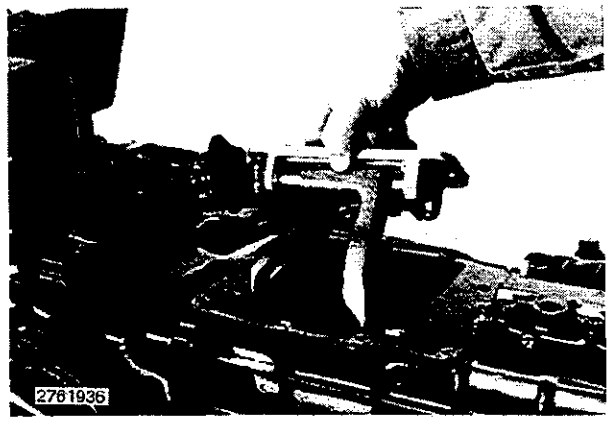
5. Remove range shift lever assembly from transmission case removing transmission upper cover-to-transmission case retaining screws (10 used).

6. Remove two fork shaft support-to-transmission case cap screws.

A – Range Shift Fork
B – Fork Shaft Support
C – Fork Shaft
D – Cap Screw

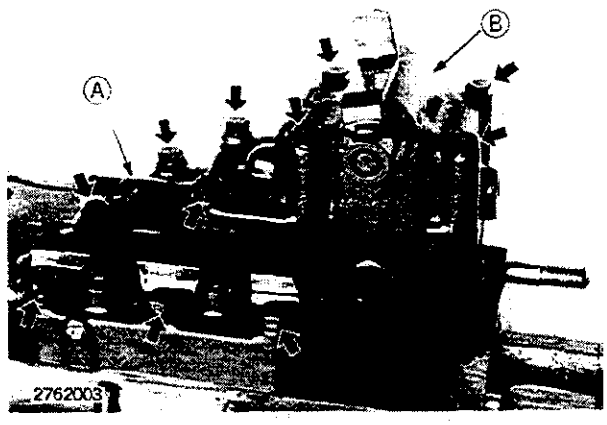


7. Remove forks, fork shaft and support assembly.



8. Remove eleven cap screws (Arrows) and remove regulator case (A).

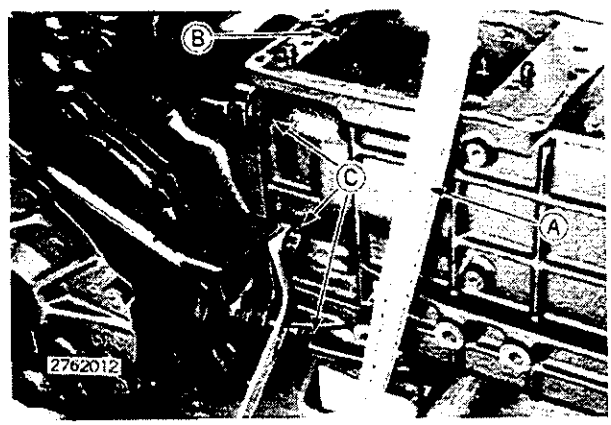
A – Regulator Case
B – Shifter Cover



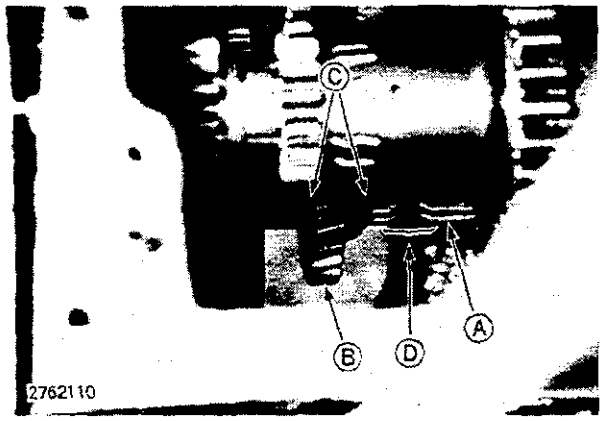
9. Use slinger belts (A) to lift the transmission case.

10. Remove one cap screw (A) inside the case and six cap screws (B) outside.

A – Slinger Belt
B – Cap Screw (one)
C – Cap Screw (6 used)

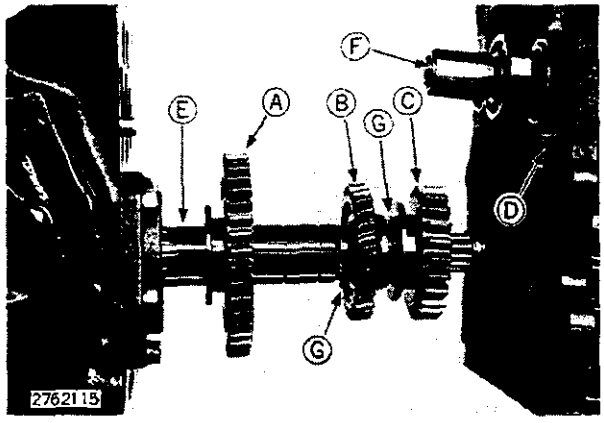


TRANSMISSION REMOVAL (Continued)



11. Remove two snap rings (C) out of their grooves, and slide them to the slim portion (D) of differential drive shaft (A).

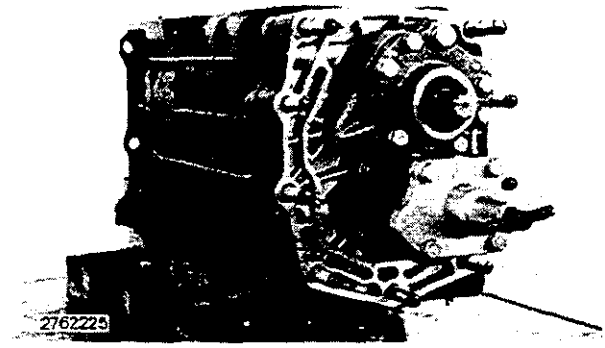
A – Differential Drive Shaft
B – Idle Gear (4.W.D.)
C – Snap Rings
D – Slim Portion



12. Slowly move the transmission case foreward with lifting the rear end of case higher, so that the gear (D) can clear over the range sliding gear (A) when separating.

A – Sliding Gear
B – Idle Gear (4.W.D)
C – Lo-Hi Sliding Gear
D – Creep Range Gear
E – Differential Drive Shaft
F – Main Shaft
G – Snap Ring (2 used)

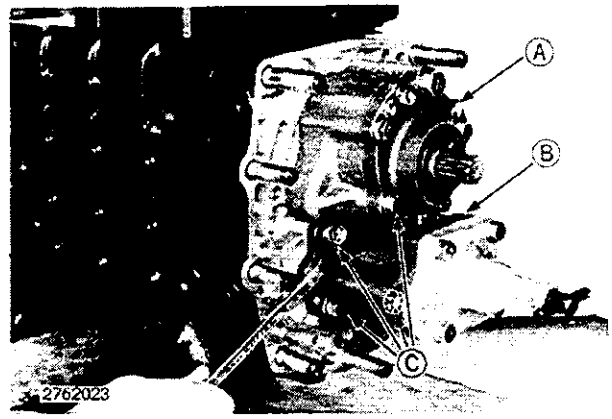
13. Place the transmission assembly on a steady stand.



COMPONENT REMOVAL

When removing pump (A) and/or oil manifold (B), it is not necessary to remove transmission assembly and regulator case.

A – Power Shift Pump
B – Oil Manifold
C – Cap Screws

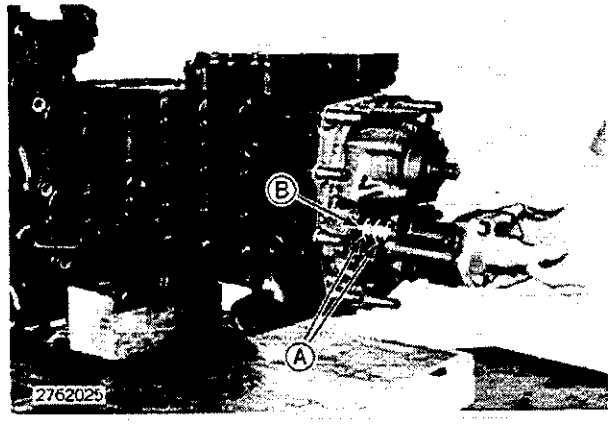


Oil Manifold

1. Remove four cap screws (C).

2. Carefully pull the manifold not to damage seal rings (A) on the clutch shaft (B).

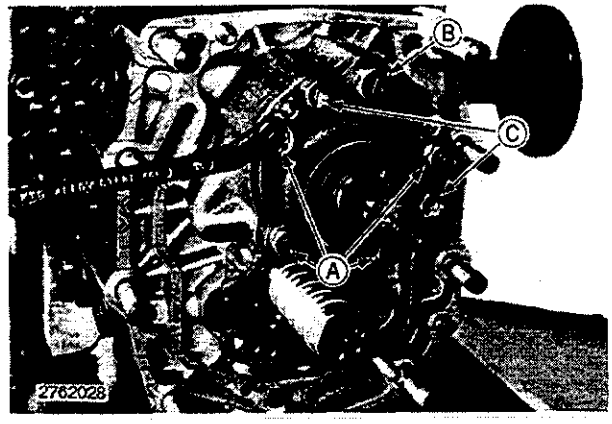
A – Seal Ring (5 used)
B – Clutch Shaft



Power Shift Pump

3. Remove four cap screws (A) and one cap screw (B). Do not remove two cap screws (C) if pump shall not be disassembled.

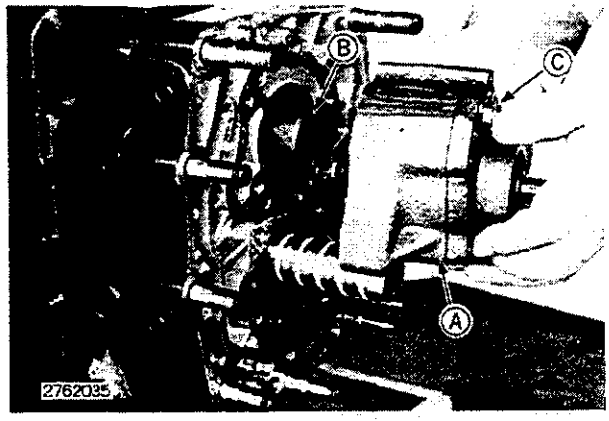
A – Cap Screw (4 used)
B – Cap Screw (1 used)
C – Pump Cover Retaining Screws



STOP Always remove the oil manifold first when removing pump.

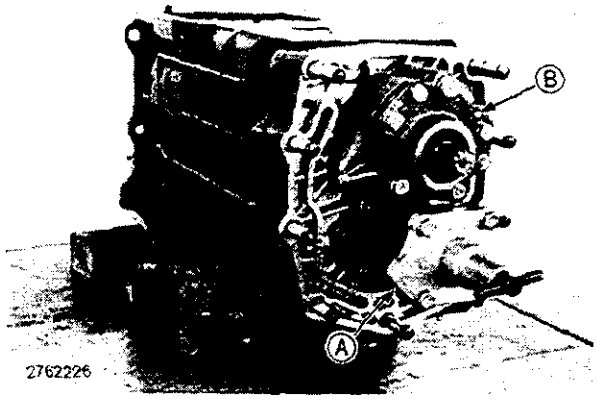
4. Remove pump and splined coupler (B).

A – Pump
B – Splined Coupler
C – Pump Cover Retaining Screw



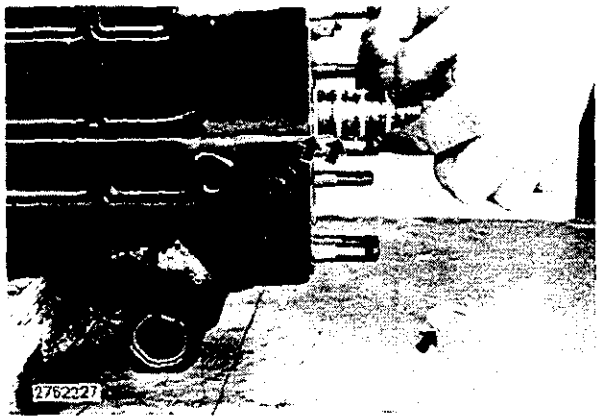
COMPONENT REMOVAL

Power Shift Assembly

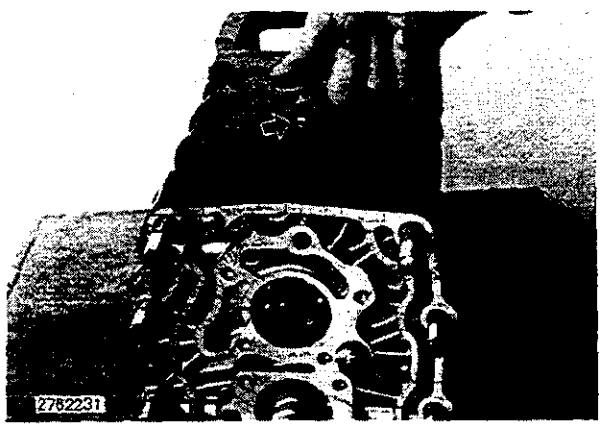


1. Remove oil manifold (A) and power shift pump (B). See page 50-10-5 for details.

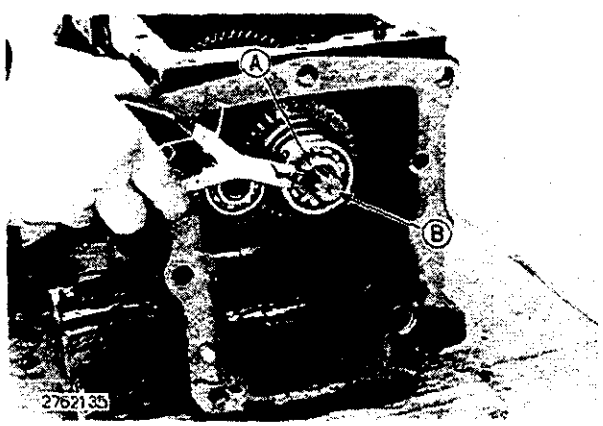
A – Oil Manifold
B – Power Shift Pump



2. Remove all seal rings (Arrows) by using fingers.



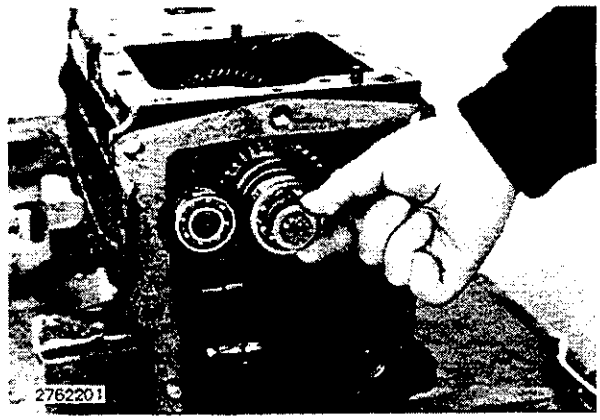
3. Remove 2nd relief valve to avoid damage during disassembly.



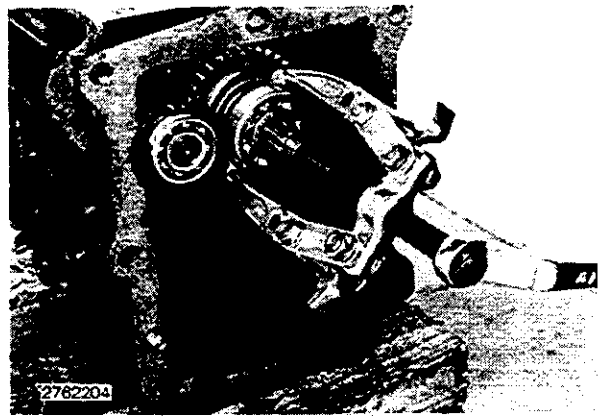
4. Remove snap ring (A) from the rear end of main shaft (B).

A – Snap Ring
B – Main Shaft

5. Remove washer from the main shaft.

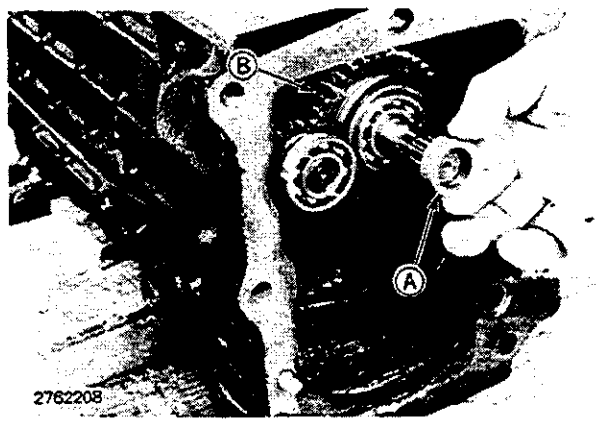


6. Use a puller to remove main shaft rear bearing.

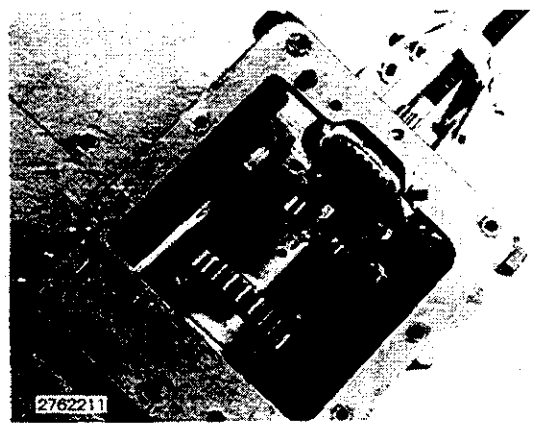


7. Remove spacer (A) in front of creep gear (B).

A – Spacer
B – Creep Gear

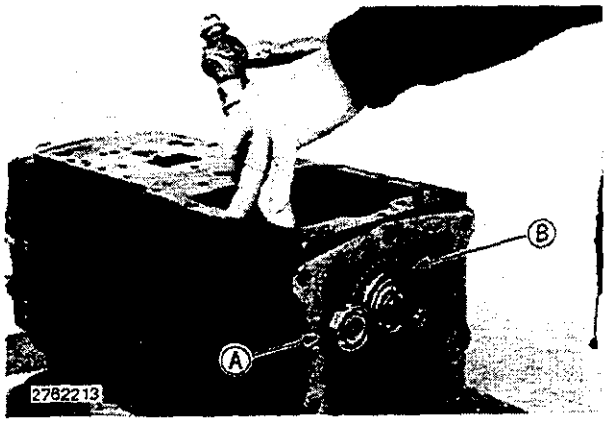


8. Use a puller to remove creep gear.



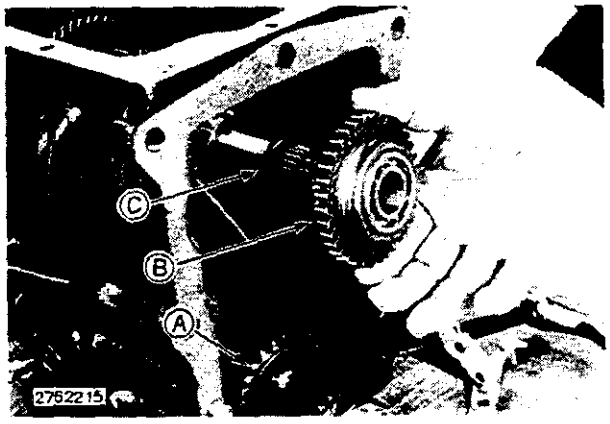
COMPONENT REMOVAL

Power Shift Assembly (Continued)



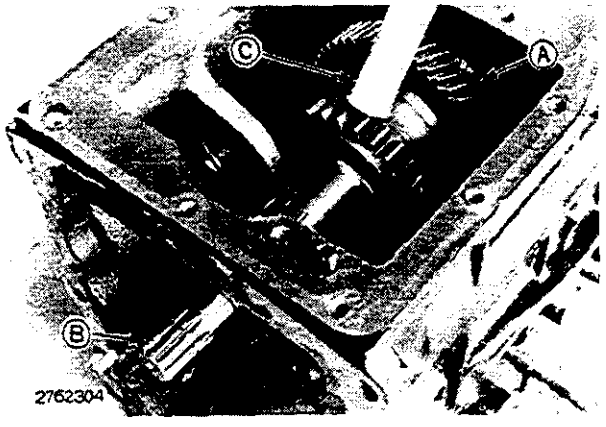
9. Strike creep reduction gear (A) with a soft metal and hummer.

A – Creep Reduction Gear
B – Creep Gear



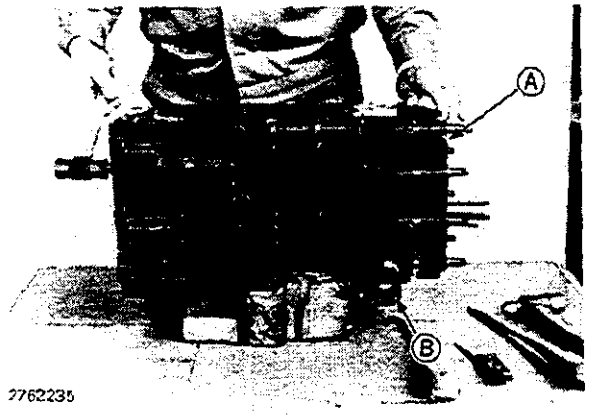
10. Remove creep reduction gear (A), creep gear (B) and thrust washer (C).

A – Creep Reduction Gear
B – Creep Counter Gear
C – Thrust Washer



11. Strike counter gear (A) to loosen it from the main shaft (B).

A – Counter Gear
B – Main Shaft
C – Soft Metal

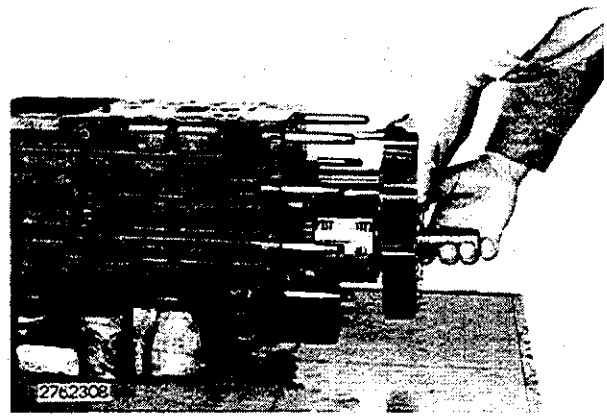


12. Strike main shaft with a soft metal or copper hammer until center plate (A) separates from transmission case (B).

    Give several shocks around the side of center plate to separate smoothly from transmission case.

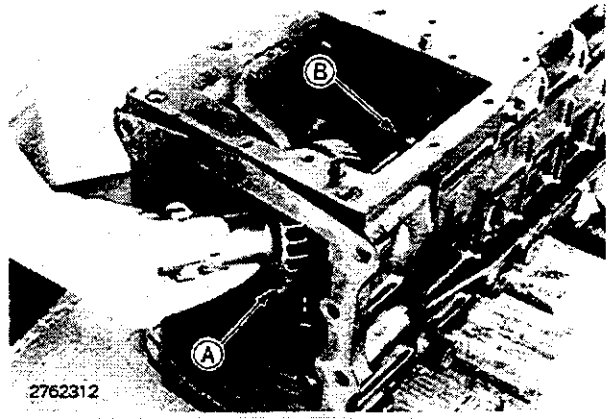
A – Center Plate
B – Transmission Case

13. When center plate comes approximately 25 mm (one inch) grasp the front end of clutch shaft and center plate, and pulling the transmission assembly out by hand. Do not pull out completely at this moment.



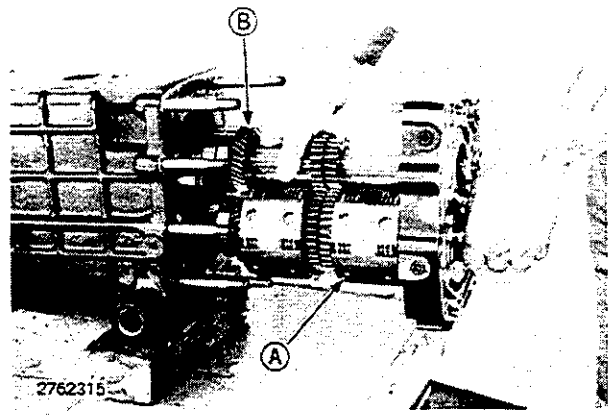
14. Remove counter cluster gear (A) from rear of transmission case when the power shift transmission assembly is pulled out about 180 mm (7 in.).

A – Counter Cluster Gear
B – Main Shaft

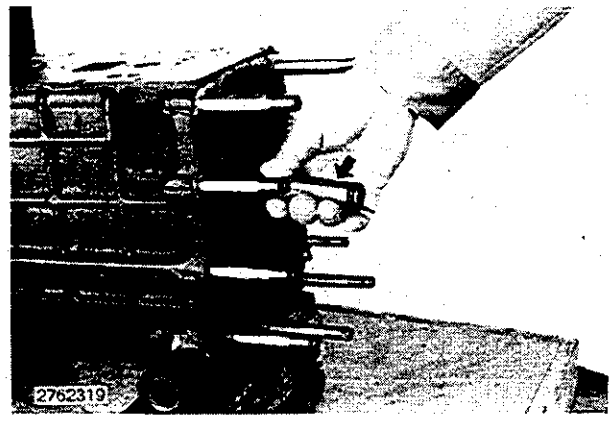


15. Continue pulling out and remove the power shift (A) and main shaft assembly (B) from the transmission case.

A – Power Shift Assembly
B – Main Shaft Assembly

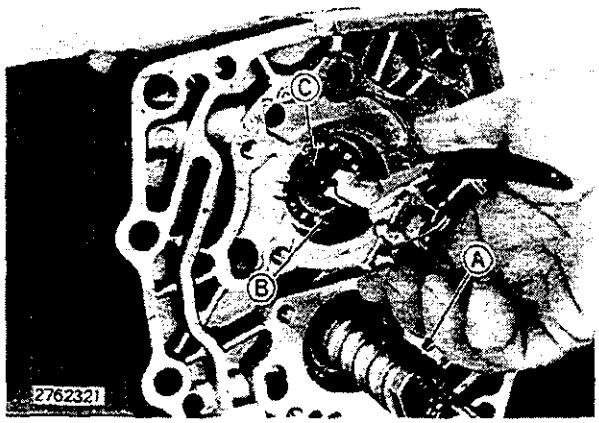


16. Remove oil suction pipe from the transmission case.



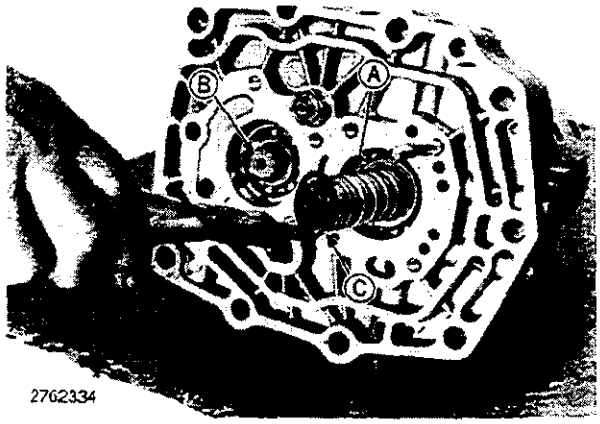
COMPONENT REMOVAL

Power Shift Assembly (Continued)



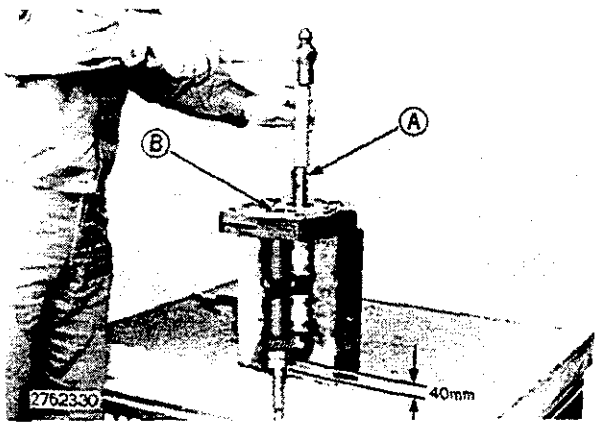
17. Remove snap ring (C) in main shaft (B).

A – Clutch Shaft
B – Main Shaft
C – Snap Ring



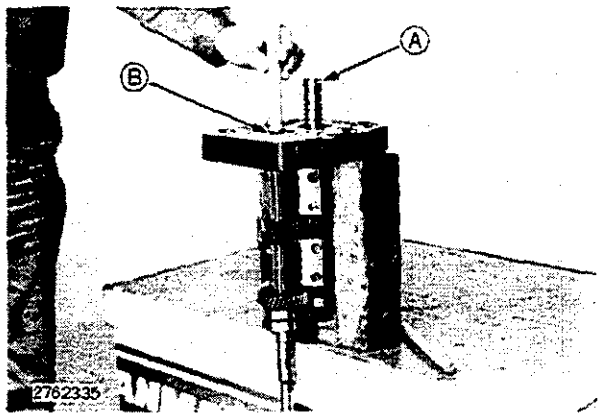
18. Remove snap ring (C) in a clutch shaft (A).

A – Clutch Shaft
B – Main Shaft
C – Snap Ring



19. Support center plate as shown in L.H. photo and place wood or soft material below the end of clutch shaft to prevent shaft assembly damage when falling it down, the clearance between clutch shaft and wood should be the same thickness as center plate.

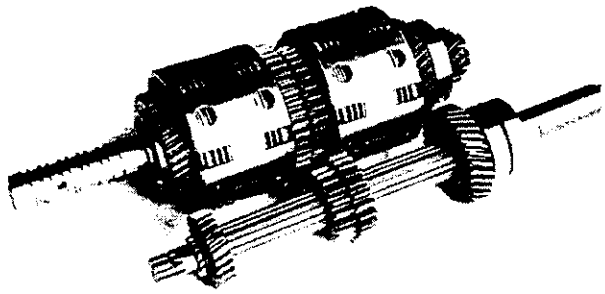
20. Drive clutch shaft (A) and main shaft (B) with soft metal (C) using hammer.



21. Drive at alternately the two shafts.

22. Set the transmission assembly on a clean table.

Note power shift transmission is very sensitive mechanism, and keep away them from any dirt or contaminations.

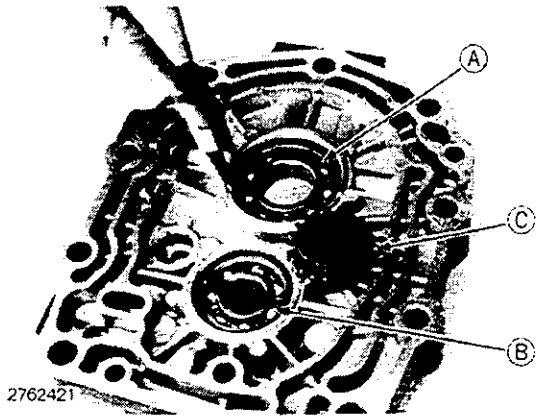


2762404

Center Plate

1. Remove snap rings from the bores of clutch shaft bearing (A) and main shaft bearing (B).

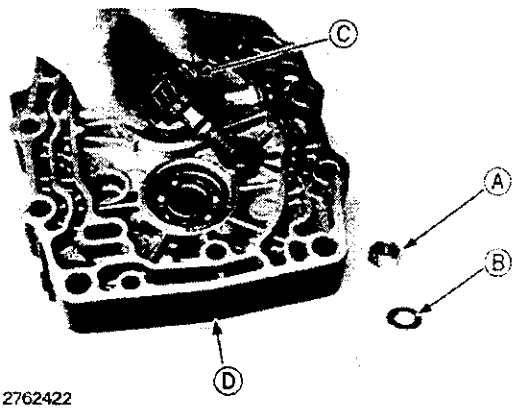
A – Clutch Shaft Bearing
B – Main Shaft Bearing
C – Reverse Idle Gear



2762421

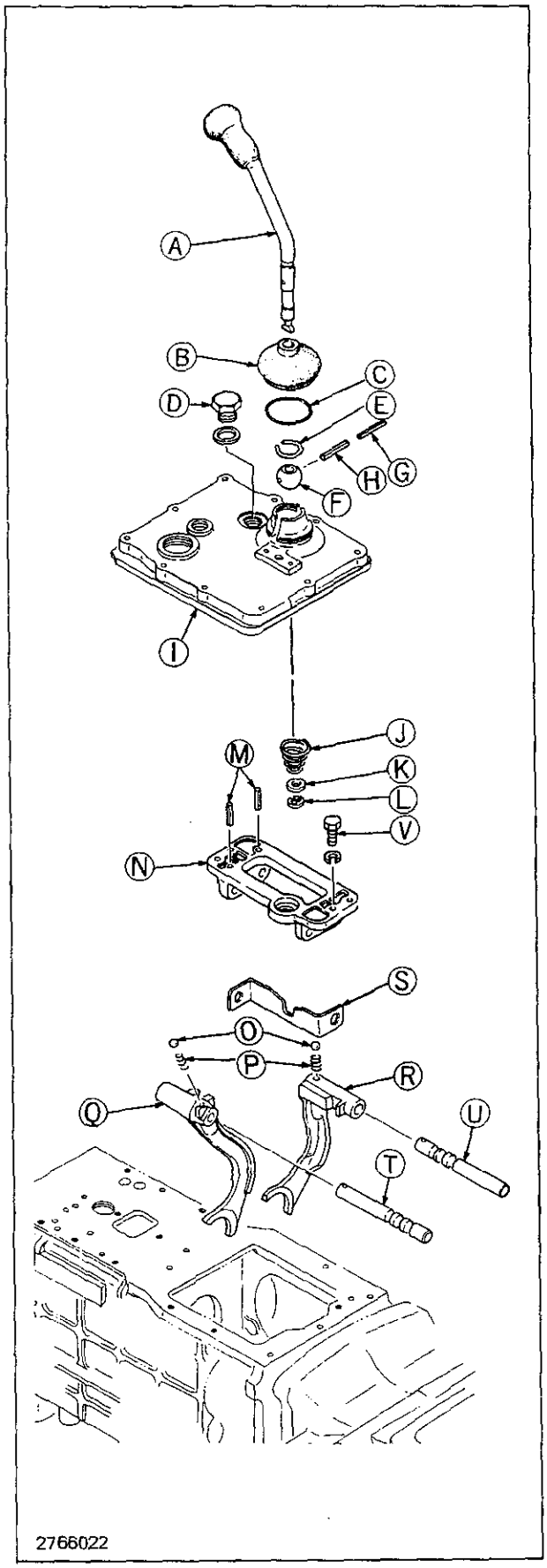
2. Remove lock nut (A) and washer (B).
Remove reverse idle gear (C) and all bearings from the center plate (D).

A – Lock Nut
B – Washer
C – Reverse Idle Gear
D – Center Plate



2762422

RANGE SHIFT LEVER



DISASSEMBLY AND INSPECTION

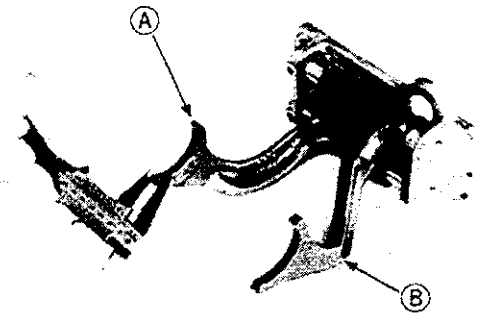
1. Replace any damaged retaining rings and spring pin (G).
2. Examine finished I.D. of cover (D). Replace if scored of excessively worn.
3. Check plastic ball (F) for cracks, chips or wear and replace if necessary.
4. Lever (A) should be replaced if finished area at lower end (which contacts shifter forks) is damaged or worn.
5. Replace boot (B) and O-ring (C) if they show any sign of stress or cracking, or if they do not fit snugly over retainer and lever.
6. Inspect spring (J) for damage or wear.

A — Range Shift Lever
B — Rubber Boot
C — O-ring
D — Plug
E — Circlip
F — Lever Ball
G — Spring Pin
H — Spring Pin
I — Shifter Cover
J — Spring
K — Washer
L — "E" Type Snap Ring
M — Spring Pin
N — Fork Shaft Support
O — Detent Ball
P — Detent Spring
Q — C-1st Range Shift Fork
R — 2nd-3rd Range Shift Fork
S — Guide Plate
T — C-1st Fork Shaft
U — 2nd-3rd Fork Shaft
V — Cap Screw

7. Inspect shift fork (Q and R). End of fork thickness is 6.8 to 6.9 mm (0.268 to 0.272 in.). Width of range sliding gear collar grooves is 8.1 to 8.3 mm (0.319 to 0.327 in.).

   Replace when clearance between fork and gear groove is 1 mm (0.004 in.).

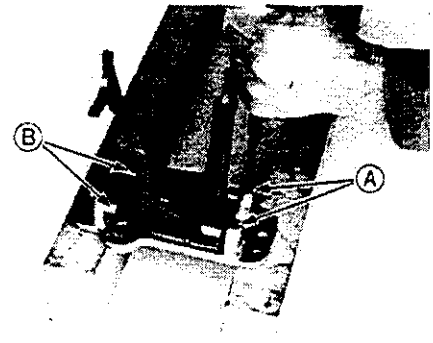
   A – 2nd-3rd Shift Fork
   B – C-1st Shift Fork



2763627

8. Remove two spring pins (A) from the fork shafts (B).

   A – Spring Pins
   B – Fork Shafts



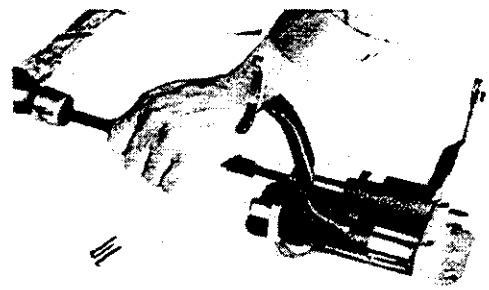
2763629

9. Remove guide plate (A) from the fork shaft support (B).

   A – Guide Plate
   B – Fork Shaft Support

2763631

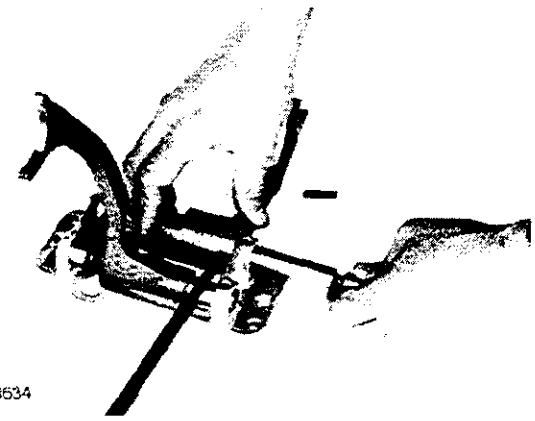
10. Push the shafts using a spring pin driver.



2763633

RANGE SHIFT LEVER

DISASSEMBLY AND INSPECTION (Continued)



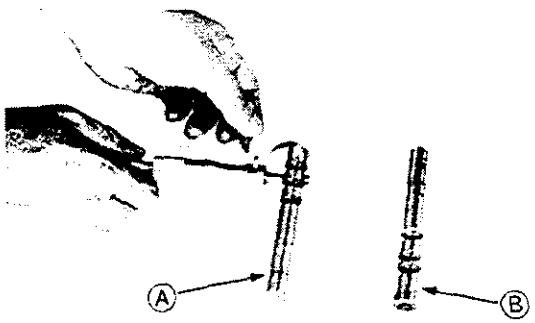
2763634

11. Use a spring pin driver to avoid the steel ball is jumping out before removing the shaft.

    Inspect detent spring.
    Replace if free length is less than 0.839 in. (21.3 mm).

DETENT SPRING SPECIFICATIONS

Free Length	Working Load
0.874 in. (22.2 mm)	0.618 in. at 26.9 lbs. (15.7 mm at 122 N)

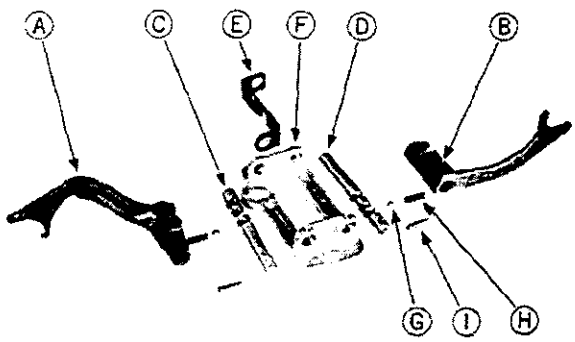


2763707

12. Measure O.D. of fork shafts.

    Replace parts when clearance between shaft (T and U) and forks is 0.12 mm (0.005 in.). O.D. of shaft is 14.96–14.98 mm (0.5892 to 0.5899 in.). I.D. of fork is 15.00–15.04 mm (0.5906 to 0.5922 in.).

A – C-1st Shifter Shaft
B – 2nd-3rd Shifter Shaft



2763701

13. Inspect all components of shift fork assembly.

A – C-1st Shift Fork
B – 2nd-3rd Shift Fork
C – C-1st Fork Shaft
D – 2nd-3rd Fork Shaft
E – Guide Plate
F – Fork Shaft Support
G – Detent Ball
H – Detent Spring
I – Inter Lock Pin

2763706

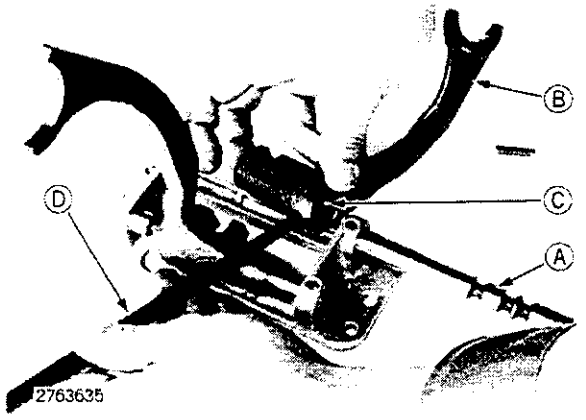
14. Measure width of shift lever groove in the each fork. Replace fork if the width exceed 14 mm (0.551 in.).

ASSEMBLY

Forks and Shafts

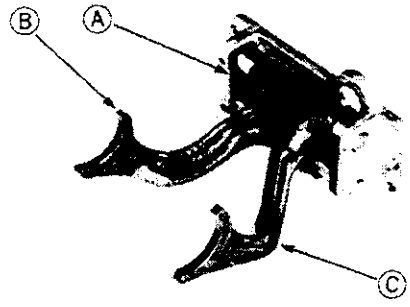
1. Install forks and shafts to the fork shaft support when installing the shaft (A) to the fork (B). Compress spring and detent ball (C) with a spring pin driver (D).

A – Fork Shaft
B – Fork
C – Detent Ball
D – Spring Pin Driver



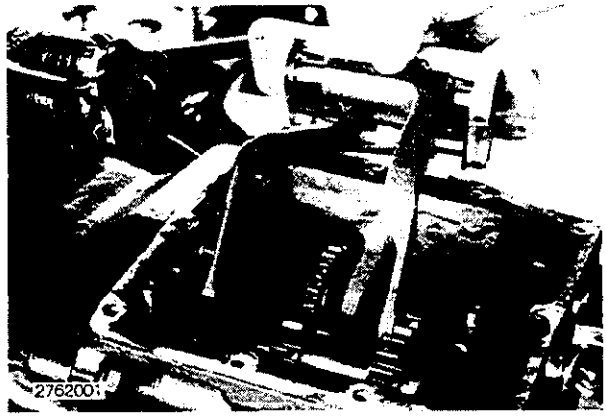
2. Make sure all parts are installed in their correct locations.

A – Guide Plate
B – 2nd-3rd Shift Fork
C – C-1st Shift Fork

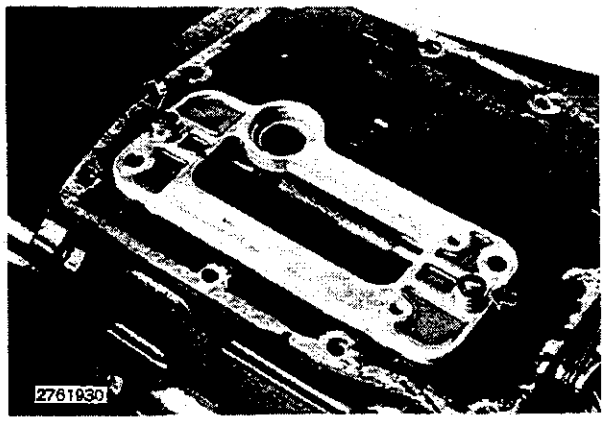


2763626

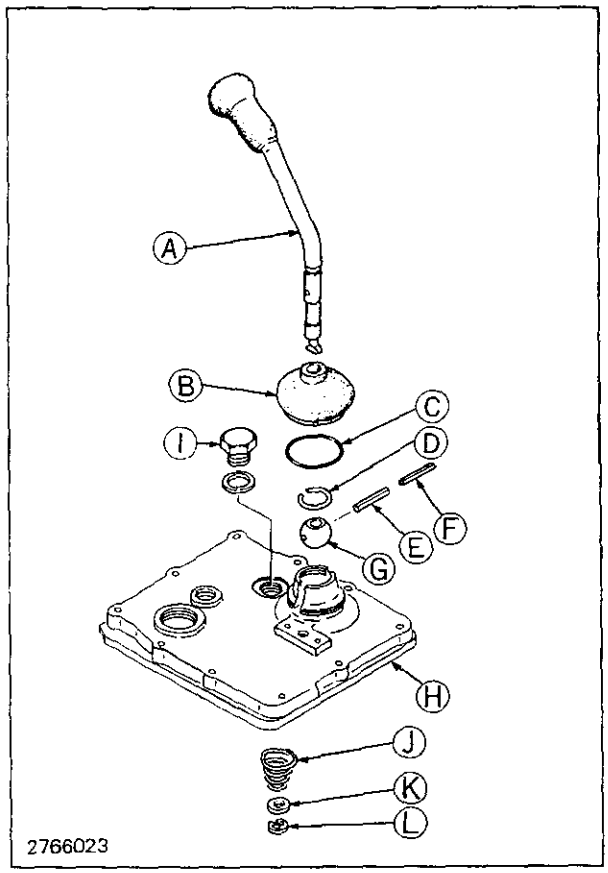
3. Install the fork shaft assembly in the transmission case. Make sure the forks and gears are in their neutral positions.



4. Tighten two cap screws (Arrows) to 25 Nm (2.5 kgm) (22 ft-lbs).



RANGE SHIFT LEVER

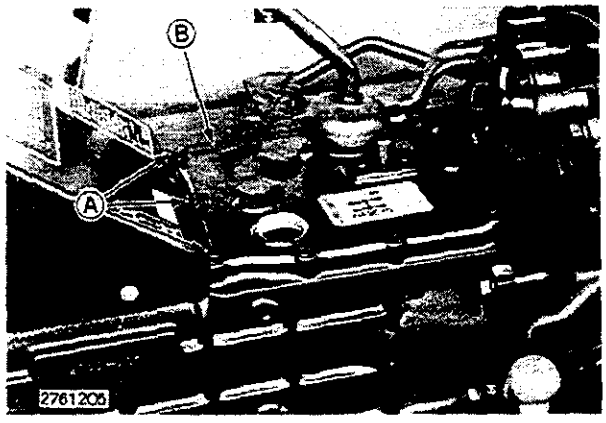


ASSEMBLY (Continued)

Shift Lever

1. Insert plastic ball (G) over lever (A) and install spring pins (E, F) through ball hole and lever hole.
   a) Install spring pin (E) so its split side faces up on the lever.
   b) The spring pin is 40 mm (1–7/16 in.) long and should protrude equally from each side of the ball.
2. Install the lever ball into the lever cover (H) and install retaining circlip (D) in the groove.
3. Install spring (J) with its larger end facing up on the lever.
4. Retain the spring with washer (K) and snap ring (L). Be sure snap ring is seated properly in the lever groove.
5. Install packing on bottom of lever cover (H). Be sure to coat gasket with sealant.

A – Range Shift Lever
B – Rubber Boot
C – O-ring
D – Circlip
E – Spring Pin
F – Spring Pin
G – Plastic Ball
H – Shifter Cover
I – Plug
J – Spring
K – Washer
L – "E" Type Snap Ring



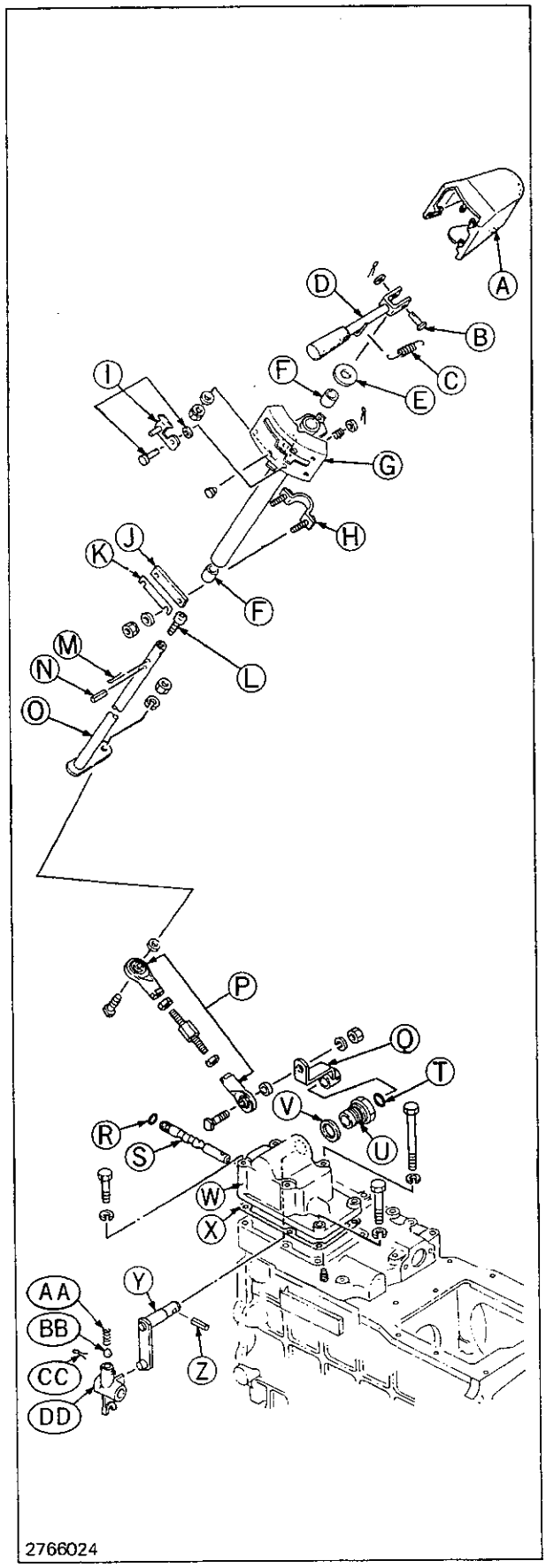
6. Install Shifter cover (B) to the transmission case and tighten cap screws (A) to 25 Nm (2.5 kgm) (22ft-lbs).

A – Cap Screw (10 used)
B – Shifter Cover

POWER SHIFT LEVER

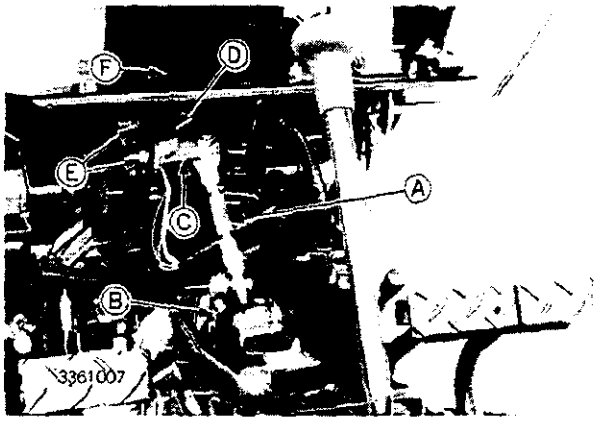
DISASSEMBLY AND INSPECTION

Refer the R.H. illustration before disassembly.



A – Cover
B – Pin
C – Spring
D – Power Shift Lever
E – Washer
F – Bushing (2 used)
G – Lever Guide
H – Clamp
I – Neutral Lock
J – Plate
K – Shim
L – Screw
M – Cotter Pin
N – Spring Pin
O – Lever Shift Arm
P – Shifting Rod
Q – Rod Shift Arm
R – O-ring
S – Shift Fork Shaft
T – O-ring
U – Holder
V – Packing
W – Shifter Cover
X – Packing
Y – Fork Shift Arm
Z – Spring Pin
AA – Detent Spring
BB – Detent Ball
CC – Cotter Pin
DD – Shift Fork

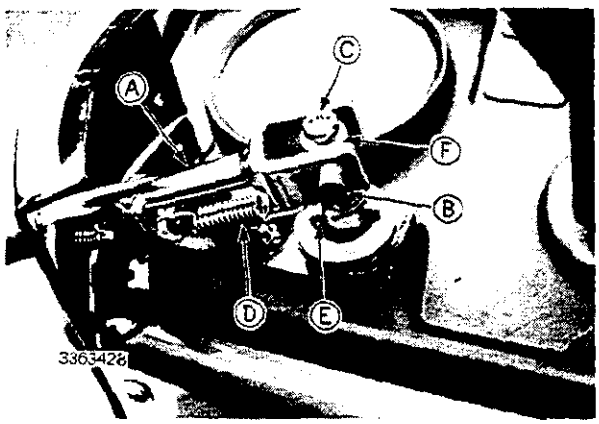
POWER SHIFT LEVER



DISASSEMBLY AND INSPECTION

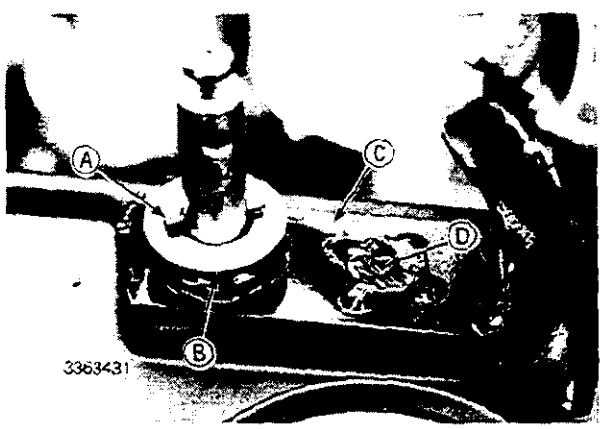
1. Disconnect shifting rod (A) from rod shift arm (B).
2. Disconnect shifting rod from lever shift arm (C).
3. Remove clamp (D) removing two nuts (E) to be free lever guide (F) from lower end.
4. Inspect shifting rod ball joints for wear.

A – Shifting Rod
B – Rod Shift Arm
C – Lever Shift Arm
D – Clamp
E – Nuts
F – Lever Guide



5. Remove cover from top of lever guide (Not illustrated).
6. Remove shift lever hinge pin (B) after loosening set screw (C). Remove spring (D) and cotter pin (E) from lever shift arm (F).

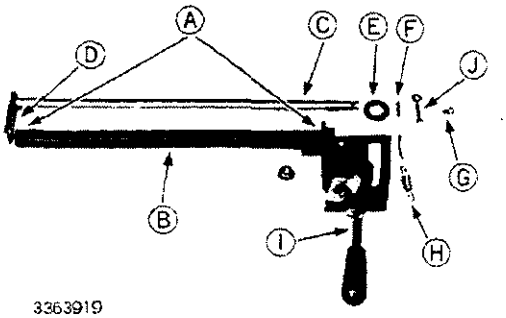
A – Power Shift
B – Hinge Pin
C – Pin Set Screw
D – Spring
E – Cotter Pin
F – Lever Shift Arm



7. Drive spring pin (A) out of lever guide (C), and remove washer (B).
8. Remove guide-to-instrument panel retaining nut which located behind retaining bolt (welded) (D).
9. Lift lever guide to separate from lever shift arm in it.

A – Spring Pin
B – Washer
C – Lever Guide
D – Guide Retaining Bolt

10. Inspect lever shift arm bushings (A) in both lower and upper ends of lever guide (B) for wear. Bushing I.D. should be 13.033 to 13.113 mm (0.5131 to 0.5163 in.). Replace bushing if I.D. exceeds 13.5 mm (0.513 in.).



3363919

A – Bushings (2 used)
B – Lever Guide
C – Lever Shift Arm
D – Shift Arm Lower Bore
E – Washer
F – Spring Pin
G – Set Screw
H – Spring
I – Shift Lever
J – Lever Hinge Pin

11. Inspect lever shift arm (C) for wear. O.D. of shift arm shaft should be 12.80 to 12.85 mm (0.504 to 0.506 in.). Replace shaft if O.D. is less than 12.5 mm (0.492 in.). Clearance between bushing and shaft should be 0.18 to 0.31 mm (0.007 to 0.012 in.). Replace parts if clearance exceeds 0.5 mm (0.02 in.).

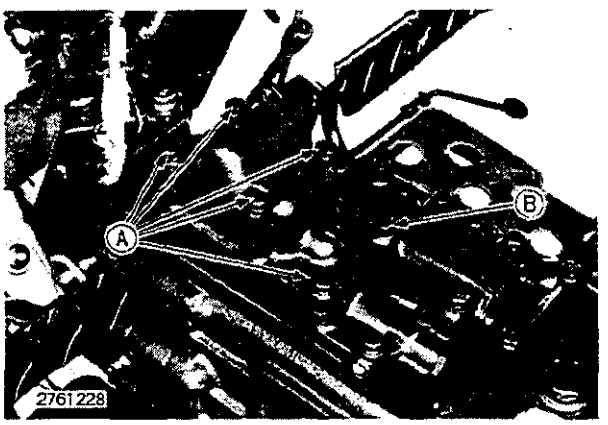
12. Inspect spring pin bore of shift arm shaft for wear.

13. Inspect spring pin (F), washer (E), spring (H) and hinge pin (J) for wear or damage. Replace as required.

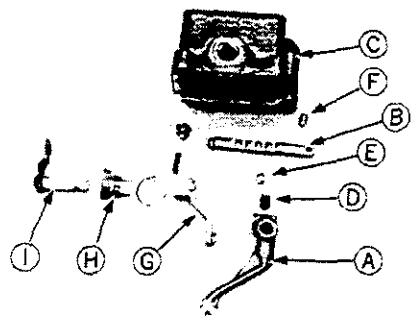
14. Inspect shifting rod connecting bore (D) on lever shift arm (C) for wear or damage. Replace lever shift arm if excessively worn.

15. Remove six cap screws from shifter cover. Remove shifter cover assembly from regulator case.

    The cap screw (B) must use a sealed washer (Rubber coated), because the bore goes through the regulator case and transmission case.



2761228



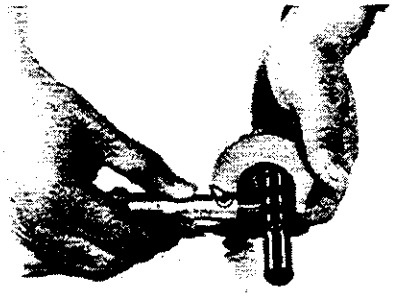
3362636

16. Inspect shift fork (A). End of fork thickness is 6.7 to 6.9 mm (0.264 to 0.272 in.). Width of speed control valve spool is 7.1 to 7.2 mm (0.264 to 0.272 in.).

    Replace shift fork when clearance between fork and valve spool is 1 mm (0.04 in.).

17. Replace parts when clearance between fork shaft (B) and fork (A) is 0.2 mm (0.008 in.). O.D. of shaft is 11.97 to 11.98 mm (0.4711 to 0.4718 in.). I.D. of fork is 12.00 to 12.03 mm (0.4725 to 0.4735 in.).

A – Fork
B – Fork Shaft
C – Shifter Cover
D – Detent Spring
E – Ball
F – Seat Screw
G – Fork Shift Arm
H – Holder
I – Rod Shift Arm



2200626

18. Inspect detent spring.
    The specifications as follow:

DETENT SPRING SPECIFICATIONS

Free length	Working Load
13.6 mm (0.535 in.)	9.3 mm at 63.4 N (0.366 in. at 14.0 lbs.)

2200625

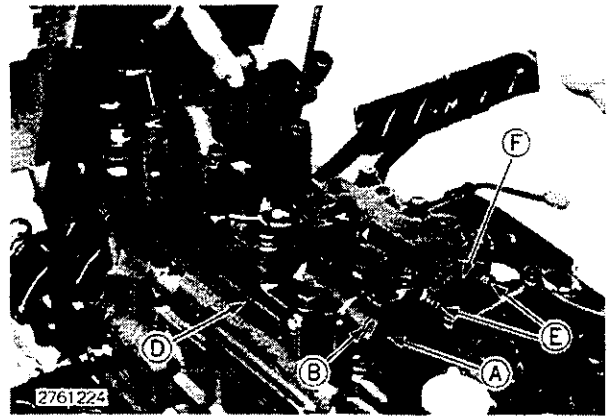
19. Inspect fork shift arm end for wear or damage. O.D. of arm end should be 9.964 to 10.000 mm (0.3923 to 0.3937 in.). Clearance between shift arm and shift fork groove should be 0.1 to 0.336 mm (0.004 to 0.013 in.). Replace parts if clearance exceeds 0.5 mm (0.02 in.).

REGULATOR CASE

DISASSEMBLY

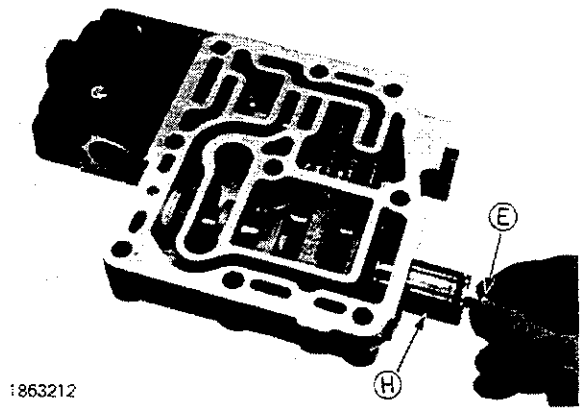
Delay Relief Valve (DRV) and Main Relief Valve

1. Remove plug (A) and copper washer (B), and pull valve spool out of regulator case (D).
2. Remove two cap screws (E) and end plate (F).



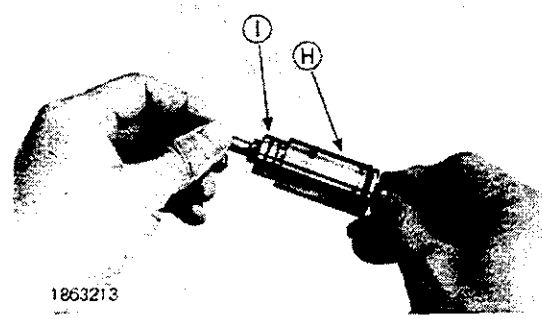
3. Install cap screw (E) to sleeve (H) and pull it out by hand.

E – Cap Screw
H – Sleeve

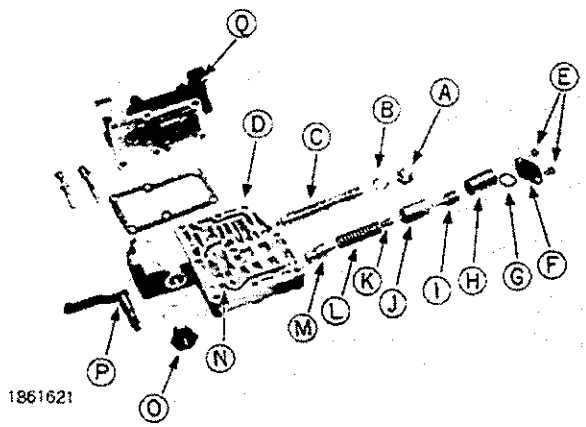


4. Pull valve body (DRV) (I) out of sleeve (H).
5. Remove two springs (K, L) and main relief valve body (M) from sleeve (N).

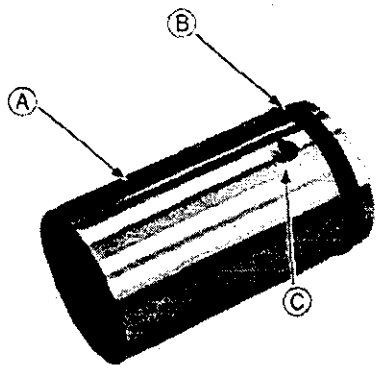
H – Sleeve
I – Valve Body (DRV)



A – Plug
B – Copper Washer
C – Valve Spool
D – Regulator Case
E – Cap Screws
F – End Plate
G – O-Ring
H – Sleeve
I – Valve (DRV)
J – Sleeve
K – Spring
L – Spring
M – Main Relief Valve
N – Sleeve
O – Arm Holder
P – Shift Arm
Q – Shifter Cover



REGULATOR CASE



1863214

INSPECTION

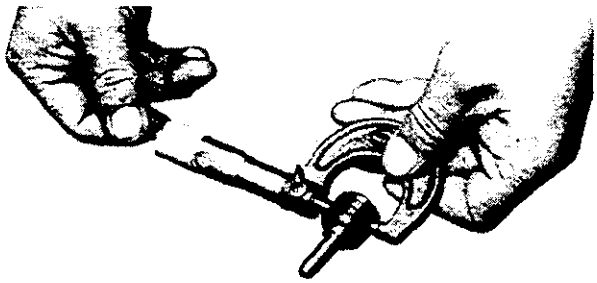
Delay Relief Valve

1. Inspect O-ring (B) on sleeve (A).
2. Inspect orifice (C) for clog. If it is clogged with dirt, wash in clean solvent and blow by pressurized air. Coat cleaned part with a thin film of oil.

A – DRV Sleeve
B – O-Ring
C – Orifice

1861627

3. Measure I.D. of DRV sleeve.

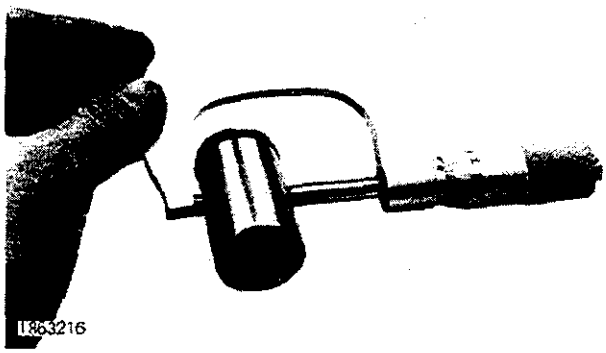


1861626

4. Measure O.D. of DRV body.

DRV SPECIFICATIONS

Item	New Part	Wear Limit
DRV Sleeve I.D.	20.00 to 20.009 mm (0.7874 to 0.7877 in.)	
DRV body O.D.	19.983 to 19.99 mm (0.7867 to 0.7870 in.)	
Clearance between DRV Sleeve and Body	0.010 to 0.026 mm (0.0004 to 0.0010 in.)	0.045 mm (0.0018 in.)



1863216

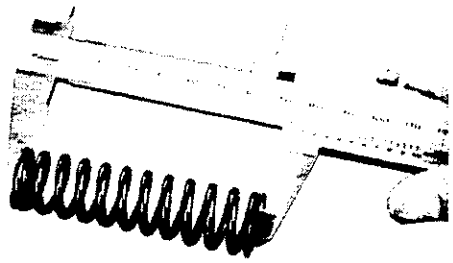
5. Measure O.D. of DRV sleeve and I.D. of regulator case bore for DRV sleeve. Compare measurements taken to the following specifications.

DRV SPECIFICATION

Item	New Part	Wear Limit
DRV Sleeve O.D.	24.97 to 24.98 mm (0.9833 to 0.9836 in.)	
DRV Sleeve Bore of Regulator Case	25.00 to 25.02 mm (0.9842 to 0.9850 in.)	
Clearance between DRV Sleeve and Regulator Case	0.015 to 0.04 mm (0.0006 to 0.0017 in.)	0.060 mm (0.0024 in.)

Spring

Inspect outer spring.

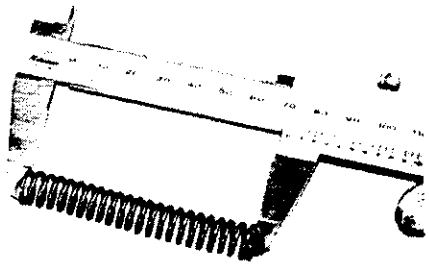


3362408

Inspect inner spring. The specifications are as follows:

SPRING SPECIFICATIONS

Item	Free Length	Working Load
Outer Spring	64.5 to 65.5 mm (2.54 to 2.57 in.)	41.5 mm at 271 N (1.63 in. at 59.8 lbs.)
Inner Spring	54 to 55 mm (2.13 to 2.16 in.)	38.5 mm at 145 N (1.52 in. at 32.0 lbs.)

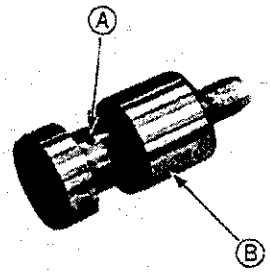


3362409

Main Relief Valve

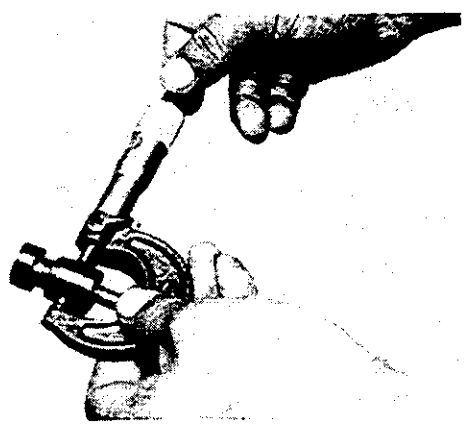
1. Inspect orifice (A) for clog. If it is clogged, wash in clean solvent and blow by pressurized air. Coat cleaned part with a thin film of oil when installing.

A – Orifice
B – Main Relief Valve



1863215

2. Measure I.D. and O.D. of main relief valve sleeve and I.D. of regulator case bore (Not illustrated).
3. Measure O.D. of main relief valve body. Compare measurement taken to the following specifications.



1861625

REGULATOR CASE

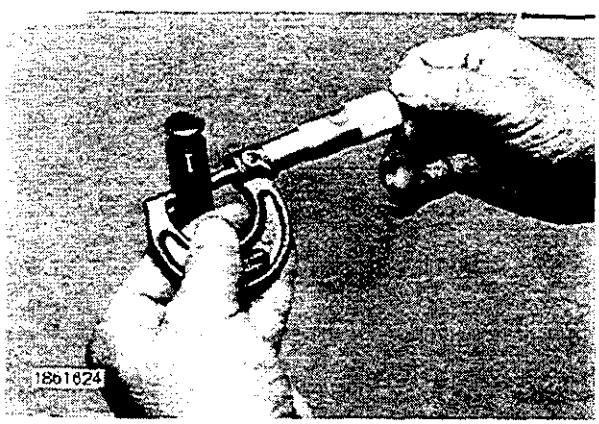
INSPECTION (Continued)

Main Relief Valve (Continued)

MAIN RELIEF VALVE SPECIFICATIONS

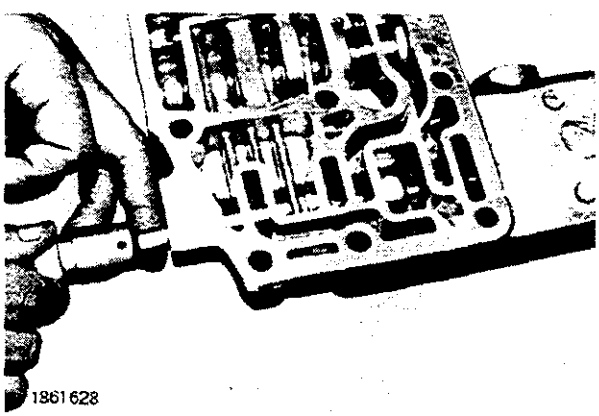
Item	New Part	Wear Limit
Sleeve I.D.	18.50 to 18.51 mm (0.7283 to 0.7289 in.)	
Valve Body O.D.	18.47 to 18.48 mm (0.7272 to 0.7275 in.)	
Clearance between sleeve and Body	0.020 to 0.043 mm (0.0008 to 0.0016 in.)	0.060 mm (0.0024 in.)
Sleeve O.D.	24.99 to 25.00 mm (0.9839 to 0.9842 in.)	
Sleeve Bore of Regulator Case	25.00 to 25.02 mm (0.9842 to 0.9850 in.)	
Clearance between Sleeve and Regulator Case	0 to 0.03 mm (0 to 0.0011 in.)	0.050 mm (0.0020 in.)

4. Check number of shims behind the outer spring. When increasing operating pressure of clutches, add shim(s). A shim (0.5 mm) can control the pressure.



Power Shift Valve Spool

1. Measure O.D. of valve spool.



2. Measure I.D. of valve spool bore of regulator case. Compare measurements taken at step 1 and step 2 to the following specifications.

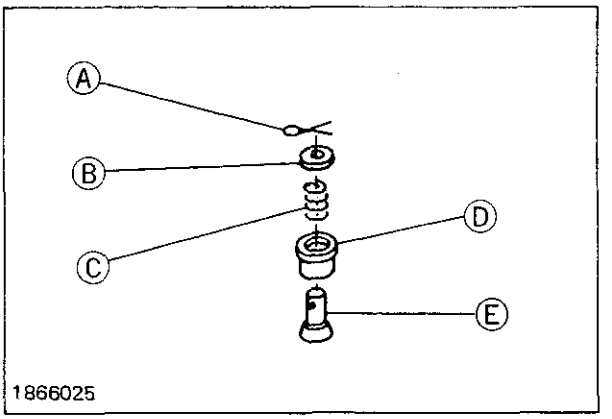
POWER SHIFT VALVE SPOOL SPECIFICATIONS

Item	New Part	Wear Limit
Valve Spool O.D.	16.007 to 16.025 mm (0.6302 to 0.6309 in.)	
Fork Groove Width of Spool	7.1 to 7.2 mm (0.280 to 0.283 in.)	
Spool Bore of Regulator Case	15.975 to 15.987 mm (0.6289 to 0.6294 in.)	
Clearance between Spool and regulator Case	0.025 to 0.045 mm (0.0001 to 0.0017 in.)	0.06 mm (0.0024 in.)

Second Relief Valve

1. Inspect second relief valve body (E) and seat (D). Replace if their seating area were worn or scratched.

A – Cotter Pin
B – Washer
C – Spring
D – Valve Seat
E – 2nd Relief Valve

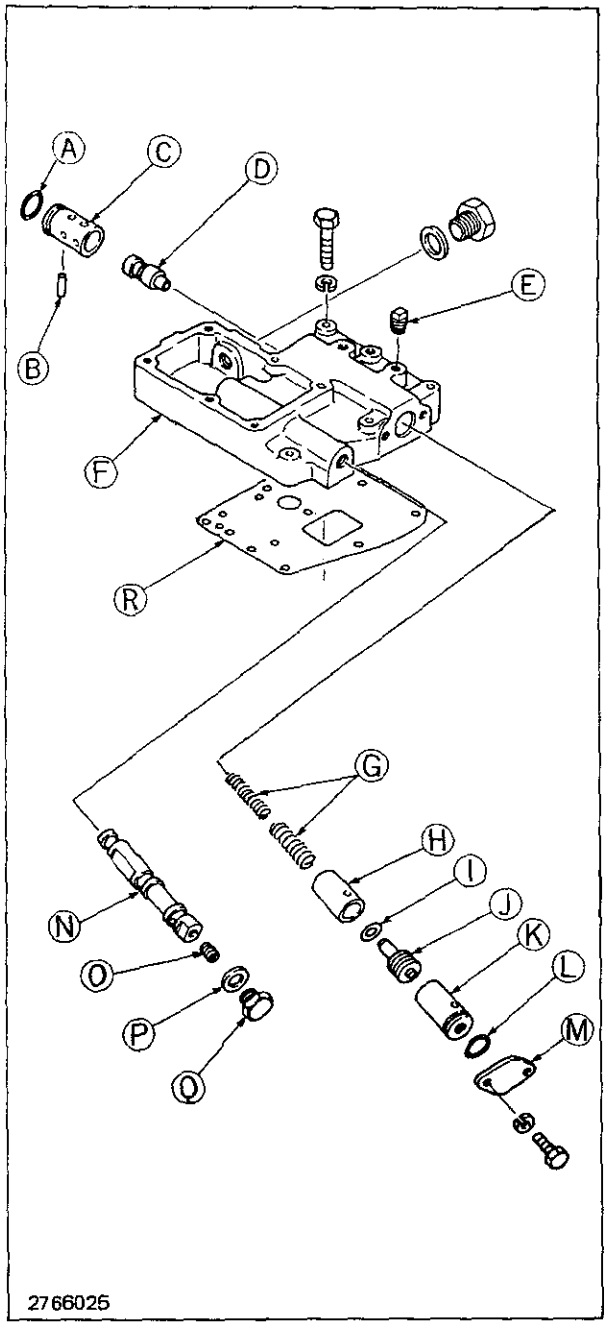


2. Measure spring (C) dimension and compare measurement taken to the following specifications.

SECOND RELIEF VALVE SPRING SPECIFICATIONS

Free Length	Loaded Length
16.3 mm (0.642 in.)	9.7 mm at 3.6 N (0.382 in. at 0.794 lbs.)

REGULATOR CASE



ASSEMBLY

1. Clean all parts solvent, and apply Transmission and Hydraulic Oil.
2. Install sleeve (C) in regulator case (F), and punch pin (B) in the case.
3. Check all O-rings for damage before installing. Replace if damaged or worn.
4. Install main and delay relief valve components (D to L) into the bore of regulator case in reverse sequence when disassembling.
5. Regulator case assembly and 2nd relief valve must be installed after installing power shift transmission assembly into transmission case.

STOP **Use new packing (R) when installing regulator case onto transmission case.**

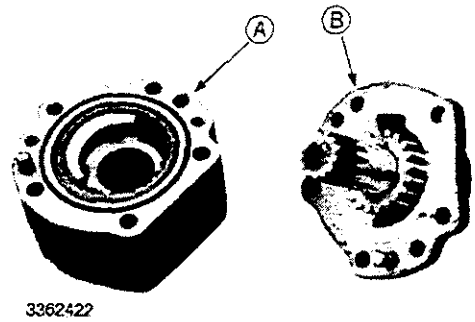
A – O-ring
B – Pin
C – Main Relief Valve Spool
D – Main Relief Valve
E – Plug
F – Regulator Case
G – Springs
H – Holder
I – Shims
J – Delay Relief Valve
K – Delay Relief Valve Sleeve
L – O-Ring
M – End Plate
N – Power Shift Valve Spool
O – Plug
P – Washer
Q – Plug
R – Packing

POWER SHIFT PUMP

DISASSEMBLY AND INSPECTION

1. Remove pump cover (A) from pump case (B).

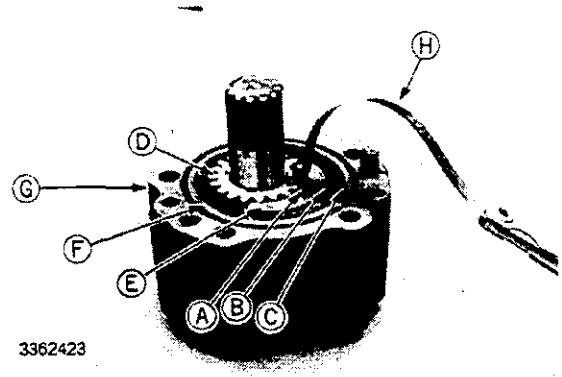
A – Pump Cover
B – Pump Case



3362422

2. Measure clearance (A) between inner gear (D) and inside face of separator (E).
3. Measure clearance (B) between outer ring gear (F) and outside face of separator (E).
4. Measure clearance (C) between outer ring gear (F) and pump case (G).

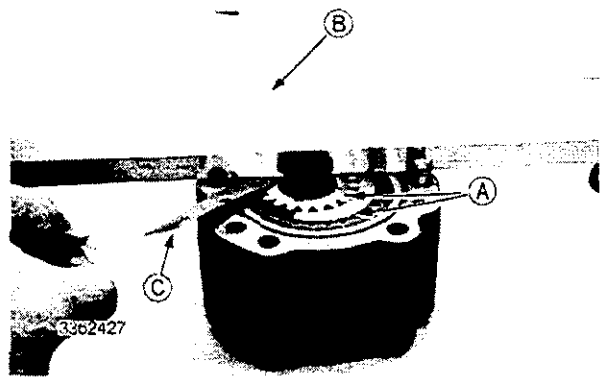
A – Clearance between Inner Gear and Separator
B – Clearance between Outer Gear and Separator
C – Clearance between Outer Gear and Pump Case
D – Inner Gear
E – Separator
F – Outer Ring Gear
G – Pump Case
H – Feeler Gauge



3362423

5. Measure clearance between pump case cover and pump gears using a straightedge and feeler gauge. Replace pump assembly if the measurement exceed 0.08 mm (0.003 in.).

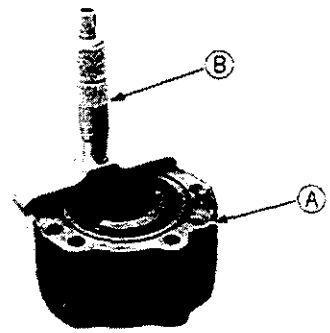
A – Pump Gears
B – Straightedge
C – Feeler Gauge



3362427

6. Measure depth for pump gears in pump case using depth micrometers.

A – Pump Case
B – Depth Micrometer



3362429

POWER SHIFT PUMP

DISASSEMBLY AND INSPECTION (Continued)

7. Measure thickness of inner gear.

3362433

8. Measure thickness of outer ring gear.

9. Use the following specifications when inspecting pump parts.

3362434

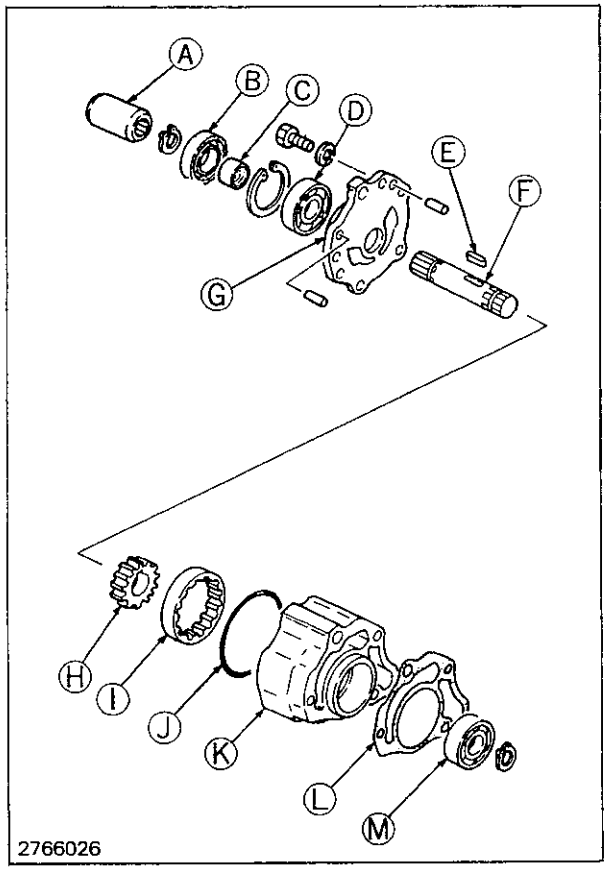
POWER SHIFT PUMP SPECIFICATIONS

Item	New Part	Wear Limit
Inner Gear (Drive gear) O.D.	42.95 to 42.97 mm (1.691 to 1.692 in.)	
Inner Gear Counter Bore at Separator	42.04 to 43.06 mm (1.694 to 1.6952 in.)	
Clearance between Inner Gear and Separator	0.065 to 0.110 mm (0.0026 to 0.0043 in.)	0.2 mm (0.0078 in.)
Outer Ring Gear I.D.	50.60 to 50.63 mm (1.969 to 1.993 in.)	
Outer Ring Gear Counter Bore at Separator	50.51 to 50.54 mm (1.989 to 1.990 in.)	
Clearance between Outer Ring Gear and Separator	0.060 to 0.120 mm (0.0024 to 0.0047 in.)	0.2 mm (0.0078 in.)
Outer Ring Gear O.D.	65.94 to 65.97 mm (2.596 to 2.597 in.)	
Outer Ring Gear Bore of Pump Case	66.00 to 66.03 mm (2.599 to 2.600 in.)	
Clearance between Outer Ring Gear and Pump Case	0.030 to 0.0090 mm (0.0012 to 0.0035 in.)	0.15 mm (0.0059 in.)
Inner and Outer Gear Bore (Depth) of Pump Case	7.995 to 8.005 mm (0.3148 to 0.3151 in.)	
Inner and Outer Gear Thickness	11.995 to 12.005 mm (0.4722 to 0.4726 in.)	
Clearance between Pump Case and Pump Gear Side	0.045 to 0.055 mm (0.0018 to 0.0021 in.)	0.080 mm (0.0031 in.)

ASSEMBLY

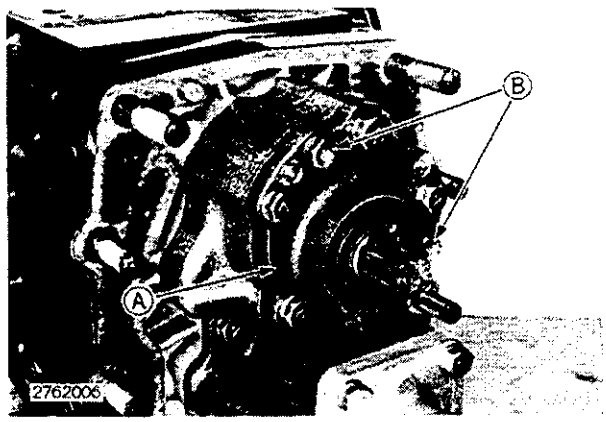
1. Clean parts and apply oil.
2. Inspect bearings (D, M) for wear.
3. Inspect oil seal (B) and seal collar (C) for wear or scoring.
4. Install O-ring (J) to pump case (K).
   Replace O-ring if it damaged.
5. Assemble two gears (H, I) in pump case (K).
6. Apply a little grease to oil seal rips (B).

A – Splined Coupler
B – Oil Seal
C – Seal Collar
D – Bearing
E – Key
F – Pump Shaft
G – Pump Cover
H – Inner Gear (Drive Gear)
I – Outer Ring Gear
J – O-Ring
K – Pump Case
L – Packing
M – Bearing

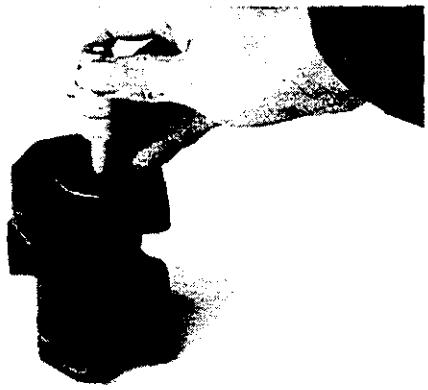


7. Install cover (A) and tighten two cap screws (B) to 25 Nm (2.5 kgm) (22 ft-lbs.).
8. Use a new packing when installing pump to center plate.

A – Pump Cover
B – Cap Screw (2 used)



OIL MANIFOLD (Seal Case)



2763120

A – Oil Manifold
B – Micrometer

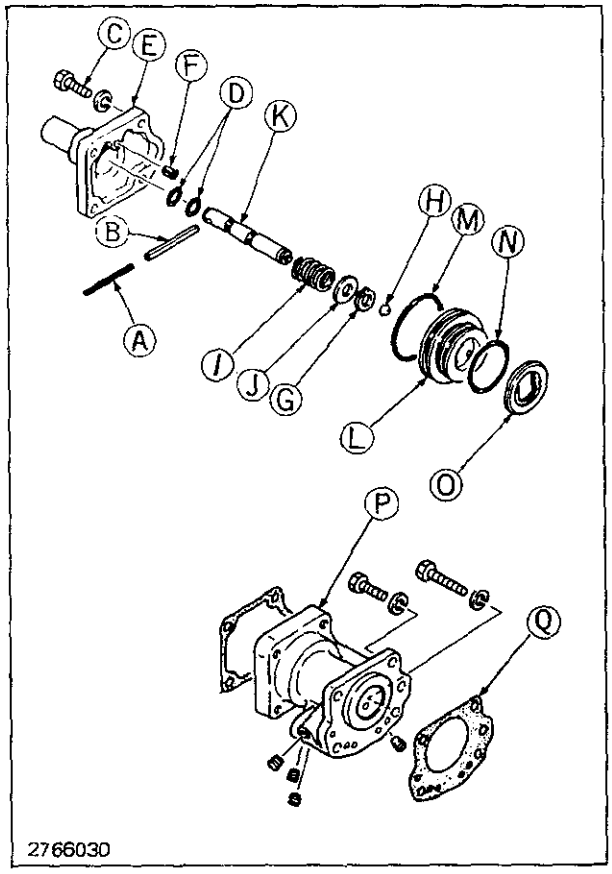
INSPECTION

1. Clean thoroughly manifold in solvent.
2. Check all oil passages for clog.
3. Measure I.D. of clutch shaft bore using cylinder gauge.
4. Measure at the several depths from the mounting surface.

   Compare measurements taken to the following specifications.

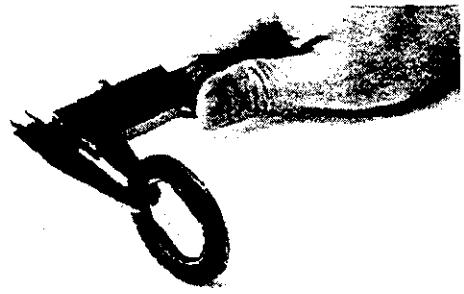
OIL MANIFOLD SPECIFICATIONS

Item	New Part	Wear Limit
Clutch Shaft Bore	30.15 – 30.20 mm (1.187 – 1.189 in.)	30.6 mm (1.204 in.)



2766030

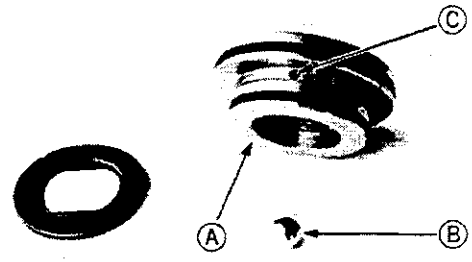
A – Spring Pin (5 mm)
B – Spring Pin (8 mm)
C – Cap Screw
D – O-ring
E – Oil Manifold Cover
F – Spring Pin
G – Snap Ring
H – Steel Ball
I – Brake Piston Spring
J – Washer
K – Release Shaft
L – Inertia Brake Piston
M – O-ring
N – O-ring
O – Brake Disk
P – Oil Manifold
Q – Packing



2763126

5. Inspect inertia brake disk for wear or damage. Thickness of brake disk should be 3.9 to 4.1 mm in. (0.154 to 0.161 in.). Replace if thickness is less than 3.5 mm (0.138 in.).

6. Inspect piston friction surface (A), ball (B) for wear or damage. Replace as necessary.
7. Inspect orifice (C) in the piston for clog.

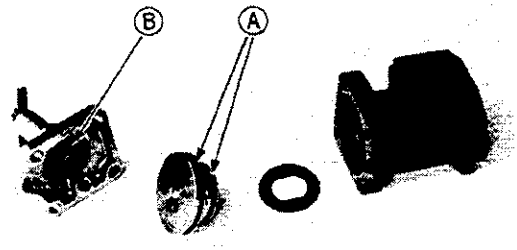


2763125

8. Inspect O-ring (A) for wear or damage. Replace as necessary.
9. Inspect piston spring (B).

PISTON SPRING SPECIFICATIONS

Free Length	Working Load
34 mm (1.339 in.)	26.4 mm at 955 N (1.04 in. at 215 lbs.)



2763123

ASSEMBLY

See "INSTALLATION" on page 50-10-58.

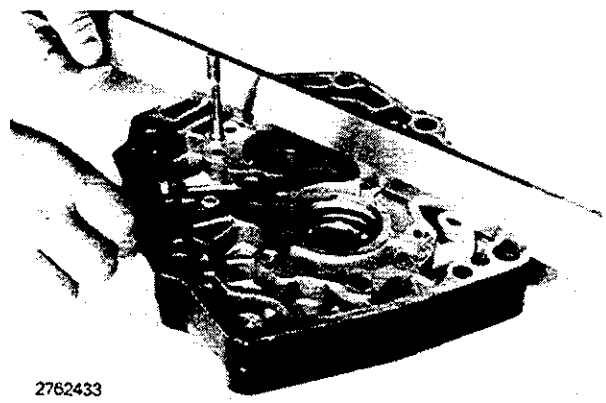
CENTER PLATE

INSPECTION

1. Wash plate in solvent and remove dirt and broken packing.

   Never use steel packing scraper to remove packing.
2. Inspect both surfaces of oil galley plate for distortion and scoring.
3. Measure flatness of surface using a straightedge and feeler gauge.

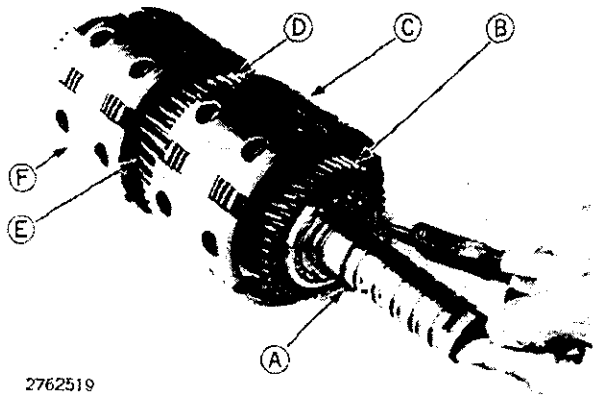
   Replace oil galley plate if surface is not flat to within 0.2 mm (0.008 in.).



2762433

CLUTCH PACK

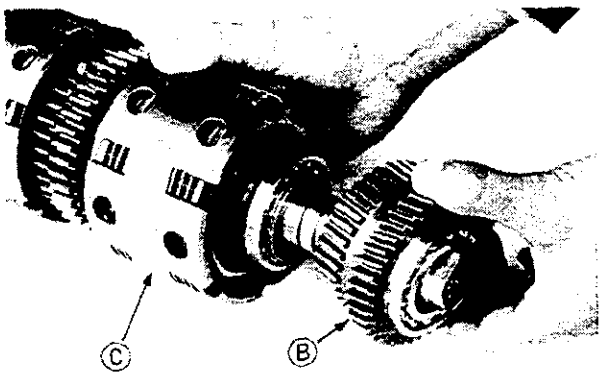
DISASSEMBLY



2762519

1. Remove snap ring (A) from the clutch shaft.

A – Snap Ring
B – Reverse Clutch Hub
C – R–1st Clutch Cylinder
D – 1st Clutch Hub
E – 2nd Clutch Hub
F – 2nd–3rd Clutch Cylinder

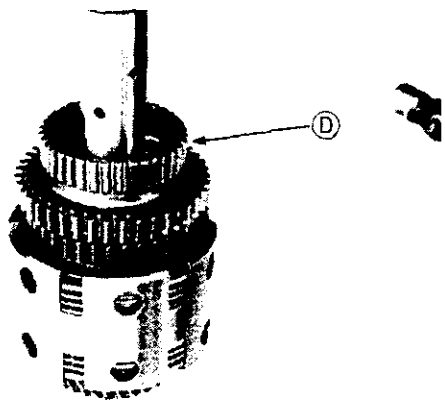


2762523

2. Remove reverse clutch hub with gear (B).
3. Remove Reverse – 1st clutch cylinder assembly (C).

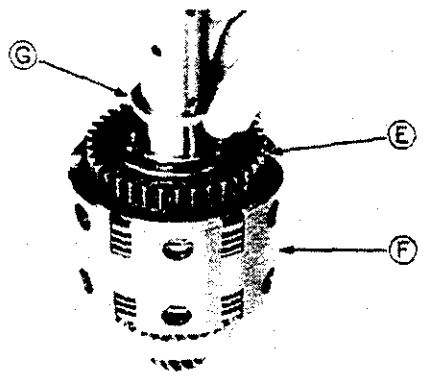
B – Reverse Clutch Hub
C – R–1st Clutch Cylinder

STOP **Do not drive cylinder by steel hammer.**
Do not damage end of clutch shift or seal ring grooves.



2762621

4. Remove 1st clutch hub (D).

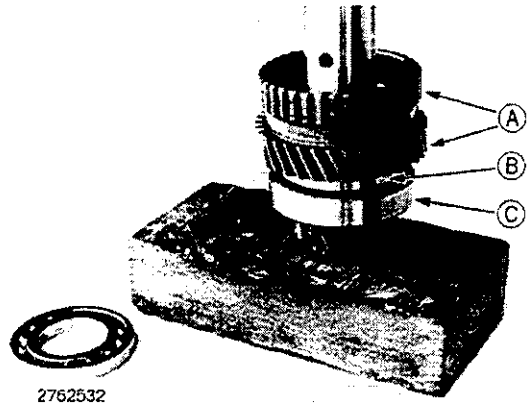


2762618

5. Remove spacer (G) and 2nd clutch hub (E).
6. Remove 2nd–3rd clutch cylinder assembly (F) in same manner of step 3.

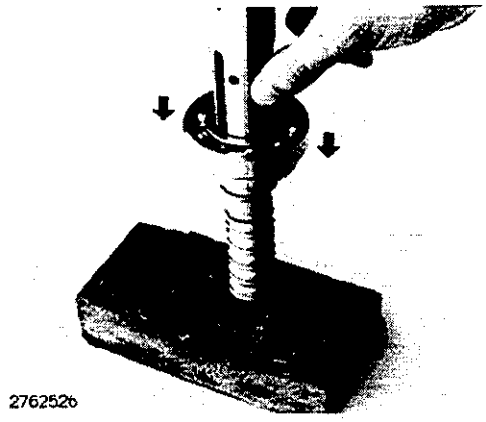
7. Remove 3rd clutch hub (A) with bearings (B).

A – 3rd Clutch Hub
B – Bearing
C – Rear Bearing

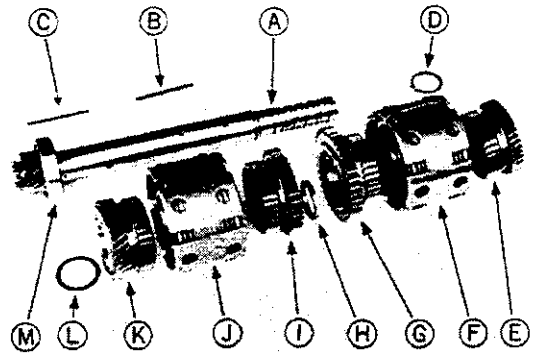


2762532

8. Remove rear bearing (B) from the shaft.


2762526

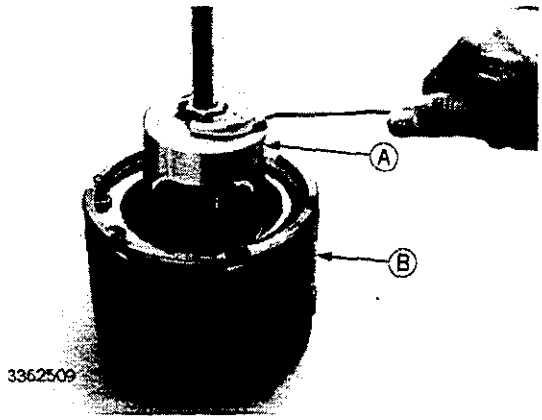
A – Power Shift Clutch Shaft
B – Key
C – Snap Ring
D – Reverse Clutch Hub
E – R–1st Clutch Cylinder
F – 1st Clutch Hub
G – Spacer
H – 2nd Clutch Hub
I – 2nd–3rd Clutch Cylinder
J – 3rd Clutch Hub
K – Spacer
L – Rear Bearing



2762535

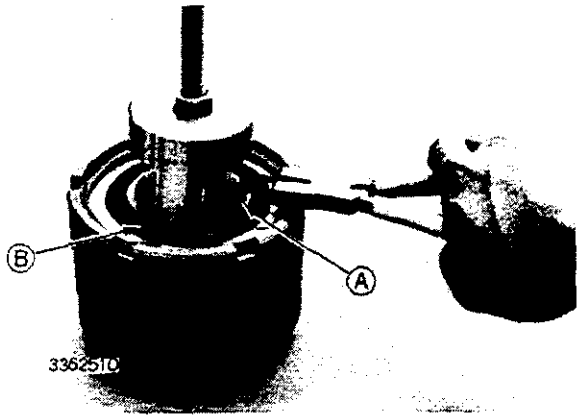
CLUTCH PACK

DISSASSEMBLY (Continued)



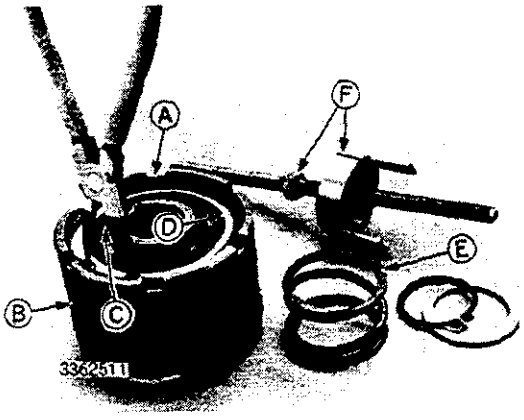
9. Install piston return spring compressor (A) to cylinder assembly (B).

A – Spring Compressor
B – Cylinder



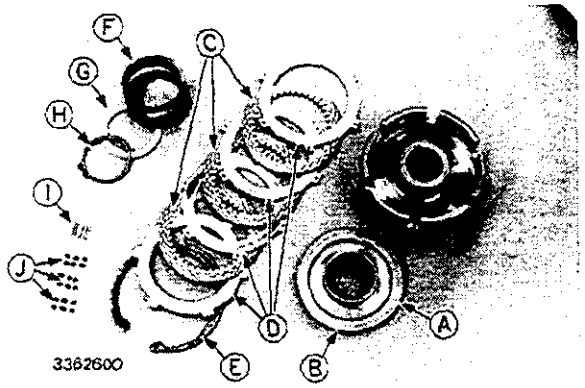
10. Remove external hole type snap ring (A) and pull spring (B).

A – Snap Ring
B – Return Spring



11. Remove internal hole type snap ring (A) from cylinder (B), then remove clutch disks (C), plates (D).

A – Snap Ring
B – Cylinder
C – Clutch Disks
D – Clutch Plates
E – Piston Return Spring
F – Spring Compressor



Do not lose separator springs (J) and pins (I) when removing disks and plates.

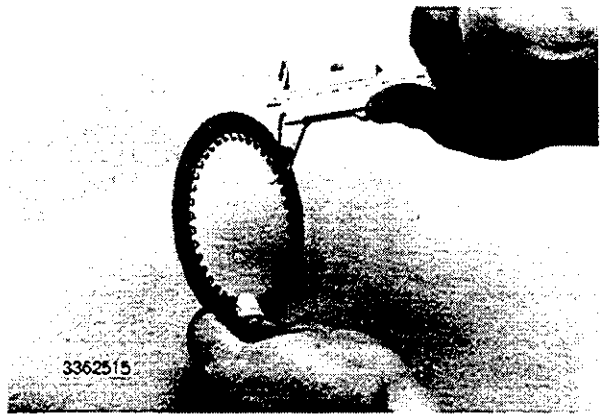
12. Place the parts disassembled on a table. Do not mix parts for each clutch pack to others.

13. Repeat the steps from 10 to 13 for disassembling the other clutch packs.

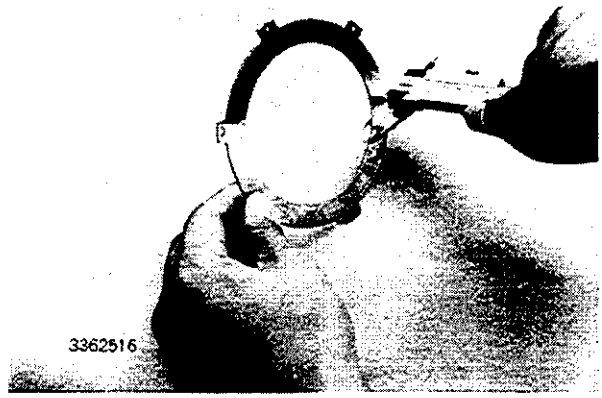
A – Piston
B – O-Ring
C – Clutch Disks
D – Clutch Plates
E – Snap Ring
F – Spring
G – Washer
H – Snap Ring
I – Separator Pins
J – Separator Spring
K – Cylinder

INSPECTION

1. Inspect clutch disks and plates for damage or scoring visually.
2. Measure thickness of clutch disk. Replace if thickness is less than 2.1 mm (0.0827 in.) and replace if burned or warped.

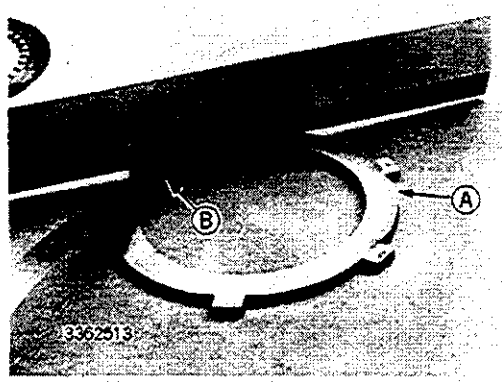


3. Measure thickness of clutch plate. Replace if thickness is less than 1.4 mm (0.0552 in.) and replace if burned or warped more than 0.3 mm (0.018 in.).



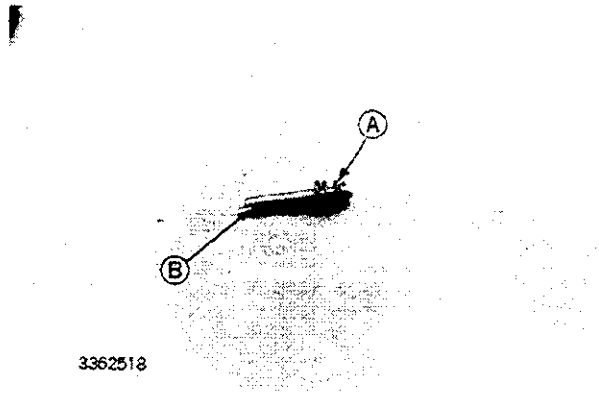
4. Measure thickness of backing plate. Replace if thickness is less than 3.30 mm (0.13 in.), or if the warpage is 0.35 mm (0.0137 in.) or more.

A – Backing Plate
B – Feeler Gauge



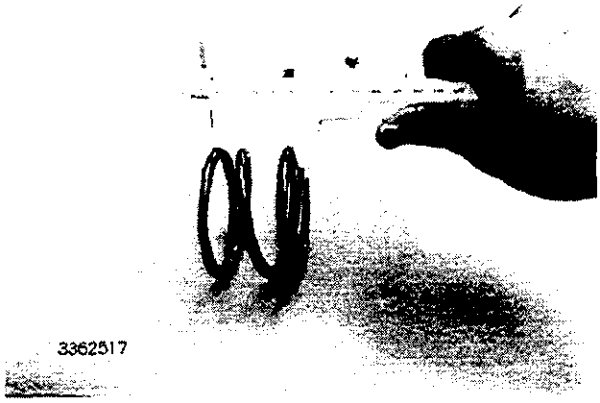
5. Inspect separator springs and pin for damage. Replace as required.

A – Separator Spring
B – Pin



CLUTCH PACK

INSPECTION (Continued)

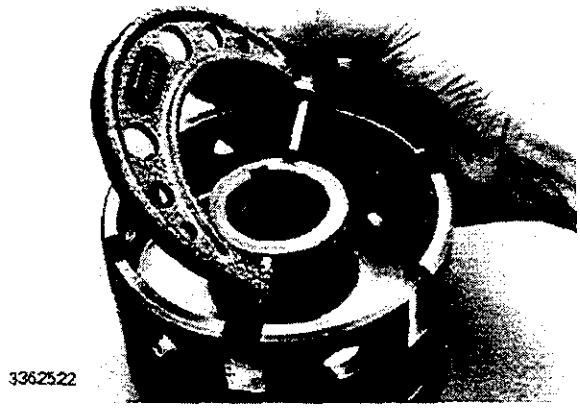

3362517

6. Inspect piston return spring. Compare measurement taken to the following specifications (Page 50-10-37).


3362521

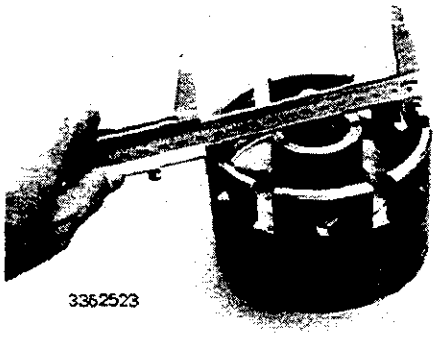
7. Measure I.D. of piston (Fig. 3362521) and O.D. of cylinder (Fig. 3362522) using micrometer to obtain clearance between piston inside edge and cylinder.

   Replace piston or cylinder whichever wear more if the clearance is more than 0.07 mm (0.0029 in.).


3362522

8. Inspect piston outer edge and inside of piston cylinder for scoring or scuffing.
   Replace cylinder and install new O-ring in piston if worn O-ring causes to score cylinder.

   A – Cylinder
   B – Vernier Caliper


3362523

9. Measure I.D. of cylinder at bottom and top of cylinder.

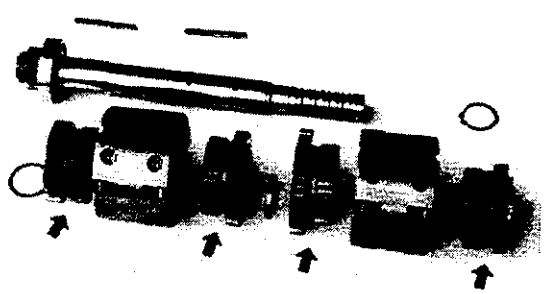
10. Measure O.D. of piston O-ring. Replace if O.D. is less than 2.75 mm (0.108 in.).

11. Use following specifications for clutch pack inspection.

CLUTCH PACK SPECIFICATIONS

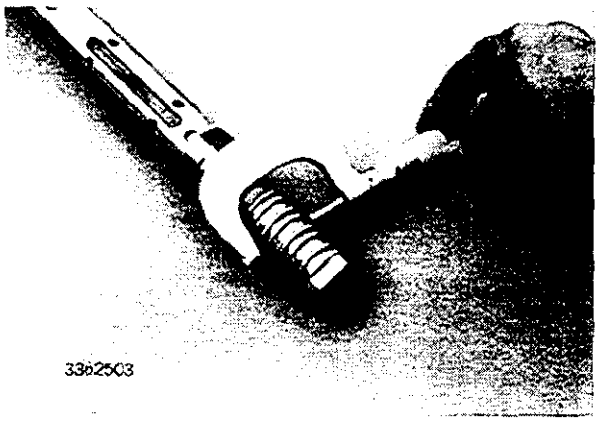
Item	New Part	Wear Limit
Cylinder I.D. at Piston	100.072 to 100.107 mm (3.9398 to 3.9412 in.)	
Piston O.D.	99.729 to 99.764 mm (3.9263 to 3.9277 in.)	
Cylinder Inside Bore O.D.	47.950 to 47.975 mm (1.8878 to 1.8888 in.)	
Piston I.D.	47.999 to 48.001 mm (1.8897 to 1.8898 in.)	
Clearance between Piston Inside Bore and Cylinder	0.024 to 0.051 mm (0.0009 to 0.0020 in.)	0.066 mm (0.0026 in.)
Piston O-ring Sectional O.D.	3.0 to 3.2 mm (0.118 to 0.126 in.)	2.75 mm (0.108 in.)
Piston Return Spring Free Length	42.0 mm (1.65 in.)	44.0 mm (1.73 in.)
Piston Return Spring Load	19.6 mm at 654 N (66.7 kg) (0.77 in. at 147 lbs.)	
Clutch Disk Thickness	2.5 to 2.7 mm *(0.098 to 0.106 in.)*	2.2 mm *(0.0866 in.)*
Clutch Disk Spline Backlash	0.2 mm (0.008 in.)	0.3 mm (0.012 in.)
Clutch Plate Thickness	1.55 to 1.65 mm (0.061 to 0.065 in.)	1.4 mm (0.055 in.)
Max. Warpage of Clutch Plate	less than 0.15 mm (less than 0.0059 in.)	0.3 mm (0.0118 in.)
Backing Plate Thickness	3.45 to 3.55 mm (0.136 to 0.140 in.)	3.30 mm (0.13 in.)
Max. Warpage of Backing Plate	0.2 mm (0.0079 in.)	0.35 mm (0.0137 in.)

12. Inspect clutch disk hub and gears for wear and damage.



2762533

CLUTCH PACK

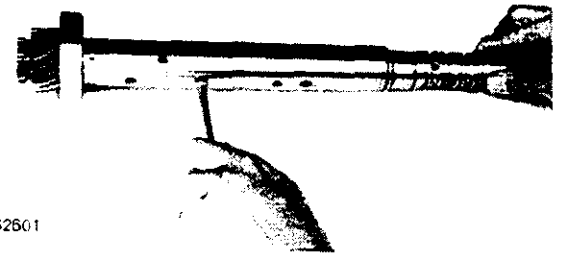


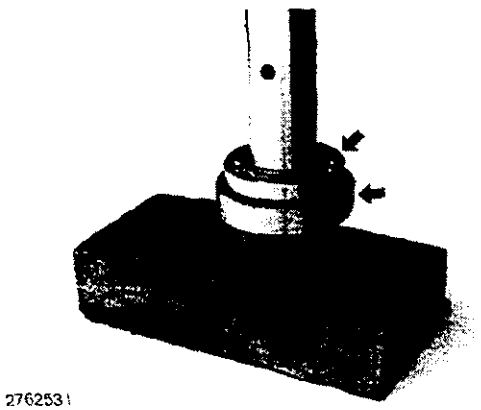
INSPECTION (Continued)

13. Measure clutch shaft O.D. at seal ring (Front end).

14. Inspect seal rings for wear or damage. Replace if measurements exceed limit.

15. Inspect all oil passage for clog using a air tube. Clean shaft thoroughly in solvent and blow through Passages with pressurized air.





16. Inspect clutch shaft bearings for wear or damage. Replace if required.

CLUTCH SHAFT SPECIFICATIONS

Item	New Part	Wear Limit
Clutch Shaft O.D. at Rear Bearing	34.984 to 34.994 mm (1.377 to 1.378 in.)	
Clutch Shaft O.D. at Cylinder	34.984 to 34.994 mm (1.377 to 1.378 in.)	
Clutch Shaft O.D. at Oil Manifold	29.925 to 29.95 mm (1.178 to 1.179 in.)	
Clutch Shaft O.D. at Front Bearing	16.994 to 17.006 mm (0.6691 to 0.6695 in.)	
Seal Ring Thickness	1.85 to 2.00 mm (0.073 to 0.079 in.)	1.5 mm (0.059 in.)
Seal Ring Width	2.85 to 3.0 mm (0.112 to 0.118 in.)	2.3 mm (0.09 in.)

ASSEMBLY

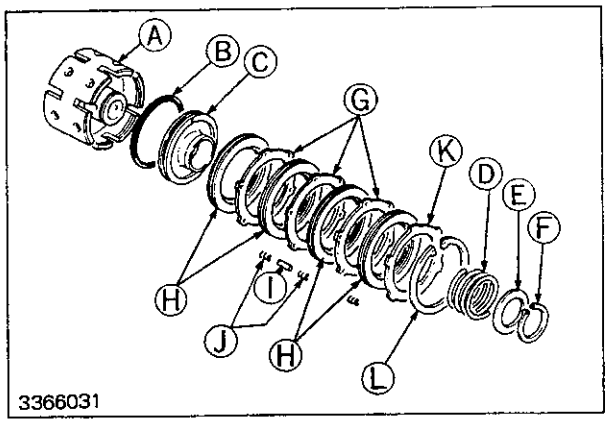
Coat all mating parts with Transmission-Hydraulic Oil to ease assembly and to minimize initial wear.

Clutch Cylinder

1. 2nd—3rd clutch cylinder is same as R—1st clutch cylinder.

   There is no difference of clutch disk, plate, piston and number of disk and plate between 2nd and 3rd clutches.

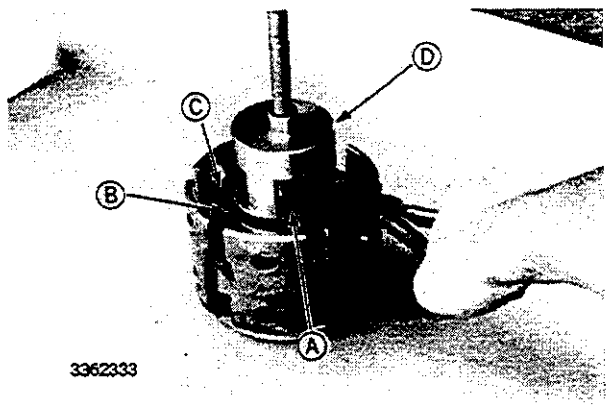
2. Install O-ring (B) in the groove of piston (C). Install Piston (C) in bottom of cylinder (A) (one side).



3366031

A — Cylinder
B — O-ring
C — Piston
D — Piston Return Spring
E — Washer
F — Snap Ring
G — Clutch Plate (3 used)
H — Clutch Disk (4 used)
I — Separator Spring Pin
J — Separator Spring
K — Backing Plate
L — Snap Ring

3. Install piston return spring (B) on piston (C) using compressor (D). Install snap ring (A).

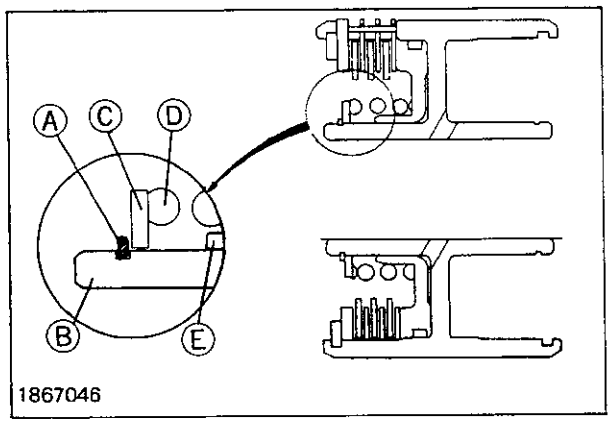


3362333

A — Snap Ring
B — Spring
C — Piston
D — Compressor

Snap ring has sharp edge on one side of face because of its shearing process. Install snap ring as shown in R.H. figure.

4. Repeat steps from 1 to 3 for other side of cylinder to install piston.



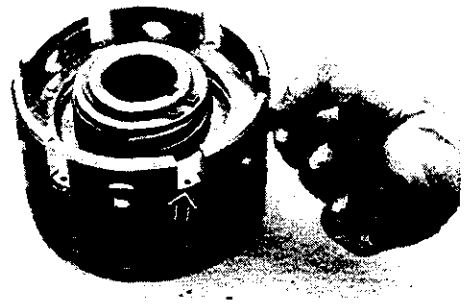
1867046

A — Snap Ring
B — Cylinder
C — Washer
D — Piston Return Spring
E — Piston

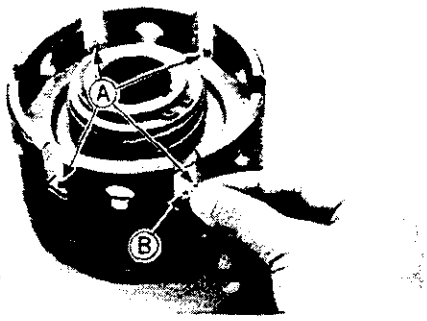
CLUTCH PACK

ASSEMBLY

Clutch Cylinder (Continued)


3362525

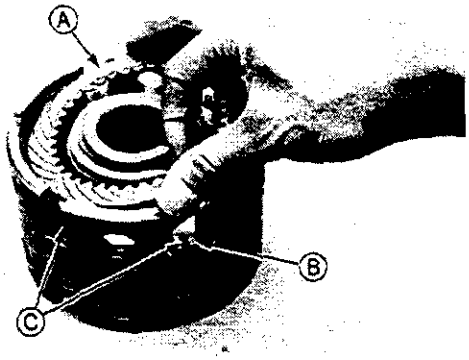
5. Place clutch plate on piston.



3362526

6. Place separator spring (A) on clutch plate on bores of six fingers of plate.

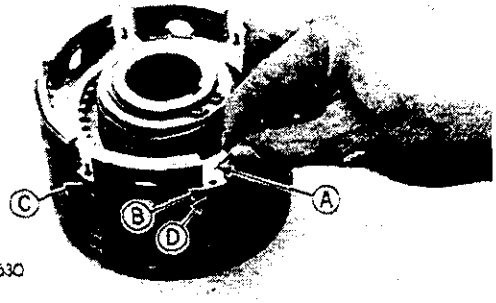
A – Separator Spring
B – Clutch Plate



3362527

7. Place clutch disk (A) on clutch plate (B) and put another plate on six separator springs (D) as aligning bores for separator spring pins.

A – Clutch Disk
B – Clutch Plate
C – Clutch Plate
D – Separator Springs



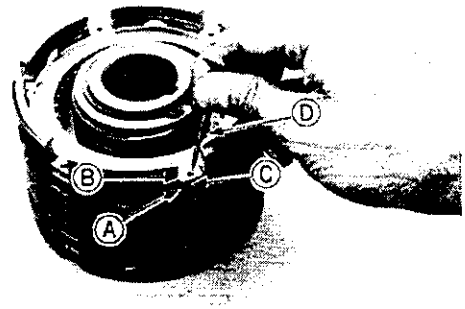
3362530

8. Insert separator spring pins (A) through clutch plate (B), spring (C) and clutch plate (D) sitting on piston.

A – Pin
B – Clutch Plate
C – Spring
D – Clutch Plate

9. Install another six springs on 2nd clutch plate (A) from piston and plate 3rd clutch place (B) on the 2nd row springs (C). Align pin and pin bore using needle (D).

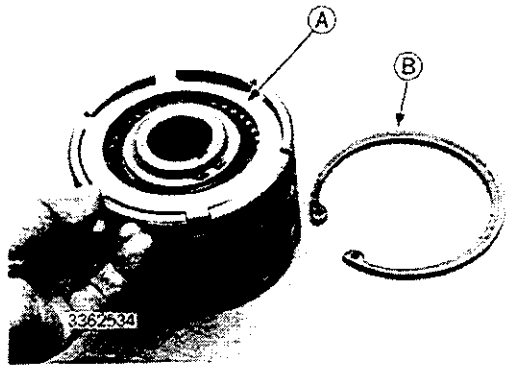
A – 2nd Clutch Plate
B – 3rd Clutch Plate
C – Springs
D – Needle



3362533

10. Install backing plate (A) on piled disks, plates and separator springs. Install snap ring (B).

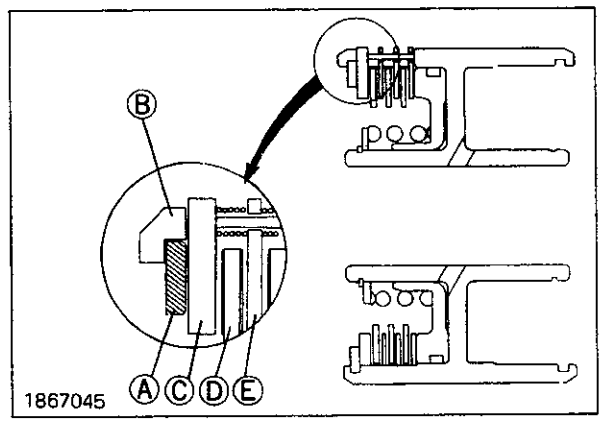
A – Backing Plate
B – Snap Ring



3362534

11. Be sure snap ring is installed as instructed in R.H. figure.

A – Snap Ring
B – Cylinder
C – Washer
D – Piston Return Spring
E – Piston



1867045

12. Rear steps from 5 to 10 for other side of cylinder.

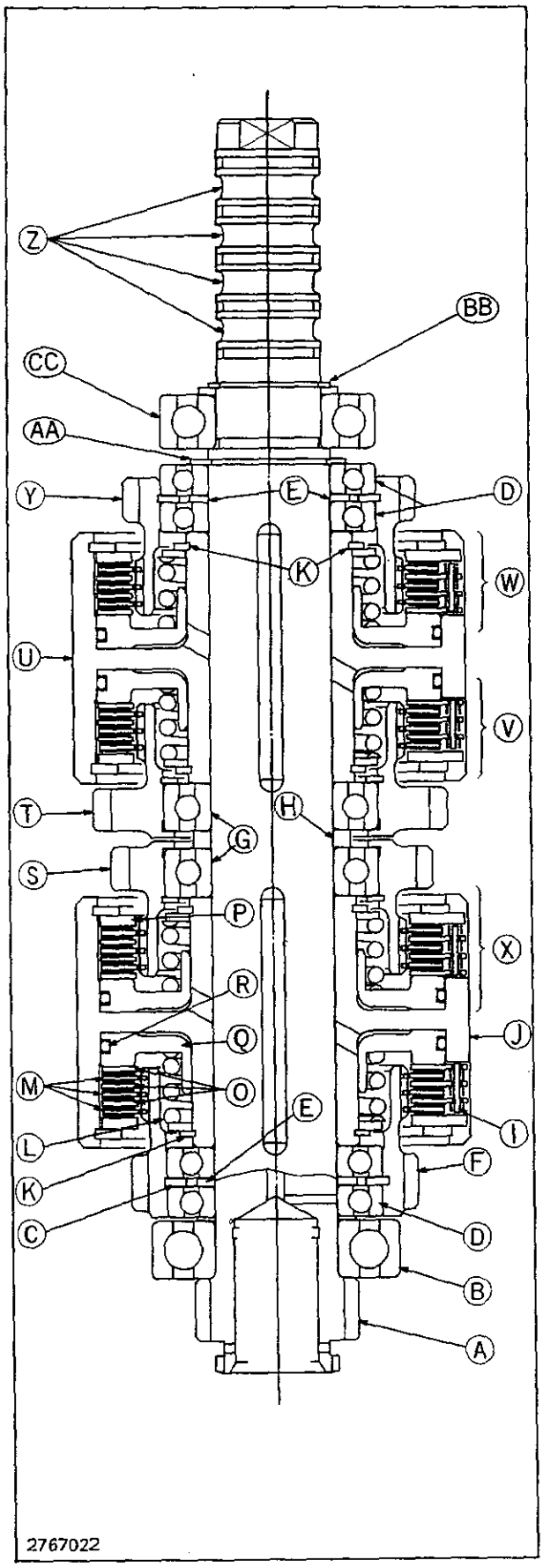
Make sure which side of cylinder is 2nd or 3rd clutch. When installing the clutch pack assembly, align oil passage holes between shaft and clutch cylinder. See page 50-10-44 for installation.

13. Assembly R-1st clutch pack as well as 2nd–3rd clutches.

CLUTCH PACK

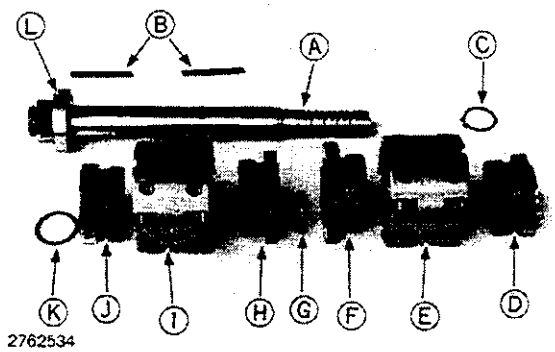
ASSEMBLY (Continued)

Clutch Shaft



A – Power Shift Clutch Shaft
B – Rear Bearing
C – Snap Ring (4 used)
D – Bearing 16007
E – Snap Ring
F – 3rd Clutch Gear/Hub
G – Bearing 6007
H – Separator Springs
I – Separator Pin
J – 2nd–3rd Clutch Cylinder
K – Snap Ring
L – Piston Spring (4 used)
M – Clutch Disks (12 used)
N – Snap Ring (4 used)
O – Steel Plate (2 used)
P – Backing Plate
Q – 3rd Clutch Piston
R – Piston O-ring (4 used)
S – 2nd Clutch Gear/Hub
T – 1st Clutch Gear/Hub
U – R-1st Clutch Cylinder
V – 1st Clutch Pack
W – Reverse Clutch Pack
X – 2nd Clutch Pack
Y – Reverse Gear/Hub
Z – Seal Grooves
AA – Snap Ring
BB – Snap Ring
CC – Bearing 6202

A – Power Shift Clutch Shaft
B – Key
C – Snap Ring
D – Reverse Clutch Hub
E – R–1st Clutch Cylinder
F – 1st Clutch Hub
G – Spacer
H – 2nd Clutch Hub
I – 2nd–3rd Clutch Cylinder
J – 3rd Clutch Hub
K – Spacer
L – Rear Bearing

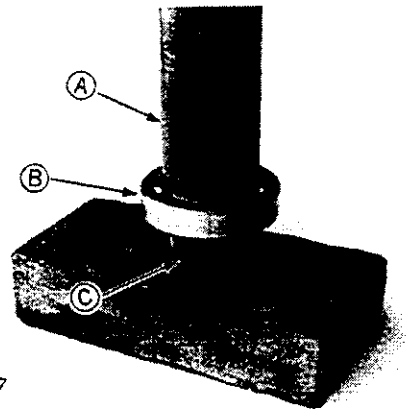


2762534

1. Install clutch shaft rear bearing (E) against spiral bevel pinion shoulder.

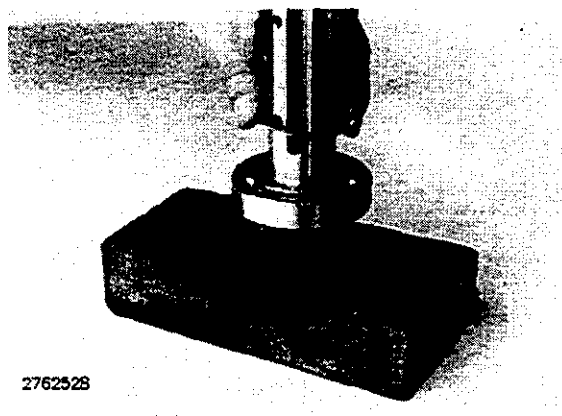
   Use bearing driver (35 mm) to install bearing.

A – Driver (35 mm)
B – Bearing
C – Clutch Shaft

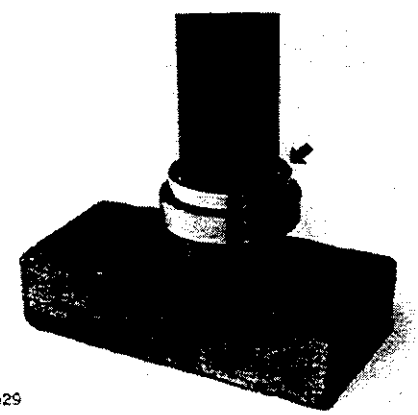


2762527

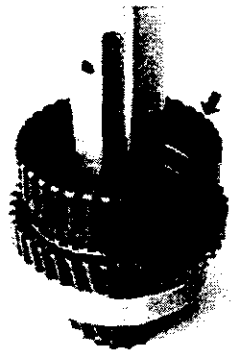
2. Install spacer over the rear bearing.


2762528

3. Install one 3rd clutch hub bearing against the spacer installed at step 2.


2762529

CLUTCH PACK

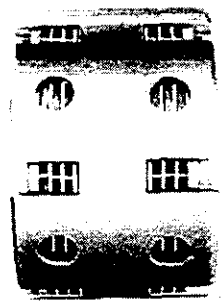


2762605

ASSEMBLY

Clutch Shaft (Continued)

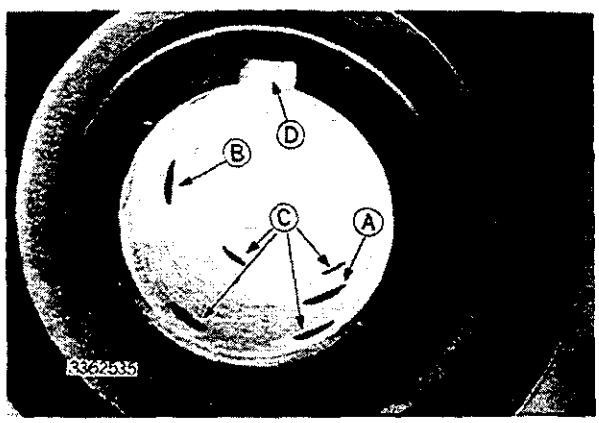
4. Install 2nd—3rd clutch hub to clutch shaft against hub bearing and rear bearing.



3362612

2nd clutch and 3rd clutch side have same appearance. Clutch cylinder is able to install both directions for its symmetry.

Be sure oil holes locations on both clutch shaft and clutch cylinder. Two oil holes at 180° from key groove of shaft are for lubricating oil.



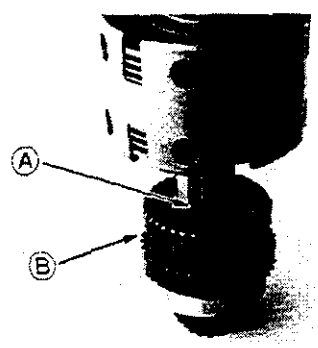
Oil Holes 2—3 Clutch Pack from View of Seal Case Side (R.H. PHOTO)

Oil hole near (90°) from key groove (A) is connected to to 3rd piston.

Oil hole far (135°) from key groove is connected to 2nd piston.

Make sure correct direction of cylinder before installing.

A — To 2nd Clutch
B — To 3rd Clutch
C — Lubricating Oil Hole
D — Key Groove



2762609

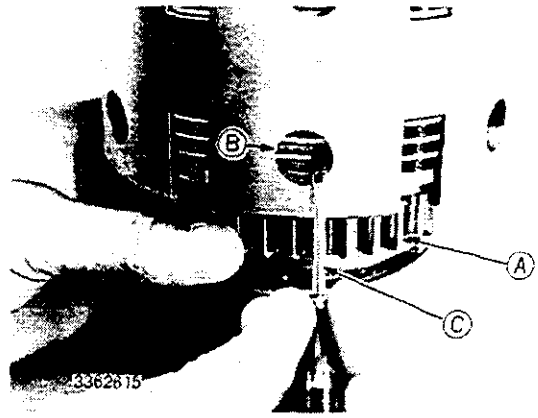
5. Install key (A) to clutch shaft, and slide clutch cylinder assembly down over the key against clutch hub teeth.

A — Key
B — 2nd—3rd Clutch Cylinder

6. Align teeth of hub (A) with teeth of clutch disk (B).

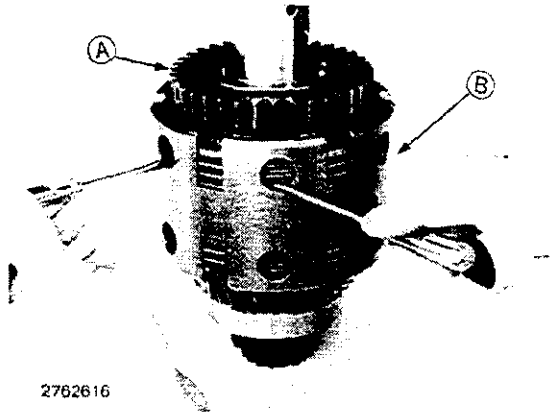
   Reduce weight on clutch disk holding clutch pack, and use screw driver (C) to rotate clutch disk and to mesh teeth try each clutch disk with same manner.

   A – Clutch Hub
   B – Clutch Disk
   C – Screw Driver

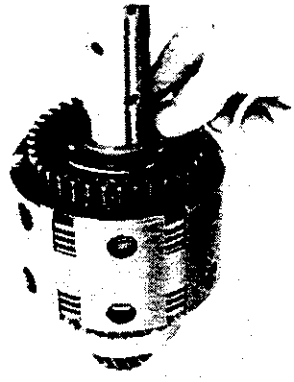


7. Install 2nd clutch hub on clutch disk and rotate the disk slightly to mesh in teeth. Repeat same manner until three disks mesh on clutch disk hub splines.

   A – 2nd Clutch Hub
   B – 2nd–3rd Clutch

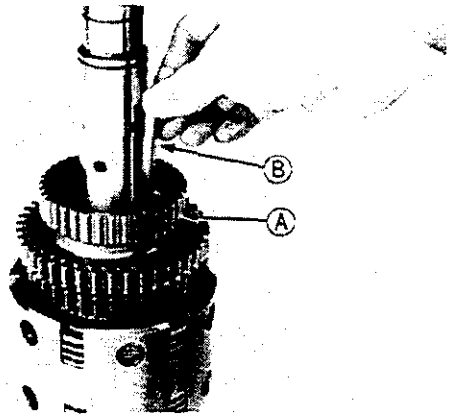


8. Install spacer against 2nd clutch hub bearing.



9. Install 1st clutch hub onto the spacer installed at Step 8.
10. Install key in clutch shaft.

    A – 1st Clutch Hub
    B – Key



CLUTCH PACK

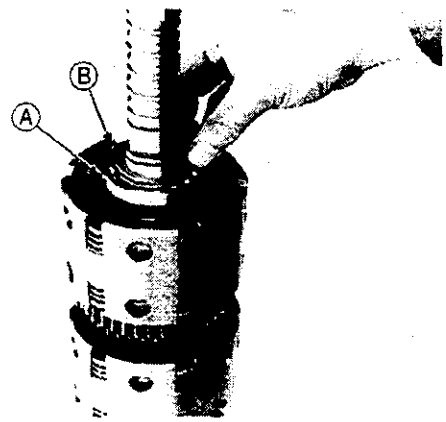
2762626

ASSEMBLY

Clutch Shaft (Continued)

11. Install R–1st clutch pack (K, Fig. 79), 1st clutch hub as well as 2nd–3rd clutch hub installation.

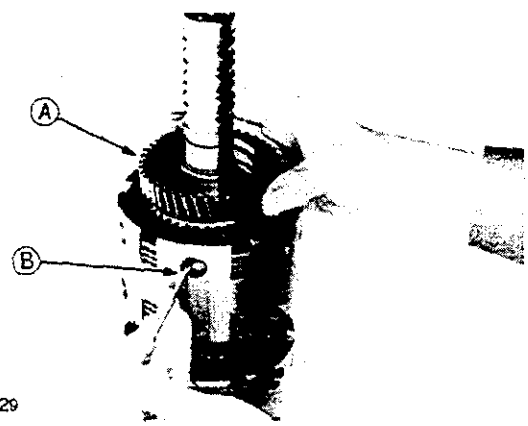
Check the oil holes locations on clutch shaft and cylinder before installing clutch pack.



2762627

12. Install bearing 16007 (A) onto the R-1st clutch cylinder, and then place spacer (B) on the bearing.

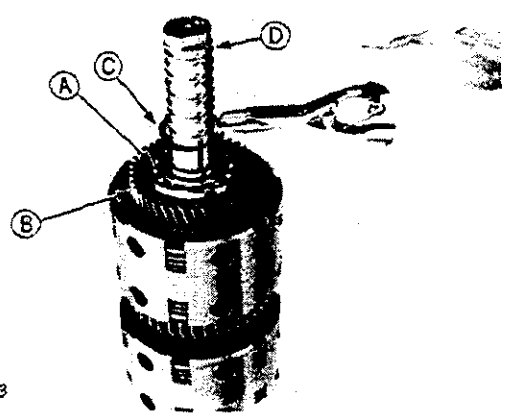
A – Bearing 16007
B – Spacer



2762629

13. Install 1st clutch hub (A) clutch disk and rotate the disk slightly to mesh in teeth.
Use needles or small screw drivers to rotate disks.

A – 1st Clutch Hub
B – Screw Drivers



2762633

14. Install bearing 16007 (A) into the reverse clutch hub (B).

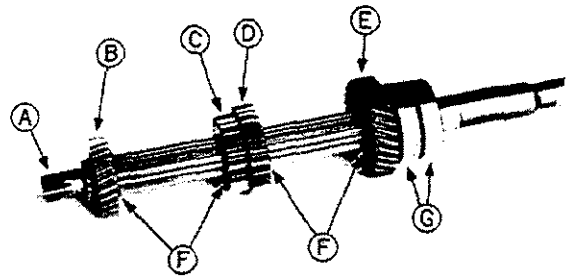
15. Install snap ring (C) to the clutch shaft (D).

A – Bearing (16007)
B – Reverse Clutch Hub
C – Snap Ring
D – Clutch Shaft

MAIN SHAFT AND MAIN GEARS

INSPECTION AND REPAIR

A – Main Shaft
B – R Gear (23T)
C – 1st Gear (25T)
D – 2nd Gear (29T)
E – 3rd Gear (33T)
F – Snap Ring
G – Washer



2762403

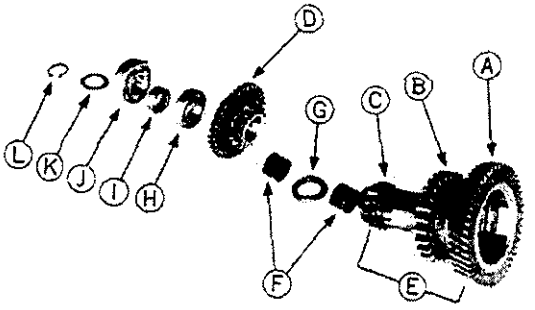
1. Inspect four gears on spline shaft for wear or damage.
2. Inspect backlash between spline shaft (A) and gears.

   The backlash should be within 0.05 to 0.17 mm (0.0024 to 0.0067 in.) Replace parts if backlash is more than 0.3 mm (0.012 in.).
3. Inspect installation condition of snap rings (F). Replace snap ring if weaken or deformed.

4. Assemble as shown in photo.
5. See specifications for shaft dimension.

COUNTER GEARS

INSPECTION AND REPAIR



2762409

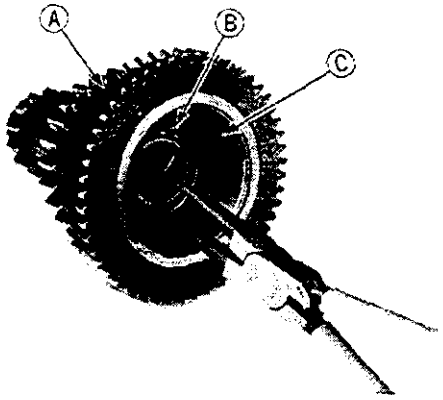
A – Counter Driven Gear
B – 2nd Range Gear
C – 1st Range Gear
D – C Range Gear
E – Counter Cluster Gear
F – Needle Bearing (2 used)
G – Thrust Washer
H – Bearing
I – Spacer
J – Bearing (6304)
K – Washer
L – Snap Ring

1. Inspect gears for wear or damage.
2. Inspect needle bearings (F) for wear or damage.
3. Inspect needle bearing bores of counter cluster gear (E) and 1st range gear (D) for wear or damage.

   I.D. of bore should be 26.007 to 26.020 mm (1.0239 to 1.0244 in.). Replace clearance between counter gear and needle bearing exceeds 0.1 mm (0.004 in.).

ONE-WAY CLUTCH

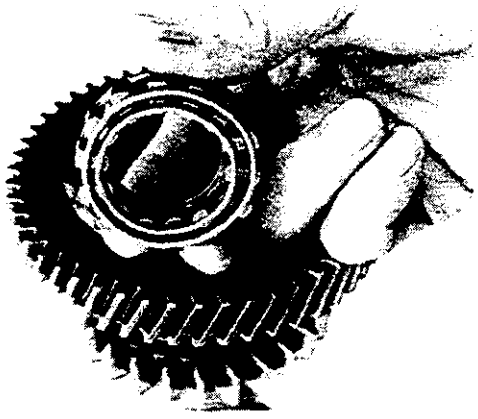
INSPECTION AND REPAIR



2763102

1. Remove snap ring (C) from counter cluster gear (A).
2. Remove cam clutch assembly (B).

A – Counter Cluster Gear
B – Cam Clutch Assembly
C – Snap Ring



2763106

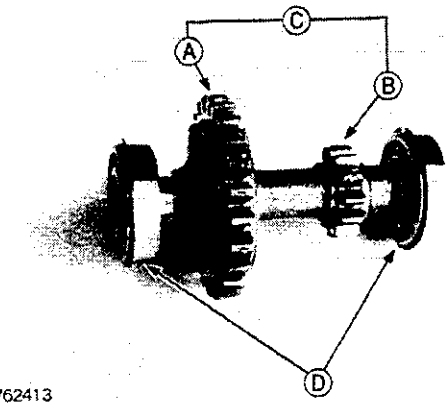
3. Inspect cam clutch cage for wear or damage. Replace assembly if necessary.

CREEP GEAR

INSPECTION AND REPAIR

1. Inspect creep gears for wear or damage. Replace as necessary.

A – Creep Drive Gear (24T)
B – Creep Drive Gear (14T)
C – Creep Gear Assembly
D – Bearing (6203N)

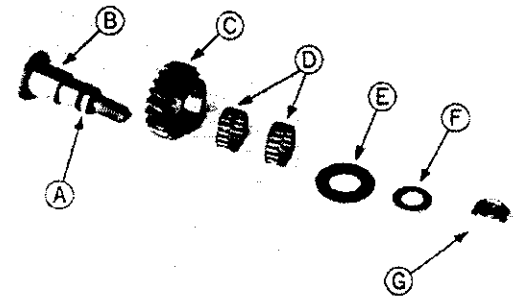


2762413

REVERSE GEAR

INSPECTION AND REPAIR

A – O-ring
B – Idle Shaft
C – Idle Gear
D – Needle Bearing
E – Thrust Washer
F – Washer
G – Lock Nut

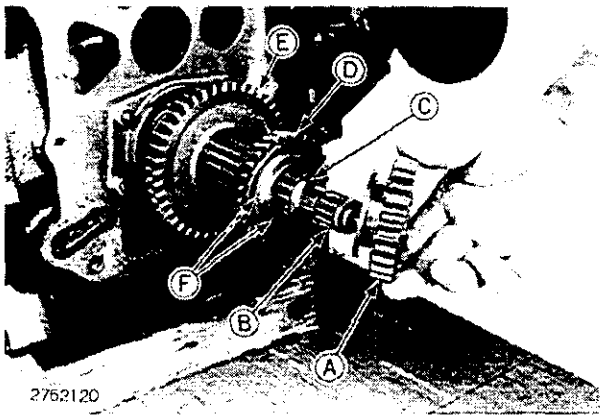


2762436

1. Inspect idle shaft needle bearing (D) for wear or damage. Replace as necessary.
2. Inspect idle shaft O-ring (A) for damage.
3. Inspect idle shaft (B). O.D. of shaft should be 21.982 to 22.000 mm (0.8654 to 0.8661 in.) Clearance between sleeve and needle bearing should be 0.009 to 0.038 mm (0.003 to 0.0015 in.). Replace parts if clearance exceeds 0.1 mm (0.004 in.).
4. Inspect idle gear bore for wear. I.D. of bore should be 125.993 to 26.020 mm (1.0233 to 1.0244 in.) Clearance between gear and bearing should be 0.009 to0.038 mm (0.0003 to 0.0015 in.). Replace if clearance exceeds 0.1 mm (0.004 in.).

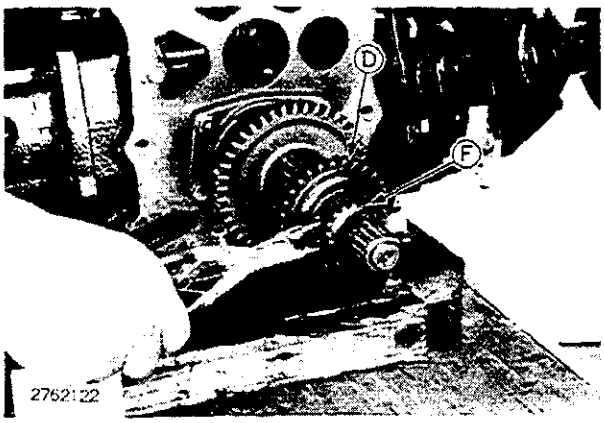
RANGE SHIFT GEARS

REMOVAL

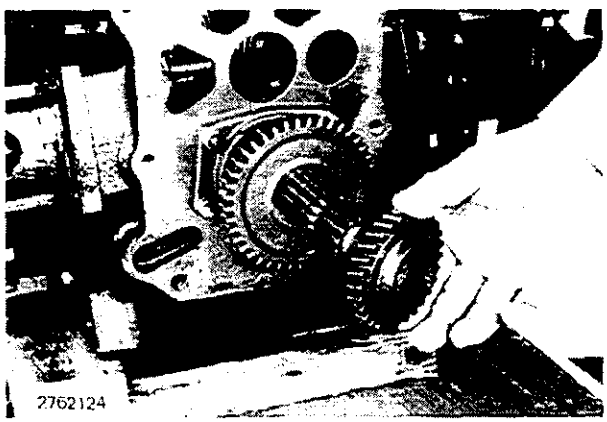


1. Remove 2nd—3rd range sliding gear (A).

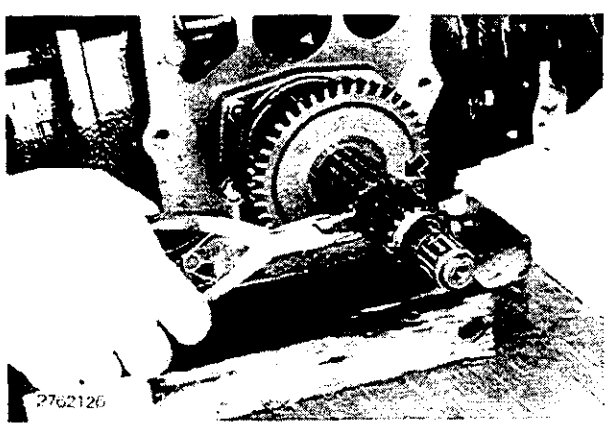
A — 2nd—3rd Range Sliding Gear
B — Needle Bearing
C — Differential Drive Shaft
D — Front Wheel Drive Gear
E — C—1st Range Sliding Gear
F — Snap Ring (2 used)



2. Remove snap ring (G) to remove front wheel drive gear (D).

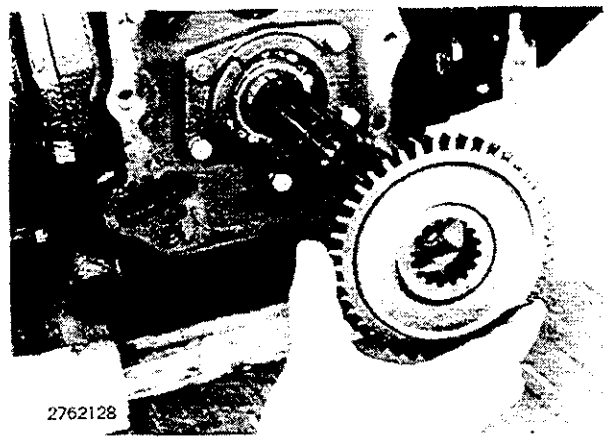


3. Remove front wheel drive gear from differential drive shaft.



4. Remove snap ring behinds the front wheel drive gear.

5. Remove C—1st range sliding gear.

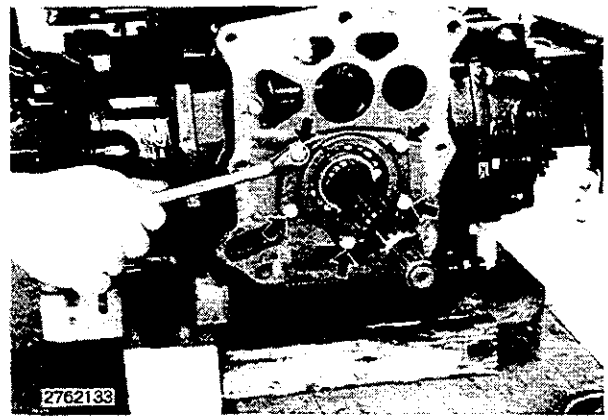


6. Remove differential drive shaft if it would be replaced.

   Remove five cap screws (Arrows) after flattening lock plate.

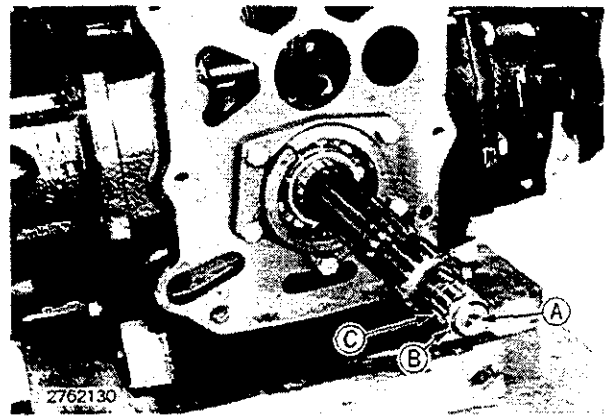
Be careful not to damage cone point adjusting shims when removing shaft.

7. See Section 30 of this chapter for differential drive shaft *removal and adjustment*.



8. Remove snap ring (A) spacer (B) and needle bearing (C) if necessary.

A — Snap Ring
B — Spacer
C — Needle Bearing



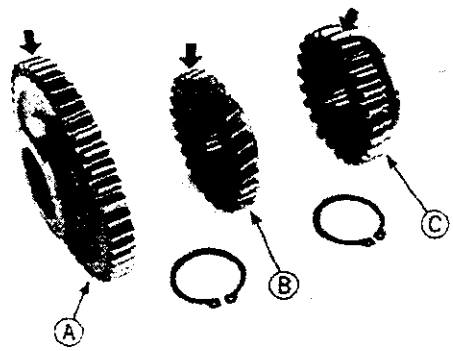
RANGE SHIFT GEARS

INSPECTION AND REPAIR

3362214

1. Inspect needle bearings for wear or damage. Replace are necessary.
2. Inspect differential drive shaft spline and at needle bearing seating area for wear or damage.

   O.D. of differential drive shaft at needle bearing should be 17.983 to 17.994 mm (0.7080 to 0.7084 in.). Replace parts if clearance to needle bearing exceeds 0.1 mm (0.004 in.).

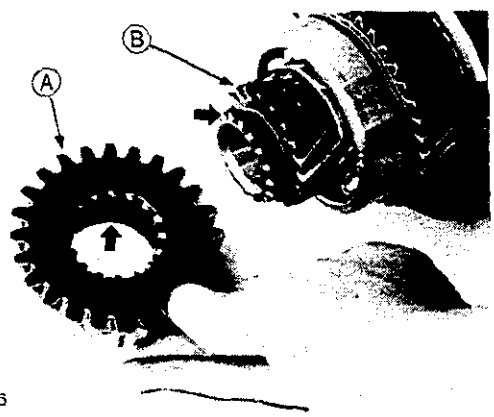


2762513

3. Inspect teeth of all sliding gears for wear or damage.

   Backlash should be 0.12 to 0.26 mm (0.0047 to 0.0102 in.). Replace if it exceeds 0.5 mm (0.02 in.).

A – C–1st Range Sliding Gear
B – Front Wheel Drive Gear
C – 2nd–3rd Range Sliding Gear



2762536

4. Inspect 3rd range dog clutch internal craw for wear or damage. Replace as necessary.

A – 2nd–3rd Range Sliding Gear
B – Power Shift Clutch Shaft

ASSEMBLY

Reverse the removal steps for assembling.

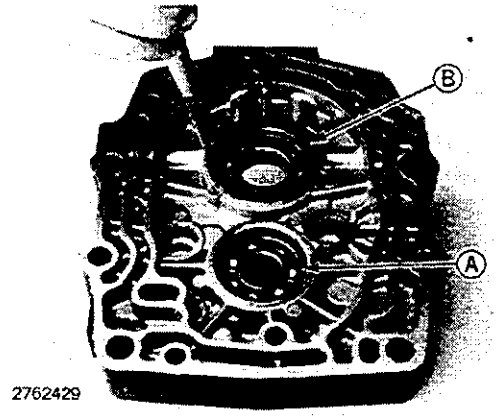
INSTALLATION

Clean all parts in solvent and apply with Transmission and Hydraulic Oil.

Center Plate

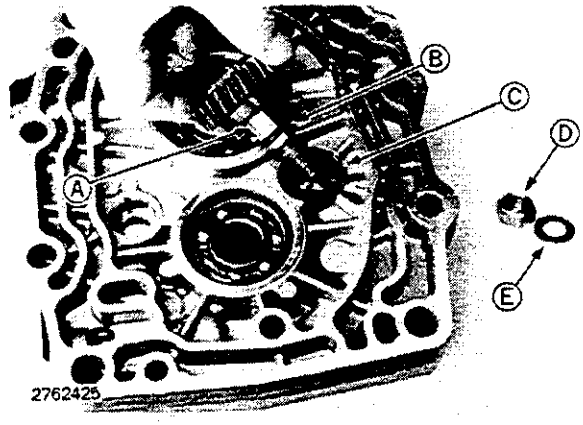
1. Install bearing 6304 (A) for main shaft and 6205 (B) for power shift clutch shaft to center plate.

A – Bearing 6304
B – Bearing 6205



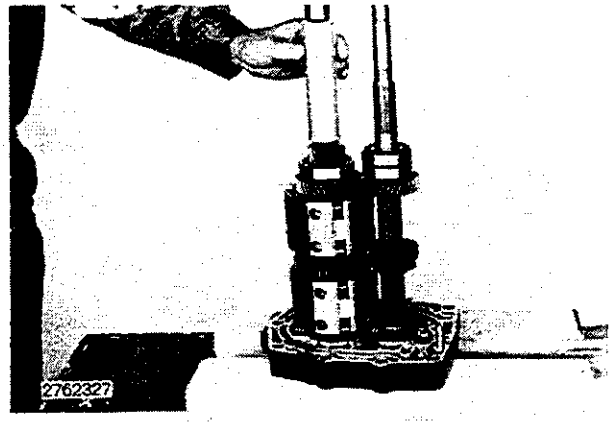
2. Install new O-ring (B) to idle gear shaft (A).
3. Install thrust washe (C) into the recess. Make sure the grooved side must face idle gear. Tighten lock nut (D) to 100 Nm (10 kgm) (72 ft-lbs).

A – Reverse Idle Gear Shaft
B – O-ring
C – Thrust Washer
D – Lock Nut
E – Washer



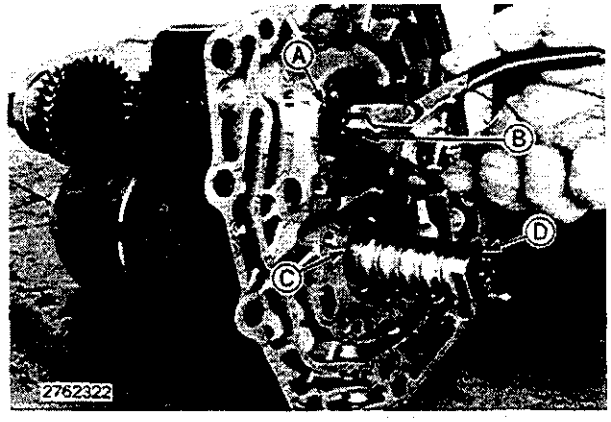
4. Install clutch shaft and main shaft assemblies to center plate.

   Drive two shaft ends alternately with soft metal.

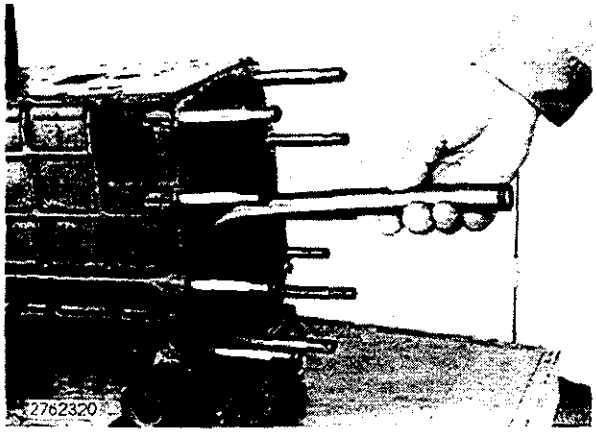


5. Install snap ring (A) to main shaft (B), and snap ring (C) to clutch shaft (D).

A – Snap Ring
B – Main Shaft
C – Snap Ring
D – Clutch Shaft

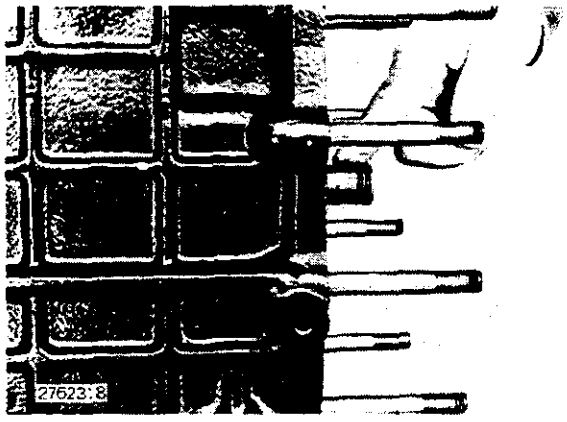


INSTALLATION

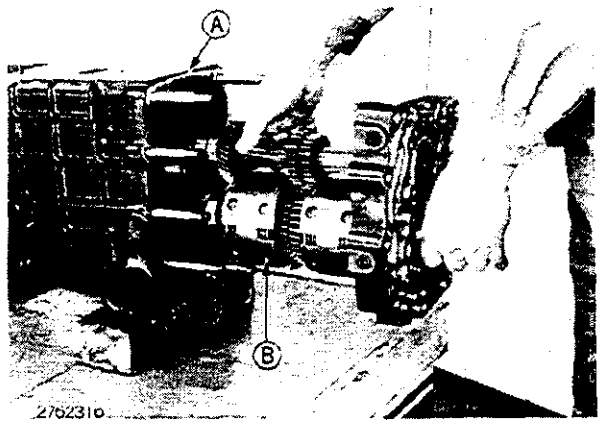


Power Shift Assembly

1. Install suction pipe to transmission case with new O-rings.

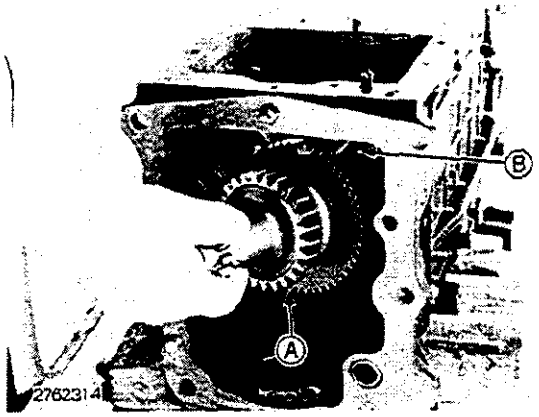


2. Apply grease to O-rings on oil suction pipe.
   It helps to install smoothly.



3. Install a new packing (A) are insert power shift assembly into transmission case as shown in L.H. photo.

A – Packing
B – Power Shift Transmission Assembly

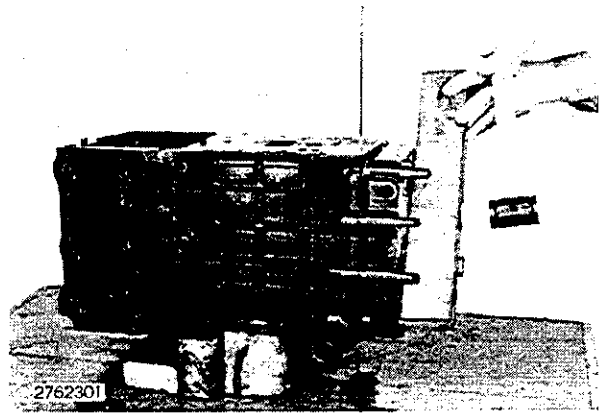


4. Before installing assembly completely, insert counter cluster gear (A) from rear side of transmission case so that the gear would be installed on main shaft (B).

A – Counter Cluster Gear
B – Main Shaft

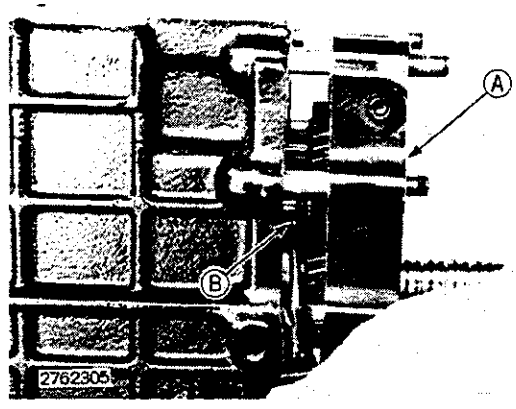
5. Drive down power shift and center plate assembly using plastick hammer with wood.

   Drive center plate evenly to avoid distortion.

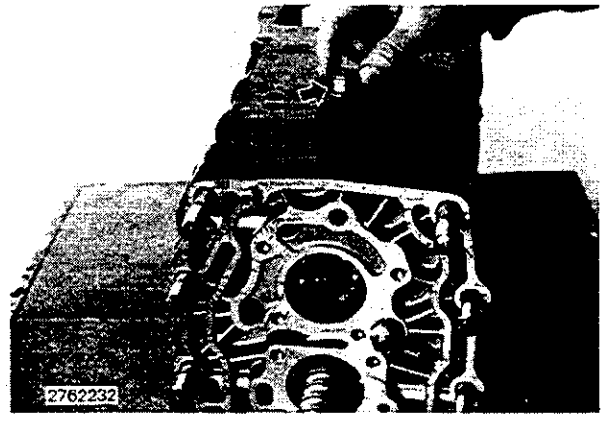


6. Stop driving the transmission assembly when center plate (A) contacts with oil suction pipe (B). Move pipe using screw driver to align pipe to the bore. Push center plate assembly into case.

   A – Center Plate
   B – Oil Suction Pipe



7. Install 2nd relief valve assembly into the bore on top surface of transmission case.

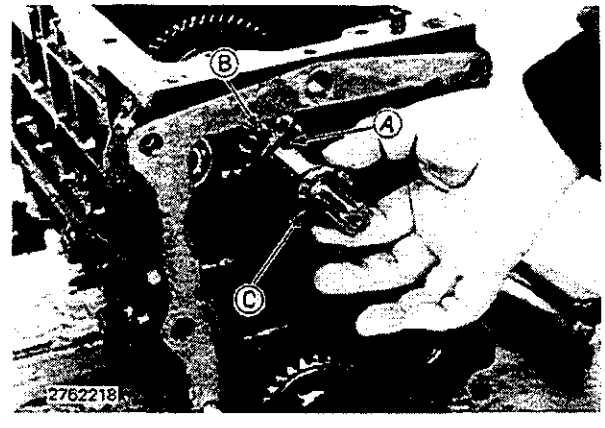


Range Shift Gears

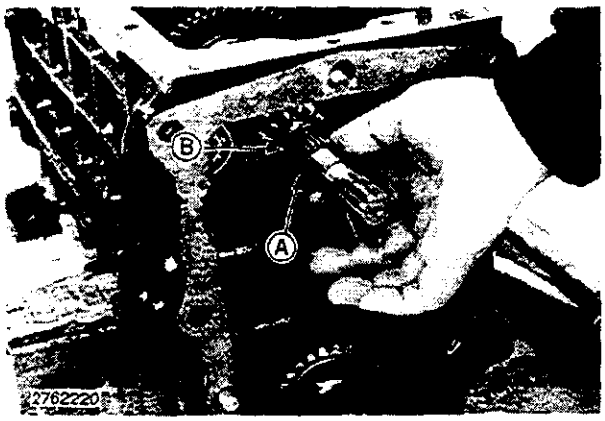
1. Install counter gear needle bearing (A) into cluster gear (B) rear end.

   Install thrust washer (C) against the rear end of cluster gear.

   A – Needle Bearing
   B – Cluster Gear
   C – Thrust Washer



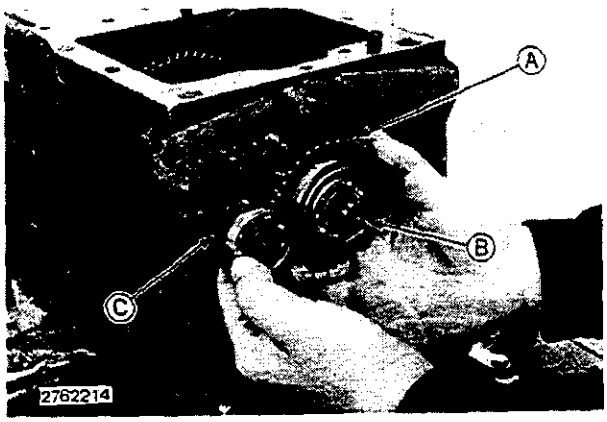
INSTALLATION



Range Shift Gears (Continued)

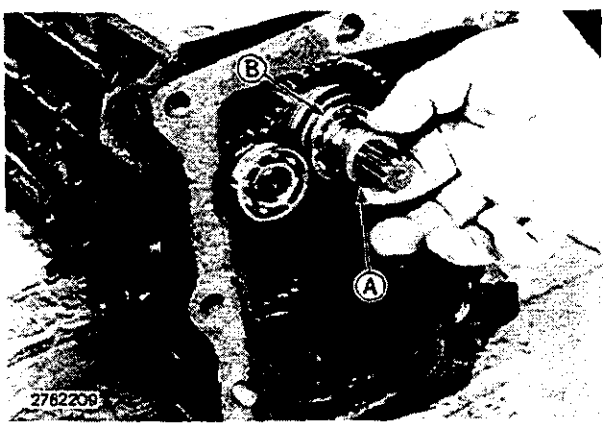
2. Install another needle bearing (A) against the thrust washer (B).

A – Needle Bearing
B – Thrust Washer



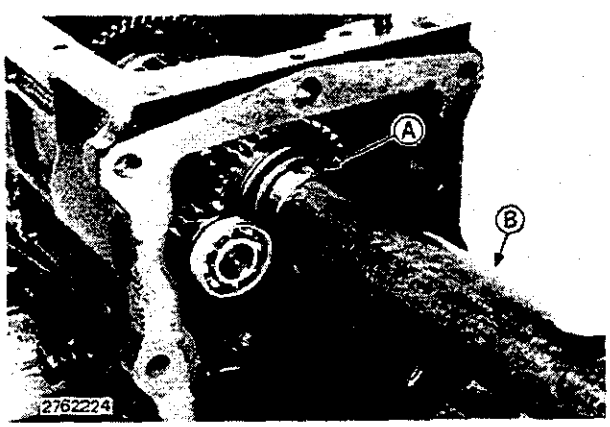
3. Install creep range gear (A) onto the main shaft (B) and creep gear set (C) at the same time.

A – Creep Range Gear
B – Main Shaft
C – Creep Gear Set



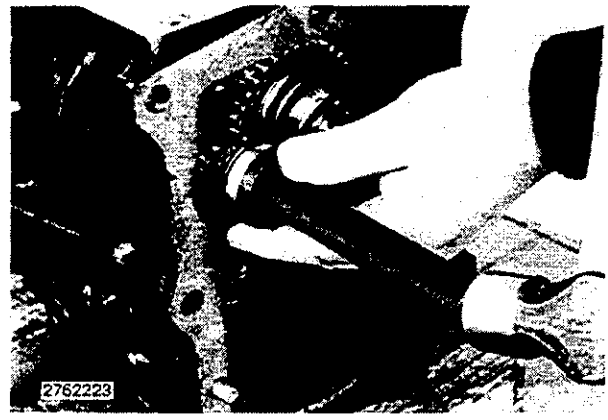
4. Install spacer (A) against the bearing (B).

A – Spacer
B – Bearing 6022



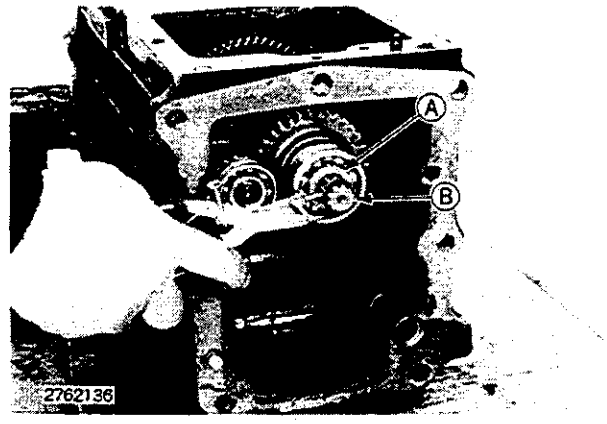
5. Install main shaft rear bearing (A) to main shaft using tube driver (B).

6. Drive creep gear set to fit firmly in the transmission case.

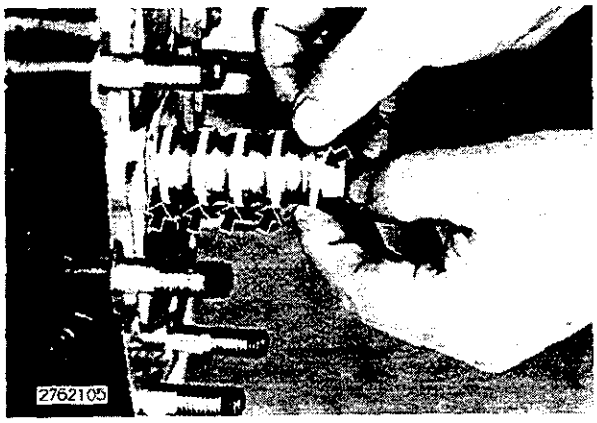


7. Install washer (A) and snap ring (B) to the main shaft.

A – Washer
B – Snap Ring



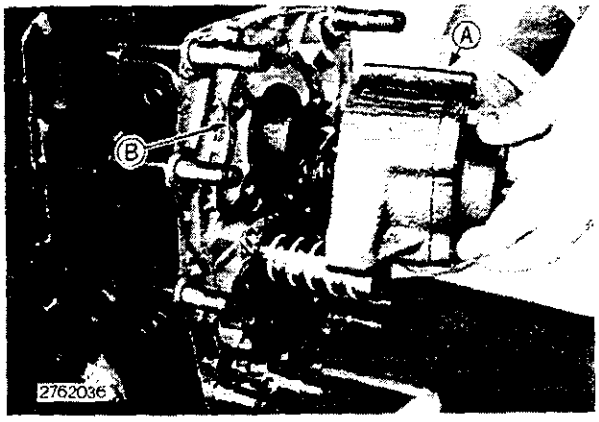
INSTALLATION



Pump and Oil Manifold

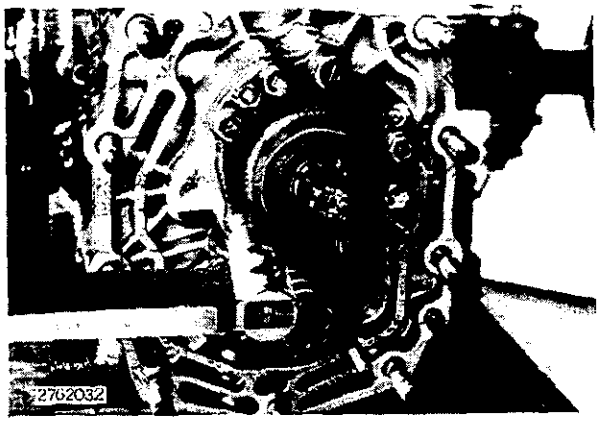
1. Install new seal rings to clutch shaft seal grooves.

Be carefull not to damage rings during manifold installation.

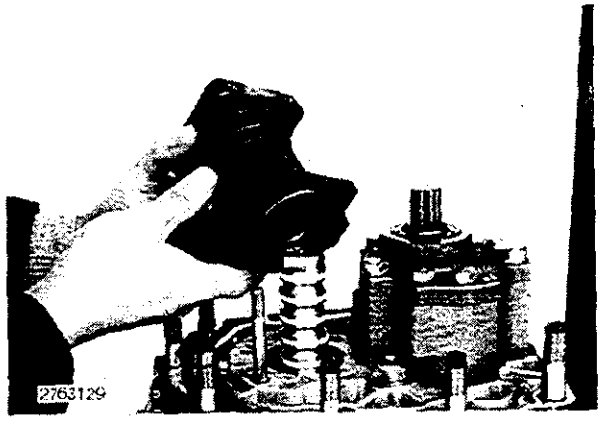


2. Install power shift pump (A) with new packing (B).

A — Power Shift Pump
B — Packing



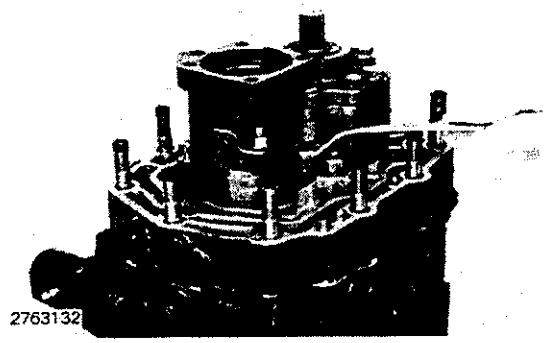
3. Tighten five cap screws to 25 Nm (2.5 kgm) (22 ft-lbs) torque.



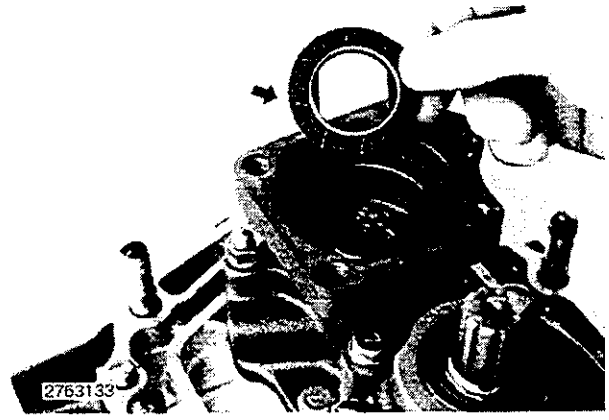
4. Install oil manifold (A) with new packing (C) to center plate (B).

A — Oil Manifold (Seal Case)
B — Center Plate
C — Packing

5. Tighten three cap screws and one nut to 25 Nm (2.5 kgm) (22 ft-lbs).

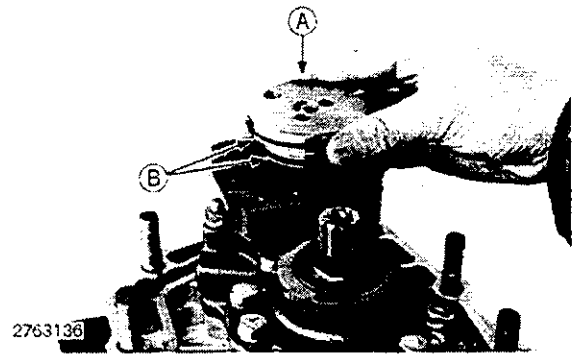


6. Install inertia brake disk to the clutch shaft end.



7. Press brake piston (A) with two O-rings (B) into the bore of oil manifold.

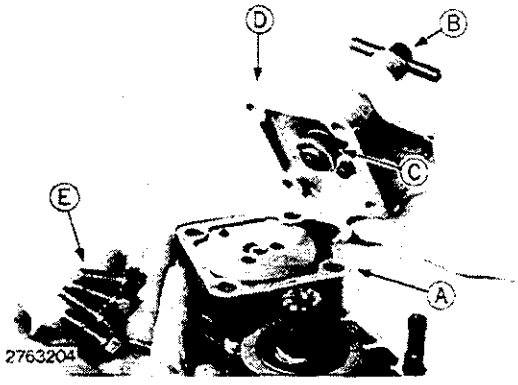
A – Brake Piston
B – O-rings



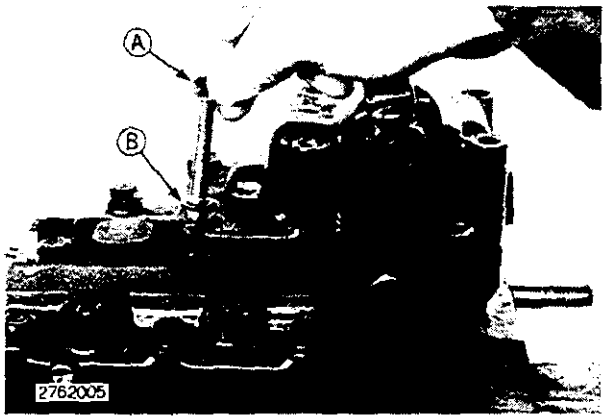
8. Install oil manifold cover (D) with spring (C) and release rod (B). Use new packing (A).

   Tighten cap screws (E) to 25 Nm (2.5 kgm) (22 ft-lbs) torque.

A – Packing
B – Release Rod
C – Spring
D – Oil Manifold Cover
E – Cap Screw



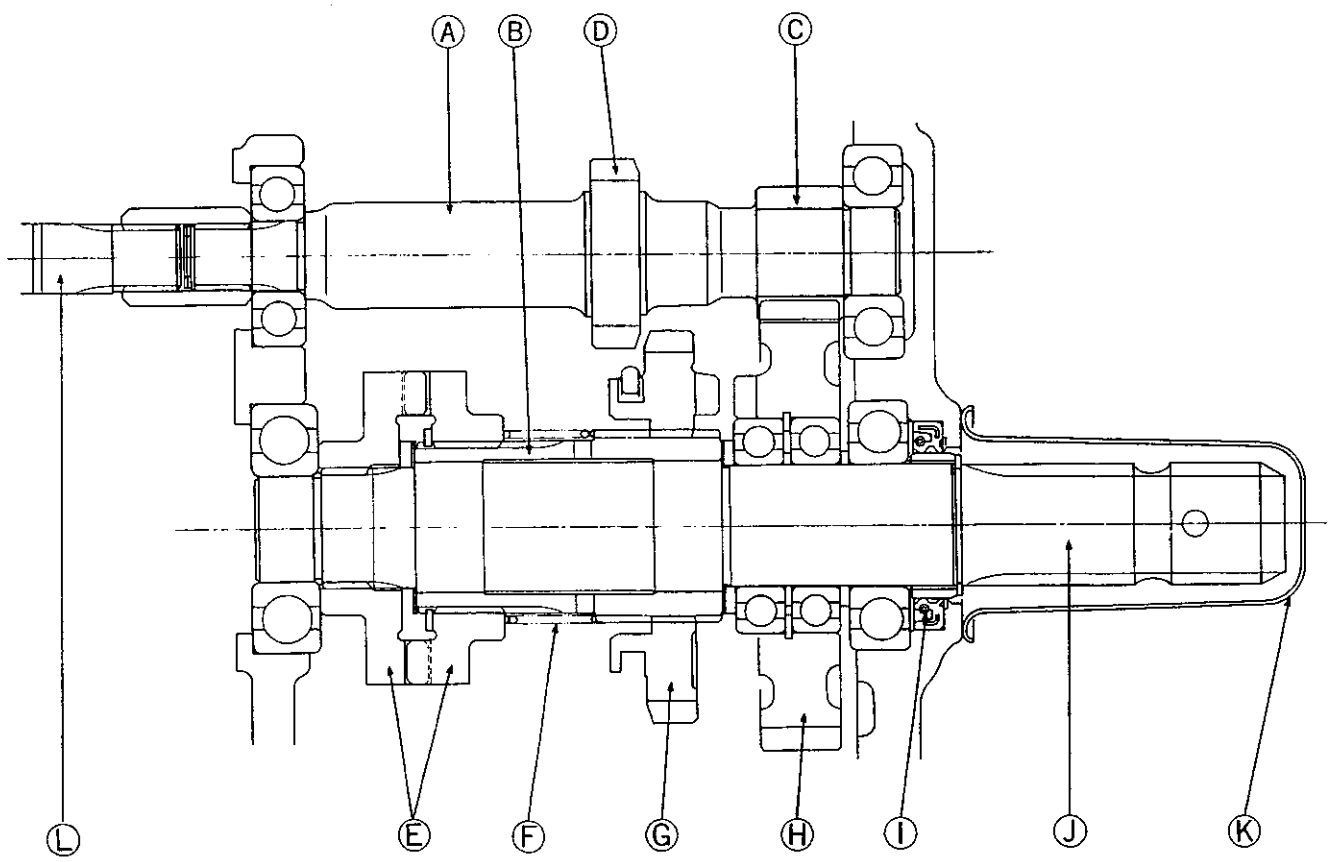
INSTALLATION



Regulator Case

1. Install regulator case assembly to transmission case.
   Tighten cap screws to 25 Nm (2.5 kgm) (22 ft-lbs) torque.

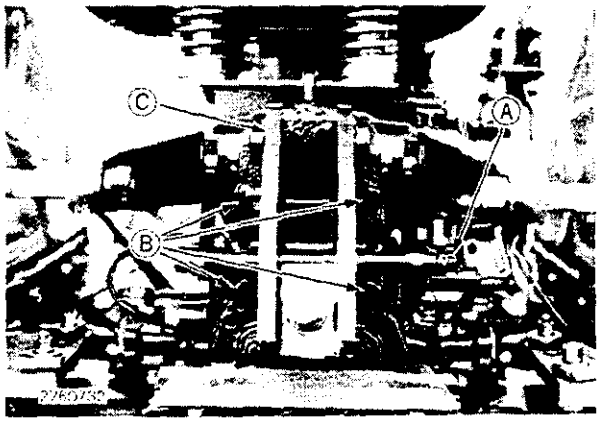
Use seal washer (B) for long cap screw (A) located at the center of case.



2767024

A – PTO Pinion Shaft
B – Spline Collar
C – PTO Pinion Gear (540rpm)
D – PTO Pinion Gear (1000rpm)
E – One-way Clutches
F – Spring
G – PTO Sliding Gear
H – PTO Gear
I – Oil Seal
J – PTO Shaft
K – PTO Safety Guard
L – PTO Connecting Shaft

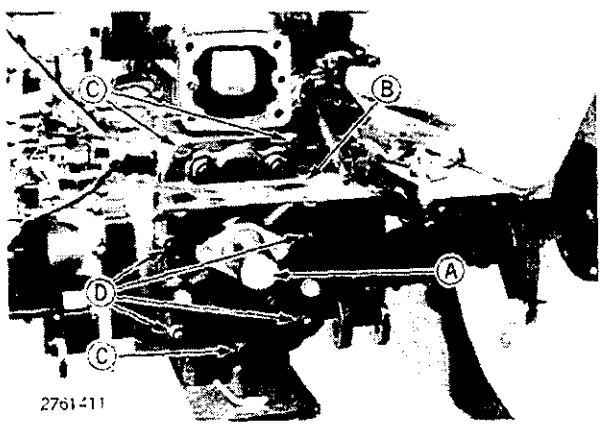
REAR PTO



REMOVAL

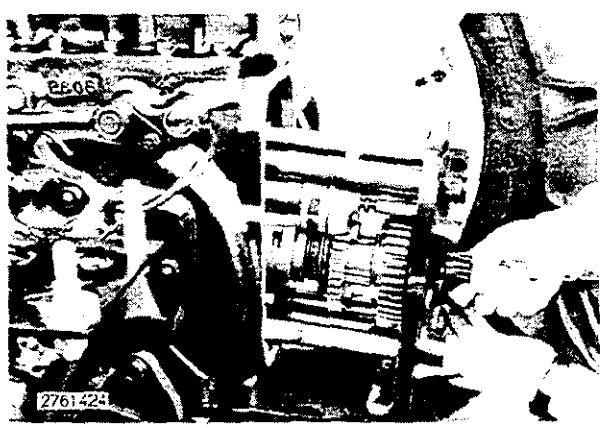
1. Drain transmission.
2. Disconnect draft control feed back rod (A).
3. Remove four cap screws (B) and upper link hinge assembly (C).

A – Draft Control Feedback Rod
B – Cap Screws
C – Upper Link Hinge



4. Remove PTO safety guard (A) and PTO shield (B).
5. Remove three cap screws (C) and four nuts (D).

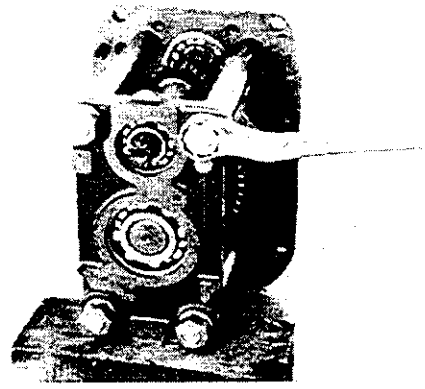
A – PTO Safety Guard
B – PTO Shield
C – Cap Screws
D – Nuts



6. Pull PTO assembly out. Do not need to remove fender as servicing PTO assembly.

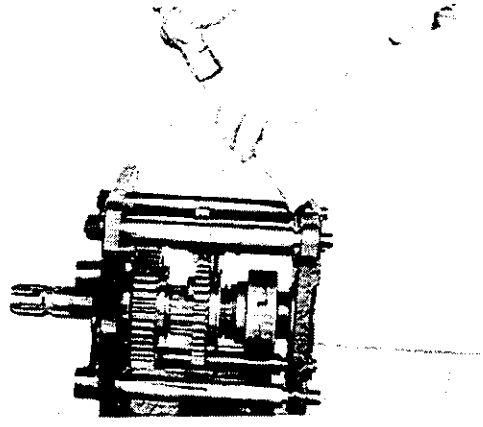
DISASSEMBLY

1. Remove four nuts.

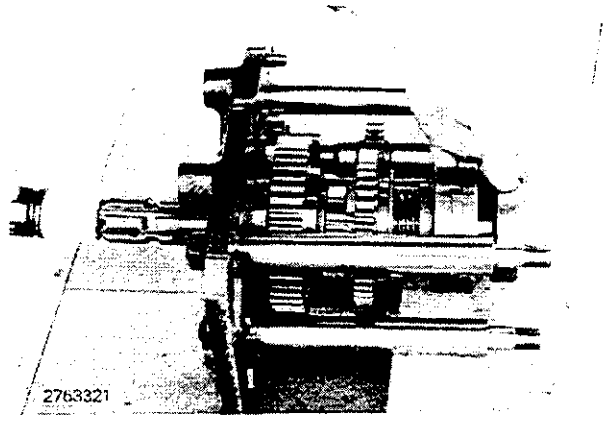

2763316

2. Remove front plate, PTO shift fork and collar.

STOP Do not lose detent ball and spring when removing the PTO shift fork.

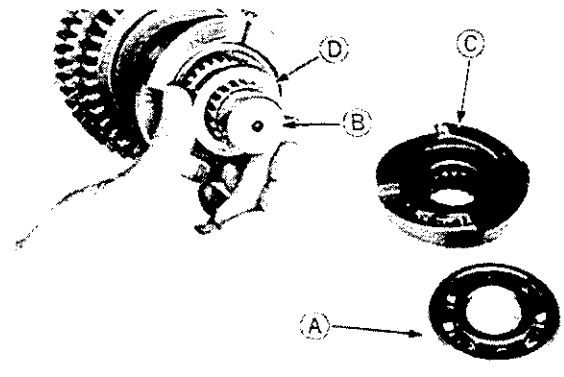

2763314

3. Remove PTO shaft assembly by tapping shaft end with plastic hammer.
   Remove PTO pinion shaft assembly at the same time.


2763321

4. Remove front bearing (A) on PTO shaft (B).
5. Remove one-way clutch front claw (C) and thrust washer (D).

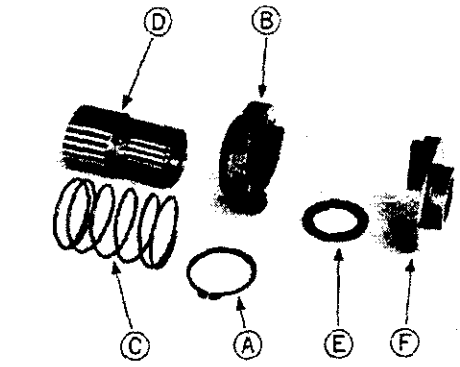
A – Front Bearing
B – PTO Shaft
C – One-way Clutch Front Claw
D – Thrust Washer



2763334

REAR PTO

DISASSEMBLY (Continued)

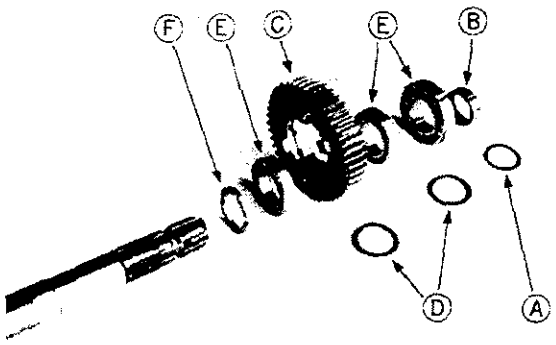


2763408

6. Remove snap ring (A), one-way clutch rear claw (B), spring (C), spline collar (D) and sliding gear.

When removing snap ring, hold one-way clutch claw tightly to avoid poping out by spring force.

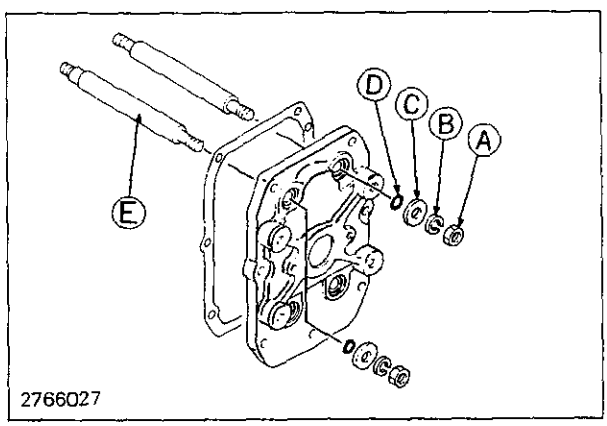
A – Snap Ring
B – One-way Clutch Rear Claw
C – Spring
D – Spline Collar
E – Thrust Washer
F – One-way Clutch Front Claw



2763416

7. Remove snap ring (A), seal collar (B), PTO gear (C), spacers (D), bearings (E) and thrust washer (F).

A – Snap Ring
B – Seal Collar
C – PTO Gear
D – Spacers
E – Bearings
F – Thrust Washers



2766027

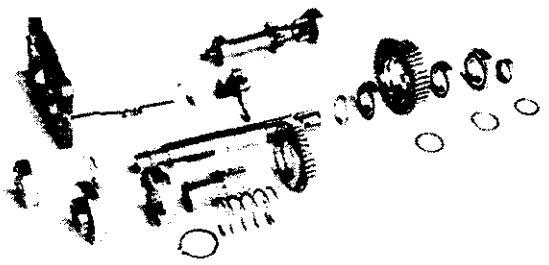
8. Remove nuts (A), spring washers (B), washers (C), O-rings (D) and supporting shafts (E).

A – Nuts
B – Spring Washers
C – Washers
D – O-rings
E – Supporting Shafts

INSPECTION

1. Inspect all gears and splines for uneven wear, chips, scoring and cracks. Replace as necessary.
2. Inspect all bearings for wear or damage. Replace as necessary.
3. Inspect all O-rings for damage. Replace as necessary.

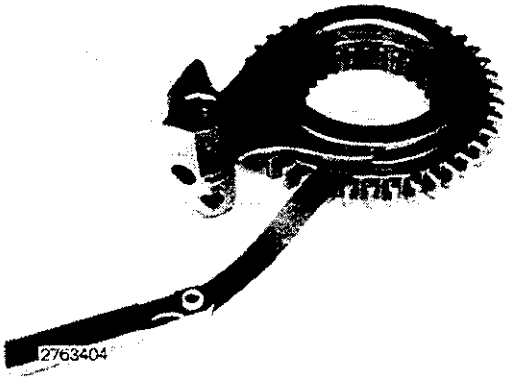
▼ **Oil seal and seal collar must be replaced when PTO shaft is disassembled.**



2763415

4. Measure clearance between shift fork and fork groove of sliding gear.

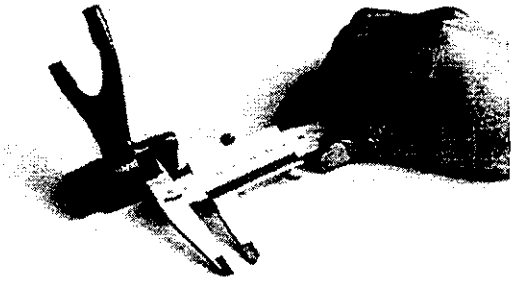
Item	New Part	Wear Limit
Shift Fork End Thickness	6.7 to 6.9 mm (0.263 to 0.272 in.)	
Sliding Gear Groove Width	7.1 to 7.3 mm (0.279 to 0.287 in.)	
Clearance between Fork and Sliding Gear Groove	0.2 to 0.6 mm (0.008 to 0.024 in.)	1.0 mm (0.040 in.)



2763404

5. Measure shift fork groove width and shift arm end thickness.

Item	New Part	Wear Limit
Shift Fork Groove Width	9.9 to 10.1 mm (0.390 to 0.398 in.)	
Shift Arm End Thickness	9.50 to 9.52 mm (0.374 to 0.375 in.)	
Clearance between Shift Fork Groove and Shift Arm	0.38 to 0.6 mm (0.015 to 0.024 in.)	1 mm (0.040 in.)



2763407

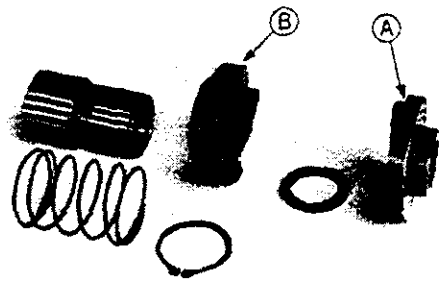
6. Measure I.D. of shift fork and O.D. of fork shaft.
   Replace parts when clearance between fork and shaft is 0.2 mm (0.008 in.)

Item	New Part	Wear Limit
Shift Fork I.D.	15.000 to 15.027 mm (0.5906 to 0.5916 in.)	
Shift Fork Shaft O.D.	14.966 to 14.984 mm (0.5892 to 0.5899 in.)	
Clearance between Fork and Shaft	0.016 to 0.061 mm (0.0006 to 0.0024 in.)	0.2 mm (0.008 in.)

2763405

REAR PTO

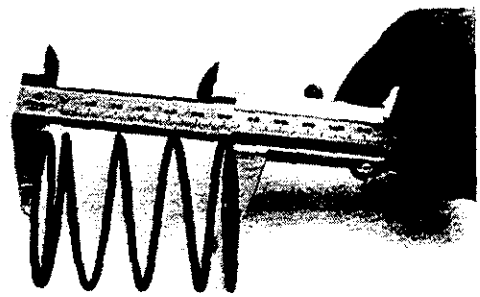
INSPECTION (Continued)



2763408

7. Check one-way clutch claws (A, B) for damage or excessive wear. Replace both claws (A) and (B) together if they were worn not to keep claws in connecting position.

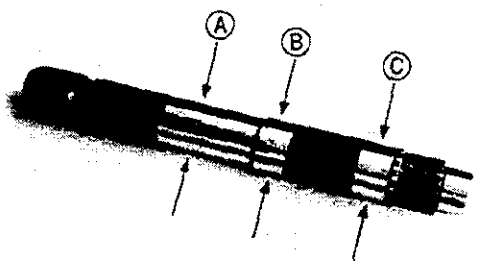
A – One-way Clutch Front Claw
B – One-way Clutch Rear Claw



3363417

8 Check clutch spring free length and tension.

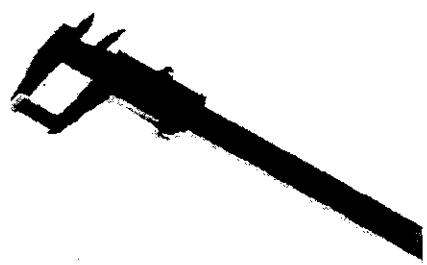
Item	New Part
Free Length	86 mm (3.386 in.)
Working Length	20.0 mm at 67 N (0.787 in. at 15 lbs)



2763412

9. Measure O.D. of PTO shaft and I.D. of spline collar.

Item	New Part
A – O.D. at Oil Seal Collar	34.992 to 35.008 mm (1.3776 to 1.3783 in.)
B – O.D. at Spline Collar	37.934 to 37.950 mm (1.4935 to 1.4941 in.)
C – O.D. at Spline Collar	37.934 to 37.950 mm (1.4935 to 1.4941 in.)
D – Spline Collar I.D.	38.000 to 38.025 mm (1.4960 to 1.4970 in.)



2763411

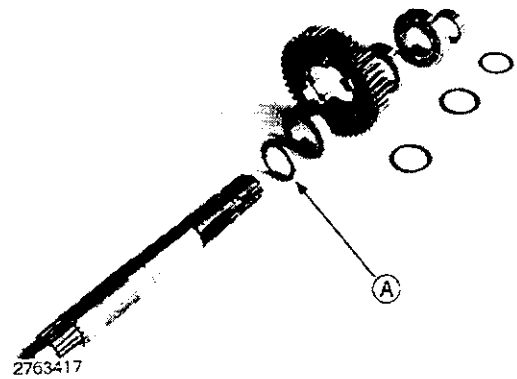
10. Inspect detent spring.

Item	New Part
Free Length	22.2 mm (0.874 in.)
Working Load	15.7 mm at 118.8 N (0.618 in. at 26.72 lbs.)

INSTALLATION

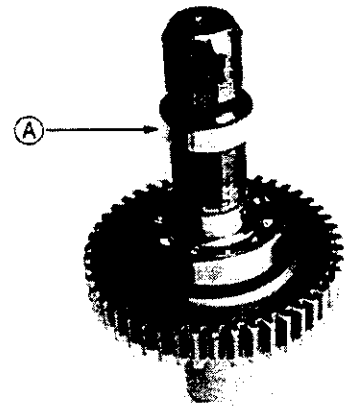
Reverse the removal steps on the preceding pages and note the installation instructions that follow.

1. Install thrust washer (A) as oil groove on washer facing to tractor forward.



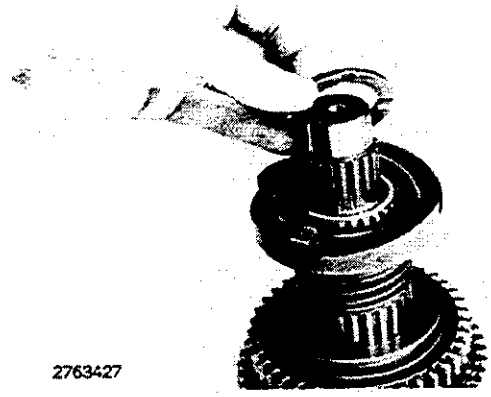
2763417

2. When installing seal collar (A), apply grease and do not damage.

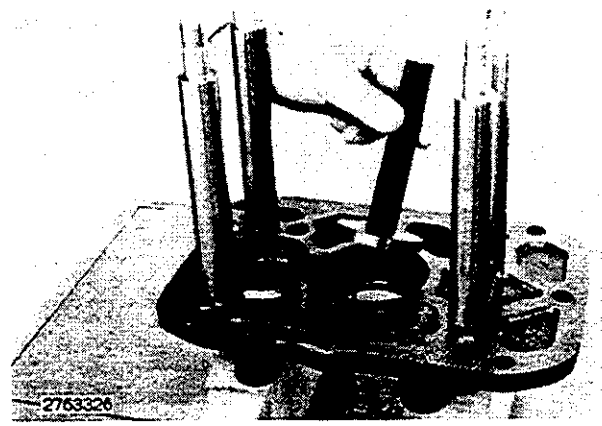


2763423

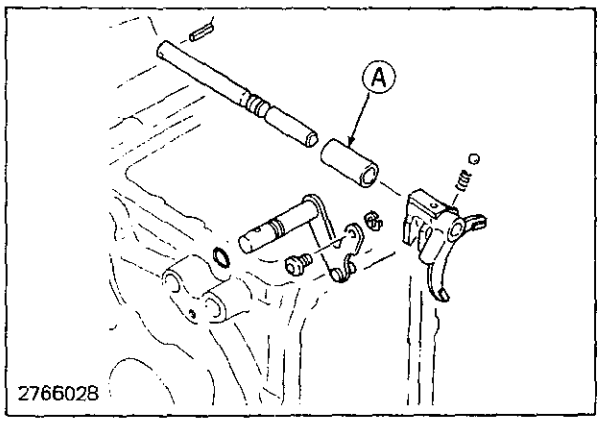
3. Install thrust washer as oil groove on washer facing to tractor rearward.


2763427

4. Before installing oil seal with seal driver, apply grease and do not damage.


2763326

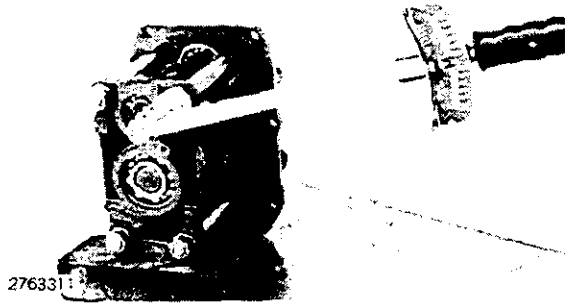
REAR PTO



INSTALLATION (Continued)

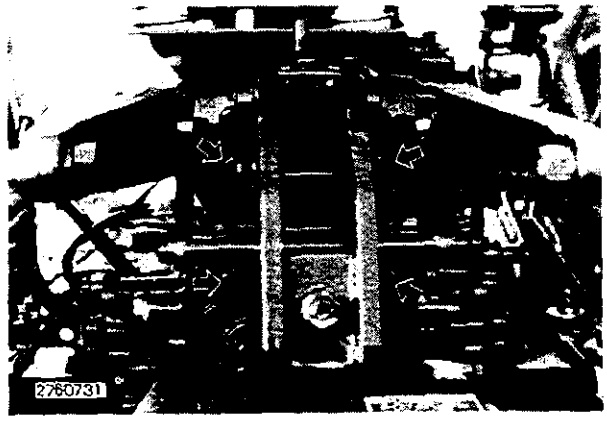
5. Install PTO shift lock collar (A) as shown figure.

6. Tighten PTO plate retaining nuts to 210 Nm (21 kgm) (152 ft-lbs.)



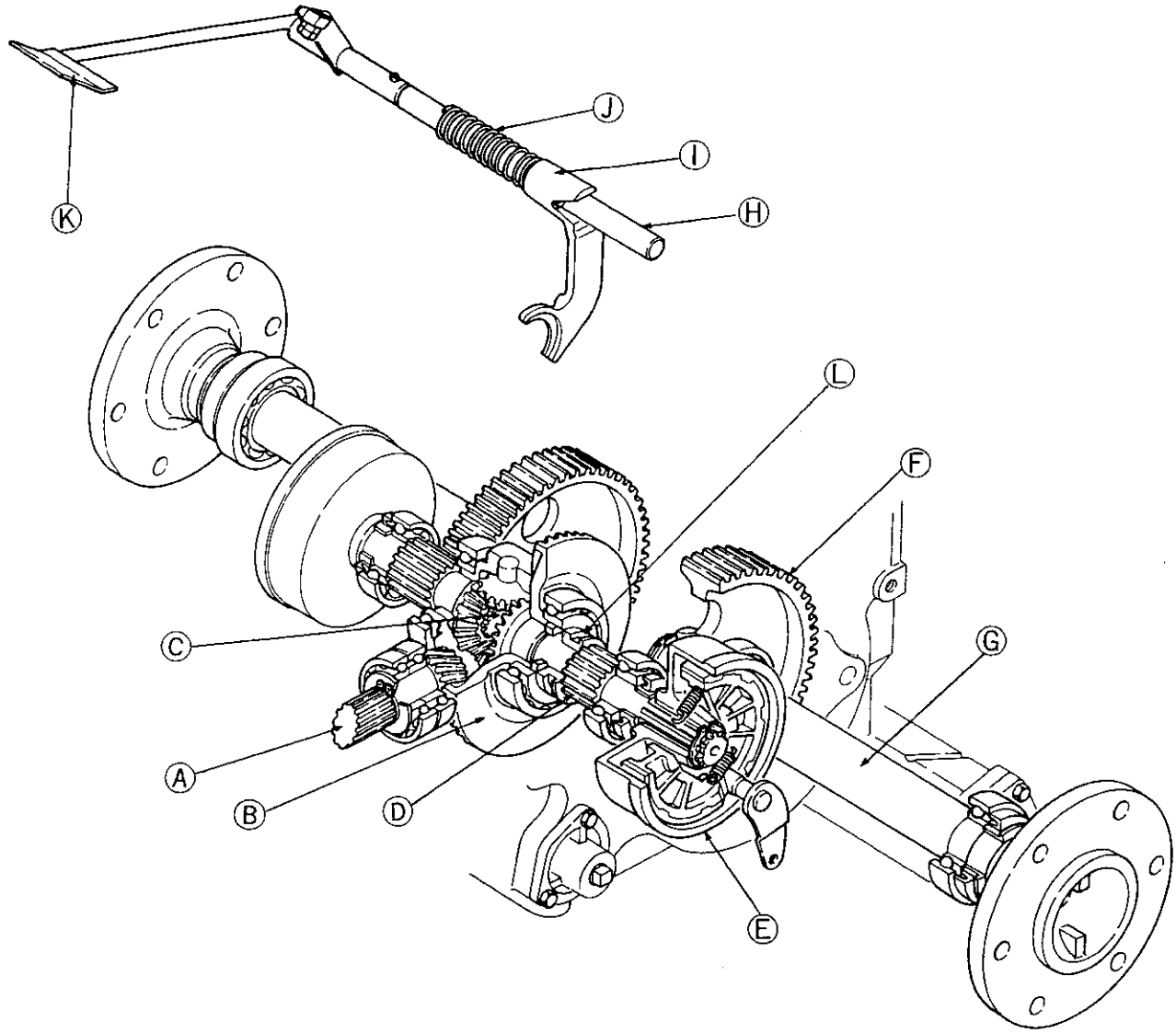
7. Replace gasket and tighten PTO rear cover retaining cap screws and nuts to differential case.

Torque . . . . . 100 Nm (10 kgm) (72 ft-lbs)



8. Replace gasket and tighten upper link hinge retaining cap screws to hydraulic cylinder case.

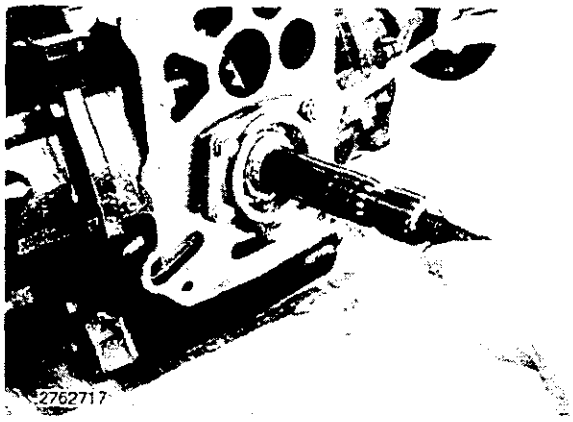
Torque . . . . . 147 Nm (15 kgm) (108 ft-lbs)



2263001A

A – Differential Drive Pinion Shaft
B – Differential Ring Gear
C – Differential Assembly
D – Final Pinion Shaft
E – Brake Assembly
F – Final Gear
G – Rear Axle Shaft
H – Differential Lock Shaft
I – Differential Fork
J – Return Spring
K – Differential Lock Pedal
L – differential Lock Slider

DIFFERENTIAL DRIVE SHIFT

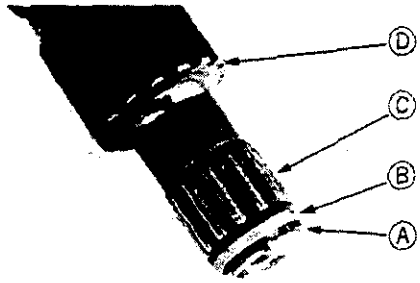

2762717

REMOVAL

1. Remove five bearing retainer cap screws from differential housing and remove bearing retainer.

2. Pull differential drive shaft from differential housing.

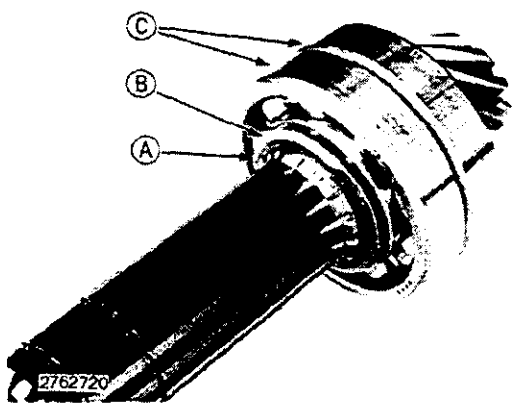

2762718



2762516

3. Remove snap ring (A), spacer (B) and needle bearing (C) from differential drive shaft (D).

A – Snap Ring
B – Spacer
C – Needle Bearing
D – Differential Drive Shaft



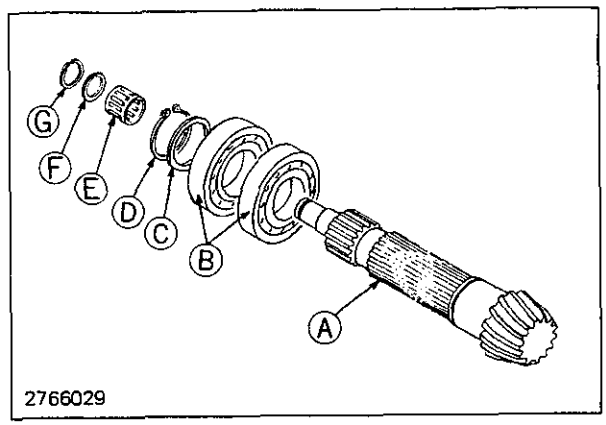
2762720

4. Remove snap ring (A), spacer (B) and bearings (C) from differential drive shaft.

A – Snap Ring
B – Spacer
C – Bearings

INSPECTION

1. Inspect gear and spline for uneven wear, chips, scoring and cracks. Replace if necessary.
2. Inspect bearings for wear or damage and replace if necessary.



2766029

A – Differential Drive Shaft
B – Bearings
C – Spacer
D – Snap Ring
E – Needle Bearing
F – Spacer
G – Snap Ring

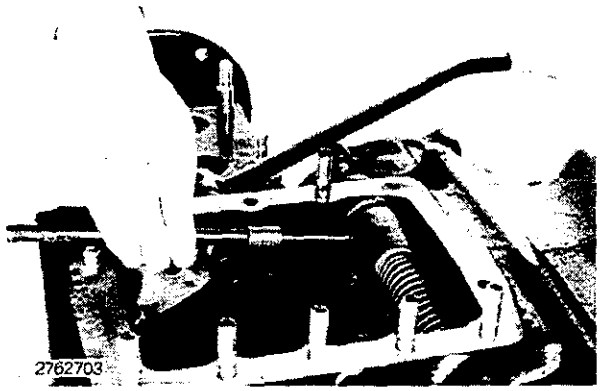
3. Inspect differential drive shaft surface at needle bearing for scoring or wear and measure O.D.

Item	New part
O.D. at Needle Bearing	17.983 to 17.994 mm (0.7080 to 0.7084 in.)

2200807

DIFFERENTIAL

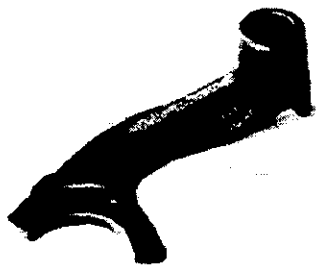
REMOVAL

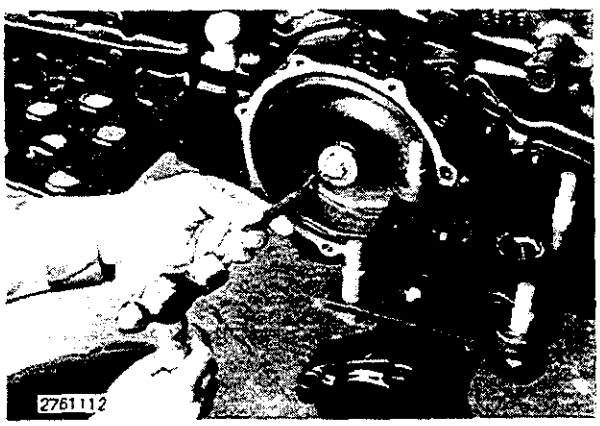

2762703

1. Remove spring pins in differential lock shaft pedal.
2. Pull differential lock pedal shaft out from differential housing.

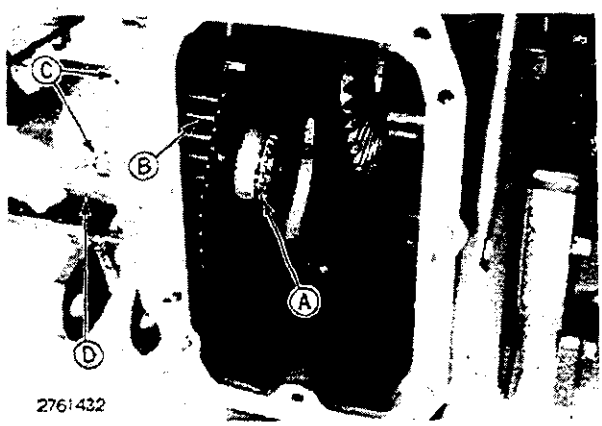
Pay full attention to spring. It may jump out at removing differential lock shaft.

3. Remove differential lock slider fork and spring.


2762726


2761112

4. Remove brake cover.
5. Flatten lock washer and remove cap screw, plate washer and brake drum.



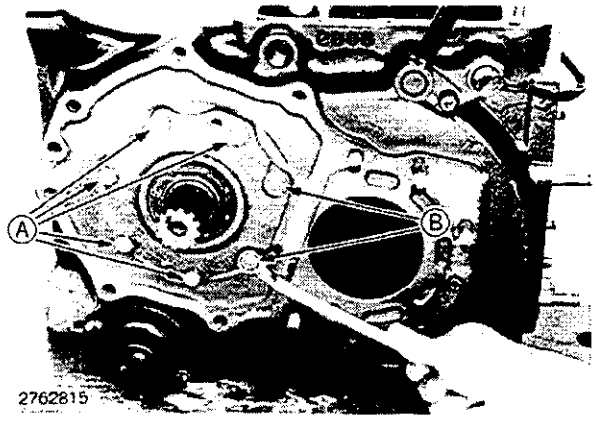
2761432

6. Remove snap ring (A) on rear axle shaft to be free final gear (B) from shaft.
7. Remove final gear.
8. Remove eight cap screws and four nuts (C).
9. Remove rear axle housing (D).

A – Snap Ring
B – Final Gear
C – Nut (4 used)
D – Rear Axle Housing

10. Remove five cap screws (A) and two nuts (B).

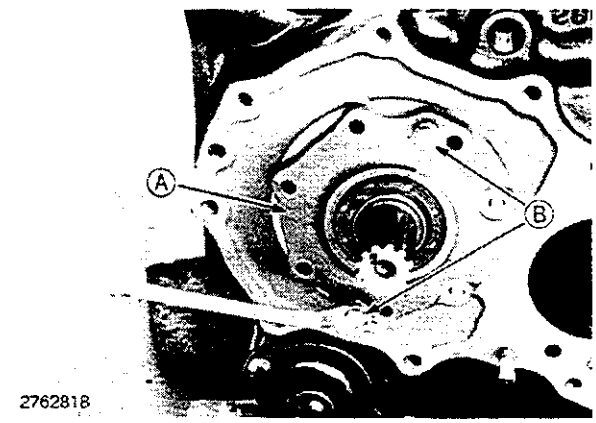
A – Cap Screws
B – Nuts



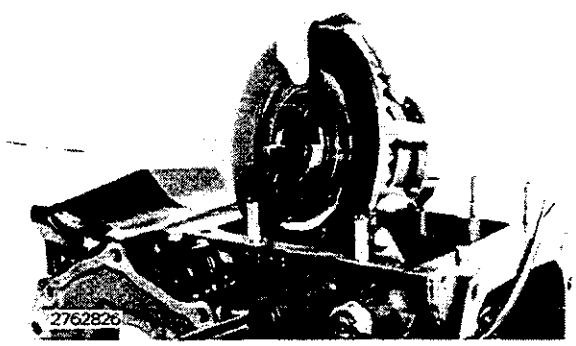
11. Remove differential carrier assembly (A) by using two jack screws (B).

12. Remove shims between differential carrier and differential housing.

A – Differential Carrier
B – Jack Screws

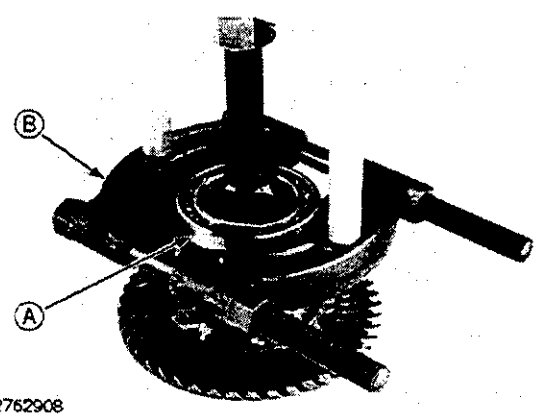


13. Take out differential assembly.



14. Remove bearing (A) with knife edge puller (B).

A – Bearing
B – Knife Edge Puller

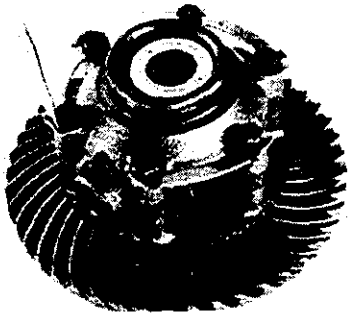


DIFFERENTIAL

REMOVAL (Continued)

15. Flatten lock washers and remove six cap screws.

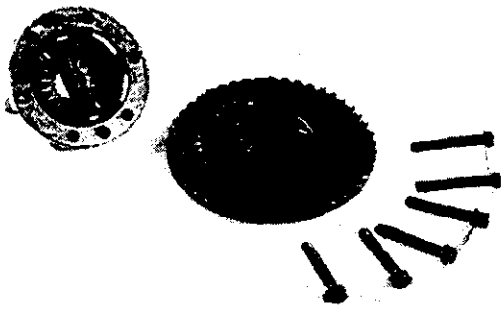
Differential ring gear retainning cap screws must be replaced as disassembling ring gear.



2762910

16. Separate differential case from ring gear.

If the differential ring gear is not to be replaced, mark the ring gear and differential case so they will be reassembled in the same position.

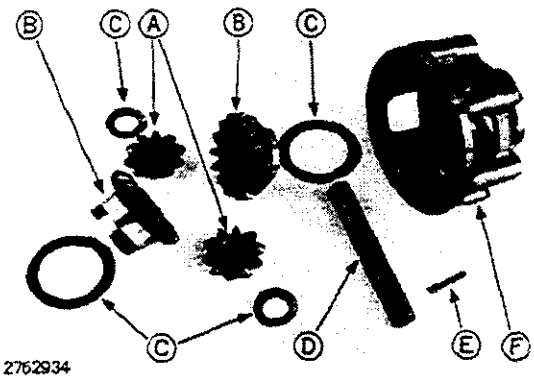


2762917

17. Drive spring pin from differential case and pinion shaft by using a spring pin punch.

2762923

18. Remove differential pinions (A), side gears (B), thrust washers (C) and pinion shaft (D).



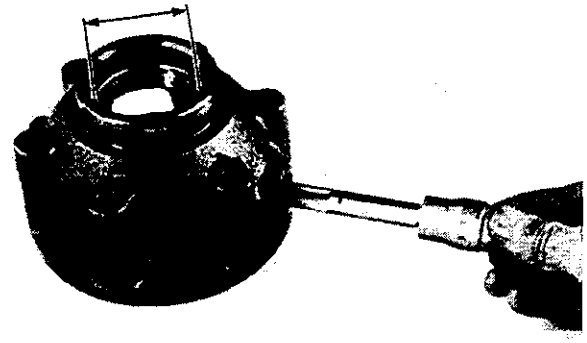
2762934

A – Differential Pinions
B – Differential Side Gears
C – Thrust Washers
D – Pinion Shaft
E – Spring Pin
F – Differential Case

INSPECTION

1. Inspect differential case for damage and measure bushing I.D. and pinion shaft I.D..

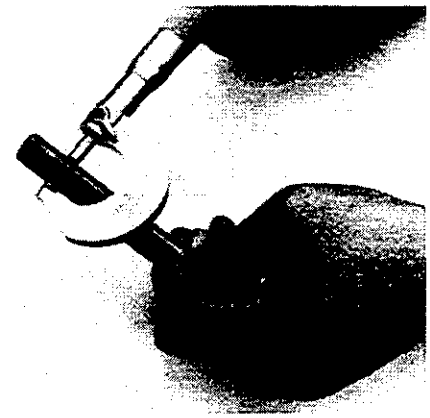
Item	Specification
Bushing I.D.	48.000 to 48.039 mm (1.8898 to 1.8913 in.)
Pinion Shaft I.D.	18 to 18.018 mm (0.7087 to 0.7094 in.)



2762930

2. Inspect pinion shaft for wear or scoring and measure O.D..

Item	Specification
Pinion Shaft O.D.	17.973 to 17.984 mm (0.7076 to 0.7080 in.)

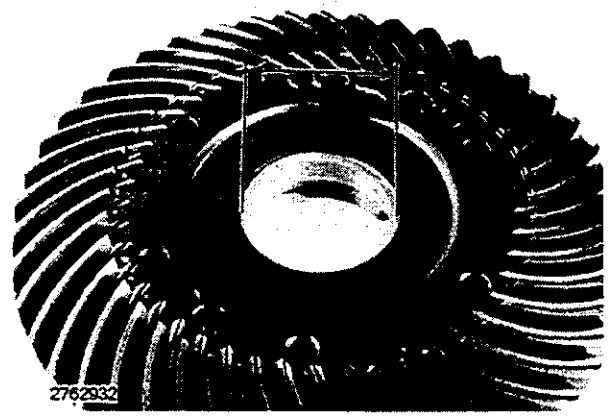


1800508

3. Inspect ring gear for uneven wear, chips, scoring and cracks. Measure bushing I.D.

Item	Specification
Bushing I.D.	48.000 to 48.039 mm (1.8898 to 1.8913 in.)

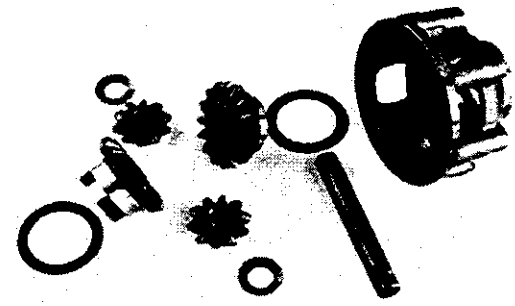
If differential ring gear is replaced, differential drive shaft must also be replaced since they are a matched set.



2762932

4. Inspect differential pinions and side gears for uneven wear, chips, scoring and cracks. Measure pinions I.D. and side gears O.D. at bushing surface.

Item	Specification
Pinion I.D.	18.032 to 18.050 mm (0.7099 to 0.7106 in.)
Side Gear O.D.	47.959 to 47.975 mm (1.8881 to 1.8888 in.)



2762935

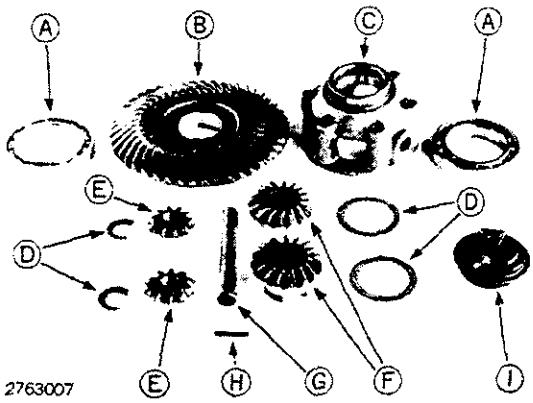
DIFFERENTIAL

INSPECTION (Continued)

2763003

5. Inspect thrust washers for damage and measure thickness.

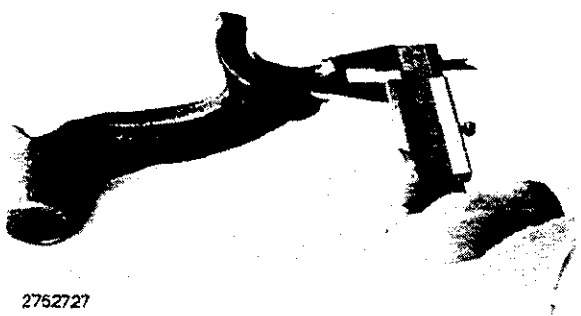
Item	Specification	Wear Limit
Thickness	0.95 to 1.05 mm (0.0374 to 0.0413 in.)	0.6 mm (0.0236 in.)



2763007

6. Inspect bearings for wear or damage.

A – Bearings
B – Ring Gear
C – Differential Case
D – Thrust Washers
E – Differential Pinions
F – Differential Side Gears
G – Pinion Shaft
H – Spring Pin
I – Differential Lock Slider



2762727

7. Inspect differential lock fork.

Item	Specification	Wear Limit
I.D. of Fork	20.040 to 20.073 mm (0.7890 to 0.7903 in.)	
Thickness of Fork End	7.8 to 8.0 mm (0.307 to 0.315 in.)	
Width of Fork Groove in Diff. Lock Slider	8.1 to 8.3 mm (0.318 to 0.327 in.)	
Clearance between Fork and Slider	0.1 to 0.5 mm (0.003 to 0.020 in.)	1.0 mm (0.040 in.)

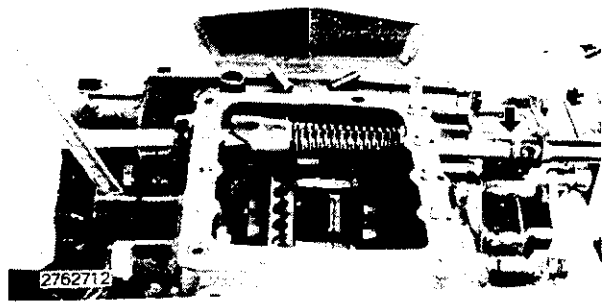
8. Inspect differential lock claws on differential lock slider and differential side gear (Left side only) for damage. Replace if necessary.

9. Inspect O-ring of differential lock shaft for damage.

2762920

10. Inspect differential lock shaft pedal for damage and measure shaft O.D. and differential housing I.D..

Item	Specification
Shaft O.D.	19.948 to 20.000 mm (0.7854 to 0.7874 in.)
I.D. of Differential Housing	20.05 to 20.10 mm (0.7894 to 0.7913 in.)



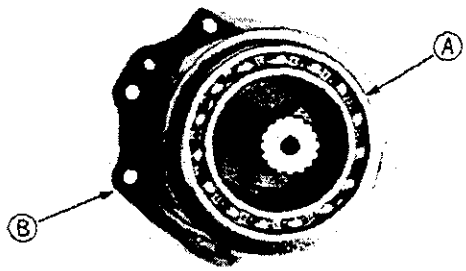
11. Inspect differential fork spring.

Item	New Part
Free Length	115 mm (4.528 in.)
Working Load	79 mm at 489 N (3.11 in. at 110 lbs.)

2762725

FINAL DRIVE

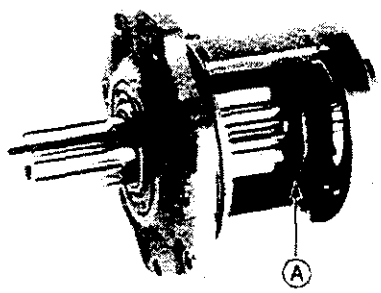
DISASSEMBLY



2762835

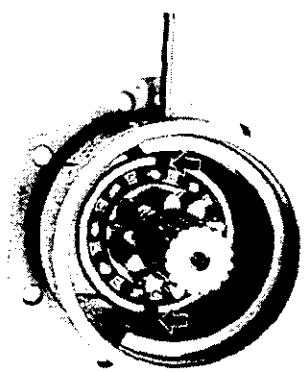
1. Remove O-ring.
2. Remove bearing (A) from differential carrier (B).

A – Bearing
B – Differential Carrier



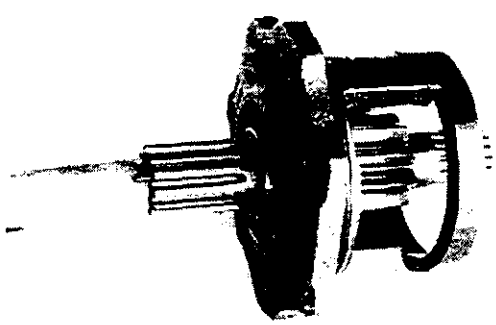
2762832

3. Remove differential lock slider (A). (Left side only)



2763028

4. Drive two spring pins from differential carrier.

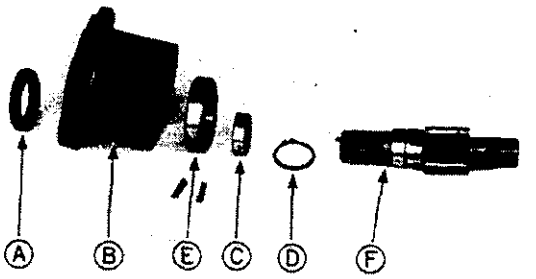


2763030

5. Drive final reduction pinion shaft assembly from differential carrier by using plastic hammer.

6. Remove oil seal (A) from differential carrier (B).
7. Remove oil seal collar (C), snap ring (D) and bearing (E).

A – Oil Seal
B – Differential Carrier
C – Oil Seal Collar
D – Snap Ring
E – Bearing
F – Final Pinion Shaft



2763213

INSPECTION

1. Inspect final reduction pinion gear and spline for damage. Measure O.D. at seal collar.

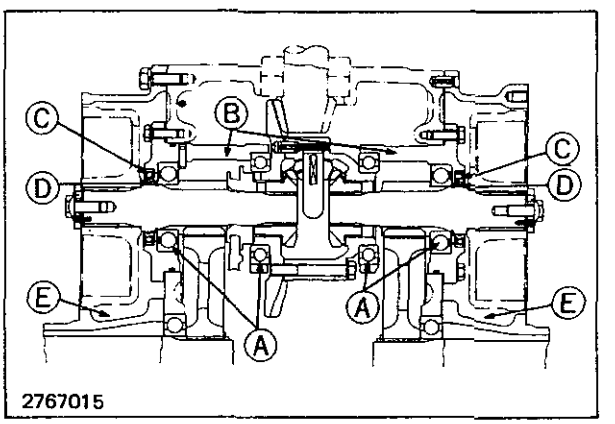
Item	Specification
O.D. (at Oil Seal Collar)	40.002 to 40.018 mm (1.5749 to 1.5755 in.)


2763215

2. Inspect bearings (A) for wear or damage.
3. Inspect differential carrier case (B) for crack or damage.
4. Inspect oil seal (C) and oil seal collar (D) for damage.

Inspect the oil leakage into brake chamber (E) of rear axle housing.

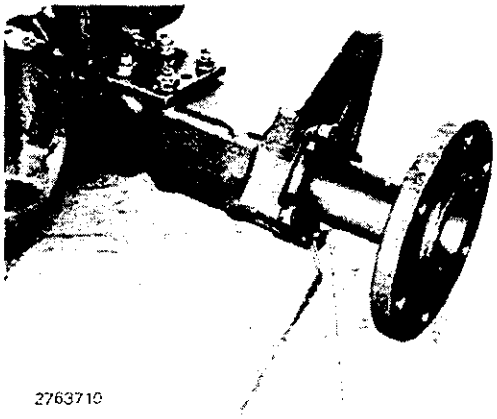
A – Bearings
B – Differential Carrier Cases
C – Oil Seals
D – Oil Seal Collars
E – Brake Chambers



2767015

REAR AXLE

DISASSEMBLY

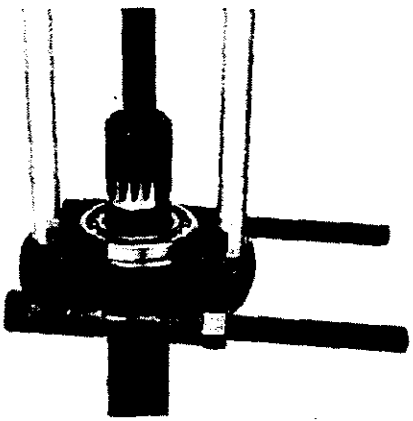


2763710

1. Remove four cap screws.

2763536

2. Drive the rear axle shaft end with plastic hammer and remove rear axle shaft assembly.

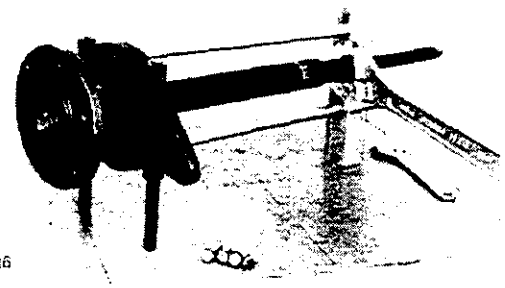


2763719

3. Remove inner bearing by using knife edge puller.

4. Remove oil seal case with outer bearing and oil seal as shown.

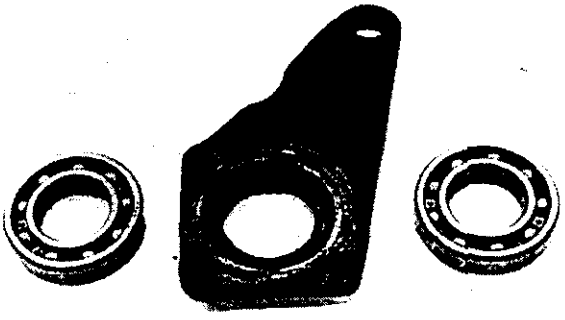
5. Remove bearing and oil seal from oil seal case.



2763716

INSPECTION

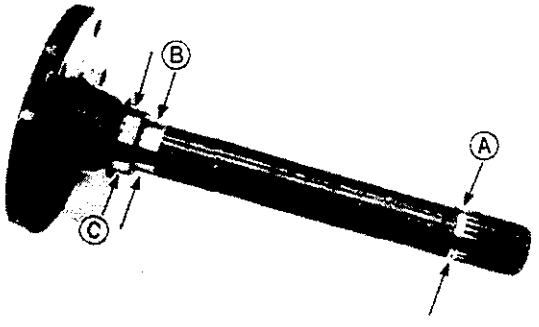
1. Inspect bearings for wear or damage and replace if necessary.
2. Inspect oil seal and seal collar for damage.



2200929

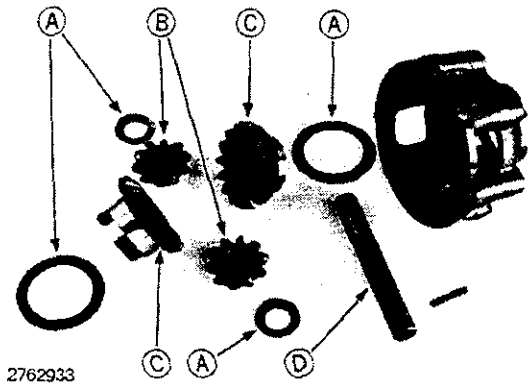
3. Inspect axle shafts and its spline for wear or damage.
4. Measure O.D. as shown.

Item	Specification
A — O.D. at Inner Bearing	49.992 to 50.008 mm (1.9682 to 1.9688 in.)
B — O.D. at Outer Bearing	49.992 to 50.008 mm (1.9682 to 1.9688 in.)
C — O.D. at Oil Seal Collar	49.97 to 50.03 mm (1.9673 to 1.9697 in.)



2200918

INSTALLATION AND ADJUSTMENT

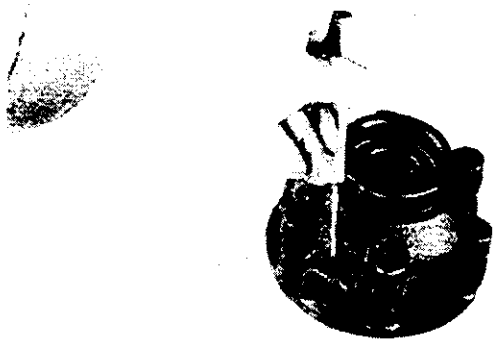


2762933

Assemble Differential

1. Grease thrust washers (A), pinions (B), side gears (C) and pinion shaft (D).
2. Install side gears in differential case and ring gear with thrust washers.
3. Install differential pinions in place with thrust washers.

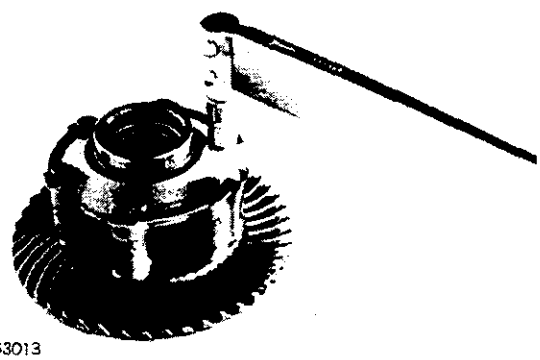
STOP To properly align the bevel pinions walk them around the bevel gears to align with the shaft bores.


2762921

4. Insert the pinion shaft through the bevel pinions and thrust washers. Be sure to align the spring pin hole in the shaft with the spring pin hole in differential case.

STOP Install the spring pin as the split in the pin facing 90° from the shaft center line.

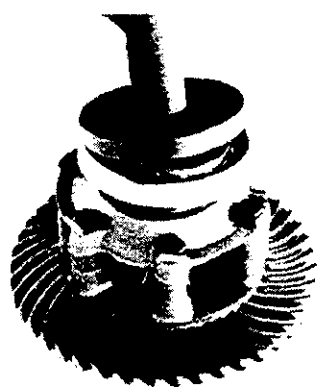
5. Check if the differential assembly turn freely in the case.


2763013

6. Install differential ring gear so ring gear holes align with housing holes. If the original ring gear is reinstalled, be sure the marks on the ring gear and housing are in the same position as when removed.
7. Install lock washers and new cap screws.
8. Tighten them to 60 Nm (6 kgm) (43 ft-lbs).
9. After tightening, bend the lock washers.

STOP Ring gear tightening cap screws must be replaced as disassembling ring gear.

10. Install bearings.


2763016

Assemble Final Drive

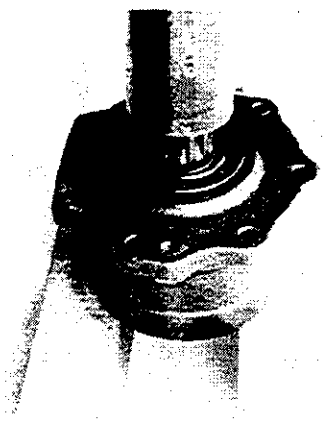
1. Install bearing into differential carrier.
2. Install spring pins.

2763218

3. Install final pinion shaft.
4. Install snap ring.
5. Grease oil seal collar and install on pinion shaft.

2763221

6. Grease oil seal and install into differential carrier case by using correct tubing oil seal driver.
7. Grease O-ring and install onto the differential carrier case.



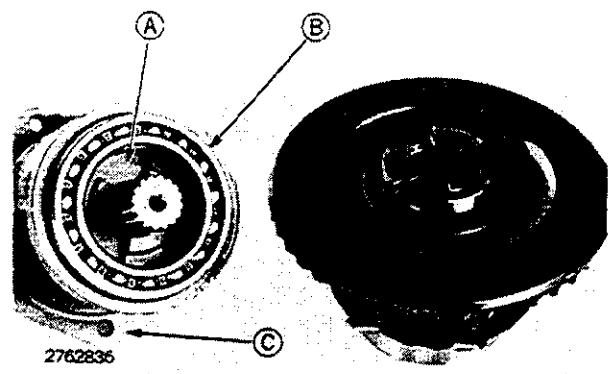
2763227

8. Install differential lock slider (A). (Left-side only)

Be sure the over all length of left-side differential carrier is longer than right one.

Be careful the direction of differential lock claws on slider should be facing as shown.

9. Install bearing (B).

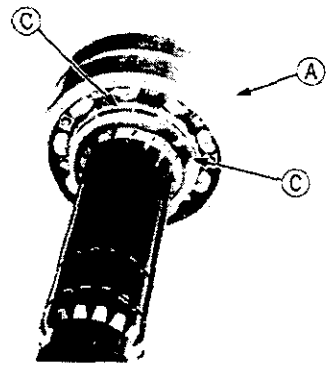


2762836

A — Differential Lock Slider
B — Bearing
C — Differential Carrier

INSTALLATION AND ADJUSTMEN

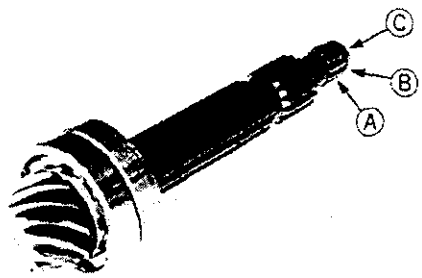
Install Final Drive and Differential



2762721

1. Install bearings (A).
2. Install spacer (B) and snap ring (C).

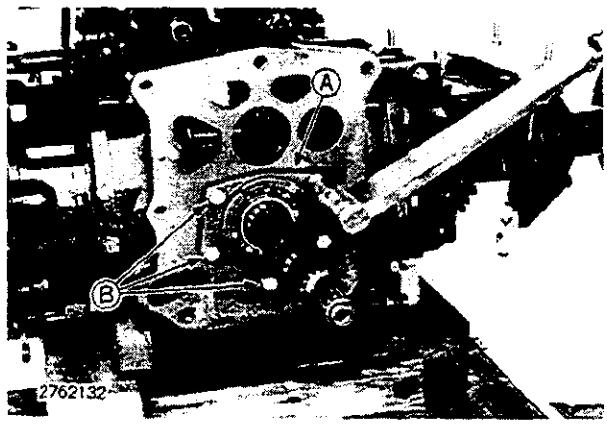
A – Bearing
B – Spacer
C – Snap Ring



2762719

3. Install needle bearing (A).
4. Install spacer (B) and snap ring (C).

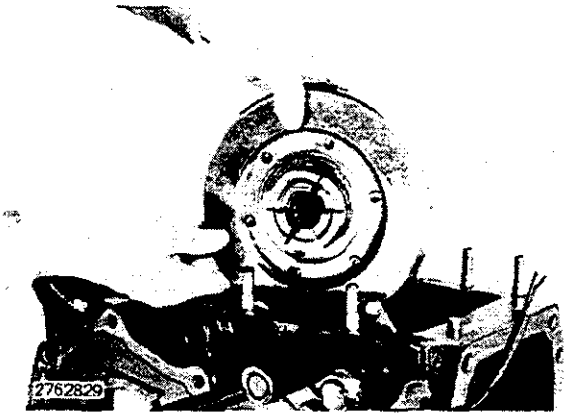
A – Needle Bearing
B – Spacer
C – Snap Ring



2762132

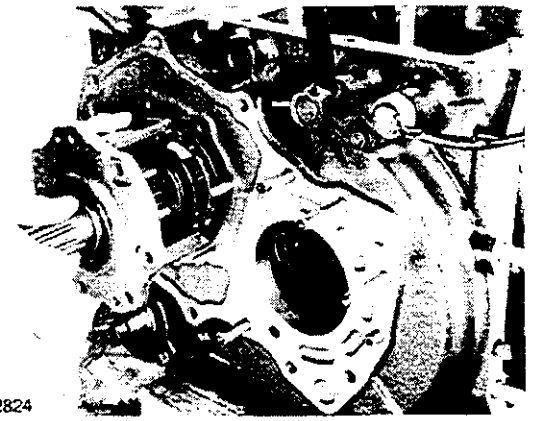
5. Install bearing retainer (A) and five cap screws (B).
6. Tighten them to 30 Nm (3 kgm) (22 ft-lbs).

A – Bearing Retainer
B – Cap Screw (5 used)


2762829

7. Put the differential assembly into differential housing. While holding it, install right-side differential carrier assembly.
8. If the differential ring gear was not replaced, install the differential carrier with the same number of shims as were removed. See the page 50-30-17~19 when ring gear were replaced or the number of shims is in question.

9. Install the left side differential carrier assembly.
10. Install the same number shims as were removed.
11. Install six cap screws and tighten to 30 Nm (3 kgm) (22 ft-lbs).


2762824

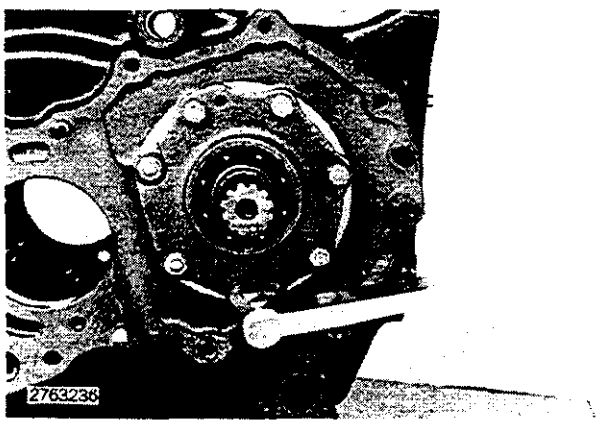
Adjustment

If the ring gear was replaced or if the number of cone point or backlash adjusting shims are in question, be sure to adjust differential ring gear cone point and backlash.

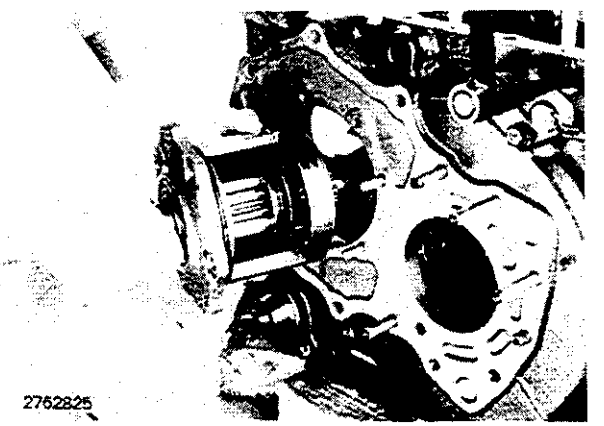
The cone point of spiral bevel pinion is fixed and not adjustable. Cone point is decided under machining process of differential drive shaft rear bearing bore in differential housing.

If differential ring gear is replaced, differential drive shaft must also be replaced since they are a matched set.

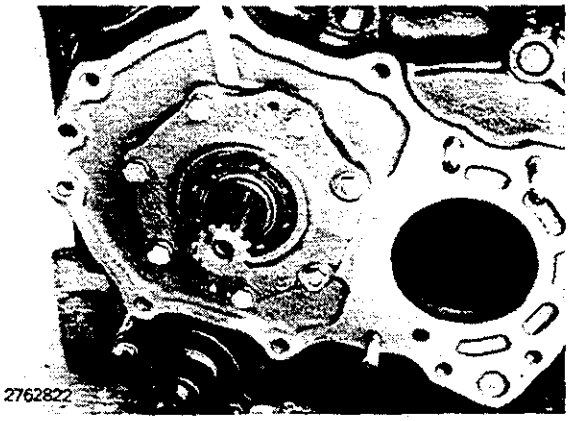
1. Install right-hand differential carrier without shim. Tighten five cap screws and two nuts.


2763236

2. Place differential bearing into right-hand differential carrier. Then strike inner race of ring gear bearing with soft slug or driver to drive the bearing into right-hand differential carrier firmly.
3. Place left-hand differential carrier to differential housing and strike it with soft slug or driver to drive the carrier swallow ring gear bearing.


2762825

INSTALLATION AND ADJUSTMENT

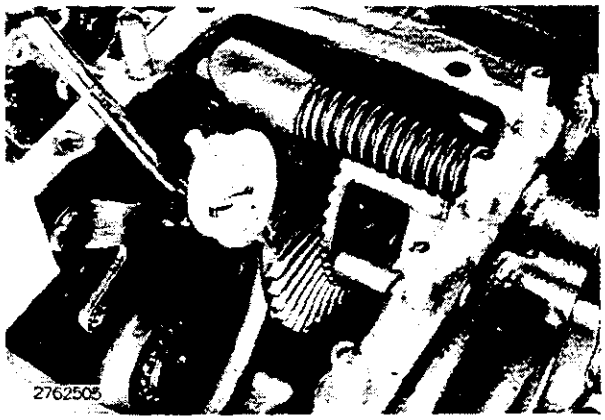


Adjustment (Continued)

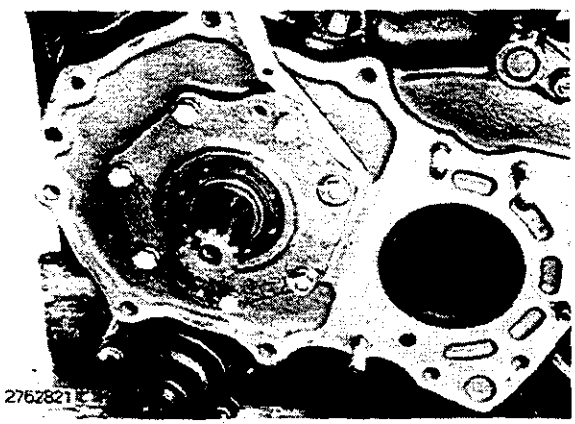
4. Remove the right-hand side five cap screws and two nuts which tightened step 1.
5. Measure clearance between differential housing and left-hand differential carrier.
6. Select shims by the clearance.

Total thickness of shims should be 0.05 to 0.10 mm (0.002 to 0.004 in.) more than the clearance.

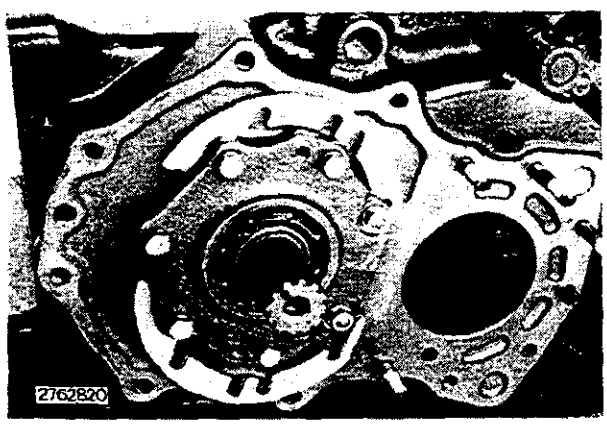
Side shims are available in three sizes. These sizes are 0.1 mm (0.004 in.), 0.3 mm (0.012 in.) and 0.5 mm (0.20 in.).



7. Install dial indicator. Be sure base of indicator is firmly attached. Point of indicator should be toward outer part of ring gear tooth and as close as to perpendicular to the tooth as possible.

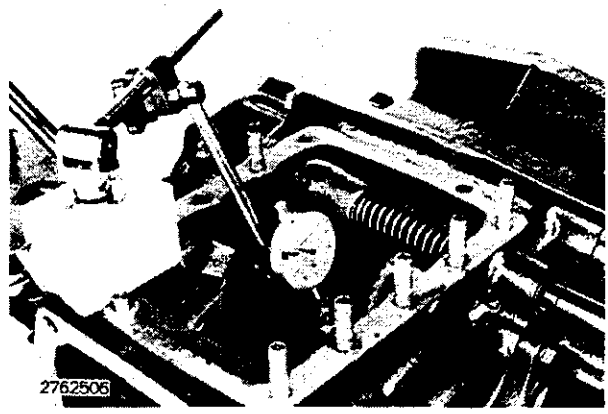


8. Adjust position of L & R differential carrier and differential assembly to get backlash being 0.13 to 0.18 mm (0.005 to 0.007 in.).
9. Measure clearance between differential housing and L & R differential carrier.

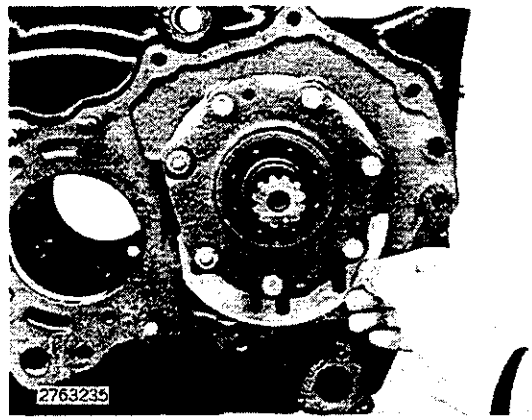


10. Divide and install the previous selected shims according to each clearance. Jack-up screws are available for installing shims.
11. Tighten both-sides differential retaining cap screws and nuts to 30 Nm (3 kgm) (22 ft-lbs).
12. Measure the backlash again.

13. If the backlash is more than 0.18 mm (0.007 in.), remove the proper left-hand shim(s) and add it to right-hand shims.
14. Retighten cap screws and nuts to 30 Nm (3 kgm) (22 ft-lbs) and measure backlash again.
15. Repeat the preceding procedures until getting the correct backlash.



16. If the backlash is less than 0.13 mm (0.005 in.), remove the proper right-side shim(s) and add it to left-hand shims.
17. Retighten cap screws and nuts to 30 Nm (3 kgm) (22 ft-lbs) and measure backlash again.
18. Repeat the preceding procedures until getting the correct backlash.

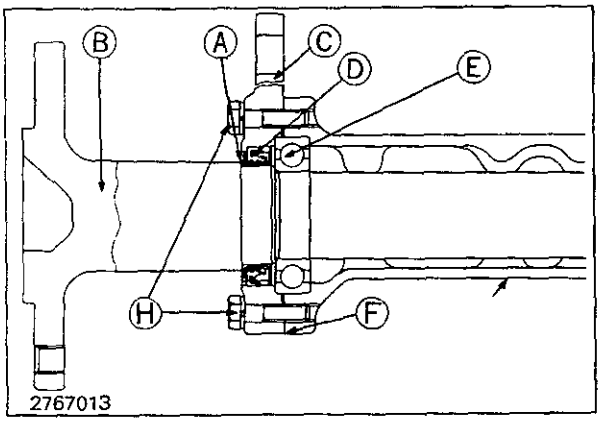


INSTALLATION AND DIFFERENTIAL

2763723

Install Rear Axle Housing

1. Apply grease for oil seal and install it into bearing retainer using oil seal driver.

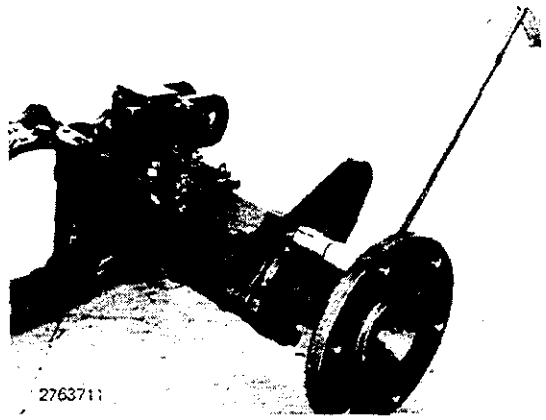


2767013

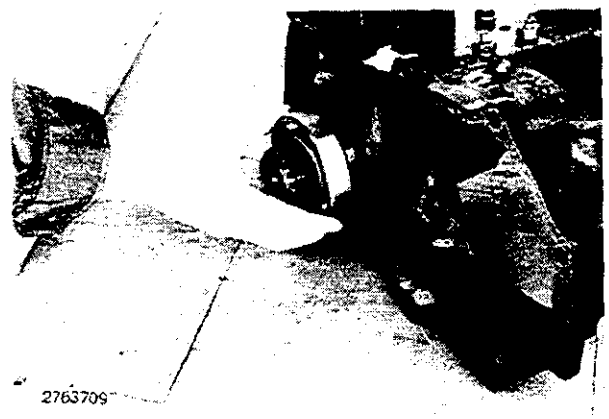
2. Apply grease for seal collar (A) and install onto rear axle shaft (B).
3. Install bearing retainer (C) with oil seal (D).
4. Install outer bearing (E) onto rear axle shaft.
5. Replace gasket (F).
6. Install rear axle housing (G).

A – Seal Collar
B – Axle Shaft
C – Bearing Retainer
D – Oil Seal
E – Outer Bearing
F – Gasket
G – Rear Axle Housing
H – Cap Screws

7. Tighten cap screws to 60 Nm (6 kgm) (43 ft-lbs).



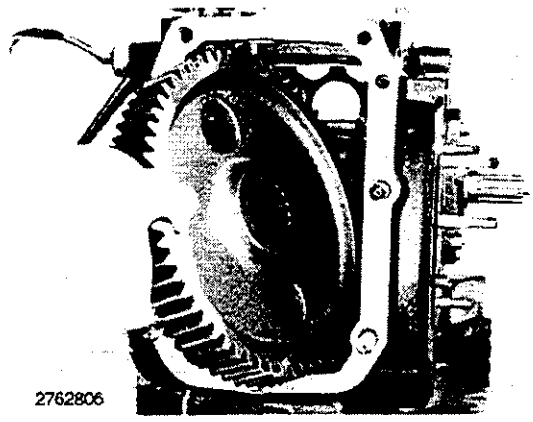
2763711



2763709

8. Install inner bearing.

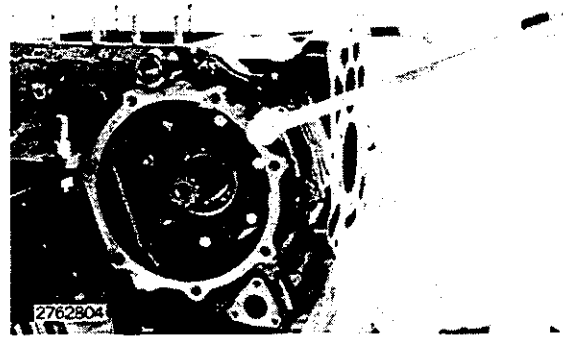
9. Prepare final reduction gear in the differential housing to mesh with rear axle shaft.
10. Replace gasket.
11. Install assembled rear axle housing to differential housing.



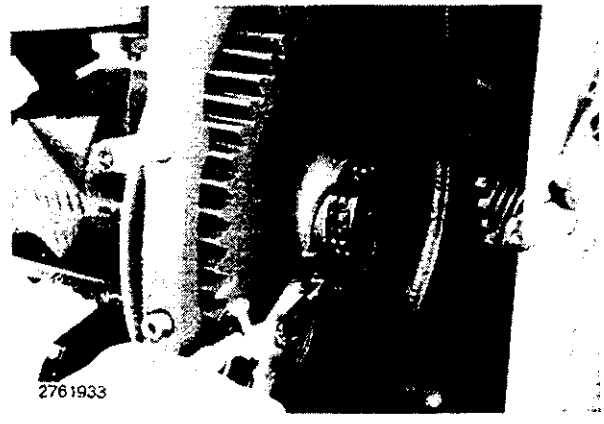
12. Install eight cap screws and four nuts and tighten them.
Tightening torque:

M10 x 58 (10.9T)	70 Nm (7 kgm) (52 ft-lbs)
All Other Nuts and Cap Screws	60 Nm (6 kgm) (43 ft-lbs)

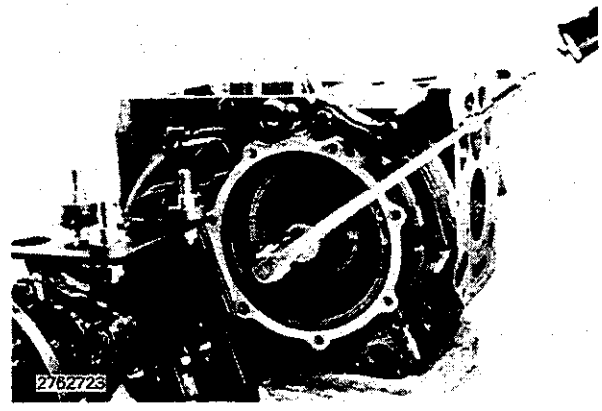
Apply "Loctite" for M10 x 58 (10.9T) cap screws.



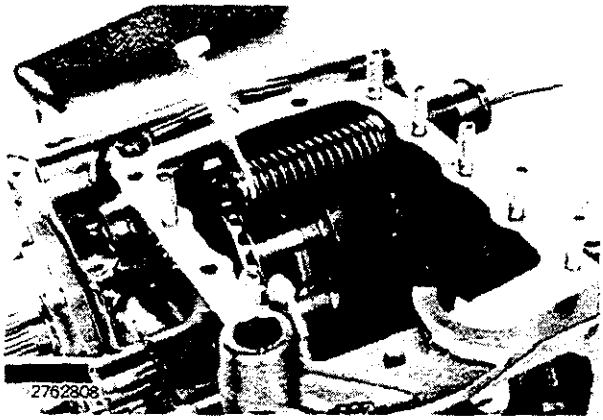
13. Install snap ring onto rear axle shaft.



14. Install brake drum, washer, lock washer and cap screw.
15. Tighten cap screw to 60 Nm (6 kgm) (43 ft-lbs).
16. Bend the lock washer.
17. Replace gasket and install brake cover and cap screws.
18. Tighten cap screws to 60 Nm (6 kgm) (43 ft-lbs).

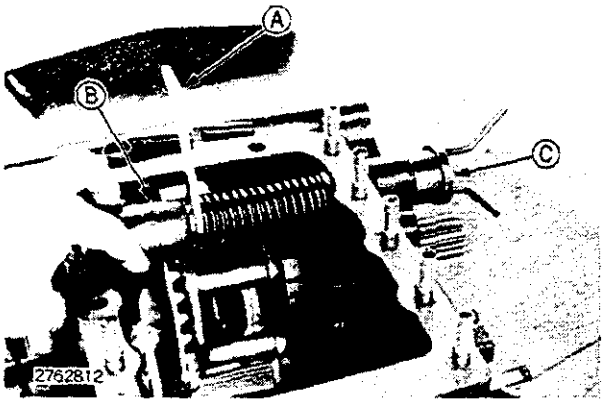


INSTALLATION AND DIFFERENTIAL



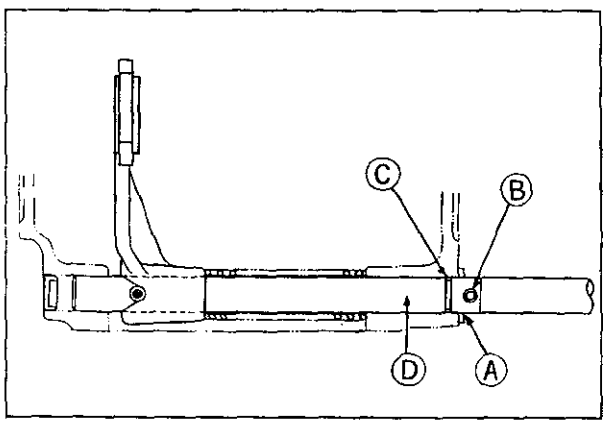
Install Differential Lock

1. Install compressor with spring and spacer into the shaft bore of differential housing right-hand wall.
2. Tighten compressor nut until enough space for lock fork is obtained.



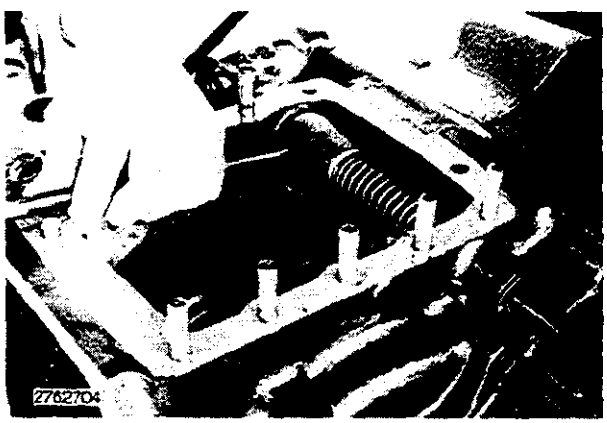
3. Install fork as aligning shaft bore of fork to spring. Pull spacer and then compressor shaft out.

A – Spacer
B – Fork
C – Compressor Nut



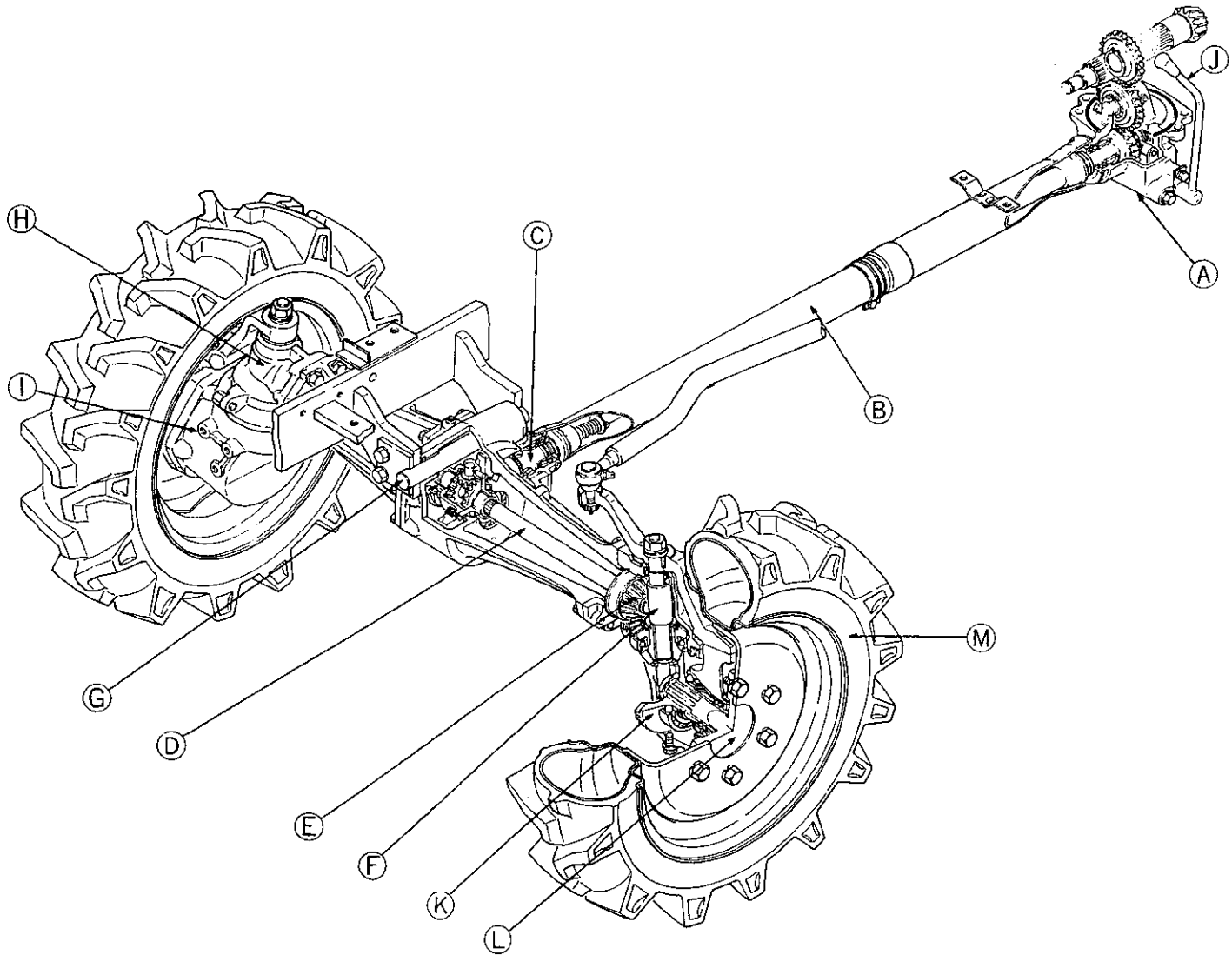
4. Install washer (A) against spring pin (B) and install O-ring (C) in shaft (D).

A – Washer
B – Spring Pin
C – O-ring
D – Shaft



5. Give it side force to align differential lock fork and bore of differential lock shaft so that spring pins can be installed by using pry bar.
6. Drive double spring pin into differential lock pedal shaft.

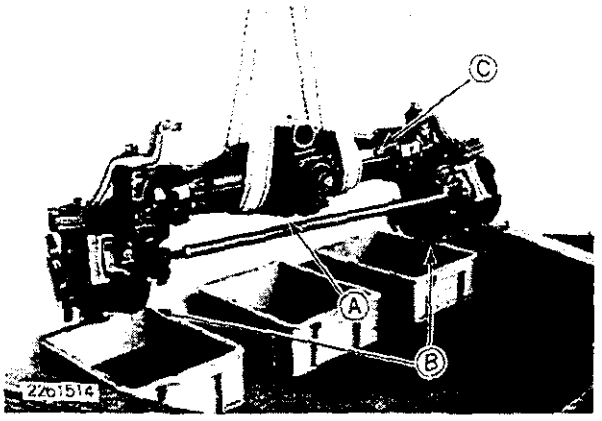
Spring pin consist of two pins, one inside the other. Note position of splits in pins for reassembly. They should face 180° from one another in a vertical plane.



A — Front Drive Case
B — Propeller Shaft
C — Differential Drive Shaft
D — Front Axle Shaft
E — Drive Shaft Bevel Pinion
F — Spindle
G — Center Pin
H — Bevel Gear Case
I — Final Gear Case
J — Front Drive Shift Lever
K — Final Gear
L — Wheel Hub
M — Front Wheel

2767004

INFORMATION



1. It is not necessary to remove whole front axle from front axle bracket for repair/maintenance on followings:

   Bevel gear case and related parts
   Final gear case and related parts
   Bearing housing and related parts

2. Repair/maintenance work on front differential, remove whole front axle from bracket as described on 80-05-8.

3. Drain gear oil by removing drain plugs, one is bottom of differential case and other two are at bottom of both final gear cases.

A — Drain Plug
B — Drain Plug (2 used)
C — Front Axle

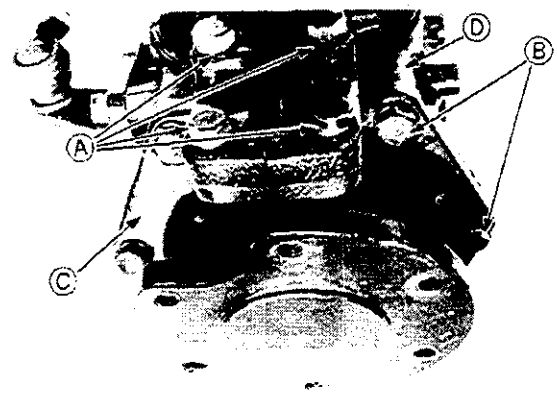
BEVEL, AND FINAL GEAR CASE

DISASSEMBLY

CAUTION: Be sure to support final gear case (D) while removing steering arm-to-gear case cap screws (A). When cap screws are removed, final gear case may drop from spindle.

1. Remove 4-cap screws on steering arm.

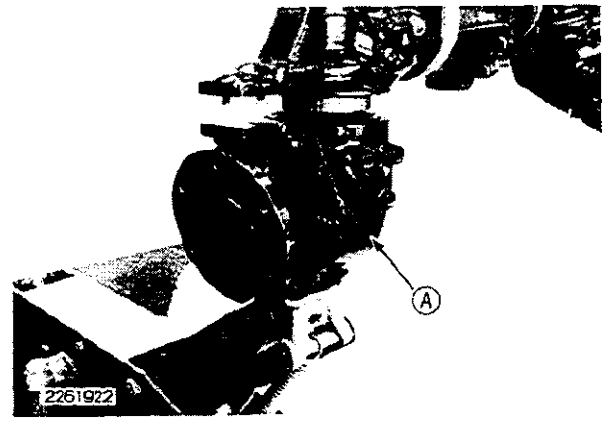
A – Cap Screws (4 used)
B – Cap Screws (6 used)
C – Bearing Housing
D – Final Gear Case



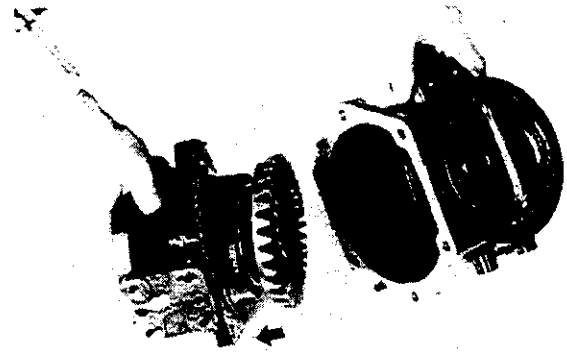
2261919

2. Pull final gear case (A) down with supporting the bottom of housing by hand or jack to avoid dropping on a floor or foot.

A – Final Gear Case

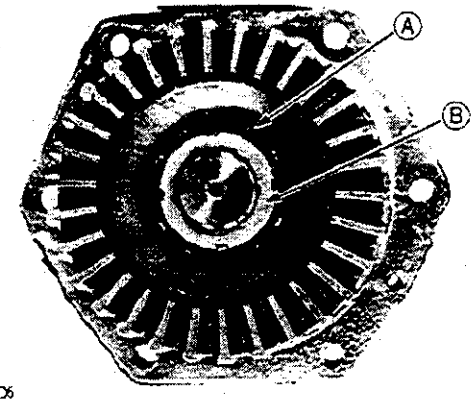


3. Remove 6-cap screws to remove bearing housing from final gear case.
4. Repeat same procedure to the other bearing housing.


2261924

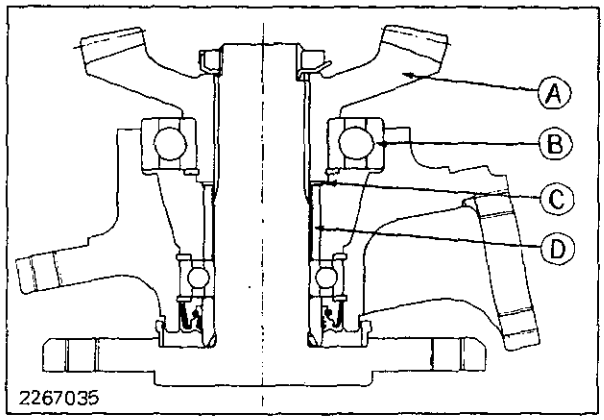
5. Flatten ear of lock washer (A) and remove nut (B).

A – Lock Washer
B – Nut



220040

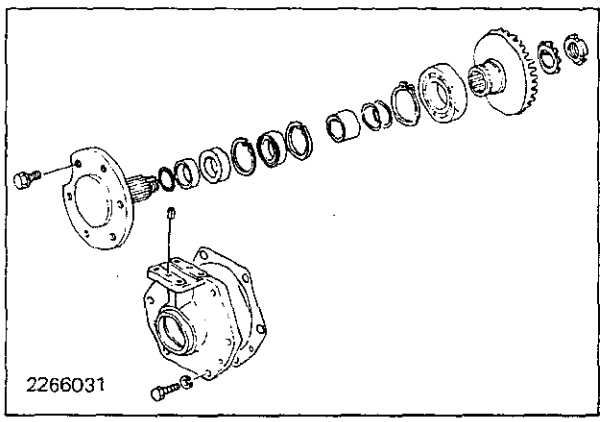
BEVEL, AND FINAL GEAR CASE



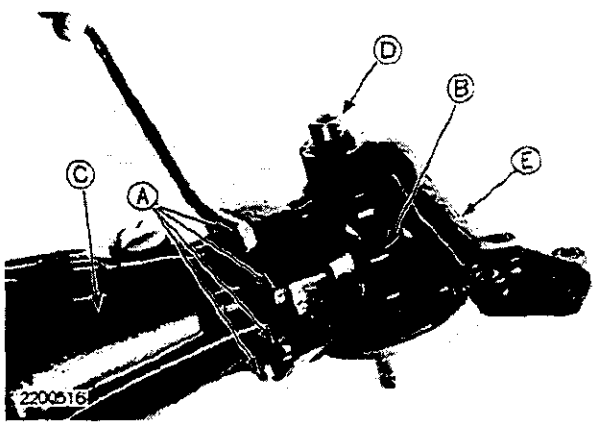
DISASSEMBLY (Continued)

6. Pull out final bevel gear (A) with bearing (B).
7. Remove shim (C) and collar (D).

A — Final Bevel Gear
B — Bearing
C — Shim
D — Collar

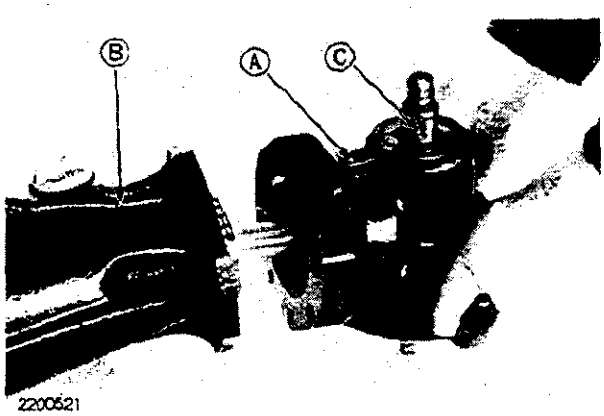


8. Strike out wheel hub with soft metal driver.



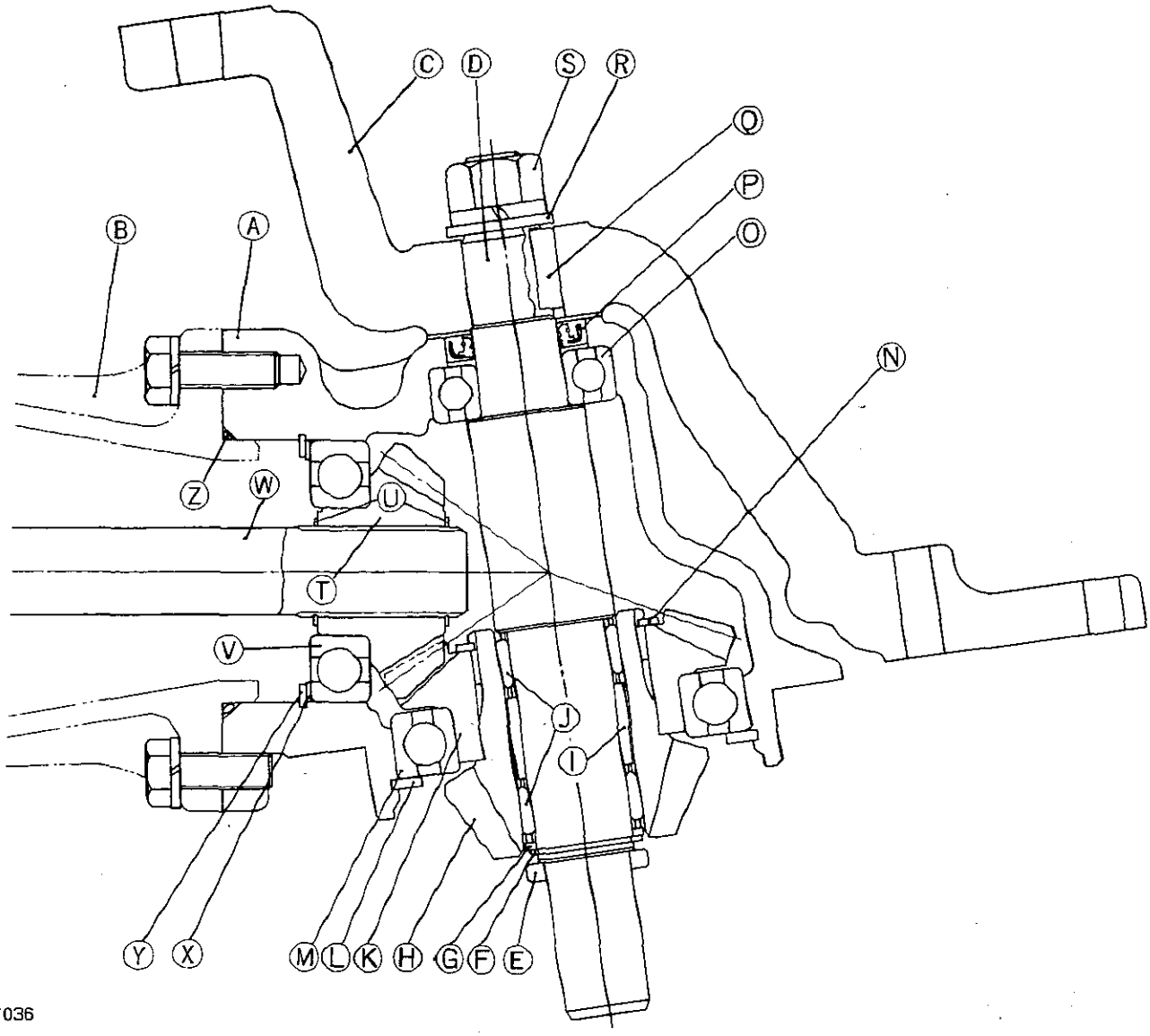
9. Remove nut (D) and put out steering arm (E).
10. Remove cap screws (A) which connects bevel gear case (B) and axle housing (C).

A — Cap Screws (8 used)
B — Bevel Gear Case
C — Axle Housing
D — Nut
E — Steering Arm



11. Separate bevel gear case assembly (A) from axle housing (B) and set the bevel gear assembly on clean table.
12. Remove key (C).

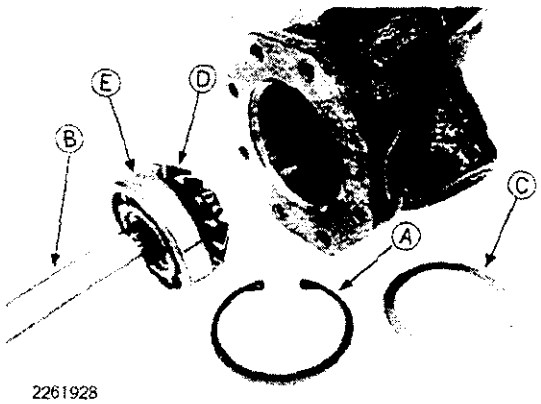
A — Bevel Gear Case
B — Axle Housing
C — Key



2267036

A – Bevel Gear Case
B – Axle Housing
C – Steering Arm
D – Spindle
E – Spacer
F – Snap Ring
G – Washer
H – Final Bevel Pinion
I – Collar
J – Needle Bearings
K – Bevel Gear
L – Snap Ring
M – Bearing 6031
N – Snap Ring
O – Bearing 6205
P – Oil Seal
Q – Key
R – Washer
S – Nut
T – Drive Shaft Bevel Pinion
U – Snap Rings
V – Bearing 6207
W – Front Axle Shaft
X – Shim
Y – Snap Ring
Z – O-ring

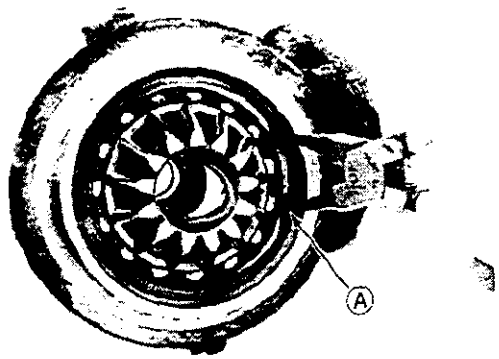
BEVEL, AND FINAL GEAR CASE



2261928

13. Remove snap ring (A), shim (C) and front axle shaft (B) with drive shaft bevel pinion (D) and bearing (E).

A – Snap Ring
B – Front Axle Shaft
C – Shim
D – Drive Shaft Bevel Pinion
E – Bearing

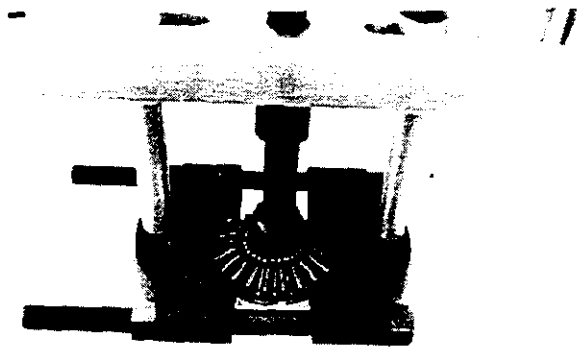


2261930A

14. Remove spacer which is left in final gear case.

15. Remove snap ring (A) and strike spindle head by using plastic hammer.

A – Snap Ring

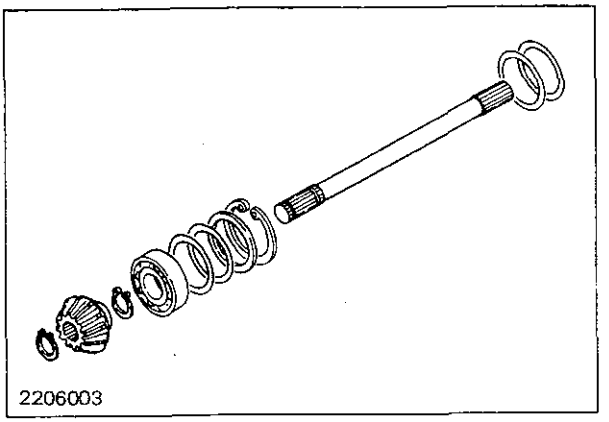


2261931

16. Remove final bevel pinion and bevel gear with bearing unit from spindle by using knife edge puller.

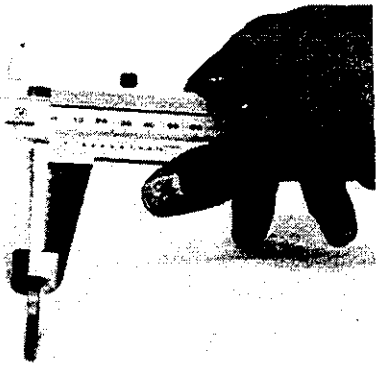
INSPECTION

1. Inspect all gears for uneven wear, chips, scoring and cracks and replace as necessary.
2. Inspect all bearings for wear and damage and replace as necessary.


2206003

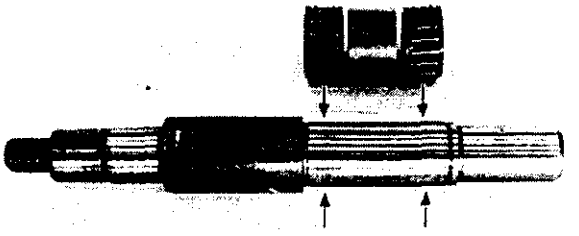
3. Measure thickness of spacer.

Item	New Part	Wear Limit
Thickness	4.9 to 5.0 mm (0.193 to 0.197 in.)	4.7 mm (0.185 in.)


2261800

4. Remove snap ring and washer to remove needle bearings and collar on spindle.
5. Inspect spindle shaft, especially needle bearing surface for wear or scoring.

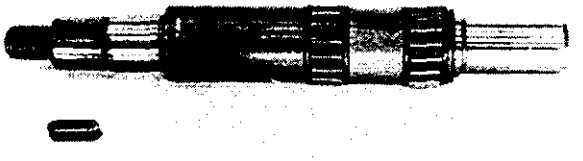
Item	New Part
O.D. at Needle Bearing	27.99 to 28.00 mm (1.1020 to 1.1024 in.)


2200410

6. Inspect key for wear or damage.

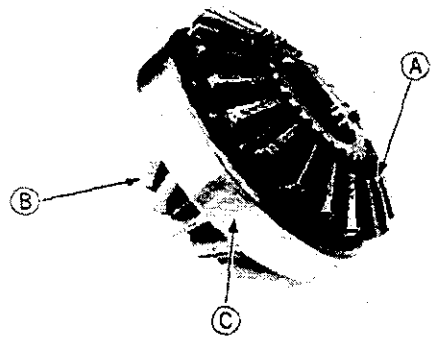
Item	New Part
Width Key Way	7.00 to 7.02 mm (0.275 to 0.276 in.)

7. Assembly key, arm and spindle and check if there was play or not. Replace it/them if required.


2200407

BEVEL, AND FINAL GEAR CASE

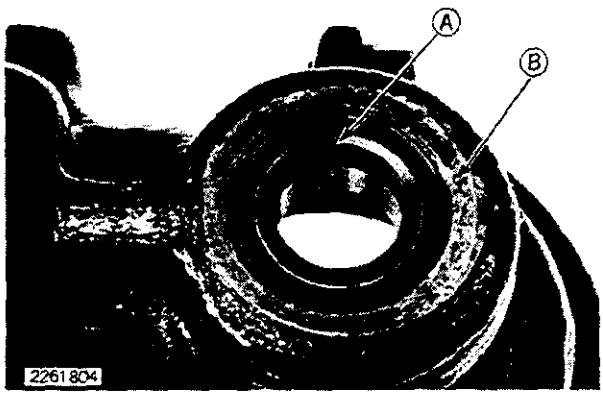
INSTALLATION



2261933

1. Assemble final bevel pinion (B), and bevel gear (A) with bearing (C).

A – Bevel Gear
B – Final Bevel Pinion
C – Bearing

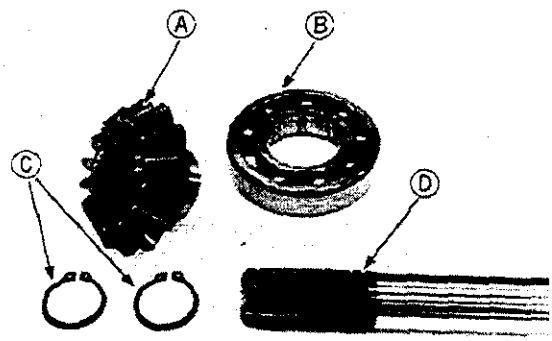


2261804

2. Replace oil seal (A) if required.

3. Be sure seal is flush top of bevel gear case and grease enough.

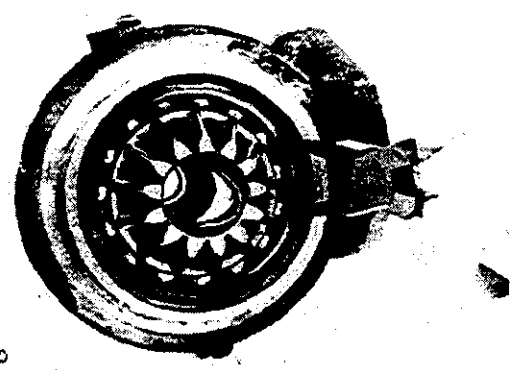
A – Oil Seal
B – Bevel Gear Case



2261934

4. Install bearing (B) on drive shaft bevel pinion (A) and onto front axle shaft (D). Install snap rings (C).

A – Drive Shaft Bevel Pinion
B – Bearing
C – Snap Rings
D – Front Axle Shaft



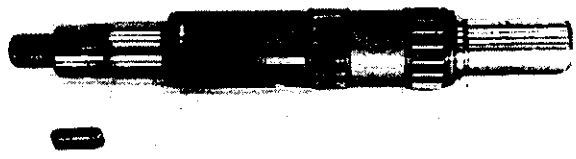
2261930

5. Install assembled bevel gear with bearing into bevel gear case and install snap ring.

6. Install assembled front axle shaft into bevel gear case and install shim and snap ring.

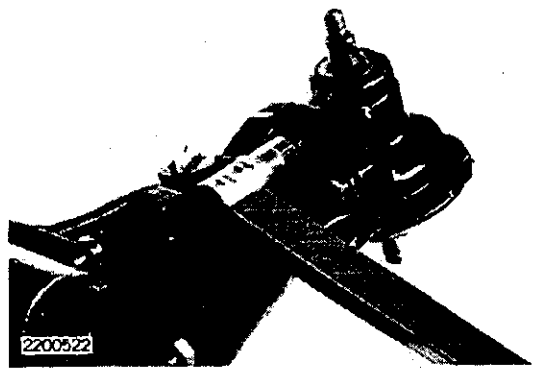

2261929

7. Install needle bearings, spacer, spacer washer and snap ring onto spindle shaft.
8. Install assembled spindle shaft to bevel gear case and install key onto spindle shaft.

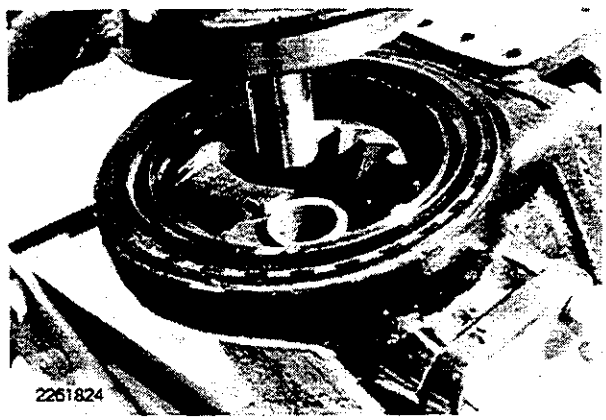

2200408

9. Install bevel gear case component to front axle housing. Be sure front axle shaft end enter into differential side gear spline. Be careful not giving damage to O-ring.
10. Apply "Loctite" to new-cleaned cap screws and tighten them.

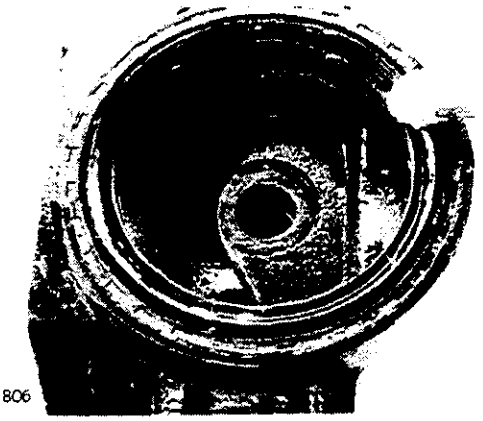
Item	Specification
Torque	60 Nm (6 kgm) (43 ft-lbs)


2200522

11. Install spacer to spindle.


2261824

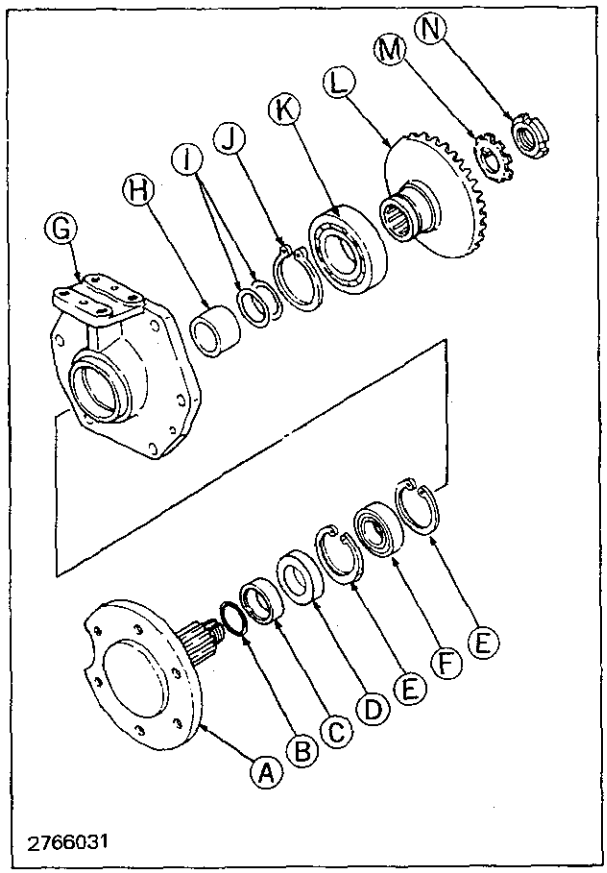
BEVEL, AND FINAL GEAR CASE


2261806

INSTALLATION (Continued)

12. Apply grease to oil seal on bevel gear case and install it to spindle with turning the case.

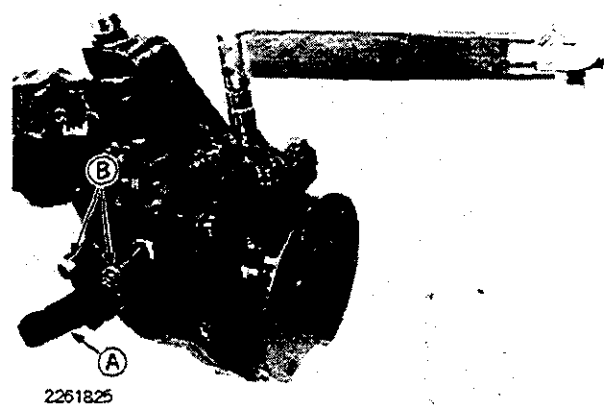
STOP **Be careful not giving damage to oil seal.**



2766031

13. Apply grease to O-ring (B) and oil seal (D).
14. Install O-ring (B) and collar (C) on wheel hub shaft (A).
15. Install snap rings (E), bearing (F) and oil seal (D) to bearing housing (G).
16. Install bearing (K) and snap ring (J) on final bevel gear (L).
17. Put wheel hub assembly into bearing housing assembly. Then install shims (I) and final gear assembly.
18. Install lock washer (M) and tighten nut (N) to 186 Nm (19 kgm) (137 ft-lbs).
19. Bend lock washer.

A – Wheel Hub Shaft
B – O-ring
C – Collar
D – Oil Seal
E – Snap Ring
F – Bearing
G – Bearing Housing
H – Collar
I – Shims
J – Snap Ring
K – Bearing
L – Final Bevel Gear
M – Lock Washer
N – Nut



2261825

20. Install bearing housing.
    Torque (Bearing housing to steering arm)
    : 60 Nm (6 kgm) (43 ft-lbs).
    Torque (Bearing housing to final gear case)
    : 100 Nm (10 kgm) (72 ft-lbs)
    Torque (Sprindle to steering arm)
    : 210 Nm (21 kgm) (152 ft-lbs)

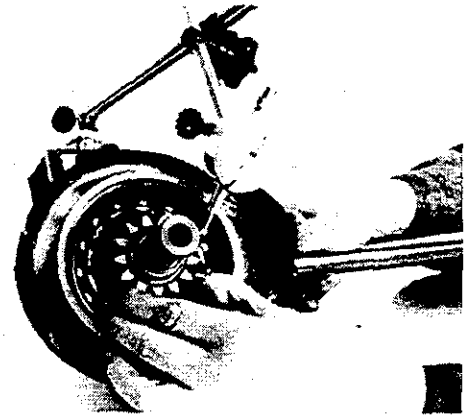
21. If tie-rod arm bracket (A) needs to be replaced, tighten cap screws (B) to 60 Nm (6 kgm) (43 ft-lbs) with "Loctite"

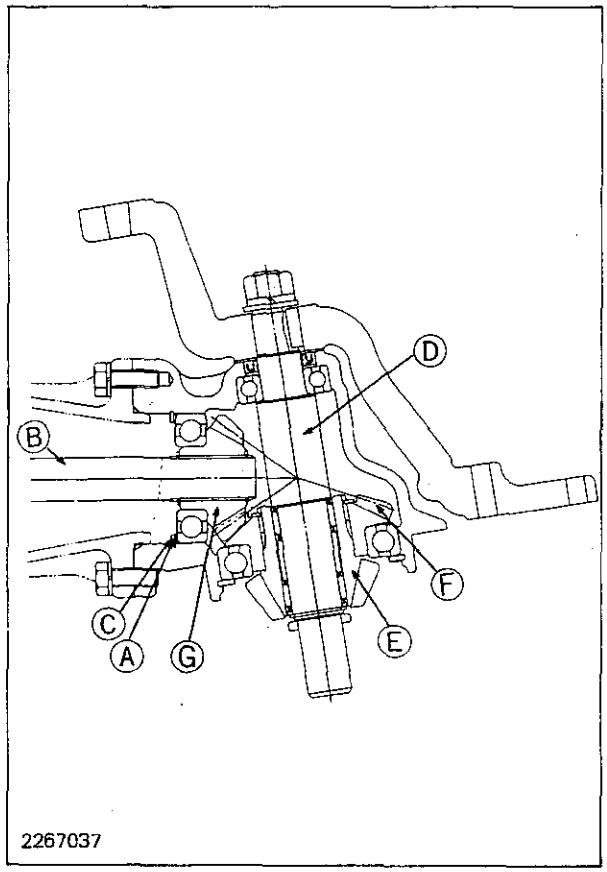
BACKLASH ADJUSTMENT FOR DRIVE SHAFT BEVEL PINION AND BEVEL GEAR

1. Turn front axle shaft as fast as possible to make the gears familiar each other.
2. Install dial indicator to bevel gear case.
3. Measure backlash between drive shaft bevel pinion and bevel gear.

Item	Specification
Backlash	0.10 to 0.15 mm (0.004 to 0.006 in.)

Adjust the backlash with shim(s) if necessary.
Three different thickness of shim are available.
Thickness: 0.1 mm (0.004 in.)
0.3 mm (0.012 in.)
0.5 mm (0.020 in.)

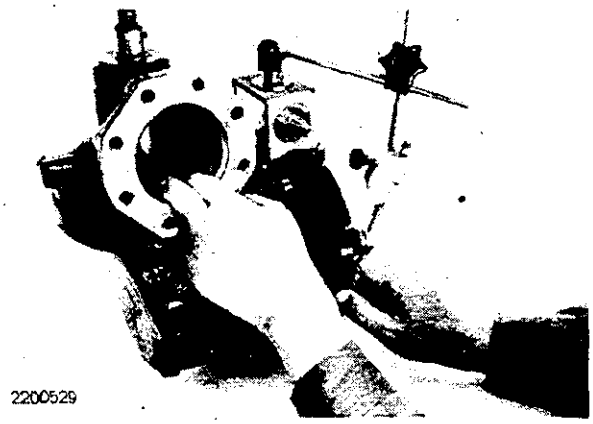

2200527



2267037

A – Shim(s)
B – Front Axle Shaft
C – Snap Ring
D – Spindle
E – Final Bevel Pinion
F – Bevel Gear
G – Bevel Pinion

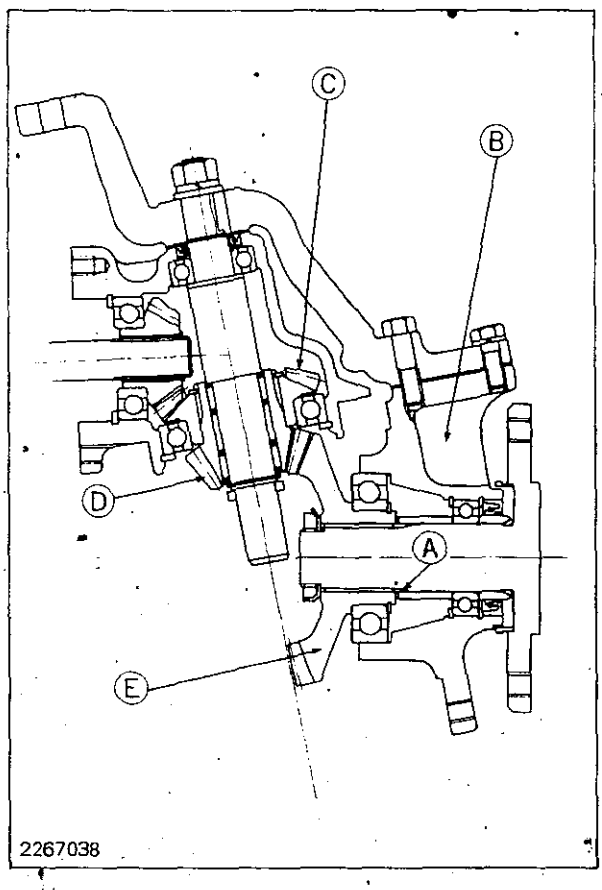
BEVEL, AND FINAL GEAR CASE


2200529

BACKLASH ADJUSTMENT FOR FINAL BEVEL PINION AND RING GEAR

1. Install dial indicator to bevel gear case.
2. Measure backlash between final bevel pinion and ring gear as shown.

Item	Specification
Backlash	0.10 to 0.15 mm (0.004 to 0.006 in.)



2267038

3. Adjust the backlash with shim(s).

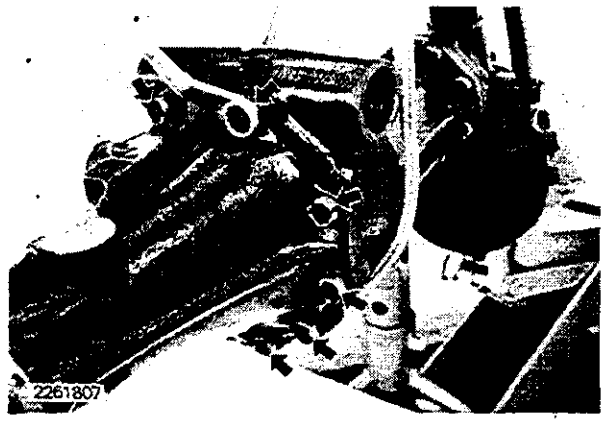
   Two different shims are available.
   Thickness: 0.2 mm (0.008 in.)
   0.3 mm (0.012 in.)

A – Shim(s)
B – Bearing Housing
C – Bevel Gear
D – Final Bevel Pinion
E – Final Gear

FRONT DRIVE DIFFERENTIAL

DISASSEMBLY

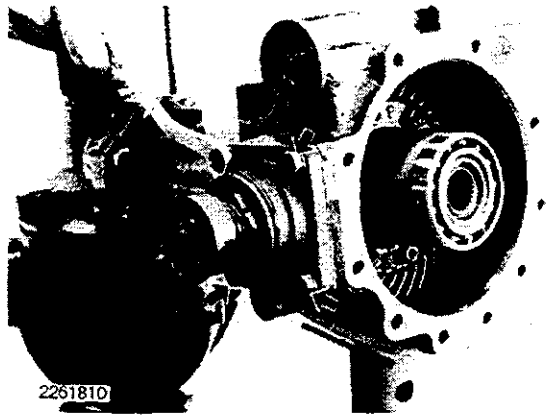
1. Remove right hand front axle housing from the left housing by removing 10 cap screws.



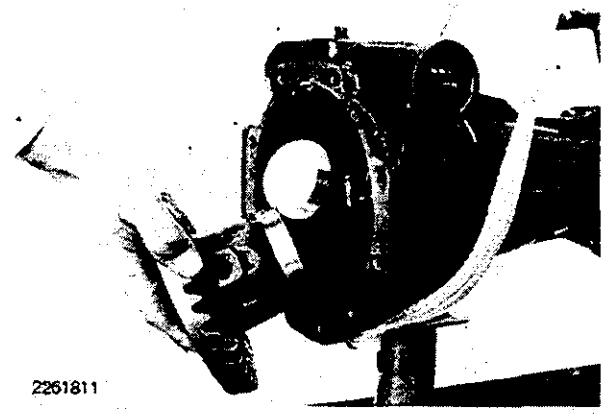
2. Remove bearing housing to axle housing cap screws.

Do not lose or damage shim(s) being between axle housing and bearing housing.

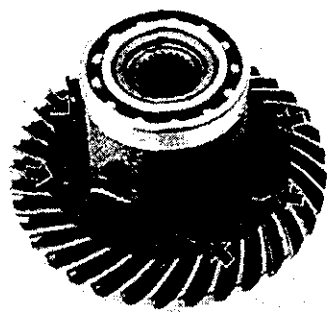
3. Remove the bearing housing (front drive pinion gear component).



4. Remove differential from left hand front axle housing.

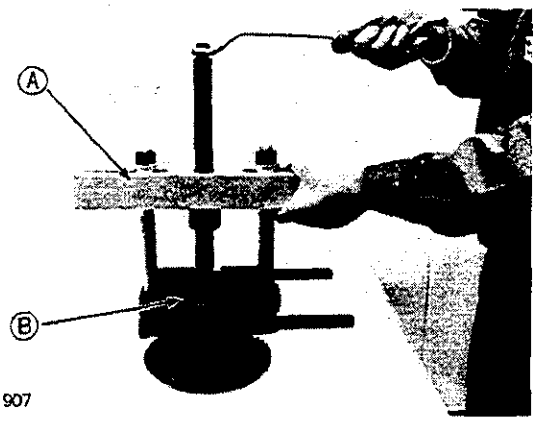


5. Remove 6-socket head cap screws on differential gear case.



FRONT DRIVE DIFFERENTIAL

DISASSEMBLY (Continued)



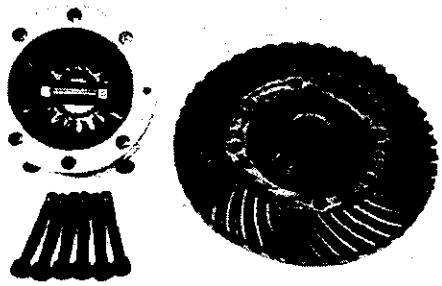
2261907

6. Remove right-hand side ball bearing from differential case.

   Repeat same procedure to the other side.

A – Knife Edge Puller
B – Ball Bearing

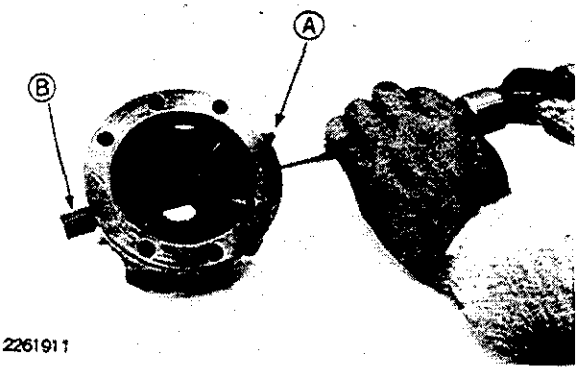
7. Separate differential case from ring gear.


2261910

If the differential ring gear is not to be replaced, mark the ring gear and differential housing so they will be reassembled in the same position.

8. Drive spring pin (A) and pinion shaft (B) from differential case by using a spring pin punch.

9. Remove pinion shaft from differential case.

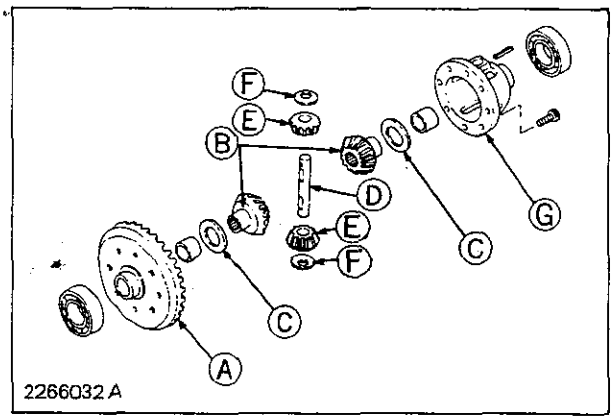


2261911

A – Spring Pin
B – Pinion Shaft

10. Remove differential pinions and thrust washers.

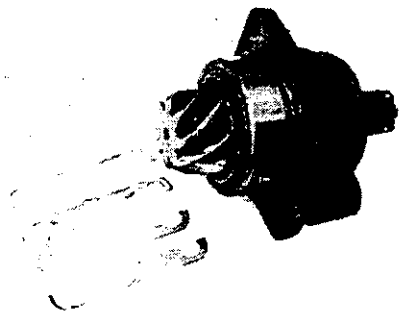
11. Remove differential side gears and thrust washers.



2266032 A

A – Ring Gear
B – Differential Side Gears
C – Thrust Washers
D – Pinion Shaft
E – Differential Pinions
F – Pinion Thrust Washers
G – Differential Case

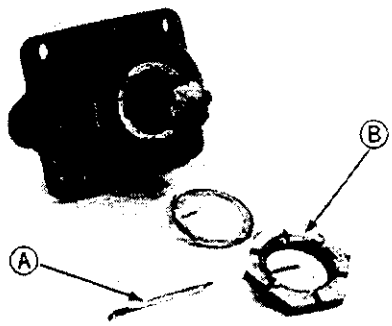
12. Remove bearing housing from left hand front axle housing.



2261814

13. Remove cotter pin (A) on nut and remove nut (B).

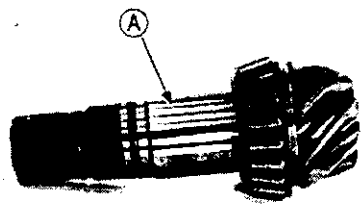
A – Cotter Pin
B – Nut



2200403

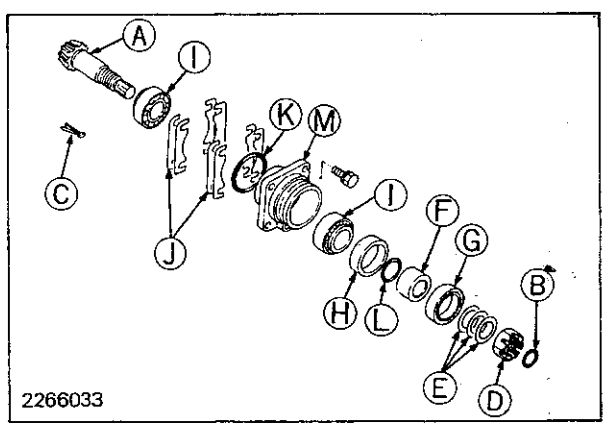
14. Remove front drive pinion (A) forward.

15. Remove bearing, O-rings, seal collar, collar and oil seal from bearing housing.



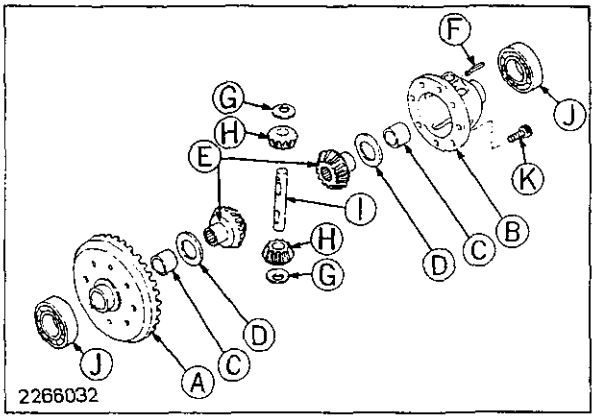
2200535

A – Pinion Shaft
B – O-ring
C - Cotter Pin
D – Nut
E – Shims
F – Collar
G – Oil Seal
H – Collar
I – Bearing
J – Shims
K – O-ring
L – O-ring
M – Bearing Housing



2266033

FRONT DRIVE DIFFERENTIAL

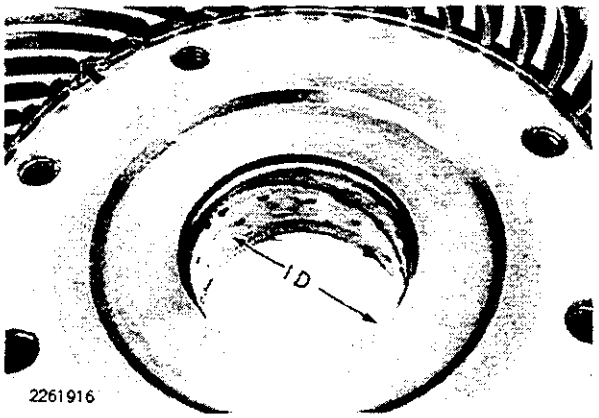


2266032

INSPECTION

1. Inspect all gears for uneven wear, chips, scoring and cracks and replace as necessary.
2. Inspect all bearings for wear and damage. Replace as necessary.

A – Ring Gear
B – Differential Case
C – Bushings
D – Thrust Washers
E – Differential Side Gears
F – Spring Pin
G – Pinion Thrust Washers
H – Bevel Pinions
I – Pinion Shaft
J – Bearings
K – Socket Head Cap Screws



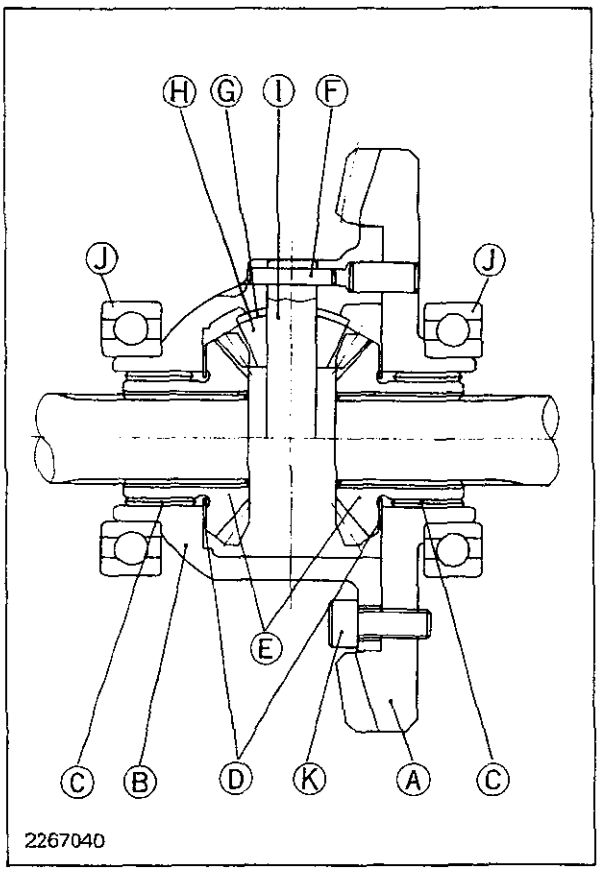
2261916

3. Inspect case for damage and measure I.D. of installed bushing.

Item	Specification
Bushing I.D.	32.00 to 32.04 mm (1.259 to 1.261 in.)

4. Inspect ring gear for wear or damage and measure installed I.D. of bushing.

Item	Specification
Bushing I.D.	32.00 to 32.04 mm (1.259 to 1.261 in.)



2267040

5. Inspect bevel gears (E) for wear or damage, and measure O.D. of boss.

Item	Specification
O.D.	31.89 to 31.92 mm (1.255 to 1.256 in.)

6. Inspect thrust washers (D) and pinion thrust washers (G) for damage or scoring. Measure thickness.

Item	Specification	Wear Limit
Thickness	0.75 to 0.85 mm (0.029 to 0.033 in.)	0.65 mm (0.025 in.)

7. Inspect bevel pinions (H) for wear or damage, and measure I.D. of bore.

Item	Specification
I.D.	14.01 to 14.03 mm (0.551 to 0.552 in.)

8. Inspect pinion shaft (I), and measure O.D..

Item	Specification
O.D.	13.97 to 13.98 mm (0.549 to 0.550 in.)

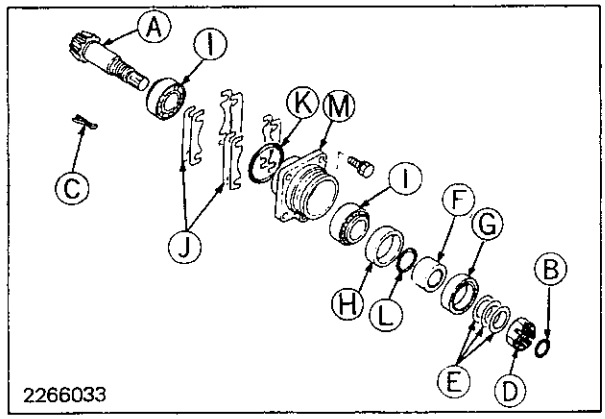
9. Inspect bearing and replace if damaged. Use knife edge puller to remove bearing.

In case replacing ring gear, replace front drive pinion shaft also.

ASSEMBLY

In case of replacing front drive pinion shaft and ring gear.

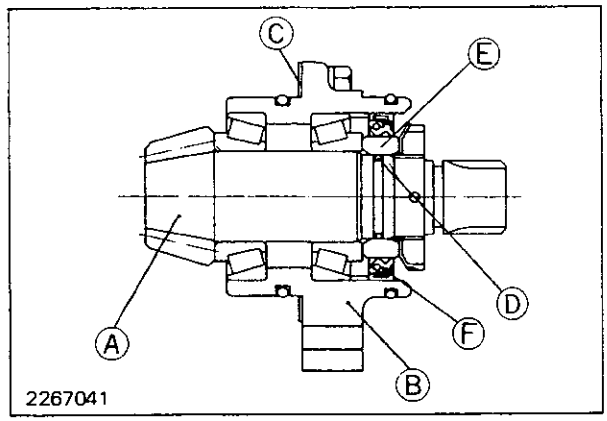
A – Pinion Shaft
B – O-ring
C – Cotter Pin
D – Nut
E – Shims
F – Collar
G – Oil Seal
H – Collar
I – Bearings
J – Shims
K – O-ring
L – O-ring
M – Bearing Housing



2266033

1. Install pinion shaft (A) with front bearing to bearing housing (B), and press rear bearing on pinion shaft.
2. Apply grease to O-ring (D), and collar (E) and install onto shaft. Apply grease to oil seal (F) and install into bearing housing.
3. Place original shim(s) on pinion shaft.

These shims are for adjusting position of pin hole on castle nut and for adjusting starting drag torque.

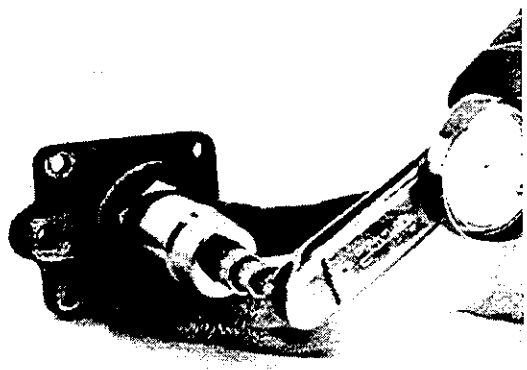


2267041

A – Pinion Shaft
B – Bearing Housing
C – Shim(s)
D – O-ring
E – Collar
F – Oil Seal

4. Tighten castle nut and check starting drag torque of pinion shaft as its rear end.

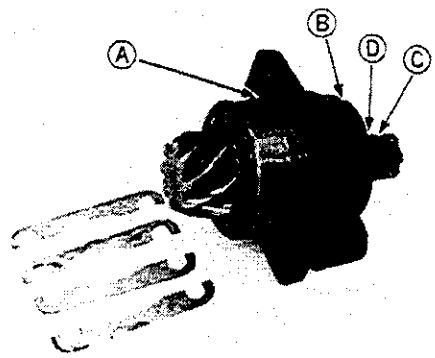
Item	Specification
Starting Drag Torque	0.31 to 1.57 Nm (0.032 to 0.16 kgm) (0.23 to 1.15 ft-lbs)


2200534

5. Adjust the starting drag torque with shim to set it within above torque.
   At the same time, align hole on shaft and pin hole of castle nut for cotter pin.

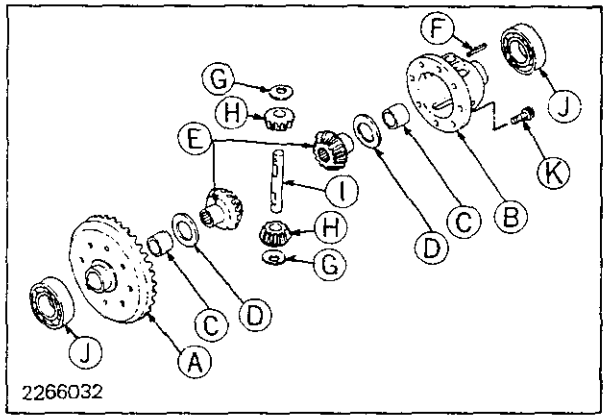
6. Place O-ring on pinion shaft. Apply grease to O-rings.

A – O-ring (63-S)
B – O-ring (60-G)
C – O-ring (21-P)
D – O-ring (25-S)

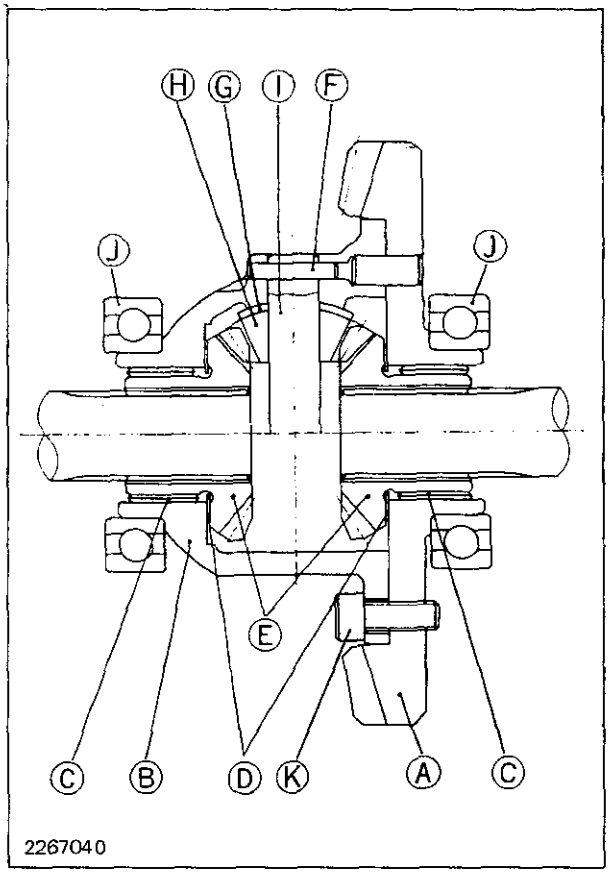


2261814

FRONT DRIVE DIFFERENTIAL



2266032



2267040

ASSEMBLY (Continued)

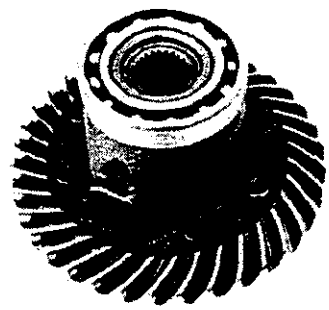
7. Grease thrust washers (G) and bevel pinions (H).
8. Grease thrust washers (D) and the side bevel gears (E).
9. Install bevel gears (E) in differential housing and ring gear (A). Be sure its thrust washer stays in place.
10. Install bevel pinions (H) with their thrust washers in place.

STOP To properly align the bevel pinions, walk them around the bevel gears to align with the shaft bores.

11. Insert the pinion shaft (I) through the bevel pinions (H) and their thrust washers (G). Be sure to align the spring pin hole in the shaft with the spring pin hole in the housing. The shaft should be free of burrs.
12. Install the shaft spring pin. Be sure the split in the pin is facing 90° from the shaft centerline.
13. Check if the gears and pinions turn freely in the housing.
14. Install differential ring gear (A) so ring gear holes align with housing holes. If the original ring gear is reinstalled, be sure the marks on the ring gear and housing are in the same position as when removed.
15. Use new cap screws (K) and apply "Loctite" to the thread.
16. Tighten cap screws (K) to 34 Nm (3.4 kgm) (25 ft-lbs).
17. Install differential bearings onto housing and ring gear.

STOP Do not hammer or use a drift on bearing outer race. Use correct tubing driver to press inner race onto housing.

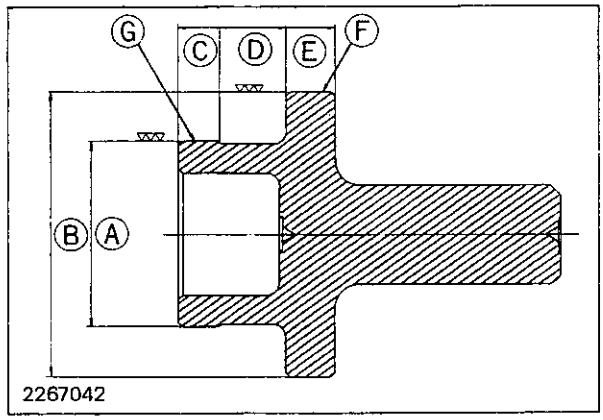
A – Ring Gear
B – Differential Case
C – Bushings
D – Thrust Washers
E – Bevel Gears
F – Pinion Shaft
G – Spring Pin
H – Pinion Thrust Washers
I – Bevel Pinions
J – Socket Head Cap Screws
K – Bearings


2261813

CONE POINT ADJUSTMENT

For cone point adjustment, mandrel is required.

A – 74.96 to 74.98 mm (2.951 to 2.952 in.)
B – 116.09 to 116.11 mm (4.570 to 4.571 in.)
C – 16 mm (0.63 in.)
D – 26 mm (1.02 in.)
E – 20 mm (0.79 in.)
F, G – Surface must be fine grinded



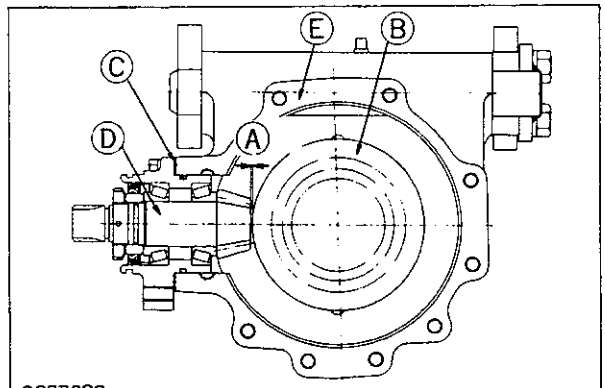
2267042

1. Install front differential drive component. Install same shims as removed and tighten 4-cap screws.

Item	Specification
Torque	30 Nm (3 kgm) (22 ft-lbs)

2. Install mandrel to left-hand front axle housing.
3. Adjust clearance (A) with shim.

Item	Specification
Clearance	0.95 to 1.05 mm (0.037 to 0.041 in.)



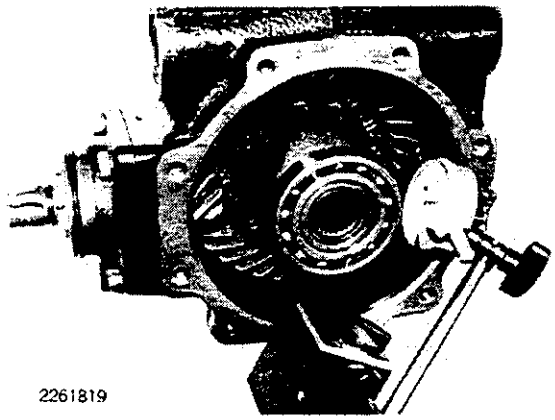
2267032

A – Clearance
B – Mandrel
C – Shims
D – Pinion Shaft
E – Front Axle Housing

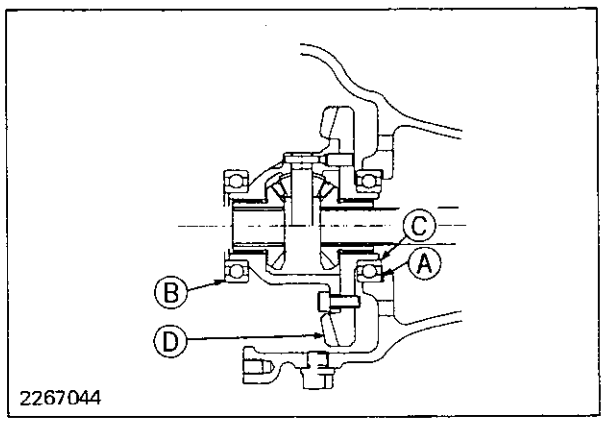
BACKLASH ADJUSTMENT

1. Install same number of shims (A) behind L.H. differential bearing (C), and install differential assembly into L.H. front axle housing.
2. Install front differential drive shaft assembly to L.H. front axle housing. Tighten cap screws to 30 Nm (3 kgm) (22 ft-lbs).
3. Drive differential assembly with plastic hammer to left hand axle housing to secure L.H. bearing is seated.
4. Install dial indicator to measure ring gear backlash. Backlash should be 0.17 to 0.23 mm (0.0066 to 0.0090 in.) Adjust as required.
5. Add shims to decrease backlash and subtract shims to increase backlash. Two shim thicknesses are available:

   Thickness: 0.2 mm (0.008 in.)
   0.3 mm (0.012 in.)


2261819

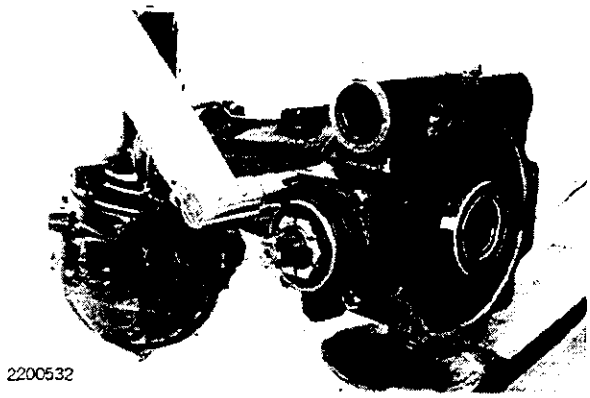
A – Shims
B – R.H. Bearing
C – L.H. Bearing
D – Ring Gear



2267044

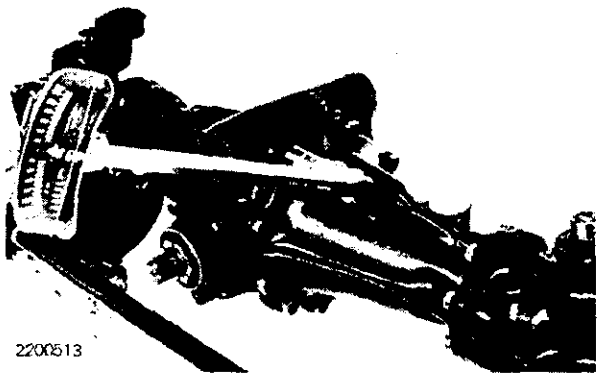
FRONT DRIVE DIFFERENTIAL

INSTALLATION



2200532

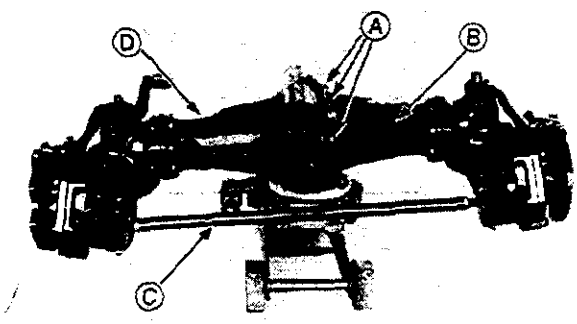
1. Assemble front axle housing if all differential adjustment have been completed. Tighten bearing housing to front axle housing to 30 Nm (3 kgm) (22 ft-lbs).



2200513

2. Install right hand front axle housing to left hand front axle.

Item	Specification
Torque	60 Nm (6 kgm) (43 ft-lbs)



2261512

3. Install tie rod to steering arm and tighten throttles nut for ball joint to 60 Nm (6 kgm) (44 ft-lbs).
4. Install front axle assembly to front axle bracket.
5. Install center pin and tighten four cap screws to 100 Nm (10 kgm) (72 ft-lbs).

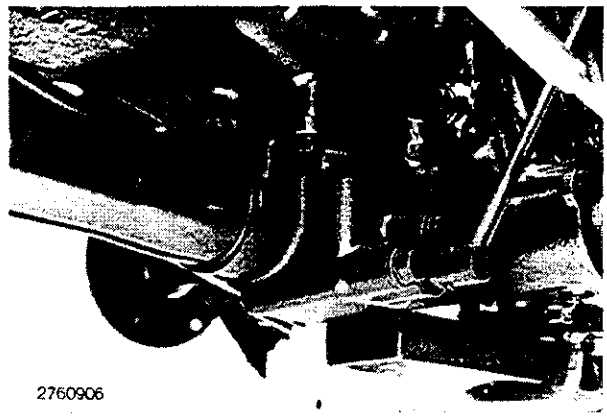
A – Cap Screws
B – R.H. Front Axle Housing
C – Tie Rod
D – L.H. Front Axle Housing

FRONT DRIVE CASE

DISASSEMBLY

Front drive gear component must be removed not only its maintenance/repair but also when separating rear axle case from transmission case.

For maintenance/repair on idle gear, front drive gear, except gear on differential drive shaft, remove front drive gear case only.


2760906

1. Remove front wheel drive propeller shaft as described on 10-20-2.

2. Drain transmission and hydraulic oil from transmission case. Remove drain plugs (A) on front drive case and differential housing.

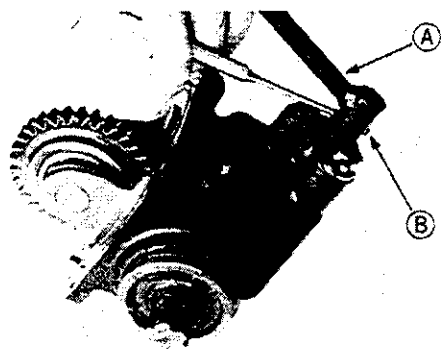
3. Remove four cap screws (B). Remove front drive case assembly (C).

A – Drain Plug
B – Cap Screws
C – Front Drive Case

2761028

4. Drive spring pin (B) from shift lever (A) and remove shift lever.

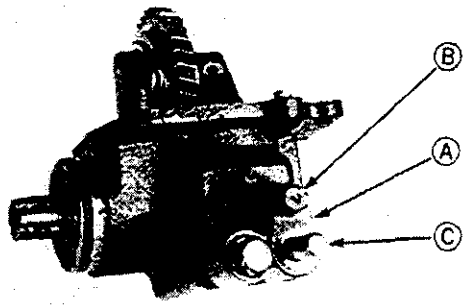
A – Shift Lever
B – Spring Pin



2763432

FRONT DRIVE CASE

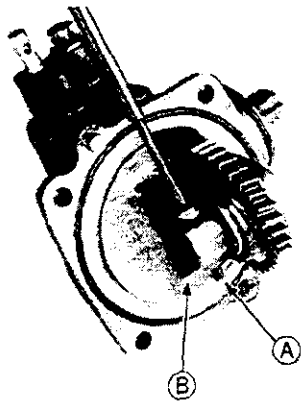
DISASSEMBLY (Continued)



2763434

5. Remove cap screw (B), and retaining plate (A) which are holding the shift arm (C).

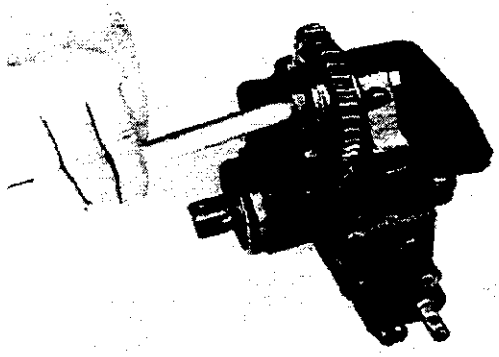
A — Retaining Plate
B — Cap Screw
C — Shift Arm



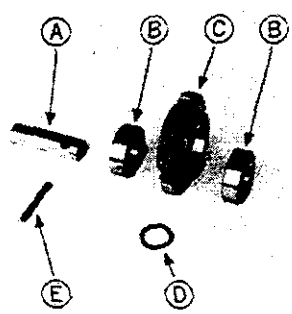
2763435

6. Remove spring pin (A) from front drive case.

A — Spring Pin
B — Front Drive Case


2763501

7. Drive idler gear shaft with driver.



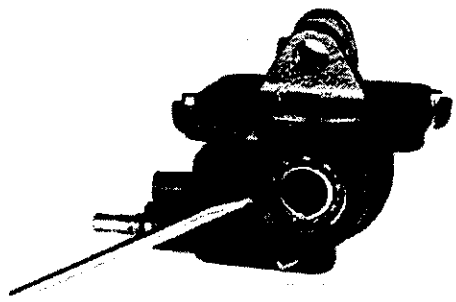
2763530

8. Remove bearings (B), idler gear (C) and spacer (D).

A — Idler Gear Shaft
B — Bearings
C — Idler Gear
D — Spacer
E — Spring Pin

9. Remove front oil seal and seal cap and both sides snap rings on drive shaft.

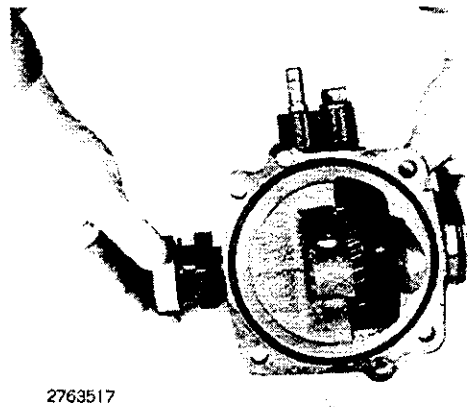
When reassembling front drive case, front oil seal and seal cap must be replaced.



2763509

10. Drive front drive shaft front end with soft hammer and remove drive shaft with bearing and sliding gear.

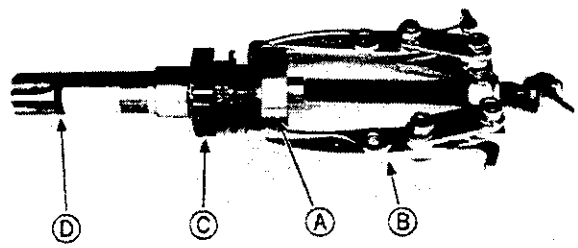
    Take out thrust washers, collar and front drive gear.



2763517

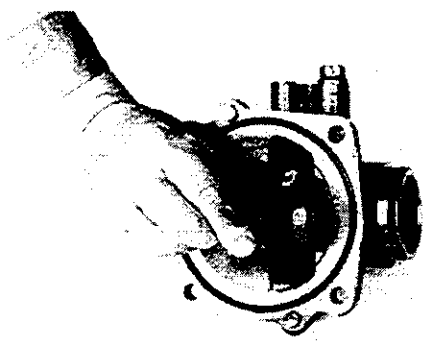
11. Remove bearing (A) with puller (B), then sliding gear (C), detent balls, spring and O-ring (D) from front drive shaft.

A – Bearing
B – Puller
C – Sliding Gear
D – O-ring



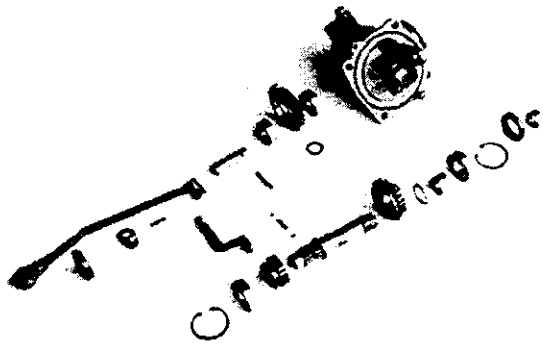
2763526

12. Remove shifter block and shift arm from upper window. Be careful not giving damage to O-ring.



2763521

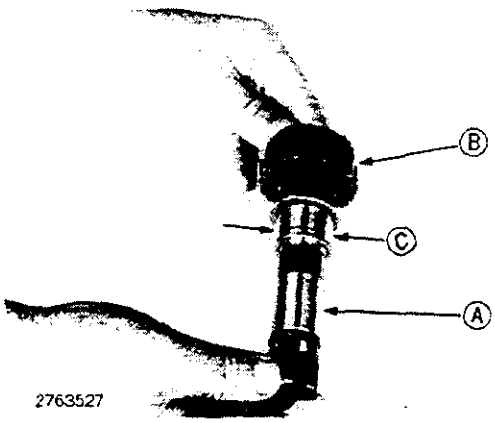
FRONT DRIVE CASE



2763529

INSPECTION

1. Inspect all gears for uneven wear, chips, scoring and cracks and replace as necessary.
2. Inspect all bearings for damage and wear and replace as necessary.
3. Inspect all O-rings for damage and replace as necessary.

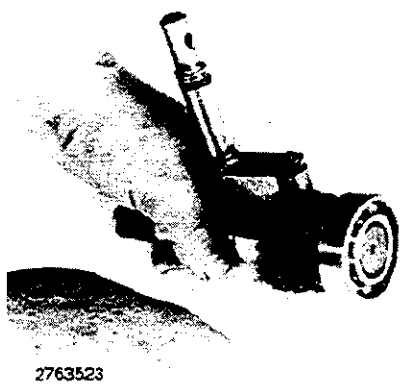


2763527

4. Inspect front drive shaft (A) and sliding gear (B) splines for wear or damage.
5. Inspect inner race O.D. (C) and front drive gear I.D..

Item	Specification
Inner Race O.D.	30.003 to 30.013 mm (1.181 to 1.182 in.)
Front Drive Gear I.D.	30.040 to 30.061 mm (1.183 to 1.184 in.)
Clearance	0.027 to 0.058 mm (0.001 to 0.0023 in.)

A – Front Drive Shaft
B – Sliding Gear
C – Inner Race O.D.



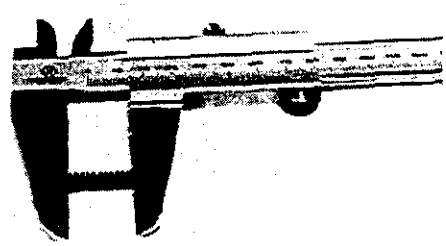
2763523

6. Inspect fork groove width in sliding gear and clearance between shifter block and fork groove with filler gauge.

Item	Part specification	Wear Limit
Groove Width	8.1 to 8.3 mm (0.319 to 0.327 in.)	
Clearance between Shifter Block and Fork Groove	0.2 to 0.6 mm (0.008 to 0.024 in.)	1 mm (0.04 in.)

7. Inspect detent spring.

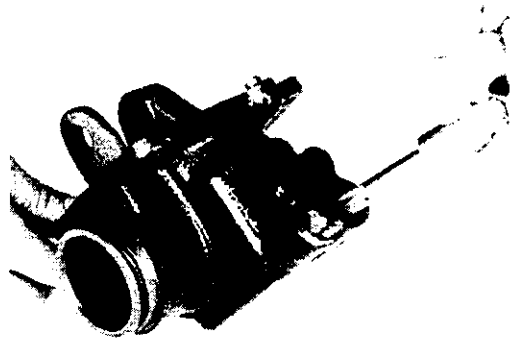
Item	New Part
Free length	21.2 mm (0.83 in.)
Working load	4 N at 18.4 mm (0.97 lbs at 0.72 in.)



2200123

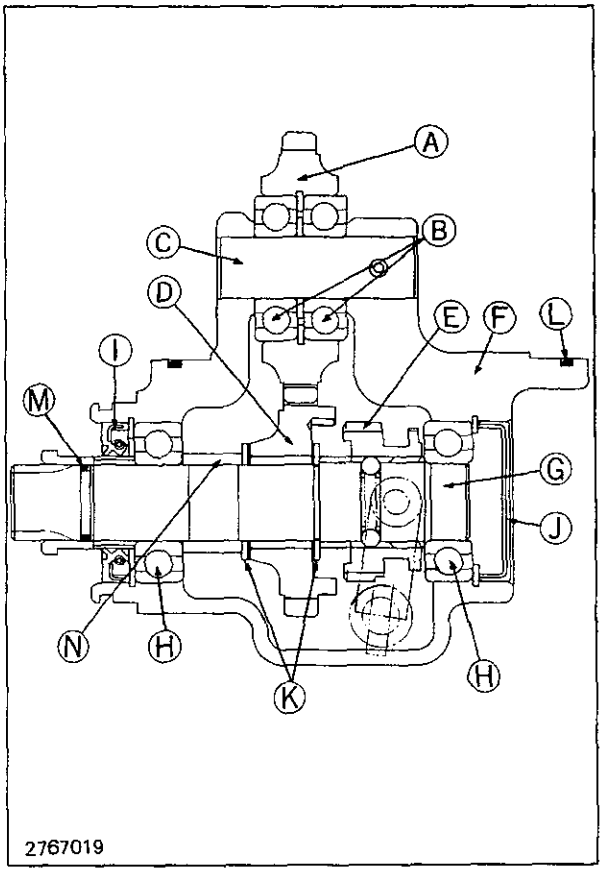
8. Inspect shifter arm shaft for wear.

Item	Part specification
O.D. of Arm Shaft	14.91 to 15.00 mm (0.587 to 0.591 in.)
I.D. of Bore for Arm Shaft	15.016 to 15.043 mm (0.591 to 0.592 in.)



2763524

FRONT DRIVE CASE



2767019

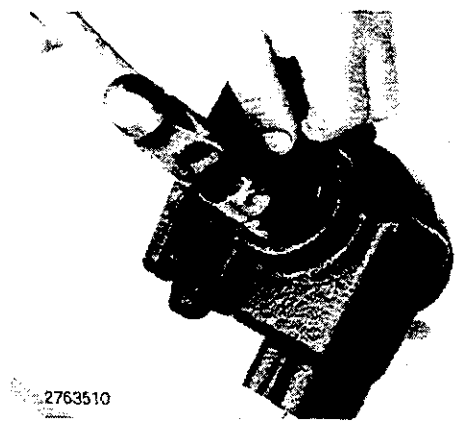
INSTALLATION

Reverse the removal steps on preceding pages and note the installation instructions that follow.

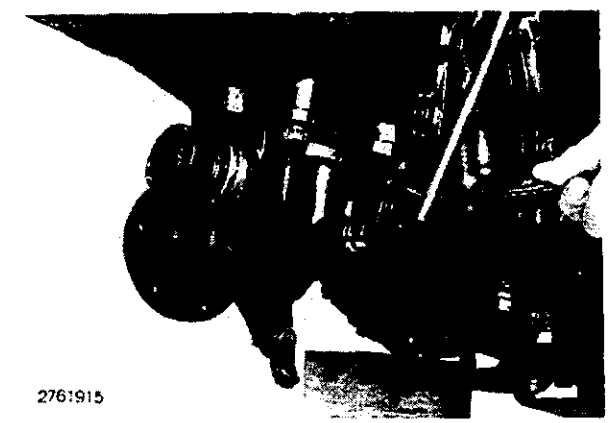
If front drive shaft (G) disassembled, oil seal (I) and seal cap (J) must be replaced.

1. Apply grease to O-rings and oil seal.
2. Thrust washers (K) should be installed as its groove facing to drive gear.

A – Idler Gear
B – Idler Gear Bearings
C – Idler Gear Shaft
D – Front Drive Gear
E – Sliding Gear
F – Front Drive Case
G – Front Drive Shaft
H – Drive Shaft Bearings
I – Oil Seal
J – Seal Cap
K – Thrust Washers
L – O-ring
M – O-ring
N – Collar


2763510

3. Apply grease to seal cap and install into front drive case.


2761915

4. Tighten front drive case to transmission case cap screws to 60 Nm (6 kgm) (43 ft-lbs).
5. Install front drive propeller shaft as described on page 10-20-3.

STEERING/BRAKE REPAIR 60

SPECIFICATIONS

Steering

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Steering Wheel Play	25 – 40 mm (0.984 – 1.575 in.)	50 mm (1.969 in.)
Sector Shaft O.D. at bushing	27.57 – 27.59 mm (1.1248 – 1.1255 in.)	
Sector Shaft Bushing I.D.	28.00 – 28.02 mm (1.1259 – 1.1267 in.)	
Clearance between Sector Shaft and Bushing	0.01 – 0.04 mm (0.0004 – 0.0016 in.)	0.5 mm (0.020 in.)
Sector Shaft Adjusting Shims (Selective installation)	1.535 mm (0.0604 in.) 1.565 mm (0.0616 in.) 1.595 mm (0.0627 in.) 1.625 mm (0.0640 in.) 1.655 mm (0.0651 in.)	
Steering Shaft End Play	0.025 – 0.102 mm (0.001 – 0.004 in.)	0.15 mm (0.006 in.)

CAP SCREWS (or NUT)		TORQUE SPECIFICATIONS
Steering Cover-to-Gear Box	(M8)	25 Nm (2.5 kgm) (20 ft-lbs)
Pitman Arm Nut	(M20)	196 Nm (20 kgm) (144 ft-lbs)
Ball Joint Throtted Nut	(M14)	118 Nm (12 kgm) (87 ft-lbs)
Steering Gear Box-to-Clutch Housing (With LOC TITE)	(M10)	60 Nm (6 kgm) (43 ft-lbs)
Steering Column to Gear Box	(M8)	25 Nm (2.5 kgm) (20 ft-lbs)

SPECIFICATIONS (Continued)

Brakes

SPRING	FREE LENGTH	WORKING LOAD
Brake Shoe Return Spring	44 mm (1.732 in.)	(51 mm at 231 N) (2.007 in. at 52.9 lbs.)
Brake Pedal Return Spring	175 mm (6.889 in.)	230 mm at 185 N (9.055 in. at 40.75 lbs.)

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Brake Drum I.D	140.00 – 140.1 mm (5.512 – 5.516 in.)	142 mm (5.59 in.)
Brake Lining thickness	4.75 mm (0.187 in.)	3 mm (0.12 in.)
Clearance between Lining and Drum	0.5 – 0.8 mm (0.02 – 0.03 in.)	1.75 mm (0.07 in.)
Brake Operating Lever		
Cam Shaft O.D.	21.96 – 22.00 mm (0.865 – 0.866 in.)	
Cam Pin Flat End Thickness	11.9 – 12.1 mm (0.468 – 0.470 in.)	
Brake Cam Shaft Boss I.D.	22.05 – 22.15 mm (0.868 – 0.872 in.)	
Clearance between Cam Shaft and Boss	0.02 – 0.09 mm (0.0008 – 0.0035 in.)	0.3 mm (0.01 in.)
Brake Anchor Pin		
O.D.	15.98 – 16.00 mm (0.029 – 0.630 in.)	
Brake Pedal Shaft O.D.	24.95 – 25.00 mm (0.982 – 0.984 in.)	
Pedal Shaft Bushing I.D.	25.05 – 25.07 mm (0.986 – 0.987 in.)	
Clearance between Pedal Shaft and Bushing	0.010 – 0.112 mm (0.0004 – 0.0044 in.)	1 mm (0.04 in.)
Brake Pedal I.D.	25.065 – 25.117 mm (0.9868 – 0.9888 in.)	
Clearance between Pedal and Shaft	0.065 – 0.167 mm (0.003 – 0.007 in.)	1 mm (0.04 in.)
Brake Shaft End Play		1 mm (0.04 in.)
Brake Pedal Free Travel	20 – 30 mm (0.787 – 1.181 in.)	50 mm (1.969 in.)

CAP SCREWS	TORQUE SPECIFICATIONS
Brake Drum-to-Shaft	25 Nm (2.5 kgm) (20 ft-lbs)
Parking Brake Lever-to-Clutch Housing	50 Nm (5 kgm) (40 ft-lbs)
Brake Cover-to-Brake housing	25 Nm (2.5 kgm) (20 ft-lbs)

SPECIAL TOOLS

Steering Wheel Puller (TOL-93110000)

Removing steering wheel

1862926

Pitman Arm Puller (TOL-93120000)

Removing pitman arm

1862932

DIAGNOSING MALFUNCTIONS

Too much steering wheel play

- Steering gear box improperly adjusted
- Worn sector gear, ball nut or balls
- Sector shaft worn

Steering wheel shaft axial play

- Worn sector gear, ball nut or balls
- Worn or damaged steering shaft ball bearings in gear box
- Loosen steering wheel retaining nut

High Vibration of Steering wheel or column

- Loosen gear box mounting cap screws
- Engine malfunctions

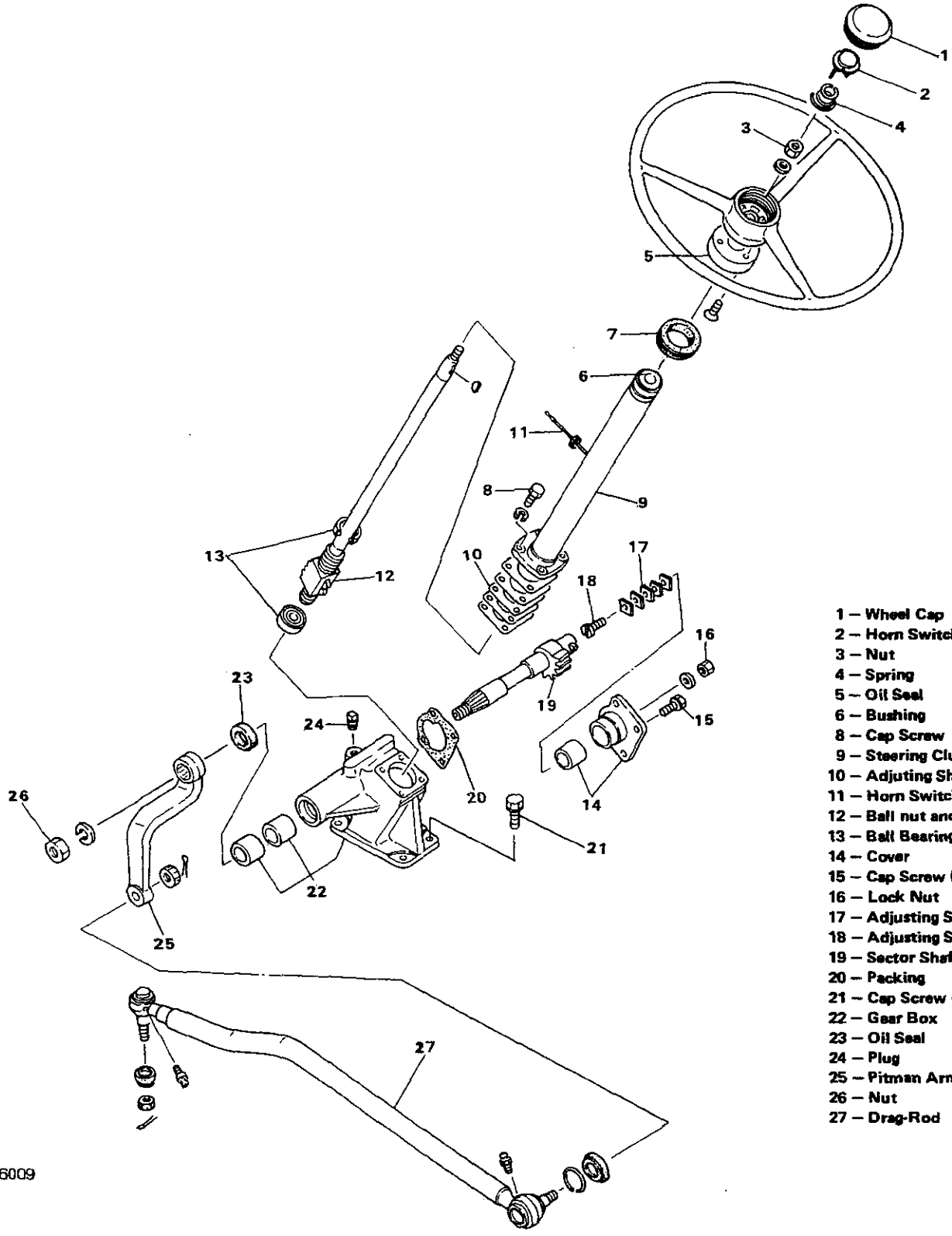
Oil leakage from gear box

- Damaged sector shaft oil seal (Left side)
- Damaged or broken cover packing (Right side)
- Damaged or broken column O-ring (Upper side)

Steering wheel can be rotate without dead end stop

- Worn steering wheel seration.
- Broken ball nut
- Broken ball nut and recirculating balls

STEERING SYSTEM



1 – Wheel Cap
2 – Horn Switch
3 – Nut
4 – Spring
5 – Oil Seal
6 – Bushing
8 – Cap Screw
9 – Steering Clumn
10 – Adjuting Shim
11 – Horn Switch Lead
12 – Ball nut and Shaft
13 – Ball Bearing (2 Used)
14 – Cover
15 – Cap Screw (2 Used)
16 – Lock Nut
17 – Adjusting Screw-Shim
18 – Adjusting Screw
19 – Sector Shaft
20 – Packing
21 – Cap Screw (4 Used)
22 – Gear Box
23 – Oil Seal
24 – Plug
25 – Pitman Arm
26 – Nut
27 – Drag-Rod

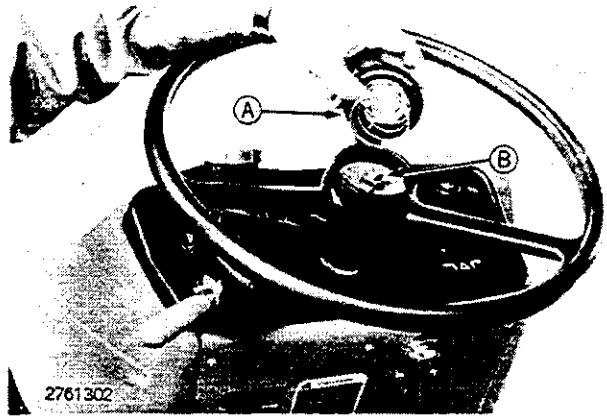
2766009

STEERING

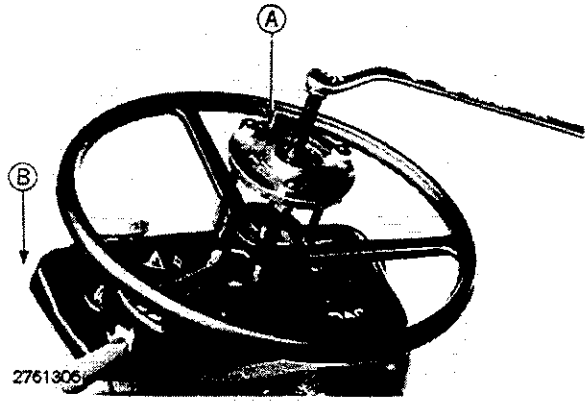
See Chapter 80 for repair and adjustment of front steering linkage and front axle assembly.

REMOVAL

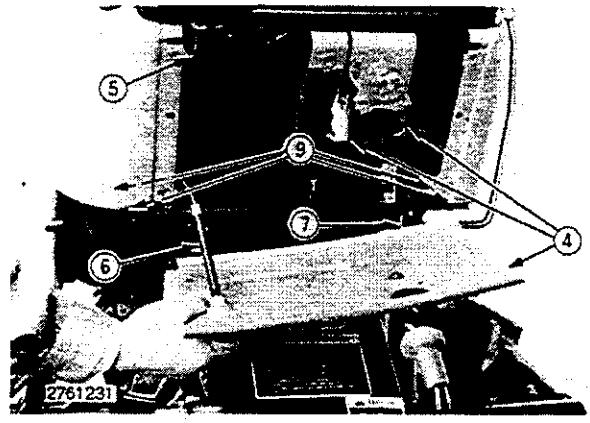
1. Remove steering wheel cap (A) and lock nut (B).
2. Install puller and remove steering wheel.



A — Puller
B — Panel Box

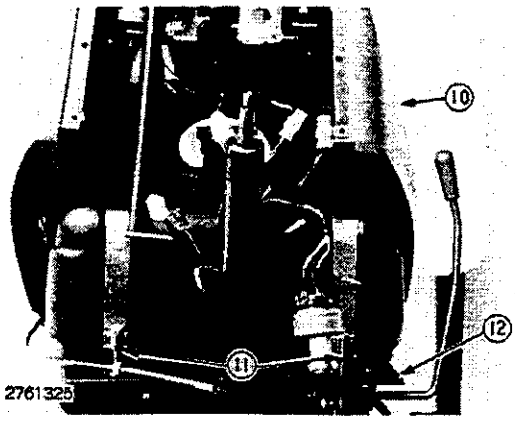


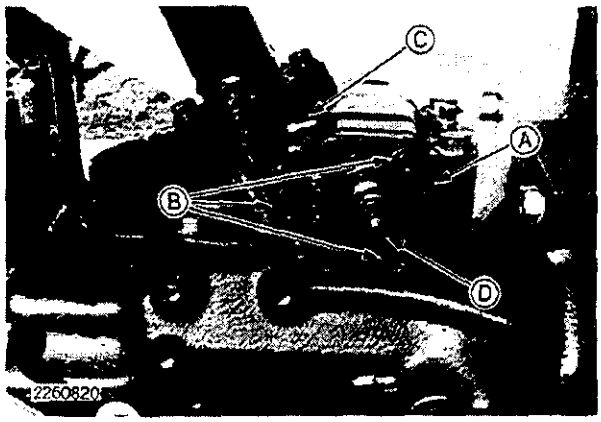
3. Disconnect battery ground cable.
4. Remove access panel and remove wiring harness from connectors.
5. Remove tachometer drive cable from tachometer.
6. Disconnect decompression linkage.
7. Disconnect throttle linkage from right-hand side.
8. Disconnect fuel lines from tank.
9. Remove two screws at front of the panel box and four screws/nuts at the rear bottom of the panel box to panel box bracket.

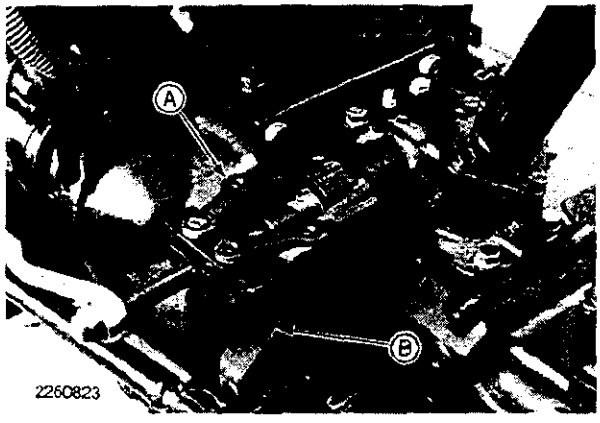


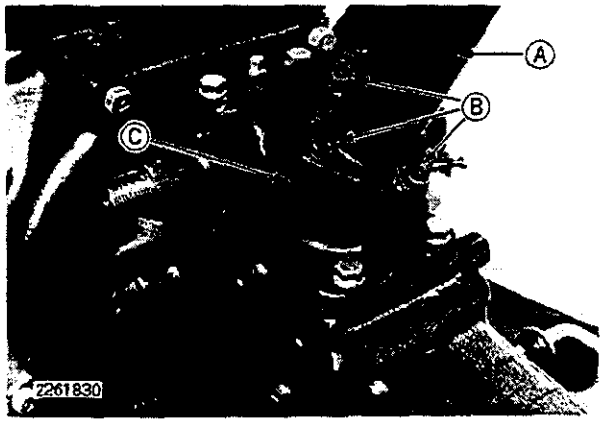
10. Remove panel box as described on page 30-10-3.
11. Loosen two nuts at the rear end of fuel tank straps and remove two cap screws at the front end of the straps.

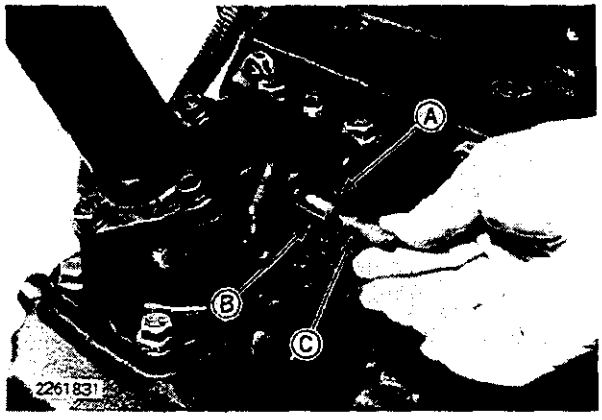
    Remove fuel tank.
12. Remove panel box bracket.











DISASSEMBLY

1. Remove three side cover-to-gear case cap screws (B) and remove lock nut from adjusting screw (D).
2. Turn adjusting screw counterclockwise to remove the side cover (A).

STOP **Gear box (C) does not need to be removed from clutch housing unless there is damage to the gear box casting or its bushings.**

3. If gear box is removed, remove four retaining cap screws and lift from clutch housing.

A – Side Cover
B – Cap Screws
C – Steering Gear Box
D – Adjusting Screw

4. Remove pitman arm retaining nut from sector shaft. Remove pitman arm using pitman arm puller (A).

A – Pitman Arm Puller
B – Pitman Arm

5. If steering column (A) is to be removed, loosen cap screw (B) and remove column from gear box (C).

A – Steering Column
B – Cap Screws
C – Gear Box

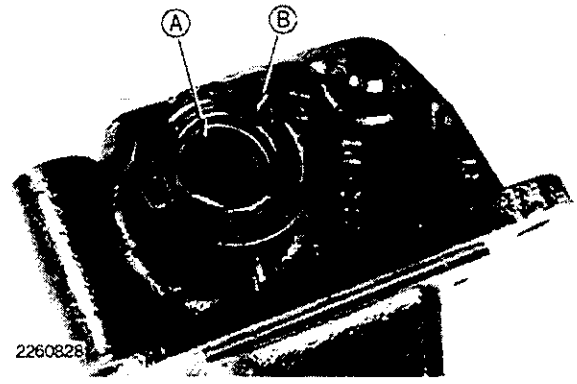
6. Remove adjusting screw (C) with shim (B).
7. Turn steering shaft so that sector shaft gear teeth can be aligned with wider opening in gear box as shown.
8. Drive sector shaft (A) through cover side of steering gear box using mallet.
9. Remove steering shaft with ball nut (if column has been removed).

A – Sector Shaft
B – Adjusting Shim
C – Adjusting Screw

INSPECTION AND REPAIR

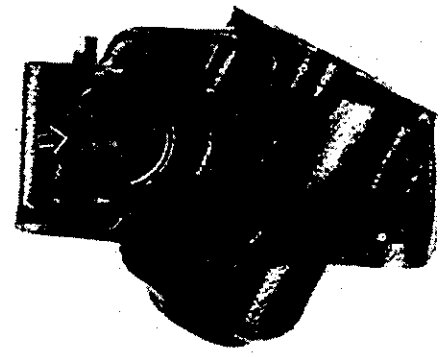
1. Inspect gear box bushing for wear or damage. If bushing is excessively worn or damaged, gear box with bushing must be replaced. I.D. of bushing is 28.00 to 28.02 mm (1.1259 to 1.1267 in.)

A – Bushing
B – Oil Seal



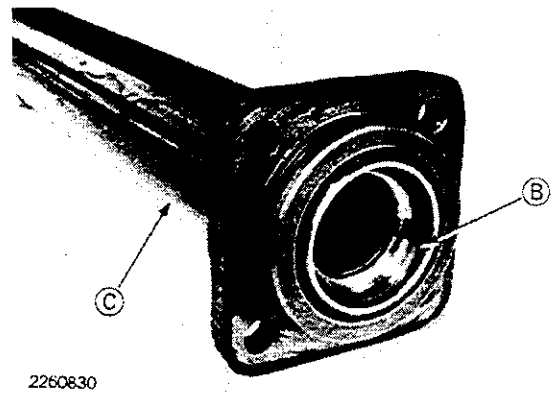
2260828

2. If seal is damaged or leaking, replace it. Coat seal with grease. Seal should be flush with end of housing.


2260829

3. Inspect upper bearing race (B) on end of column (C). Replace them and coat with grease if it was damaged or deformed.

B – Upper Bearing Race
C – Steering Column



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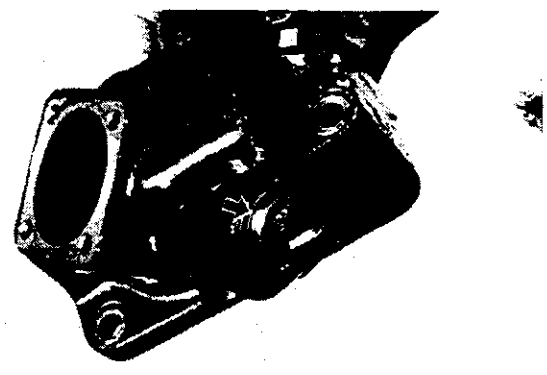
4. Inspect bearing race in bottom of gear box. Install new race tight in bottom of gear box.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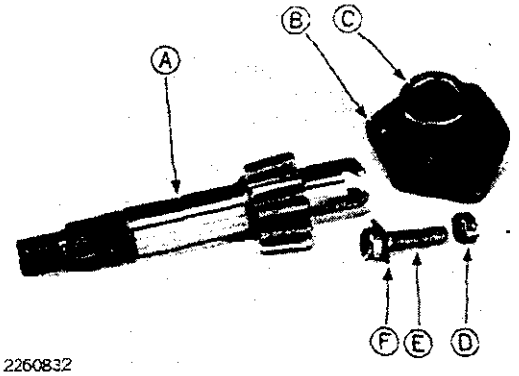
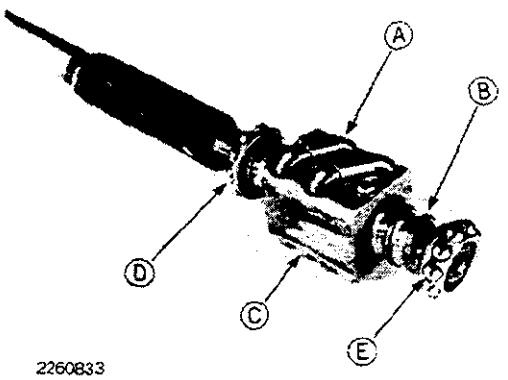
INSPECTION AND REPAIR (Continued)



2260832

6. Inspect sector shaft (A). O.D. at bushing is 27.57 to 27.59 mm (1.1248 to 1.1255 in.).

A – Sector Shaft
B – Side Cover
C – Packing
D – Lock Nut
E – Adjusting Screw
F – Adjusting Shim



2260833

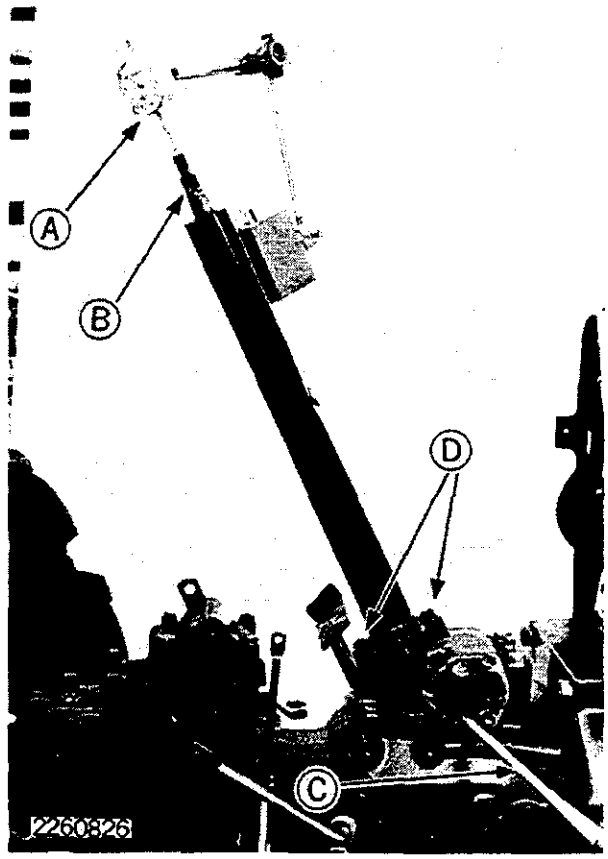
7. Inspect upper and lower bearings (D and E) for wear or damage. Replace as required.
8. Wash steering shaft (B) and ball nut (C) in clean solvent.
9. Carefully turn the ball nut on the shaft, feeling for any roughness, binding or sticking. Be sure the ball nut turns smoothly on the worm and is neither loose nor binding.
10. Examine worm path for nicks or scratches. Shaft and ball nut (B and C) will have to be replaced if damage is found.

A – Guide with Retainer
B – Steering Shaft
C – Ball Nut
D – Upper Bearing
E – Lower Bearing

ASSEMBLY

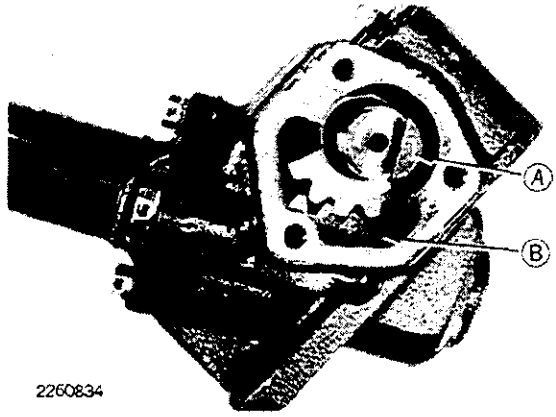
1. Grease bearings and worm gear shaft. Install bearing in bottom of box.
2. Install steering shaft into box and tighten steering cap screw to gear box.
3. Install shaft key and turn shaft while pushing downward to seat the bearing against gear box.
4. Attach a dial indicator (A) to the top of the steering column with indicator touching end of shaft (B).
5. Pry ball nut upward to check shaft bearing play. End play should be 0.025 – 0.102 mm (0.001 to 0.004 in.)

   Five types of shims are available for adjustment of shaft bearing play. See parts catalog on STEERING.



A – Dial Indicator
B – Steering Shaft
C – Pry Bar
D – Lock Nut

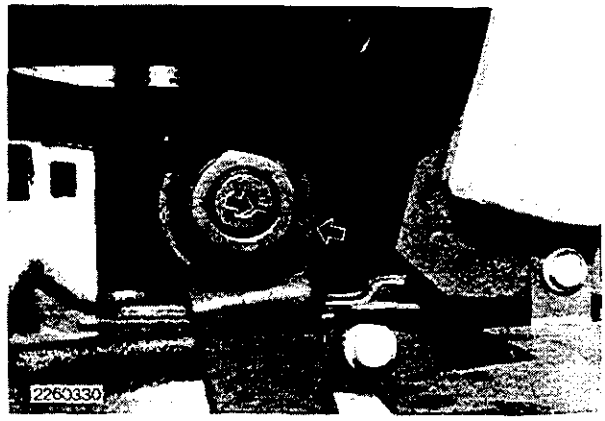
6. Install sector shaft (A) with middle tooth in center of ball nut. This is the straight forward position of the assembly. Install steering wheel.
7. Install adjusting cover by threading adjusting screw through cover. Torque cover cap screws to 25 Nm (2.5 kgm) (20 ft-lbs). Install lock nut on screw.



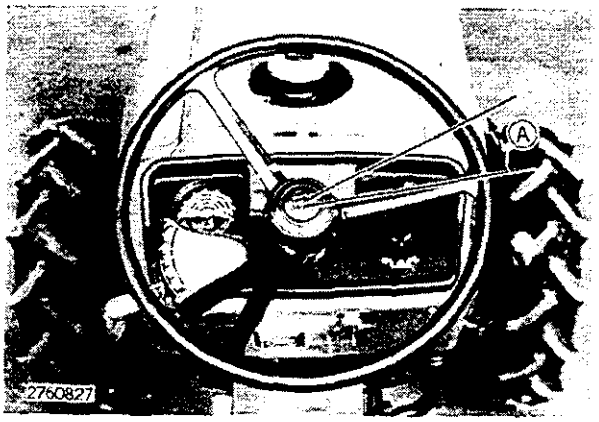
A – Sector Shaft
B – Ball Nut

8. Install pitman arm, indexing arm to sector shaft. Torque nut to 196 Nm (20 kgm) (144 ft-lbs).
9. Fill steering gear box with Multi-Purpose grease. Capacity is 0.24 Liters (0.06 gallons)
10. Reverse removal procedures for installing control console and reconnect wires and fuel lines. Connect drag link to pitman arm. Torque nut to 69 – 78 Nm (7 –8 kgm) (51 – 58 ft-lbs).
11. Install steering wheel.

    Tighten nut to 25 to 30 Nm (2.5 to 3.0 kgm) (18 to 22 ft-lbs) torque.



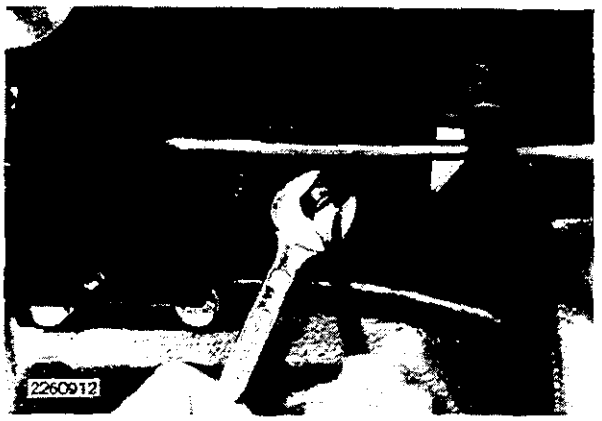
Do not tighten steering wheel more than 30 Nm (3.0 kgm) (22 ft-lbs).



ADJUSTMENT

1. Measureing Steering Free Play

A – Steering Free Play: 25 – 50 mm (0.984 to 1.969 in.)



2. Adjustment of steering play is made by adjusting backlash of the gears. Turn the adjusting screw in the adjusting cover to obtain 25 – 40 mm (0.984 to 1.575 in.) of free play measured at outer rim of steering wheel.

By turning the screw to the right, the amount of play can be reduced. The standard position for the screw is a quarter-turn back when wheel becomes hard to turn.

DIAGNOSING MALFUNCTIONS

Oil in Brake Housing

- Loosen brake drum retaining nut
- Damaged or worn O-ring on final reduction pinion shaft (Brake shaft)
- Clogged vent tube or extention hose

Brake Shoes Burned

- Parking brake lever had been engaged while tractor running.
- Riding brake for long time
- Brake shoes slip on drum for leaked oil

Scored Brake Drum

- Abrasive foreign material in housing
- Braken brake return spring
- Excessively worn shoes

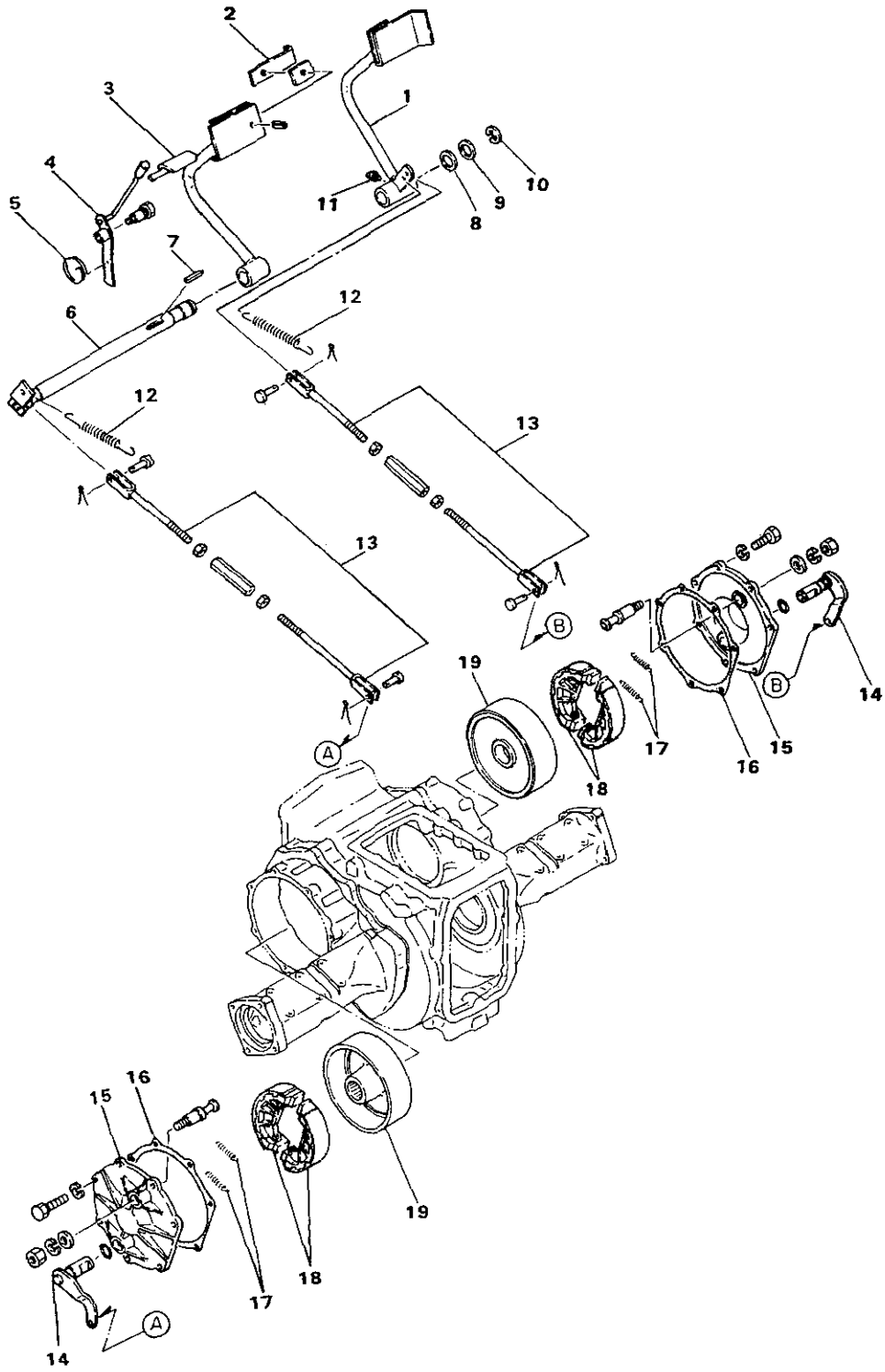
Water or Mad in Brake Housing

- Broken brake housing cover packing
- Loosen Brake cover retainging screws
- Damaged operating Cam shaft O-ring
- Broken or removed vent tube extension hose

Brake can not be adjusted

- Worn out shoes
- Rusty brake operating rod

BRAKE SYSTEM



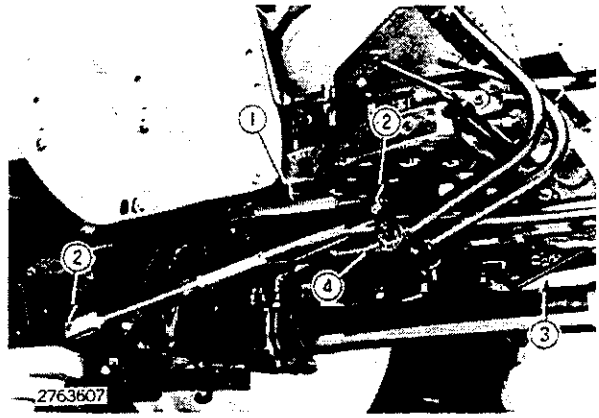
1 – Brake Pedal (R)
2 – Connector
3 – Brake Pedal (L)
4 – Parking Brake Lever
5 – Park Spring
6 – Pedal Shaft
7 – Key
8 – Spacer
9 – Washer
10 – "E" Type Snap Ring
11 – Grease Fitting
12 – Return Spring (2 Used)
13 – Brake Rod (2 Used)
14 – Cam Lever
15 – Brake Cover
16 – Packing
17 – Return Spring (2 Used)
18 – Brake Shoe (4 Used)
19 – Brake Drum

2766010

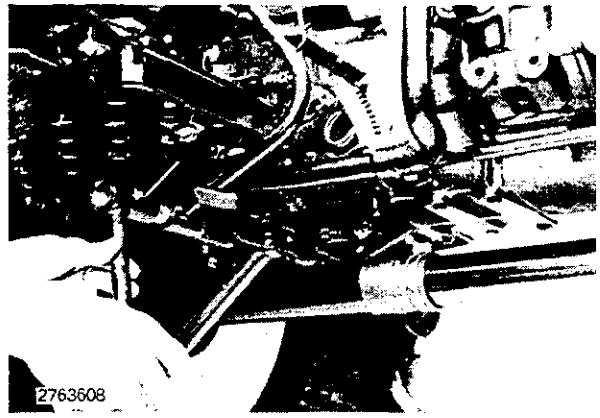
BRAKE PEDAL ASSEMBLY

REMOVAL AND DISASSEMBLY

1. Remove pedal return spring from arm at each end of pedal shaft.
2. Remove cotter pin and headed pin from yoke and arm at each end of pedal shaft.
3. Disconnect clutch pedal linkage from clutch pedal (See Section 50).
4. Remove retaining ring from right-hand end of shaft.



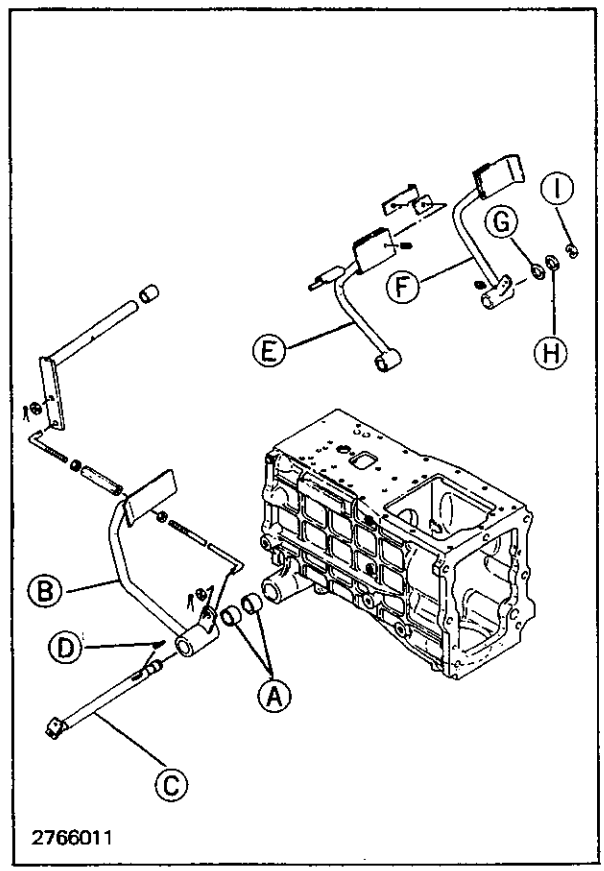
5. Remove brake pedals from shaft.
6. Remove key from pedal shaft and remove shaft to the left through the clutch housing.



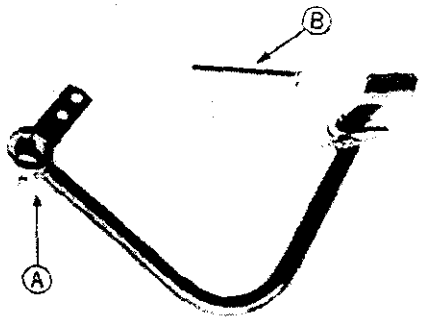
REPAIR AND INSTALLATION

1. Inspect pedal shaft (C) for wear or damage and replace as necessary. O.D. at brake pedal is 24.95 – 25.00 mm (0.982 to 0.984 in.)
2. Inspect and assemble clutch pedal as instructed in Chapter 50.
3. Inspect shaft bushings (A). Bushing I.D. is 25.05 – 25.07 mm (0.986 to 0.987 in.).
4. Install bushing with grease.
5. Coat shaft (C) with grease and install through lefthand side of clutch housing.

A – Bushings (4 used)
B – Clutch Pedal
C – Pedal Shaft
D – Key
E – Brake Pedal (L)
F – Brake Pedal (R)
G – Spacer
H – Washer
I – "E" Ring



REPAIR AND INSTALLATION
(Continued)



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6. Inspect brake pedals (A). Pedal I.D. is 25.065 – 25.117 mm (0.9868 to 0.9888 in.).

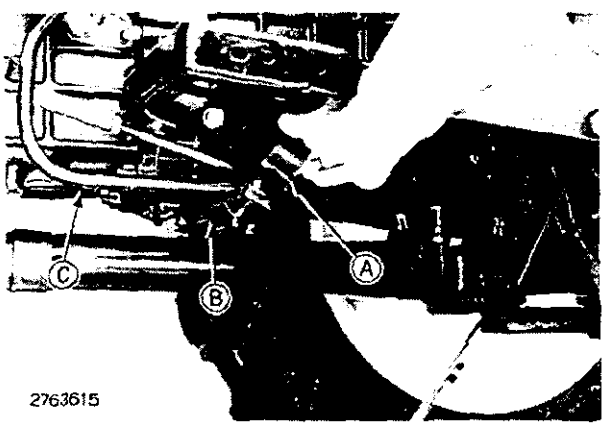
A – Brake Pedals
B – Return Springs

7. Insepct brake pedals (A). Pedal I.D. is 25.065 to 25.117 mm (0.9868 to 0.9888 in.). Replace parts if the clearance between shaft and pedal exceeds 0.04 in. (1mm).

BRAKE PEDAL SPECIFICATIONS

Brake pedal I.D.	**25.065 to 25.117 mm (0.9868 to 0.9888 in.)**
Pedal Shaft O.D.	**24.95 to 25.00 mm (0.982 to 0.984 in.)**
Pedal and Shaft Clearance Limit	**1 mm (0.04 in.)**

8. Check return spring (B) for proper tension. Replace if the loaded dimension exceeds 230 mm at 185 N (9.055 in. at 40.75 lbs.).



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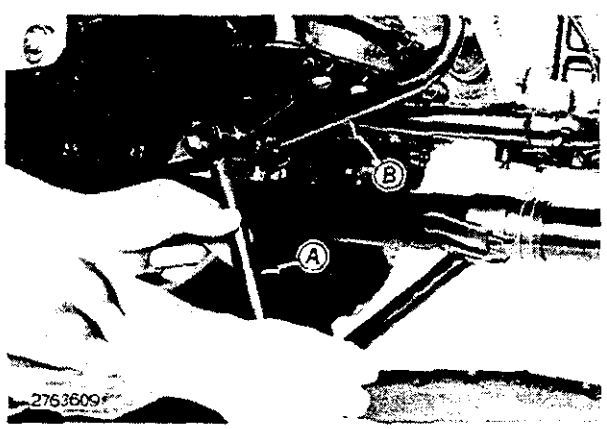
9. Insert pedal shaft (A) through clutch pedal (C) into clutch housing.

A – Pedal Shaft
B – Clutch Housing
C – Clutch Pedal



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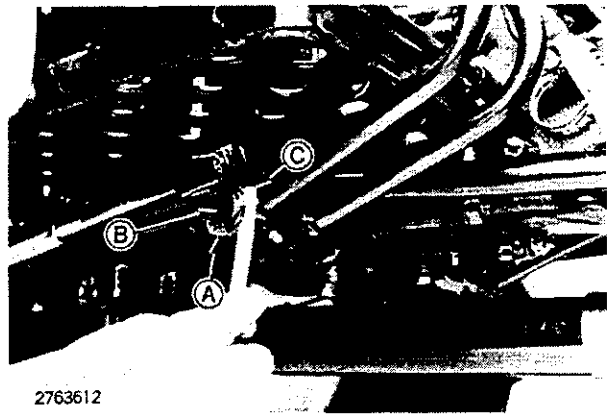
10. Install spacer washer against clutch housing and key on the shaft, and install left brake pedal (A) and right brake pedal (B).

11. Install shaft retaining snap ring (A) to the end of shaft.

A – Left Brake Pedal
B – Right Brake Pedal

12. Measure side play with feeler gauge. Install as many spacers as required to provide less than 0.04 in (1 mm).
13. Connect brake rods, clutch pedal rod and return springs.
14. Install parking brake. Tighten retaining screw to 19 to 50 Nm (5 kgm) (40 ft-lbs).

A – "E" Type Snap Ring
B – Pedal Shaft
C – Feeler Gauge

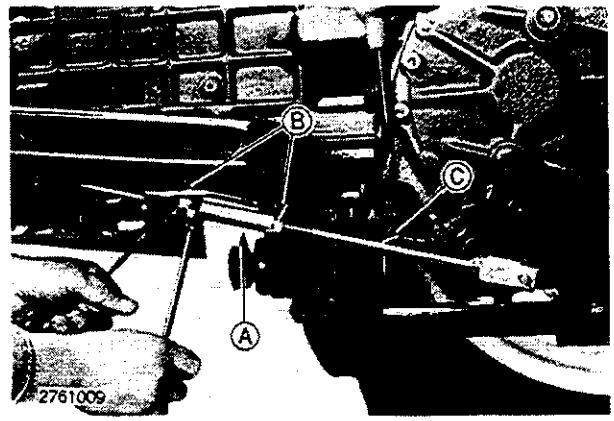


2763612

ADJUSTMENT

1. Loosen lock nuts on each brake rod to unlock turnbuckle (A).
2. Depress each brake pedal individually to measure free travel of pedals before engagement.
3. Maximum free travel is 50 mm (1.969 in.). Adjust so pedals are matched to 25 mm (0.984 in.) free travel.

A – Turnbuckle
B – Lock Nuts
C – Brake Rod



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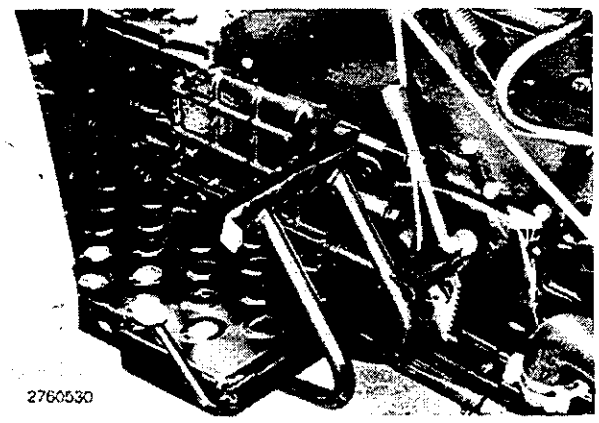
4. Depress brake pedals and engage parking brake. Check operation of lever for proper engagement and disengagement.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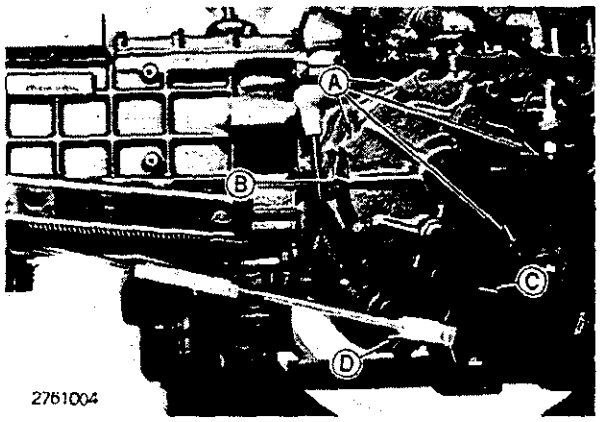
BRAKE HOUSING



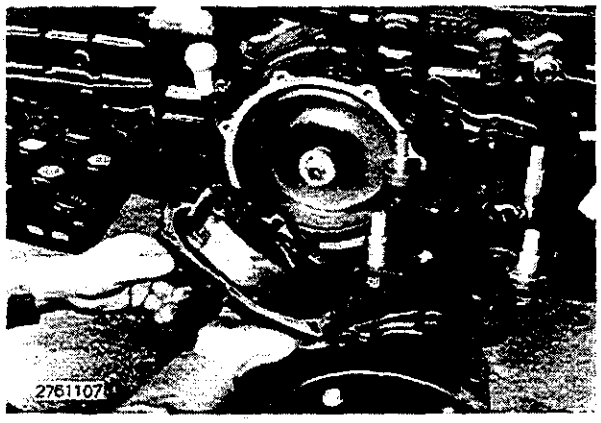
2761004

Refer to Chapter 50, Section 25 for information concerning repair of the drive train components related to the brake housing.

REMOVAL

1. Disconnect brake rod yoke (D) from operating cam lever (C).
2. Remove cover-to-brake housing cap screws (A).

A – Cap Screw
B – Brake Cover
C – Cam Lever
D – Brake Rod Yoke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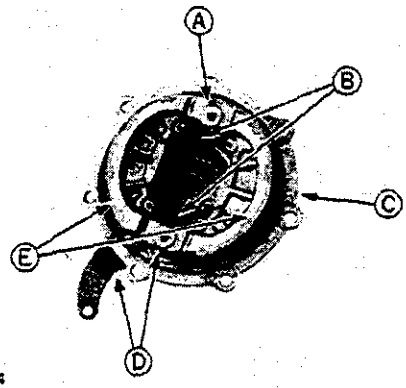
3. Remove brake cover assembly with shoes.

DISASSEMBLY



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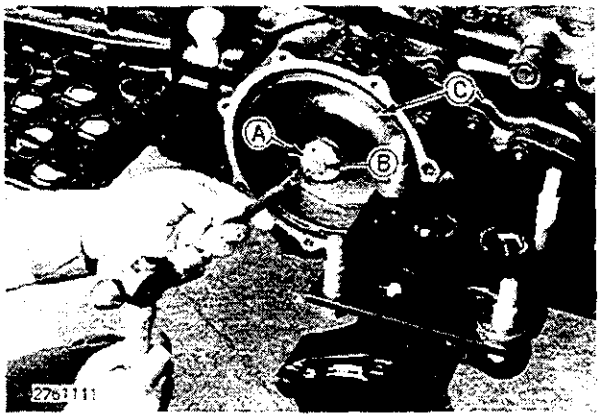
1. Remove reutrn springs (B) and remove shoes (E).
2. Remove operating lever with shaft (D).

A – Anchor Pin
B – Shoe Reutrn Springs
C – Cover
D – Operating Lever with Cam Shaft
E – Brake Shoes

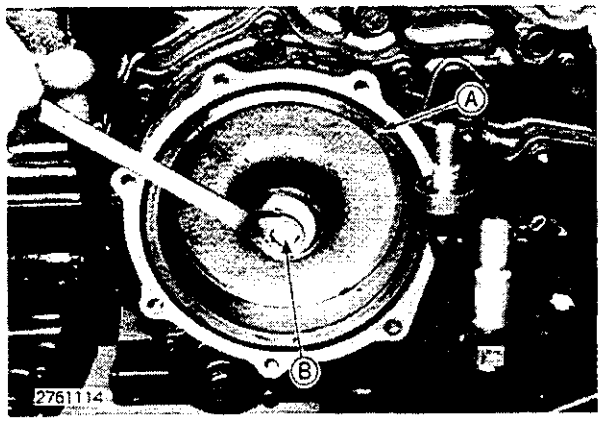


2761111

3. Flatten lock plate (A) for cap screw (B) for brake drum (C).

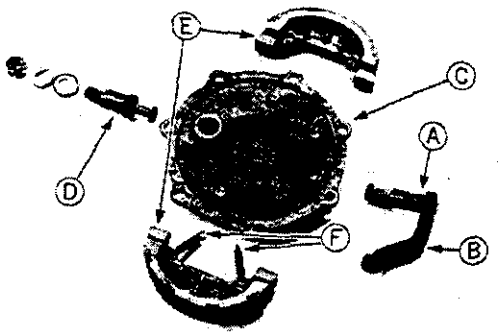
A – Lock Plate
B – Cap Screw
C – Brake Drum

4. Remove cap screw (B) and brake drum (A).



BRAKE HOUSING (Continued)

INSPECTION AND REPAIR



2761406

1. Disassemble brake cover for inspection.

A – O-Ring
B – Operating Cam Lever
C – Cover
D – Anchor Pin
E – Brake Shoes
F – Brake Shoes Return Spring

2761311

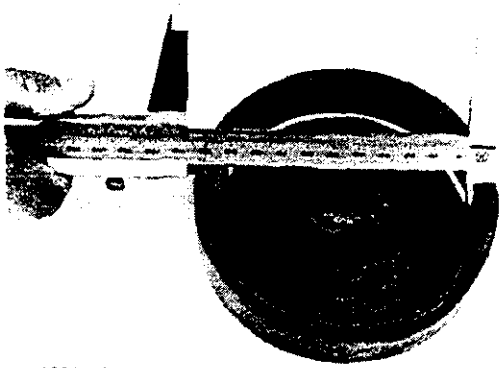
2. Inspect operating cam lever (B). Cam shaft 17.95 – 18.00 mm (0.707 to 0.709 in.)

   Thickness at flat end of shaft is 7.9 – 8.1 mm (0.311 ot 0.319 in.)

3. Inspect anchor pin (D) with cover (C). O.D. at end of pin is 17.96 –18.00 mm (0.7071 to 0.7087 in.). Thickness at flat end of pin is 7.9 – 8.1 mm (0.311 to 0.319 in.).

4. Check brake shoe return springs (F) for damage or wear. Length of spring is 39 mm (1.535 in.) at 117 N (26.2 lbs.)

5. Inspect brake linkage for wear or damage.



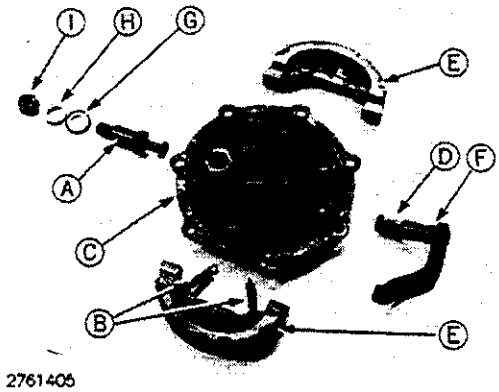
1802515

6. Inspect I.D. of brake drum for wear or damage. I.D. of drum should be 140.0 to 140.1 mm (5.512 to 5.516 in.). Replace if I.D. exceeds 142 mm (5.59 in.).

2411224

7. Inspect brake linings for wear or damage. The lining thickness of new part is 4.75 mm (0.187 in.). Replace if lining thickness is less than 3 mm (0.188 in.).

ASSEMBLY AND INSTALLATION



2761405

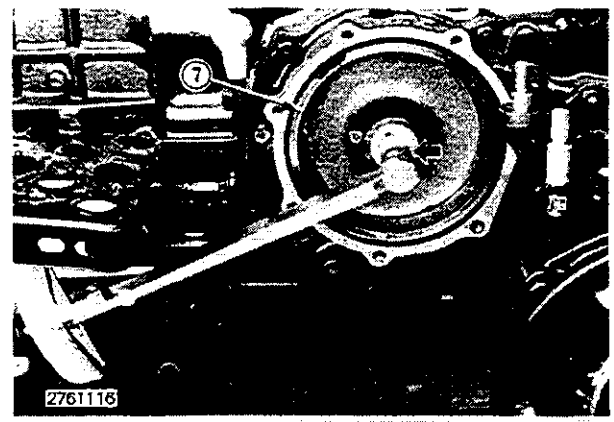
1. Check that retaining washer on end of cam and anchor pin is not loose.
2. Install O-ring (F) and coat with grease.
3. Inspect pin and cam pin bores in cover for wear or damage.
4. Install oepating arm cam (D) so arm faces downward.
5. Install anchor pin (A).

A – Anchor Pin
B – Shoe Reutrn Spring
C – Cover
D – Operating Arm with Cam Pin
E – Brake Shoes
F – O-Ring
G – Wahser
H – Spring Wahser
I – Nut

The levers are not same parts for left and right side brakes.

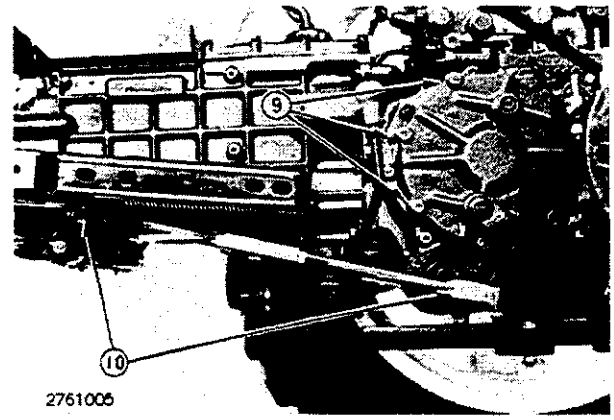
6. Install Brake shoes (E) and return springs (B).

7. Put tractor in gear and engage differential lock. Install brake drum on shaft. Torque retaining nut to 25 Nm (25 kgm) (20 ft-lbs).
8. Install new gasket without sealant and install cover on rear axle housing.



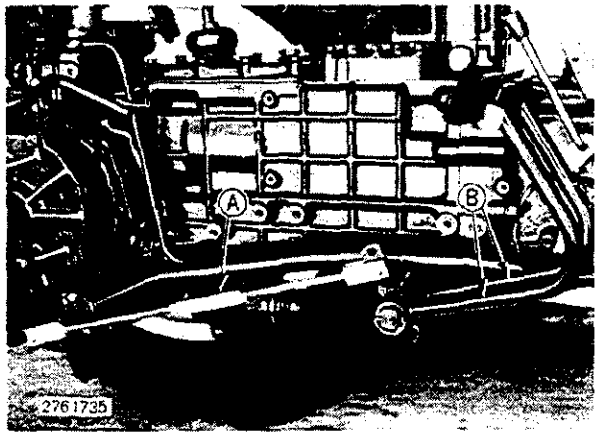
2761116

9. Engage brake while torquing cover cap screws. Torque to 25 Nm (2.5 kgm) (20 ft-lbs).
10. Connect brake rod to operating arm and adjust pedal free play as instructed on page. 60-15-10.



2761006

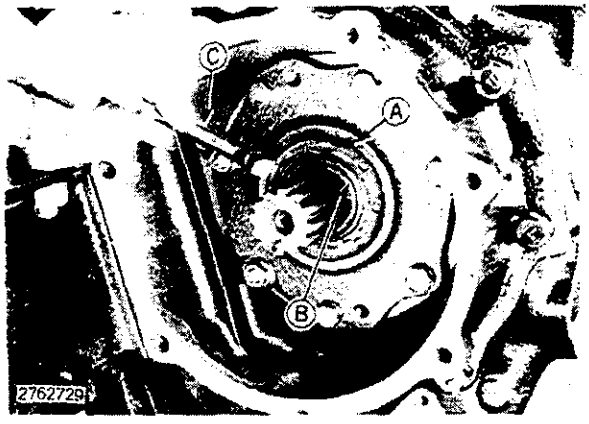
BRAKE HOUSING (Continued)



ADJUSTMENT

1. Loosen jam nuts on each brake rod to unlock adjusting nut (A).
2. Depress each brake pedal (B) individually to measure free travel of pedals before engagement.
3. Maximum free travel is 35 mm (1 – 3/8 in.). Adjust so pedals are matched to 25 mm (1 in.) free travel.

BRAKE SHAFT SEALS

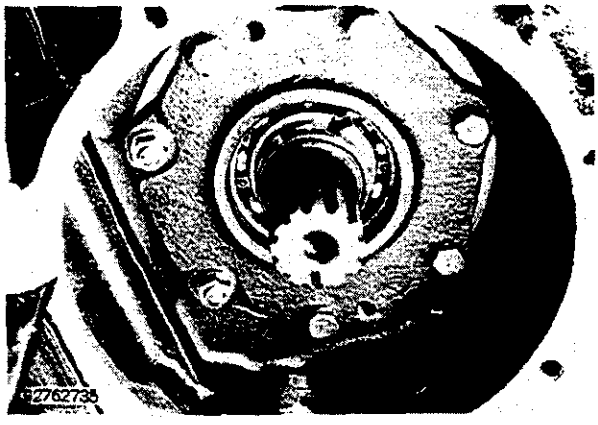


If oil contamination is present in the brake housing or in the shoes, pinion shaft (Brake shaft) seals must be replaced.

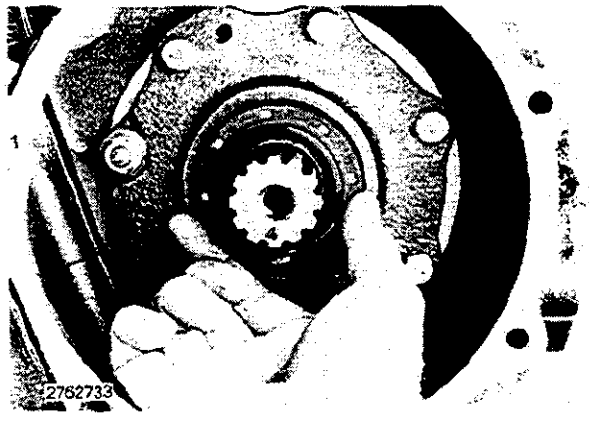
REMOVAL

1. Drain Transmission-Hydraulic Oil.
2. Remove oil seal (A) using a chisel (C).

A – Oil Seal
B – Seal Collar
C – Chisel



3. Inspect seal collar sealing surface for wear. Replace as required.



4. Install new oil seal by using tube driver.

HYDRAULIC REPAIR 70

SPECIFICATIONS

Miscellaneous Hydraulic Repair

ITEM	NEW PARTS SPECIFICATIONS	WEAR LIMIT
Transmission Oil Filter (Suction Screen)	150 Mesh	
Hydraulic Oil Filter (Cartridge Type)	35μ	
Hydraulic Outlet Block		
Inlet/Outlet Plug	3/4 – 16 UNF – 2B with O-ring	
By-pass Shut off Plug	1/4 – 18 NPTF	
Return Oil Plug on Transmission Case	3/4 – 16 UNF – 2B with O-ring	

CAP SCREWS	TORQUE SPECIFICATIONS
Transmission Oil Filter Cover	12 Nm (1.2 kgm) (8.7 ft-lbs)
Hydraulic Oil Filter Housing-to-Bracket	25 Nm (2.5 kgm) (18.1 ft-lbs)
Hydraulic Inlet, Outlet and Return Port Plugs	32 Nm (3 kgm) (21.7 ft-lbs)
Hydraulic Hollow Plug	78 Nm (8 kgm) (57.9 ft-lbs)

Hydraulic Pump and Drive Unit

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Pump Drive Shaft O.D. at Gear	24.99 – 25.00 mm (0.9839 – 0.9842 in.)	
Pump Drive Gear I.D.	24.965 – 24.975 mm (0.9829 – 0.9832 in.)	
Pump Drive Gear and Shaft Interference (Tightness)	0.015 – 0.035 mm (0.00059 – 0.00137 in.)	
Pump Drive Gear Backlash	0.05 – 0.13 mm (0.002 – 0.005 in.)	0.25 mm (0.01 in.)

CAP SCREWS	TORQUE SPECIFICATIONS
Pump-to Mounting Flange Nut	26 Nm (2.7 kgm) (19.5 ft-lbs)
Oil lines-to-Hydraulic Pump Cap Screw	10 Nm (1 kgm) (7.3 ft-lbs)
Front Cover-to-Hydraulic Pump Housing	(2 kgm) (15 ft-lbs)

Hydraulic Lift and Implement Hitches

SPRING	FREE LENGTH	WORKING LOAD
Main Relief Valve	50.7 mm (1.996 in.)	42 mm at 324 N (1.654 in. at 73.0 lbs)
Slow Return Valve	19.0 mm (0.748 in.)	9 mm at 10 N (0.354 in. at 2.25 lbs)
Safety Valve	44.0 mm (1.732 in.)	35.1 mm at 250 lbs (1.382 in. at 56.3 lbs)
Draft Control Spring		
Outer	97.5 mm (3.839 in.)	82.5 mm at 3.70 kN (3.248 in. at 832 lbs)
Inner (only before YM276 – 20586 / only before YM276D – 41399)	87.0 mm (3.425 in.)	74.5 mm at 1.11 kN (2.933 in. at 249 lbs)

ITEM	NEW PARTS SPECIFICATIONS	WEAR LIMIT
Lifting Shaft Sleeve O.D.	54.97 – 54.99 mm (2.164 – 2.165 in.)	
Lifting Shaft Bushing I.D. (installed)	55.07 – 55.14 mm (2.168 – 2.171 in.)	
Clearance between Sleeve and Bushing	0.080 – 0.169 mm (0.003 – 0.007 in.)	0.4 mm (0.016 in.)
Lifting Shaft Bushing Installation Depth	8.0 – 8.5 mm (0.31 – 0.33 in.)	
Hydraulic Piston O.D.	79.94 – 79.97 mm (3.147 – 3.148 in.)	
Hydraulic Cylinder I.D.	80.000 – 80.046 mm (3.150 – 3.151 in.)	
Clearance between Piston and Cylinder	0.03 – 0.106 mm (0.0011 – 0.0041 in.)	0.3 mm (0.012 in.)
Piston Stroke	89.7 mm (3.531 in.)	
Lift Arm Free Play	7 – 10 mm (0.3 – 0.4 in.)	
Position Control Lever Shaft		
Shaft O.D.	11.957 – 12.000 mm (0.4707 – 0.4724 in.)	
Pin End O.D.	7.942 – 8.000 mm (0.3126 – 0.3150 in.)	

ITEM	NEW PARTS SPECIFICATIONS	WEAR LIMIT
Draft Control Lever Shaft		
Shaft O.D.	11.957 – 12.000 mm (0.4707 – 0.4724 in.)	
Pin End O.D.	7.942 – 8.000 mm (0.3126 – 0.3150 in.)	
Side Cover Lever Shaft Bore	12.016 – 12.043 mm (0.4730 – 0.4741 in.)	
Clearance Between Control Lever and Side Cover	0.01 – 0.04 mm (0.0004 – 0.0016 in.)	0.4 mm (0.016 in.)
Slot Width of Control Bar	8.05 – 8.10 mm (0.317 – 0.319 in.)	
Pin Bore of Control Bar	8.03 – 8.10 mm (0.316 – 0.319 in.)	
Upper Link Hinge Pivot Pin O.D.	21.967 – 22.000 mm (0.8648 – 0.8661 in.)	
Upper Link Hinge Pivot Pin Bore I.D.	22.000 – 22.100 mm (0.866 – 0.870 in.)	
Draft Control Spring Mounting Length	92.5 mm (3.64 in.)	
Stopper Clearance to Upper Link	5.6 mm (0.22 in.)	
Position Control Feed Back Rod Length	159 mm (6.26 in.)	
Draft Control Feedback Rod Length	173 mm (6.81 in.)	
Distance From Center of Rear Hole of Upper Link Hinge to Cylinder Case Rear Machining Surface	134.5 mm (5.3 in.)	

CAP SCREWS	TORQUE SPECIFICATIONS
Control Valve to Side Case	34 Nm (3.5 kgm) (25 ft-lbs)
Hydraulic Lift Assembly to Transmission Case	60 Nm (6.0 kgm) (43 ft-lbs)
Lift Arm to Lifting Shaft	98 Nm (10.0 kgm) (72 ft-lbs)
Upper Link Hinge to Hydraulic Cylinder	100 Nm (10 kgm) (72 ft-lbs)
Lower Link Bracket to Rear Axle Housing	60 Nm (6.0 kgm) (43 ft-lbs)
Drawbar Bracket to Transmission Case	98 Nm (10.0 kgm) (72 ft-lbs) with Lock-tite.
Lift Arm Pin to Lift Arm Nut	210 Nm (21 kgm) (152 ft-lbs)
Cylinder Head to Hydraulic Cylinder Case	147 Nm (15 kgm) (108 ft-lbs)
Side Case to Hydraulic Cylinder Case	25 Nm (2.5 kgm) (18 ft-lbs)

SPECIAL TOOLS

Safety Valve Removal and Installation Tool (TOL-9302000)

1864225

Removing safety valve spring holder. Remove and install valve seats of safety and stop valves.

Install valve seat O-rings for safety and stop valves.

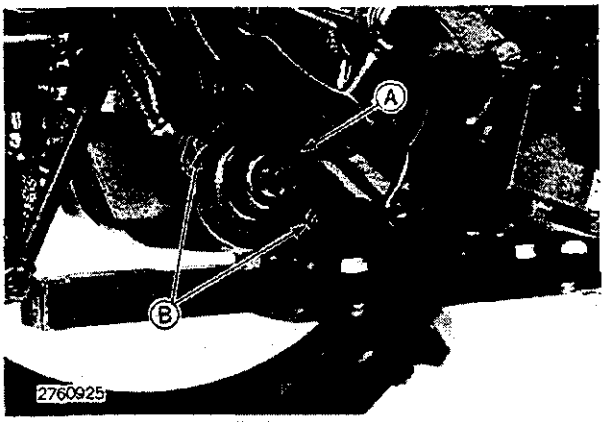
Ratchet Box (M6) (TOL-93010000)

1864234

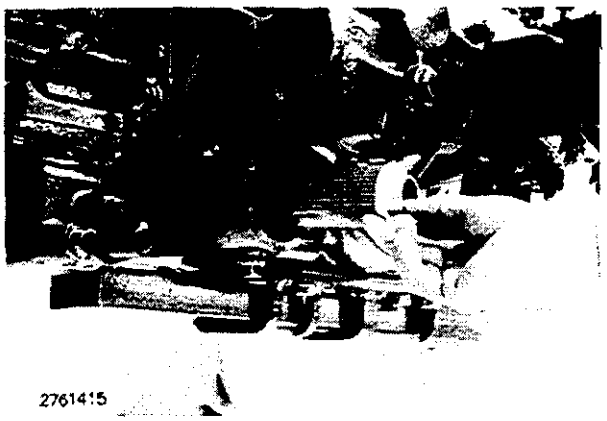
Removing and installing hydraulic lines retaining cap screws.

TRANSMISSION OIL FILTER

1. Remove filter cover (A) from the left side of transmission case.
2. Remove filter screen.
3. Clean filter screen in solvent and carefully dry with compressed air.
4. Be sure the housing is free of contaminants or debris and install filter screen.
5. Lightly coat O-ring (Not illustrated) on cover (A) with grease before installing filter cover. Replace O-ring as necessary.
6. Tighten cover-to-transmission case cap screws to 12 Nm (1.2 kgm) (8.7 ft-lbs).

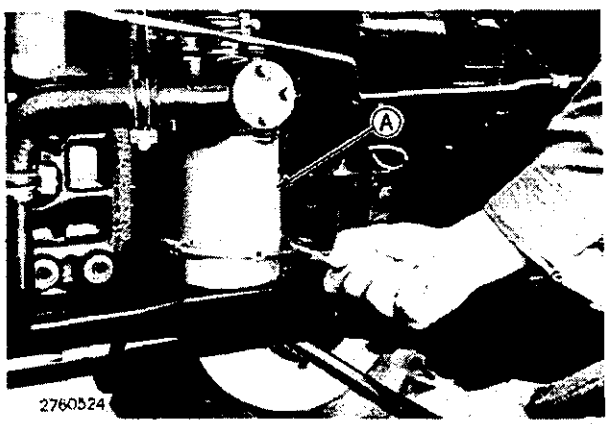


A — Filter Cover
B — Cap Screws



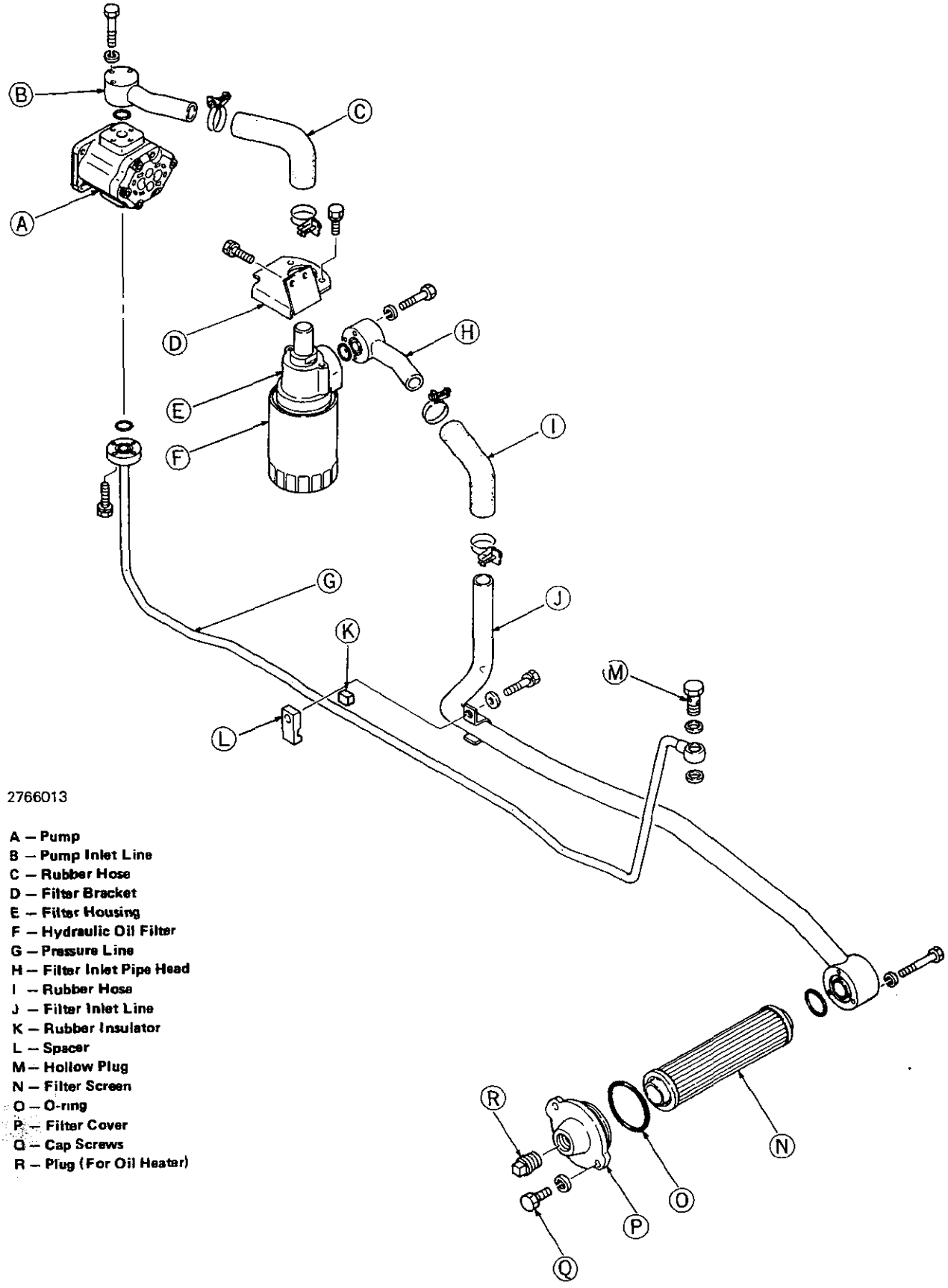
HYDRAULIC OIL FILTER (CARTRIDGE TYPE)

1. Remove hydraulic oil filter (A).
2. Clean filter mounting pad.
3. Install new filter element, appling a thin film of oil to sealing ring.
4. Screw filter element down by hand until seal just touches mounting pad. Then tighten an additional 3/4 to 1-1/4 turns. Do not overtighten.
5. Start engine and check for leakage.



A — Filter

HYDRAULIC OIL LINES



2766013

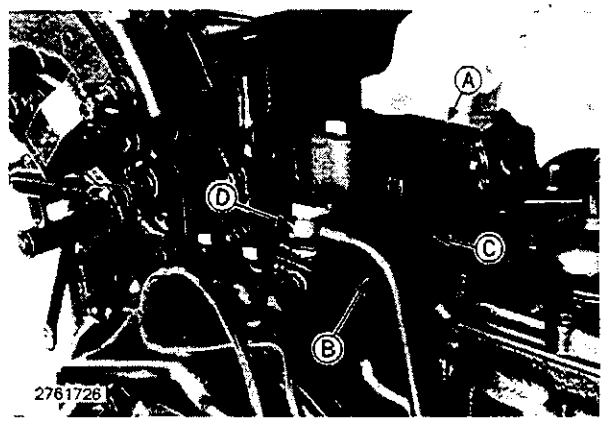
A – Pump
B – Pump Inlet Line
C – Rubber Hose
D – Filter Bracket
E – Filter Housing
F – Hydraulic Oil Filter
G – Pressure Line
H – Filter Inlet Pipe Head
I – Rubber Hose
J – Filter Inlet Line
K – Rubber Insulator
L – Spacer
M – Hollow Plug
N – Filter Screen
O – O-ring
P – Filter Cover
Q – Cap Screws
R – Plug (For Oil Heater)

HYDRAULIC OUTLET

The hydraulic outlet and inlet are on the hydraulic cylinder head. Thread is 3/4—16 UNF — 2B with O-ring.

These provide hydraulic oil flow to the auxiliary valves of hydraulic powered implements.

A — Cylinder Head
B — Plug for Outlet
C — Plug for Inlet
D — High Pressure Line (From Pump)



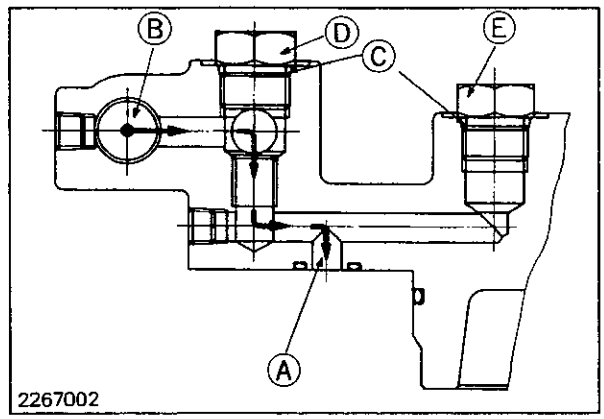
CONNECTING LINES TO OUTLET BLOCK

1. Remove plug (D) and install 1/4 — 18 NPTF headless plug (F) into bottom of bore.
2. Connect hydraulic line, to be connected to "IN or P" of auxiliary valve, to upper plug (D) as illustrated.
3. Remove plug (E) and connect hydraulic line, to be connected to "PBY" of auxiliary valve, to lower plug (H) as illustrated.
4. Connect hydraulic line, to be connected to "OUT or T" of auxiliary valve, to return plug.

Caution: Make sure all connections and fittings are securely tightened before starting engine.

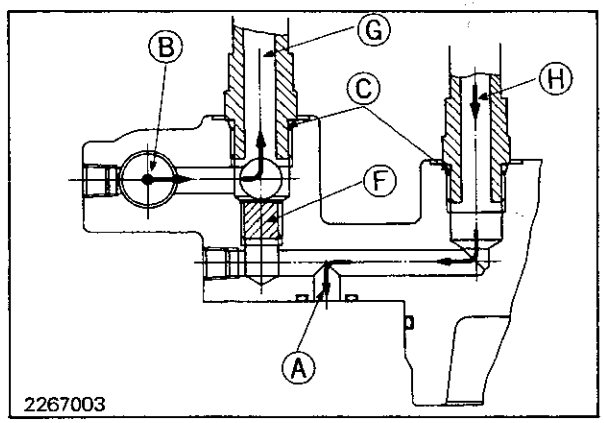
Oil Flow Without Auxiliary Connections (Fig. 2267002)

A — To Control Valve
B — From Pump
C — O-ring
D — Plug Outlet
E — Plug Inlet



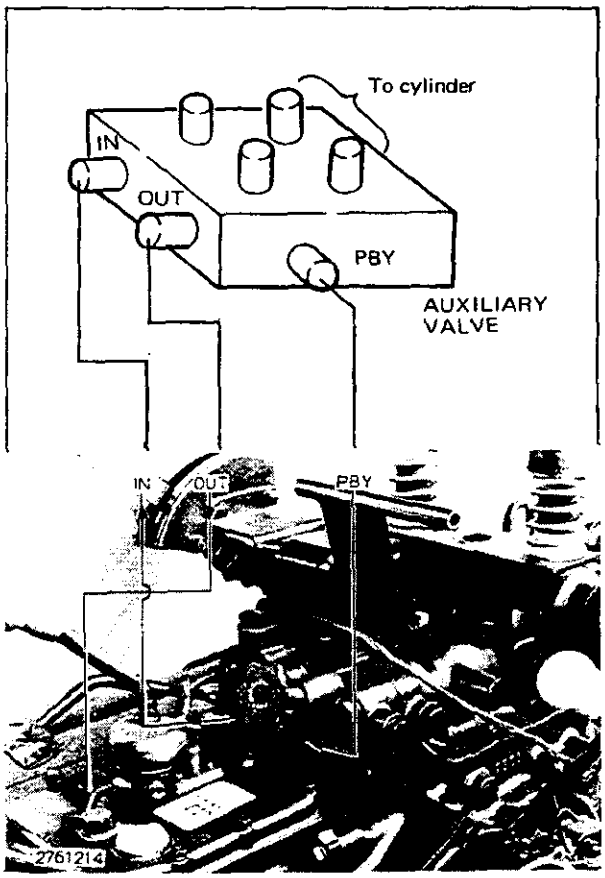
Oil Flow With Auxiliary Connections (Fig. 2267003)

A — To Control Valve
B — From Pump
C — O-ring
F — ¼—18 NPTF Headless Plug
G — To Auxiliary Valve
H — From Auxiliary Valve



HYDRAULIC OUTLET (Continued)

CONNECTING LINES TO OUTLET BLOCK (Continued)



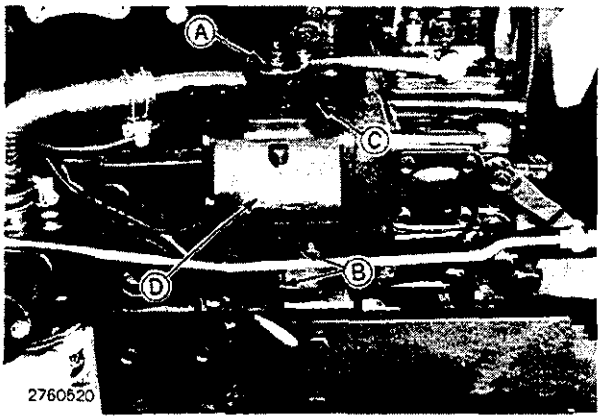
Hydraulic Connections for Auxiliary Valve

Volume of oil required to extend cylinder of implement must not lower transmission-hydraulic oil level below end of dipstick. Check oil level with the cylinder fully extended.

Whenever dismounting the hydraulic lines of implement from the outlet ports, the headless plug MUST be removed to avoid hydraulic pump breakage.

REMOVAL

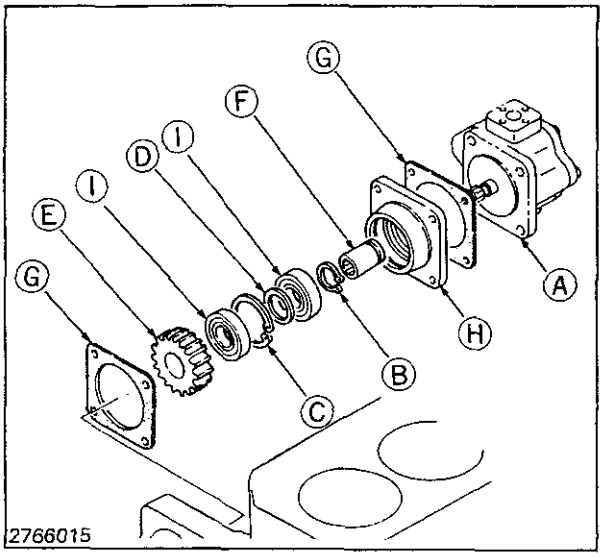
1. Remove cap screws from both inlet and outlet lines (A and B) at hydraulic pump (D).
2. Remove pump retaining nuts (C) and remove pump from pump drive unit.
3. Remove drive unit assembly from cylinder block.



A – Inlet Line (Large O.D.)
B – Outlet Line (Small O.D.)
C – Retaining Nuts
D – Hydraulic Pump

INSPECTION AND REPAIR

1. Inspect pump drive shaft (F) for wear or damage. Replace as necessary.
2. Inspect tightness of drive gear (E) on shaft (F). Inspect drive gear I.D. when replacing drive shaft. Replace shaft too if interference between shaft and gear is not 0.015 – 0.035 mm (0.00059 to 0.00137 in.).
3. Measure pump drive gear (E) backlash. Backlash should be 0.05 – 0.13 mm (0.002 to 0.005 in.). Replace faulty parts as necessary.
4. Inspect bearings (I) for wear or damage. Replace as necessary.
5. Inspect snap rings (B and C) and spacer (D). Replace as necessary.

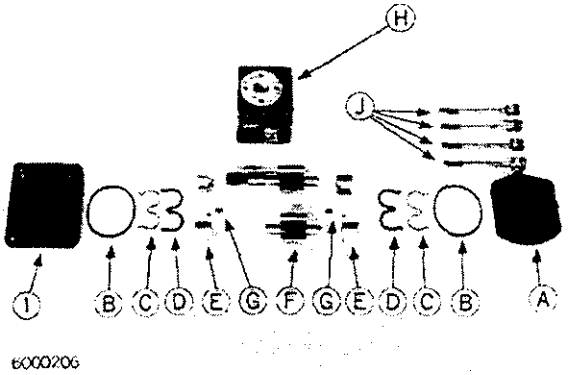


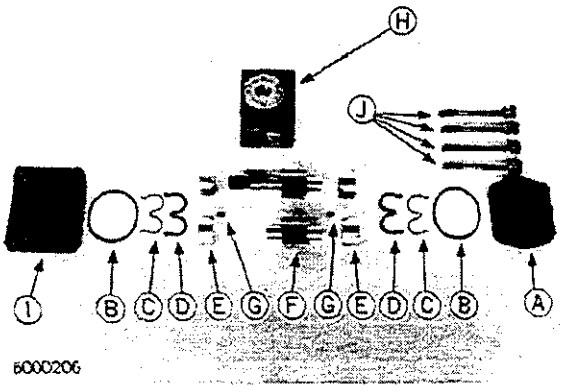
A – Hydraulic Pump
B – Snap Ring
C – Snap Ring
D – Spacer
E – Drive Gear
F – Shaft
G – Packing (2 used)
H – Pump Mounting Flange
I – Bearing (2 used)

If worn or damaged, the hydraulic pump must be replaced as a unit; it is not a serviceable item.

Disassemble pump in orderly fashion so that pump parts can be reinstalled in the same location as removed.

6. Inspect pump shaft seal and pump cover for oil leakage. Replace if leakage is detected.
7. Disassemble pump to replace O-ring or shaft seal in housing as follows.:
   a) Remove cap screws (J) and carefully remove front cover (A) and rear cover (I).
   b) Disassemble as shown.
   c) Inspect back-up rings (C), seals (D) and O-rings (B) for damage. Replace as necessary.

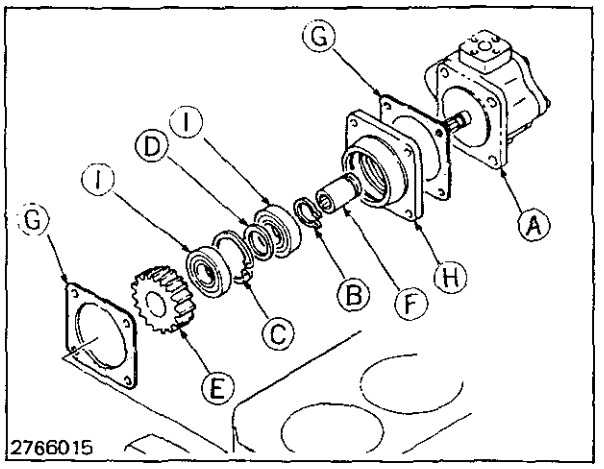




d) Check four bronze bushings (E) and pump gears (F) for damage. Replace as necessary.

8. To reassemble pump, proceed as follows.
   a) Throughly rinse all parts in clean Transmission Hydraulic Oil.
   b) Install a new oil seal in front cover if old one was removed.
   c) After greasing lightly, install inner bronze housings, back-up rings and O-rings.
   d) Install pump gears (F) in the same location and direction as removed.
   e) Grease lightly and install O-rings to covers.
   f) Install covers.
   g) Tighten bolts to 20 Nm (2 kgm) (15 ft-lbs).

A – Front Cover
B – O-rings
C – Back-up Rings
D – Seals
E – Bushings
F – Pump Gears
G – Woodruff Keys
H – Pump Housing
I – Rear Cover
J – Cap Screws



ASSEMBLY AND INSTALLATION

1. Install one bearing (I) in pump mounting flange (H). Install snap ring (C) and other bearing (I) with spacer (D).
2. Install pump drive gear (E) with shaft (F) through bearings (I). Install snap ring (B) on the end of shaft (F).
3. Install new gaskets (G) between cylinder block and pump mounting flange and between flange and pump housing.
4. Apply grease to pump drive unit bearings (I). Install the unit and pump assembly on stud bolts.
5. Temporarily tighten pump retaining nuts.
6. Rotate engine crankshaft pulley to align the centers of pump shaft and pump drive gear shaft.
7. Tighten pump retaining nuts to 26 Nm (2.7 kgm) (19.5 ft-lbs).
8. Connect hydraulic lines to pump. Tighten cap screws to 10 Nm (1 kgm) (7.3 ft-lbs).

STOP **Pay attention to length of screws connecting hydraulic lines. Inlet screws are longer than outlet screws.**

To avoid damaging threads inside pump housing always use line cap screws of correct length and specified torque.

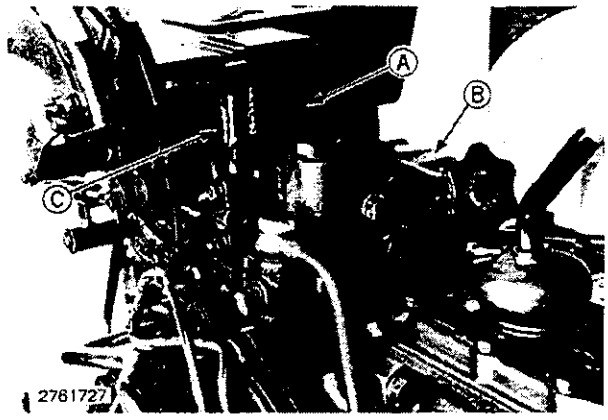
GENERAL

⚠ **CAUTION: Before attempting to remove or disassemble any hydraulic components, turn engine off, lower lift arm, and cycle all hydraulic controls to relieve any residual hydraulic oil pressure.**

The hydraulic lift assembly consists of four components.

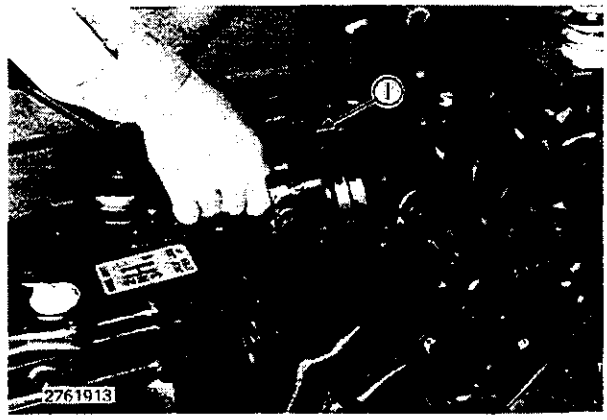
Accessing a part in the hydraulic system for servicing usually involves removing one or two of the four components listed below. Some parts, however, do not require such removals.

A — Hydraulic Cylinder Case
B — Cylinder Head
C — Side Case



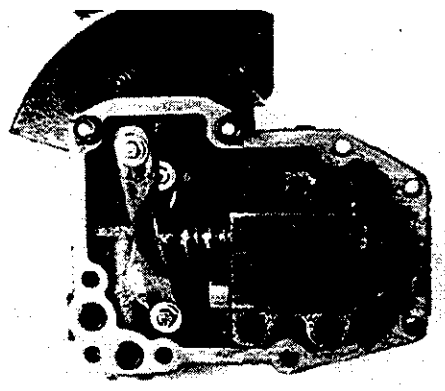
2761727

The each hydraulic system part is to be disassembled with the following component removals.



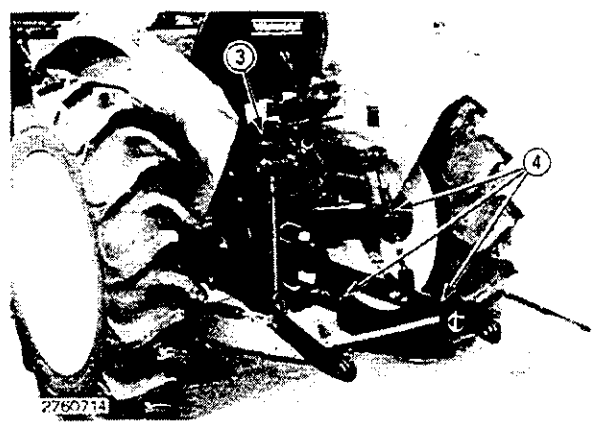
2761913

1. Cylinder head removal
   for
   - Main Relief Valve
   - Safety Valve
   - Stop Valve



2412928

2. Side Case removal
   for
   - Main Spool
   - Load Check Valve
   - Flow Control Valve
   - Mechanical Check Valve
   - Unload Valve
   - Control Lever Linkage



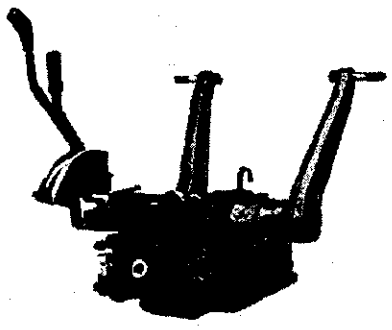
2760714

3. Hydraulic cylinder case
   for
   - Hydraulic Piston
   - Lifting Crank and Shaft
   - Feedback Rod Adjustment

4. Implement hitches
   for
   - 3-point Hitch
   - Drawbar
   - Upper Link Hinge
   - Draft Control Spring

REMOVAL

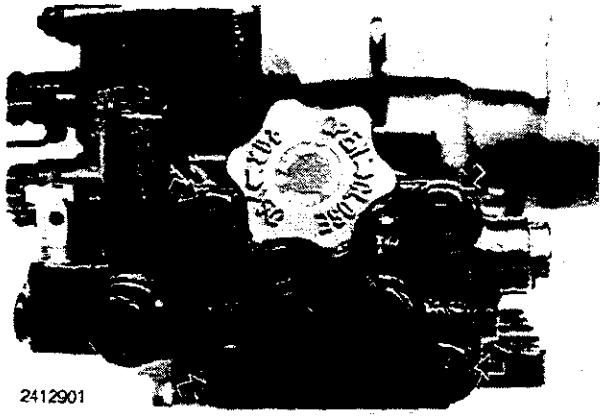
Hydraulic Lift Assembly



2412835

Remove hydraulic lift assembly as described on page 10-20-19.

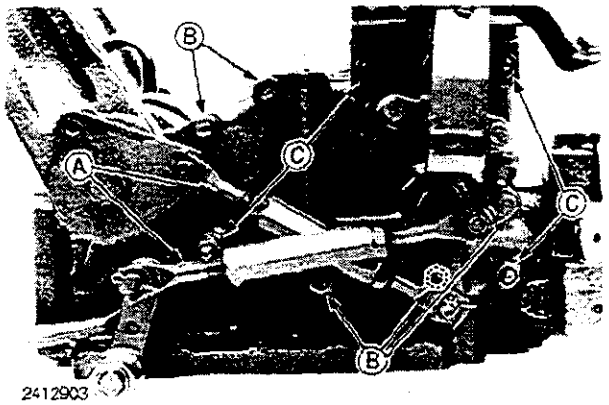
Cylinder Head



2412901

Remove the 4 cap screws.

Side Case



2412903

1. Disconnect control lever linkage.
2. Remove the 4 nuts and 5 cap screws.

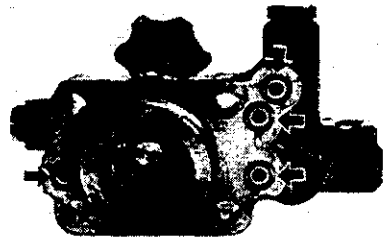
Hydraulic lift assembly removal is not necessary to remove side case for inspection of control valve and control lever linkage.

A – Control Lever Linkage
B – Cap Screws (5)
C – Nuts (4)

INSTALLATION

Cylinder Head

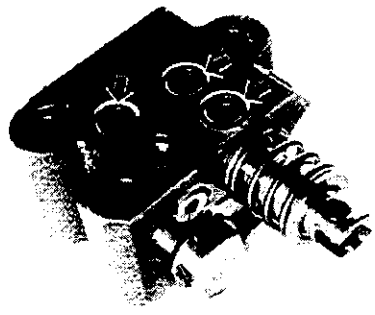
1. Be sure all O-rings are in good condition.
2. Tighten bolts to 147 Nm (15 kgm) (108 ft-lbs).
3. Connect hydraulic lines.
4. Tighten hydraulic hollow plug to 78 Nm (8 kgm) (57.9 ft-lbs).



2260602

Control valve Assembly

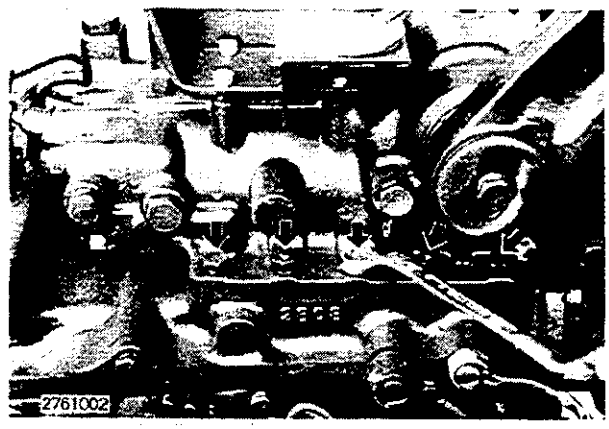
1. Be sure all O-rings are in good condition.
2. Tighten bolts to 34 Nm (3.5 kgm) (25 ft-lbs).



2413001

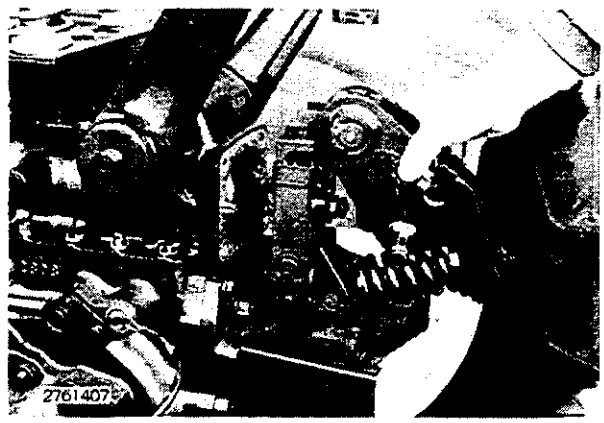
Hydraulic Lift Assembly

1. Replace gasket.
2. Tighten bolts and nuts to 60 Nm (6.0 kgm) (43 ft-lbs).

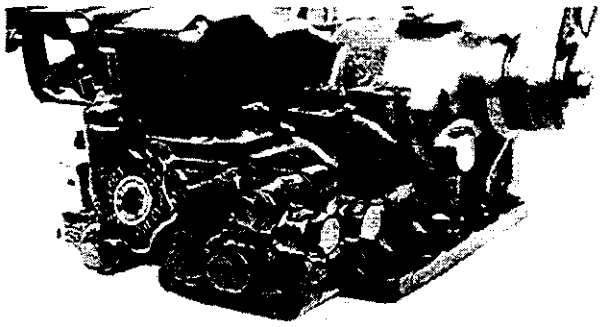


Upper Link Hinge

1. Clean mating surfaces of upper link hinge and hydraulic cylinder case.
2. Replace gasket.
3. Tighten bolts to 100 Nm (10 kgm) (72 ft-lbs).



MAIN RELIEF VALVE

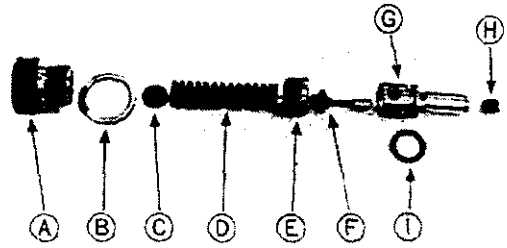


2412836

Coat all mating parts and gaskets with Transmission – Hydraulic Oil prior to assembly and installation.

REMOVAL

1. Remove plug (A).
2. Remove shim (C) and spring (D).
3. Remove screw (E) with Special Tool TOL-9302000. (see p. 70-00-4)
4. Carefully extract valve seat (G), and valve body (F), with hook on Special Tool.



2260620

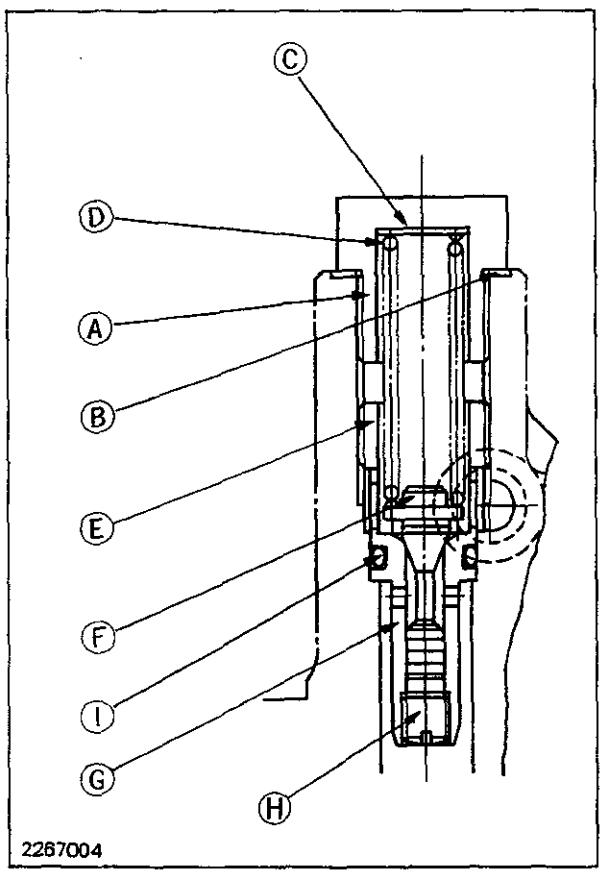
A – Plug
B – Packing
C – Shim
D – Spring
E – Screw
F – Valve Body
G – Valve Seat
H – Lock Screw
I – O-ring

INSPECTION

1. Examine valve seat (G) and valve body (F) for damage, burr and contaminants.
2. Free length of spring (D) should be 50.7 mm (1.996 in.) and should compress to 42 mm at 324 N (1.654 in. at 73.0 lbs).

   There are five shim (C) thicknesses available:
   0.1 mm (0.0039 in.)
   0.2 mm (0.0079 in.)
   0.3 mm (0.0118 in.)
   0.5 mm (0.0198 in.)
   1.0 mm (0.0393 in.)

   Replace spring or shim as necessary.
3. Replace O-ring (I) as necessary.



2267004

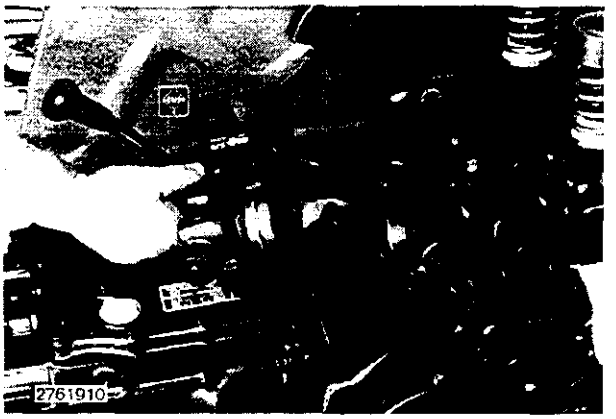
INSTALLATION

1. Carefully install valve body (F) with its valve seat (G).
2. Tighten screw (E).
3. Install spring (D) and shim (C).
4. Before installing plug (A), check that packing (B) is free from damage and positioned correctly.
5. Tighten plug (A).

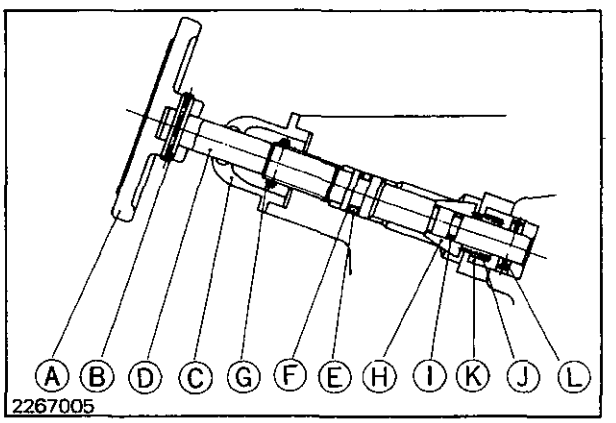
SLOW RETURN & STOP VALVE

REMOVAL

1. Remove hydraulic cylinder head. See page 70-15-2.



2. Remove spring pin (B) and knob (A).
3. Pull out cap (C) and remove spring pin (G).
4. Turn stop bolt (D) anti-clockwise to remove.
5. *Disassemble stop valve (H), return spring (J), stop bolt holder (K).*

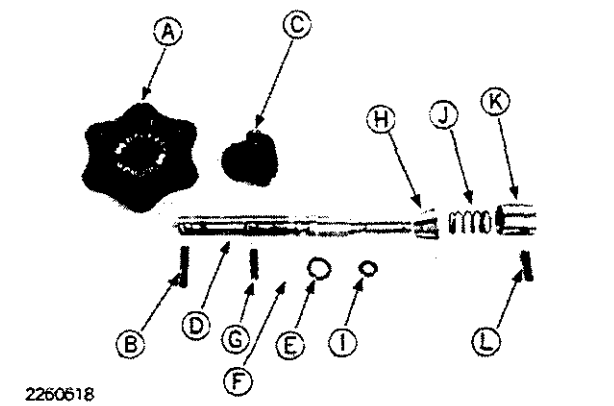


A – Knob	G – Spring Pin
B – Spring Pin	H – Stop Valve
C – Cap	I – O-ring
D – Stop Bolt	J – Return Spring
E – O-ring	K – Stop Bolt Holder
F – Back-up Ring	L – Spring Pin

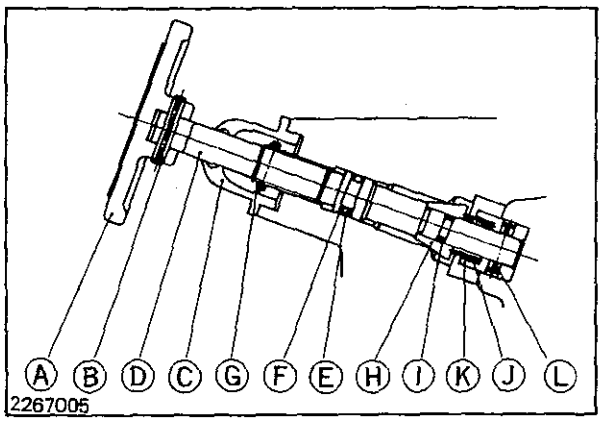
INSPECTION

1. Inspect valve (H) for damage and burr.
2. Inspect stop bolt (D) for scoring or damage.
3. Stop bolt O.D. at center is 12.40 to 12.42 mm (0.488 to 0.489 in.).

   Cap (C) I.D. where stop bolt moves is 12.5 to 12.52 mm (0.492 to 0.493 in.).
4. Inspect O-Rings (E and I) for damage. Replace as necessary.
5. Free length of return spring (J) is 19 mm (0.748 in.).
   It should compress to 9 mm at 10.0 N (0.354 in. at 2.25 lbs).
6. Inspect back-up ring (F) for damage. Replace as necessary.



SLOW RETURN & STOP VALVE (Continued)



INSTALLATION

1. Assemble valve before installing.

A – Knob	G – Spring Pin
B – Spring Pin	H – Stop Valve
C – Cap	I – O-ring
D – Stop Bolt	J – Return Spring
E – O-ring	K – Stop Bolt Holder
F – Back Up Ring	L – Spring Pin

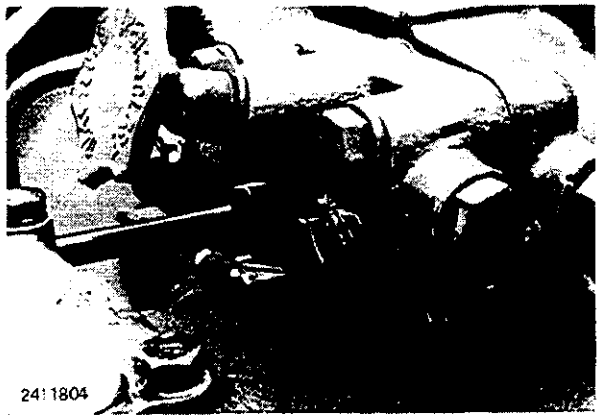
2. Apply multipurpose grease to valve assembly.
3. Install valve to hydraulic cylinder head.
4. Install spring pin (G), cap (C) and knob (A).

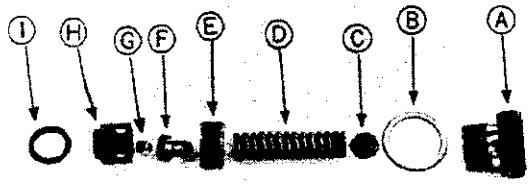
SAFETY VALVE

REMOVAL

1. Remove plug (A) and remove shim (C) and spring (D).
2. Remove screw (E) using special tool "TOL-9302000" described on page 70-00-4.
3. Remove valve holder (F) and steel ball (G).
4. Pull out valve seat with "TOL-9302000".
5. Remove O-ring (I) from bottom of bore.

A – Plug
B – Packing
C – Shim
D – Spring
E – Screw
F – Valve Holder
G – Steel Ball
H – Valve Seat
I – O-Ring





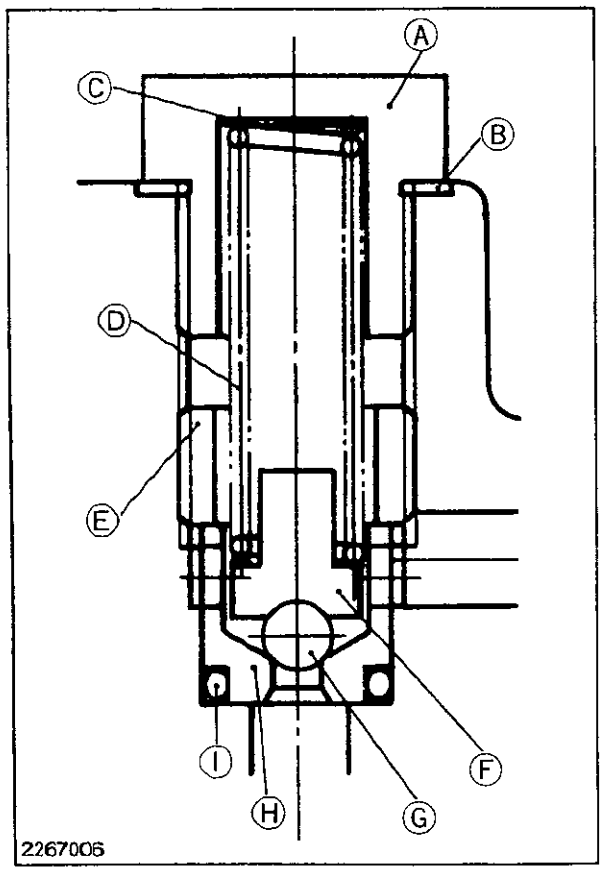
2260622

INSPECTION

1. Inspect valve seat (H) and steel ball (G) for damage and burrs.
2. Free length of spring (D) is 44 mm (1.732 in). It should compress to (35.14 mm at 249.6 N) (1.383 in. at 56.15 lbs).
3. Shims:
   0.2 mm (0.0078 in.)
   0.5 mm (0.0197 in.)
4. Replace spring or shim as necessary.
5. Inspect O-Ring for damage. Replace as necessary.

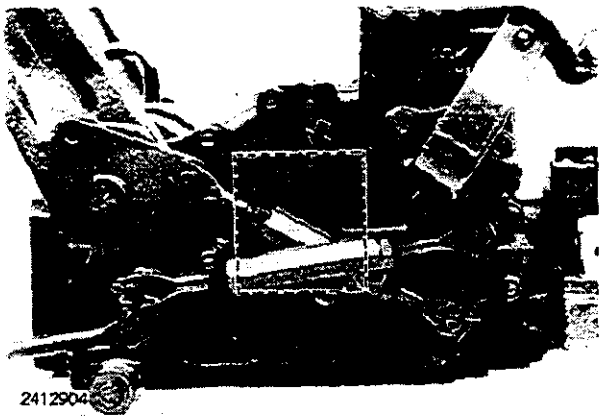
INSTALLATION

1. Carefully install O-ring using "TOL-9302000".
2. Install valve seat, steel ball and valve holder.
3. Tighten screw (E) with "TOL-9302000".
4. Install spring and shim.
5. Tighten plug. Be sure packing is free from damage and positioned correctly.



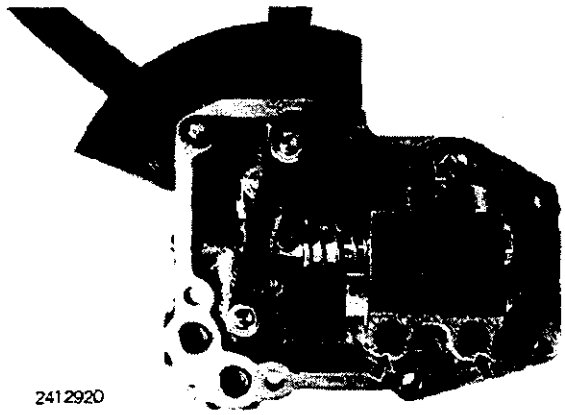
2267006

CONTROL VALVE


2412904

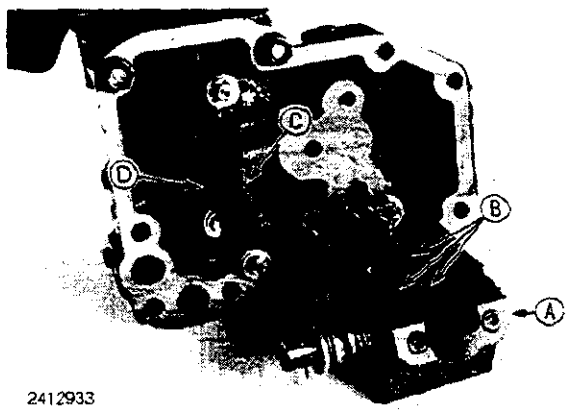
GENERAL

The control valve is in the side case to protect it from dirt and rust.


2412920

REMOVAL (General)

1. Remove the three recessed hex socket bolts.



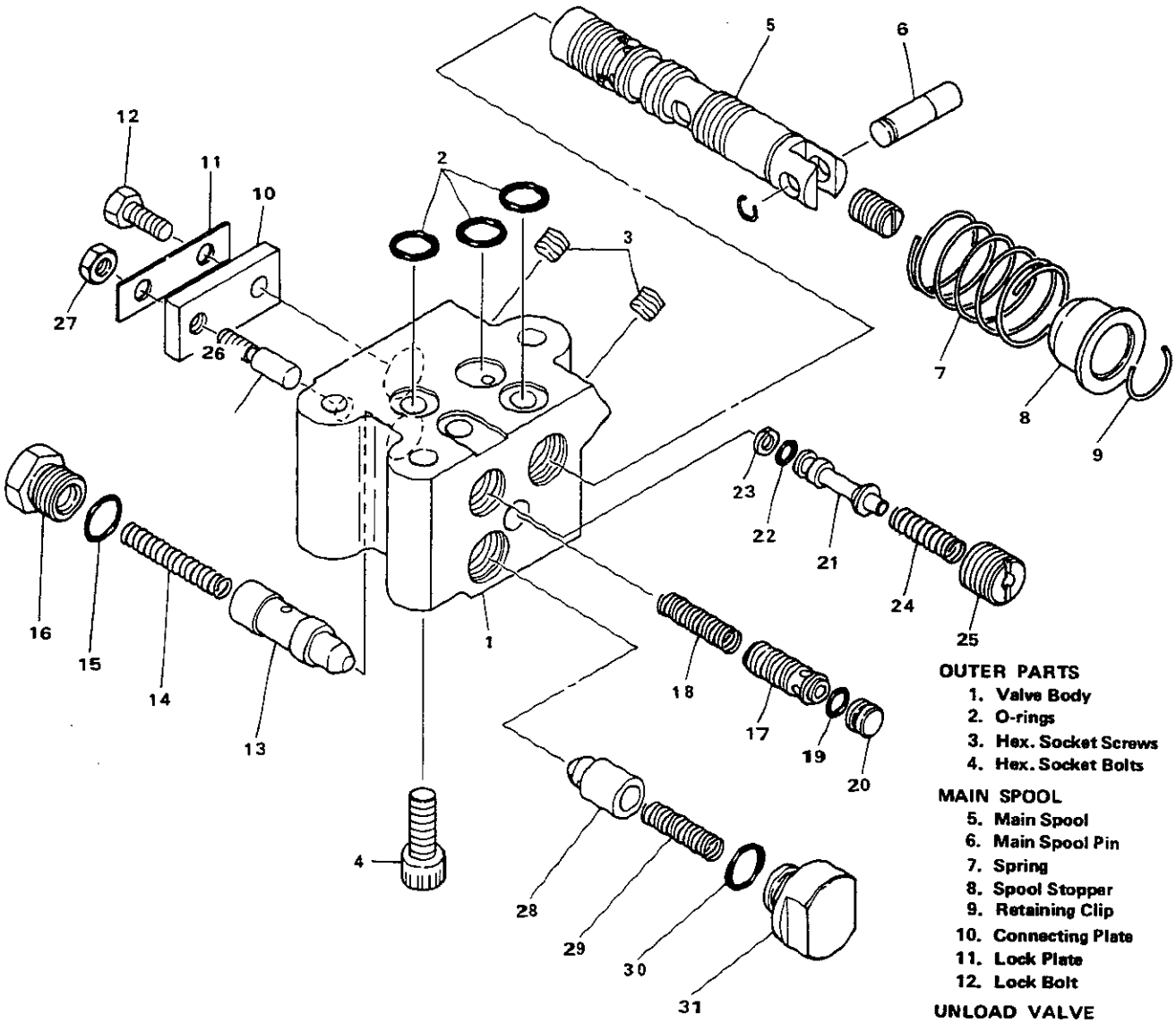
2412933

INSPECTION (General)

1. Inspect O-ring for damage.
2. Check for excessive wear on position control bar, draft control bar and pin at their connecting points.

A — Control Valve Assembly
B — O-Rings (3)
C — Position Control Bar
D — Draft Control Bar

CONTROL VALVE



1806001

OUTER PARTS
1. Valve Body
2. O-rings
3. Hex. Socket Screws
4. Hex. Socket Bolts

MAIN SPOOL
5. Main Spool
6. Main Spool Pin
7. Spring
8. Spool Stopper
9. Retaining Clip
10. Connecting Plate
11. Lock Plate
12. Lock Bolt

UNLOAD VALVE
13. Poppet
14. Spring
15. O-ring
16. Plug

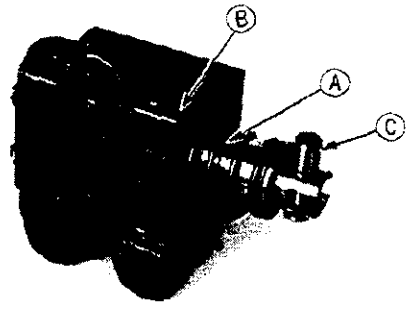
FLOW CONTROL VALVE
17. Spool
18. Spring
19. O-ring
20. Plug

MECHANICAL CHECK VALVE
21. Poppet
22. O-ring
23. Back-up Ring
24. Spring
25. Holder
26. Push Bar
27. Push Bar Nut

LOAD CHECK VALVE
28. Poppet
29. Spring
30. O-ring
31. Plug

MAIN SPOOL

For location of main spool, see photo.

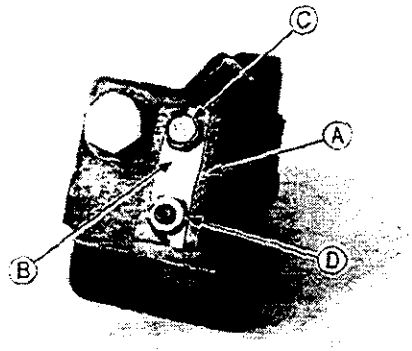


1802114

A — Main Spool
B — Valve Body
C — Main Spool Pin

REMOVAL AND INSPECTION

1. Flatten lock plate (B) and remove bolt (C).



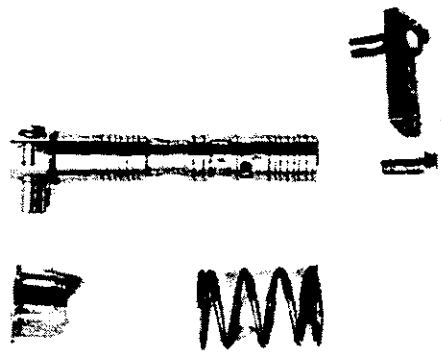
1802116

A — Connecting Plate
B — Lock Plate
C — Lock Bolt
D — Push Bar Nut

STOP **Do not loosen or remove push bar nut. (If loosened, see 70-15-16).**

STOP **Do not attempt to remove main spool pin for any reason. Removal will damage main spool.**

2. Carefully remove main spool.

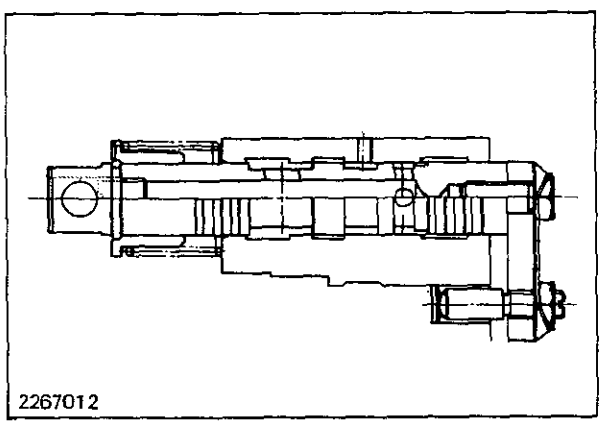


1802126

3. Inspect spring for misalignment, wear and damage.

4. Check spring length:

Free length	40 mm (1.575 in.)
Working Load	26.5 mm at 83.3 N (8.5 kg) (1.043 in. at 18.7 lbs)



2267012

5. Inspect spool for damage and burr.

6. Check oil clearance between spool and case.
   It must be 0.008 to 0.015 mm (0.0003 to 0.0006 in.)

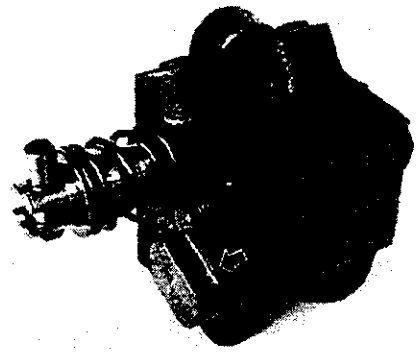
INSTALLATION

1. Insert assembled spool into valve body.

2. Tighten set screw.
   Torque . . . . . 8 Nm (0.8 kg-m) (6 ft-lbs)

LOAD CHECK VALVE

For location of load check valve, see photo.

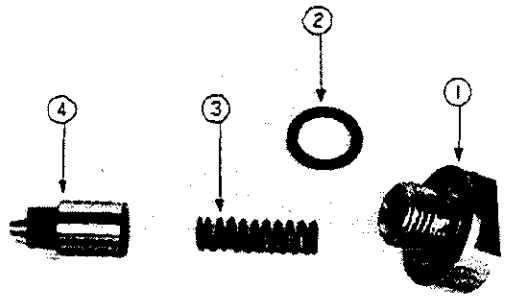


1802124

REMOVAL AND INSPECTION

1. Unscrew plug. Remove spring and poppet.
2. Inspect spring for misalignment, wear and damage. Check spring length.

Free Length	25.5 mm (1.004 in.)
Working Load	17.5 mm at 29.3 N (3.0 kg) (0.689 in. at 6.6 lbs)



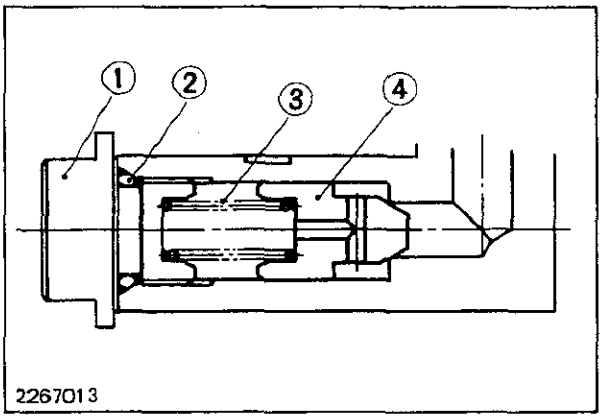
1802132

3. Inspect poppet for damage and burr.
4. Check oil clearance between poppet and case.

Oil Clearance	0.016 to 0.045 mm (0.0006 to 0.0017 in.)

5. Inspect O-ring on plug. Replace as necessary.

1. Plug
2. O-ring
3. Spring
4. Poppet



2267013

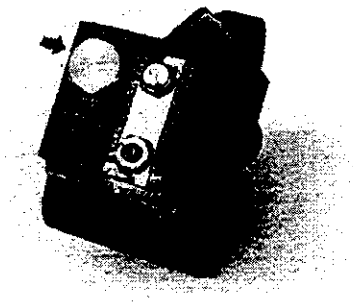
INSTALLATION

1. Install poppet, spring and plug with O-ring.
2. Tighten plug.

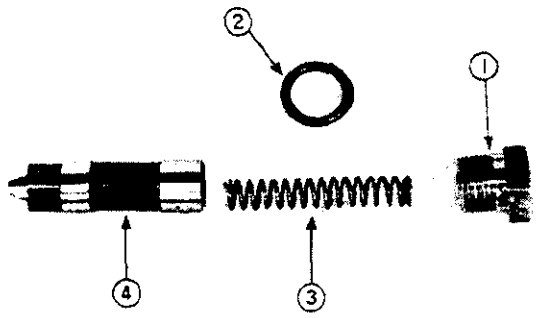
Torque	30 Nm (3.0 kgm) (22 ft-lbs)

UNLOAD VALVE

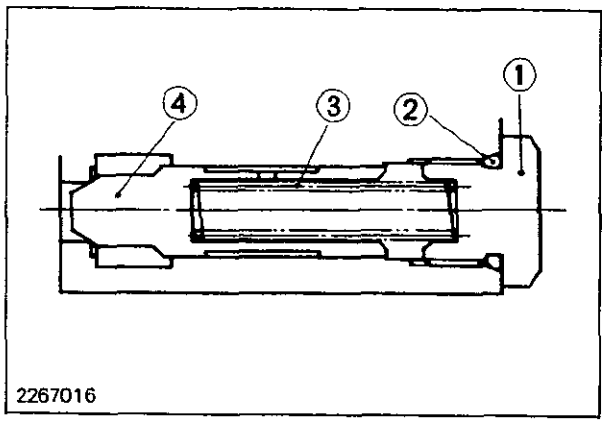
For location of unload valve, see photo.



1802115



1802205



2267016

REMOVAL AND INSPECTION

1. Remove plug from valve body.
2. Carefully pull out spring and poppet.
3. Inspect O-ring on plug.
4. Inspect and measure spring.

Free Length	40 mm (1.575 in.)
Working Load	35 mm at 4.9 N (1.378 in. at 1.1 lbs)

5. Inspect poppet for damage and burr.
6. Check oil clearance between case and poppet.

Oil Clearance	0.016 to 0.045 mm (0.0006 to 0.0018 in.)

1. **Plug**
2. **O-ring**
3. **Spring**
4. **Poppet**

INSTALLATION

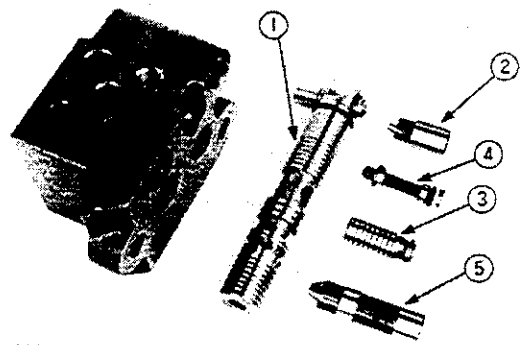
1. Install poppet, spring, plug and O-ring.
2. Tighten plug.

Torque	30 Nm (3.0 kgm) (22 ft-lbs)

CONTROL VALVE

REPLACEMENT OF SPOOL & POPPET

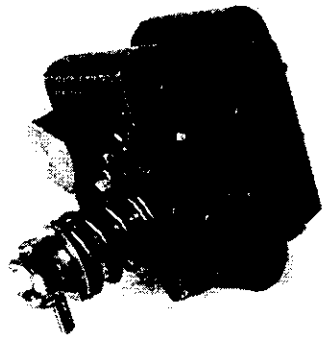
While other parts are available as replacements (see Parts Catalog), spools and poppets are not interchangeable. If there is damage, burrs, or excessive oil clearance, replace the control valve assembly as a unit.



1802208

1. **Main Spool**
2. **Poppet (Load Check Valve)**
3. **Spool (Flow Control Valve)**
4. **Poppet (Mechanical Check Valve)**
5. **Poppet (Unload Valve)**

DAMAGE
BURRS
⇨ REPLACE WHOLE CONTROL VALVE



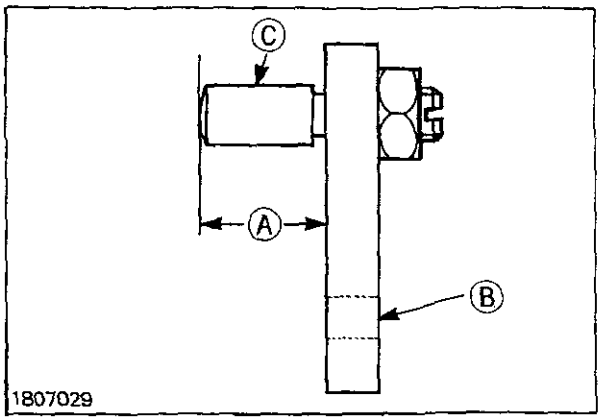
1802111

PUSH BAR ADJUSTMENT

PUSH BAR

As stated in Main Spool—Removal and Inspection the PUSH BAR should be neither loosened nor removed from connecting plate.
However if it is done accidentally, adjust as followes.

1802130

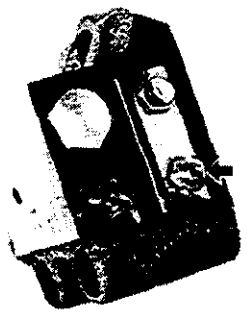


1807029

STEP A—1. Adjust locknut on push bar (C) until it protrudes a distance (A) of 13.4 mm (0.527 in.) from connecting plate (B).

—2. Install the preadjusted push bar in control valve body. (See page 70-15-10)

A — Push Bar Length
B — Connecting Plate
C — Push Bar



1802121

STEP B—1. Attach control valve to hydraulic case with three hex. socket bolts.

—2. Attach assembled hydraulic case to transmission case with eight cap screws.

—3. Connect hydraulic lines

STEP C—1. Start engine and set engine speed at 1500 rpm.

—2. Move control lever rearward to the raise position.

If attached implement up and down, decrease push bar length (A) slightly.

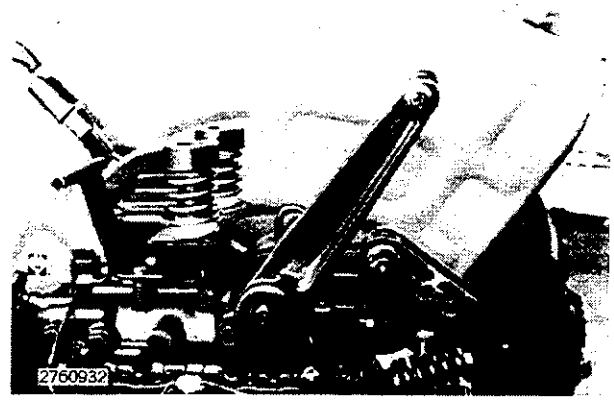
—3. Move control lever forward to lower position.

If lowering speed is too slow, increase push bar length (A) slightly.

HYDRAULIC PISTON

REMOVAL

1. Remove hydraulic lift assembly (10-20-10/11), hydraulic cylinder head (70-15-2), and upper link hinge (70-15-27).
2. Push the piston forward with a soft metal drift.

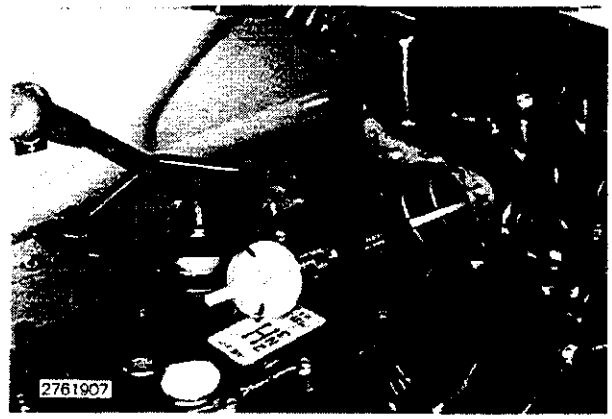


INSPECTION

1. Inspect hydraulic piston and cylinder for scoring or damage.

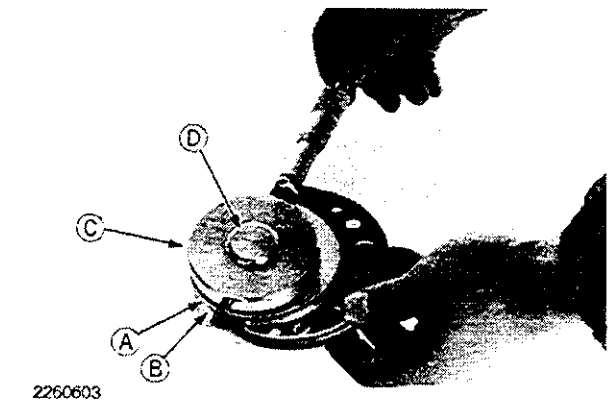
   Piston O.D. . . . . 79.94 to 79.97 mm (3.147 to 3.148 in.)
   Cylinder I.D. . . . . 80.000 to 80.046 mm (3.150 to 3.151 in.)

Replace piston or cylinder if clearance between them exceeds 0.3 mm (0.012 in.)



2. Check O-ring (A) and back-up ring (B) on piston for damage. Replace as necessary.
3. When installing O-ring and back-up ring, insure that O-ring is closer to piston head and back-up ring is closer to piston skirt.

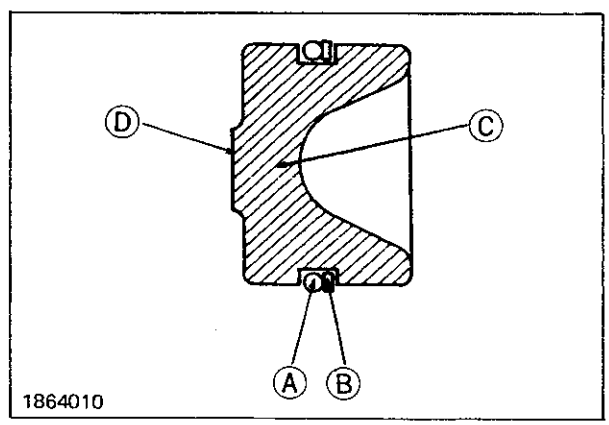
A — O-ring
B — Back-up Ring
C — Piston
D — Piston Head



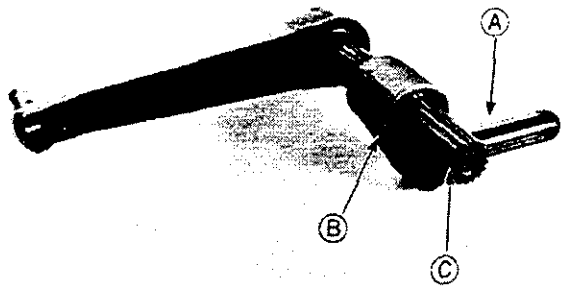
INSTALLATION

1. Apply transmission-hydraulic oil to piston assembly and install in cylinder. Take care not to damage O-ring when installing.

A — O-ring
B — Back-up Ring
C — Piston
D — Piston Head



LIFTING CRANK AND SHAFT

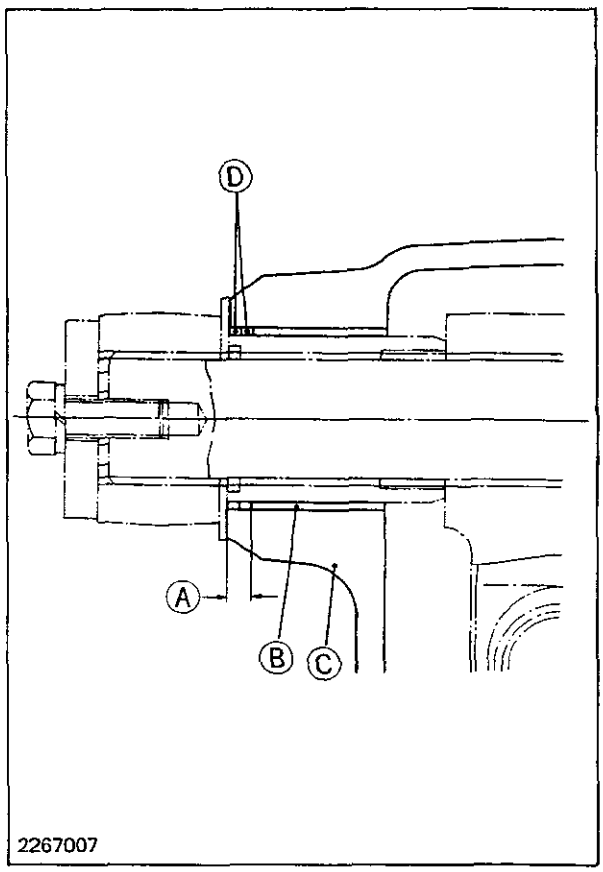


2260936

REMOVAL

1. Lower the lift arm to shift the piston forward in the cylinder.
2. Disconnect control lever linkage.
3. Remove lift arms from lifting shaft.
4. Remove upper link hinge (70-15-27).
5. Remove lifting shaft and then lift crank with piston rod.
6. Remove splined sleeves.

A – Piston Rod
B – Lift Crank
C – Lifting Shaft



2267007

INSPECTION AND REPAIR

1. Check bushings for excessive wear or damge. I.D. should be 55.07 to 55.14 mm (2.168 to 2.171 in.).
2. Check splined sleeve for excessive wear or damage. O.D. should be 54.97 to 54.99 mm (2.164 to 2.165 in.).

   The clearance between the bushing and the splined sleeve should be between 0.080 and 0.169 mm (0.003 to 0.007 in.).

   If it exceed 0.4 mm (0.016 in.), replace the splined sleeve, the bushing, or both.
3. Press-fit a new bushing into the hydraulic cylinder case until the distance between its outer edge and the lip of the bore (dimension A in the illustration) is between 8.0 and 8.5 mm (0.31 to 0.33 in.).
4. Inspect-O-rings for damage. Replace as necessary.

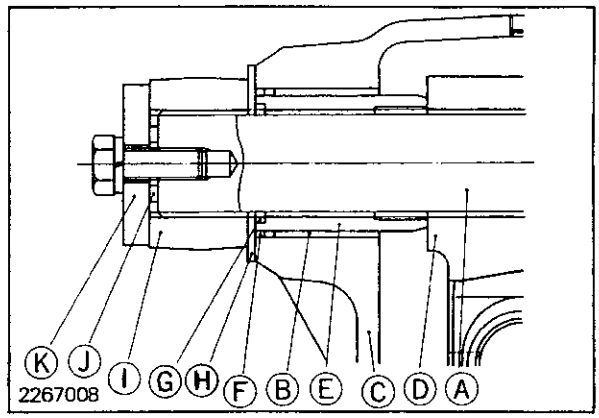
A – 8.0 – 8.5 mm (0.31 – 0.33 in.)
B – Bushing
C – Hydraulic Cylinder Case
D – O-rings

LIFTING CRANK AND SHAFT

INSTALLATION

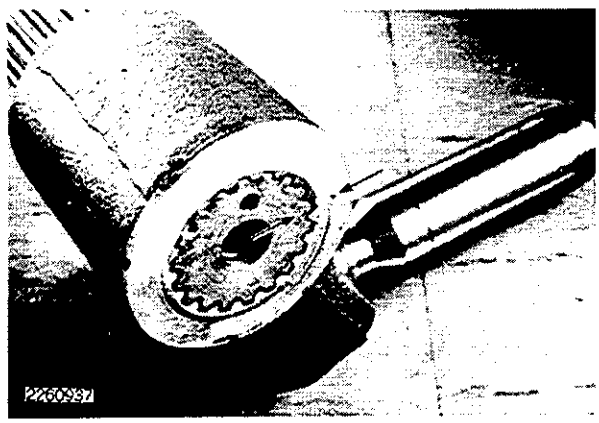
Lubricate all mating parts with clean transmission-hydraulic oil prior to assembly.

A – Lifting Shaft
B – Bushing
C – Case
D – Crank Arm
E – Splined Sleeve
F – O-ring
G – Seal
H – Thrust Washer
I – Lift Arm
J – Washer (1, left side only)
K – Washer



1. Install crank arm (D) and piston rod in hydraulic cylinder case (C).
2. Install lifting shaft (A) in case (C), aligning index marks on crank arm (D) and lifting shaft (A).

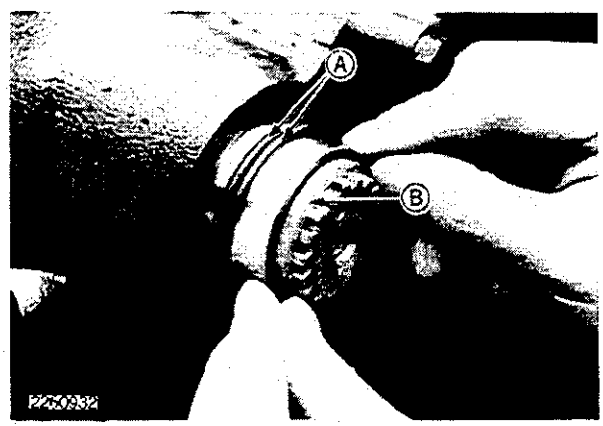
   Insure that end of lifting shaft (A) with drilled-hole is on the right hand side.



3. Fit two O-rings (F) onto splined sleeve (E). Lightly grease splined sleeve and fit it over lifting shaft (A). Repeat on opposite side.

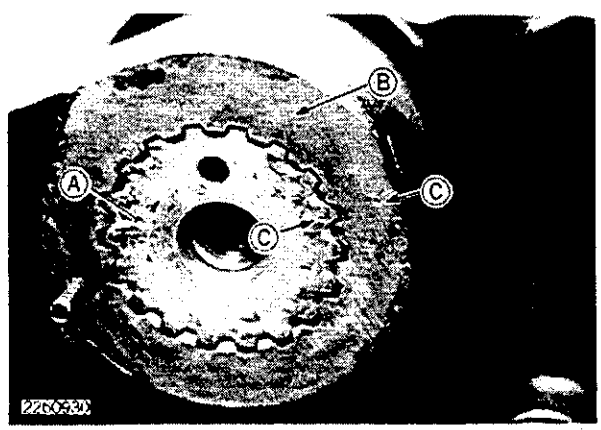
   Be sure to install splined sleeves (E) tapered end first. Be careful not to damage O-rings.
4. Install seals (G) over lifting shaft (A) and into splined sleeves (E).
5. Install thrust washer (H) over shaft.

A – O-rings
B – Seal

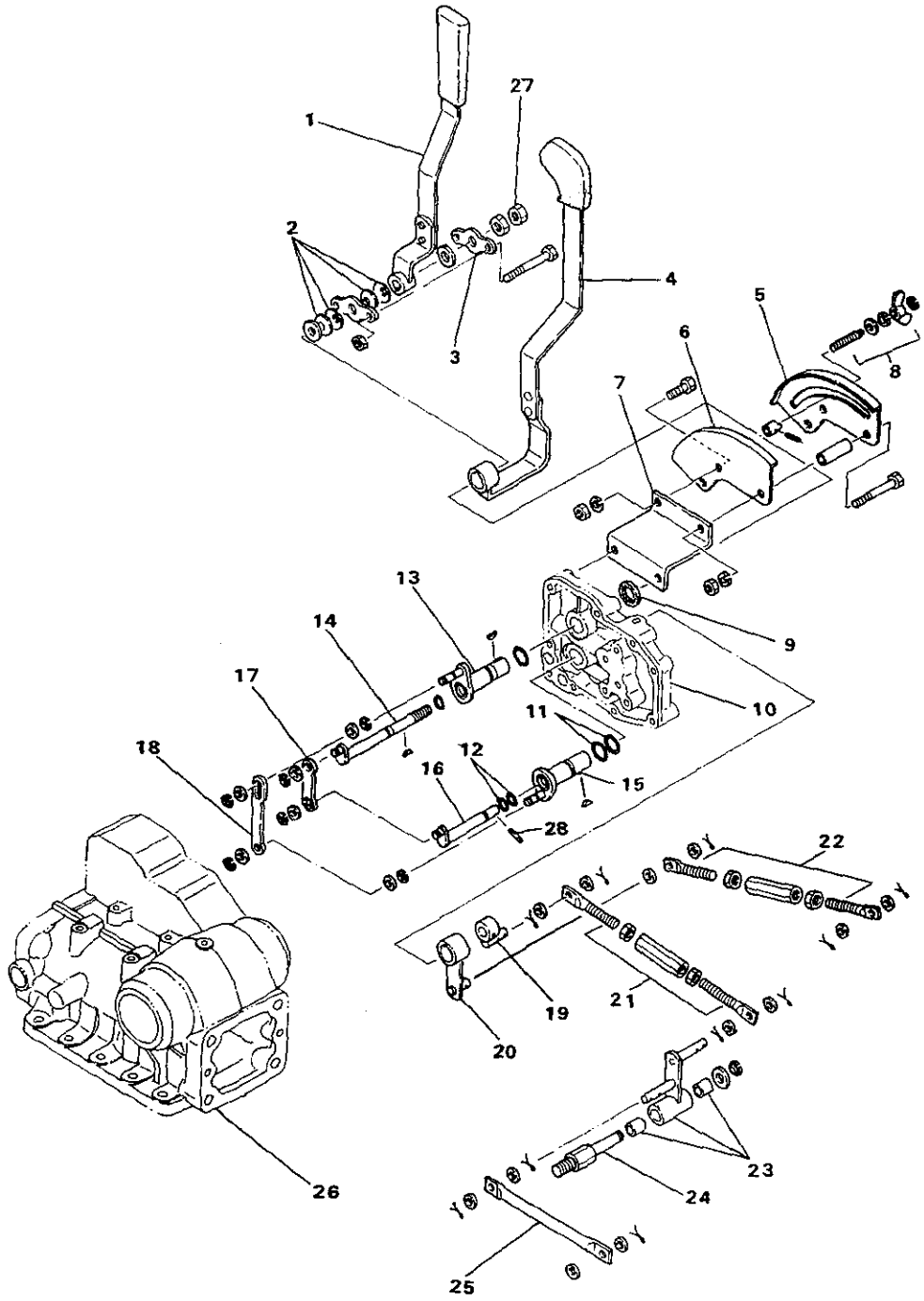


6. Install lift arms (C), aligning index mark on the lifting shaft (A) and lift arms (B).
7. Install small washer (J) on left hand side.
8. Install washer (K) and control linkage arm.
9. Connect control lever linkage.

A – Lifting Shaft
B – Lift Arm
C – Aligning Index Marks



CONTROL LEVER AND LINKAGE



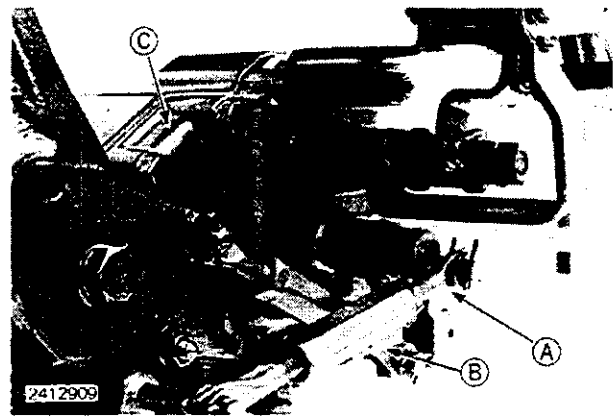
2766016

1. Draft Control Lever
2. Conical Spring Washer
3. Plate
4. Position Control Lever
5. Lever Guide (Outer)
6. Lever Guide (Inner)
7. Lever Guide Bracket
8. Lever Stopper
9. Friction Plate
10. Side Cover
11. O-ring (P-15)
12. O-ring (P- 9)
13. Position Control Shaft
14. Draft Control Shaft
15. Position Feedback Shaft
16. Draft Feedback Shaft
17. Draft Control Bar
18. Position Control Bar
19. Draft Control Feedback Arm
20. Position Control Feedback Arm
21. Draft Feedback Rod
22. Position Feedback Rod
23. Intermediate Arm
24. Pivot Stud
25. Rear Draft Feedback Rod
26. Hydraulic Cylinder Case
27. Nut
28. Spring Pin

REMOVAL

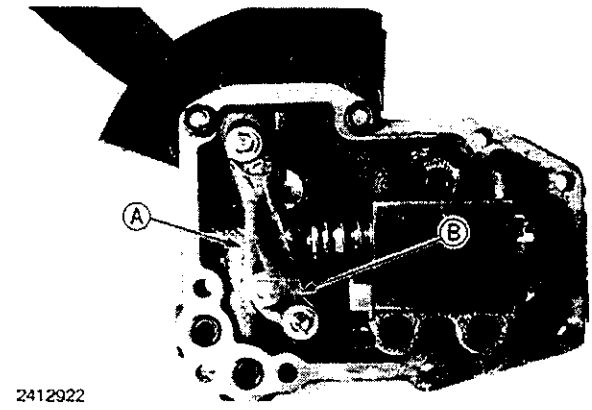
1. Disconnect draft feedback rod (A) and Position feedback rod (B).
2. Remove side cover (C) from hydraulic cylinder case.

A – Draft Feedback Rod
B – Position Feedback Rod
C – Side Cover



3. Remove draft control bar (A) and position control bar (B) from control shafts.

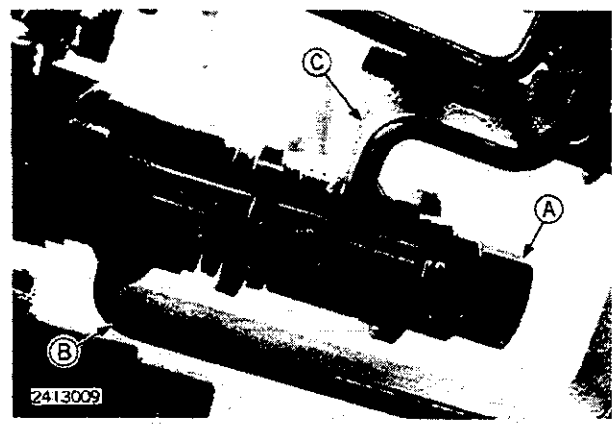
A – Draft Control Bar
B – Position Control Bar



4. Remove lock nut (A) from the control lever, and remove position control lever (B) and draft control lever (C) from two control shafts.

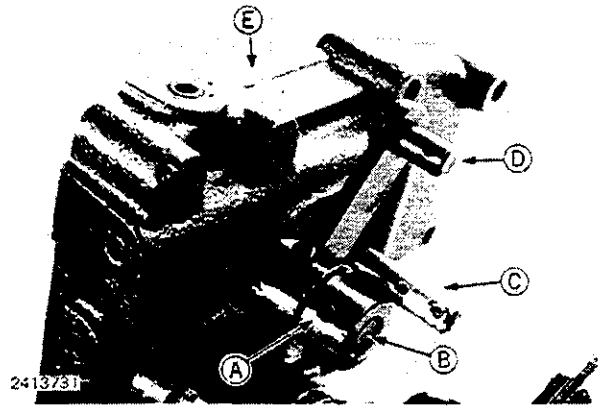
A – Nut
B – Position Control Lever
C – Draft Control Lever

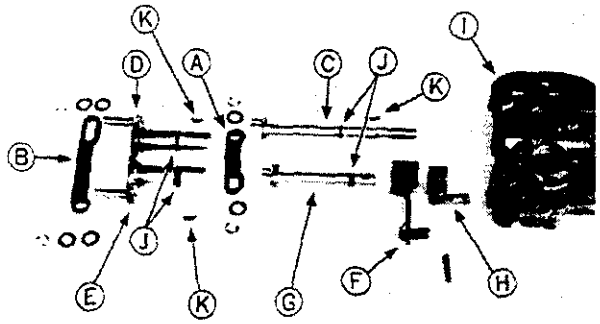
5. Pull position and draft control shafts out after removing woodruff key from position control shaft.



6. Remove spring pin (A) from draft feedback shaft (B), and then remove two feedback arms (C and D).
7. Remove woodruff key from position feedback shaft, and pull the shaft out.

A – Spring Pin
B – Draft Feedback Shaft
C – Draft Feedback Arm
D – Position Feedback Arm
E – Side Cover



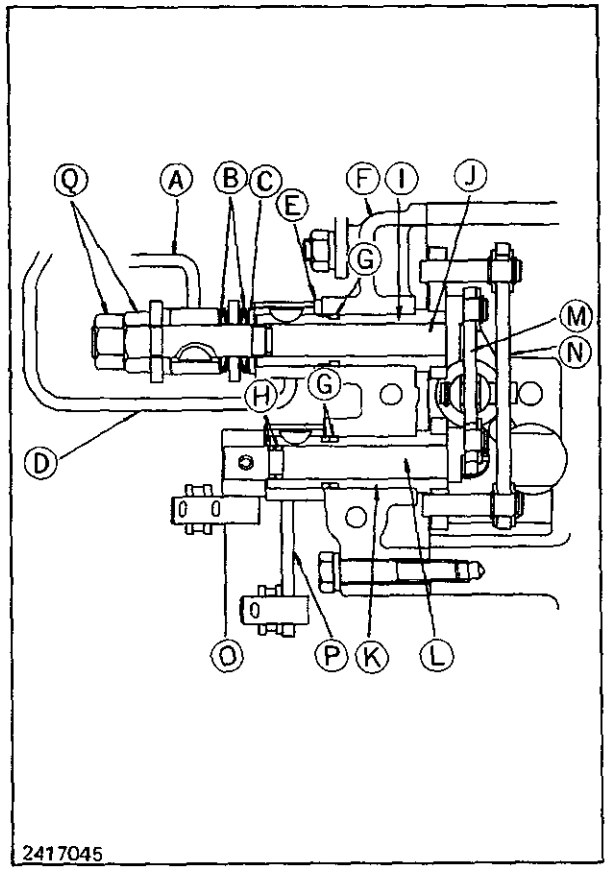


2413727

INSPECTION AND REPAIR

1. Inspect O-rings (J) for damage or wear. Replace as necessary.
2. Inspect slots in control bars (A and B) for wear.
3. Inspect pin ends of position control shaft (D), draft control shaft (C), position feedback shaft (E) and draft feedback shaft (G) for wear or damage. Replace as necessary.

A – Draft Control Bar
B – Position Control Bar
C – Draft Control Shaft
D – Position Control Shaft
E – Position Feedback Shaft
F – Position Feedback Arm
G – Draft Feedback Shaft
H – Draft Feedback Arm
I – Side Cover
J – O-ring
K – Woodruff Key



2417045

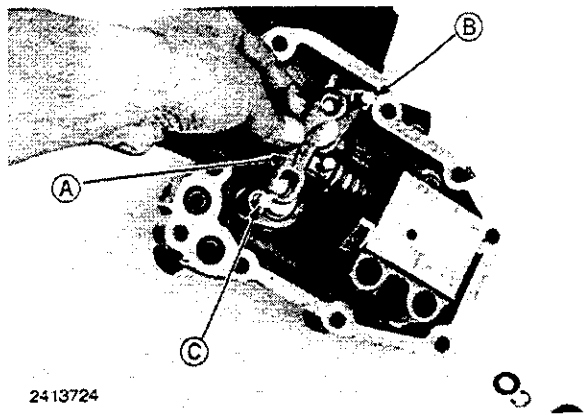
ASSEMBLY

1. Install position control shaft (I) and position feedback shaft (K) into the bore of side cover (F) with O-ring (G). Install draft control shaft (J) and draft feedback shaft (L) into the bore of them with O-ring (G).
2. After installing friction plate (E) against side cover install position control lever (D) with woodruff key.
3. Install plate (C) and two conical springs (B), and friction plate, and another two conical spring (B).
4. Install draft control lever (A) over the conical springs (B) with woodruff key, and install washer and nuts (Q).
5. Adjust the control lever to move with 30 to 60 N (3 to 6 kg) (6.6 to 13.2 lbs) force.
6. Install position feedback arm (P) with woodruff key and draft feedback arm (O).

A – Draft Control Lever
B – Conical Spring Washeres
C – Plate
D – Position Control Lever
E – Friction Plate
F – Side Cover
G – O-ring (P-15)
H – O-rings (P-9)
I – Position Control Shaft
J – Draft Control Shaft
K – Position Feedback Shaft
L – Draft Feedback Shaft
M – Draft Control Bar
N – Position Control Bar
O – Draft Feedback Arm
P – Position Feed-back Arm
Q – Nuts

6. Install draft control bar (A) to draft control shaft (B) and draft feedback shaft (C) with slot hole side onto draft feedback shaft (Lower side).

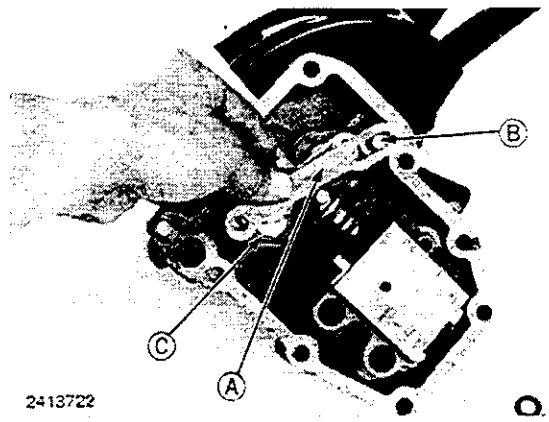
A — Draft Control Bar
B — Draft Control Shaft
C — Draft Feedback Shaft



2413724

7. Install position control bar (A) to position control shaft (B) and position feedback shaft (C) with slot hole side onto positon control shaft (Upper side).

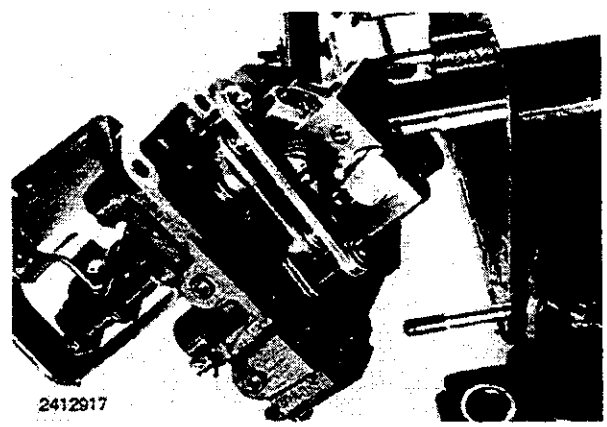
A — Position Control Bar
B — Position Control Shaft
C — Position Feedback Shaft

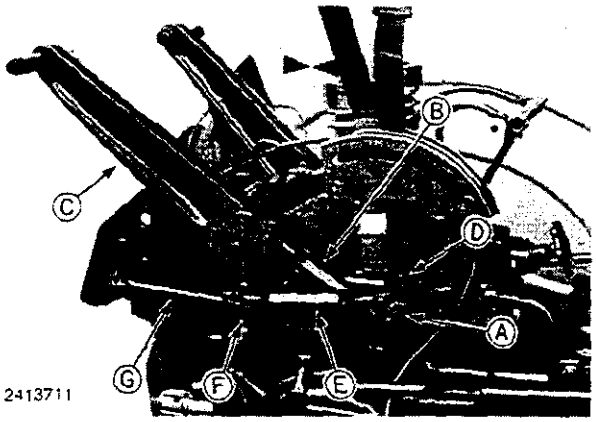


2413722

INSTALLATION

1. Replace gasket.
2. Install side cover on cylinder case.
3. Tighten cap screws and nuts to 25 Nm (2.5 kgm) (18 ft-lbs).


2412917

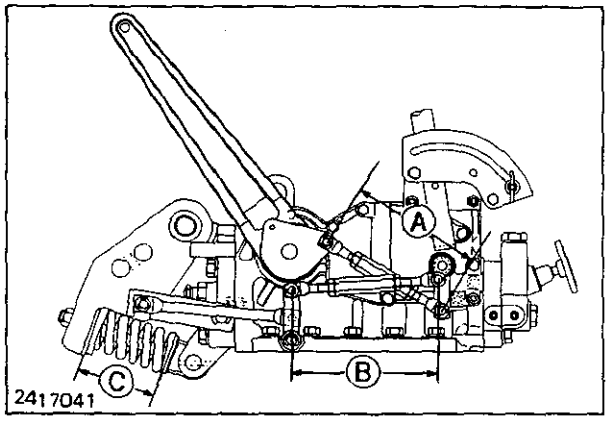


2413711

CONTROL LEVER AND LINKAGE (Continued)

ADJUSTMENT

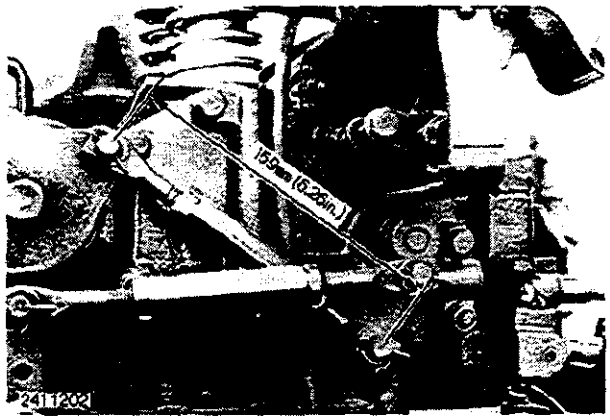
A – Position Feedback Arm
B – Position Feedback Rod
C – Lift Arm
D – Draft Feedback Arm
E – Draft Feedback Rod
F – Intermediate Arm
G – Rear Draft Feedback Rod



2417041

Feedback Rod Adjustment Length

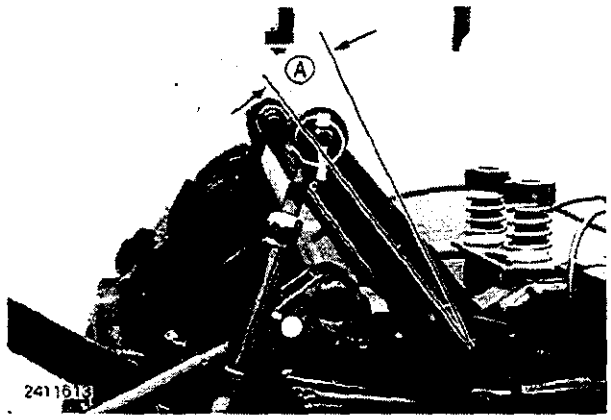
A – 159 mm (6.26 in.)
B – 173 mm (6.81 in.)
C – 92.5 mm (3.64 in.)



2411202

Position Control Feedback Rod Adjustment

1. Adjust position control feedback rod to approximately 159 mm (6.26 in.) length.
2. Start engine and run at 1500 rpm.
3. With slow return stop valve open, pull the position control lever (outer lever) rearward raising lift arm to maximum height.

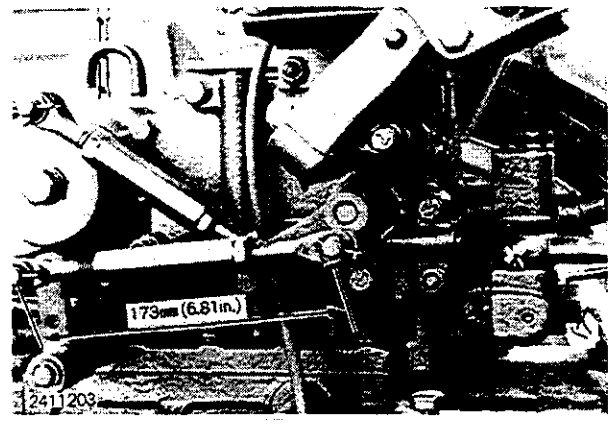


2411613

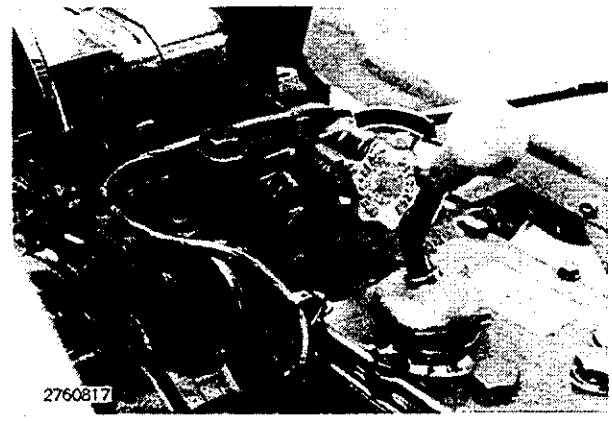
4. Check free play at lift arm end. Play should be 7 to 10 mm (0.3 to 0.4 in.). If not, adjust length of position control feedback rod at turnbuckle.

A – 7 to 10 mm (0.3 to 0.4 in.)

Draft Control Feedback Rod Adjustment



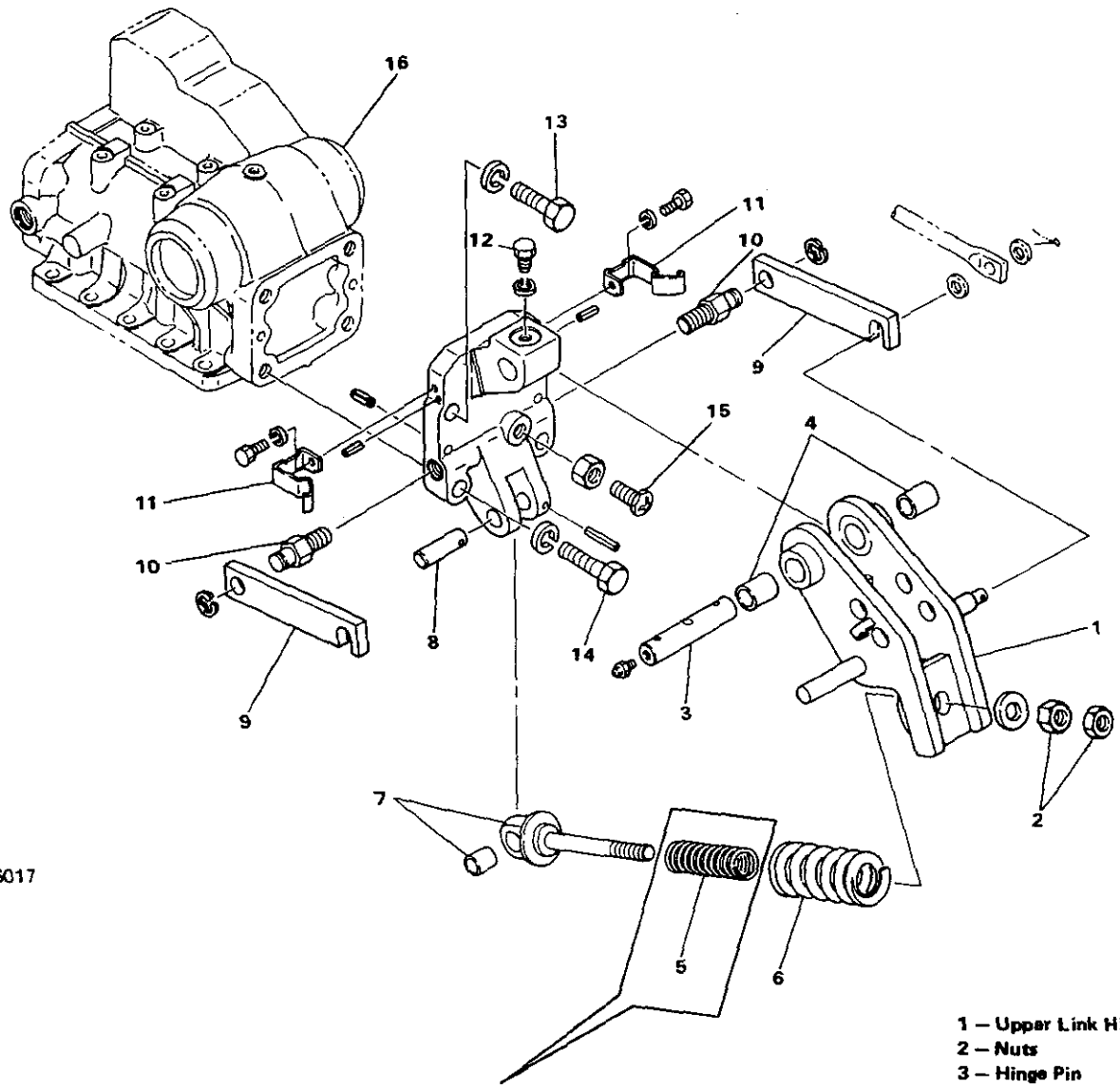
1. Move the position control lever forward to lower 3-point hitch.
2. Adjust draft control feedback rod to approximately 173 mm (6.81 in.) length.



3. With draft control lever in rearward position (upper position), close slow return & stop valve to operate main relief valve. If relief noise is not heard, lengthen draft feedback rod.
4. Shorten draft feedback rod until relief noise disappears then tighten turnbackle another 2–1/2 to 3 turns.
5. Lock turnbuckle with lock nuts.

STOP Draft feedback spring must be correctly adjusted when adjusting feedback rod.

DRAFT CONTROL SPRINGS



2766017

* Inner spring is used only on the tractors as follows:
YM276 . . . . . before #20586
YM276D . . . . . before #41399

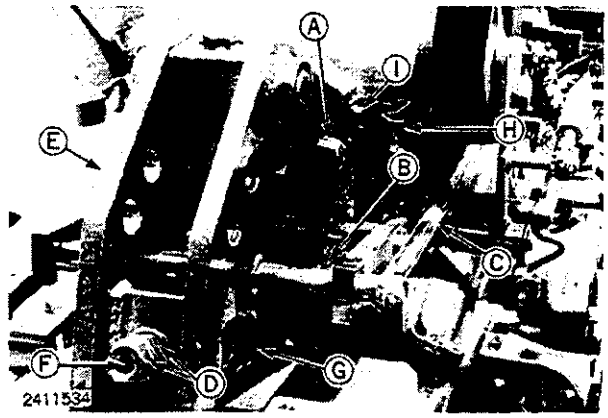
1 – Upper Link Hinge
2 – Nuts
3 – Hinge Pin
4 – Bushings
5 – Inner Spring
6 – Outer Spring
7 – Bolt
8 – Pin
9 – Lock Plates
10 – Lock Hinges
11 – Hinge Stopper Springs
12 – Set Screw
13 – Cap Screw (M14 – 45)
14 – Cap Screw (M14 – 55)
15 – Hinge Stopper Screw
16 – Hydraulic Cylinder Case

REMOVAL

1. To remove upper link hinge assembly, remove four cap screws (A, B) from cylinder case rear cover.

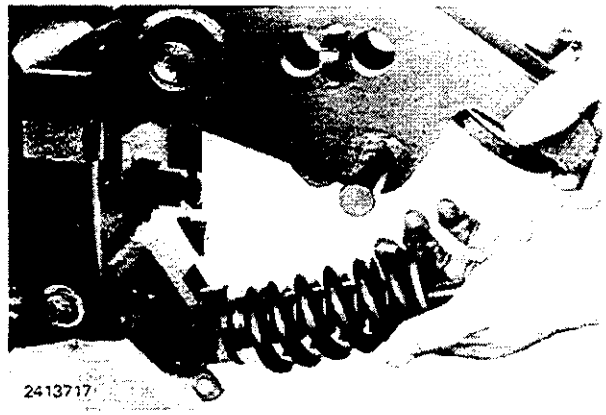
2. To replace sensor springs (G), disconnect rear draft feedback rod (C), and remove two nuts (D) from bolt (F).

A – Cap Screw (M14 x 45)
B – Cap Screw (M14 x 55)
C – Rear Draft Feedback Rod
D – Nuts
E – Upper Link Hinge
F – Bolt
G – Sensor Springs
H – Hinge Stopper Springs
I – Cap Screws



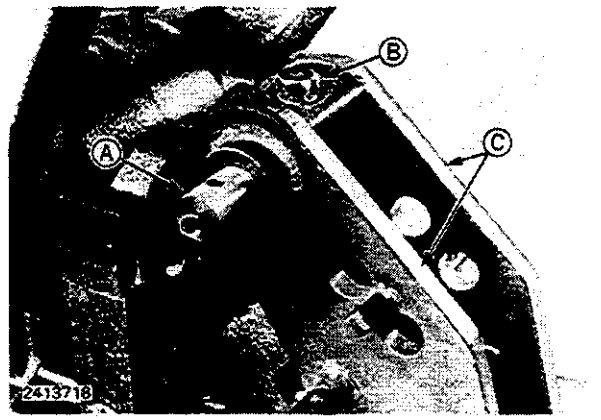
3. Flip the upper link hinge up and remove inner and outer springs.

Inner spring is not used on the following tractors.
YM276 ..... before #20586
YM276D ..... before #41399



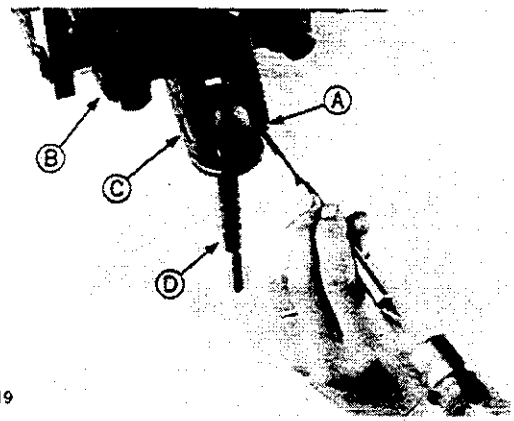
4. Loosen set screw (B) and pull hinge pin (A) out.

A – Hinge Pin
B – Set Screw
C – Upper Link Hinge

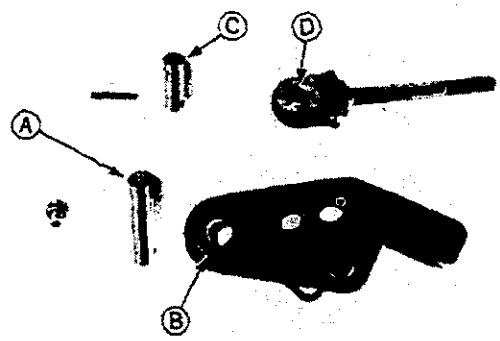


5. Remove spring pin (A) and pin (C) from the rear cover (B), and remove bolt (D).

A – Spring Pin
B – Hydraulic Cylinder Case Rear Cover
C – Pin
D – Bolt



DRAFT CONTROL SPRINGS (Continued)



2413721

INSPECTION

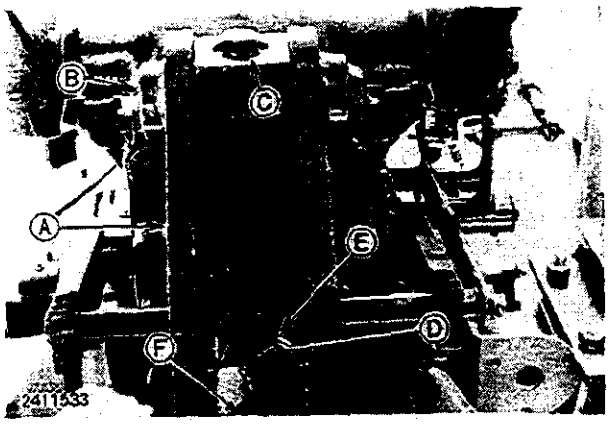
1. Inspect all pins and the bores for wear or damage.
2. Replace parts if the clearance between pin and bore exceeds 1 mm (0.04 in.).
3. Inspect outer spring for damage.

Free Length	97.5 mm (3.839 in.)
Working Load	82.5 mm at 3.70 KN (3.248 in. at 832 lbs)

4. Inspect inner spring for damage.

Free Length	87.0 mm (3.425 in.)
Working Load	74.5 mm at 1.11 KN (2.933 in. at 249 lbs)

A – Hinge Pin
B – Upper Link Pin Bore
C – Pin
D – Pin Bore In Bolt



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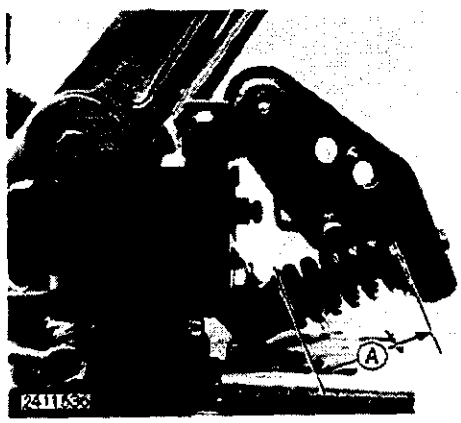
ASSEMBLY

1. Install hinge pin (B) and upper link hinge (A), and tighten set screw (C) to 33 Nm (3.5 kgm) (24 ft-lbs).
2. Install inner and outer springs (E) between cylinder case rear cover and upper link hinge.

A – Upper Link Hinge
B – Hinge Pin
C – Set Screw
D – Bolt
E – Springs
F – Nut



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3. Tighten nut (F) until spring length (A) is 92.5 mm (3.64 in.)
4. Tighten lock nut.
5. If the upper link hinge assembly was removed, replace gasket and install the assembly and tighten cap screws to 147 Nm (15 kgm) (108 ft-lbs).
6. Install rear draft feedback rod.
7. Lubricate upper link hinge pivot pin with grease.

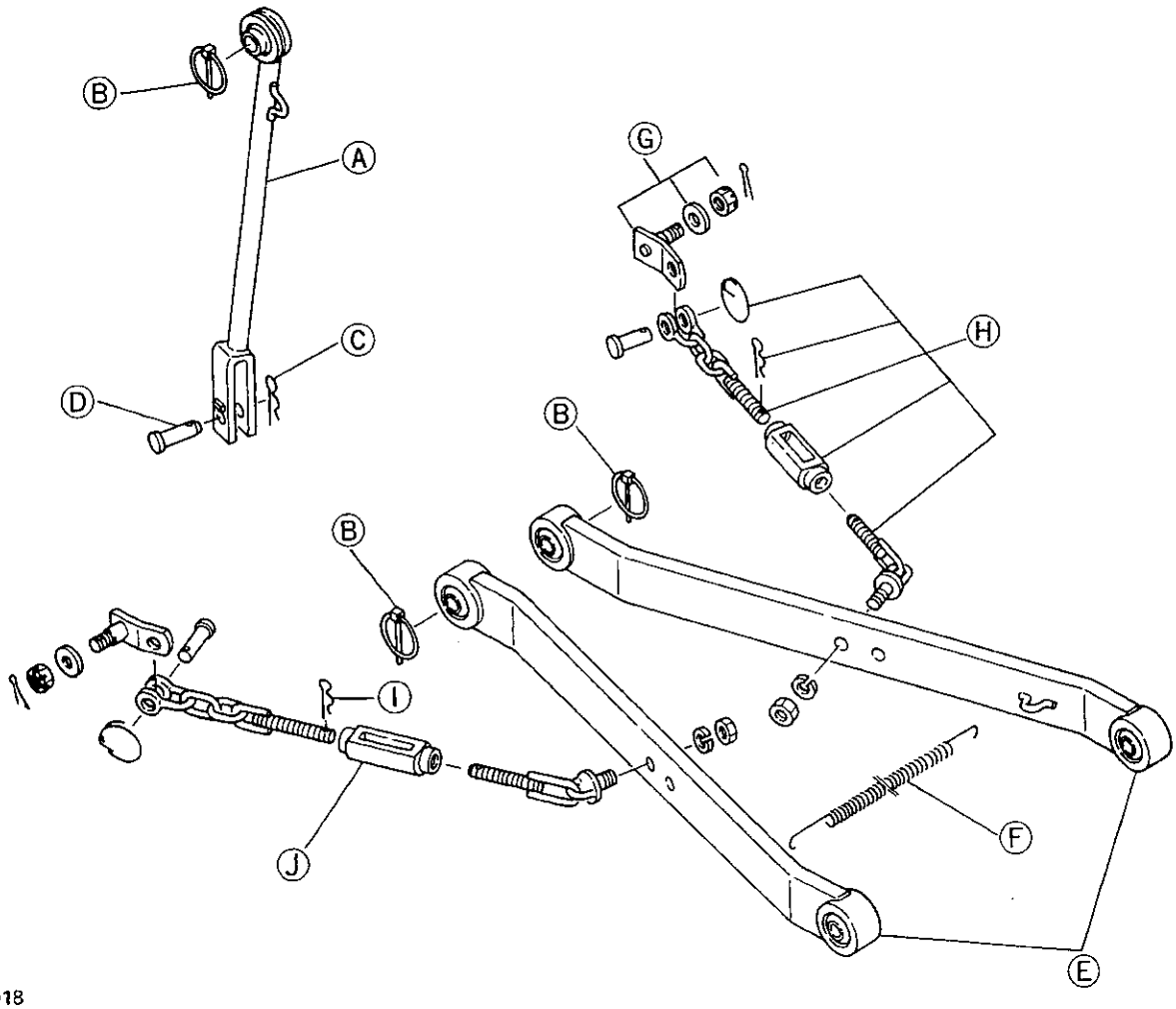
A – Spring Mounting Dimension

3-POINT HITCH AND DRAWBAR

Inspect and repair hitch using Fig. as guide.

When assembling, insure all bolts are tightened to specified torques.

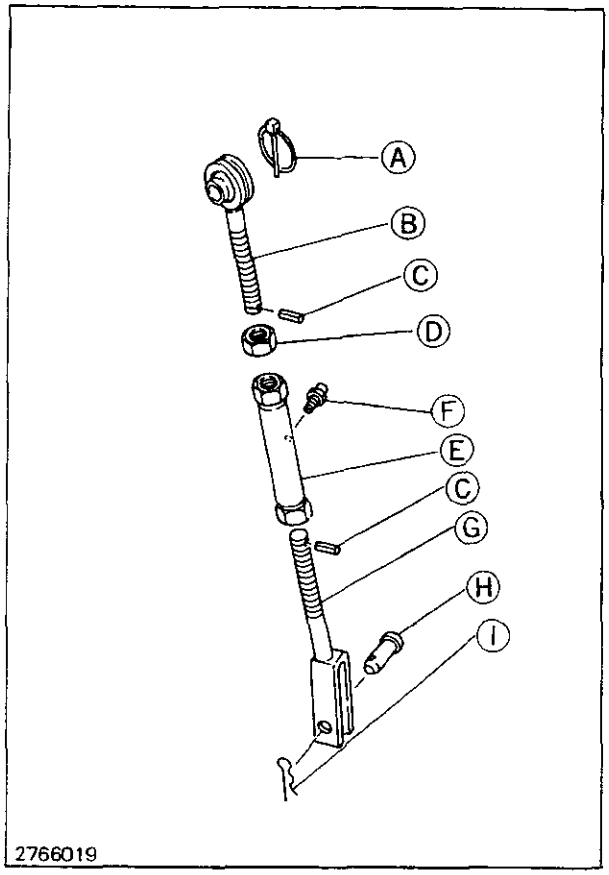
LOWER LINK



2766018

A – Lift Link (Left)
B – Quick Lock Pins
C – Spring Lock Pins
D – Pin
E – Lower Link
F – Connecting Spring
G – Check Chain Hinge Pin
H – Check Chain Assembly
I – Spring Lock Pins
J – Turn Buckles

3-POINT HITCH AND DRAWBAR (Continued)

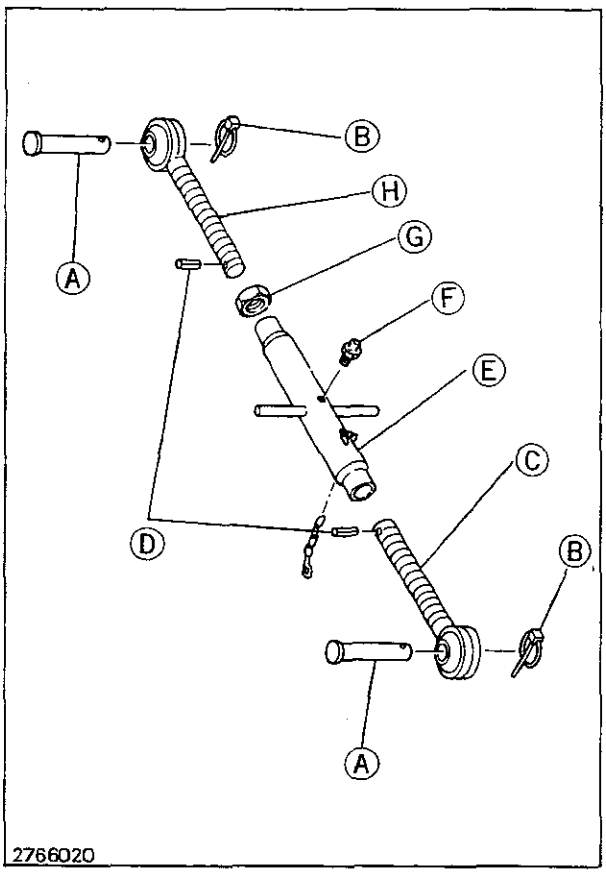


2766019

RIGHT HAND LIFT LINK DISASSEMBLY

1. Remove grease fitting (F) from turnbuckle (E).
2. Thread lift link assembly together until threaded end of link (B) and spring pin (C) can be seen through grease fitting hole.
3. Remove spring pin (C). The spring pin fits loosely in its bore.
4. Remove link (B).
5. Remove lower spring pin (C) from yoke (G) as well as the upper spring pin.
6. Remove yoke (G) from turnbuckle (E).

A – Quick Lock Pin
B – Upper Link End
C – Spring Pins (2)
D – Nut
E – Turnbuckle
F – Grease Fitting
G – Yoke
H – Pin
I – Spring Lock Pin



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UPPER LINK DISASSEMBLY

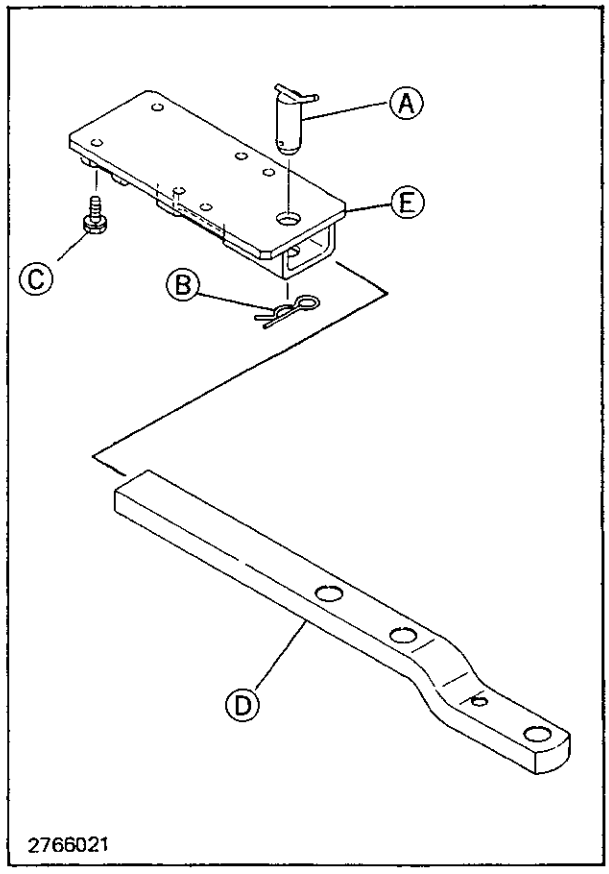
1. Remove grease fitting (F) from middle of upper link turnbuckle (E).
2. Thread upper link ends (C and H) in until threaded end is seen through grease fitting hole.
3. Remove spring pins (D). The spring pins fits loosely in its bore.
4. Thread upper link ends out to remove.

A – Pin (2)
B – Quick Lock Pins (2)
C – Upper Link End (Left-Hand Thread)
D – Spring Pins 4 x 24 mm (2)
E – Turnbuckle
F – Grease Fitting
G – Lock Nut
H – Upper Link End (Right-Hand Thread)

DRAWBAR

1. If the drawbar bracket (E) was removed, tighten cap screws (C) to 98 Nm (10 kgm) (72 ft-lbs) with lock-tite.

A – Pin
B – Spring Lock Pin
C – Cap Screws (6)
D – Drawbar
E – Drawbar Bracket



MISCELLANEOUS REPAIR 80

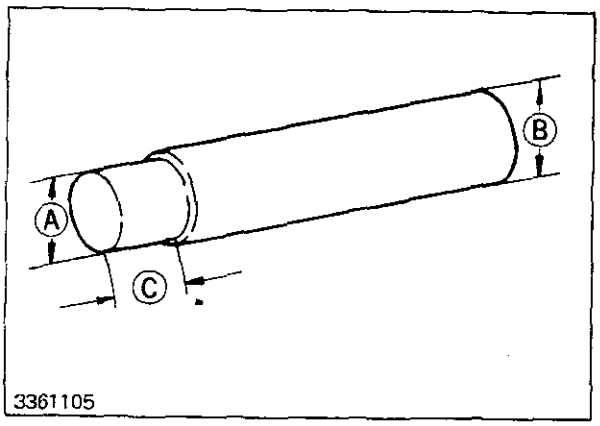
SPECIFICATIONS

Front Axle Assembly

ITEM	NEW PARTS SPECIFICATIONS	WEAR LIMIT
Center Pin Bushing I.D.	30.02–30.08 mm (1.182–1.184 in.)	
Center Pin O.D.	29.94–30.00 mm (1.179–1.181 in.)	
Center Pin-to-Bushing Clearance	0.02–0.14 mm (0.0008–0.0055 in.)	0.4 mm (0.016 in.)
Center Pin End Play (Front Axle Play)	0–0.3 mm (0–0.012 in.)	1.0 mm (0.04 in.)
Toe-in Adjustment	4–8 mm (0.157–0.315 in.)	10 mm (0.394 in.)
King Pin O.D. (2-Wheel Drive Model)	29.96–29.98 mm (1.179–1.180 in.)	
King Pin Bushing I.D. (2-Wheel Drive Model)	30.00–30.03 mm (1.181–1.182 in.)	
King Pin Bushing-to-King Pin Clearance (2-Wheel Drive Model)	0.02–0.07 mm (0.001–0.003 in.)	0.25 mm (0.01 in.)

CAP SCREWS	TORQUE SPECIFICATIONS
2-Wheel Drive and 4-Wheel Drive	
Center Pin-to-Axle Bracket	80 Nm (8 kgm) (58 ft-lbs)
Drag-rod-to-Steering Arm Nut	45–60 Nm (4.5–6 kgm) (33–44 ft-lbs)
Tie-rod-to-Steering Arm Nut	45–60 Nm (4.5–6 kgm) (33–44 ft-lbs)
Front Axle Bracket-to-Engine	98 Nm (10 kgm) (72 ft-lbs)
2-Wheel Drive	
King Pin Cap Screw	98 Nm (10 kgm) (72 ft-lbs)
Hub Bearing Slotted Nut	9.8–11.5 Nm (1–1.2 kgm) (7.2–8.5 ft-lbs)
Tie-rod Slotted Nut	49 Nm (5 kgm) (36.2 ft-lbs)
Front Axle-to-Knee Nut	196 Nm (20 kgm) (147 ft-lbs)
Wheel Bolts	
Front Wheel-to-Hub	137 Nm (14 kgm) (103 ft-lbs)
Rear Wheel-to-Hub	294 Nm (30 kgm) (221 ft-lbs)
Rear Wheel Disk-to-Rim	196 Nm (20 kgm) (147 ft-lbs)

SPECIAL TOOLS



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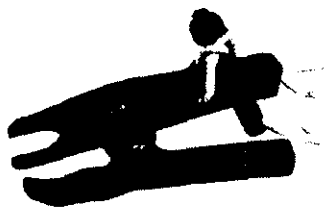
King Pin Bushing Installation Tool (30 mm)

Installing king pin bushing.

A – 1.180 in. (29.98 mm)
B – 1.339 in. (34 mm)
C – 1.260 in. (32 mm)

Ball Joint Removal Tool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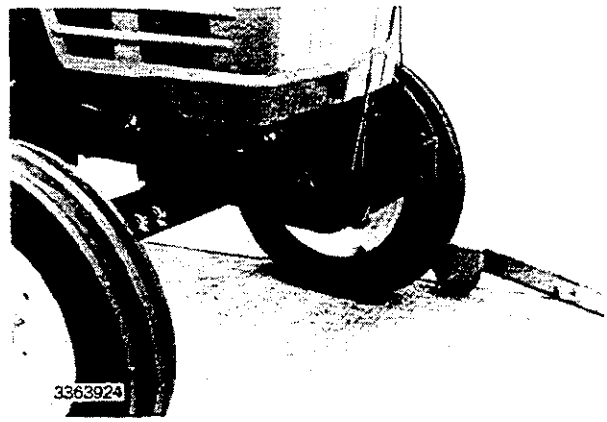
Removing tie-rod or drag-rod ball joints.

Removal and installation of both 2-wheel and 4-wheel drive front axle assemblies are covered in this Section. Inspection and replacement bushings and bearings and repair of king pin assembly on 2-wheel drive front axle are also provided. For inspection and repair of 4-wheel drive front axle, see Chapter 50, Section 40.

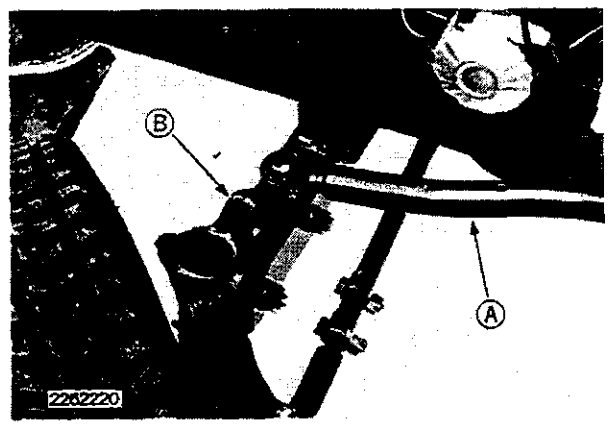
2-WHEEL DRIVE FRONT AXLE REMOVAL

1. Set parking brake and block rear wheels.
2. Attach a hoist or jack to bumper, lift up tractor just enough to take weight off tires.



CAUTION: Do not lift so high that the tractor tip over for slipping out of block or jack head.

3. Disconnect drag rod (A) from steering arm (B).

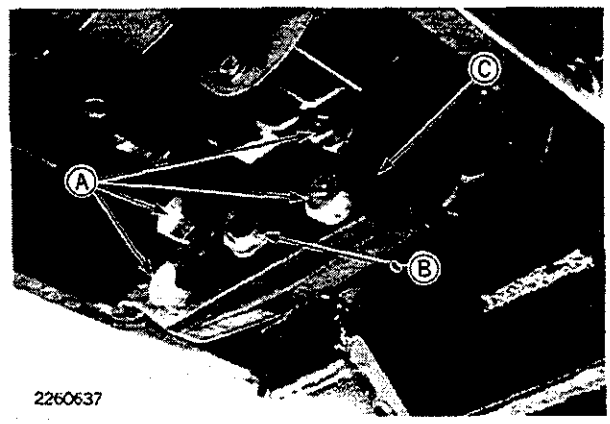


A — Drag Rod
B — Steering Arm

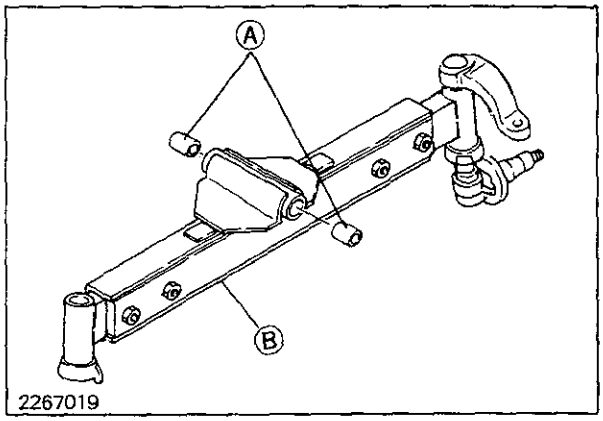
4. Remove four cap screws (A) from center pin (B).
5. Place floor jack under center of axle.
6. Carefully pull the center pin out.

Do not loose or damage adjusting shims behind the square plate of center pin.

7. Raise front of tractor with the hoist or jack and roll front axle away.



A — Cap Screws
B — Center Pin
C — Shims

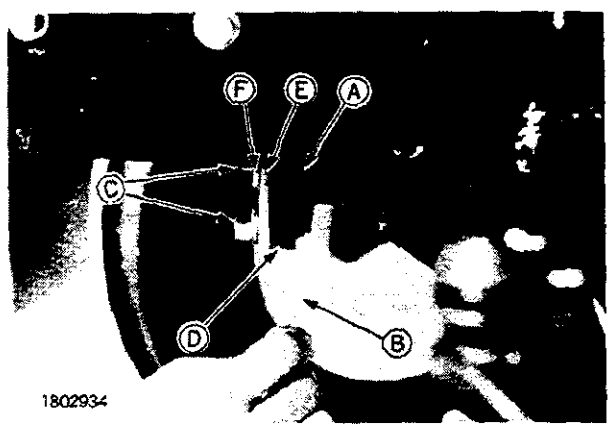


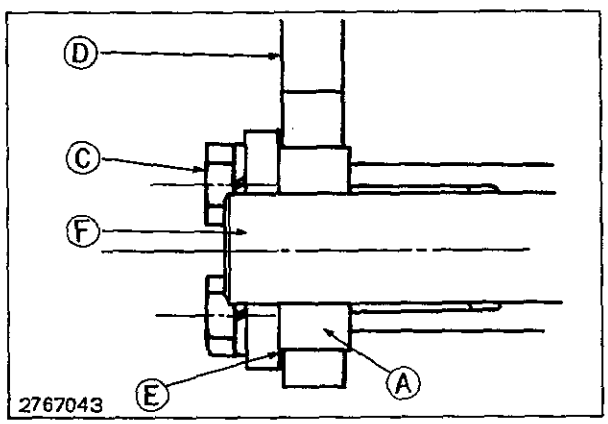
INSPECTION AND REPAIR

CAUTION: Lower front end of tractor onto splitting stand, while repairs are being made.

1. Inspect center pin at bushing surfaces for wear and scoring. The diameter of the pin at bushing surfaces should be 29.94 to 30.00 mm (1.179 to 1.181 in.).
2. Inspect center pin bushings in axle for wear and scoring. They should measure 30.02 to 30.08 mm (1.182 to 1.184 in.).
3. The clearance between center pin and center pin bushings should be 0.02 to 0.14 mm (0.0008 to 0.0055 in.), but no more than 0.4 mm (0.016 in.).
4. Pull out old bushings with blind bushing puller as needed.

A – Center Pin Bushing
B – Front Axle





INSTALLATION

Reverse the removal steps given on the preceding pages and note the installation instructions that follow.

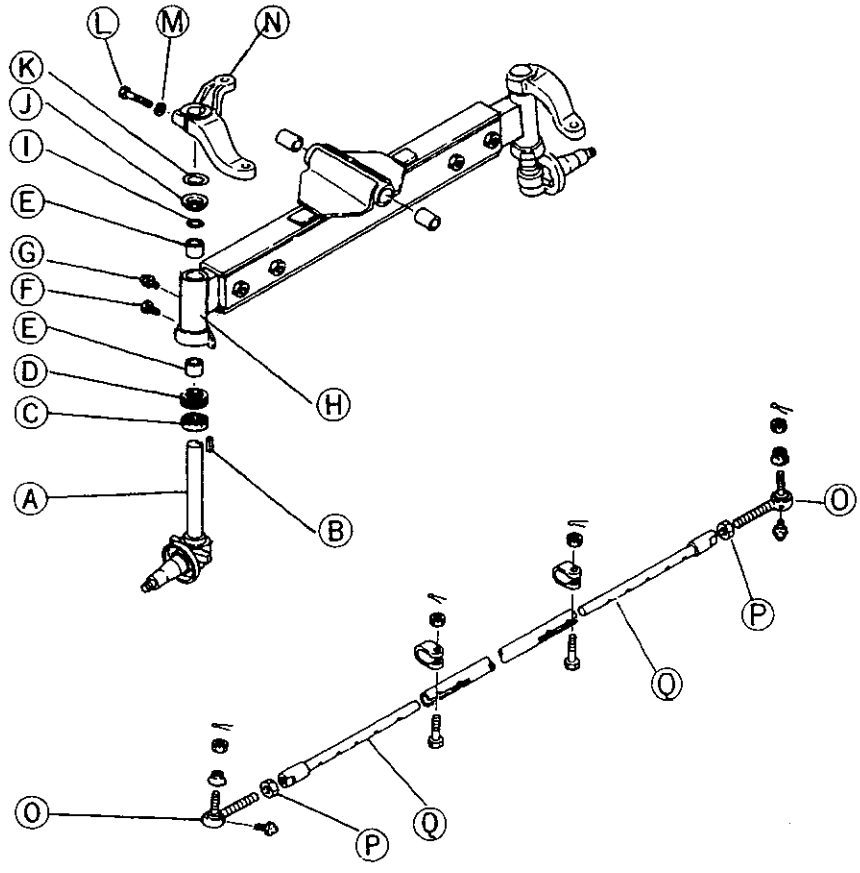
1. Install spacer (A) into front support of axle bracket (D).
2. Install center pin (F) by tapping it into front support from the front.

Grease center pin and center pin bushings inside.

3. After adjusting shims (E) are inserted behind the center pin mounting plate, tighten four cap screws (C) to 80 Nm (8 kgm) (58 ft-lbs).
4. Check axle end play by pulling axle fully rearward on center pin.
5. Insert a filler gauge (B) between spacer (A) and front end of housing.
6. Front axle end play should be 0 to 0.3 mm (0 to 0.012 in.). If there is excessive end play, loosen center pin cap screws and remove adjusting shims.
   0.25 mm (0.01 in.) and 0.5 mm (0.02 in.) thick shims are installed. Remove most suitable one for decreasing end play.
7. Tighten four cap screws on center pin and repeat end play check.

A – Spacer
B – Filler Gauge
C – Cap Screws
D – Front Support
E – Shims
F – Center Pin

KNEE ASSEMBLY



A – King Pin
B – Key
C – Oil Seal
D – Thrust Bearing
E – Bushing (2 used)
F – Plug
G – Grease Fitting
H – Knee
I – O-Ring
J – Retainer
K – Shim
L – Cap Screw
M – Washer
N – Steering Arm
O – Tie Rod End (L & R)
P – Nut (L & R)
Q – Tie Rod Extension (L & R)

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DISASSEMBLY

Position a floor jack under the front axle. Set parking brake and block rear wheels. Raise tractor until the front wheels clear the ground. Place a splitting stand under tractor.

1. Remove wheels.
2. Remove cap screw (L) on steering arm (N) and remove arm. It may be necessary to tap the steering arm with a hammer to loosen it from king pin (A).
3. Remove key (B) from king pin.
4. Remove king pin from knee (H) of front axle housing.

Do not allow king pin to fall on floor.

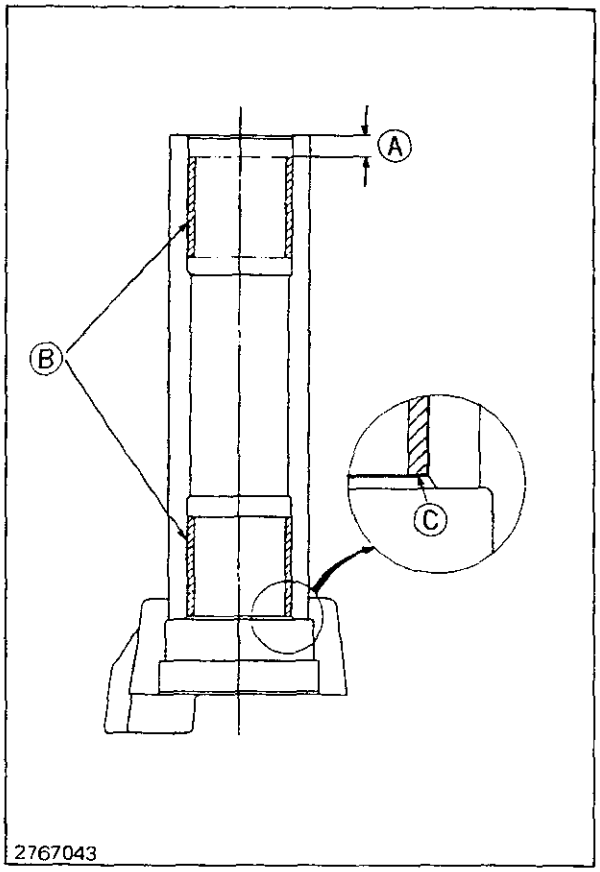
INSPECTION AND REPAIR

1. Inspect knee bushings (E) for wear or scoring. Bushing I.D. should be 30.00 to 30.03 mm (1.181 to 1.182 in.)
2. Inspect king pin for wear or scoring. Shaft O.D. should be 29.96 to 29.98 mm (1.179 to 1.180 in.).

The king pin-to-bushing clearance should be 0.02 to 0.07 mm (0.001 to 0.003 in.), but no more than 0.25 mm (0.01 in.).

3. Inspect thrust bearing (D), oil seal (C) and O-ring (I) for wear or damage. Replace if necessary.

KNEE ASSEMBLY (Continued)



INSPECTION AND REPAIR (Continued)

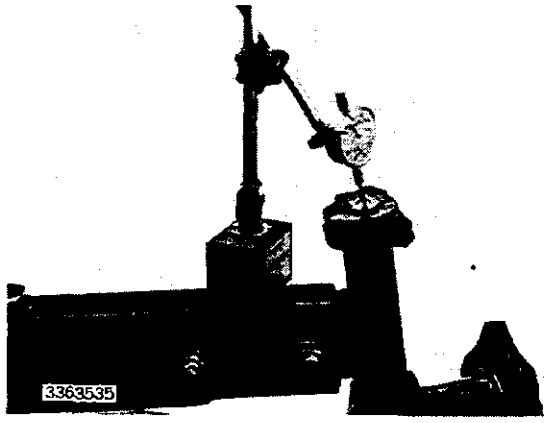
4. If bushing (B) must be replaced, drive old bushings out with a long drift.
5. Drive lower bushing in flush with chamfered edge (C) of tube using Bushing Installation Tool (30 mm).
6. Drive upper bushing until dimension (A) is obtained.

Since the king pin and spindle is an integrated unit, it should be carefully inspected for cracks. If there is any question about the condition of the unit, it should be inspected by Magnaflux or a similar crackdetection process.

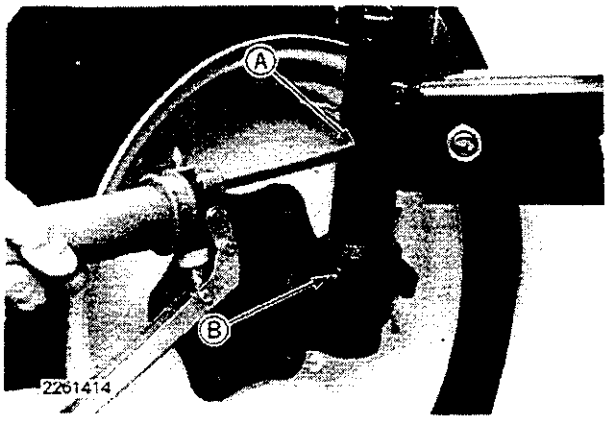
A – 6.2 to 6.5 mm (0.244 to 0.256 in.)
B – Bushing (2 used)
C – Chamfered Edge

ASSEMBLY AND INSTALLATION

1. Lightly lubricate bushings and install king pin assembly in knee.
2. Lightly lubricate O-ring and place O-ring, retainer and shim over king pin. Install steering arm and key on shaft. Tighten cap screw to 98 Nm (10 kgm) (72 ft-lbs).
3. Install a dial indicator as shown. Move the king pin up and down as shown while observing the dial indicator. Play should be 0.03 to 0.61 mm (0.001 to 0.024 in.).

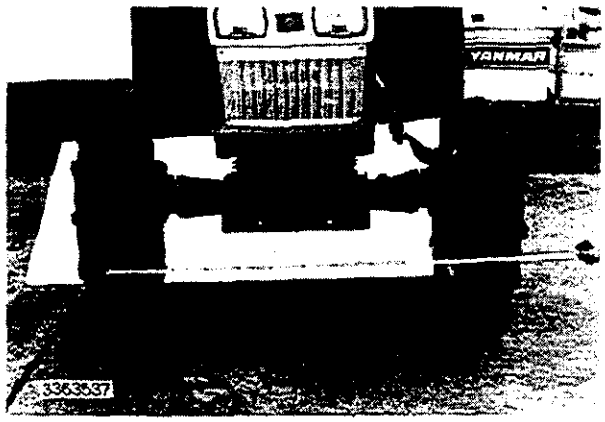


4. Install wheel and tire assembly. Tighten four cap screws to 137 Nm (14 kgm) (103 ft-lbs).
5. Remove splitting stand and lower tractor.
6. Using a multi-purpose grease lubricate spindle shafts. To lubricate, remove plug (B). Inject grease until it flows from plug opening. Install plug and repeat for other king pin.



A – Grease Fitting
B – Plug

TOE-IN ADJUSTMENT
2-Wheel and 4-Wheel Drive



Check toe-in adjustment, and adjust to 4 to 8 mm (0.157 to 0.315 in.) if necessary. To adjust toe-in:

1. Turn steering wheel until two front wheels are pointing straight ahead, parallel to centerline of the tractor.
2. Measure distance between left and right tires at rear of tires.
3. Measure distance between left and right tires at front of tires.

▼ **Front measurement should be 4 to 8 mm (0.157 to 0.315 in.) less than rear measurement.**

4. If need to adjust toe-in, loosen both tie rod jam nuts and turn tie rod until toe-in is correct. Turn the tie rod toward the front of the tractor to increase toe-in and to the rear to decrease toe-in.

▼ **Toe-in adjustment remains the same for 2-wheel and 4-wheel drive tractors.**

FRONT TREAD ADJUSTMENT (2-Wheel Drive)

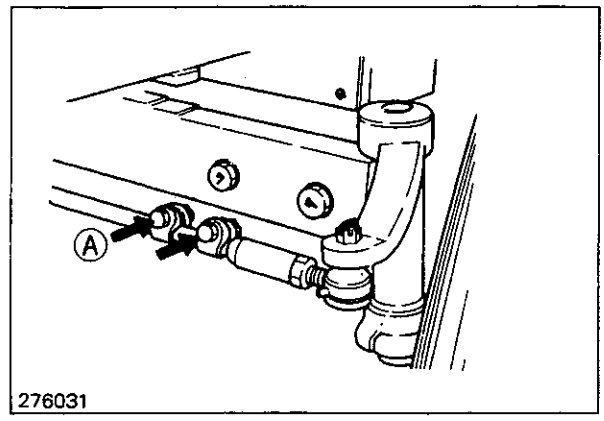
Front wheel tread can be adjustable in 100 mm (4 in.) steps.

Do not reverse front wheels to extend tread.

Position a floor jack under the front axle. Set parking brake and block rear wheels. Raise tractor until the front wheels clear the ground. Place a splitting stand under tractor.

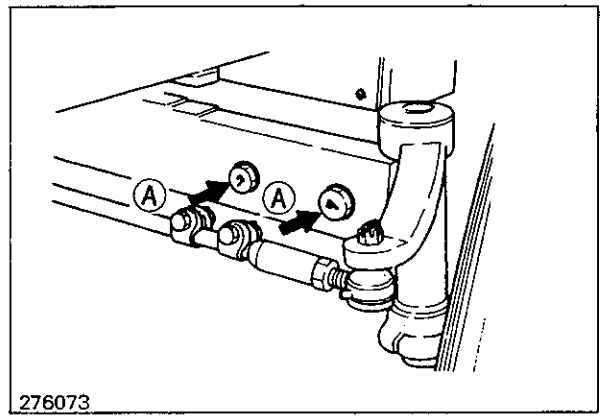
1. Remove cap screws (A) from tie-rod clamps.

A – Cap Screws

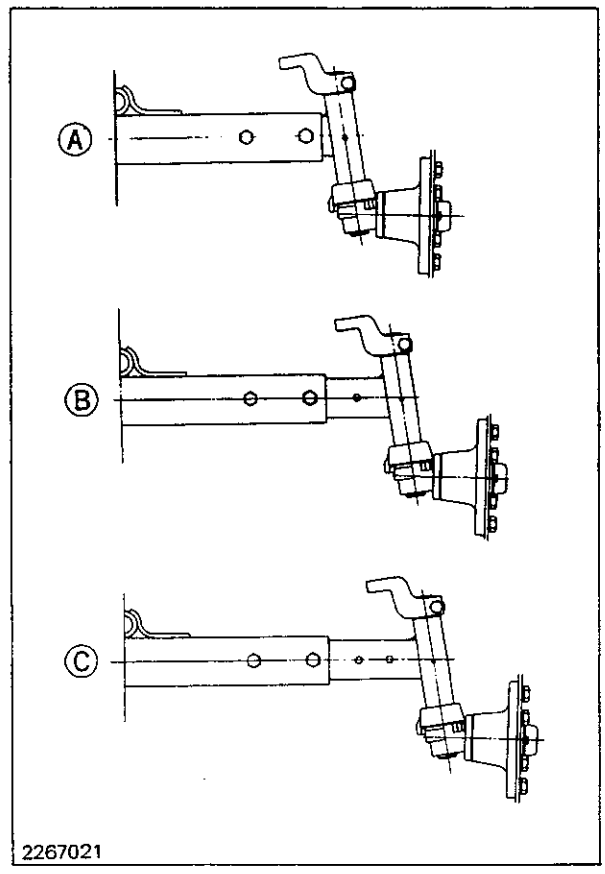


2. Remove cap screws (A) from front axle.
3. Slide axle knee to desired position.
4. Install cap screws and tighten nut to 196 Nm (20 kgm) (147 ft-lbs).
5. Install cap screws in tie-rod clamps, making sure tie-rod is changed same amount as axle. Tighten tie-rod slotted nut to 49 Nm (5 kgm) (36.2 ft-lbs).
6. Install new cotter pin.

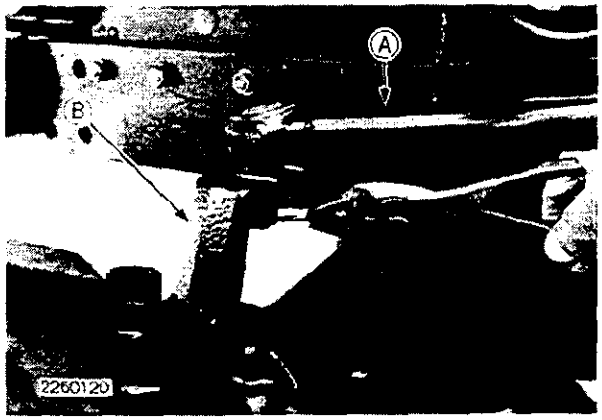
(A) – Cap Screws



7. Do not need to adjust drag rod length for 2-wheel and 4-wheel drive models, even if front tread of 2-wheel drive model adjusted as shown A, B, C.
8. Tighten jam nuts on tie-rod securely using two wrenches.



4-WHEEL DRIVE FRONT AXLE REMOVAL

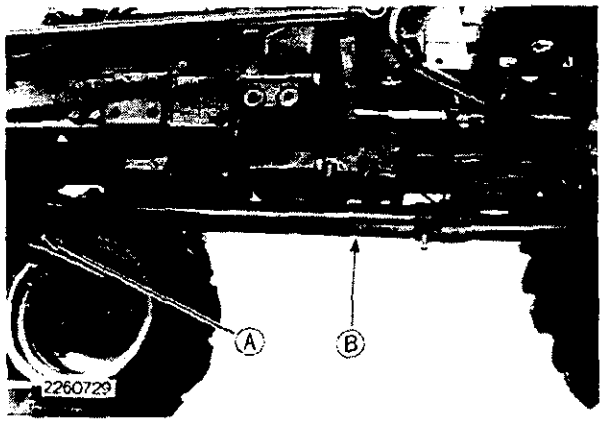


1. Set parking brake and block rear wheels.
2. Attach a hoist or jack to bumper, lift up tractor just enough to take weight off tires.

CAUTION: Do not lift so high that the tractor tip over for slipping out of block or jack head.

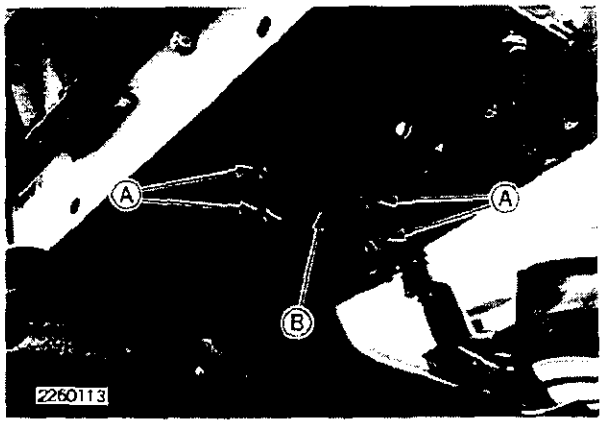
3. Disconnect drag rod (A) from steering arm (B).

A – Drag Rod
B – Steering Arm



4. Remove cap screw (A) on propeller shaft front cover (B) and loosen cap screw of rubber hose clamp. Then slide the cover to center.
5. Remove front drive propeller shaft as described on Chapter 10, Section 20.

A – Propeller Shaft Cover Retaining Cap Screw
B – Propeller Shaft Cover



6. Remove four cap screws (A) from center pin (B).

A – Cap Screws
B – Center Pin

7. Place floor jack under center of axle.
8. Carefully pull the center pin out.

Do not loose or damage adjusting shims behind the square plate of center pin.

9. Raise front of tractor with the hoist or jack and roll front axle away.

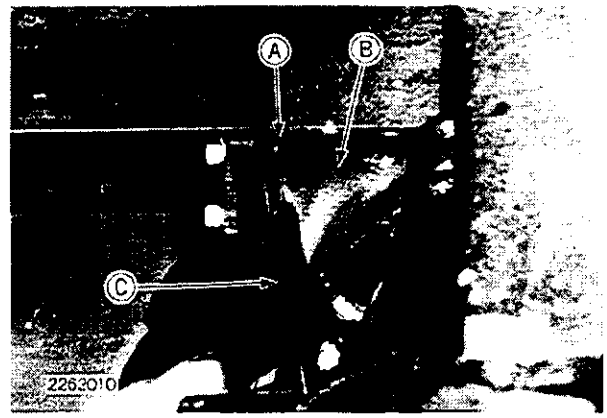
INSTALLATION

Reverse the removal steps given on the preceding pages and note the installation instructions that follow.

1. Install spacer (A) into front support of axle bracket.
2. Install center pin by tapping it into front support from the front.

Grease center pin, oil seal and center pin bushings inside.

A – Spacer
B – Axle Housing
C – Filler Gauge



3. After adjusting shims are inserted behind the center pin mounting plate, tighten four cap screws to 80 Nm (8 kgm) (58 ft-lbs.).
4. Check axle end play by pulling axle fully forward on center pin.
5. Insert a filler gauge (C) between spacer (A) and front end of axle housing (B).
6. Front axle end play should be 0 to 0.3 mm (0 to 0.012 in.). If there is excessive end play, loosen center pin cap screws and remove adjusting shims.

   0.25 mm (0.01 in.) and 0.5 mm (0.02 in.) thick shims are installed. Remove most suitable one for decreasing end play.
7. Tighten four cap screws on center pin and repeat end play check.

TOE-IN ADJUSTMENT

See 80-05-6.

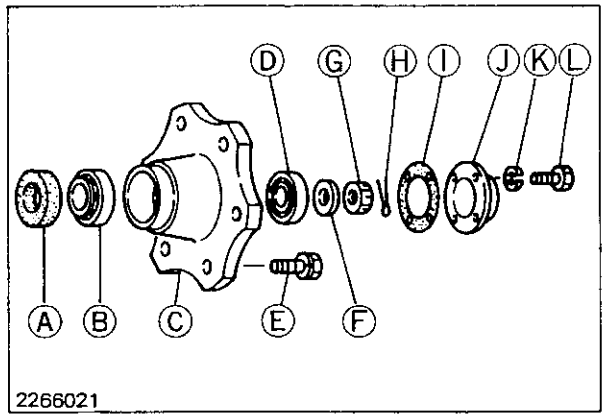
GENERAL INFORMATION

Removal and installation of both 2-wheel and front-wheel drive rear wheels are covered in this section. Inspection and replacement of bearings, oil seals, and bearing cups on 2-wheel drive front wheel hubs are also provided. For inspection and repair of front wheel drive front wheel hubs, see Chapter 50, Section 40.

2-WHEEL DRIVE FRONT WHEEL ASSEMBLY

REMOVAL

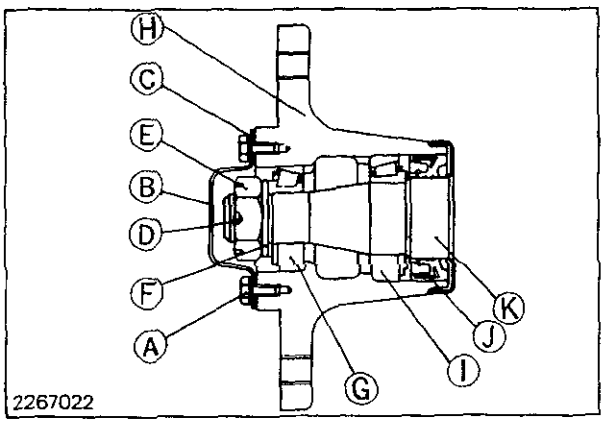
1. Set parking brake and block rear wheels.
2. Position a floor jack under front of tractor. Raise tractor.
3. Remove wheel.
4. Remove cap screws (L) and hub cap (J).
5. Remove cotter pin (H) and slotted nut (G).
6. Pull hub (C) forward slightly to unseat outer bearing (D). Remove washer (F) and outer bearing.
7. Remove hub from spindle.
8. Remove oil seal (A), and inner bearing (B) by driving out the bearing with a drift.



A – Oil Seal
B – Inner Bearing
C – Hub
D – Outer Bearing
E – Cap Screws (6 used)
F – Washer
G – Slotted Nut
H – Cotter Pin
I – Packing
J – Hub Cap
K – Spring Washer (4 used)
L – Cap Screws (4 used)

INSPECTION AND REPAIR

1. Inspect inner and outer bearings for worn rollers. Replace as necessary.
2. Inspect inner and outer bearing cups for wear. If cups are worn, drive them out using a drift.



ASSEMBLY

1. Insert inner bearing (I) in hub (H).
2. Install new oil seal (J) in hub.

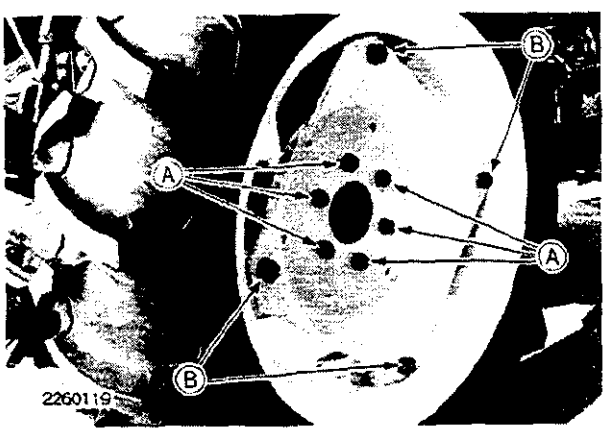
Before installing spindle, grease oil seal.

3. Place hub on spindle (K). Install outer bearing (G) and washer (F).
4. Install hub slotted nut and tighten to 9.8 to 11.5 Nm (1 to 1.2 kgm) (7.2 to 8.5 ft-lbs.).
5. If slots in nut do not line up with cotter pin hole, remove nut and use different size washer, so that torque remains the same and pin hole lines up.

Fill hub housing with grease enough.

6. Install packing (C), hub cap (B) and cap screws (A).
7. Install wheel on hub. Tighten four cap screws to 137 Nm (14 kgm) (103 ft-lbs.).

A – Cap Screws
B – Hub Cap
C – Packing
D – Cotter Pin
E – Slotted Nut
F – Washer
G – Outer Bearing
H – Hub
I – Inner Bearing
J – Oil Seal
K – Spindle



REAR WHEELS

1. Check rear wheel disks and rims for dents, scores, cracks or other damage. Replace or repair as necessary.
2. Tighten rear wheel disk-to-hub cap screws (A) to 294 Nm (30 kgm) (221 ft-lbs.).
3. Tighten rear wheel disk-to-rim cap screws (B) to 196 Nm (20 kgm) (147 ft-lbs.).

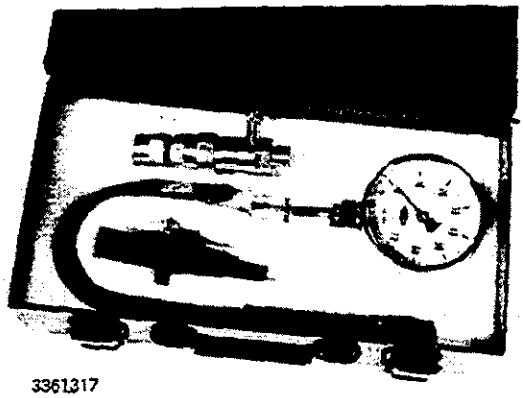
A – Rear Wheel Disk-to-Hub Cap Screws
B – Rear Wheel Disk-to-Rim Cap Screws

ENGINE OPERATION AND TESTS 220

SPECIFICATIONS

ITEM	SPECIFICATIONS
Engine Oil Pressure	245 to 392 KPa (2.5 to 4.00 kg/cm^2) (36 to 57 psi)
Compression Pressure	3430 to 3920 KPa (35 to 40 kg/cm^2) (497 to 569 psi) at 300 rpm
Radiator Leakage Test	98 Kpa (1.0 kg/cm^2) (14 psi)
Fan Belt Tension	10 to 15 mm at 8.86 N force (3/8 to 5/8 in. at 20 lbs.)
Valve Clearance	0.15 mm (0.006 in.)
Crankshaft End Play	(New Part) 0.09 to 0.19 mm (0.0035 to 0.0075 in.) (Maximum Acceptable) 0.33 mm (0.013 in.)

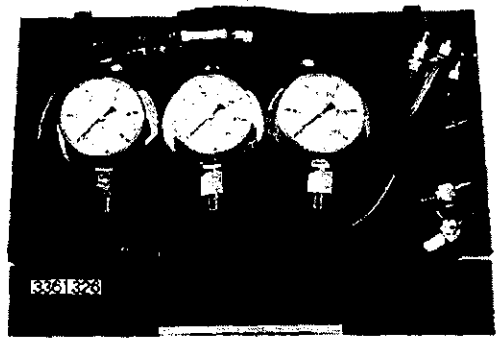
SPECIAL TOOLS



3361317

Compression Gauge Kit (TOL-92080001)

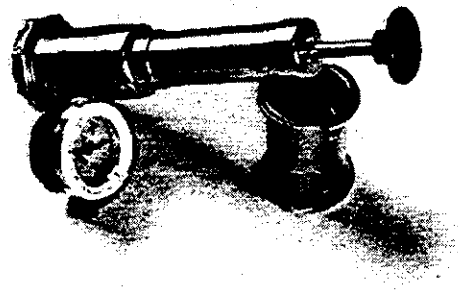
Checking engine compression pressure



3361318

Lube. Oil Pressure Gauge Kit

Checking engine lubricating oil pressure

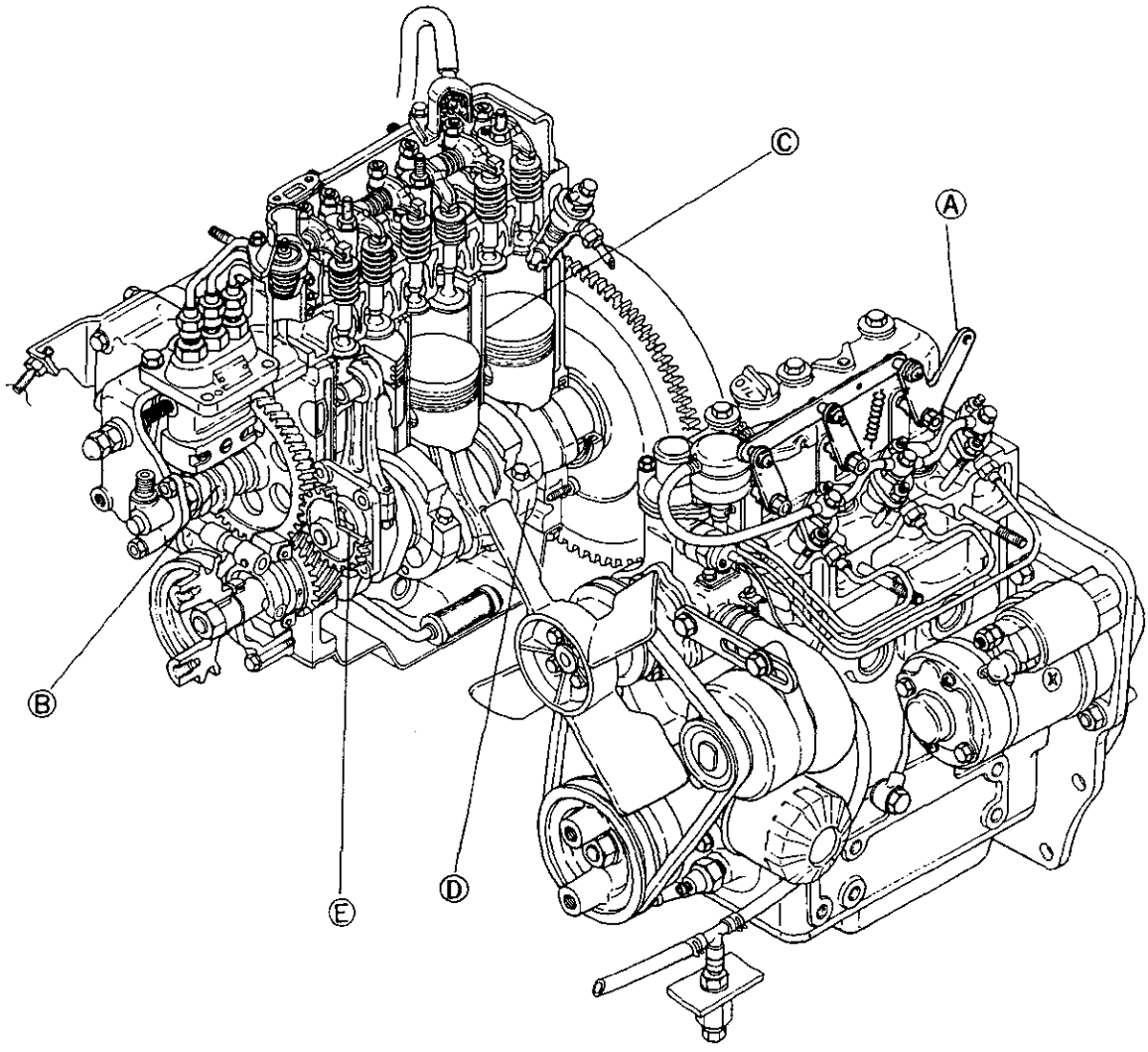


3361314

Radiator Tester

Checking radiator cap and system leakage

GENERAL INFORMATION



1867037

A – Decompression Device
B – Camshaft
C – Cylinder Liners
D – Main Bearing Housings
E – Oil Pump

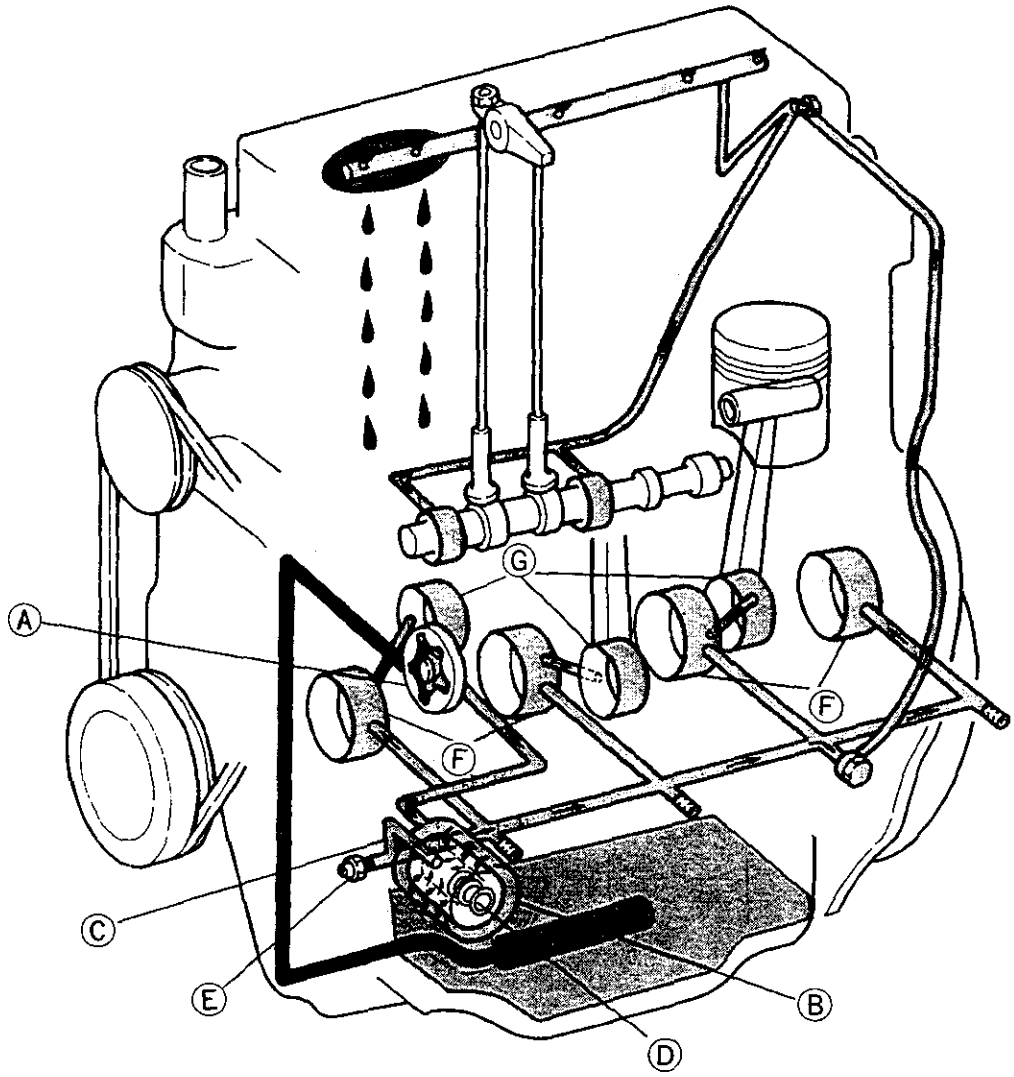
The tractor use vertical in-line, water cooled, 4-cycle engine. A manual decompression device (A) located on the rocker arm cover unseats the exhaust valves for cold weather starting. The cylinder head is equipped with replaceable valve guides. Mushroom type cam tappets ride off-center of camshaft journals causing rotaion for even wear. The camshaft is supported in the block at four points. Camshaft middle and rear journals rotate in the block casting (no bearings). Two middle bearings are lubricated with pressurized oil.

Ball bearings support the camshaft at the front journal. The engine are equipped with hand-press fit dry-sleeve, replaceable type liners.

The crankshaft has four main bearing supports. The two center bearings are enclosed in individual housings (D) within the block.

The engine oil pump (E) located at the front of the cylinder block provides lubrication for the engine.

LUBRICATION SYSTEM



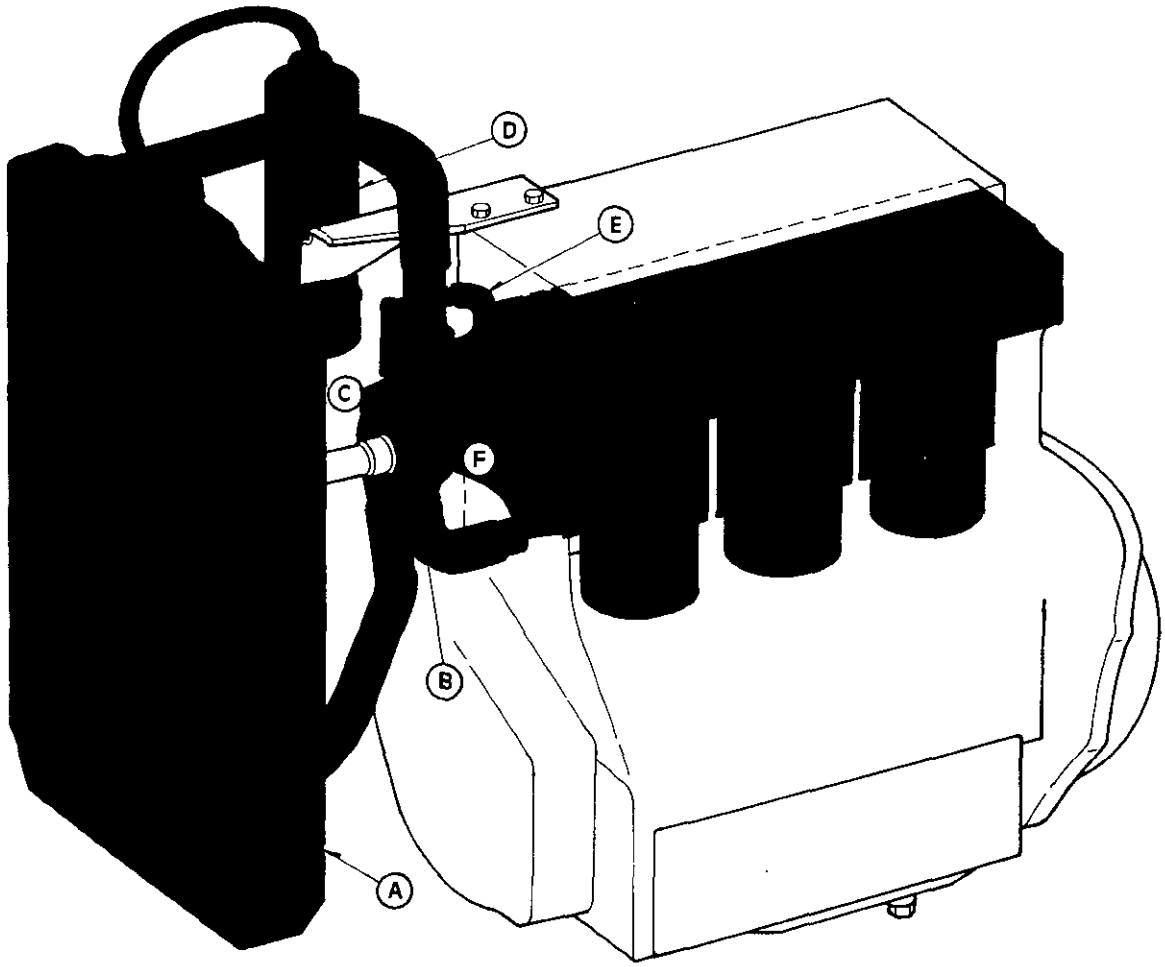
2267047

A – Oil Pump
B – Filter
C – Oil Pressure Regulating Valve
D – Oil Filter By-Pass Valve
E – Oil Pressure Sending Unit
F – Main Bearings
G – Connecting Rod Bearings

Pressure Free Oil
Pressure Oil

The engine lubrication system consists of a trochoid rotor-type pump (A), oil filter (B), oil pressure regulating valve (C), and oil filter by-pass valve (D) (within oil filter). Oil is pumped from the oil pan by the engine oil pump to the filter. Passing through the filter, oil continues on around the filter by-pass valve and in front of the oil pressure regulating valve. Oil is then distributed, under pressure, to each main bearing (F) and on through cross drilled passages in the crankshaft to connecting rod bearings (G). An external line carries oil from the rear of the engine oil gallery to the cylinder head to lubricate rocker arms and valves. Oil run from external line is divided at the top of cylinder brock toward camshaft middle bearing journals to lubricate camshaft. Oil run-off from the cylinder head splash lubricates camshaft and tappets. Piston pin bushings are also splash lubricated by crank-shaft rotation.

COOLING SYSTEM



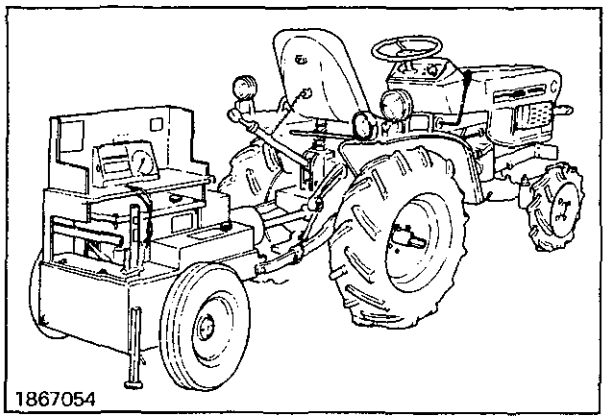
1863049

A – Radiator
B – Water Pump
C – Thermostat
D – Expansion Tank
E – By-pass Hose
F – Water Temperature Sending Unit

The cooling system consists of a radiator (A), water pump (B), and thermostat (C). A hose from the radiator filler neck is connected to an expansion tank (D). When cooling system pressure exceeds 88 Kpa (0.9 kg/cm^2) (13 psi) (engine overheating), a valve in the radiator cap opens to allow steam to discharge into the expansion tank, where it is condensed. When engine temperature is reduced, a vacuum is created in the radiator, and coolant is drawn back out of the sub-tank (expansion tank).

DYNAMOMETER TEST

If possible, test the engine on a dynamometer before it is tuned. This test gives the indicated PTO horsepower output and fuel consumption of the engine as it is. This will help determine if a tune-up can restore the engine or whether an overhaul is needed.


1867054

Good performance by the engine depends on these basic things.

1. An adequate supply of clean air and fuel.
2. Good compression.
3. Proper valve and injection pump timing for good combustion.

Make the dynamometer test as follows:

1. Connect the engine to the dynamometer using the manufacturers instructions.
2. Operate the engine at one-half load until the coolant and crankcase oil temperature are up to normal.
3. Run engine at fast idle (2775 rpm).
4. Gradually increase the load on the engine until its speed is reduced to 2600 rpm.
5. Read the horsepower on the dynamometer.
6. Compare the reading taken with the following chart.

PTO OUTPUT SPECIFICATIONS

Engine RPM	PTO Speed	Rated PTO Output
2600 (Full load)	622 rpm	22.5 HP (16.5 kW)

DIAGHOSING ENGINE MALFUNCTIONS

PROBLEM	POSSIBLE CAUSE	SUGGESTED REMEDY
Will not start	Operator Error	
	• Throttle not pushed far enough forward	Push throttle lever forward, check linkage
	• Decompression device out of correct adjustment	Check linkage
	Fuel System Malfunction	
	• *Air in fuel pump*	*Bleed pump*
	• Air in fuel lines	Bleed fuel line
	• Clogged filter	Replace filter
	• Sticking plunger or delivery valve	Replace plunger or delivery valve
	• Injection pump roller guide stuck	Replace roller guide
	• Excessive wear on injection lobes	Replace injection pump cam lobes
	• High pressure fuel line connector loose	Tighten
	• Nozzle valve stuck	Replace nozzle valve
	• Improper nozzle spray pattern	Clean nozzle
	• Thermo-start operation faulty (cold weather)	Check and replace plug as required
	Basic Engine Problem	
	• Compression pressure low	Check valve clearance, and/or check piston rings and cylinder liner
Engine runs irregularly or Misses	Basic Engine Problem	
	• Improper valve clearance	Adjust valve clearance
	• Compression pressures of cylinders are uneven	Check pressure, and replace cylinder
	• Air in fuel (injection pump and lines)	Bleed
	Fuel System Malfunction	
	• Improper throttle lever adjustment	Adjust throttle lever
	• Injection pump contains air	Bleed pump
	• Defective nozzle	Check nozzle with tester
	• Faulty injection pump	Check pump
	• Improper governor adjustment	Adjust governor system
Frequent stalling	Fuel System Malfunction	
	• Clogged fuel line	Clean, or replace line
	• Clogged fuel filter	Replace filter element
	• Air in fuel	Bleed system
	• Clogged fuel tank air vent	Clean vent hole

PROBLEM	POSSIBLE CAUSE	SUGGESTED REMEDY
Lack of power	Basic Engine Problem	
	• Improper valve clearance	Adjust valve clearance
	• *Improper valve seating*	*Lap valve seats*
	• Cylinder head gasket blow-by	Replace head gasket
	• Worn, stuck, or broken piston rings	Replace piston Rings
	• Improper decompression device setting	Check linkage and replace as required
	• Injection pump out of adjustment	Adjust timing
	• Faulty injection nozzle	Recondition nozzle
	• Clogged air cleaner or fuel filter	Clean or replace element
	Fuel System Malfunction	
	• Faulty injection timing	Adjust timing
	• Low fuel injection rate	Adjust governor system
	• Faulty injection pressure	Adjust injection nozzle spring with shim
	• Clogged fuel system line	Clean or replace line
	• Clogged air filter element	Clean filter element
	• *Air in fuel*	*Bleed fuel system*
	• Water in fuel	Empty filter or tank and refill with new fuel
	• Clogged fuel filter	Replace with new filter element
Engine overheats	Basic Engine Problem	
	• Loose or broken fan belt	Tighten or replace belt
	• *Faulty thermostat*	*Replace thermostat plug*
	• Faulty water pump	Replace pump
	• Damaged fan blades	Replace blade
	Service Problem	
	• Low coolant level	Add coolant
	• Low oil level	Add oil
	• Engine overloaded	Reduce load
	• Clogged radiator	Clean radiator, or replace
	• Antifreeze ratio too high	Correct mixture ratio
	Fuel System Malfunction	
	• Excess fuel delivery	Adjust governor system
	• Improper injection timing	Adjust timing
Excessive oil consumption	Basic Engine Problem	
	• Excessive piston liner clearance	Replace piston rings and cylinder liner
	• Worn, stuck, or damaged piston rings	Replace rings
	• Piston ring gaps not staggered	Replace rings
	• Faulty valve stem seal	Replace valve stem seal
	Service Problem	
	• Oil pressure regulating valve adjusted too high	Adjust regulating valve
	• Engine oil too thin	Replace with new oil

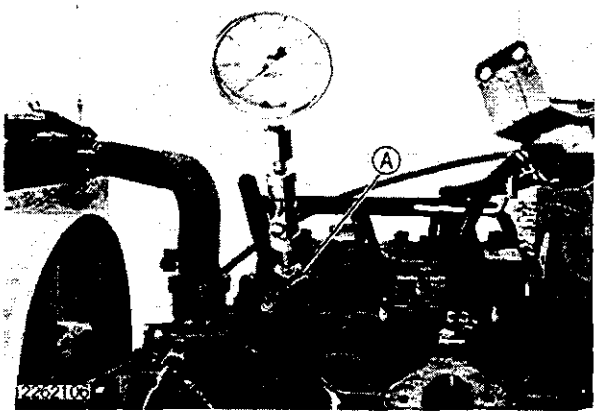
DIAGNOSING ENGINE MALFUNCTIONS (Continued)

PROBLEM	POSSIBLE CAUSE	SUGGESTED REMEDY
Low oil pressure (Grow indicator light)	Basic Engine Problem	
	• Faulty pressure regulating valve setting	Adjust valve
	• Excessive main and connecting rod clearance	Replace bearings
	• Plugged oil pump intake screen	Clean screen
	• Worn oil pump	Replace pump
	Service Problem	
	• Low oil level	Add oil
	• Improper oil viscosity	Replace with correct viscosity oil
	Operator Error	
	• Engine speed too slow	Place throttle lever to correct position
High oil pressure	Basic Engine Problem	
	• Stuck or improperly adjusted regulating valve	Replace or adjust valve
Black exhaust smoke	Fuel System Malfunction	
	• Improper injection timing	Adjust timing
	• Excessive injection rate	Adjust governor system
	• Faulty nozzle spray	Clean nozzles
	Operator Error	
	• Engine overloaded	Reduce load
	Service Problem	
	• Clogged air cleaner	Clean air cleaner
White exhaust smoke	Basic Engine Problem	
	• Low compression	Check valve clearance
	Operator Error	
	• Engine Not warmed up	Warmup engine
Excessive fuel consumption	Basic Engine Problem	
	• Low compression	Check valve clearance, head gasket for leaks and cylinder liner clearance
	Fuel System Malfunction	
	• Improper injection pump timing	Adjust pump timing
	• Excessive fuel delivery	Adjust governor system

TESTING COMPRESSION PRESSURE

STOP Befor begining test, ensure that battery is fully charged.

Thoroughly clean external area around injection nozzles.



1. Remove fuel injection and fuel leak-off lines from injection nozzles.
2. Remove nozzle retainers and nozzles.
3. Remove Precombustion chambers from each nozzle bore, except bore on cylinder to be tested.
4. Install adapter (A) in injection nozzle bore, and reinstall nozzle retainer.
5. Attach test guage to adapter.
6. Remove wire (B) from thermo-start unit.
7. Make sure throttle is in the full rearward position.
8. Make sure decompression device is not engaged.
9. Crank engine and check gauge reading. Repeat check for each cylinder, and compare reading taken to the following specification.

COMPRESSION PRESSURE SPECIFICATIONS

Specified Pressure	Lower Limit
3430 to 3920 KPa (35 to 40 kg/cm²) * (497 to 569 psi)	2940 KPa (30 kg/cm²) * (426 psi)

* Pressure given was taken at 305 m (1000 feet) above sea level. A 3.6% reduction in gauge pressure will result for each additional 305 m (1000 feet) of altitude.

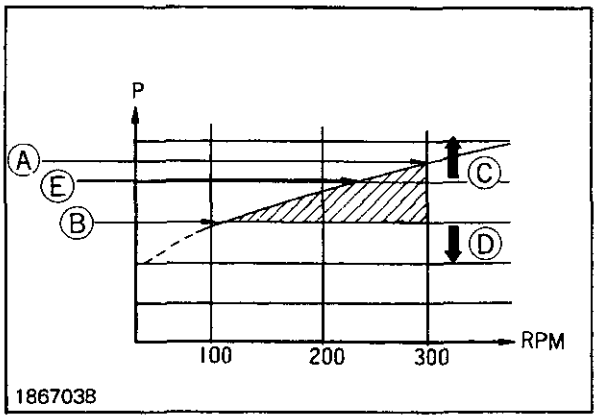
A – Adapter

An engine with compression pressure of 2940 KPa (30 kg/cm²) (426 psi) or less will be hard to start and is in need of overhaul.

If pressure is much lower than shown, remove gauge and apply oil to the ring area of piston through injection nozzle hole. Do not use too much oil. Do not get oil on the valves.

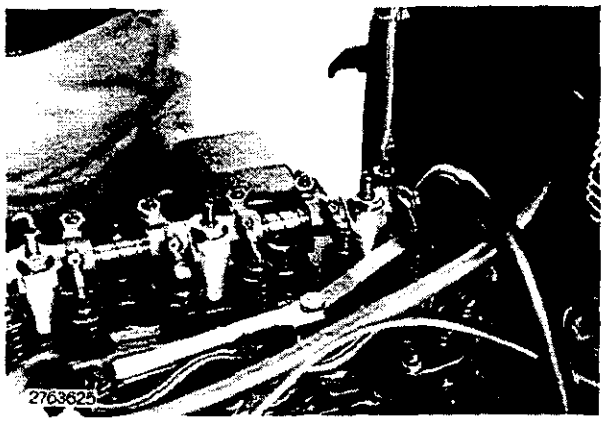
Test compression again. If pressure is higher, worn or stuck piston rings are indicated. If the pressure is still low, it is possible that valves are worn or sticking.

It is very important that all cylinder pressures be approzimately alike. There should be less than 172 KPa (1.75 kg/cm²) (25 psi) difference between cylinder pressures.



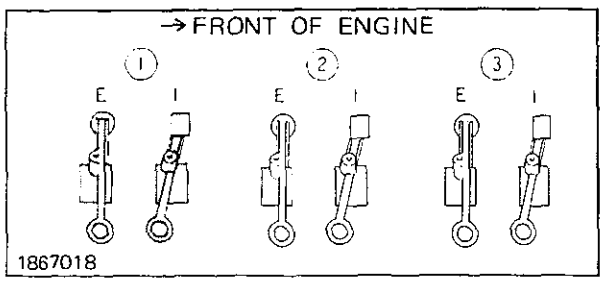
A – Specified Pressure (High)
B – Lower Limit
C – Easy to Start
D – Hard to start
E – Specified Pressure (Low)
3.43 MPa (35 kg/cm²) (497 psi)

CHECKING VALVE CLEARANCE



Check and adjust the valve clearance after assembly and after every 300 hours of operation. Check the engine when cold as follows:

1. Disconnect decompression linkage.
2. Remove thermo-start reservoir support cap screws.
3. Remove expansion tank bracket cap screws.
4. Remove cylinder head cover cap screws, and remove cylinder head cover.
5. Crank engine until No. 1 cylinder is at TDC of its compression stroke. Both valves should be in the up position (rocker arms loose).

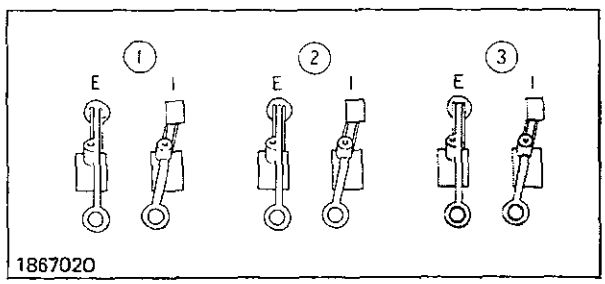


6. Check the intake and exhaust valve clearances of the No. 1 CYLINDER IS AT REAR OF ENGINE.

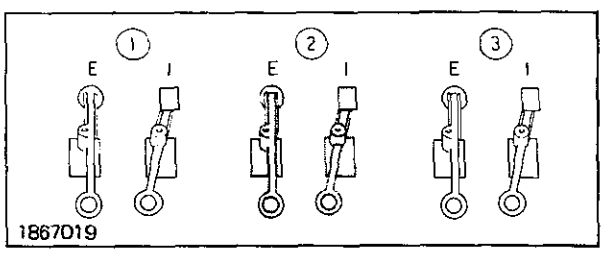
   Adjust to the following specifications.

INTAKE AND EXHAUST VALVE CLEARANCE SPECIFICATIONS

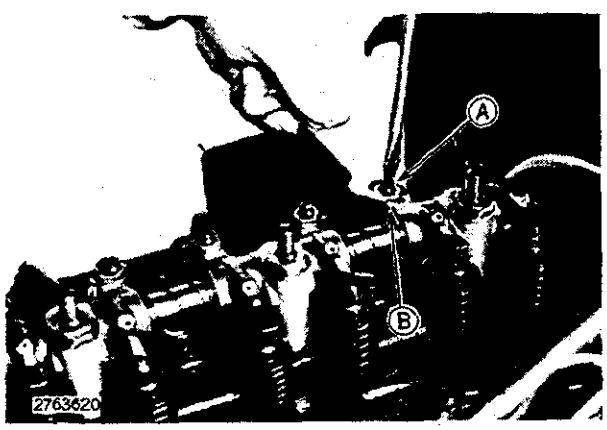
Valve clearance	0.2 mm (0.008 in.)



7. Turn the crankshaft clockwise 240° to align the TDC mark of the No. 3 cylinder.



8. Check the vlave clearance of the intake and exhaust valves of the No. 3 cylinder, and adjust to proper specification.
9. Turn the crankshaft another 240° clockwise to align the TDC mark of the No. 2 cylinder.

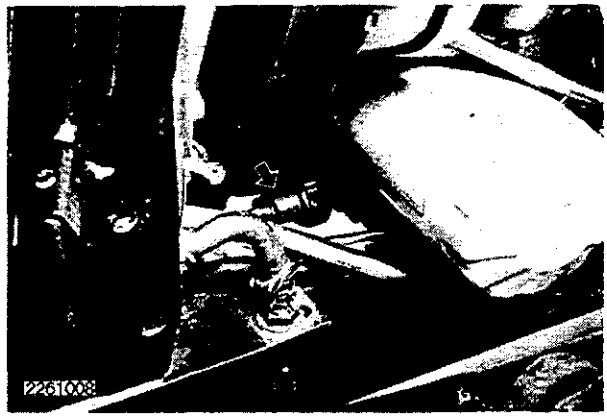


10. Check the valve clearance of the intake and exhaust valves of the No.2 cylinder, and adjust to proper specification.

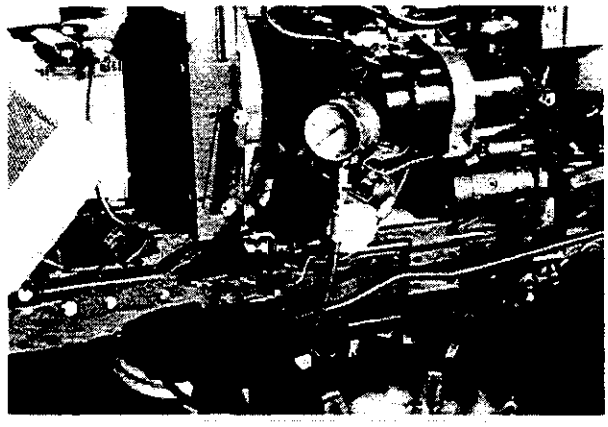
STOP When tightening the lock nut (B), be sure not turning the adjusting screw (A). Hold the screw with screw driver as shown in figure.

CHECKING OIL PRESSURE

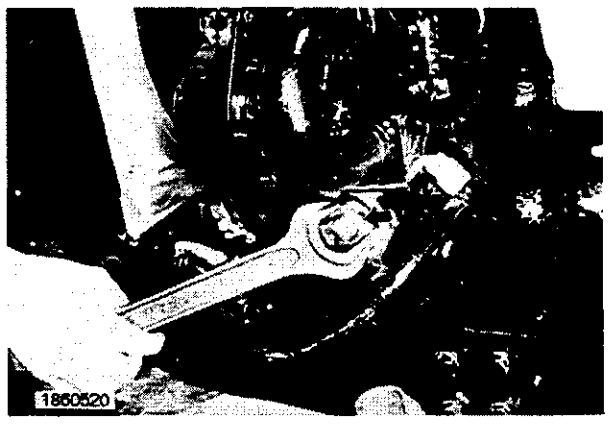
1. Remove oil pressure sending unit.



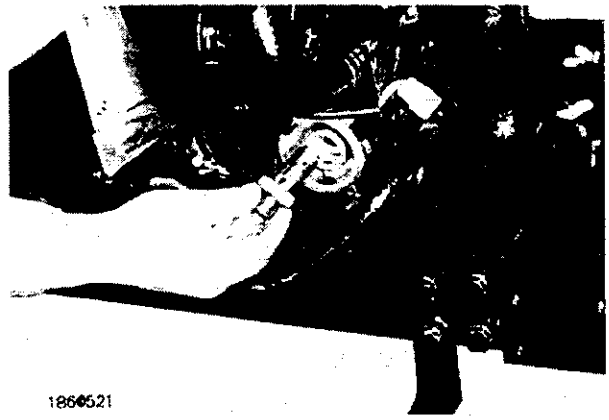
2. Install pressure gauge and fitting.
3. Warm up engine.
4. Starting at 900 rpm, slowly increase engine speed to 1800 rpm while watching pressure gauge. If there is not a smooth increase in oil pressure, check for defective oil pressure regulating valve.
5. At 1800 rpm, oil pressure should be 245 to 392 Kpa (2.5 to 4.00 kg/cm^2) (36 to 57 psi).
6. To adjust oil pressure, first remove oil filter.



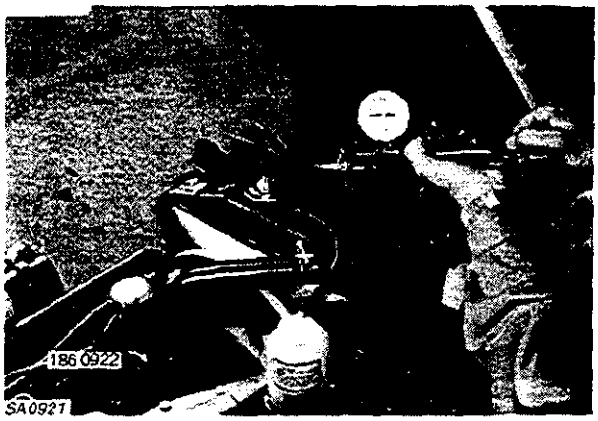
7. Remove oil pressure regulating valve body.



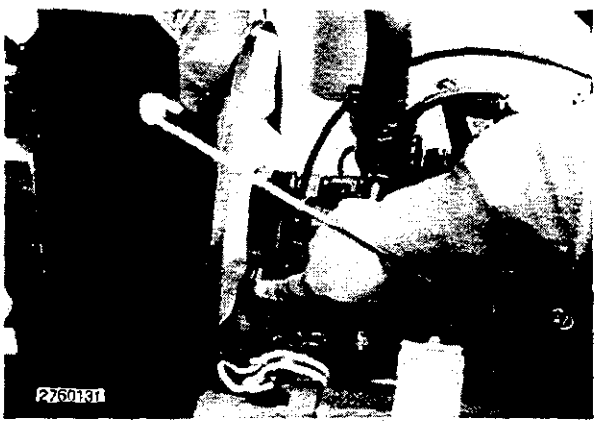
8. Remove spring retainer from valve body.
9. Add shims to increase oil pressure, and subtract shims to decrease oil pressure. Addition of one shim increases oil pressure 17 Kpa (0.18 kg/cm^2) (2.6 psi).



TESTING COOLING SYSTEM

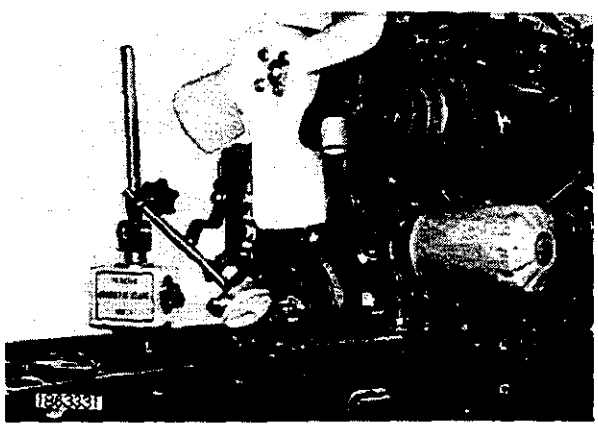


1. Tilt hood forward.
2. Visually check the radiator for leaks or damage.
3. Remove radiator cap.
4. Attach radiator tester to filler neck.
5. Use pump to apply 98 Kpa (1.0 kg/cm^2) (14 psi) compressed air to system.
6. Check radiator, hoses, water pump and engine for leaks.



CHECKING BELT TENSION

Check belt tension. Belt should deflect 10 to 15 mm (3/8 to 5/8 in.) at 8.86 N (20 lbs.) force.



CHECKING CRANKSHAFT END PLAY

Use the following procedure to check crankshaft end play while engine is in tractor.

1. Place a dial indicator base on tractor frame as shown.

Use care not to distort the timing gear cover or crankshaft pulley when prying. Place pry bar in place as shown.

2. Pry between the pulley and timing gear cover to determine end play. Compare reading taken to the following specification:

CRANKSHAFT END PLAY SPECIFICATIONS

New Part	Maximum Acceptable
0.09 to 0.19 mm (0.0035 to 0.0075 in.)	0.33 mm (0.013 in.)

FUEL/AIR OPERATION AND TESTS 230

SPECIFICATIONS

Air intake System

ITEM	SPECIFICATIONS
Intake Manifold	
Intake manifold-to-Cylinder head	25 Nm (2.5 kgm) (18 ft-lbs)

Fuel System

ITEM	SPECIFICATIONS
Fuel Tank	
Capacity	32 ℓ (8.4 US gallons)
Fuel Injection Pump	
Timing to engine	21° ± 2° Before TDC

Control Linkage

ITEM	SPECIFICATIONS
Speed Control Linkage	
Force to move throttle lever	Approx. 44 N (4.5 kg) (9.9 lbs.)

Engine/PTO Speed Relationship

	ENGINE RPM	PTO RPM
Fast idle speed	2775 ± 25	664 ± 6
Slow idle speed	900 ± 25	191 ± 6
Rated (Full load)	2600	622 1133
PTO	2258	540
	2294	1000

TOOLS REQUIRED

Screw Driver (Philips Tip)

Bleeding fuel system

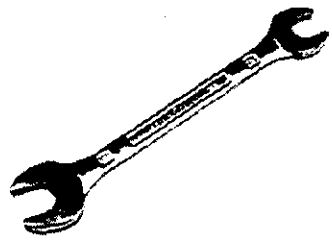
1863131

Open end Wrench

Adjusting governor system

Bleeding fuel injection pipe

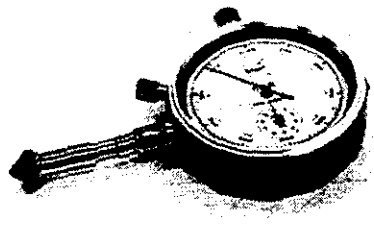
13 mm . . . . . Two
17 mm
19 mm
22 mm



1863136

Hand Tachometer

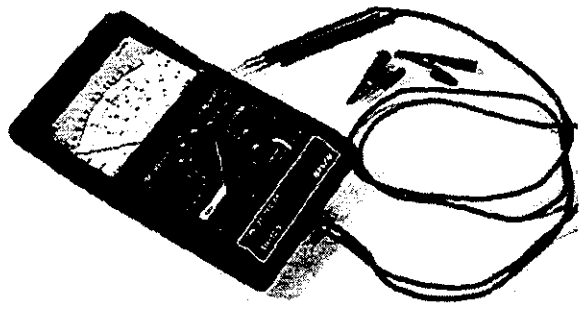
Checking engine and PTO speeds



3361034

Circuit Tester

Checking thermostart system



3361327

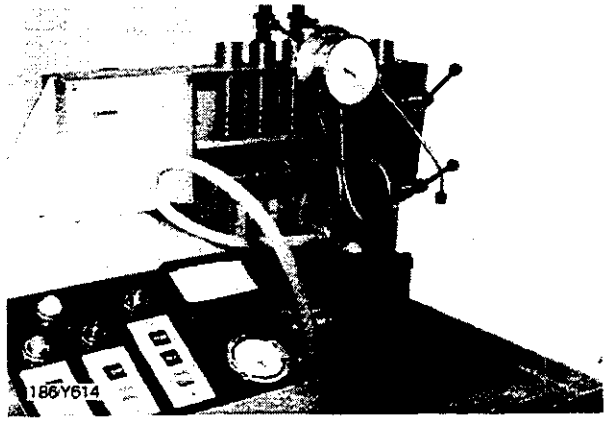
Injection Pump Adjusting Adapter (TOL-92060000)

Measuring pump plunger top clearance with a dial gauge.

3361111

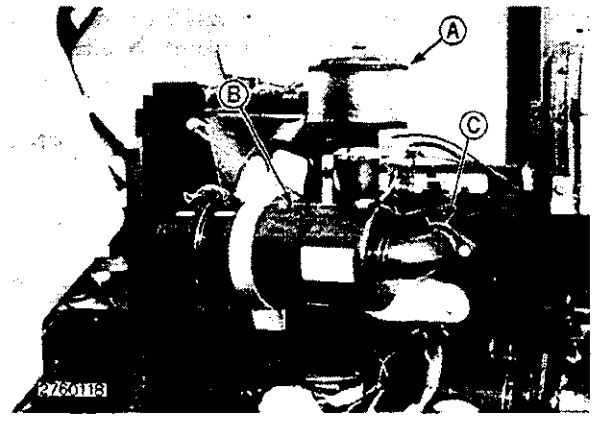
Yanmer Pump Tester (Type 1)

Testing fuel injection pump.



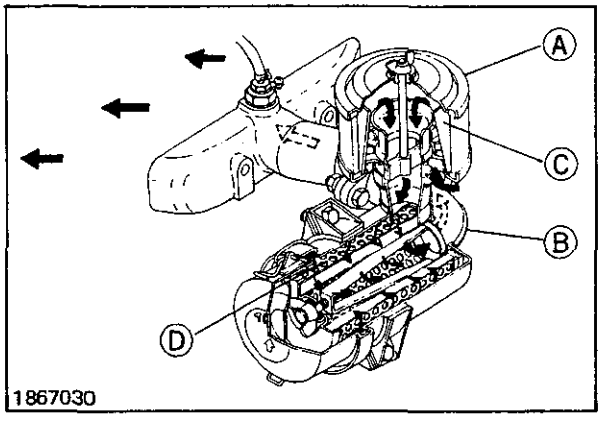
HOW THE SYSTEM WORKS

Outside air is drawn into the air intake system by engine suction. The air is filtered in the precleaner (A) and air cleaner (B) to remove dust and flows through intake manifold (C), and into engine cylinders.



A — Precleaner
B — Air Cleaner
C — Intake Manifold

Dust-laden air enters the precleaner inlet and is forced into a high-speed centrifugal motion. Heavier dust particles are separated from the air (because of centrifugal motion) and deposited in the dust cup (C). Lighter particles are removed from the air and retained by the filter element (D) before the air leaves the air clearner at outlet (B).



A — Precleaner
B — Air Outlet
C — Dust Bowl
D — Filter Element

DIAGNOSING SYSTEM MALFUNCTIONS

The following is a guide for diagnosing air intake system malfunctions. For specific diagnosis of air intake system components, refer to the headings which cover complete diagnosing of engine malfunctions (Page 220-10-2).

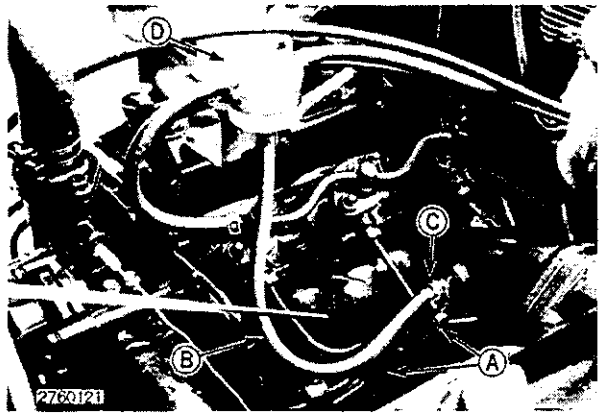
PROBLEM	POSSIBLE CAUSE	SUGGESTED REMEDY
Engine does not develop full power	• Restriction in air cleaner is restricted	Clean or replace element (Chapter 30, Section 05)
Engine emits excessive black smoke	• Restriction in air cleaner element is restricted	Clean or replace element (Chapter 30, Section 05)

THERMOSTART SYSTEM

The thermostart system is provided on the tractor to aid engine starting when the ambient air temperature is below the 0° to −5°C (32° to 40°F) range.

This system differs from a conventional glow plug system in that two energy sources — electrical and raw diesel fuel — are used instead of one. The glow plug system uses only electrical energy.

Durability of the thermostart plug is good because the plug is not exposed to combustion chamber heat. In addition, the electrical energy consumed during preheating is low, thereby reducing the load on the electrical system for good starting performance.



HOW THE SYSTEM WORKS

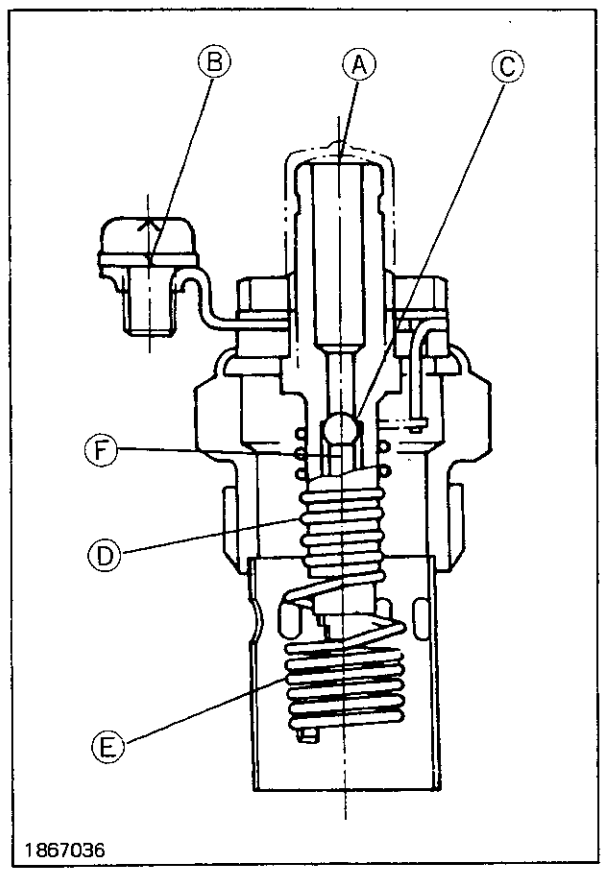
Turning the key switch on dash in a counterclockwise direction energizes the electrical system, permitting current to flow to the thermostart plug (C). As long as the key switch is held in this position, current will be supplied to the thermostart plug.

A — Wiring Lead
B — Supply Hose
C — Thermostart Plug
D — Cup

Diesel fuel from a cup (D) is supplied by hose (B) to the thermostart plug. As the electrical current flows into the plug, the heater coil (D) is heated, causing push rod (F) to shift to the right. The ball check valve (C) then opens.

When the ball check valve opens, fuel enters the thermostart plug and evaporates when it contacts the heater coil. The evaporated fuel is then ignited by the ignitor (E) and a flame is produced.

After the recommended preheating time of 15 — 20 seconds has transpired, the operator turns the key switch to the "start" position. The flame produced during preheating is drawn into the cylinders by suction during cranking, warming the intake air sufficiently for starting.

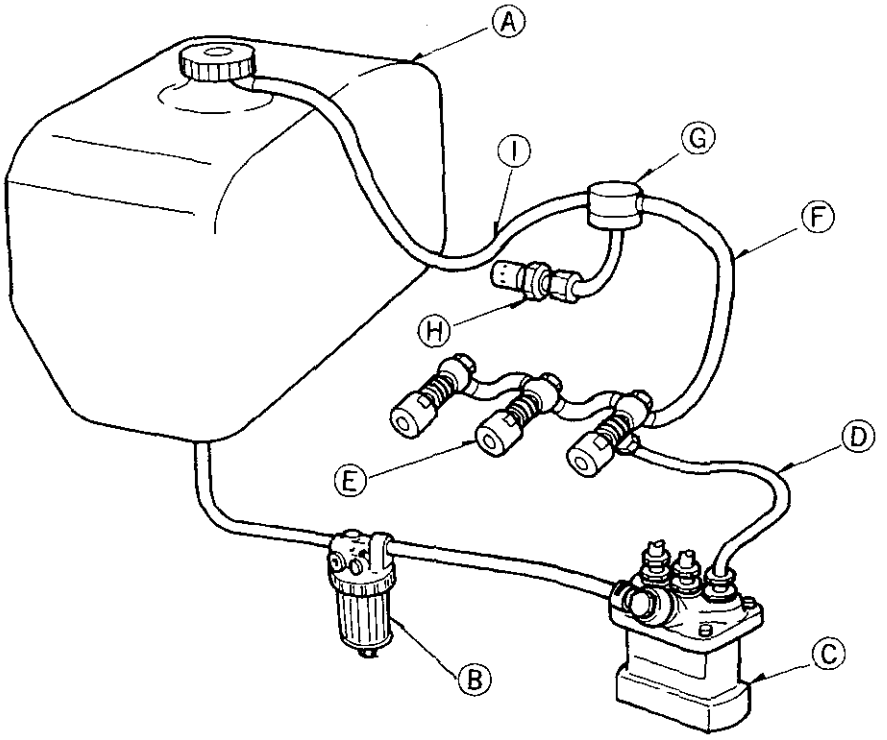


A — Fuel Flow
B — Terminal
C — Check Valve
D — Heater Coil
E — Ignitor
F — Pushrod

The thermostart system is also energized when the engine is cranking. However, the engine often will start before a flame is produced, especially if the key switch is held to the left long enough for adequate preheating during cold weather operation.

Once the key switch is released to the "run" position, the heater coil is cooled by incoming air. The pushrod then shifts to the left, causing the ball check valve to close, shutting off the fuel supply to the plug.

Refer to Chapter 30, Section 05 and Chapter 40, Section 20 for instructions on testing the thermostart plug.



1863038

A – Fuel Tank
B – Fuel Filter
C – Injection Pump
D – Fuel Injection Pipe
E – Injection Nozzle
F – Excess Fuel Line
G – Thermostart Fuel Cup
H – Thermostart Plug
I – Fuel Return

HOW THE SYSTEM WORKS

Fuel flows by gravity from the fuel tank (A), through the fuel filter (B), and fills into the fuel gallery of the injection pump (C).

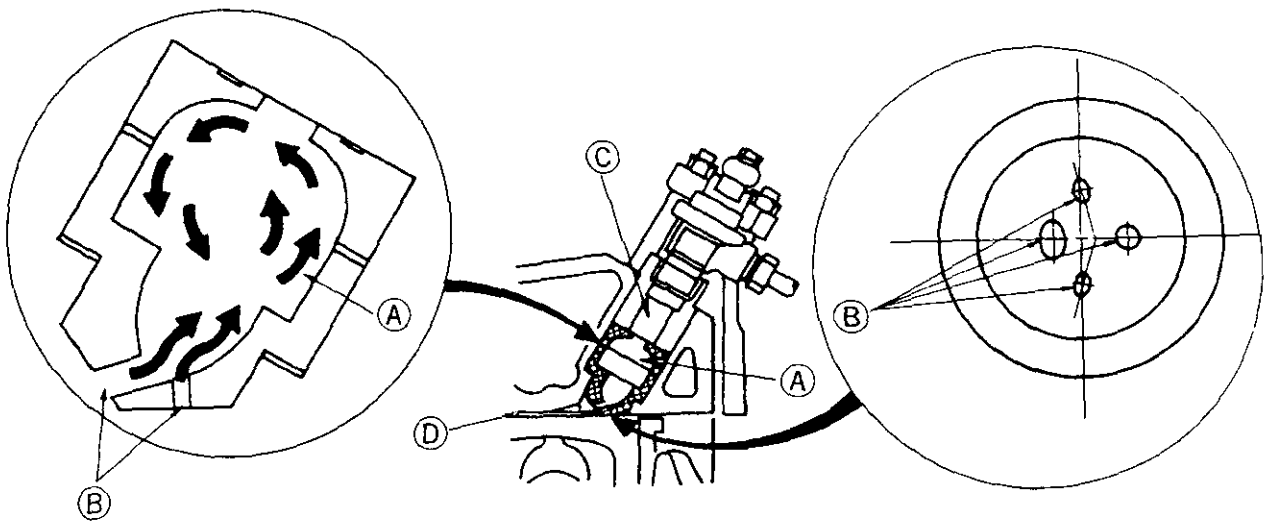
With the fuel gallery being kept full of fuel by the supply pump, the injection pump plungers pressurize the fuel to about 29.30 Mpa (299 kg/cm^2) (4250 psi). Injection pipes (D) are used to route this high pressure fuel to the injection nozzles (E).

Fuel entering the injection nozzle at 29.30 Mpa (299 kg/cm^2) (4250 psi) easily overcomes the 15.68 Mpa (160 kg/cm^2) (2275 psi) pressure required to open the nozzle valve. When the nozzle valve opens, fuel is forced out through the nozzle opening into the precombustion chamber (A).

Compressed air from the cylinder (D) is directed into the precombustion chamber through four holes (B) in the bottom of the chamber. The design of the cylinder head and precombustion chamber causes the compressed air to enter the precombustion chamber in a swirling motion. Thus, when the piston is on the compression stroke, the compressed air not only fills the space between the piston and cylinder head, but fills the space in the precombustion chamber as well.

As the rather coarse spray of fuel is injected into the precombustion chamber, there is rapid rise of pressure created by the ignition of fuel with heat of the intake air under pressure.
The pressure rise is restricted, however, by the limited space of compressed air contained in the precombustion chamber.

PRECOMBUSTION CHAMBER



1867032

A – Precombustion Chamber
B – Holes
C – Injection Nozzle
D – Cylinder

Because of the relatively high pressure in the precombustion chamber caused by fuel ignition, the resulting gaseous mixture of burned, partially burned, and unburned fuel and air is ejected out of the four holes (B) in the bottom of the precombustion chamber at high velocity in a swirling motion. This gaseous mixture enters the main combustion chamber, where the combustion process is completed.

Incorporated into the fuel system is a means of returning excess (or unused) fuel back to the fuel tank. Excess fuel comes from the injection nozzles, where a small amount of fuel seeps past the nozzle valve for lubrication purposes.

This fuel is routed through a leak-off line (F) to the fuel reservoir (G) which supplies fuel for the thermostart plug (H). When the reservoir is full, any remaining fuel is routed back to the fuel tank through a fuel return line (I).

DIAGNOSING SYSTEM MALFUNCTIONS

The following is a guide for diagnosing fuel system malfunctions. For a specific diagnosis of the fuel system components, refer to the pages which cover complete servicing.

DIAGNOSING FUEL SYSTEM MALFUNCTIONS

PROBLEM	POSSIBLE CAUSE	SUGGESTED REMEDY
Engine starts with difficulty or won't start	• Fuel tank empty	Fill tank with correct grade of fuel (see machine operation manual)
	• Fuel too heavy at low temperature	Use correct grade of fuel (see machine operation manual)
	• Low cetane fuel	Use correct grade of fuel (see machine operation manual)
	• Air in system	Correct problem and bleed air from system (this section)
	• Water in fuel	Drain water from fuel; Install new filter (this section)
	• Fuel filter clogged	Replace fuel filter (this section)
	• Incorrect pump timing	Adjusting (Chapter 30, Section 10)
	• Injection pump is faulty	Repair (Chapter 30, Section 10)
	• Injection nozzles faulty or sticking	Repair (Chapter 30, Section 10)
	• Thermostart system not working (cold weather starting)	No fuel in cup; wiring lead to terminal loose or broken; defective thermostart plug (Chapter 30, Section 10)
	• Defective (or missing) precombustion chamber copper washer	Replace (Chapter 30, Section 10)
Engine starts and stops	• Air in system	Correct problem and bleed fuel system (this Section)
	• Fuel filter clogged	Replace fuel filter (this section)
	• Fuel lines clogged or restricted	Clean lines as required
	• Water in fuel	Drain water from fuel. Install new filter (this section)
	• Vent hole in fuel tank cap clogged	Check vet for restriction; clean as required
	• Injection pump faulty	Repair (Chapter 30, Section 10)
Erratic engine operation	• Fuel filter clogged	Replace fuel filter (this Section)
	• Fuel too heavy at low temperature	Use correct grade of fuel (see machine Operation manual)
	• Low cetane fuel	Use correct grade of fuel (see machine Operation manual)
	• Water in fuel	Drain water from fuel; install new filter (this section)
	• Incorrect timing	Adjust timing (Chapter 30, Section 10)
	• Governor faulty	Repair (Chapter 30, Section 10)
	• Injection nozzles faulty or sticking	Repair (Chapter 30, Section 10)
	• Injection nozzle return lines clogged	Clean lines as required
	• Fuel lines clogged or restricted	Clean as required

DIAGNOSING FUEL SYSTEM MALFUNCTIONS (Continued)

PROBLEM	POSSIBLE CAUSE	SUGGESTED REMEDY
Engine does not develop full power	• Low cetane fuel	Use correct grade of fuel (see machine OM)
	• Fuel filter clogged	Replace fuel filter (this section)
	• Water in fuel (or gasoline in fuel)	Drain and replace with clean fuel. Install new filter (this section)
	• Incorrect fast idle speed	Adjust speed (this section)
	• Incorrect pump timing	Adjust timing (Chapter 30, Section 10)
	• Injection pump or governor faulty	Repair (Chapter 30, Section 10)
	• Injection nozzle return lines clogged	Clean as required
	• Injection nozzles faulty or incorrectly adjusted	Adjust or repair (Chapter 30, Section 10)
	• Torque spring shaft incorrectly adjusted	Adjust (Chapter 30, Section 10)
	• Defective precombustion chamber copper gasket	Replace (Chapter 30, Section 10)
Engine idles poorly	• Injection nozzles faulty or sticking	Repair (Chapter 30, Section 10)
	• Incorrect pump timing	Adjust timing (Chapter 30, Section 10)
	• Pump slow idle speed not correctly adjusted	Adjust slow idle speed (Section 15, this Chapter)
	• Injection pump faulty	Repair (Chapter 30, Section 10)
	• Defective precombustion chamber copper gasket	Replace (Chapter 30, Section 10)

FUEL FILTER

GENERAL INFORMATION

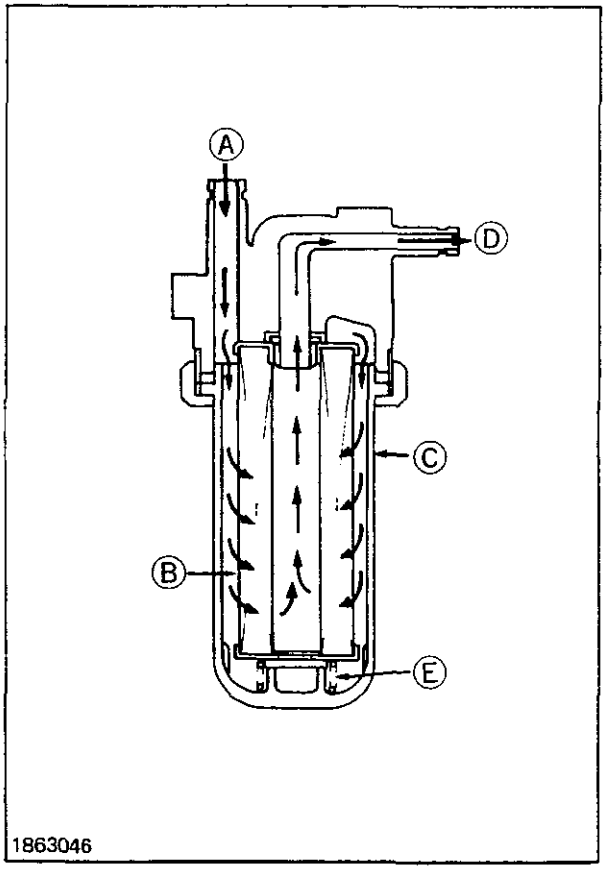
A fuel filter is used to prevent dirty fuel from reaching the injection pump and injection nozzles.

The filter element will require occasional replacement to maintain an adequate flow of fuel to the injection pump. The frequency of this service will vary according to the cleanliness of available fuel and the care used in storage.

HOW THE FUEL FILTER WORKS

Fuel from the tank enters the filter housing inlet (A) (Fig. above) and fills the sediment bowl (C). The fuel is then filtered as it passes through the filter element (B), leaves housing at outlet (D), and flows to the injection pump.

Two air vent screws (E) (Fig. under) are used to bleed air from the fuel system up to the injection pump (a third air vent screw is located on the pump inlet fitting for the purpose of removing air from inside the pump). The left-hand vent screw on filter permits removal of air in sediment bowl before the filter element; the right-hand screw after the filter element.
Water and sediment settle to the bottom of the sediment bowl for removal when necessary.

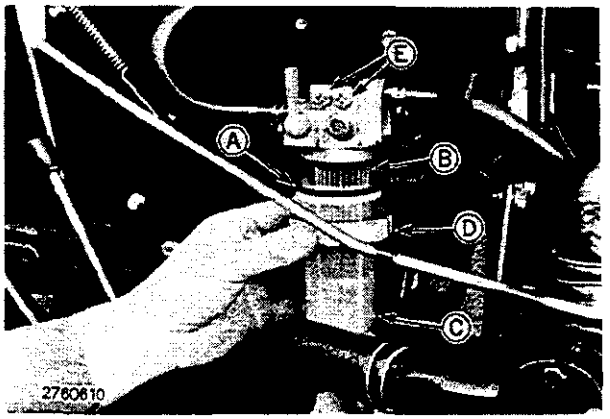


A – Inlet
B – Filter Element
C – Sediment Bowl
D – Outlet
E – Spring

REPLACING FILTER ELEMENT

Before replacing the filter element, shut-off the fuel supply to the filter by turning the fuel shut-off lever straight up. Then, do the following.

1. Unscrew large nut (D) (Fig. under) which retains the sediment bowl from filter housing.
2. Remove nut and sediment bowl (C) from filter housing.
3. Remove filter element (B), and install a new element in its place.
4. Thoroughly clean sediment bowl. Be sure that O-ring seal (A) is in good condition and install onto sediment bowl. Also, be sure that spring (E) (Fig. above) is in place.
5. Install sediment bowl, being careful not to overtighten nut.
6. Turn on fuel supply.
7. Open both air vent screws (E) on filter and bleed screw on injection pump to bleed air form fuel. Tighten screws when fuel flows free of bubbles.



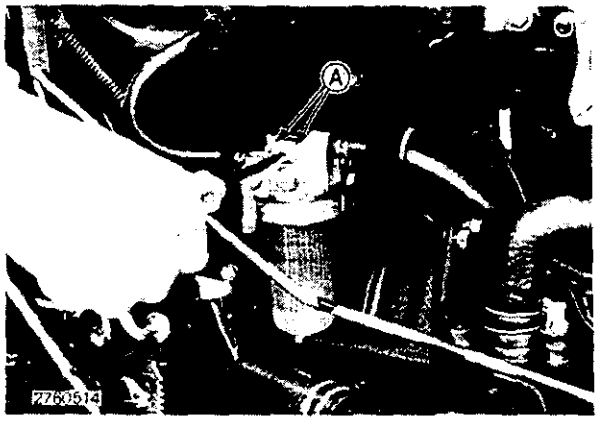
A – O-ring Seal
B – Filter Element
C – Sediment Bowl
D – Retaining Nut
E – Bleed Screws

BLEEDING FUEL SYSTEM

CAUTION: Escaping diesel fuel under pressure can have sufficient force to penetrate the skin, causing serious personal injury. Before disconnecting lines be sure to relieve all pressure. Before applying pressure to the system, be sure all connections are tight and that lines, pipes and hoses are not damaged. Fuel escaping from a very small hole can be almost invisible. Use a piece of cardboard or wood, rather than hands, to search for suspected leaks.

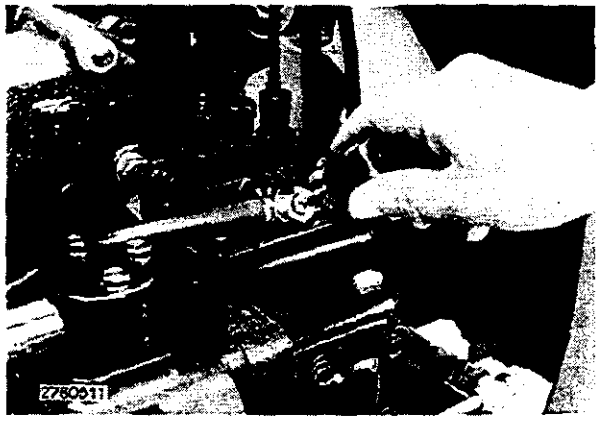
If injured by escaping fuel, see a doctor at once. Serious infection or reaction can develop if proper medical treatment is not administered immediately.

Whenever the fuel system has been opened up for service (lines disconnected of filter removed), it will be necessary to bleed the air from system.

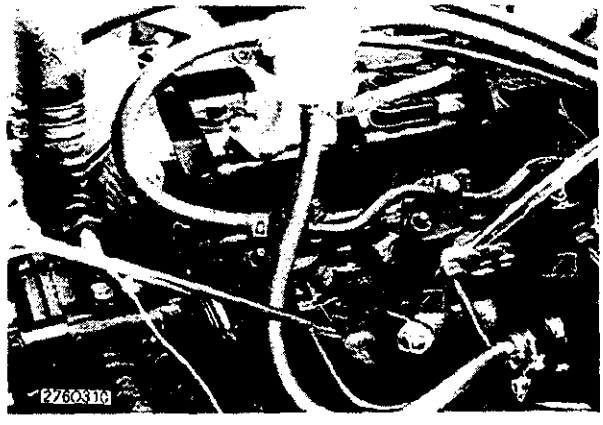


1. Refill fuel tank if it is empty.
2. Open shut-off valve.
3. Loosen both bleed screws on fuel filter housing. When air bubble is gone and fuel flows out bleed hole, tighten screws.

A – Bleed Plugs



4. If the fuel line from injection pump is also empty, loosen bleed screw on injection pump. When fuel flows out bleed hole, tighten screws.



5. If the lines from injection pump to fuel injection nozzles are also empty, loosen lines where they connect to injection nozzles. Push throttle lever fully forward and operate starter until fuel runs from fittings. Tighten lines.

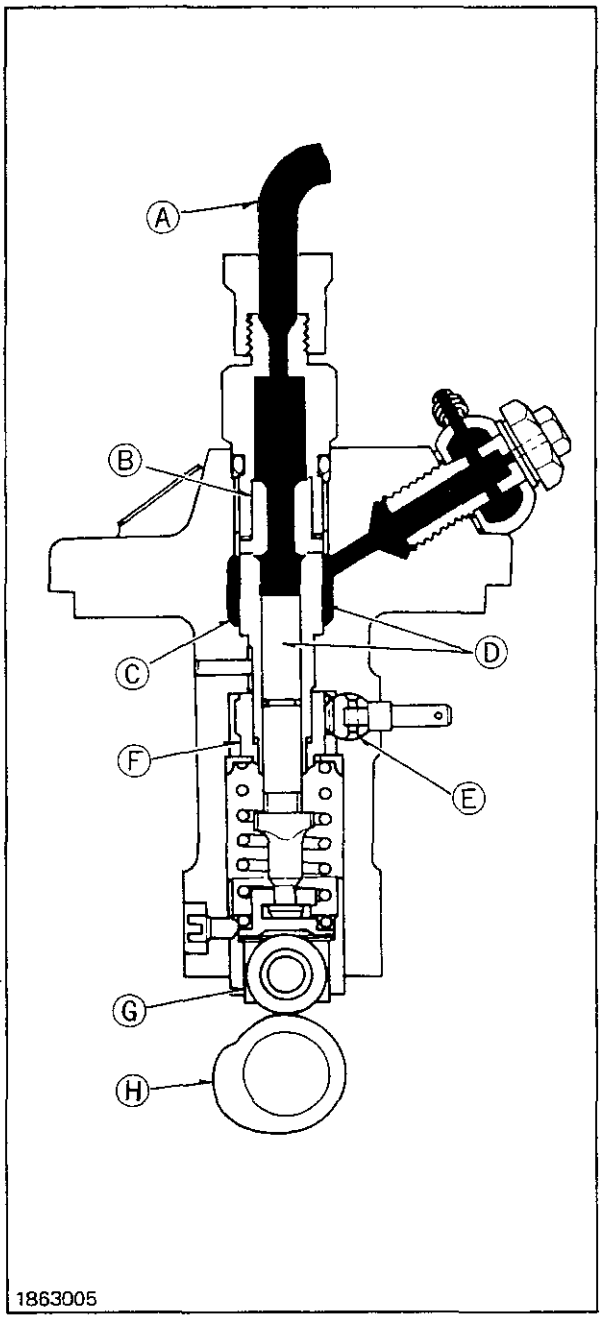
STOP Never operate starter longer than 10 seconds continuously. Allow one minute to cool before engaging starter again.

FUEL INJECTION PUMP

GENERAL INFORMATION

The Yanmar YPER-0707 injection pump is a multiplunger, in-line type pump. It differs from most in-line type pumps however, in that it does not have its own camshaft and governor.

To operate the pump, three special lobes on the engine camshaft are used (Chapter 20, Section 05). The engine crankshaft has the governor flyweights and thrust sleeve attached to it to provide the centrifugal force to the governing systme (see page 230-10-16).



HOW THE FUEL INJECTION PUMP WORKS

Filtered fuel under gravity pressure from the fuel tank fills into the injection pump fuel gallery (C). As the engine camshaft rotates, roller tappets (G) riding on the camshaft lobes (H) operate the plungers (D) to supply high pressure fuel through the delivery valves (B) and fuel injection pipes (A) to the injection nozzles.

A governor-operated control rack (E) is connected to the control sleeves (F) and plungers to regulate the quantity of fuel delivered to the engine.

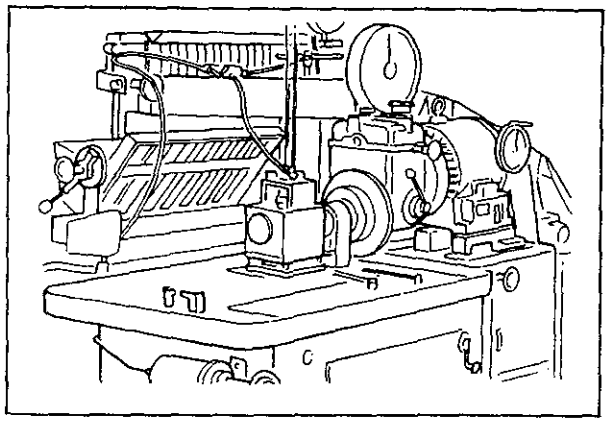
A – Fuel Injection Pipe
B – Delivery Valve
C – Fuel Gallery
D – Barrel and Plunger
Injection Pressure

E – Control Rack
F – Control Sleeve
G – Roller Tappet
H – Engine Camshaft
Gravity Pressure

DIAGNOSING MALFUNCTIONS

Refer to charts on pages 230-10-3 and 4.

TESTING INJECTION PUMP



Whenever the pump receives a new plunger and barrel, or its barrel stopper has been moved must be tested by YANMAR Pump tester (Type i).

When using a non-YANMAR tester, the following cambox is necessary.

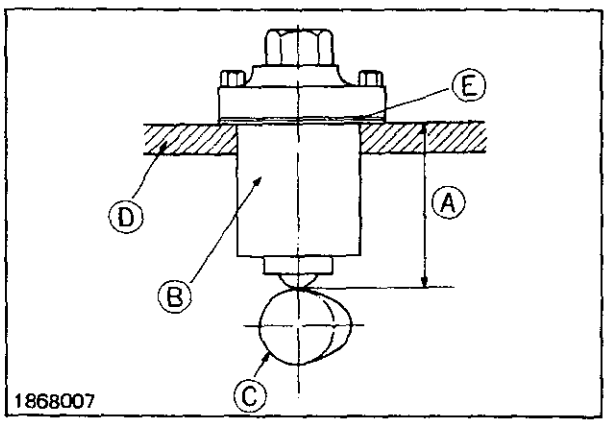
NON-YANMAR TESTER

Pump Type	Cam box Part No.	Applicable pump Tester
2 cyl.		Bosch 385
. . . . .		Bacharach specialist 10 U7500A
3 cyl.		Bosch 385
. . . . .		Bacharach specialist 10 U7500A

PREPARATION FOR TESTING

1. Place the pump on the pump tester.

When the fuel injection pump is installed on the cam box (D), to measure the calibration, check the mounting distance (A) which should be within 76 ± 0.05 mm (2.992 ± 0.002 in. for the YPFR-0707 Pump type.



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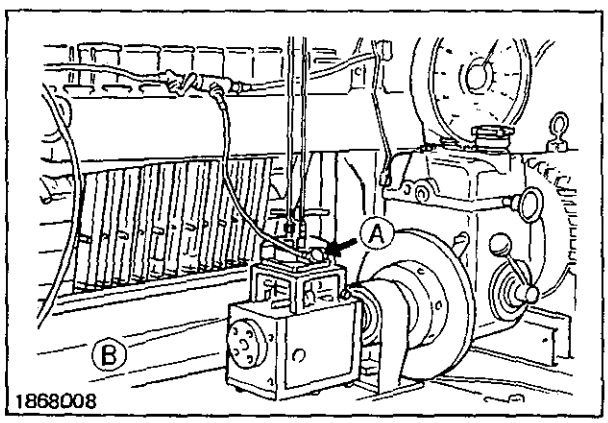
The mounting distance means the dimension from the mounting surface of the cam box to a base circle of the cam profile.
If this dimension is out of the specified value, the adjusting shims should be added or reduced so that the mounting distance is within the specified value.

2. Check the control rack stroke.
   Operate the control lever and make sure that the total stroke of the control rack is about 18 mm (0.7 in.) and that the rack moves smoothly. If the rack does not move smoothly, recheck the pump and recondition the rack.

A – Mounting Distance
B – Pump
C – Cam
D – Cam Box
E – Timing Adjusting Shims



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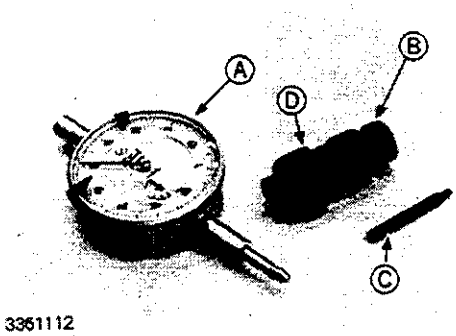
3. Run the pump tester at a low speed and loosen the pump's air bleed screw to bleed air out.

A – Bleed Screw
B – Cam Box

ADJUSTING PLUNGER TOP CLEARANCE

Remove the delivery valve holder and the delivery valve. By rotating the camshaft, set the plunger at top dead center. With a dial gauge measure the clearance (A) (Fig. under) in the level between the tops of the plunger barrel and the plunger (space above the top).

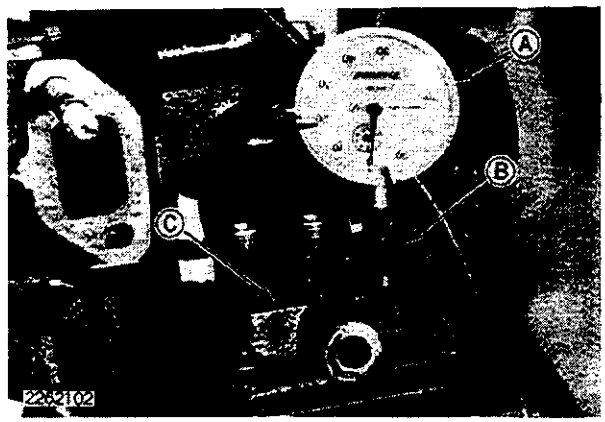
1. Attach the dial gauge (A) to the adapter (D).



3361112

A – Dial Gauge
B – Jig
C – Extension
D – Adapter

2. Stand the jig on a surface plate and adjust the dial gauge reading to zero.



223-2102

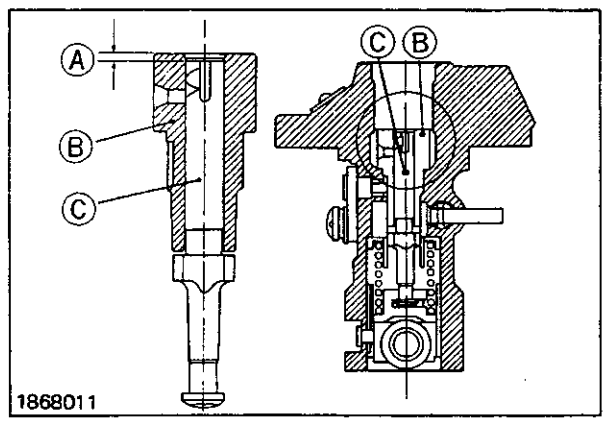
A – Dial Gauge
B – Adapter
C – Pump

3. Remove the pump's delivery valve and mount the measuring jig in its place.

4. Rotate the camshaft to bring the plunger to top dead center. The dial gauge now shows the vertical distance of the space above the plunger top.

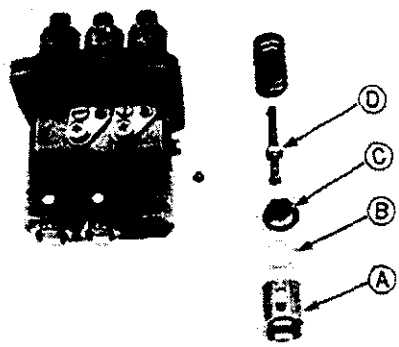
PLUNGER SPECIFICATIONS

Plunger Top Clearance	1.0 ± 0.05 mm (0.0394 ± 0.00197 in.)



1868011

A – Top Clearance
B – Plunger Barrel
C – Plunger



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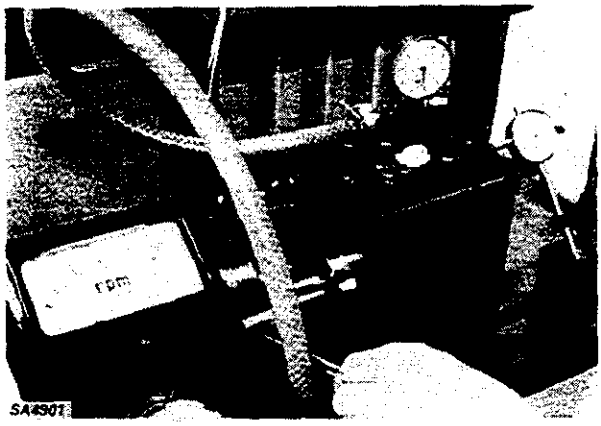

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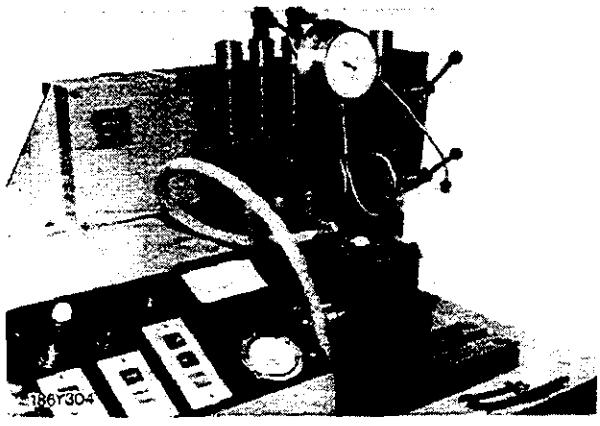

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5. If the top clearance of the plunger is greater than the specified valve, remove the plunger guide (A), and insert a plunger stroke adjusting shim (B) between the lower plunger spring retainer (C) and the plunger guide. Adjust each cylinder in a similar manner. If a measuring adaptor is not available, insert a shim with the same thickness as the one removed. Measure the injection timing of all cylinders, and make the plunger top clearance of each cylinder uniform.

A — Plunger Guide
B — Shims
C — Lower Spring Retainer
D — Plunger

PLUNGER TOP CLEARANCE ADJUSTING SHIM SPECIFICATIONS

Parts Code	Thickness
174307-51710	0.1 mm (0.004 in.)
174307-51720	0.2 mm (0.008 in.)

6. Install delivery valve holder after measuring. Tighten the holder 39 to 44 Nm (4 to 4.5 kgm) (29 to 33 ft-lbs).

TESTING PRESSURE OF DELIVERY VALVE

1. Attach a 98 Mpa (1000 kgf/cm^2) (14220 psi) pressure gauge to the delivery valve holder.
2. Operate pump tester and give a pressure about 11.76 Mpa (120 kgf/cm^2) (1700 psi) to the delivery valve.
3. Measure the time required for the pressure to drop from 9.8 Mpa (100 kgf/cm^2) (1422 psi) to 8.82 Mpa (90 kgf/cm^2) (1278 psi). Compare measurement taken to the following specifications.

DELIVERY VALVE SPECIFICATION

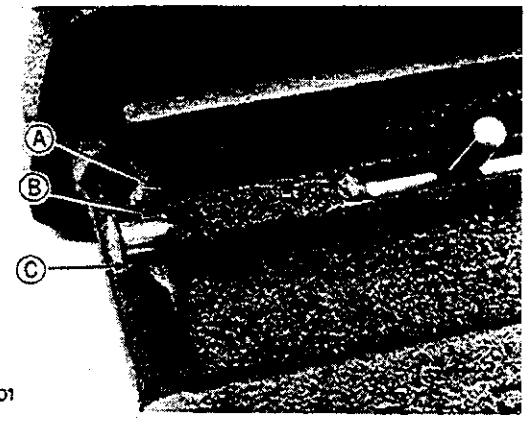
Time Allowance	
Pressure drop	Max. 5 sec.
Testing Pump Speed	200 RPM

TESTING PLUNGER PRESSURE LEAK

1. Attach a 98 Mpa (1000 kgf/cm^2) (14000 psi) pressure gauge to the delivery valve holder.
2. Increase pressure about 49 Mpa (500 kgf/cm^2) (7000 psi) and check for fuel leaks from the delivery valve holder and injection pipe connection. Make sure does not drop instantly.

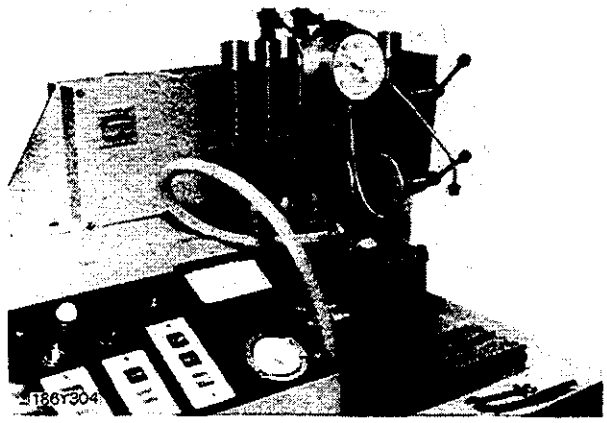
TESTING FUEL INJECTION VOLUME

1. Align the mark (B), of the fuel control rack with the reference surface (A).



A — Reference Surface
B — Punch Mark
C — Control Rack

2. Set the revolution speed of the pump camshaft at 1500 rpm.



INJECTION VOLUME SPECIFICATION

ENGINE	Camshaft Speed	Injection Volum
3T84HA	1500RPM	22.5 to 23.5 mℓ/1000 Stroke (0.79 to 0.83 oz/1000 Stroke)

3. Check fuel injection nozzle.

INJECTION NOZZLE SPECIFICATIONS

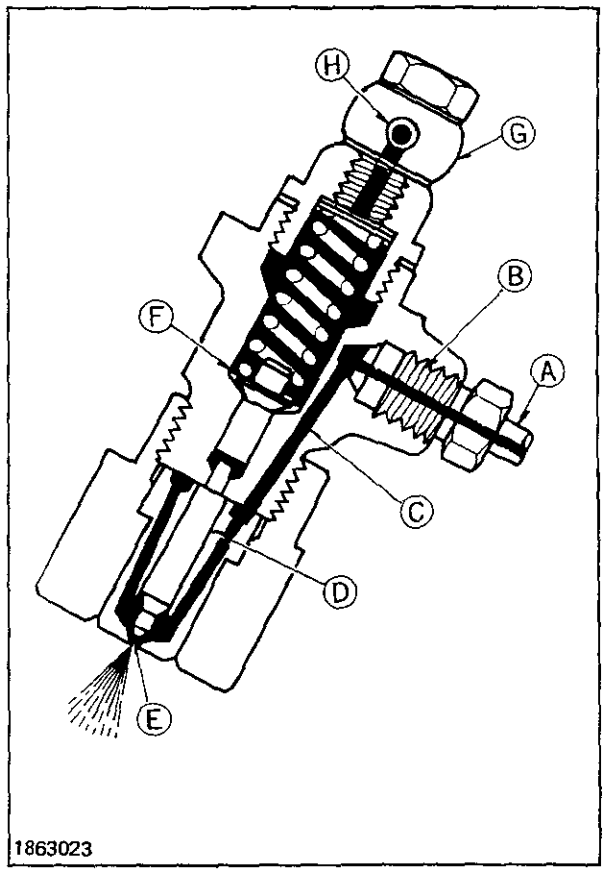
Type	YND-OSDYD1
Injection pressure	15.68 Mpa (160 kgf/cm^2) (2275 psi)
Calibration fluid	SAE J967C calibrating
Fuel feed pressure	49 Kpa (0.5 kgf/cm^2) (7 psi)
Fuel injection pipe	Use the same dimension as the engine's

FUEL INJECTION NOZZLES

GENERAL INFORMATION

They Yanmar YDN-OSDYD1 injection nozzles are of the single-hole, inward-opening, throttle type. Throttle nozzles are commonly used on engines having precombustion chamber design, because the spray pattern produced through the single hole opening works well in a high air swirl environment of the precombustion chamber.

Nozzle valve opening pressure is set at 15.68 Mpa (160 kg/cm^2) (2275 psi). Addition or deletion of shims regulates the opening pressure.



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HOW THE FUEL INJECTION NOZZLE WORKS

The injection pump presurizes the fuel to about 29.3 Mpa (299 kg/cm^2) (4250 psi) on the PFR3K pump. Fuel pipes (A), deliver the fuel to the injection nozzle.

Fuel enters the injection nozzle inlet (B) and is routed down through a passage (C) in nozzle holder to the nozzle valve (D). The nozzle valve is lifted instantly off its seat by the high pressure inlet fuel acting on the face of the valve.

Since the nozzle valve opening pressure of the injection nozzle is set to open at 15.68 Mpa (160kg/cm^2) (2275 psi) the inlet fuel pressure easily overcomes the resistance of the nozzle valve spring (F).

When the nozzle valve opens, a definite quantity of fuel (determined by the injection pump output for each plunger stroke) is forced out through the throttling valve (E). The fuel ignites the swirling air in the precombustion chamber and the resulting explosion forces the gaseous mixture out of the precombustion chamber and into the cylinder. See pages 230-10-1 and 230-10-2.

As soon as the "change" of fuel has been delivered by the injection pump plunger, the pump delivery valve closes. The nozzle valve then closes instantly to stop fuel delivery and prevent after-dribble. It stays closed until opened at the next delivery stroke.

The injection pump delivery valve has a "relief plunger" (or sometimes called a "retraction piston") which is part of the delivery valve. Its function is to provide additional volume in the delivery valve holder for the fuel in the delivery valve holder for the fuel in the delivery pipe when the delivery valve closes.

The plunger (or piston) volume is 25 mm^3. This increase in volume available for the fuel causes the pressure within the delivery pipe to drop suddenly to about 294 kPa (3kg/cm^2) (50 psi.) When this happens, the nozzle valve closes abruptly because of the heavy spring tension exerted on it.

The nozzle assembly is lubricated by a small amount of fuel which seeps between the lapped surfaces of the nozzle and valve when it accumulates around the spring (F).

The leakage fuel is routed out of the nozzle holder through a leak-off connector (G) and returned back to the fuel tank by means of a hose connected to the leak-off outlet (H).

A – Fuel Injection Pipe
B – Fuel Inlet
C – Fuel Passage
D – Nozzle Valve
E – Throttling Valve
F – Nozzle Valve Spring
G – Leak-Off Connector
H – Leak-Off Outlet
High Pressure Fuel
Return Fuel

FUEL INJECTION NOZZLE
DIAGNOSING MALFUNCTIONS

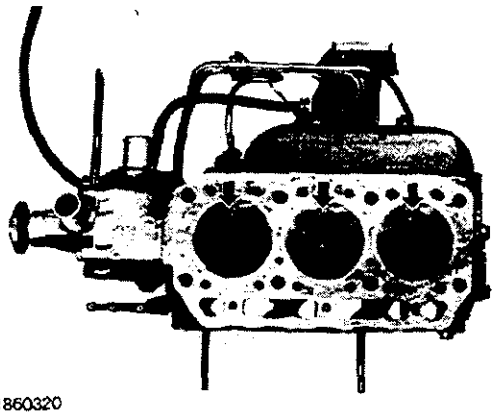
PROBLEM	POSSIBLE CAUSE	SUGGESTED REMEDY
Engine has low horsepower	• Nozzle orifice plugged	Repair (Chapter 30, Section 10)
	• Incorrect nozzle valve opening pressure	Adjust (Chapter 30, Section 10)
	• Broken or damaged parts a. Broken nozzle valve spring b. Cracked or split nozzle valve tip c. Cracked or split nozzle body d. Internal leak	Repair as required (Chapter 30, Section 10)
	• Nozzle loose in cylinder head	Tighten, following instruction in Chapter 30, Section 10.
Engine emits too much smoke	• Nozzle orifices plugged	Clean (Chapter 30, Section 10)
	• Broken or damaged parts a. Broken nozzle valve spring b. Cracked or split nozzle tip c. Cracked or split nozzle body d. Internal leak	Repair as required (Chapter 30, Section 10)
	• Worn nozzle valve seat	Replace nozzle assembly (Chapter 30, Section 10)

Fuel injection nozzles must usually be removed from the engine whenever there is a noticeable loss of power of excessive smoking.

Listed above are various malfunctions which may occur on the Yanmar throttle nozzles. Only possible defects related to these nozzles are listed. Failures in other components of the fuel injection system are listed under their respective headings in this section.

Refer to Chapter 30, Section 10 for repair information.

PRECOMBUSTION CHAMBER



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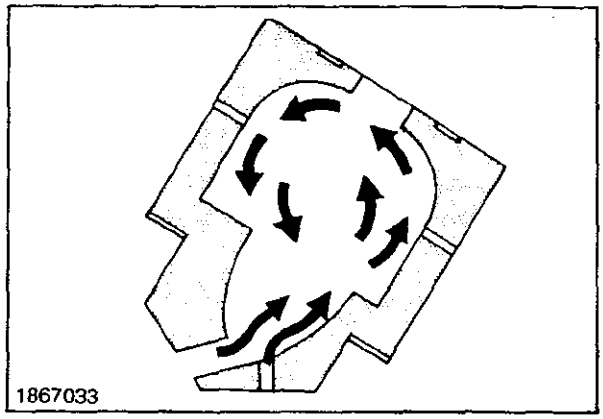

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HOW THE PRECOMBUSTION CHAMBER WORKS

As the piston begins compressing the air in the cylinder (compression stroke), a limited amount of air can enter the precombustion chamber through the four holes located in the bottom of the chamber. Note that the precombustion chamber extends out from the bottom of the cylinder head.

The four holes not only limit the volume of air which can enter the precombustion chamber, but also are designed in such a way (along with the shape of the cylinder head) so as to force the compressed air to flow into a swirling motion. At the precise moment that fuel is injected into the insufficient volume of air in the precombustion chamber, the gaseous mixture (air, burned fuel, partially burned fuel, and unburned fuel) is discharged into the cylinder at high velocity.

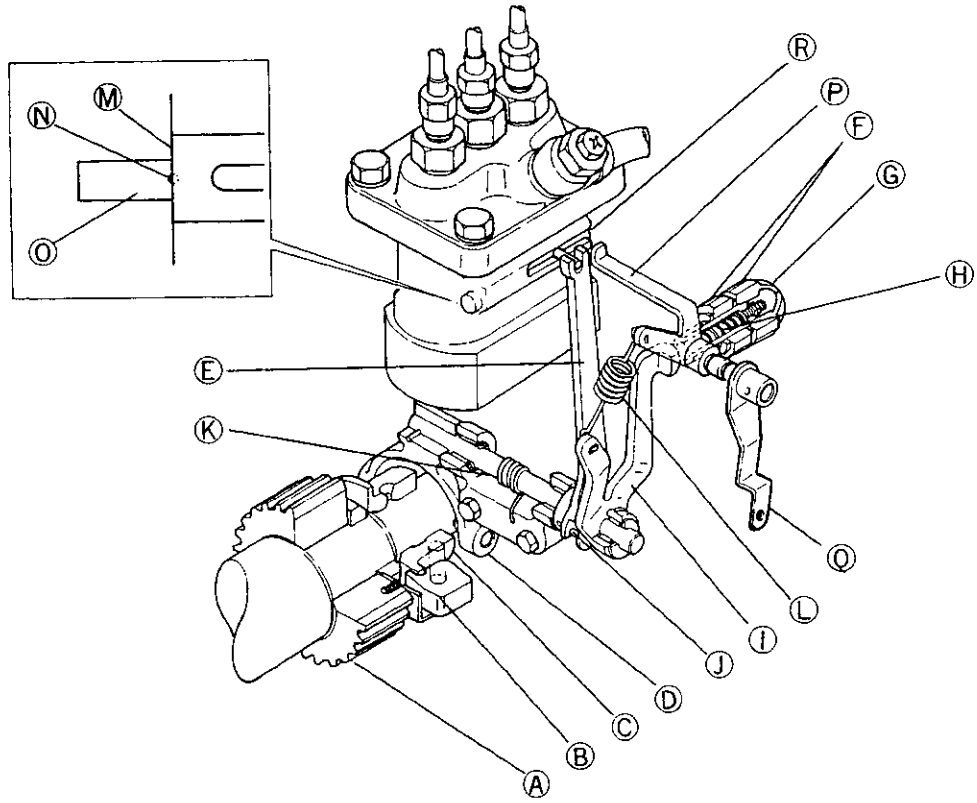
Because the initial ignition takes place within the precombustion chambers, firing pressures in the cylinders are kept low. This results in smaller loads (when compared with engines not having precombustion chambers) on vital engine parts, such as bearings and rings. Other operational advantages not to be overlooked are low noise and gaseous emission levels.

DIAGNOSING MALFUNCTIONS

The precombustion chambers generally do not malfunction. However, if a problem occurs, the complaint will usually be difficult starting, low power or rough running. Look for.

POSSIBLE CAUSE	SUGGESTED REMEDY
Compression Leak (Hissing Noise)	Replace copper washers (2 used) — Chapter 30, Section 10.

GOVERNOR



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A – Crankshaft Gear
B – Governor Flyweights
C – Thrust Sleeve
D – 1st Governor Lever
E – 2nd Governor Lever
F – Lock Nut and Cap Nut
G – Fuel Limiter
H – Limiter Spring
I – Control Lever
J – Pin
K – Governor Lever Return Spring
L – Regulator Spring
M – Reference Face
N – Punch Mark
O – Control Rack
P – Regulator Lever
Q – Regulator Handle

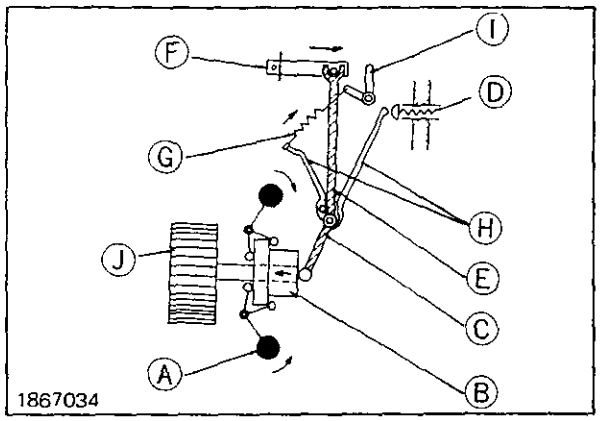
GENERAL INFORMATION

The governor regulates the amount of fuel which the injection pump delivers to the engine, the amount of fuel being dependent upon engine speed and load conditions.

Part of the governing mechanism (thrust sleeve C) and flyweights (B) is mounted on the engine crankshaft gear (A) and part (governor levers (D, E) and fuel limiter (G)) is mounted on the timing gear cover.

A 2nd governor lever (E), connected to the injection pump control rack (D), transmits engine requirements to the injection pump. A Regulator spring (L) connects to the regulator lever (P) and control lever (I) together for obtaining a desired speed selection. A Pin (J) on the control lever (I) push the 2nd governor lever (E) to the front for increase fuel injection volume. The control lever (I) also contacts with the fuel limiter (G).

GOVERNOR (Continued)



HOW THE GOVERNOR WORKS

Two major forces affect governor operation – (1) centrifugal force and, (2) Regulator spring. Centrifugal force acts upon the governor flyweights and thrust sleeve. Counteracting centrifugal force is the force exerted by the regulator spring.

A third force, torque spring, works to oppose regulator spring force when the engine speed drop below the rated speed (a condition of low centrifugal force).

Essentially for a constant speed, the centrifugal force and regulator spring force must be balanced. When either one of the two forces exceeds the other, a change in fuel delivery will take place as long as the demands are within operational limits.

Let's take a look at two different operating conditions and see how the governor responds to them: (1) Engine load increased, and (2) Engine load decreased.

Engine Load Increased

Referring to the illustration, notice how the governor responds to an increased load on the engine. The regulator lever (I) had previously been set for the desired engine speed. This tensions the regulator spring (G).

1. As the load on the engine is increased, engine speed is reduced (needs more fuel). The centrifugal force, therefore, is reduced.
2. A decrease in the centrifugal force causes the governor flyweights (A) to come closer together. This in turn, moves the governor thrust sleeve (B) to the left, toward the crankshaft gear (J).
3. The 1st governor lever (C) moves to the left, following the thrust sleeve, because of tension on the regulator spring through pin (K) on control lever (H).
4. If the increased load on the engine does not produce an overload condition, governor lever will move against fuel limiter spring (D), but not compress it (this is the rated, or full load speed position).
5. If an overload condition exists, the 1st governor lever will move to the left, and 2nd governor lever will move to the right to increase fuel injection volume.
6. When moving the 2nd governor lever to the right, the control lever (H) also moves to right by regulator spring force, until the pin (K) hits against the 2nd governor lever, compressing limiter spring (D).
7. As the load on engine stabilizes or is decreased, the centrifugal force becomes balanced with the governor spring force, and the amount of fuel delivered to the engine will be lessened to produce a constant speed.

   Should an overload condition still exist, the injection pump will deliver fuel at its maximum rate until either the overload condition is removed, or the tractor stalls.

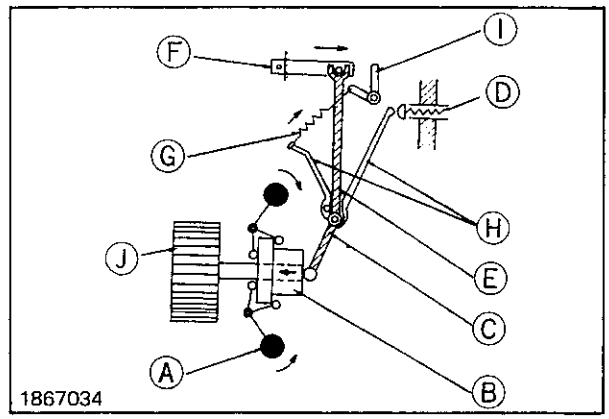
A – Flyweights
B – Thrust Sleeve
C – 1st Governor Lever
D – Fuel Limiter and Spring
E – 2nd Governor Lever
F – Control Rack
G – Regulator Spring
H – Control Lever
I – Regulator Lever
J – Crankshaft Gear
K – Pin

Engine Load Decrease

Referring to the illustration, notice how the governor responds to an decreased load on the engine. The regulator lever (I) had previously been set for the desired engine speed. The tensions the regulator spring (G).

1. As the load on the engine is decreased, engine speed is increased (needs less fuel). The centrifugal force, therefore, increases.
2. An increase in the centrifugal forces causes the governor flyweights (A) to move further outward. This in turn, moves the governor thrust sleeve (B) to the right, away from the regulator gear (J).
3. The 1st governor lever (C) moves to the right, being pushed by the thrust sleeve (moving because of centrifugal force).

   At the same time, the 2nd governor lever moves to the left to decrease fuel injection volume.
4. Control lever (H) is also moved to the left through the pin (K) by the 2nd governor lever.
5. As the load on the engine stabilizes or is increased, the centrifugal force becomes balanced with the governor spring force, and the amount of fuel delivered to the engine will produce a constant speed.



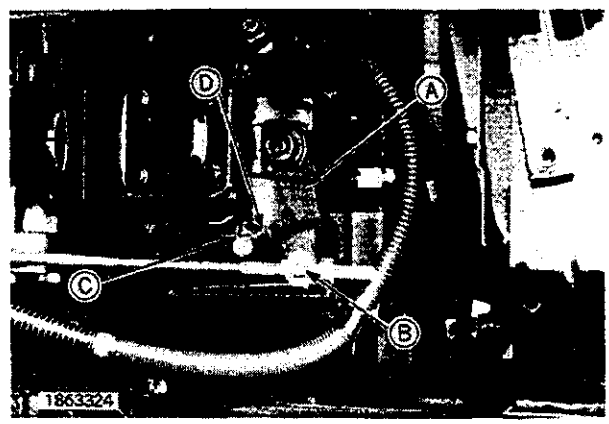
A – Flyweights
B – Thrust Sleeve
C – 1st Governor Lever
D – Fuel Limiter and Spring
E – 2nd Governor Lever
F – Control Rack
G – Regulator Spring
H – Control Lever
I – Regulator Lever
J – Crankshaft Gear
K – Pin

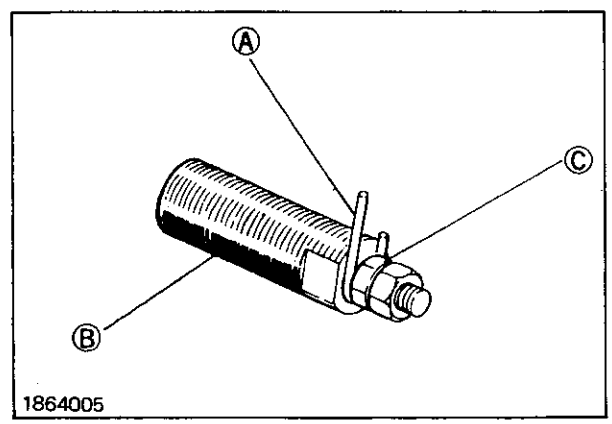
ADJUSTMENTS

Use this procedure only if the torque spring shaft has been disassembled (Section 30, Group 10) or the adjustment has been altered.

1. Remove cover plate (A)
2. Remove cap nut (B), and loosen lock nut (C).
3. Screw the fuel limiter (B) (Fig. under) out, and insert the spacer (C) as described as follows.

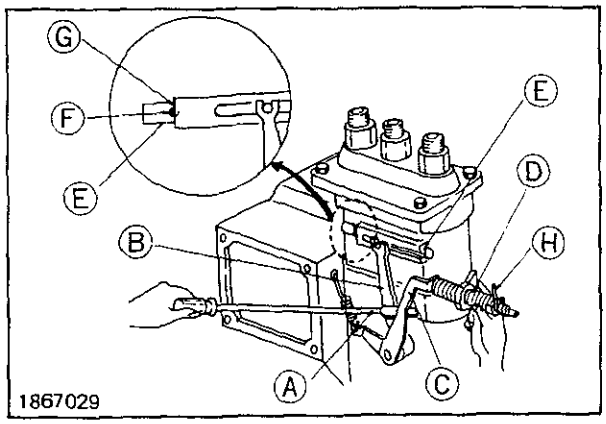
   Insert space (A) (Fig. under) which has the thickness of 0.8 to 0.9 mm (0.031 to 0.035 in.) nut (C), and screw into the timing gear cover.





A – Spacer
B – Limiter
C – Lock Nut

GOVERNOR (Continued)



ADJUSTMENTS (Continued)

4. Insert screw driver (A) between governor lever (B) and Regulator lever (C) to keep away from each other.

   Then, turn the limiter screw (D) clockwise to push the governer and regulator levers an fuel control rack (E) until the punch mark (F) on control rack (E) is centered on reference face (G) of pump housing.

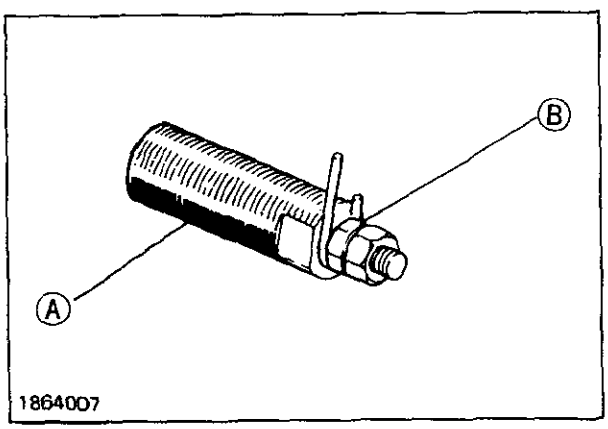
5. (FOR LIMITER WITHOUT MARK)

   Remove the screw driver (A) and the spacer (B), and screw limiter 220° to 230° (5/8 turn) out of timing gear cover.

   (FOR LIMITER WITHOUT MARK)

   Remove the screw driver (A) and the spacer (B), and screw limiter 375° to 400° (1-1/8 turns) out of timing gear cover.

A – Screw Driver
B – Governor Lever
C – Regulator Lever
D – Limiter
E – Control Rack
F – Punch Mark
G – Reference Surface
H – Spacer



6. Secure adjustment with lock nut (B) and install cap nut.

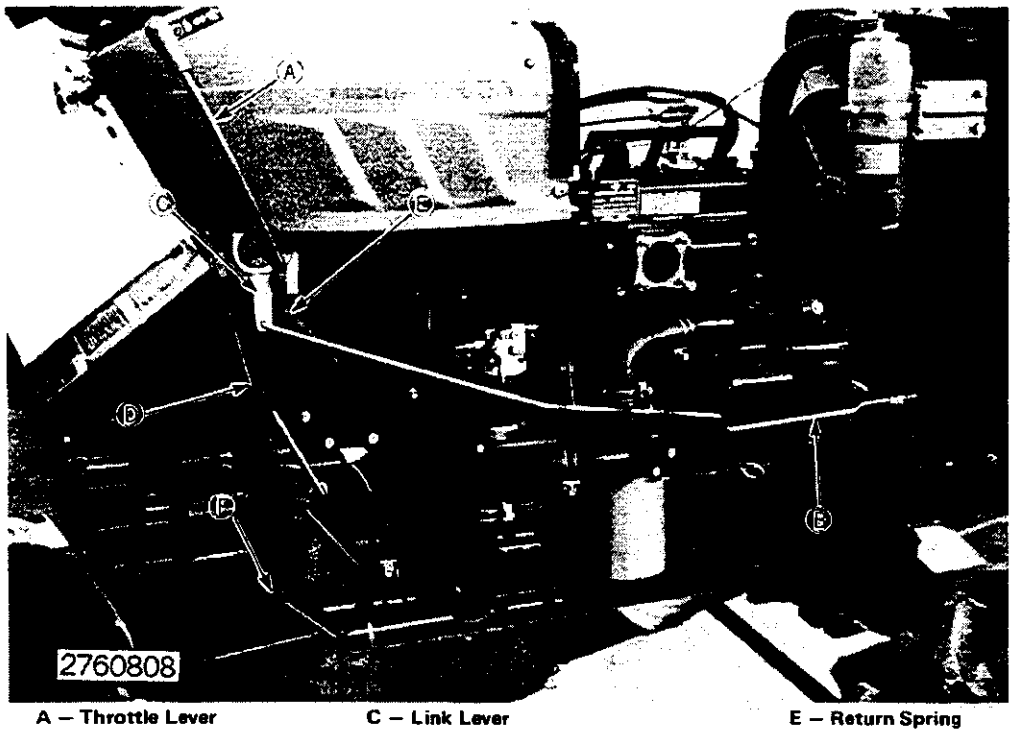
Be sure for limiter (A) not to be turned when tightening lock nut (B).

7. Install cover plate to the timing gear cover.
8. Check engine fast idle speed after adjustment.

   The fast idle speed should be 2750 to 2800 rpm.

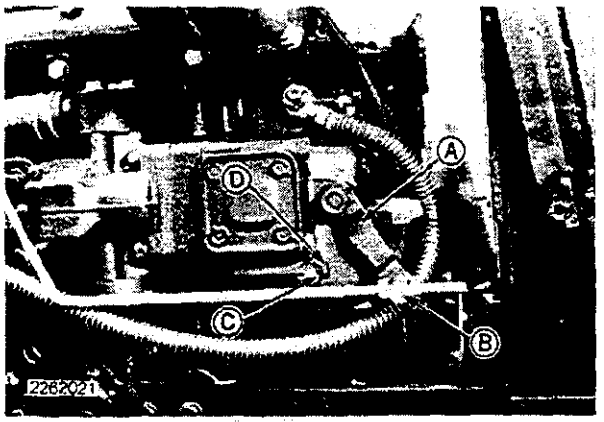
A – Fuel Limiter
B – Lock Nut

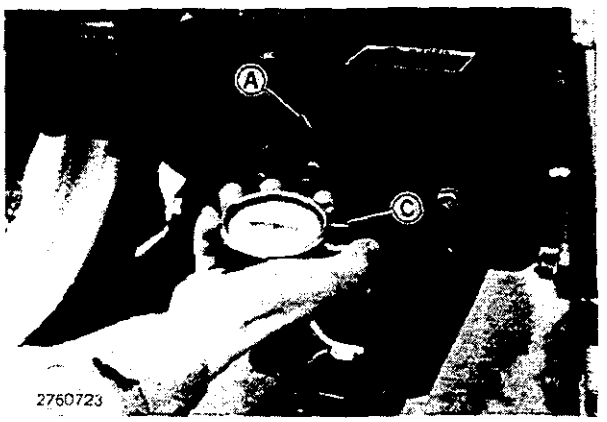
SPEED CONTROL LINKAGE



A – Throttle Lever
B – Link Rod
C – Link Lever
D – Foot Throttle Rod
E – Return Spring
F – Foot Throttle Pedal

SPEED CONTROL LINKAGE (Continued)





ADJUSTMENT

Fast Idle Speed

1. Operate the engine until it is thoroughly warmed up.
2. Disconnect the speed control rod swivel (B) from regulator handle (A).

A – Regulator Handle
B – Swivel
C – Lead Seal Wire
D – Stop Screw

3. Remove the PTO shaft cover from the PTO shaft (A) (Fig. under).
4. Operate the engine and engage the PTO.
5. Using a heavy string or wire, tie the regulator handle all the way forward, so that stop screw (D) (Fig. above) contacts the injection pump mounting flange.
6. Measure the PTO shaft speed using the Hand Tachometer (C, Fig. under). The PTO shaft speed/engine fast idle speed is as follows:

A – PTO Shaft
C – Hand Tachometer

FAST IDLE SPEED SPECIFICATIONS

	PTO RPM	Engine RPM
PTO Gear (540 rpm)....	664 ± 6	2775 ± 25

7. If the speed is incorrect, remove the lead seal wire (C) (Fig. above) from stop screw, loosen lock nut, and adjust screw as required to obtain the correct speed.
8. When the adjustment is correct, tighten locknut securely and connect speed control rod (B) to throttle lever. Install a new lead seal wire in stop screw and install PTO shaft cover.

Slow Idle Speed

1. Move the speed control lever (A) (page 230-15-1) to the slow idle position. Make sure that spring-loaded ball in lever assembly has entered its detent hole in mounting bracket.
2. Remove the PTO shaft cover from the PTO shaft (A).
3. Operate the engine and engage the PTO.
4. Measure the PTO shaft speed using Hand Tachometer (C). The PTO shaft speed/engine slow idle speed is as follows:

SLOW IDLE SPEED SPECIFICATIONS

	PTO RPM	*Engine RPM*
PTO Gear (540 rpm)	191 ± 6	900 ± 25

5. If the slow idle speed is incorrect, adjust the position of swivel (B) (page 230-15-2, Fig. above) on control rod. When the adjustment is correct, tighten both lock nuts.
6. Install the PTO shaft cover.

Foot Throttle Return Spring

Check tension of foot throttle return spring (E) (page 230-15-1). Replace it if it is insufficient.

ELECTRICAL OPERATION AND TESTS 240

SPECIFICATIONS

General Information

		SPECIFICATIONS
Battery	Battery Ground	Negative
	BCI Group	27
	Battery Volts	12.4 to 12.8
	Cold cranking amps at −18° (0°F)	390A
	Reserve capacity (minutes at 25 amps)	115 min.
	Full charge specific gravity	1.260
		FUSE USED
Fuses	Headlights	15 amp
	Horn/Front PTO	10 amp
	Flashing/Warning Lamps	10 amp
	Indicator Lamps	5 amp

Changing Circuit 15A

	SPECIFICATIONS
Alternator Model	GP9150
Alternator output (minimum at 1400 rpm)	15 amps
Pulley nut torque	54 Nm (5.4 kgm) (40 ft-lbs)
Belt deflection with 89 Nm (9 kg) (20 lbs.) force applied	10 to 16 mm (3/8 to 5/8 in.)
Regulator Model	RS1105

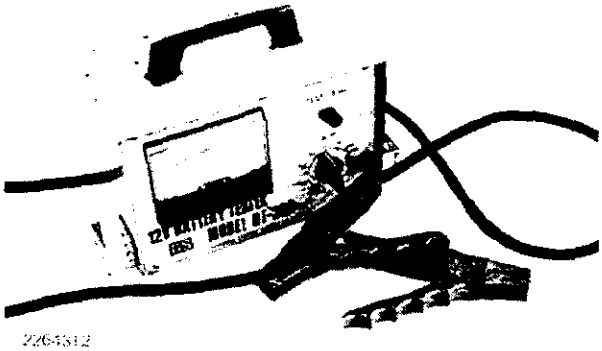
Changing Circuit 35A (Optional for Northern Europe)

Alternator Model	LT135 −54
Alternator output (minimum at 2600 rpm)	35A
Pulley nut torque	54 Nm (5.4 kgm) (40 ft-lbs)
Belt deflection with 89 Nm (9 kg) (20 lbs.) force applied	10 to 16 mm (3/8 to 5/8 in.)
Regulator Model	TL1Z − 86E

Starting Circuit

	NEW PART SPECIFICATIONS	WEAR LIMIT
No-Load Current Draw	70 amps max. @6000 rpm	
Brush Length	22 mm (0.866 in.)	14 mm (0.55 in.)
Commutator O.D.	43 mm (1.69 in.)	40 mm (1.57 in.)
Insurator Undercut Depth	0.5 − 0.8 mm (0.02 − 0.003 in.)	0.2 mm (0.006 in.)
Pinion Clearance	0.3 − 1.5 mm (0.008 − 0.060 in.)	1.5 mm (0.006 in.)
Pinion Mesh Clearance to Ring Gear	3 − 5 mm (0.12 − 0.19 in.)	5 mm (0.2 in.)
Brush Spring Tension	850 g (30 oz)	

SPECIAL TOOLS



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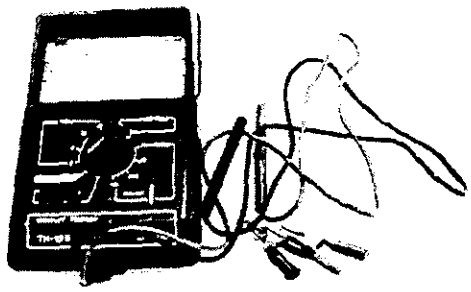
Battery Tester

Test battery.



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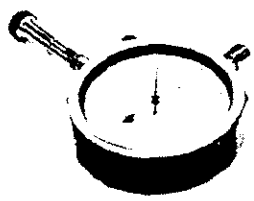
Circuit Tester (V-A-Ω Meter)

Test any electrical components for voltage, resistance, or current draw.



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Hand-Held Tachometer

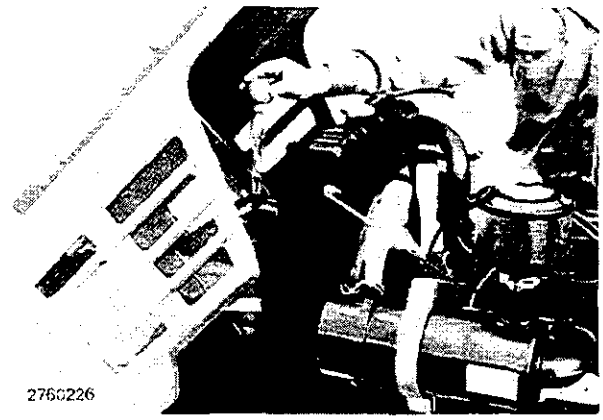
Measuring Starter Motor Speed.

GENERAL DIAGNOSIS

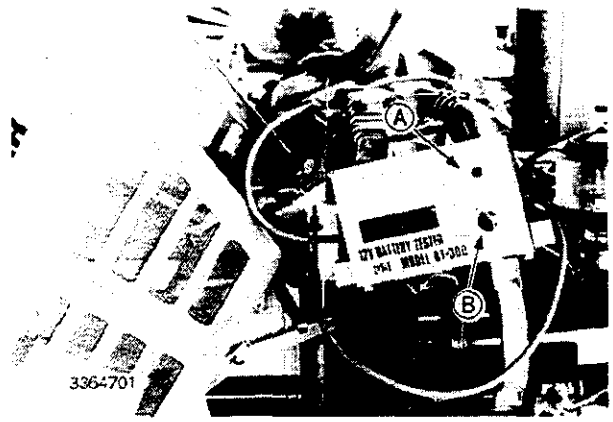
BATTERY TEST

Always test the battery first before attempting to diagnose any problem with the tractor's electrical system. A fully operational battery is crucial to every component of the electrical system.

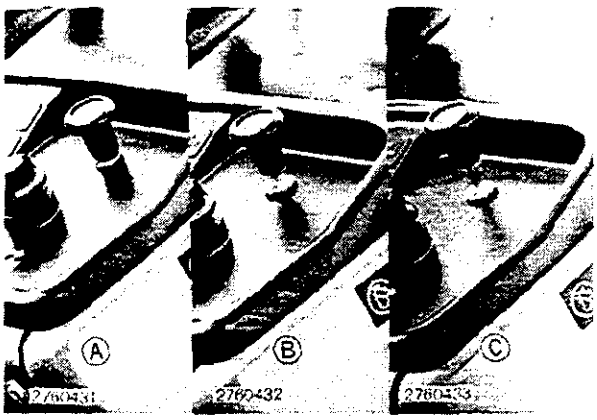
1. Inspect battery for cracked, damp or dirty case. Case should be clean and dry to prevent surface discharge. Check for loose or corroded terminals and correct as necessary.
2. Check electrolyte level and specific gravity in each cell. Add clean, mineral free water if necessary to bring level to bottom of filler neck.
3. Connect Battery Tester with red clip to positive (+) terminal and black clip to negative (–) terminal.

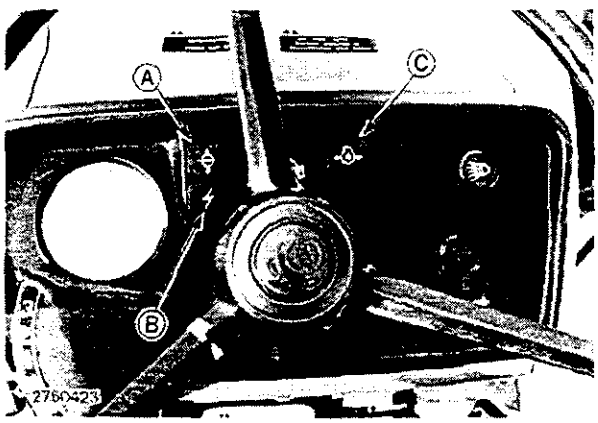


4. Set switch (A), on 12 volts and turn selector switch (B) to "VOLTS." Check battery voltage. It should be 12.4 to 12.8 volts.
5. If voltage is too high, turn headlights on for 30 seconds to remove surface charge. Then recheck voltage.
6. If voltage is too low, charge battery. Then recheck voltage.
7. If voltage is correct, check battery condition.
8. Turn selector switch to "OFF".



A – Battery Voltage Switch
B – Selector Switch





PRELIMINARY CHECKS

After making sure that the battery is in a fully operational condition, perform the following operational checks for the entire electrical system. Make a note of anything which does not work — and make sure that it is repaired.

After making any necessary repairs, repeat the operational checks to make sure that the entire electrical system is working properly.

The first step is usually to determine whether the suspect component is, in fact, receiving power. If the component is not readily accessible, measure the voltages at the surrounding ones.

1. Turn light switch to each position and check all lamps that should glow.

   "A" – All lamps should not grow.

   "B" – Headlights on high beam.

   "C" – Headlights on low beam.

2. With key switch on, check indicator lamp cluster for operation.

   Oil pressure lamp ( ) and charge indicator lamp ( ) should glow. Temperature indicator lamp ( ) should not glow.

3. Shift transmission to neutral and turn key switch to START position. Do not depress clutch.

   Starter should not operate. Temperature indicator lamp ( ) should glow.

4. Depress clutch pedal and start engine.

   With engine running, check indicator lamp cluster. All lamps should be off.

A – Temperature **C – Oil**
B – Charge

DIAGNOSING MALFUNCTIONS

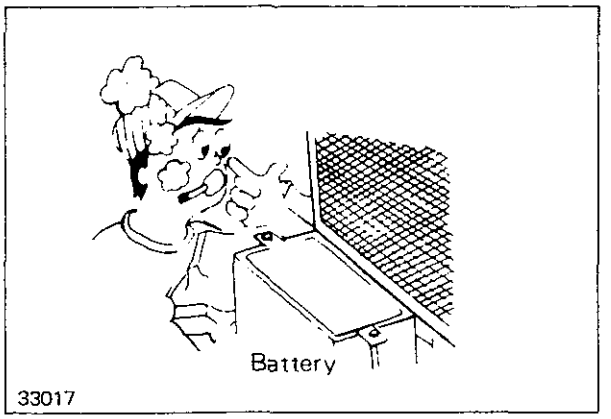
Use carefull logic in diagnosing any problem. Be sure exactly what is wrong before beginning the repair. Always follow the seven basic diagnostic steps:

1. Know the system.
2. Ask the operator.
3. Inspect the system.
4. Operate the machine (if possible).
5. List possible causes.
6. Reach a conclusion.
7. Test the conclusion.

Usually one of the first checks is to determine if there is voltage at the suspected component. If access is not convenient, determine first at a more convenient place whether voltage is available to other units nearby.

PRECAUTIONS

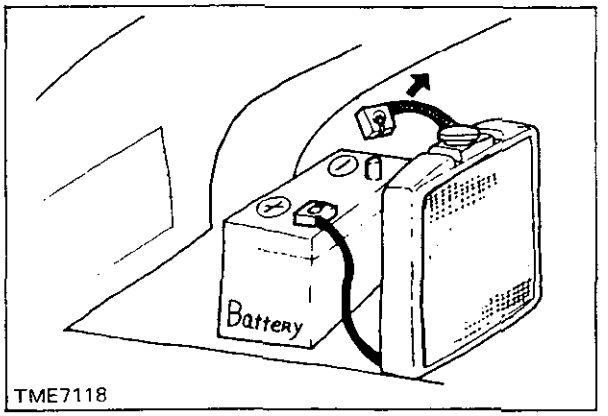
When working on electrical system, observe the following rules for your safety and prevention of damage to tractor:



SAFETY

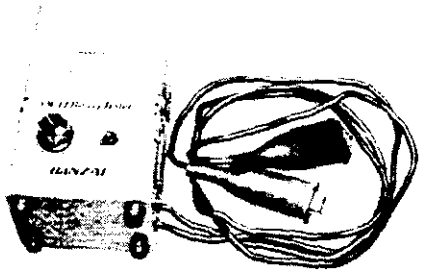
1. Keep all sparks and flames away from battery. Gas from battery electrolyte is highly flammable. Also avoid spilling electrolyte on yourself or on anything which could be damaged by the sulphuric acid.
2. Avoid sparks when connecting booster batteries or battery chargers. When possible, make last connection at a point away from battery. Battery charger should be turned off before connecting or disconnecting.
3. When connecting battery, always connect ground cable last. Disconnect it first.
4. When possible, disconnect battery ground cable before working on electrical system.

PREVENTION OF DAMAGE



1. Before connecting battery cables, be sure that battery and alternator connections are correct. Reverse polarity can cause permanent damage.
2. When connecting a booster battery, connect positive terminal of booster battery to positive terminal of battery. Then connect negative terminal of booster battery to tractor frame. Reverse polarity can cause permanent damage.
3. Never run engine with alternator or battery cables disconnected. Doing so might damage alternator.
4. Never short across or ground alternator terminals unless specifically recommended. Be careful to prevent grounding alternator wires when disconnected.
5. Never attempt to polarize an alternator.
6. Before using an electric welder on tractor, disconnect battery ground cable. Connect welder ground clamp as never as possible to the area being welded, and be sure it makes good electrical contact.

ELECTRICAL DIAGNOSTIC EQUIPMENTS

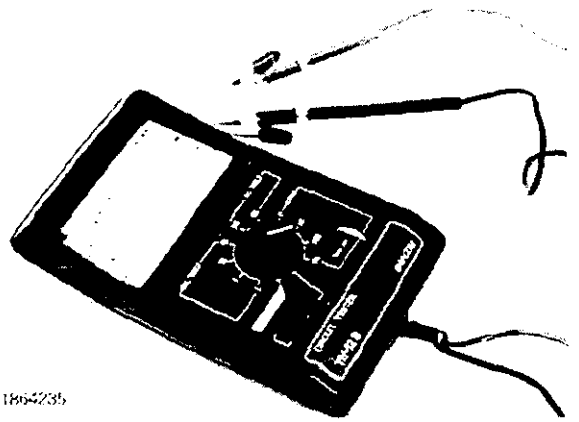


1861929

The following electrical diagnostic equipment is recommended for all tractors.

BATTERY TESTER

1. Battery Tester quickly indicates battery condition. Battery testing instructions are on page 240-05-1, and an tractor operation manual is included with the tester.

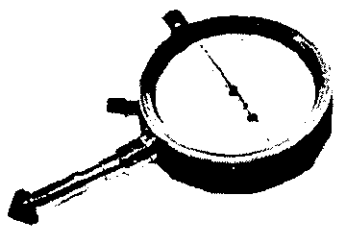


1864235

VOLT-OHM-AMP METER

2. Circuit Tester is used for testing alternator and for other jobs that require measuring voltage, resistance, or current flow up to 10 amps.

Alternator test instructions are in Section 10 of this Chapter. Also refer to the operation manual included with the meter. For accurate results and protection of the meter, it is vitally important that you follow instructions carefully.



1863133

HAND-HELD TACHOMETER

3. The hand-held tachometer is used for measuring starter motor speed.

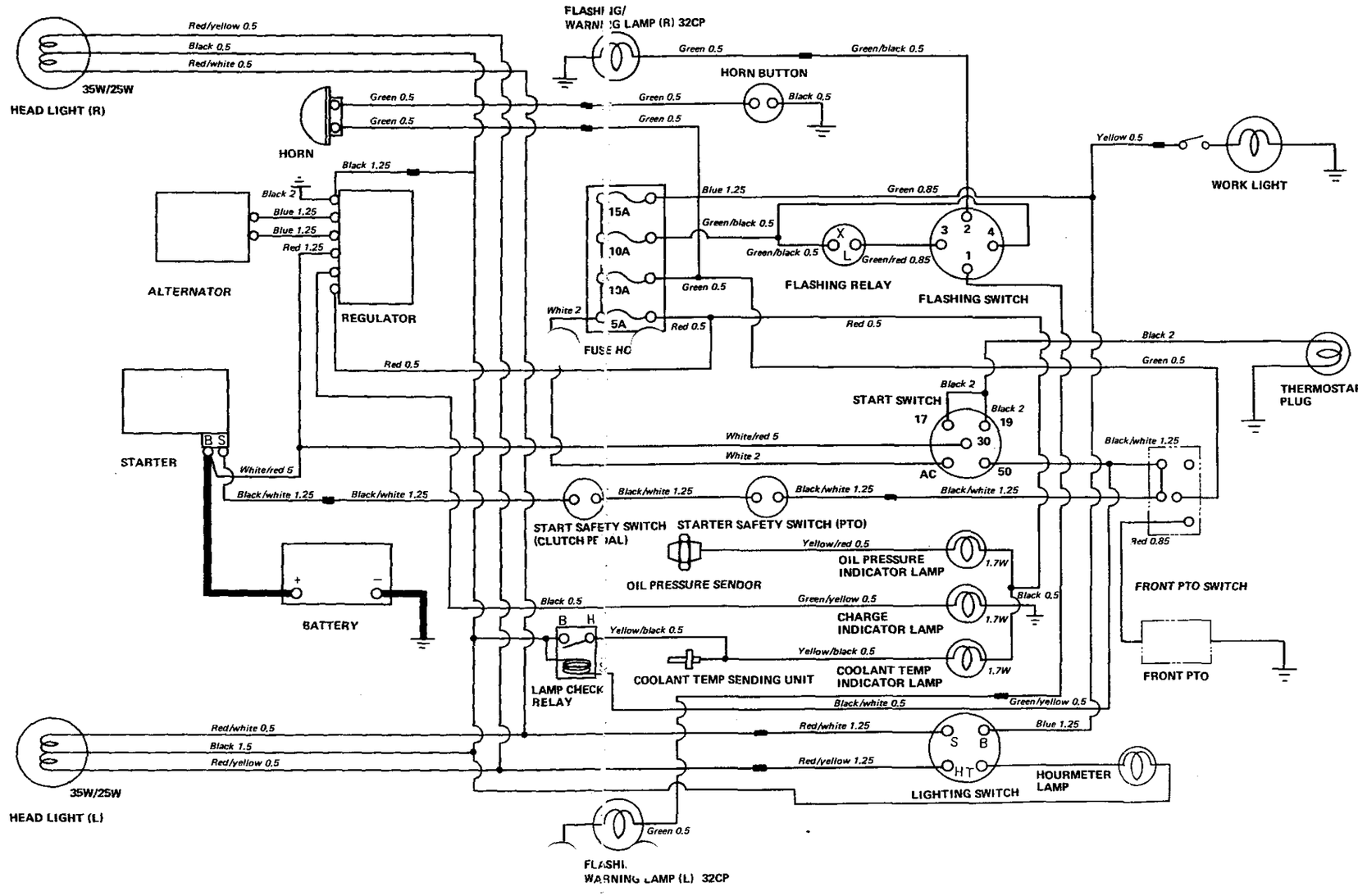
WIRING DIAGRAMS

Diagrams on the following pages illustrate all wiring connections. Use these diagrams and information in the following groups for diagnosis.

A. shows location of all wires on the tractor.

B. shows location of all electrical components.

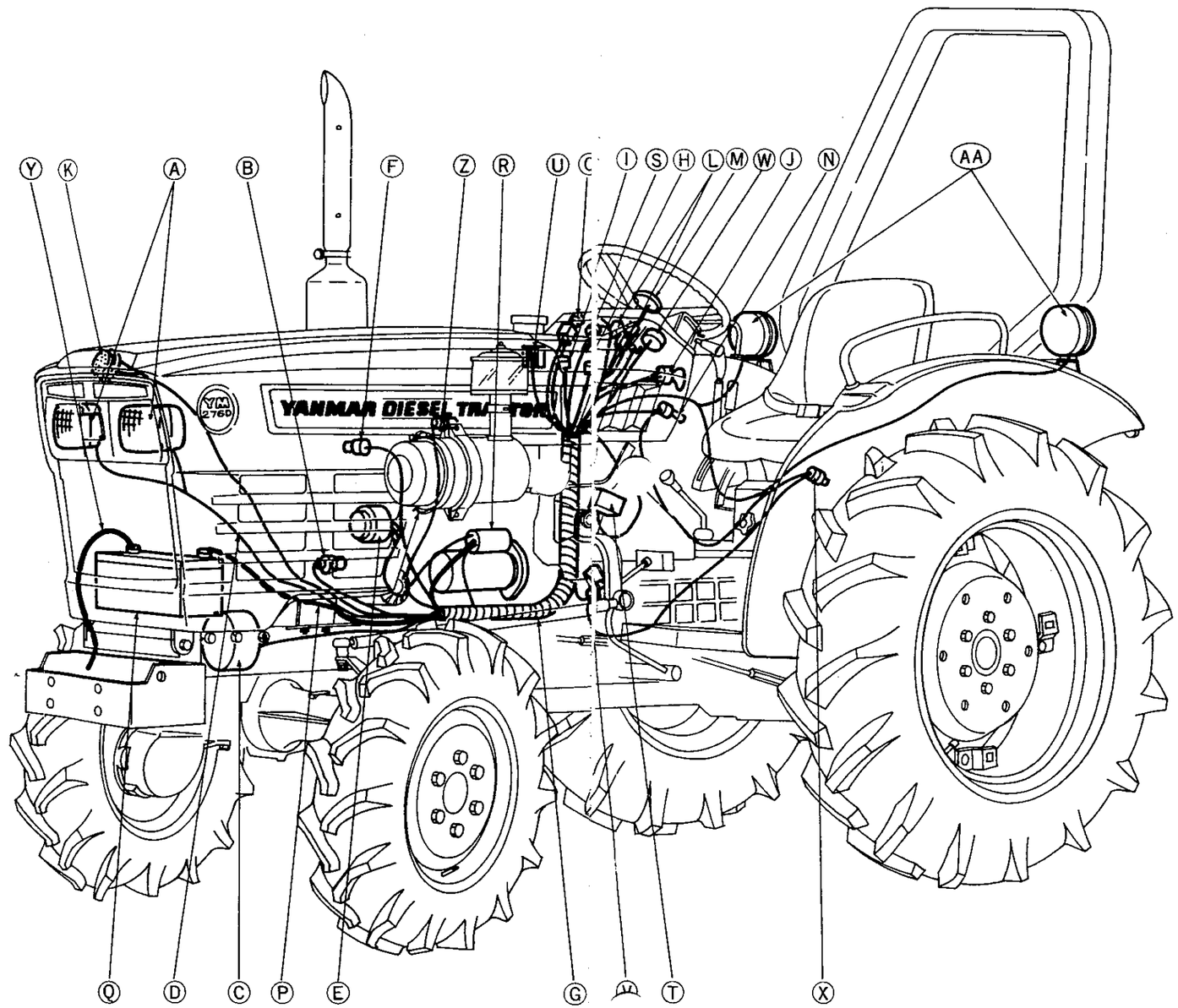
A. TRACTOR WIRING (15A)



2767028

B.TRACTOR EL ECTRICAL SYSTEM (15A)

A — Dual Beam Head Light
B — Oil Pressure Sender
C — Front PTO Magnet Clutch
D — Light Harness
E — Alternator
F — Coolant Temperature Sender
G — Main Wiring Harness
H — Flasher Relay
I — Indicator Lamp Check Relay
J — Key Switch
K — Buzzer
L — Indicator Lamp Cluster
M — Horn Button
N — Front PTO Switch
O — Light Switch
P — Battery Cable
Q — Battery
R — Starter
S — Parking Lamp Switch
T — Fuse Box
U — Regulator
V — Start Safety Switch (on Clutch Pedal)
W — Hourmeter
X — PTO Shift Lever Safety Switch
Y — Battery Ground Cable
Z — Thermostart Plug
AA — Turn Signal & Flashing Warning Lamp



2767040A

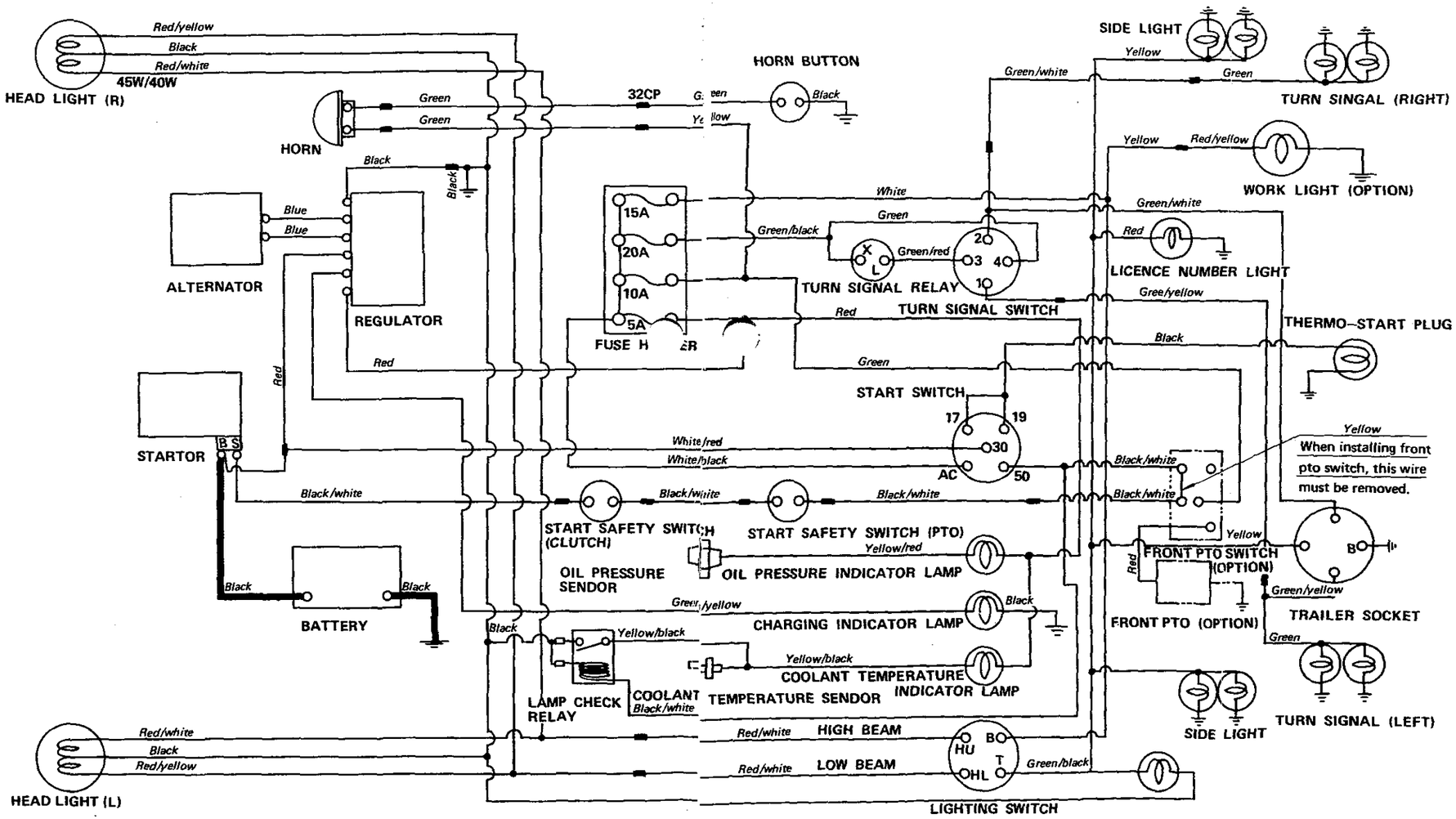
WIRING DIAGRAMS

Diagrams on the following pages illustrate all wiring connections. Use these diagrams and information in the following groups for diagnosis.

A. shows location of all wires on the tractor.

B. shows location of all electrical components.

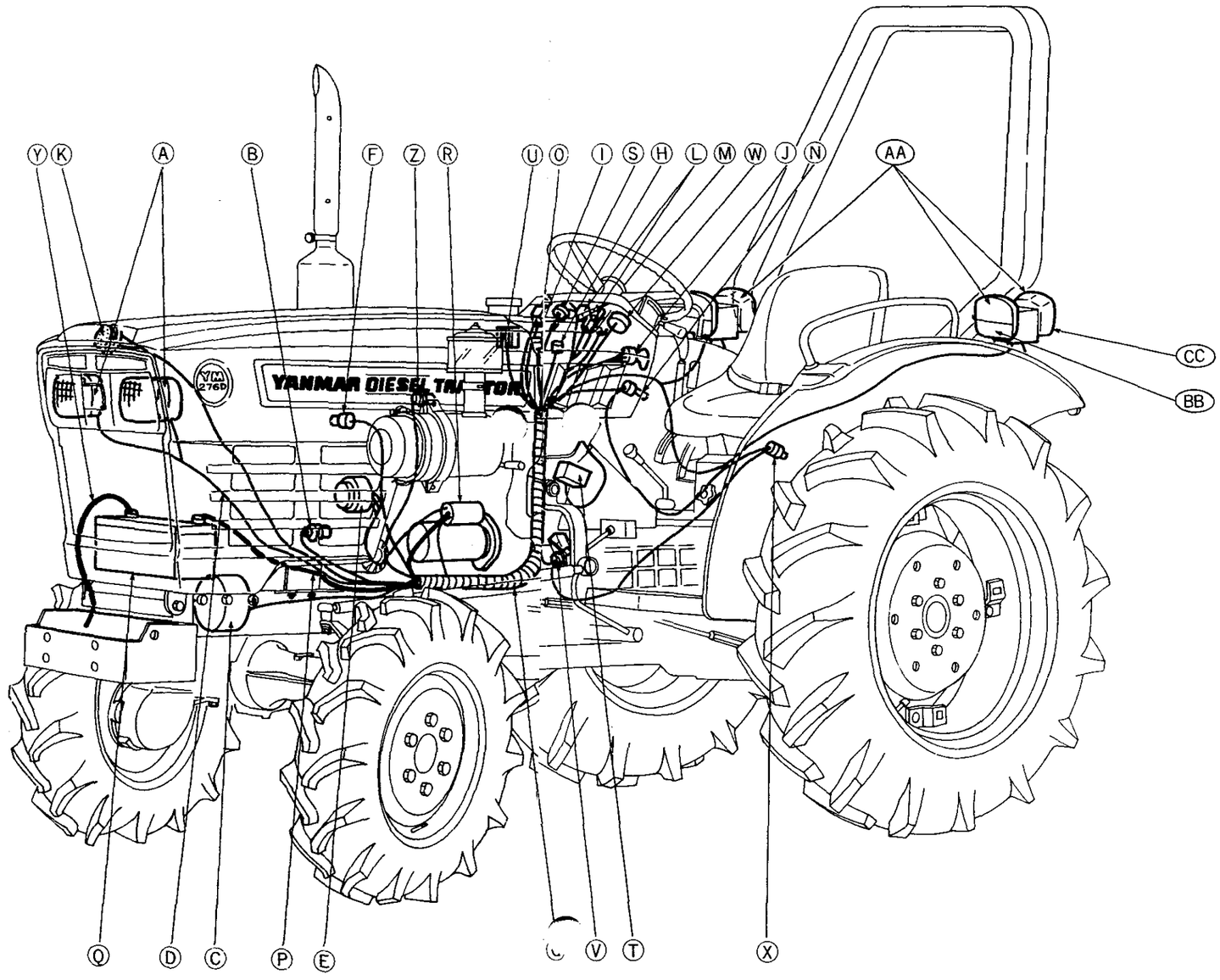
A. TRACTOR WIRING (35A)



2767030

B. TRACTOR ELECTRIC \L SYSTEM (35A)

A – Dual Beam Head Light
B – Oil Pressure Sender
C – Front PTO Magnet Clutch
D – Light Harness
E – Alternator
F – Coolant Temperature Sender
G – *Main Warning Harness*
H – Flasher Relay
I – Indicator Lamp Check Relay
J – Key Switch
K – Buzzer
L – Indicator Lamp Cluster
M – Horn Button
N – *Front PTO Switch*
O – Light Switch
P – Battery Cable
Q – Battery
R – Starter
S – Parking Lamp Switch
T – Fuse Box
U – Regulator
V – Start Safety Switch (on Clutch Pedal)
W – Hourmeter
X – PTO Shift Lever Safety Switch
Y – Battery Ground Cable
Z – Thermostart Plug
AA – Turn Signal & Flashing Warning Lamp
BB – Clearance Lamp
CC – Tail Lamp



2767041A

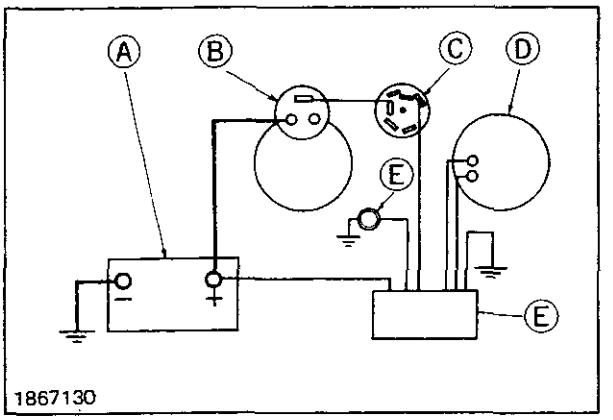
CHARGING CIRCUIT 15A

GENERAL INFORMATION

See chapter 40, Section 10 for charging system repair.

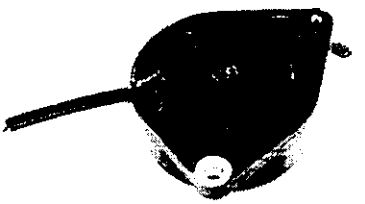
Fig. Shows components of charging circuit. Wiring is contained in main wiring harness.

A – Battery
B – Starter
C – Key Switch
D – Alternator
E – Regulator
F – Pilot Lamp



ALTERNATOR

The alternator is composed of stator coil and magnetic flywheel. It contains only generating components, and other rectifing components, are composed in transistor type regulator.

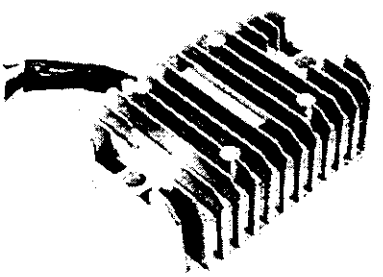


1864229

REGULATOR

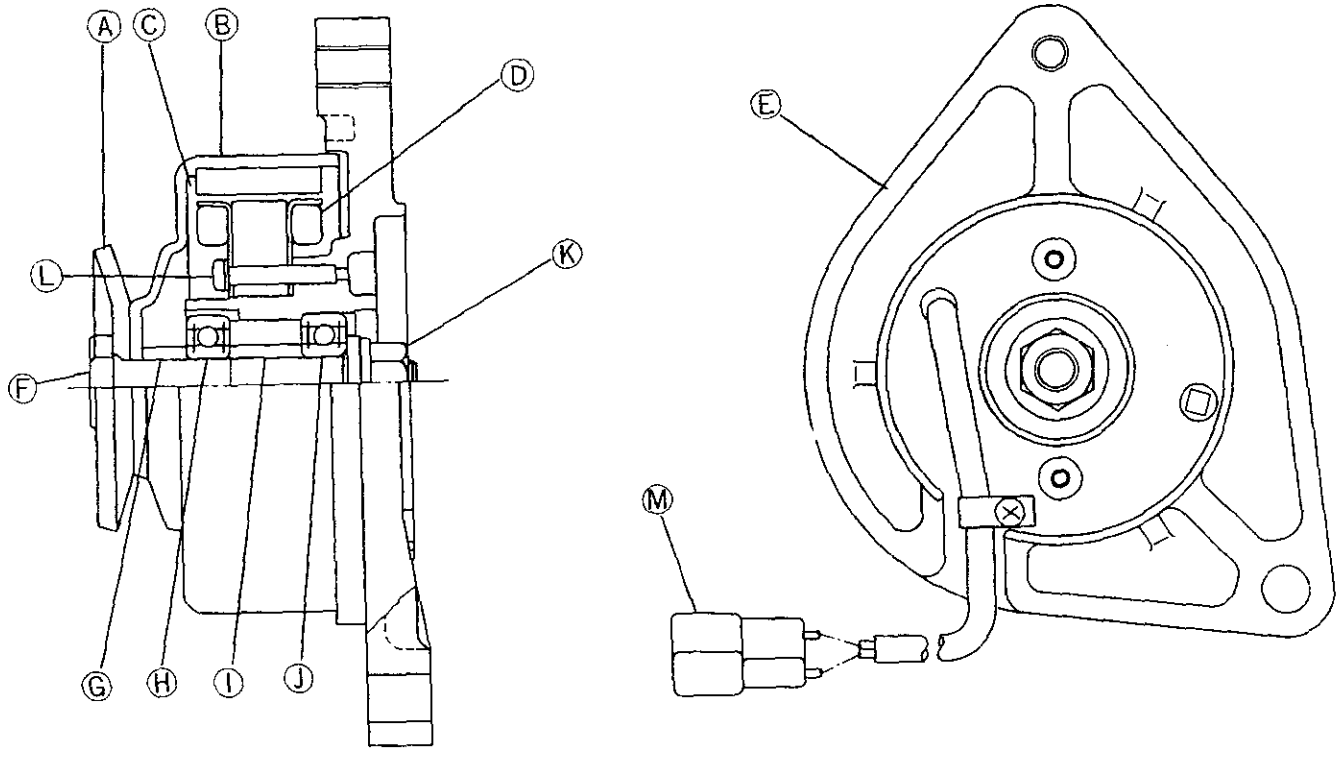
The transistor regulator is composed of rectifing and regulating circuits, combined diodes and transistors. It is not repairable, replace if it damaged.

Keep regulator away from any heat generating equipments when servicing or testing.



2261326

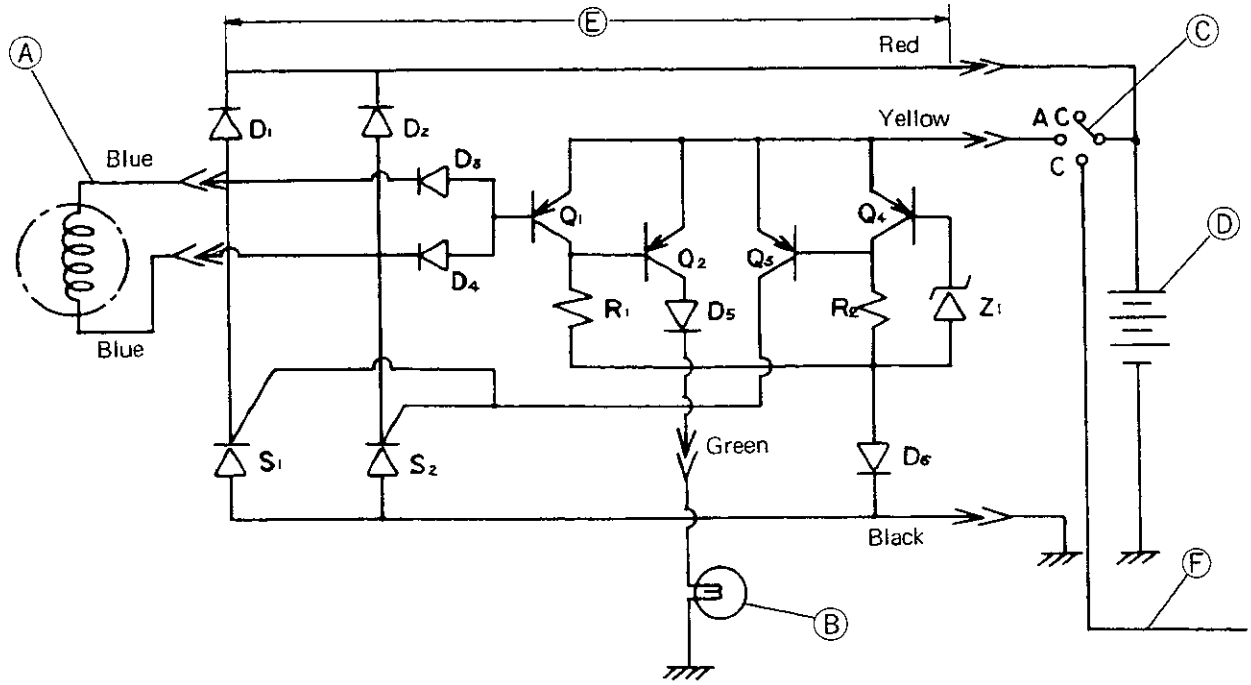
ALTERNATOR



1867089

A – Pulley Half
B – Flywheel with Magnets
C – Magnets
D – Stator Coil
E – Alternator Body
F – Shaft
G – Spacer
H – Outer Bearing
I – Bearing Spacer
J – Inner Bearing
K – Nut
L – Stator Coil Retaining Screw
M – Connector

HOW THE SYSTEM WORKS



1867093

A — Alternator
B — Charging Indicator Lamp
C — Key Switch
D — Battery
E — Regulator
F — To starter
G — Load

S_1, S_2 — Thyristor for Rectifing Current
D_1, D_2 — Diodes for Rectification
D_3, D_4 — Diodes for Detecting Current
D_5, D_6 — Diodes for Protecting from Battery Cable Counterconnection
R_1, R_2 — Resistors

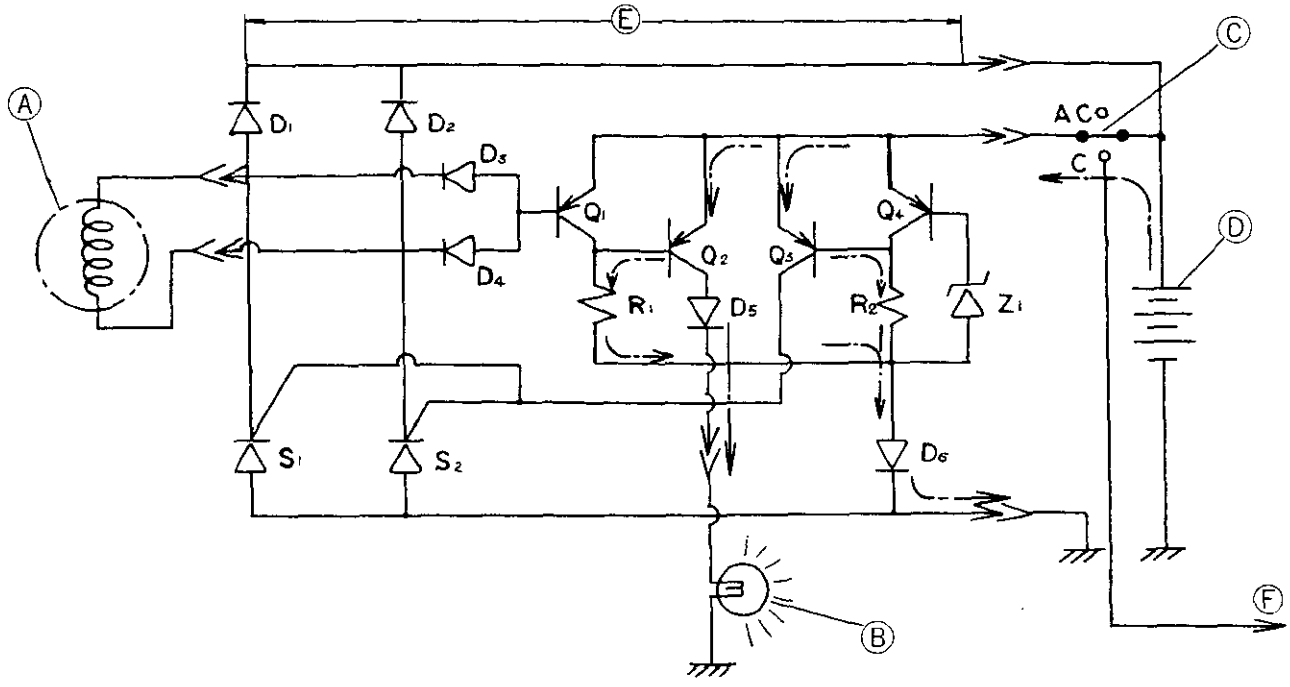
Z_1 — Zener Diode for Controling Battery Voltage
Q_1 — Transistor for Detecting Generated Voltage
Q_2 — Transistor for Indicator Lamp Relay
Q_3 — Transistor for Controling Gate Current
Q_4 — Transistor for Detecting Battery Voltage

The transistor type regulator is composed of six diodes, one zener diode, two thyristors and two resistors. D_1 and D_2 diodes rectify a single phase alternating current generated by alternator (A).

Q_1 and Q_2 work for controling charging indicator lam glowing.

Q_3, Q_4 and Z_1 control current to S_1 and S_2, and adjust charging current and voltage of battery.

PHASE 1 – ALTERNATOR STOPPED



1867094

A – Alternator
B – Charging Indicator Lamp
C – Key Switch
D – Battery
E – Regulator
F – To starter
G – Load

S_1, S_2 – Thyristor for Rectifing Current
D_1, D_2 – Diodes for Rectification
D_3, D_4 – Diodes for Detecting Current
D_5, D_6 – Diodes for Protecting from Battery Cable Counterconnection
R_1, R_2 – Resistors

Z_1 – Zener Diode for Controling Battery Voltage
Q_1 – Transistor for Detecting Generated Voltage
Q_2 – Transistor for Indicator Lamp Relay
Q_3 – Transistor for Controling Gate Current
Q_4 – Transistor for Detecting Battery Voltage

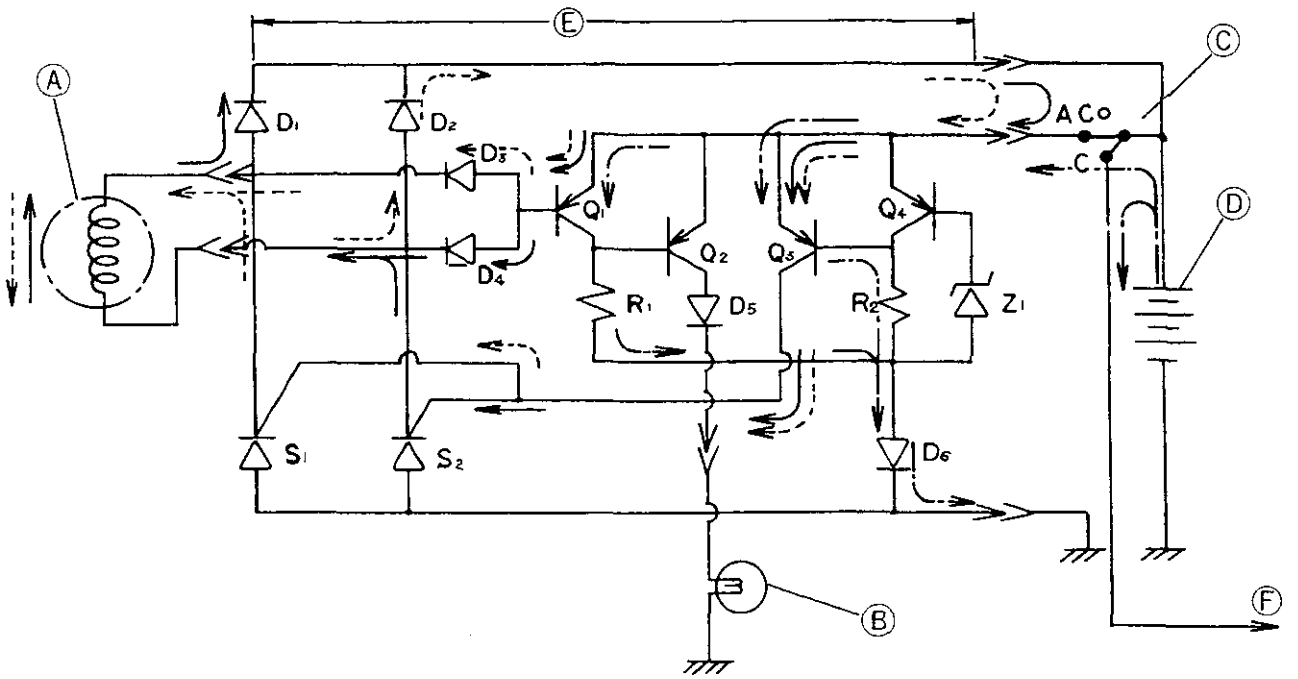
1. When turning key switch (C) to position 1 (AC), current from battery (D) flows through key switch → Emitter base of transistor (Q_2) → Resistor (R_1) → Diodes (D_6) and to ground.

   The base current to transistor (Q_2) means closed circuit in Q_2. This allows to flow current through collector of Q_2 → Diode (D_5) → Charging indicator lamp (B) and to ground, and glow the indicator lamp (B).

2. From the key switch, current also flows through emitter base of transistor (Q_3) → Resistor (R_2) → Diode (D_6) and to ground.

   Base current also flows in transistor Q_3, but not the collector current; the alternator is stopped and not generating current.

PHASE 2 – KEY SWITCH POSITIONS "START" (Generated Voltage: Low)



1867095

A – Alternator
B – Charging Indicator Lamp
C – Key Switch
D – Battery
E – Regulator
F – To starter
G – Load

S_1, S_2 – Thyristor for Rectifing Current
D_1, D_2 – Diodes for Rectification
D_3, D_4 – Diodes for Detecting Current
D_5, D_6 – Diodes for Protecting from Battery Cable Counterconnection
R_1, R_2 – Resistors

Z_1 – Zener Diode for Controling Battery Voltage
Q_1 – Transistor for Detecting Generated Voltage
Q_2 – Transistor for Indicator Lamp Relay
Q_3 – Transistor for Controling Gate Current
Q_4 – Transistor for Detecting Battery Voltage

When having started engine, alternator start to generate electricity.

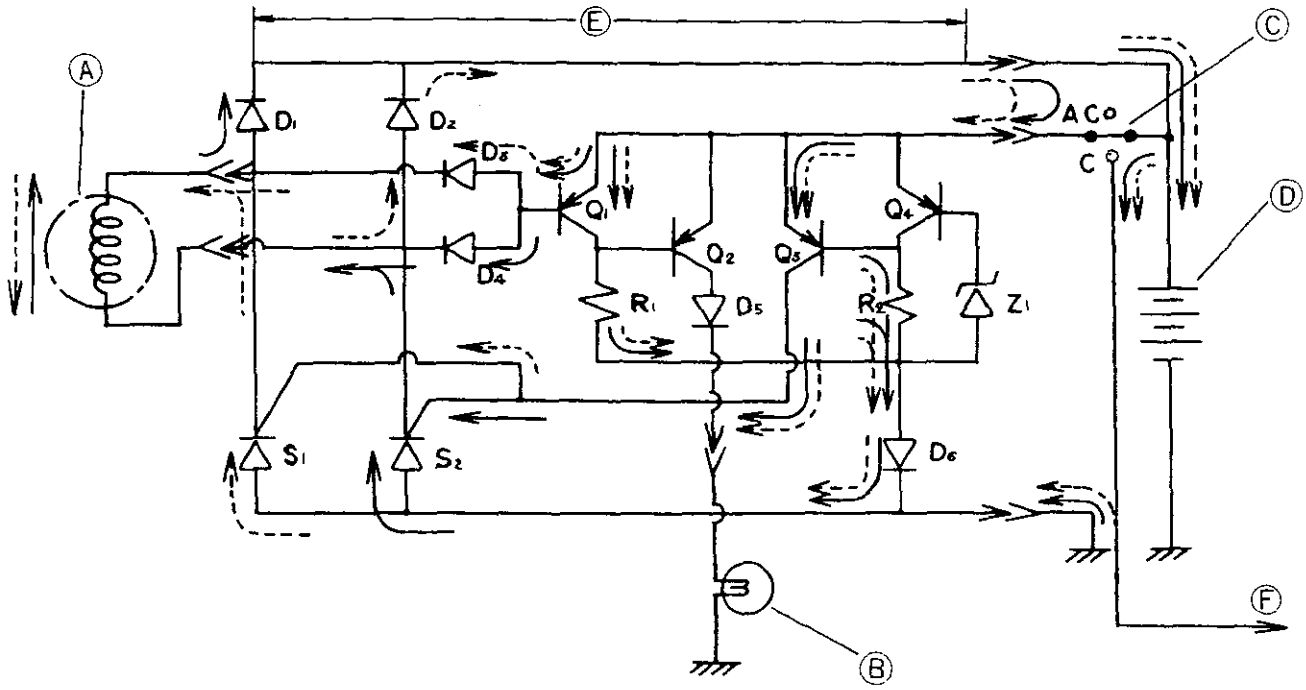
Current circulates from alternator (A) through Diode (D_1) → Transistor (Q_1) Emitter → Diode (D_4) to alternator.

Current also circulated from alternator (A) through Diode (D_2) → Transistor (Q_1) Emitter → Diode (D_3) to alternator.

The current flow of Q_1 emitter means shorted circuit between emitter and base of transistor (Q_2). This allows indicator lamp to go off.

For a short time after the engine starts, the battery terminals have a potential difference less than 14.5 V, the Zener diode level. As a result, the transistor Q_4 is open and does not pass current. Instead, the current from the battery flows through the Q_3 emitter --+ R_2 --+ D_6 to the ground. This flow allows Q_3 collector current to flow to the gate cathodes of the thyristors S_1 and S_2.

PHASE 2 – KEY SWITCH POSITIONS "START" (Generated Voltage: High)



1867096

A – Alternator
B – Charging Indicator Lamp
C – Key Switch
D – Battery
E – Regulator
F – To starter
G – Load

S_1, S_2 – Thyristor for Rectifing Current
D_1, D_2 – Diodes for Rectification
D_3, D_4 – Diodes for Detecting Current
D_5, D_6 – Diodes for Protecting from Battery Cable Counterconnection
R_1, R_2 – Resistors

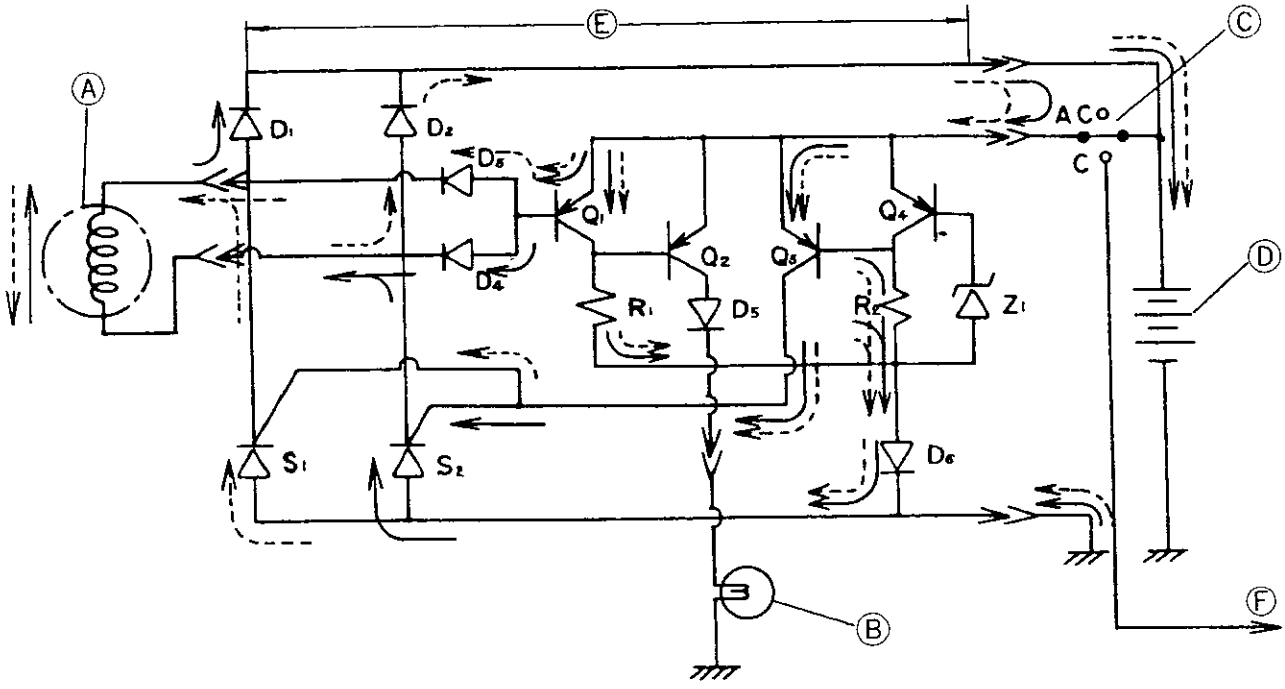
Z_1 – Zener Diode for Controling Battery Voltage
Q_1 – Transistor for Detecting Generated Voltage
Q_2 – Transistor for Indicator Lamp Relay
Q_3 – Transistor for Controling Gate Curent
Q_4 – Transistor for Detecting Battery Voltage

Above a certain engine speed, the voltage generated by the alternator exceeds the battery's terminal voltage. The thyristors S_1 and S_2 close to allow current to flow across them. In this case, the alternator current flows through diode D_1, the battery D, the thyristor S_1, and back to the alternator.

Current also flow from alternator through diode (D_2) → Battery (D) → Anode cathode of thyristor (S_2) to alternator.

After S_1 and S_2 and closed (connected), the collector current of Q_1 and the base current of Q_3 flow from not battery but alternator.

PHASE 3 – KEY SWITCH POSITIONS "ON" (Battery Voltage Low)



1867097

A – Alternator
B – Charging Indicator Lamp
C – Key Switch
D – Battery
E – Regulator
F – To starter
G – Load

S_1, S_2 – Thyristor for Rectifing Current
D_1, D_2 – Diodes for Rectification
D_3, D_4 – Diodes for Detecting Current
D_5, D_6 – Diodes for Protecting from Battery Cable Counterconnection
R_1, R_2 – Resistors

Z_1 – Zener Diode for Controling Battery Voltage
Q_1 – Transistor for Detecting Generated Voltage
Q_2 – Transistor for Indicator Lamp Relay
Q_3 – Transistor for Controling Gate Curent
Q_4 – Transistor for Detecting Battery Voltage

During the battery terminal voltage is lower than the zener diode level (14 to 15 volts), the battery is charged as shown in Fig.

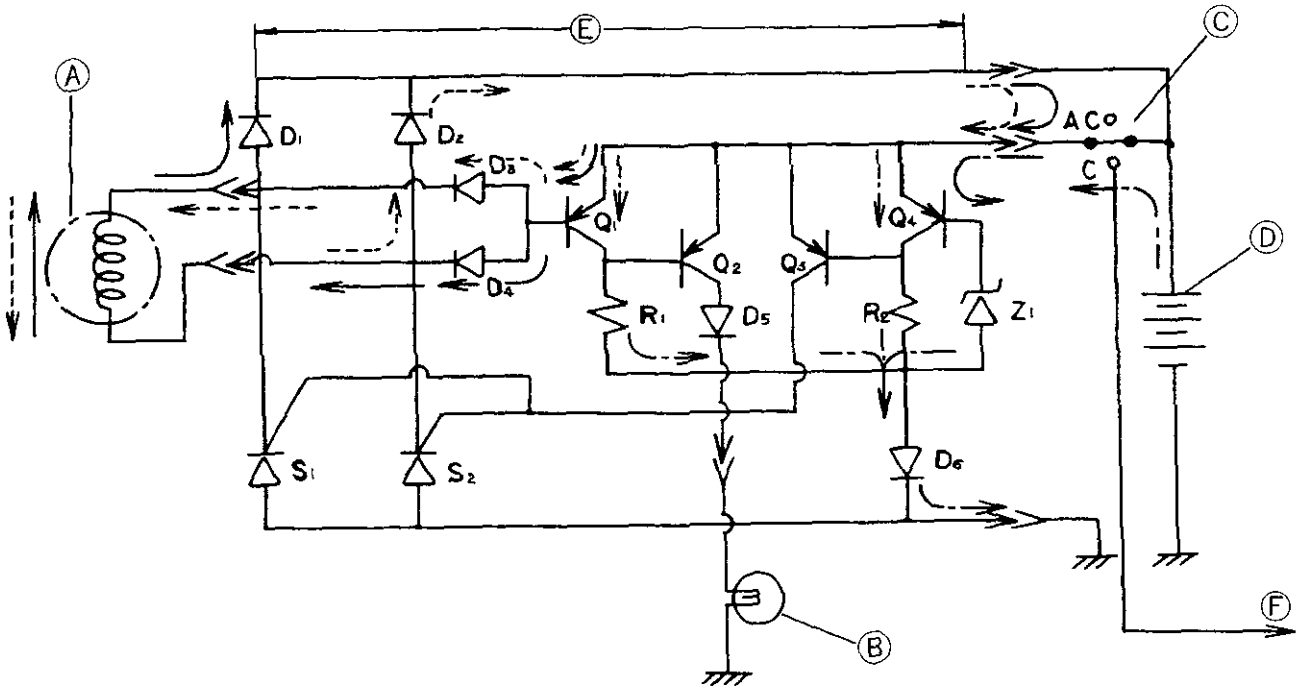
Current from alternator frows as follows.

Alternator → D_1 → Battery → S_1 →

or

Alternator → D_2 → Battery → S_2

PHASE 3 – KEY SWITCH POSITIONS "ON" (Battery Voltage High)



1867098

A – Alternator
B – Charging Indicator Lamp
C – Key Switch
D – Battery
E – Regulator
F – To starter
G – Load

S_1, S_2 – Thyristor for Rectifing Current
D_1, D_2 – Diodes for Rectification
D_3, D_4 – Diodes for Detecting Current
D_5, D_6 – Diodes for Protecting from Battery Cable Counterconnection
R_1, R_2 – Resistors

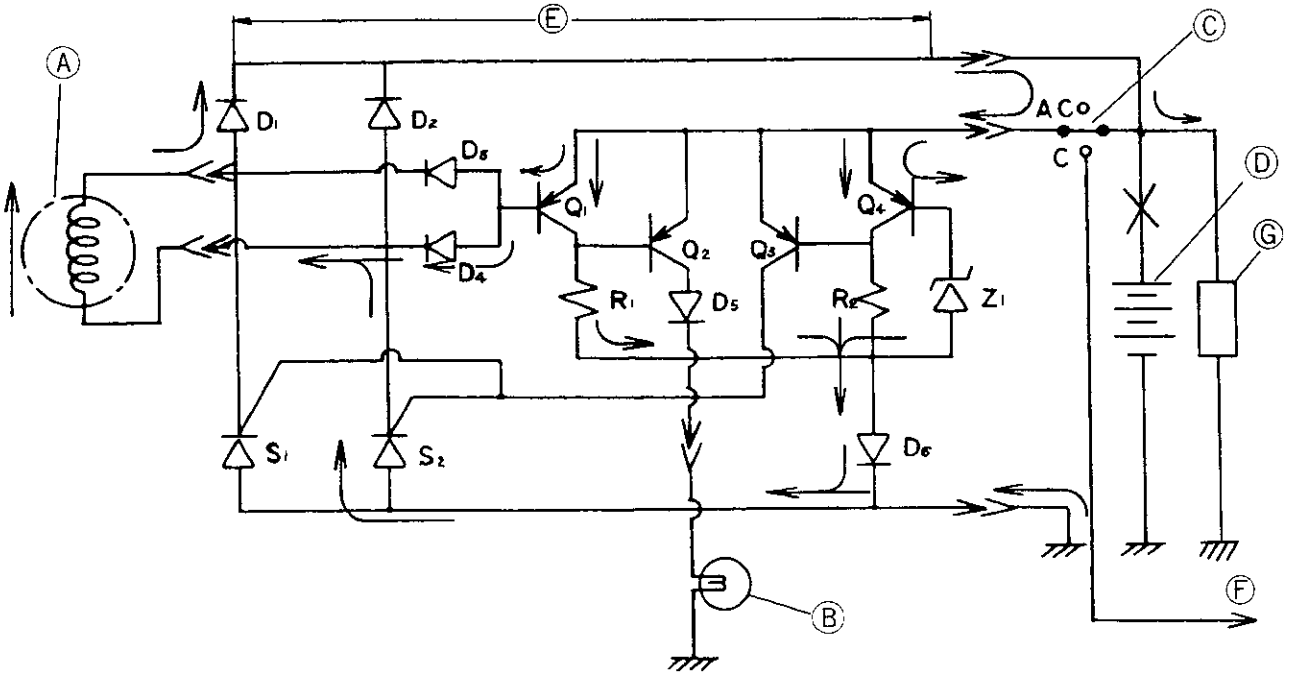
Z_1 – Zener Diode for Controling Battery Voltage
Q_1 – Transistor for Detecting Generated Voltage
Q_2 – Transistor for Indicator Lamp Relay
Q_3 – Transistor for Controling Gate Curent
Q_4 – Transistor for Detecting Battery Voltage

If battery voltage becomes higher than the zener diode level (14 to 15 volts), the battery is not charged.

Current flows as follows:
Battery → Emitter of transistor (Q_4)
↑ Diode (D_6) ← Zener Diode (Z_1) ←

As Q_3 is open condition because of no current on its base, S_1 and S_2 keep their open conditions. At this time, Q_2 is still open and the lamp (B) does not glow.

PHASE 4 — WHEN BATTERY REMOVED (In a short time)



1867099

A — Alternator
B — Charging Indicator Lamp
C — Key Switch
D — Battery
E — Regulator
F — To starter
G — Load

S_1, S_2 — Thyristor for Rectifing Current
D_1, D_2 — Diodes for Rectification
D_3, D_4 — Diodes for Detecting Current
D_5, D_6 — Diodes for Protecting from Battery Cable Counterconnection
R_1, R_2 — Resistors

Z_1 — Zener Diode for Controling Battery Voltage
Q_1 — Transistor for Detecting Generated Voltage
Q_2 — Transistor for Indicator Lamp Relay
Q_3 — Transistor for Controling Gate Curent
Q_4 — Transistor for Detecting Battery Voltage

Thyristor has a character that it keeps closed circuit until the current flow becomes zero.

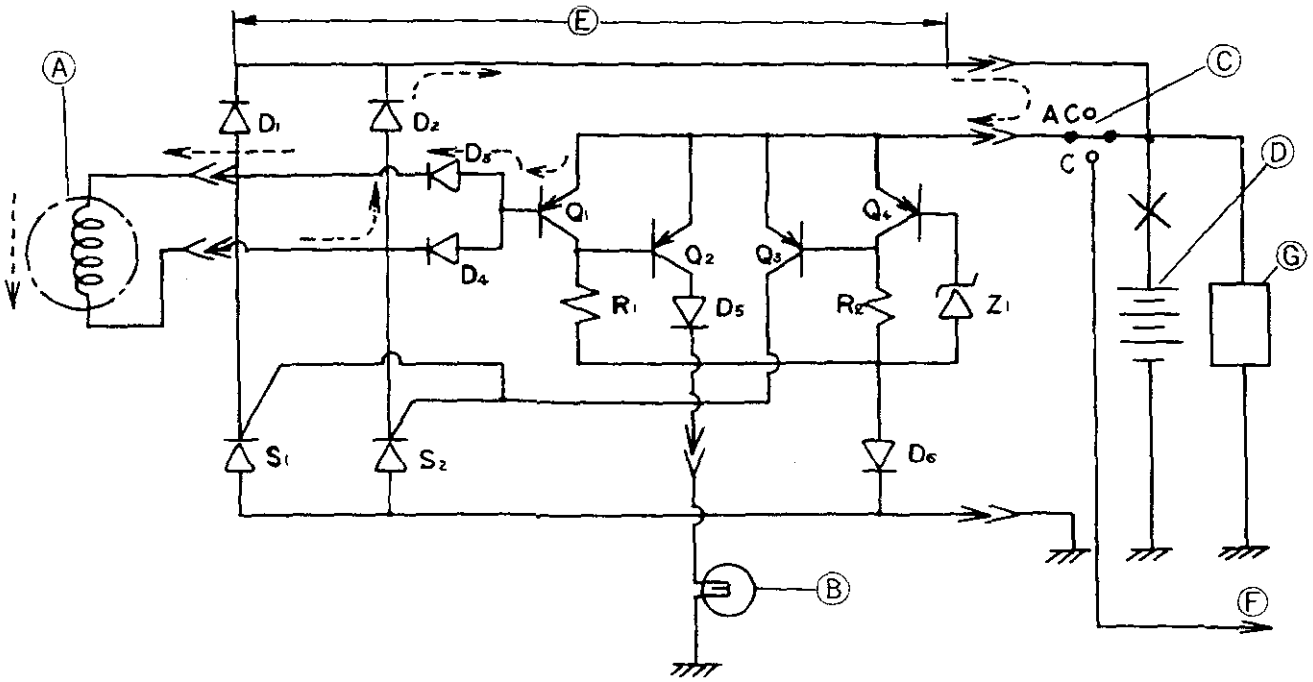
Current flows as shown in the figure.
Alternator → D_1 → Load → S_2

At this time, Q_2 is open condition and the lamp keeps off.

When removed battery, the voltage of load becomes higher than 14 ~ 15 volts.

Therefore, Q_3 is open and the current to S_2 gate is cut.

PHASE 4 – WHEN BATTERY REMOVED (Later)



1867100

A – Alternator
B – Charging Indicator Lamp
C – Key Switch
D – Battery
E – Regulator
F – To starter
G – Load

S_1, S_2 – Thyristor for Rectifing Current
D_1, D_2 – Diodes for Rectification
D_3, D_4 – Diodes for Detecting Current
D_5, D_6 – Diodes for Protecting from Battery Cable Counterconnection
R_1, R_2 – Resistors

Z_1 – Zener Diode for Controling Battery Voltage
Q_1 – Transistor for Detecting Generated Voltage
Q_2 – Transistor for Indicator Lamp Relay
Q_3 – Transistor for Controling Gate Curent
Q_4 – Transistor for Detecting Battery Voltage

When S_1 and S_2 are opened, voltage to the load does not increase and current flows as shown in Fig.

Current flows as follows
Alternator → D_2 → Q_1 → D_3
↑

Base current flows only in transistor (Q_1).

Therefore, this regulator does not allow to damage load (electrical equipements) even if the battery is removed during charging.

PRECAUTIONS

⚠ CAUTION: When working on charging circuit, observe the following rules for your safety and prevention of damage to tractor:

Safety

1. Keep all sparks and flames away from battery. Gas from battery electrolyte is highly flammable. Also avoid spilling electrolyte on yourself or on anything which could be damaged by the sulphuric acid.
2. Avoid sparks when connecting booster battery or battery chargers. When possible, make last connection at a point away from battery. Battery charger should be turned off before connecting or disconnecting.
3. When connecting battery, always connect ground cable last. Disconnect ground cable first.
4. When possible, disconnect battery ground cable before working on electrical system.

PREVENTION OF DAMAGE

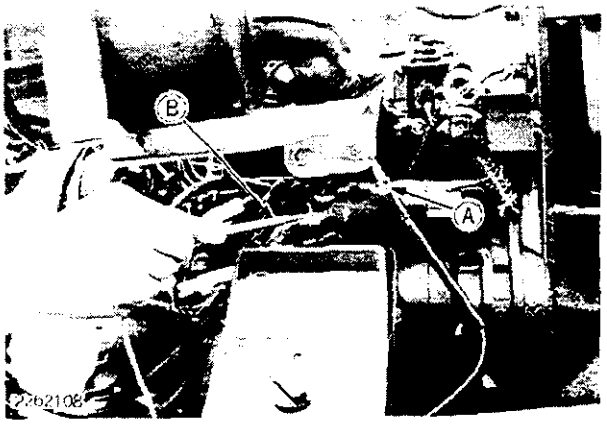
1. Before connecting battery cables, be sure that battery and alternator connections are correct. Reverse polarity can cause permanent damage.
2. *When connecting a booster battery, connect positive* (+) terminal of booster battery to positive terminal of tractor battery. Then connect negative (—) terminal of booster battery to tractor frame. Reverse polarity can cause permanent damage.
3. Never run engine with alternator or battery cables disconnected; doing so might damage alternator.
4. *Never short across or ground alternator terminals* unless specifically recommended. Be careful to prevent grounding alternator wires when disconnected.
5. Never attempt to polarize an alternator.

DIAGNOSIS AND TESTS

Before testing alternator itself, see if problem is somewhere else.

- Check for loose or worn alternator belt.
- Check for excessive loads, such as add-on lighting, which might exceed alternator capacity.
- Ask how tractor is used. Problem might be frequent starting, with too little running to recharge battery.
- Test battery as instructed in Section 05.
- Check for a slow drain on battery. With all switches off, disconnect battery ground cable and connect a sensitive ammeter between cable and battery post. If current exceeds 100 milliamps, see where it is going. Unplug connectors until you locate the circuit, then try to find the problem.
- Check entire charging circuit for a poor connection. Problem could be at battery, starter, key switch, regulator or alternator.

DIAGNOSIS AND TESTS (Continued)



TEST BATTERY CONNECTIONS

With engine stopped and key switch off, use D-19001TT V-Ω-A meter to check for battery voltage at alternator.

1. Set selector switch to "30 VOLTS" .
2. Connect COM (–) probe to ground. Be sure it makes good electrical contact.
3. Connect V-Ω-A (+) probe to "B" terminal on starter and read voltage. It should be 12.4 to 12.8 volts if battery is fully charged.
4. If reading is low, check for defective battery or poor connections at battery, starter or alternator.

CHECK ALTERNATOR OUTPUT

1. Disconnect alternator wiring harness and connect an AC Volt meter to the two terminals of the connector.
2. Run engine at fast idle. Open circuit voltages should be at least 30 volts AC. If voltage is low, magnets may have become weak, requiring replacement of flywheel.

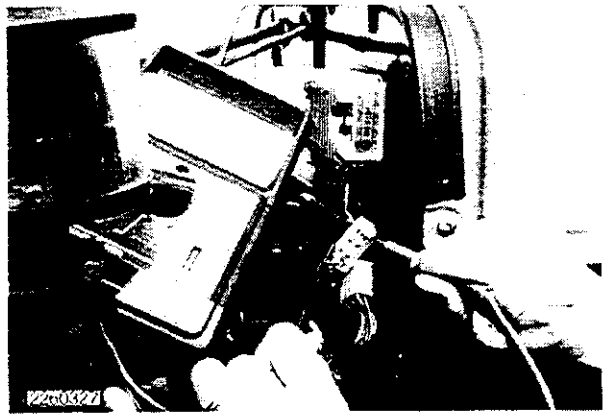
STOP Perform this test quickly to prevent possible damage to alternator.

CHECK REGULATOR

The voltage regulator is mounted on a heat insulating plate. For access, open the hood.

The following checks will not guarantee that regulator is working properly, but a bad reading will guarantee that it is not.

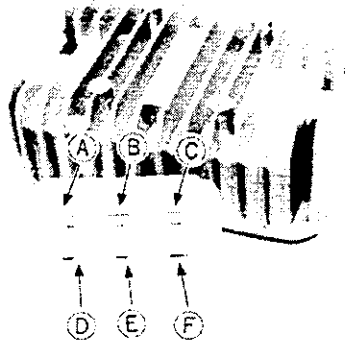
Disconnect the regulator from the main wiring harness.



Use a Circuit Tester to check the electrical continuity between all possible pairs of terminals. (See Table below) If the continuity for even one pair is not as indicated, install a new regulator.

NOTE: Correct readings for all possible pairs does not necessarily guarantee that the regulator is functioning properly. Other defects may dictate replacement.

Terminal A – Blue
Terminal B – Black
Terminal C – Blue
Terminal D – Green
Terminal E – Yellow
Terminal F – Red



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Continuity Checks

Tester Probe + / Tester Probe –		Colors of lead					
		Blue (A)	Blue (C)	Red (F)	Yellow (E)	Green (D)	Black (B)
Colors of lead	Blue (A)		DIS.	CON.	DIS.	DIS.	DIS.
	Blue (C)	DIS.		CON.	DIS.	DIS.	DIS.
	Red (F)	DIS.	DIS.		DIS.	DIS.	DIS.
	Yellow (E)	CON.	CON.	CON.		DIS.	CON.
	Green (D)	DIS.	DIS.	DIS.	DIS.		DIS.
	Black (B)	DIS.	CON.	DIS.	DIS.	DIS.	

CON. – Continuity
DIS. – Discontinuity

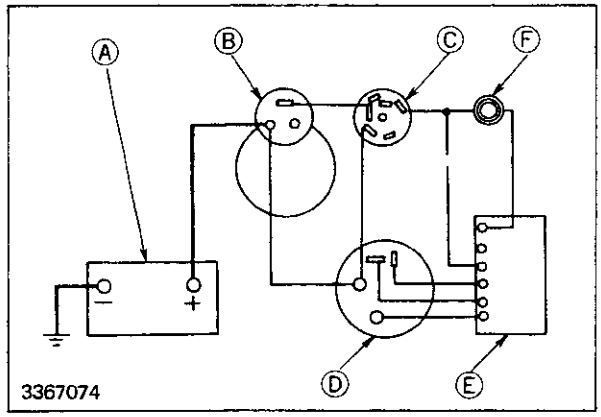
CHARGING CIRCUIT 35A

GENERAL INFORMATION

See chapter 40, Section 10 for charging system repair.

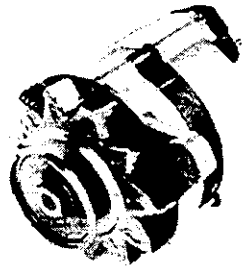
L.H. figure shows components of charging circuits. Wiring is contained in main harness.

A — Battery
B — Starter
C — Key Switch
D — Alternator
E — Regulator
F — Pilot Lamp



ALTERNATOR

The alternator (also called an AC generator) is composed of stator coil and magnetic rotor and rectifier. An alternator provides a better output at lower engine speeds and, in the heavier models, provides a very high output at cruising speeds.



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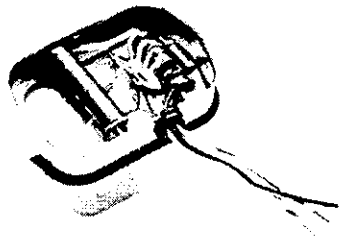
REGULATOR

The regulator is composed of charging regulator and voltage regulator parts, having double set of contact points and magnetic coils.

Keep regulator away from any heat generating equipment when servicing or testing.



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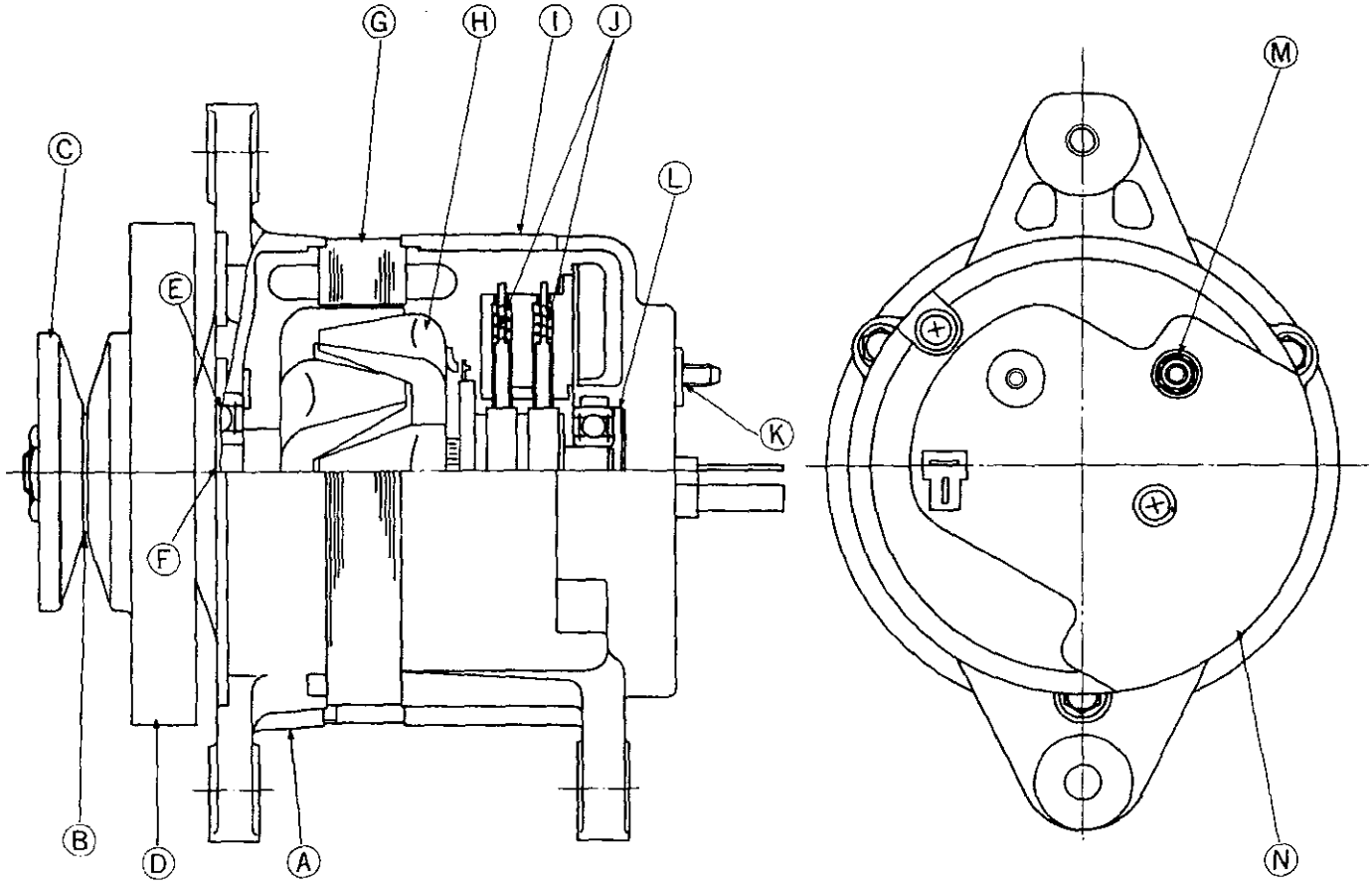

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A – Front Cover
B – Spacer
C – Pulley
D – Fan
E – Front Bearing
F – Bearing Retainer
G – Stator Coils
H – Rotor Assembly
I – Stator Housing
J – Brushes
K – Rectifier
L – Rear Bearing
M – "A" Terminal
N – Rear Cover

HOW THE SYSTEM WORKS

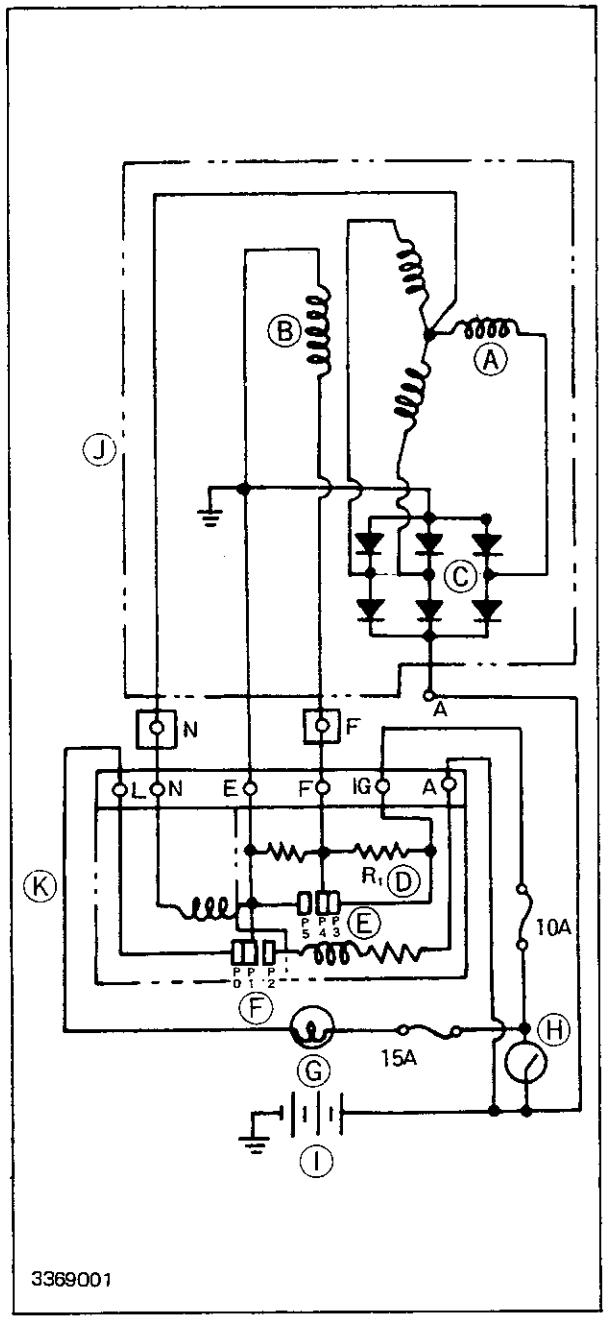
SCHECMATIC OF CIRCUIT

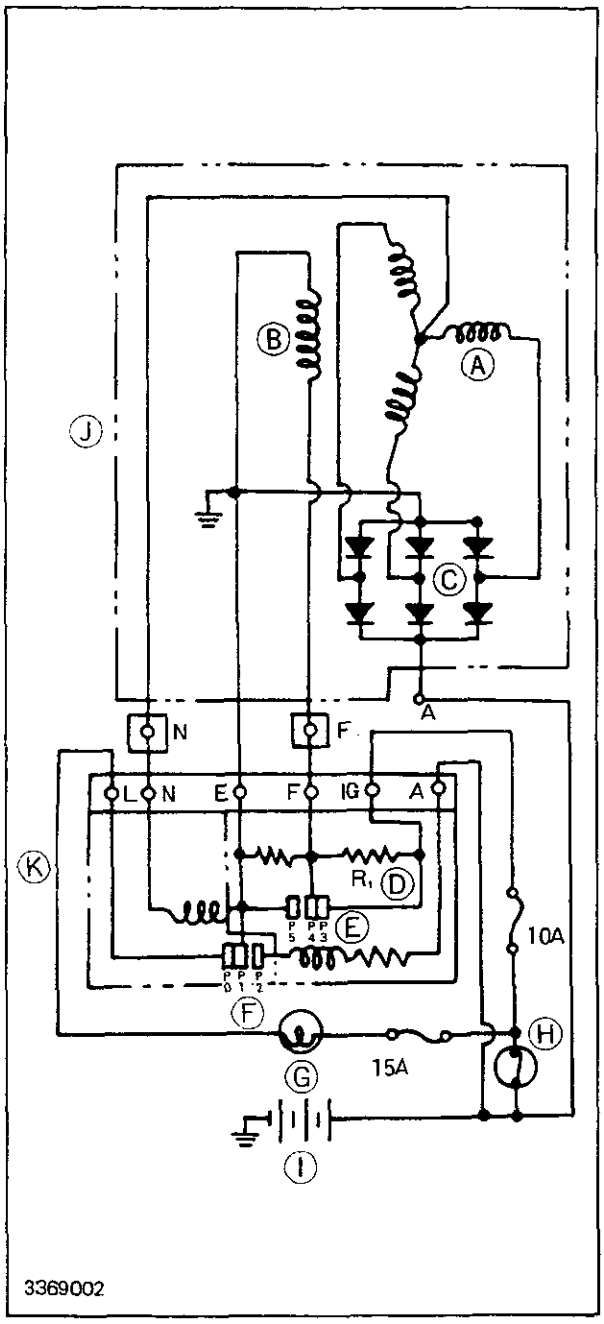
In an alternator, unlike a DC generator, the magnetic field (B) rotates and the windings (A) are stationary.

The magnetic field is externally excited, meaning it requires an external current source. The rotor consists of two interlocking soft iron sections and a wire coil wrapped around an iron core. When current is passed through the wire coil, the rotor becomes an electromagnet.

The rotating magnetic field induces alternating current in the stator windings. This is converted to direct current by six diodes (C) in the rectifier bridge.

A – Stator Coil
B – Rotor Coil
C – Diodes
D – Resistor R1
E – Charge Contacts
F – Regulator Contacts
G – Charge Indicator Light
H – Key Switch
I – Battery
J – Alternator
K – Regulator





PHASE 1 – ALTERNATOR STOPPED (ALSO EXTREMELY LOW SPEED)

Alternator Stopped:

1. Current flows from battery through key switch to "IC" terminal on regulator, and through charge indicator light to "L" terminal.
2. From there, current flows through resister R1 to contacts P3 and P4. Current from "L" terminal flows to contacts P0 and P1.
3. This allows current to flow through rotor coil, enabling alternator to generate electricity.

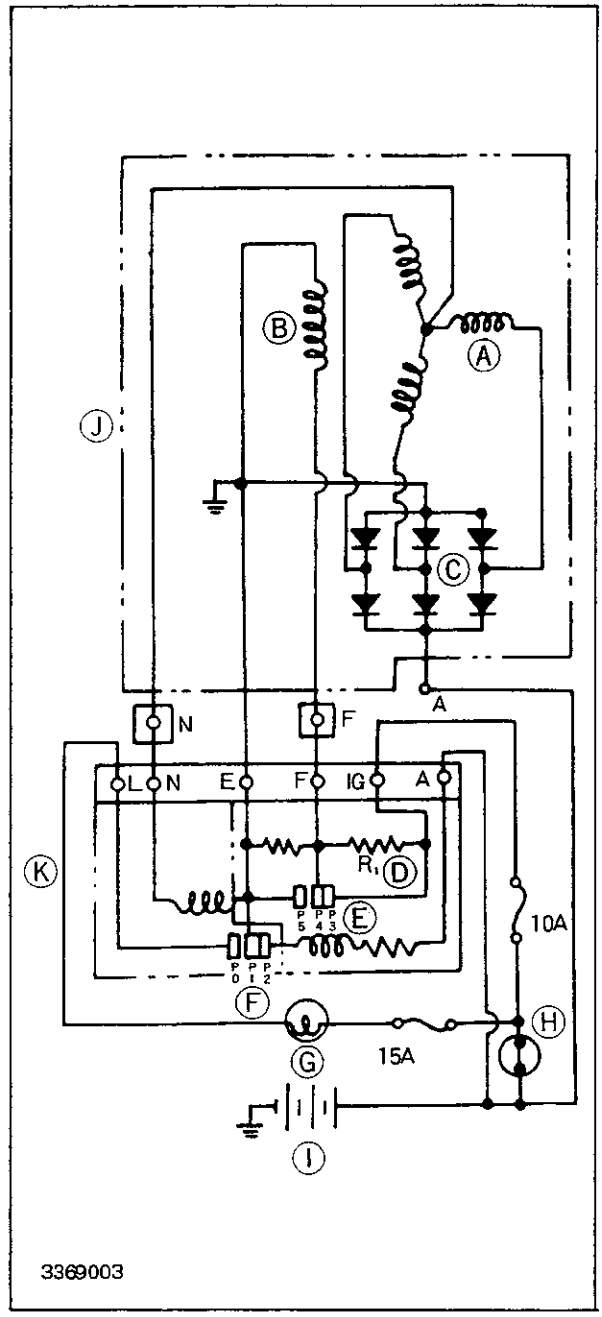
A – Stator Coil
B – Rotor Coil
C – Diodes
D – Resister R1
E – Charge Contacts
F – Regulator Contacts
G – Charge Indicator Light
H – Key Switch
I – Battery
J – Alternator
K – Regulator

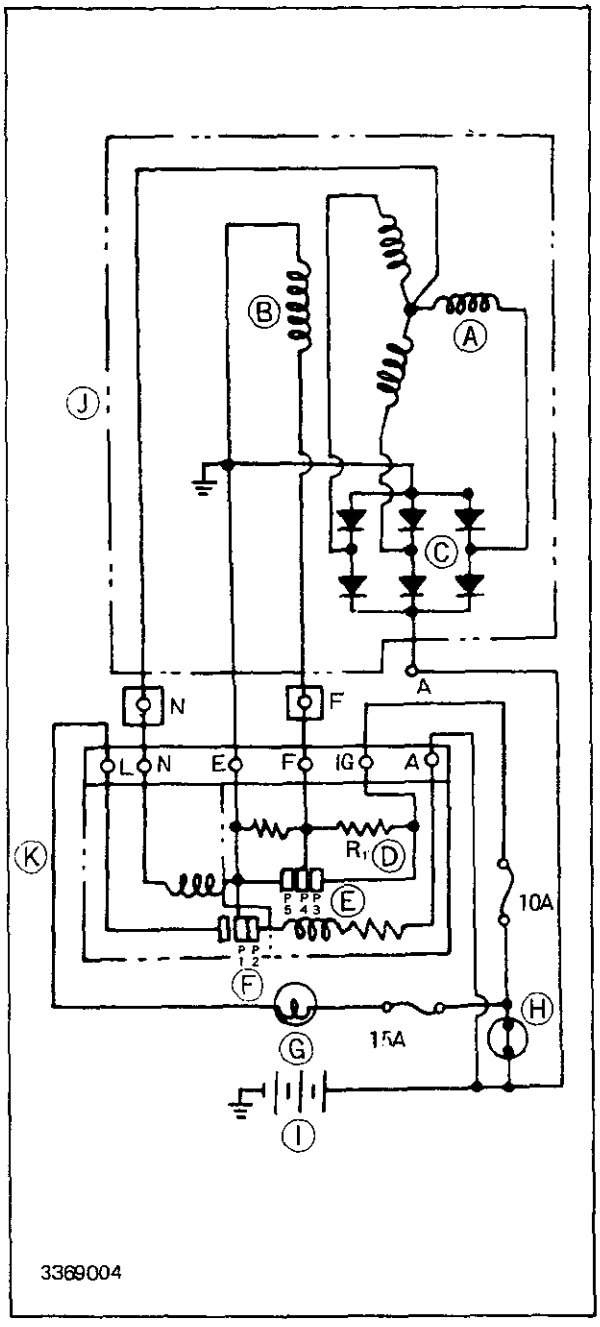
PHASE 2 – LOW SPEED OPERATION

Generating Electricity:

1. As rotor turns, 3-phase alternating current is generated in stator coil and is rectified to direct current by the six diodes.
2. When generated voltage becomes higher than battery voltage, current flows through alternator "A" terminal to battery, charging the battery.
3. At the same time, voltage at "N" terminal flows through charge relay coil, bringing contacts P1 and P2 together. The charge indicator light goes out.

A – Stator Coil
B – Rotor Coil
C – Diodes
D – Resister R1
E – Charge Contacts
F – Regulator Contacts
G – Charge Indicator Light
H – Key Switch
I – Battery
J – Alternator
K – Regulator





PHASE 3 – MEDIUM SPEED OPERATION

Controlling Voltage at Medium Speed

1. As engine speed increases, voltage at "N" terminal through, energizing coil.
2. Contact P4 parts from P3 and stays between P3 and P5.
3. Current to rotor flows through resister R1, causing alternator to decrease generating electricity.

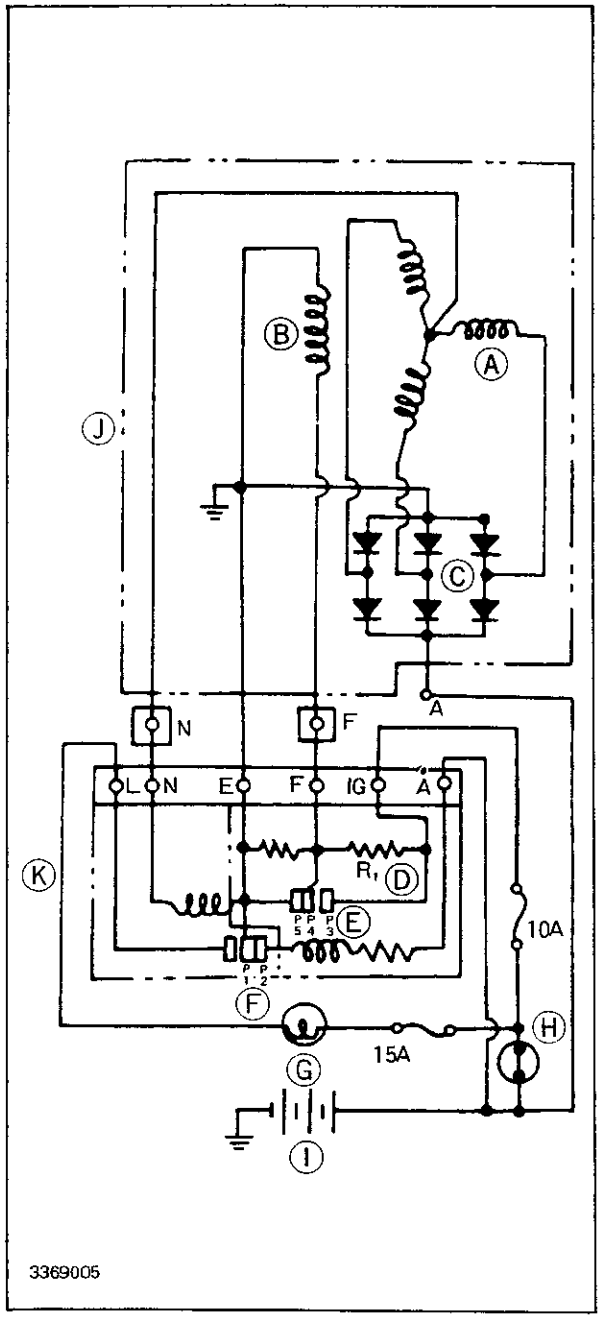
A – Stator Coil
B – Rotor Coil
C – Diodes
D – Resister R1
E – Charge Contacts
F – Regulator Contacts
G – Charge Indicator Light
H – Key Switch
I – Battery
J – Alternator
K – Regulator

PHASE 4 – HIGH SPEED OPERATION

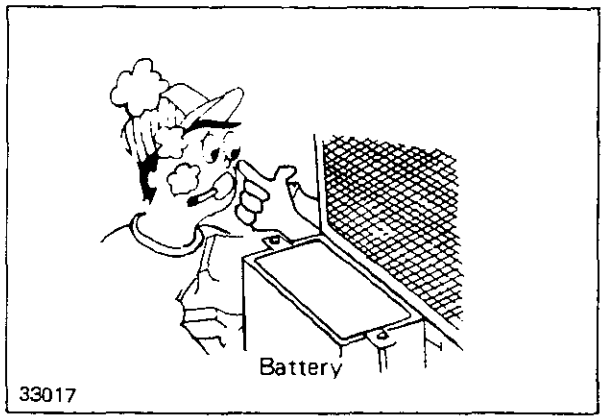
Shut-Off

1. As engine speed increases, more voltage at "N" terminal through voltage coil increases, energizing coil.
2. Contacts P4 and P5 come together, forcing rotor current to ground through "E" terminal.
3. Current to rotor is shut off and alternator stops generating electricity.
4. Phases 3 and 4 are repeated many times per second to maintain voltage at proper level.

A – Stator Coil
B – Rotor Coil
C – Diodes
D – Resister R1
E – Charge Contacts
F – Regulator Contacts
G – Charge Indicator Light
H – Key Switch
I – Battery
J – Alternator
K – Regulator



PRECAUTIONS



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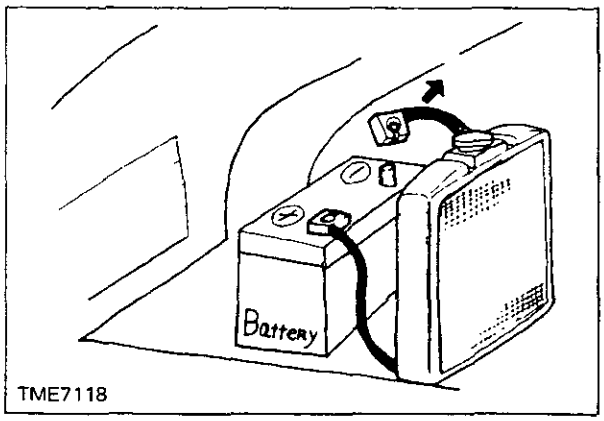

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CAUTION: When working on charging circuit, observe the following rules for your safety and prevention of damage to tractor:

SAFETY

1. Keep all sparks and flames away from battery. Gas from battery electrolyte is highly flammable. Also avoid spilling electrolyte on yourself or on anything which could be damaged by the sulphuric acid.
2. Avoid sparks when connecting booster battery or battery chargers. When possible, make last connection at a point away from battery. Battery charger should be turned off before connecting or disconnecting.
3. When connecting battery, always connect ground cable last. Disconnect ground cable first.
4. Disconnect battery ground cable before working on electrical system.

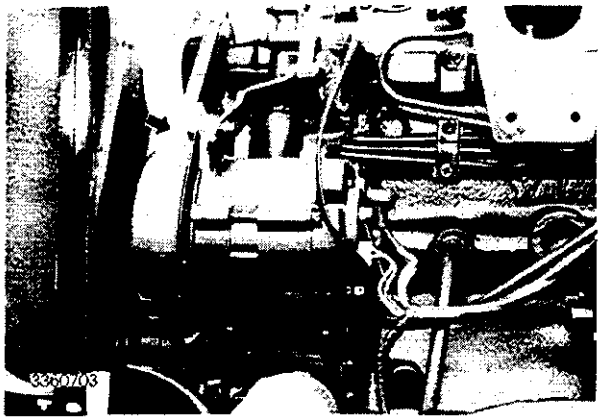
PREVENTION OF DAMAGE

1. Before connecting battery cables, be sure that battery and alternator connections are correct. Reverse polarity can cause permanent damage.
2. When connecting a booster battery, connect positive (+) terminal of booster battery to positive terminal of tractor battery. Then connect negative (−) terminal of booster battery to tractor frame. Reverse polarity can cause permanent damage.
3. Never run engine with alternator or battery cables disconnected; doing so might damage alternator.
4. Never short across or ground alternator terminals unless specifically recommended. Be careful to prevent grounding alternator wires when disconnected.
5. Never attempt to polarize an alternator.

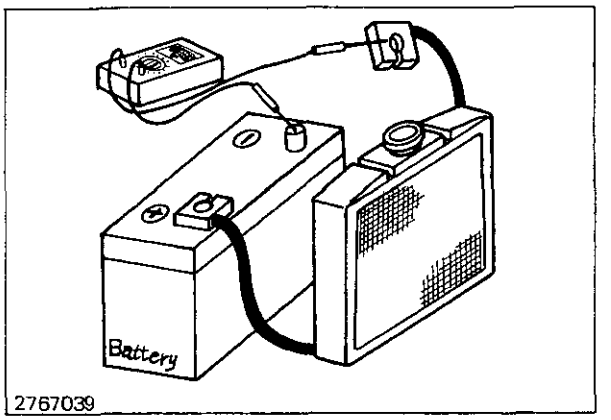
DIAGNOSIS AND TESTS

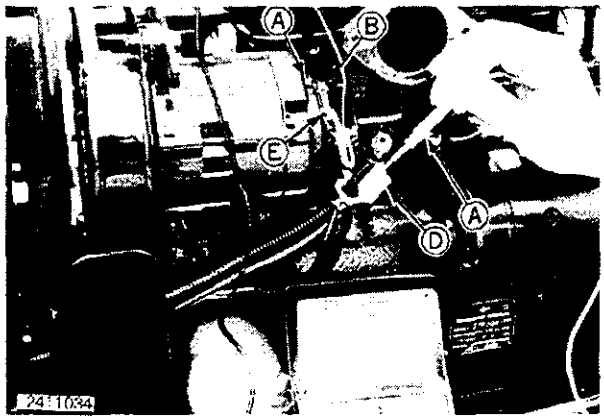
Before testing alternator itself, see if problem is somewhere else.

1. Check for loose or worn alternator belt.
2. Check for excessive loads, such as add-on lighting, which might exceed alternator capacity.
3. Ask how tractor is used. Problem might be frequent starting, with too little running to recharge battery.
4. Test battery as instructed in Section 05.



5. Check for a slow drain on battery. With all switches off, disconnect battery ground cable and connect a sensitive ammeter between cable and battery post. If current exceeds 100 milliamps, see where it is going. Unplug connectors until you locate the circuit, then try to find the problem.
6. Check entire charging circuit for a poor connection. Problem could be at battery, starter, key switch, regulator or alternator.



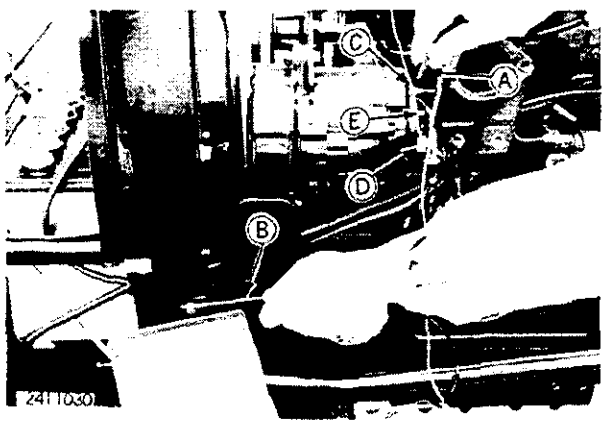


BATTERY CONNECTIONS TEST

With engine stopped and key switch off, use Volt-Ohm-Amp meter to check for battery voltage at alternator.

1. Set selector switch to "30 VOLTS".
2. Connect COM (—) probe to ground. Be sure it makes good electrical contact.
3. Connect V-Ω-A (+) probe to "A" terminal on alternator and read voltage. It should be 12.4 to 12.8 volts if battery is fully charged.
4. If reading is low, check for defective battery or poor connections at battery, starter or alternator.

A — (+) Probe
B — (—) Probe
C — "A" Terminal
D — "N", "F" Connector
E — "E" Terminal



VOLTAGE CHECK TO ROTOR

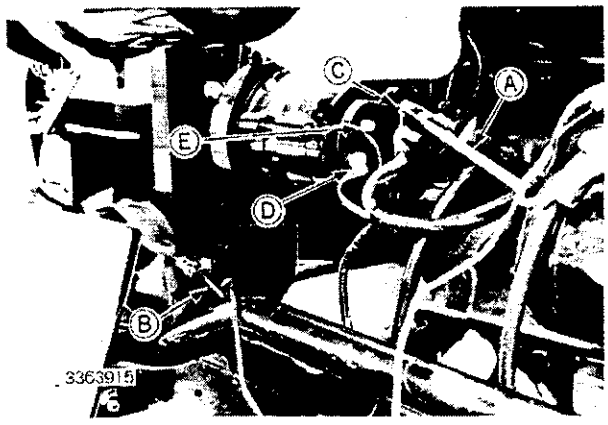
1. Disconnect connector from back of alternator.
2. Connect COM (—) probe to "E" terminal and connect V-Ω-A (+) probe to "F" terminal.
3. Set selector switch to "30 VOLTS".
4. Turn key switch on. Do not start engine. Observe voltmeter.

A — (+) Probe
B — (—) Probe
C — "A" Terminal
D — "N", "F" Connector
E — "E" Terminal

If reading is at least 12 volts, check alternator output.

If reading is 0 or less than 12 volts, check wiring from battery to regulator and from "F" terminal to regulator for continuity and poor connections. If wiring is OK, regulator is defective and must be replaced. See page 40-10-12.

REGULATED VOLTAGE CHECK



Checking Regulated Voltage

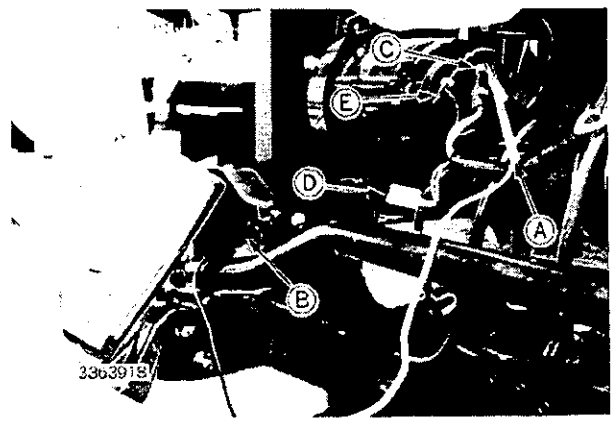
1. Set selector switch to "30 VOLTS". Connect COM (–) probe to a suitable ground. Connect V-Ω-A (+) probe to "A" terminal on alternator. (Same connections as for testing battery connections.)

2. Start engine and run it several minutes at 1500 rpm to charge battery. Meter should read 13 to 15 volts.

A – (+) Probe
B – (–) Probe
C – "A" Terminal
D – "N", "F" Connector
E – "E", Terminal

3. With engine running, touch other end of jumper wire to "A" terminal, and observe voltage as at left. If voltage rises to 13 to 15 volts, voltage regulator is defective and must be replaced. If not, alternator is defective. See Section 10 of Chapter 40 for repair instruction.

STOP Perform this test quickly to prevent possible damage to alternator.



Bypassing Voltage Regulator

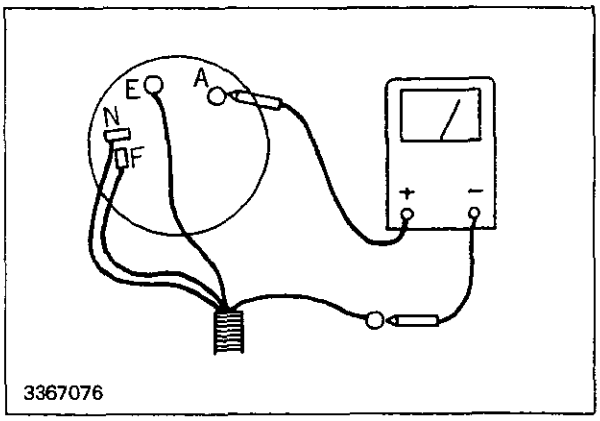
1. Disconnect connector from "N" and "F" terminals.

2. Attach a jumper wire to "F" terminal, making sure it does not touch alternator case. An easy method to use a jumper wire with a female blade connector on one end.

A – (+) Probe
B – (–) Probe
C – "A" Terminal
D – "N", "F" Connector
E – "E" Jumper wire

If voltage is higher than 15 volts, voltage regulator is defective and must be replaced.

If voltage is lower than 13 volts, charge battery and repeat test. If voltage stays low, whether alternator or voltage regulator is defective. Bypass voltage regulator as follows to test alternator.



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ALTERNATOR OUTPUT CHECK

1. Disconnect large wire from "A" terminal, and connect an ammeter capable of measuring at least 30 amps in series as shown above.
2. Attach a jumper wire to "F" terminal.
3. With engine running at 2600 rpm, touch other end of jumper wire to "A" terminal, and observe output on meter.

Perform this test quickly to prevent possible damage to alternator.

If output is less than 35 amps, alternator is defective. Refer to Section 10 of Chapter for repair instructions.

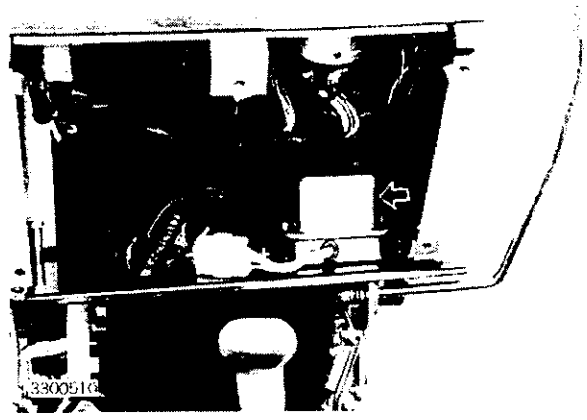
If alternator produces at least 35 amps in this test but does not work properly in normal operation, voltage regulator is probably defective.

REGULATOR CHECK

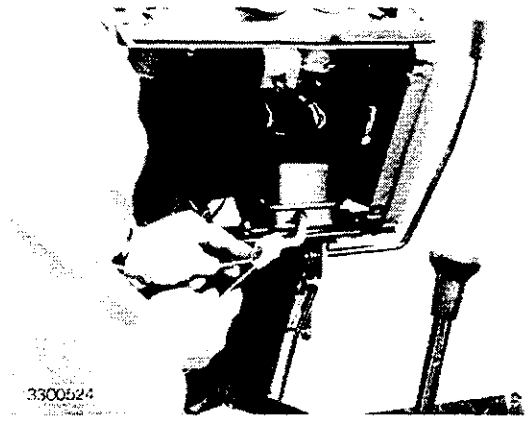
Voltage regulator is in compartment below instrument panel.

The following checks will not guarantee that voltage regulator is working properly, but a bad reading will guarantee that it is not.

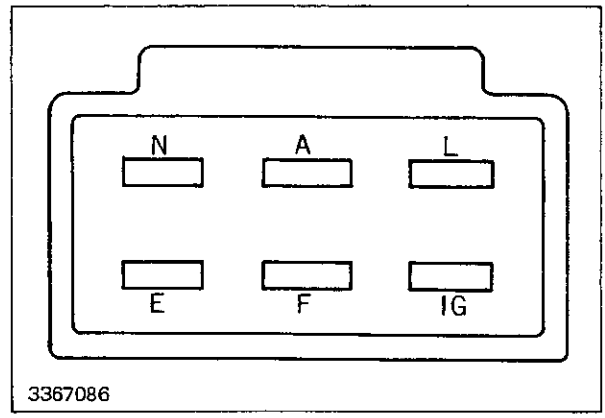
1. Disconnect voltage regulator from main wiring harness. Fig. 1 shows identification of terminals in connector.



2. Use Volt-Ohm-Amp Meter to check for continuity between the following terminals.



Wire Colors:
Terminal "N" – White
Terminal "A" – White with red stripe
Terminal "L" – Yellow
Terminal "E" – Black
Terminal "F" – White with black stripe
Terminal "IG" – Blue
(Some wire colors change at connector.)



CONTINUITY CHECKS

Terminal "E" to ground . . . . . continuity
Terminal "L" to Terminal "E" . . . . . continuity
Terminal "IC" to Terminal "F" . . . . . continuity
Terminal "N" to Terminal "E" . . . . . 20 ohms approx.

If continuity does not check as indicated, or if a defective voltage regulator is indicated by the previous tests, install a new one.

STARTING CIRCUIT

GENERAL INFORMATION

See Chapter 40, Section 15 for starting circuit repair.

Never operate starting motor longer than 20 seconds. Allow at least two minutes for cooling and battery recovery before operating again. Overheating, caused by excessive opration, will seriously damage starting motor.

HOW THE SYSTEM WORKS

Fig. shows components of the starting circuit. Wiring is contained in the main wiring harness.

Current flows from battery (A), by way of starter to "B" terminal of key switch (J).

When key switch is in "START" position and starter override switch is closed (clutch pedal depressed), current flows to switch terminal of starter solenoid, engaging starter.

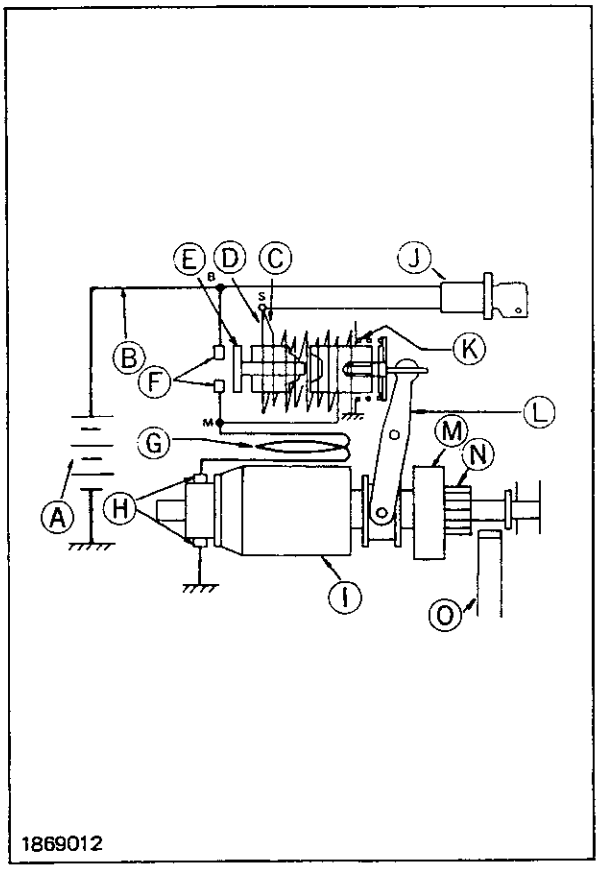
Current at switch terminal flows through both pull-in winding (C), and hold -in winding (D) to ground.

Current through windings engages solenoid plunger (E) which pushes pinion gear into mesh with ring gear and closes main contacts (F). This permits battery current to flow to field coils (G) and through brushes (H) to armature (1).

The armature begins to rotate at high speed. Gear train reduces output speed by one third. At this time, plunger is held in by force of hold-in coil only since pull-in coil has been short-circuited.

When engine starts, overrunning clutch spins freely on shaft. This prevents overspeeding of armature by flywheel.

When key switch is released, current to hold-in coil is shut off. Return spring forces plunger back to original position, opening main contacts and shutting off current to field and armature coils.



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A — Battery
B — Cable from Battery
C — Pull-in Winding
D — Hold-in Winding
E — Solenoid Plunger
F — Main Contacts
G — Field Windings
H — Commutator Brushes
I — Armature
J — Key Switch
K — Return Spring
L — Shift Lever
M — Overrunning Cluch
N — Pinion Gear
O — Ring Gear

DIAGNOSIS AND TESTS

1. Diagnose the problem as thoroughly as possible before beginning disassembly.
2. Disassemble only as far as necessary to correct problem.

DIAGNOSING MALFUNCTIONS

Any starting motor malfunciton will almost certainly result in one of the following four situations.

A – When key switch is turned to start-position, nothing happens. Solenoid does not click.

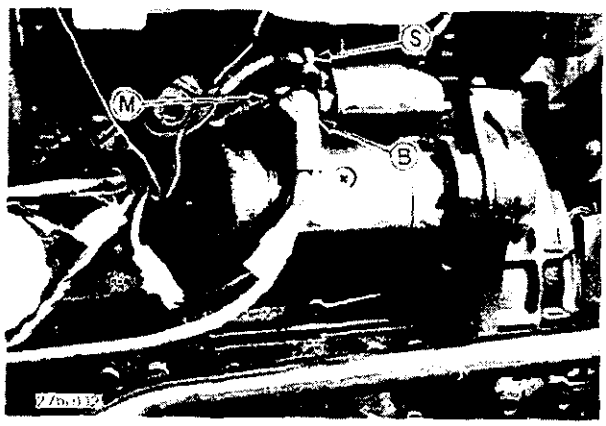
B – Solenoid clicks, but starting motor does not operate.

C – Starting motor runs, but does not crank engine.

D – Starting motor cranks engine slowly or erratically.

Determine which of the four situations applies, and diagnose problem as instructed for those symptoms.

Use jumper cable to test starter. Refer to the figure for each solenoid terminals.



B – Battery Terminal
S – Switch Terminal
M – Motor Terminal

⚠ CAUTION: Be positive that transmission is in neutral before using jumper wire to starter. Unless you want engine to start, place throttle lever in "STOP" position.

DIAGNOSING MALFUNCTIONS (Continued)

PROBLEM	POSSIBLE CAUSE	REMEDY
When Key Switch is Turned to Start Position, Nothing Happens. Solenoid Does Not Click	• Loose connections between starter, battery and key switch.	Clean and tighten.
	• Faulty starter switch.	Replace.
	• Pinion gear seizes on shaft.	Replace.
	• Faulty solenoid plunger or short-circuit of windings.	Replace.

1. Connect a jumper wire to positive terminal of battery. Briefly touch jumper wire to switch terminal (S), of solenoid. If starter operates, problem is in wiring or switches. Refer to circuit tests on page 5.
2. If starter does nothing when jumper wire is touched to switch terminal, test batteries as instructed on page 1 of Section 05. Make sure all battery cable connections are clean and tight.
3. If batteries and connections are good, test solenoid as instructed in Section 15 of Chapter 40.

Solenoid Clicks, but Starting Motor Does Not Operate	• Loose connections at battery or solenoid switch (terminals "B" and "M")	Tighten and Replace Battery Cable as necessary.
	• Faulty pinion gear or ring gear.	Replace.
	• Worn brushes, weaken brush springs or dirty commutator.	Replace brushes or spring. Clean commutator.
	• Faulty field coil.	Replace windings.
	• Faulty or damaged main contacts in solenoid.	Replace.

1. Make sure all battery cable connections are clean and tight. Low voltage caused by a poor connection is a common problem.
2. Test batteries as instructed on page 1 of Section 05. Recharge or replace batteries if necessary.
3. If solenoid chatters and low voltage is not the cause, an open circuit in hold-in winding is indicated. Replace solenoid.
4. If solenoid appears to work properly, problem is inside starting motor. Remove and check starting motor as instructed in Section 15 of Chapter 40.

DIAGNOSIS AND TEST (Continued)

DIAGNOSING MALFUNCTIONS (Continued)

PROBLEM	POSSIBLE CAUSE	REMEDY
Starting Motor Runs, But Does Not Crank Engine	• Faulty overrunning clutch.	Replace.
	• Broken armature shaft or pinion gear.	Replace.

Problem would appear to be a defective overrunning clutch drive, broken armature shaft or broken gears in gear train.

Whatever the case, starting motor must be removed and checked as instructed in Section 15 of Chapter 40.

Starting Motor Cranks Engine Slowly or Erratically	• Loose battery cable connections.	Tighten.
	• Low volltage in battery.	Charge battery.
	• Inside problem in starter.	Repair or replace as necessary.
	a) Brushes.	
	b) Windings are short circuited or open circuited.	
	c) Pole shoes are dragging on armature.	
	• Ring gear is deffective or binding.	Repair.

1. Make sure all battery cable connections are clean and tight. Low voltage caused by a poor connection is a common problem.
2. Test batteries as instructed on page 1. Section 05. Recharge or replace batteries if necessary.
3. If low voltage is not at fault, problem is inside starter. Brush assembly could be defective. Field windings or armature windings could be short circuited or open circuited. Bushings, pinion, or flywheel ring gear could be defective and binding. Pole shoes could be dragging on armature.

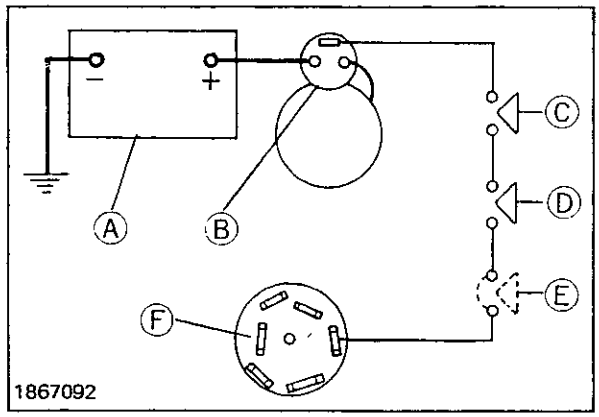
   Remove and check starting motor as instructed in Chapter 40, Section 15.

CIRCUIT TESTS

The figure (right) shows components of starting system. If no current reaches switch terminal of solenoid when key switch is in start position, fault could be in any component or connection.

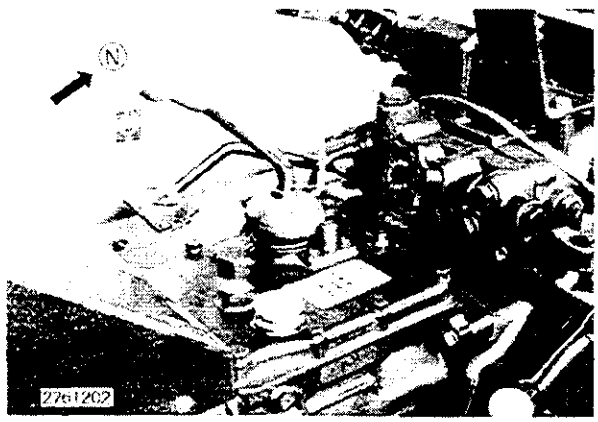
Make simplest checks first.

1. If any electrical equipment works, circuit is good from batteries to key switch. If not, check batteries, battery cable connections, and starter connections.
2. Turn key switch "ON". If lights work, key switch is probably not defective. Remove and test switch only if problem cannot be found elsewhere.

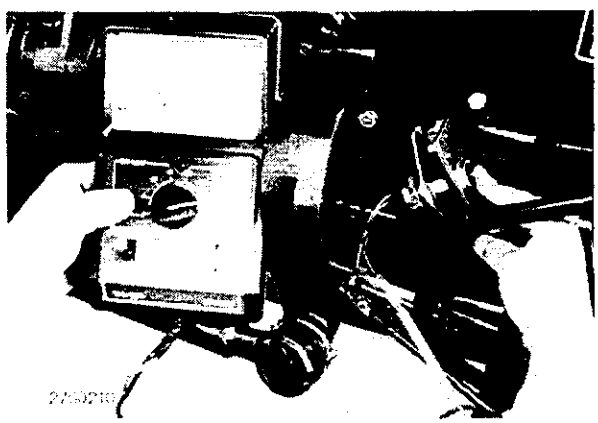


CAUTION: Be positive that transmission is in neutral before using jumper wire. Unless you want engine to start, place throttle lever in "STOP" position.

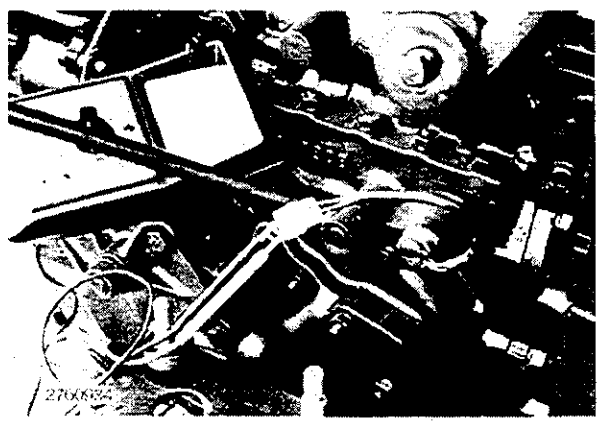
A — Battery
B — Starting Motor
C — Clutch Pedal
Start Safety Switch
D — Front PTO
Start Safely Switch
E — Rear PTO
Start Safety Switch
F — Key Switch



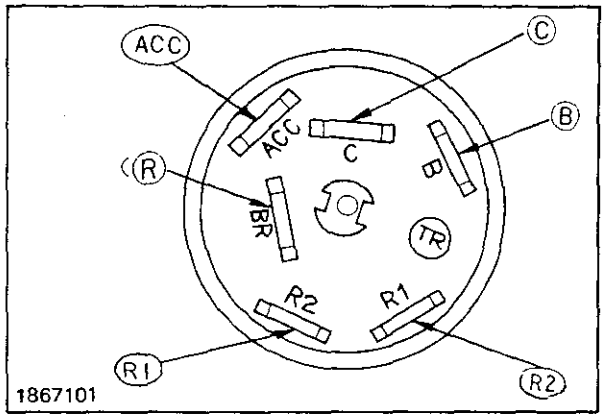
3. Connect a jumper wire to battery terminal on starting motor. Briefly touch jumper wire to switch terminal. Starting motor should engage. If it does not, problem is in solenoid or starting motor.
4. Test start safety switch on clutch pedal with a test light or ohmmeter. The switch should close only when the clutch pedal is depressed.



5. Repeat for the start safety switch on the rear PTO shift lever.



CAUTION: DO NOT attempt to start tractor by depressing clutch pedal by hand while standing on ground, out of operators station.



CIRCUIT TESTS (Continued)

6. If necessary to remove and check key switch, test for continuity between the following terminals.

Thermostart position	B to R1, B to R2, B to BR
On position	B to BR
Start position	B to BR, B to C

GENERAL INFORMATION

See Chapter 40, Section 20 for lighting and accessory circuit repair.

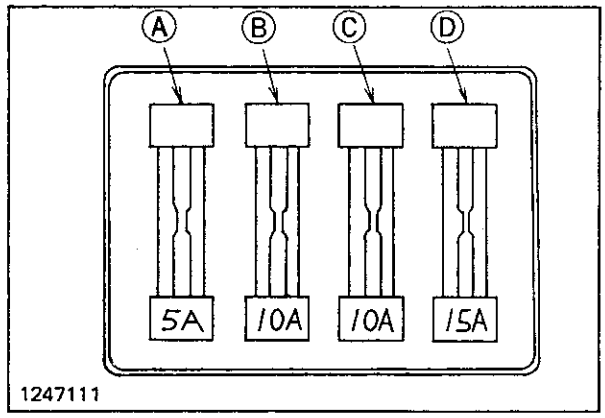
Refer to Figs. (section 05 page 5 and 6) for lighting and accessory circuit wiring diagrams and component locations.

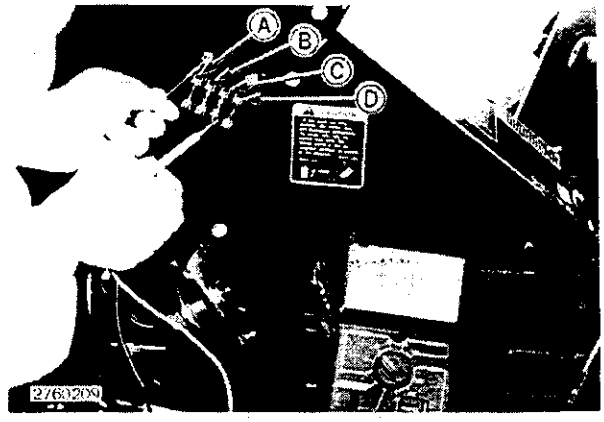
FUSES

All lighting circuits are protected by fuses located on left-hand control console support. If all lights on one circuit fail at the same time, a fuse may have blown.

DO NOT attempt to correct lighting circuit problems by installing a larger fuse, as it may cause additional damage to the circuit.

If a fuse blows, turn off the circuit. Remove fuse block cover and pull out blown fuse. Install new fuse of equal amp capacity.





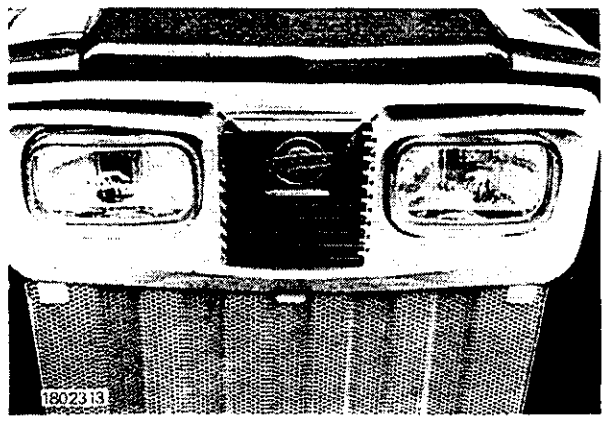
A — Indicator Clustor
B — Flashing/Warning Lights
C — Horn and Front PTO
D — Headlights and Work Light

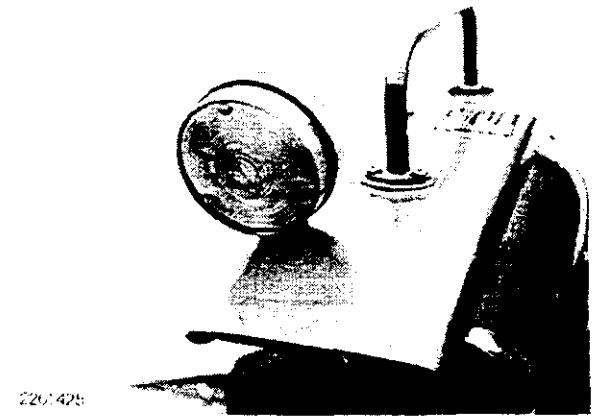
Turn circuit on. If fuse blows again, check carefully for a short or ground in wiring.

HEADLIGHTS

The tractor is equipped with two dual beam headlights mounted on the front of hood.

The headlights are on when the light switch is in the S or H position. The high beam is "ON" in S position.



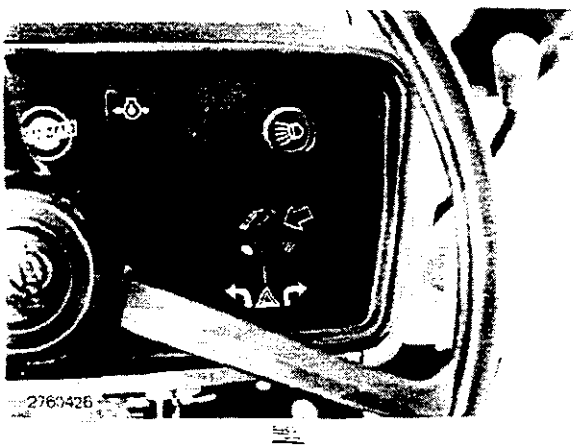


FLASHING WARNING-TURN SIGNAL LIGHTS

The flashing warning-turn signal light is mounted on each fender. These lights work as both flashing warning and turn signal lights.

To flash the lights as warning light, pull the light switch.

To flash one of each light as turn signal, turn the switch at the both pushed and pulled positions. If turned clockwise, right hand light flashes. If turned counterclockwise, left hand light flashes.



If the flashing warning-turn signal lights do not work correctly, inspect and test flasher relay and switch as instructed on page 240-20-3.

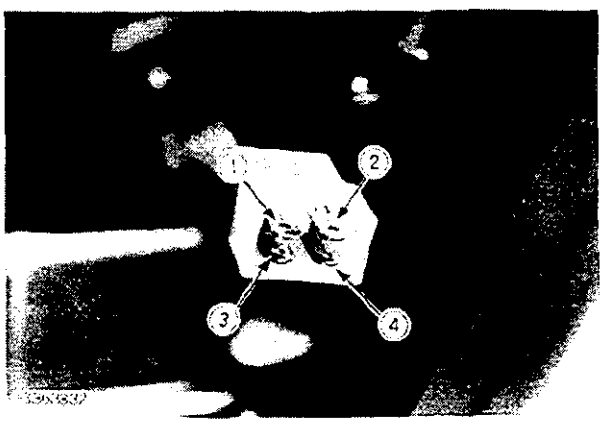
FLASHING WARNING AND TURN SIGNAL SWITCH TESTING

1. Remove access panel from panel box. Disconnect connector (B), from main wiring.
2. Use an ohmmeter to check for continuity. The following chart gives continuity checks for the switch.

   The switch can be pulled to switch on for flashing warning lights, and be turned to flash the one of warning light and to keep glowing for another.

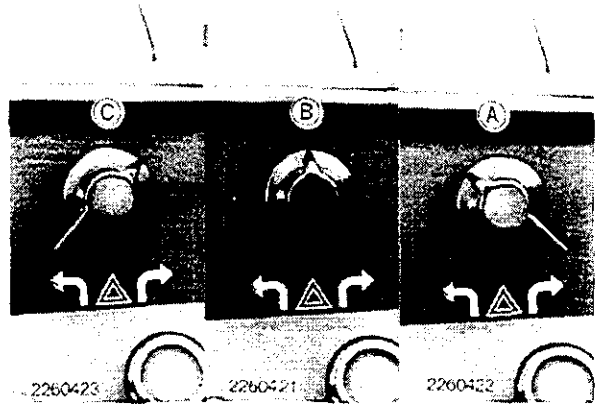
A – Flashing Warning-Turn Signal switch

B – Connector From Switch



Terminal 1 – Green/Yellow (To left light)
Terminal 2 – Green/Black (To right light)
Terminal 3 – Green/Red (Power in from relay)
Terminal 4 – Green (Power in from a "hot" circuit)

A – Right Turn Flashing Position
B – Neutral Position
C – Left Turn Flashing Position

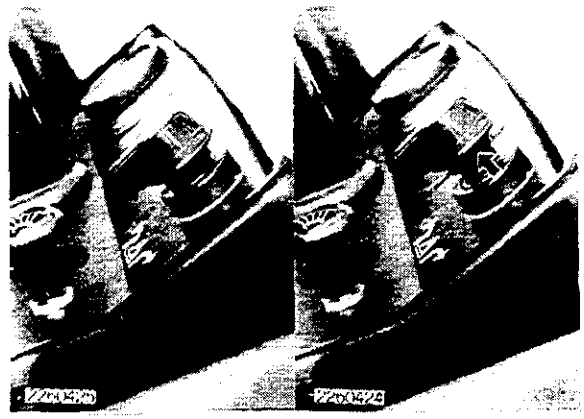


(A) Pushed Position

SWITCH POSITION	TERMINAL IN CONTINUITY
Neutral N	1 and 2
Right R	1 and 3
Left L	2 and 3

(B) Pulled Position

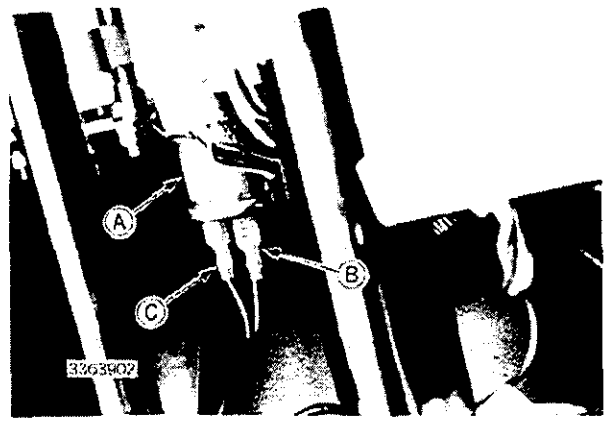
SWITCH POSITION	TERMINAL IN CONTINUITY
Neutral N	1,2 and 3
Right R	1 and 3
	2 and 4
Left L	2 and 4
	2 and 3



FLASHER TESTING

To test flasher on tractors without turn signals:

1. Remove access panel below instrument panel.
2. Disconnect wires B and C from flasher relay.
3. Pull boot back on wire B and C.
4. Touch the two exposed terminals together. With key switch "ON" and flashing warning-turn signal light switch is pulled position, the lamps should glow steadily.
5. If flashing warning-turn signal lamps do not glow, check for loose connections, blown fuse or defective bulbs.



A – Flasher
B – "Hot" (Green/Black)
C – To Switch (Green/Red)

LIGHT SWITCH

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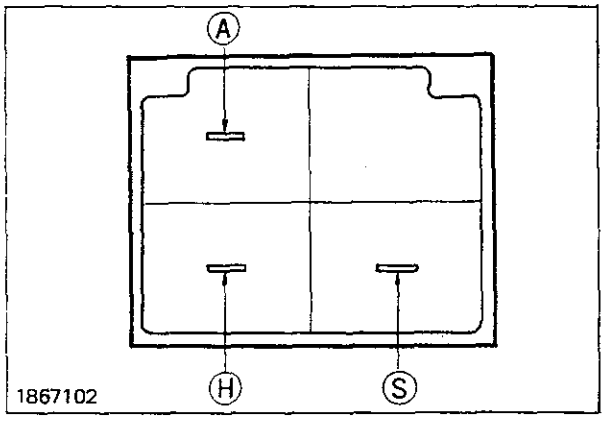
1. Remove set screw and knob from shaft. Remove access panel below instrument panel.
2. Disconnect wiring from switch at connector.
3. Remove nut holding switch to panel. Remove switch.



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Light switch should have continuity between connector terminals listed below.

SWITCH POSITION	CONTINUITY BETWEEN CONNECTOR TERMINAL B
OFF	NONE
1st Pulled Position	S and H
2nd Pulled Position	H

B – To key Switch
S – To High Beam Headlights and Work Light
H – To Low Beam Headlight

INDICATOR AND INSTRUMENT LIGHTS

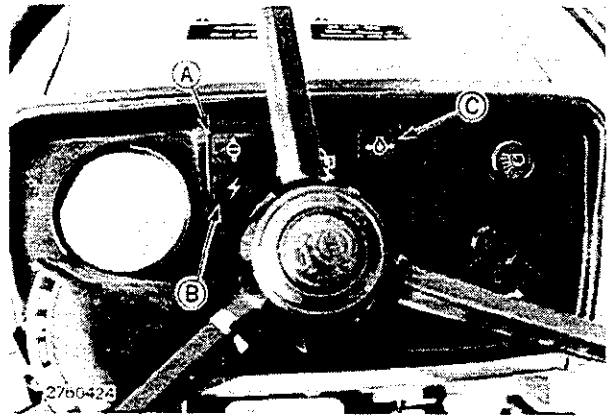
INDICATOR LAMPS

The "TEMP" light (A), glows when engine coolant temperature exceeds 110°C (230°F).

The "CHG" light (B) glows when alternator output is insufficient.

The "OIL" light (C) glows when engine oil pressure drops below 14.2 psi (1.0 kg/cm^2).

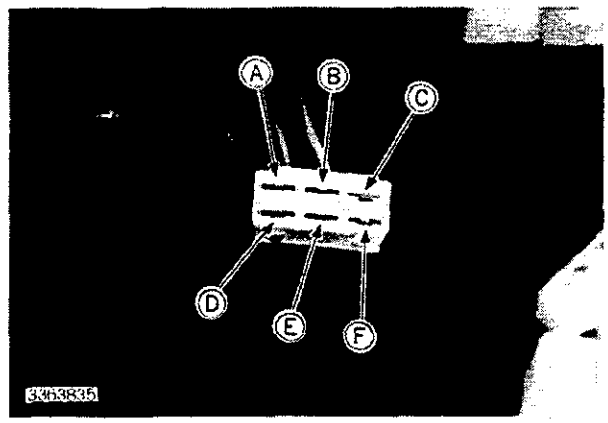
All three lights should be off when engine is running. If any light comes on, stop engine immediately and correct problem.



A – Temperature
B – Charge
C – Oil

Diagnosing Indicator Lamps

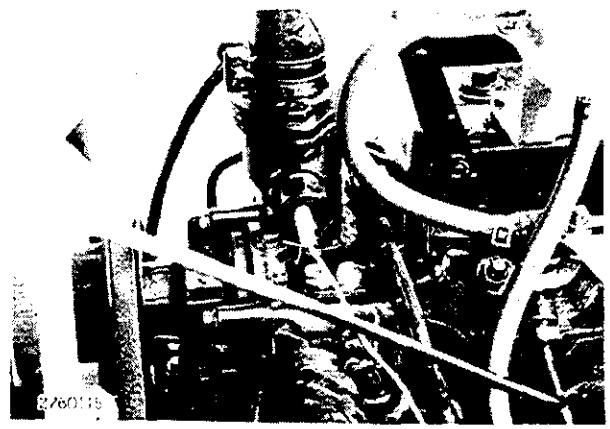
The "CHG" and "OIL" lights should glow when key switch is "ON" with engine not running. If they don't glow, check for a blown fuse. If fuse is OK, check continuity of hot wire between fuse holder and 6-pin connector terminal (A). Repair as necessary.

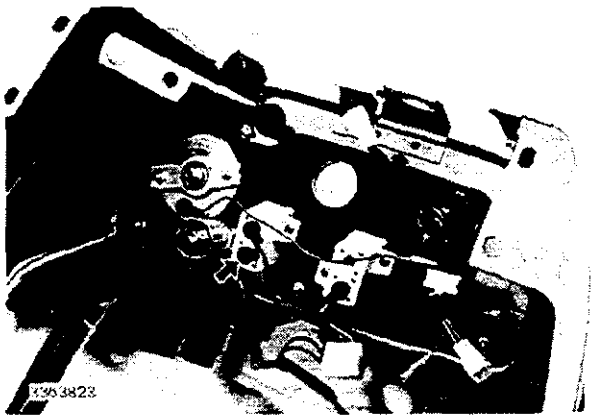


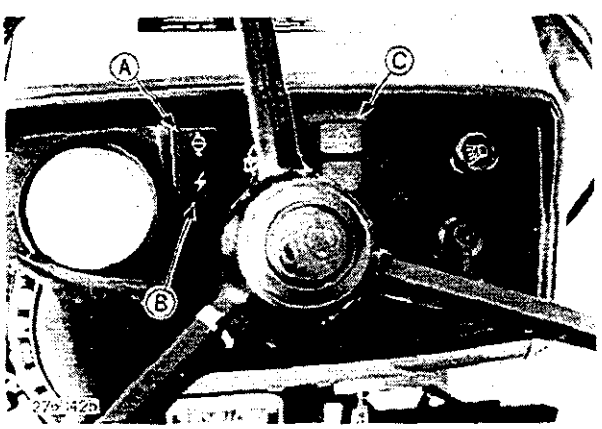
A – Not used
B – To Regulator
C – To Ground
D – To "OIL" Sender
E – Hot Lead
F – To "TEMP" Sender

Temperature Light Tests

1. Disconnect wire from oil pressure sender.
2. With key switch "ON", touch wire to a good ground. If "OIL" light glows, sender is defective and must be replaced.
3. If light does not glow, check continuity of wire between sender and 4-pin connector terminal (D) with an ohmmeter or test light. Repair as necessary.
4. If light still does not glow, replace bulb and repeat step 2. See BULB REPLACEMENT.







Charge Light Tests

1. If fuse is OK, open hood and unplug connector between voltage regulator and main harness.
2. Connect a jumper to charge light wire at main harness connector (yellow and green wire).
3. With key switch "ON", touch jumper to a good ground. If "CHG" light glows, regulator is defective and must be replaced.
4. If light does not glow, check continuity of yellow and green wire between regulator connector and charge light socket. Repair as necessary and repeat step 3.
5. If light still does not glow, check bulb and replace as necessary. See Bulb Replacement. Repeat step 3.

Oil Light Tests

1. Disconnect wire from temperature sender.
2. With key switch "ON", touch wire to a good ground. If "TEMP" light glows, sender is defective and must be replaced.
3. If light does not glow, check continuity of wire between sender and oil light socket with an ohmmeter or test light. Repair as necessary.
4. If light still does not glow, replace bulb and repeat step 2. See Bulb Replacement.

Indicator Lights On With Engine Running

If any light comes on while engine is running, stop engine immediately and correct problem.

If "OIL" light comes on, check wiring for shorts. If wiring is OK, install a known-good oil pressure sender and start engine. If light comes on momentarily and then goes out, original sender is defective.

If light stays on, check oil pressure. Refer to Chapter 20, Section 10.

If "TEMP" light comes on, check wiring for shorts. If wiring is OK, install a known-good temperature sender and start engine. If light does not come on, original sender is defective.

If light comes on, check cooling system. Refer to Chapter 20, Section 20.

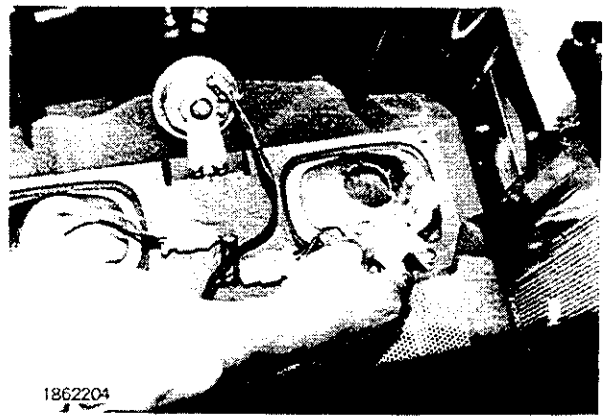
If "CHG" light comes on, check regulator as directed in Chapter 240, Section 10. Replace as necessary.

A – Temperature
B – Charge
C – Oil

BULB REPLACEMENT

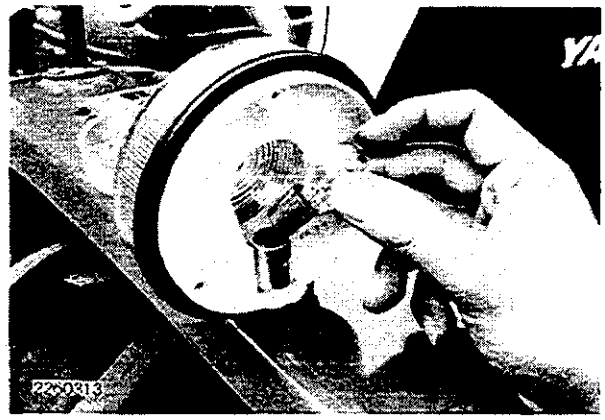
HEADLIGHTS

1. Turn bulb socket counterclockwise and pull.
2. Remove bulb base by pressing down slightly and turning counterclockwise. Lift out bulb.
3. Insert new bulb. Press bulb base down slightly and turn cleckwise.



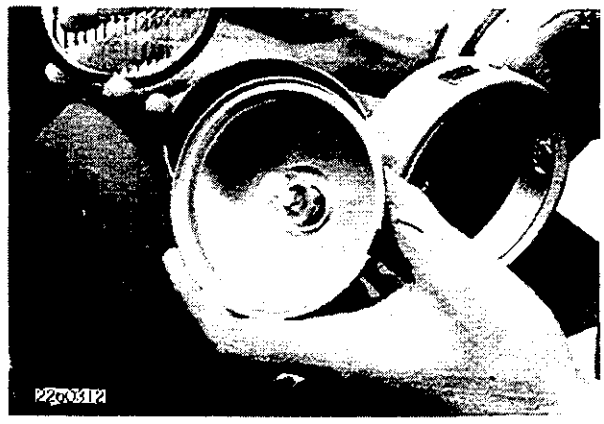
Flashing Warning-turn Signal Lamps

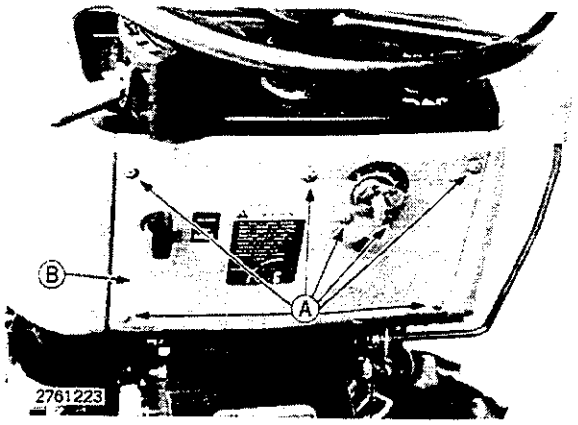
1. Remove lens by removing thress screws.
2. Remove bulb by pressing down and turning counterclockwise.
3. Press new bulb in, turning clockwise. Replace lens.



WORK LIGHT (Optional)

1. Remove rear cover by removing three screws.
2. Remove reflector and lens from housing. Remove lens from reflector.
3. Remove bulb by pressing down and turning counterclockwise.
4. Press new bulb in, turning clockwise.
5. Replace lens on reflector and install in housing. Replace rear cover.

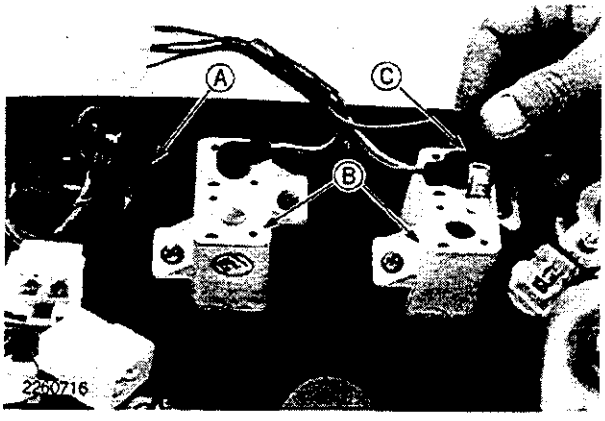




INDICATOR CLUSTER LAMPS

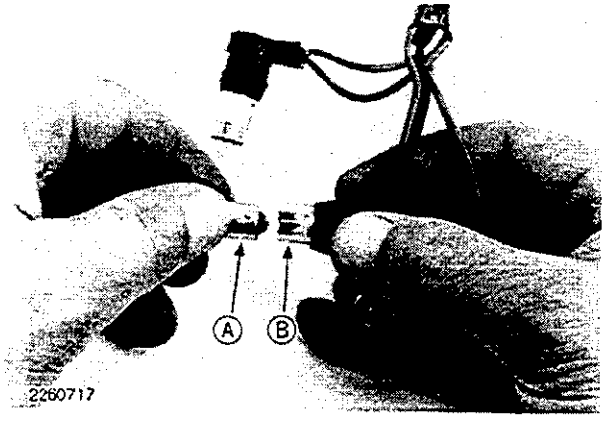
1. Remove access panel by removing five screws (A).

A – Screws
B – Access Panel



2. Turn 1/4 counterclockwise to remove holder with bulb (C) from lamp cluster (B).

A – Instrument Panel
B – Lamp Cluster
C – Lamp Holder



3. Remove bulb by pressing down and turning counterclockwise.
4. Press new bulb in, turning clockwise.
5. Insert lamp holder and turn clockwise to lock the holder to cluster.
6. Be sure bulbs are under correct lenses. "OIL" and "CHG" lamps should glow with key switch "ON". "TEMP" lamps should glow with key switch at "START" position.
7. Install access panel with five screws.

A – Bulb
B – Bulb Holder

POWER TRAIN OPERATION AND TESTS 250

SPECIFICATIONS

Engine Clutch

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Disk Facing		
O.D.	200mm (7.87 in.)	
I.D.	140mm (5.51 in.)	
Thickness	8.3~8.9mm (0.327~0.350 in.)	6.6mm (0.260 in.)
Area	160.2cm^2 (24.8 sq.in.)	
Clutch Static Torque	225.4Nm (23kgm) (166.4ft-lb.)	

Power Shift Transmission

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Power Shift Clutch Disk		
O.D.	100mm (3.94 in.)	
I.D.	80mm (3.15 in.)	
Thickness	2.5~2.7mm (0.0984~0.1063 in.)	2.1mm (0.0827 in.)
Area	28.3cm^2 (4.38 sq.in.)	
Facing	Copper Sintered Alloy	
Clutch Static Torque	274.1Nm (27.97kgm) (202.3ft-lb.)	
Clutch Dynamic Torque	182.8Nm (18.65kgm) (134.9ft-lb.)	
ower Shift Pump		
Type	Internal Gear	
Drive	Driven by Clutch Drive Shaft (Main Drive Shaft)	
Capacity (at 2600 rpm.)	12.48ℓ/min (3.28 GPM)	9.36ℓ/min (2.46 GPM)
Clutch Operating Pressure (Main Relief Valve)	1500kPa (15kg/cm^2) (213 psi.)	
Lubricating Oil Pressure (2nd Relief Valve)	40kPa (0.4kg/cm^2) (5.69 psi.)	19.6kPa (0.2kg/cm^2) (2.84 psi.)
Transmission Oil Filter (Suction Screen)	150 Mesh	
Hydraulic Oil Filter (Cartridge Type)	35 μ	
Transmission Oil YM276	17.5ℓ (4.6 US gal.)	
YM276D	18.0ℓ (4.8 US gal.)	

SPECIFICATIONS (Continued)

PTO

ITEM	SPECIFICATIONS
PTO Shaft	
Speed	540 rpm. (at 2258 engine rpm.) 1000 rpm. (at 2294 engine rpm.)
Type	1-3/4 in. SAE 6-Splines
One-way Clutch Type	Claw

Final Drive and Differential

ITEM	SPECIFICATIONS
Differential Reduction Ratio	4.091 to 1
Final Drive	
Reduction Ratio	6.300 to 1
Total Reduction Ratio	25.773 to 1

Front Wheel Drive

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Front Differential Reduction Ratio	4.500 to 1	
Front Drive Shaft		
Gear-to-Bevel Pinion Reduction Ratio	1.571 to 1	
Front Drive Final		
Gear-to-Pinion Reduction Ratio	2.308 to 1	
Front Drive Total Reduction Ratio	15.736 to 1 (from rear differential drive shaft)	
Front Axle-to-Rear Axle Speed Ratio	1.638 to 1	
Front Wheel Pre-Run Percent	0%	0 and 6%
Front Drive Oil Reservoir Capacity	1.58 US gal (6.0 ℓ)	

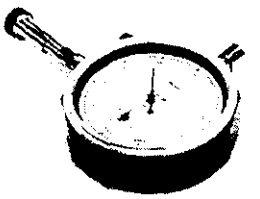
Shift Levers Operating Force

ITEM	NEW PART SPECIFICATIONS
Clutch Pedal	196 N (20 kg) (44 lbs)
Power Shift Lever	49 N (5 kg) (11 lbs)
Range Shift Lever	98 N (10 kg) (22 lbs)
PTO Shift Lever	69 N (7 kg) (15 lbs)
Differential Lock Pedal	98 N (10 kg) (22 lbs)
Front Wheel Drive Shift Lever	49 N (5 kg) (11 lbs)

SPECIAL TOOLS

Hand Tachometer

Checking engine and PTO speeds.



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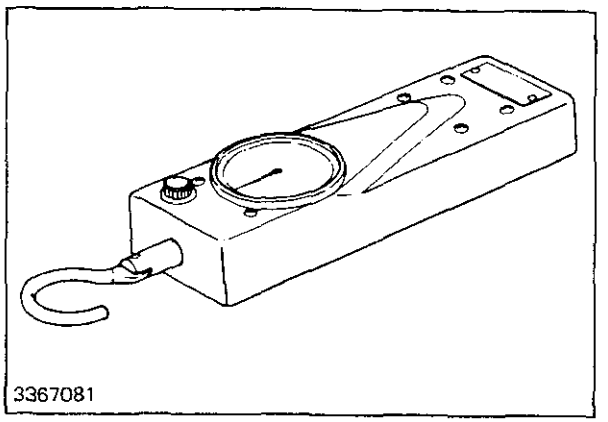
Push-Pull Gauge

Checking shift lever and pedal operating force.



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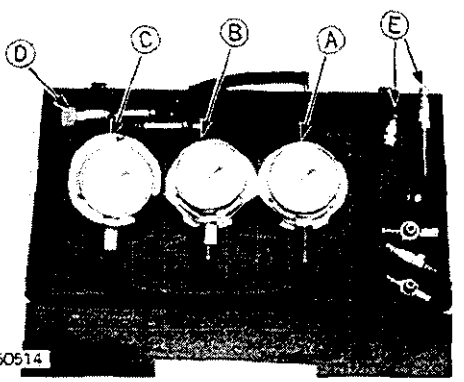
Hydraulic Pressure Gauge Kit (TOL 91000000)

Checking the following pressure:

- Power shift system pressure.
- Power shift lubricating pressure.

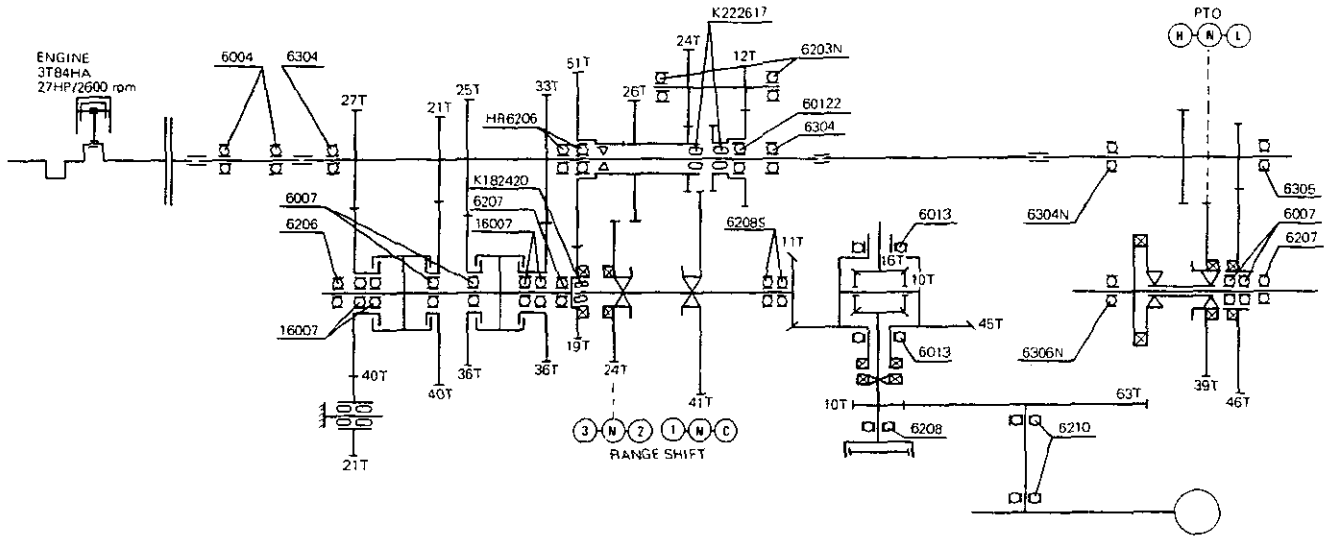
A – 0–250 kg/cm²
B – 0–35 kg/cm²
C – 0–5 kg/cm²
D – Hose with Quick Coupler
E – Adapters with Quick Coupler



3360514

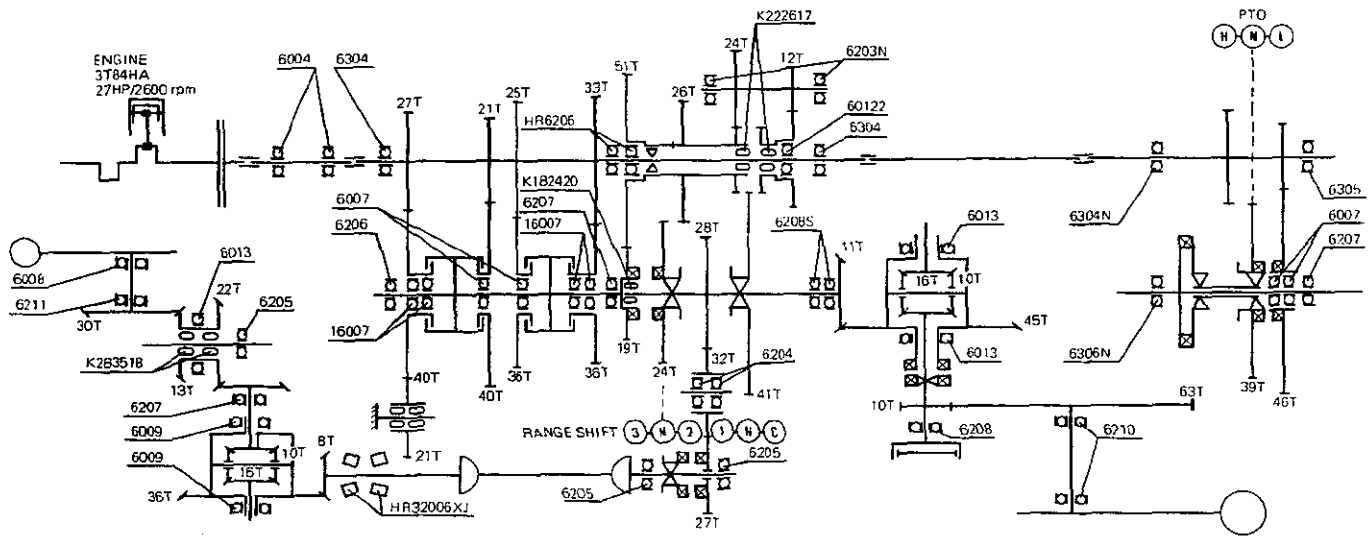
POWER FLOW DIAGRAM

YM276 (2WD)



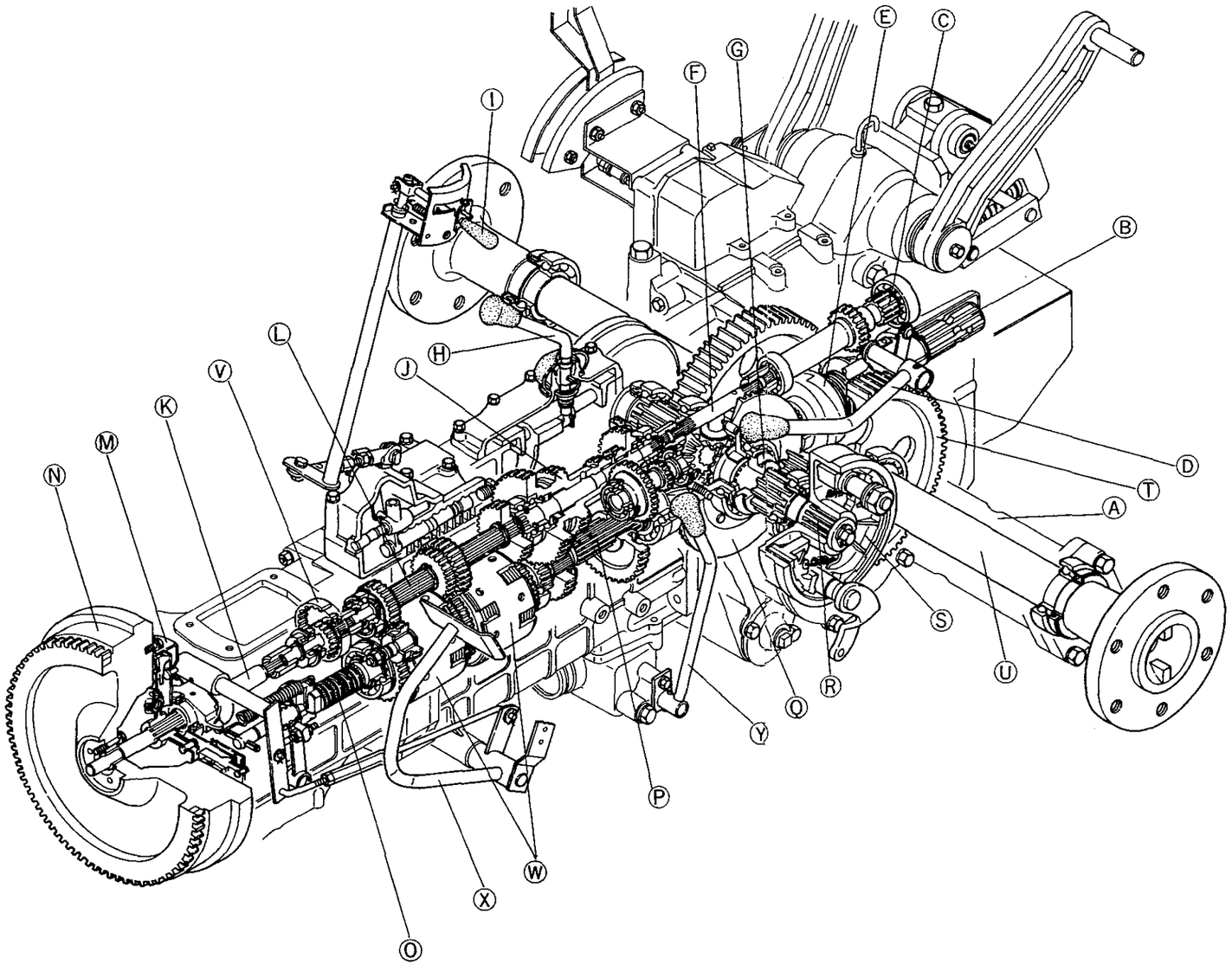
2767025A

YM276D (4WD)



2767025

CLUTCH AND TRANSMISSION OPERATION



2767001

A — Axle Housing
B — PTO Shaft
C — PTO Pinion Shaft
D — PTO Shift Lever
E — PTO One-Way Clutch
F — PTO Connecting Shaft
G — Differential Lock
H — Range Shift Lever
I — Power Shift Lever
J — Counter Gear
K — Clutch Drive Shaft (Main Drive Shaft)
L — Main Shaft
M — Clutch
N — Engine Flywheel
O — P.S. Clutch Shaft
P — Differential Drive Shaft
Q — Differential Ring Gear
R — Final Reduction Pinion Shaft
S — BrakeShoe
T — Final Drive Gear
U — Rear Axle Shaft
V — PowerShift Pump
W — Clutch Packs
X — Clutch Pedal
Y — Front Drive Shift Lever

The clutch (M) is located at the front portion of the clutch housing. The transmission is located in the front compartment of the transmission case. The differential is located in the center compartment of the transmission case and the PTO is located in the rear compartment of the transmission case.

Hand-operated levers (D, H, I and Y) provide control of the transmission and PTO gears.

Foot-operated pedals provide control of the brakes (S), clutch (M) and differential lock (G).

All gears and pinions through the power train are spur gears.

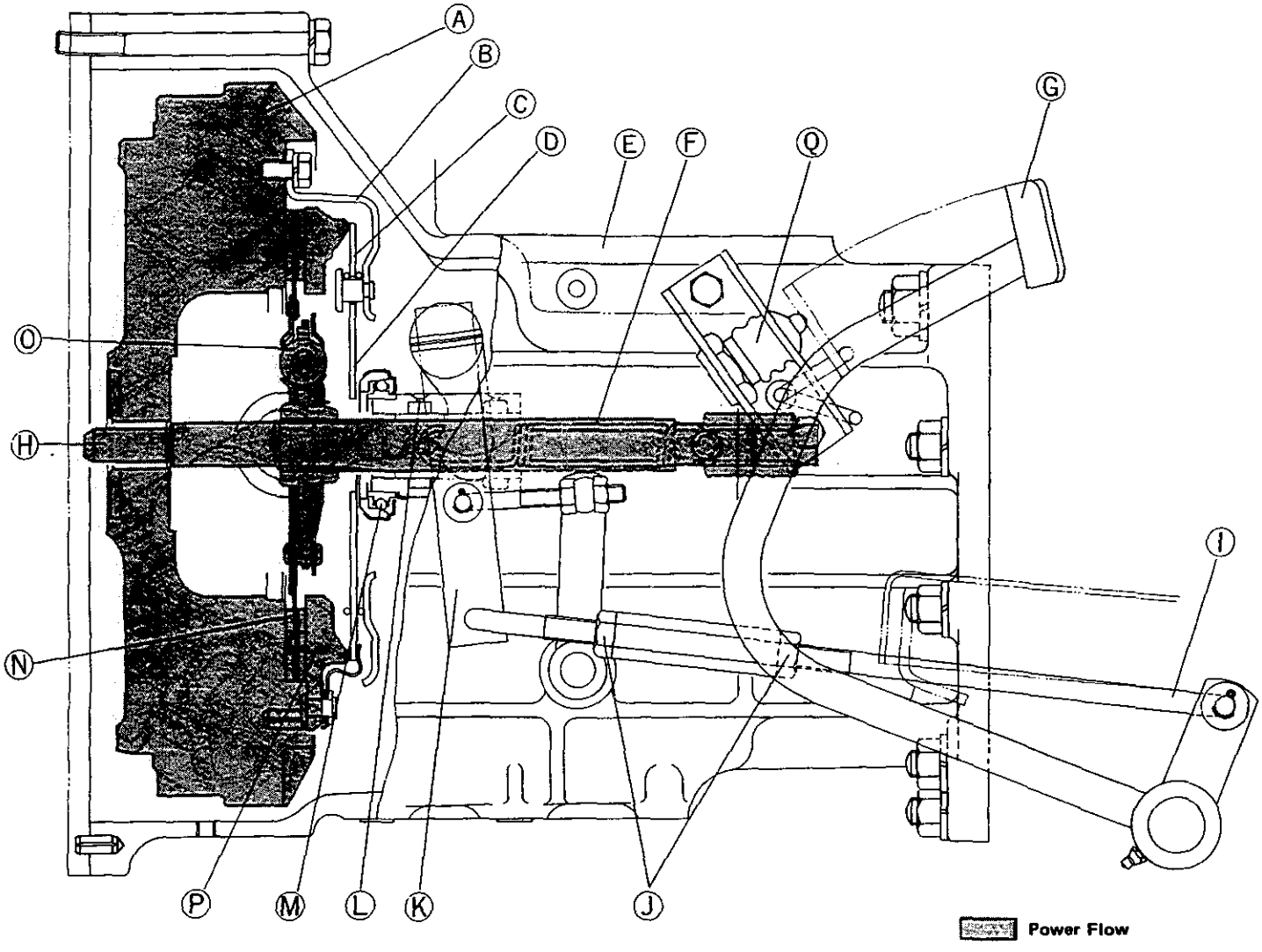
Bearings are straight ball bearings lubricated by splash from the transmission case (which also serves as the main hydraulic oil reservoir).

The two paired power shift clutch (W) packs provide one reverse and three forward speeds control without clutching. The wet disk clutches and plates are lubricated by splash and pressurized transmission oil. The individual pump (V) for clutch operation is driven by main drive shaft (K).

The clutch has a single dry disk which also operates the PTO. The PTO is transmission driven and a collar shift engages or disengages the PTO gear train.

The brakes (S) provide a means to stop tractor motion by braking the final drive pinion shaft (R).

POWER FLOW DIAGRAM



2767016

A – Flywheel
B – Clutch Cover
C – Pressure Springs
D – Spring Fingers
E – Clutch Housing
F – Return Springs
G – Clutch Pedal
H – Main Drive Shaft
I – Clutch Rod
J – Adjusting Nuts
K – Arm Shaft
L – Bearing Sleeve
M – Release Bearing
N – Clutch Disk
O – Torsional Springs
P – Pressure Plate
Q – Start Safety Switch

The clutch assembly is attached to the rear of the engine flywheel. The dry disk clutch provides a positive means of mechanically engaging and disengaging power flow from the engine to the transmission and PTO.

The clutch also acts as a shock absorber that protects the transmission and engine from excessive load. Torsional springs (O) in the clutch disk dampen the transmission of torque by allowing twist between the disk facings and the flywheel (A) when the clutch is engaged.

DISENGAGING THE CLUTCH

Depressing the clutch pedal (G) moves the clutch rod (I) forward rotating armshaft (K) forward. This rotates a yoke which pushes the release bearing (M) forward on the main drive shaft (H).

The release bearing contacts the diaphragm spring fingers (D) pushing them forward. Since the lever bolts are attached to the clutch pressure plate (P), the pressure plate moves rearward bending the clutch pressure springs (C) against the clutch cover (B).

Since the clamping action of the springs has been released and the pressure plate is no longer held against the clutch disk (N), the disk is no longer forced to turn with the engine flywheel. The clutch is disengaged.

ENGAGING THE CLUTCH

Releasing the clutch pedal (G) allows the return springs (F) to move the release bearing assembly (M) and pedal rearward. The diaphragm spring fingers (D) also move of the pressure plate (P) to move it against the clutch disk (N). This clamps the disk between the friction surface of the engine flywheel and the pressure plate (P).

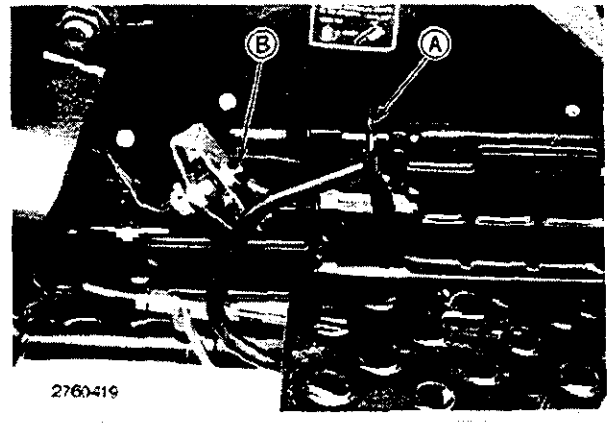
The disk has friction facing on both sides to allow power flow from the engine flywheel to the main drive shaft (H). (since the main drive shaft is splined to the inner diameter of the clutch disk hub.)

START SAFETY SWITCH

When the clutch pedal (A) is depressed, the pedal head push start safety switch.

The start safety switch (B) prevents starting the engine when clutch is engaged. It is adjustable and should never be depressed by anything other than the clutch pedal.

A — Clutch Pedal
B — Start Safety Switch



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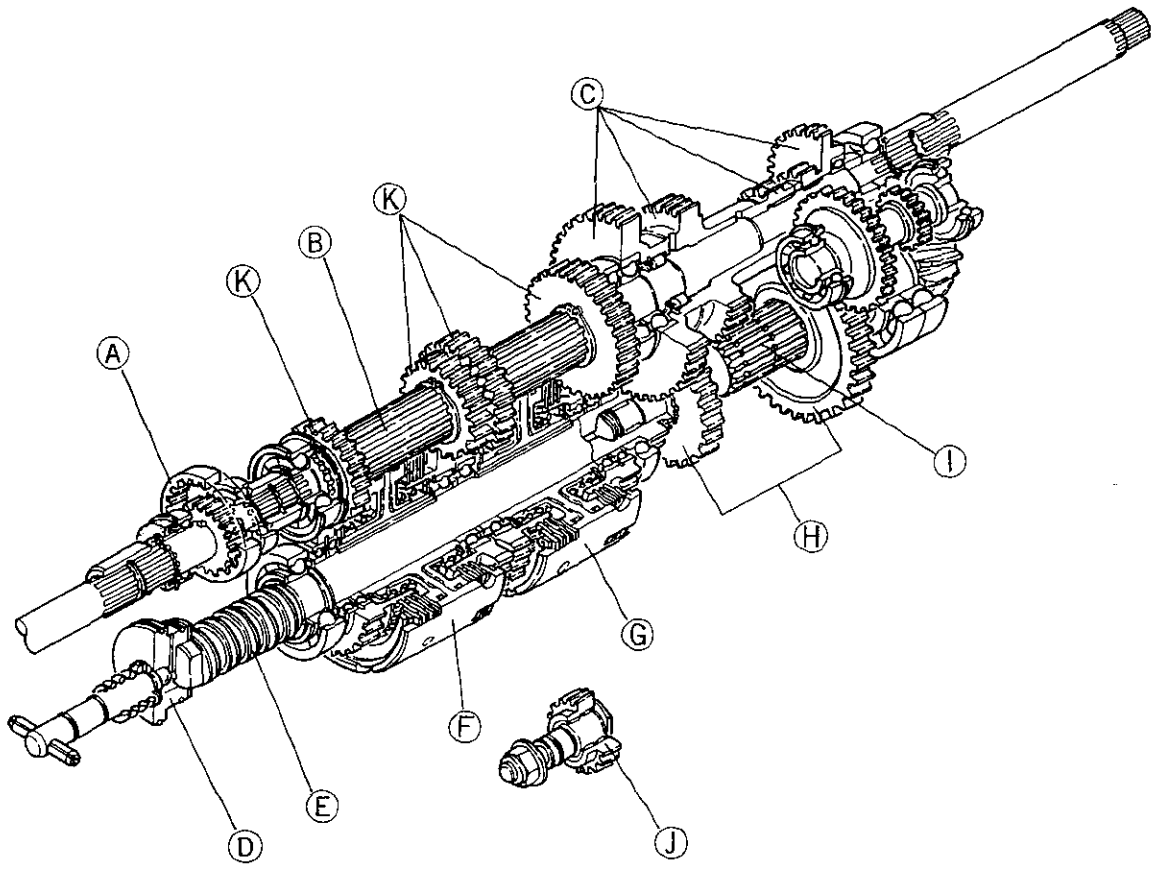


2767003A

A – Internal Gear Pump (Power Shift Pump)
B – Main Shaft
C – Counter Gears
D – Inertia Brake
E – Power Shift Clutch Shaft
F – 1st-Reverse Clutch Pack
G – 2nd-3rd Clutch Pack
H – Range Sliding Gears
I – Differential Drive Shaft
J – Reverse Idle Gear
K – Main Gears

HOW THE SYSTEM WORKS

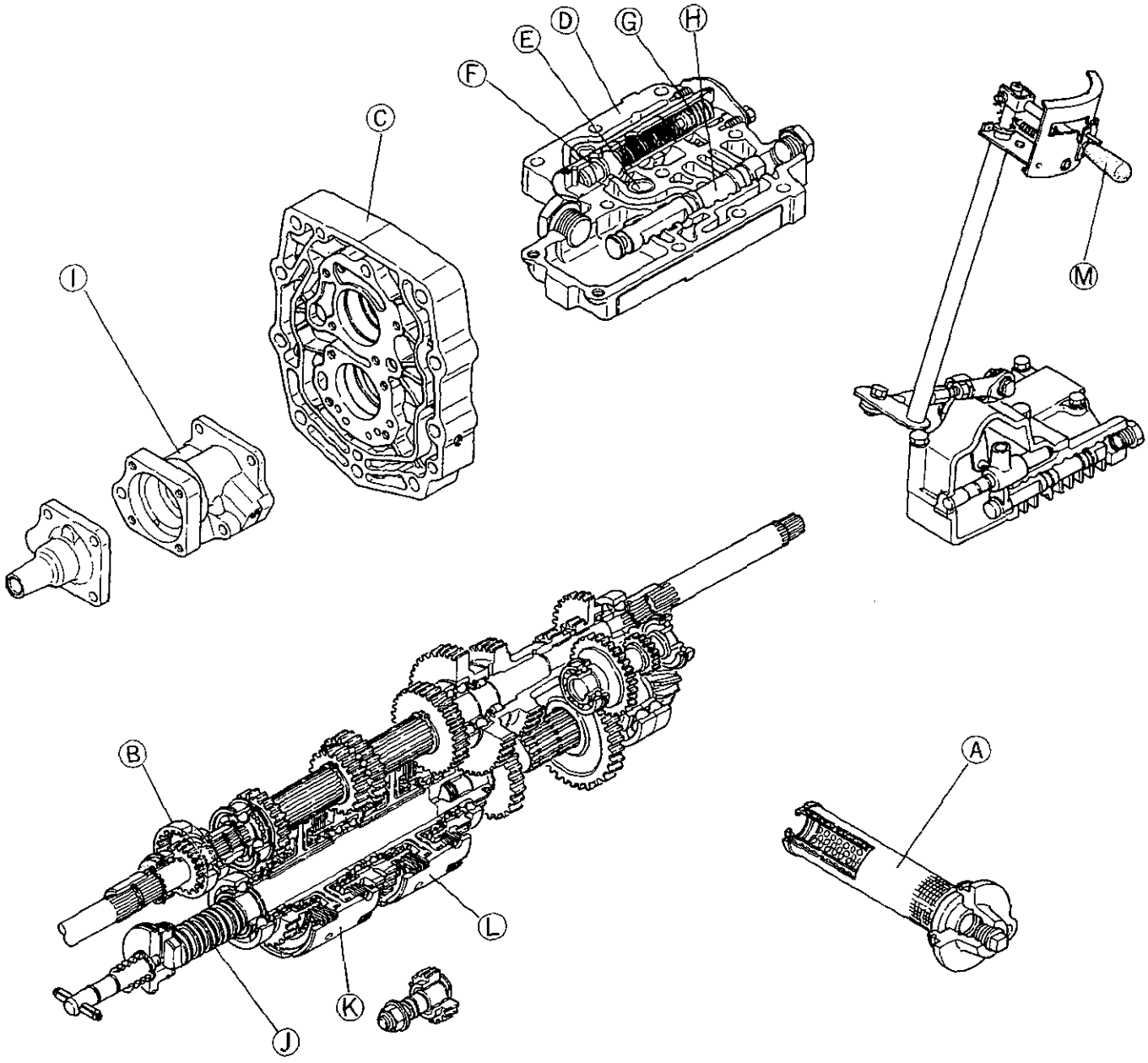
The power shift transmission is composed of sliding gear transmission for range shifting and constantmesh transmission with hydraulically operated clutches for power shifting instead of sliding collars. The power shifting part contains two compound clutch packs controlled four clutches. Power shifting part permit three forward and one reverse speeds without foot-clutching in each speed range. Sliding gear part permit speed ranges. Forward speeds and rearward speeds are obtained by these two components.

The engine power is transmitted from main drive shaft through power shift pump (A) to main shaft (B). The power from main gears (K) on main shaft is transmitted to the constantmeshed gears on power shift clutch shaft (E).

The power from power shift clutch shaft is transmitted to counter gears (C), and then down to differential drive shaft (J) for creep, 1st and 2nd speed ranges.

The power from power shift clutch shaft is also transmitted to directly differential drive shaft for 3rd speed range.

Differential drive shaft (I) drive differential ring gear.



2767003

A — Suction Screen
B — Internal Gear Pump
C — Center Plate
D — Regulator Case
E — 2nd Relief Valve
F — Main Relief Valve
G — Delay Relief Valve
H — Valve Spool
I — Oil Manifold
J — Power Shift Clutch Shaft
K — Rev-1st Clutch Pack
L — 2nd-3rd Clutch Pack
M — Power Shift Lever

POWER SHIFT COMPONENTS

The power shift control system generates, directs, and controls the pressure and flow of oil within the transmission. It also lubricates and cools the power shift clutches and plates.

Oil is drawn from the transmission case, through suction tube and suction screen (A). The oil flow after passing screen is divided to internal gear pump (B) and to hydraulic pump through hydraulic oil filter (Cartridge type).

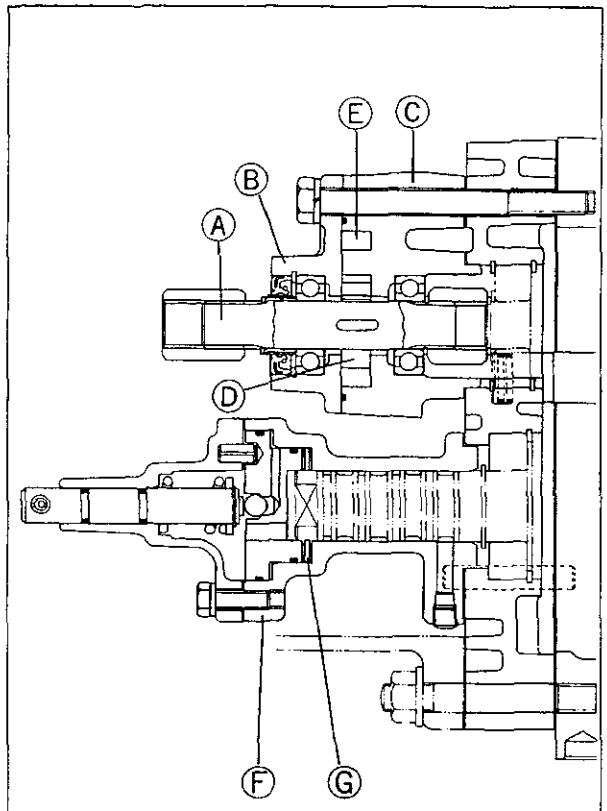
The power shift control system consists of the following components: power shift pump (B), center plate (C), regulator case (D), oil manifold (I), power shift clutch shaft (J), valve spool (H) and valves (E, F, G).

When the power shift lever is moved from one speed to another, control is achieved by these components, which are described on the following pages.

POWER SHIFT PUMP

The internal gear pump is located in the front of main shaft. It supplies pressure oil to operate the transmission and lubricate the clutch packs.

A – Pump Shaft
B – Pump Housing Cover
C – Pump Housing
D – Pump Drive Gear
E – Pump Outer Gear
F – Oil Manifold
G – Inertia Brake

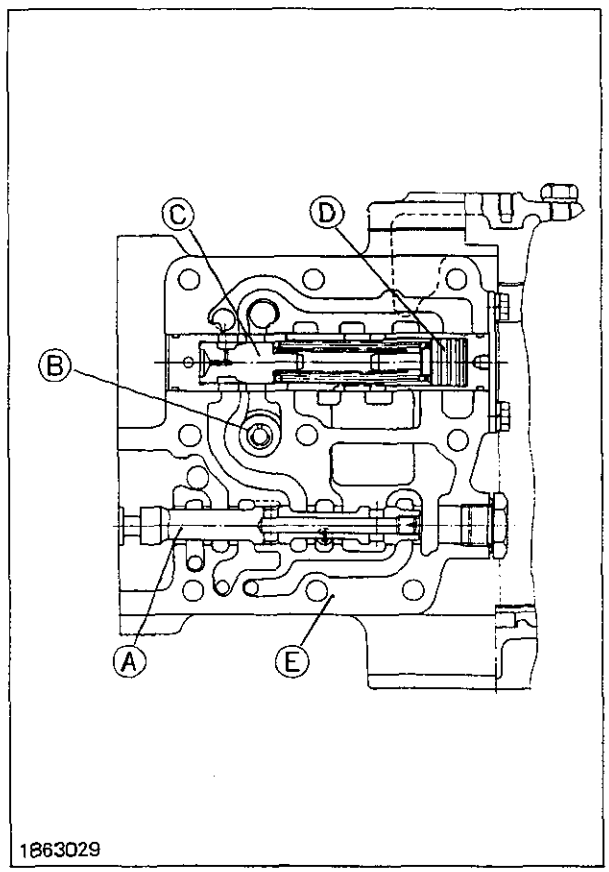


2767020

REGULATOR CASE

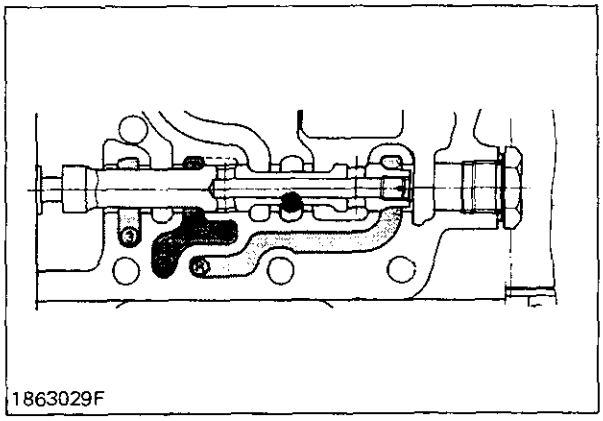
The regulator case consists of valve spool (A), 2nd relief valve (B), main relief valve (C) and delay relief valve (D), and is located on the upper side of transmission case.

A – Valve Spool
B – 2nd Relief Valve
C – Main Relief Valve
D – Delay Relief Valve
E – Regulator Case



1863029

POWER SHIFT COMPONENTS (Continued)


1863029F

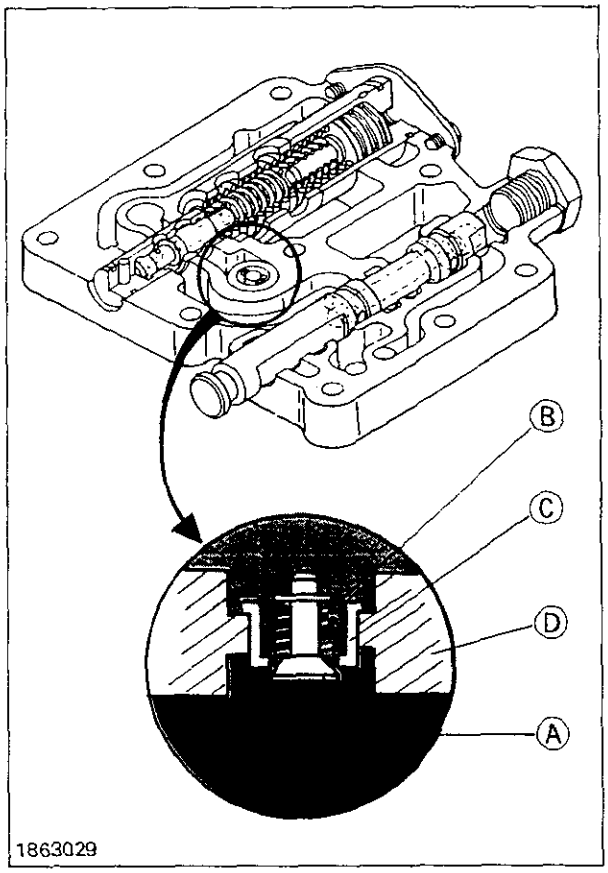
REGULATOR CASE (Continued)

Valve Spool

The valve spool is connected to the power shift control lever. The valve direct pressure oil to the selected clutch piston.

The valve spool has five positions, Reverse, Neutral 1st, 2nd and 3rd. Each positions is connected to the clutch piston.

- To 1st Clutch Piston
- To 2nd Clutch Piston
- To 3rd Clutch Piston
- To Reverse Clutch Piston



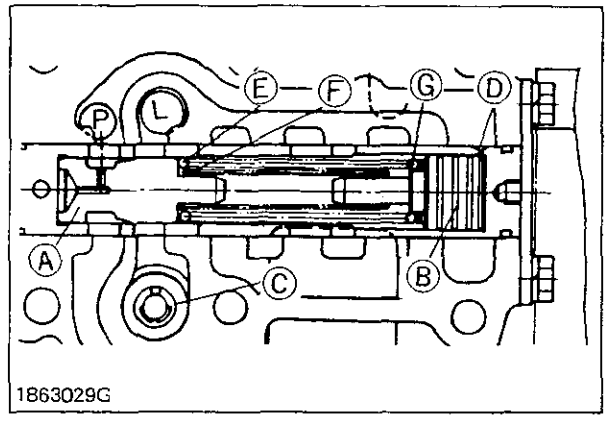
1863029

2nd Relief Valve

The second relief valve is located on the transmission case facing to regulator case lubricating oil gallery. The valve regulates lubricating oil pressure for clutch packs.

- Pressurized Oil
- To Reservoir (transmission)
- A – 2nd Relief Valve
- B – Valve Spring
- C – Valve Seat
- D – Transmission Case

Main Relief Valve and Delay Relief Valve (DRV)



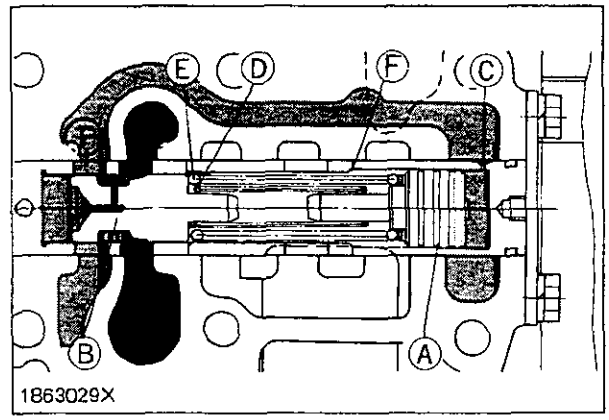
1863029G

The main relief valve (A) is located on the right hand side of the regulator case. The valve having pilot hole on its side control power shift clutch operating pressure. The regulated pressurized oil is directed to valve spool.

The delay relief valve (DRV) (B) is located on the rear side of main relief valve (A) against outer spring (E).

When moving power shift lever from neutral to speed position, the pressure of oil trapped in pump gallery starts to increase.

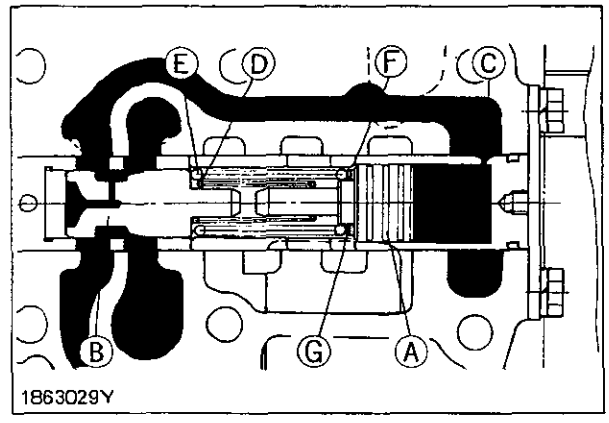
A – Main Relief Valve
B – Delay Relief Valve (DRV)
C – 2nd Relief Valve
D – Orifice
E – Outer Spring
F – Inner Spring
G – Adjusting Shims
P – From Power Shift Pump
L – To Lubrication



1863029X

The pressure affect to move main relief valve to the rearward against outer spring (E). The same pressure oil is sprayed through small orifice (C) into DRV sleeve to move DRV body (A) to the foreward against outer spring (E). The moving speed to DRV body is not fast because of orifice. This time lag permit main relief valve to increase gradually the system pressure for smooth power connection.

Pressurized Oil (On the increasing)
To lubrication



1863029Y

When DRV body comes to the shoulder (F) of sleeve against springs (D, E), the system pressure 1520 kpa (15.5 kg/cm^2) (220.5 psi) is obtained.

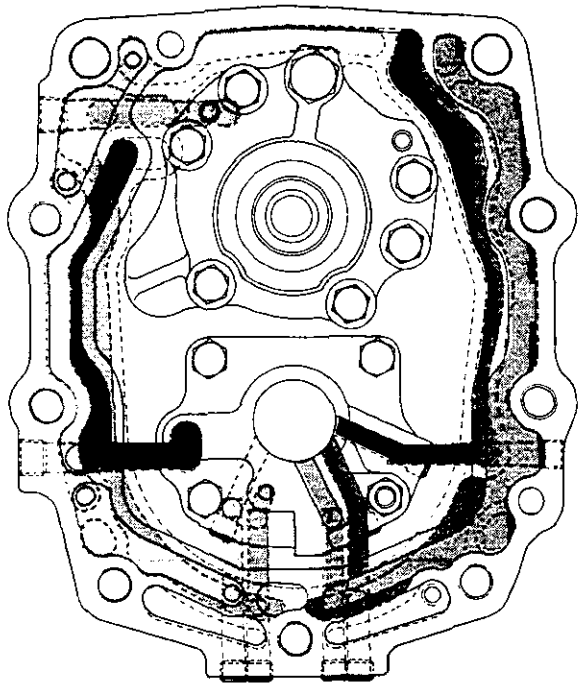
The inner floating spring (F) gives additional tension to outer spring (E) to obtain the system pressure. The system pressure can be adjusted by adding or removing adjusting shims (G) located between outer spring and DRV.

Pressurized Oil
To lubrication

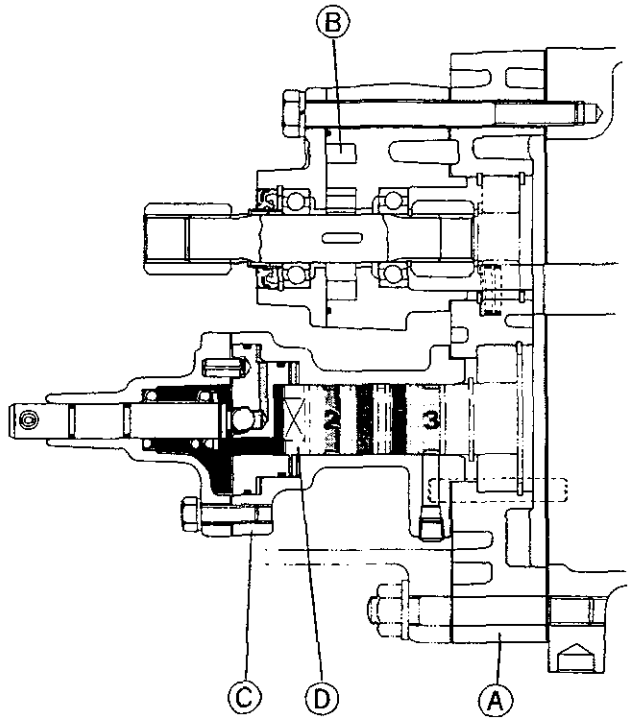
A – Delay Relief Valve (DRV)
B – Main Relief Valve
C – Orifice
D – Inner Spring
E – Outer Spring
F – Shoulder
G – Shims

POWER SHIFT COMPONENTS (Continued)

CENTER PLATE (OIL GALLERY PLATE) AND OIL MANIFOLD



2767021



2767020

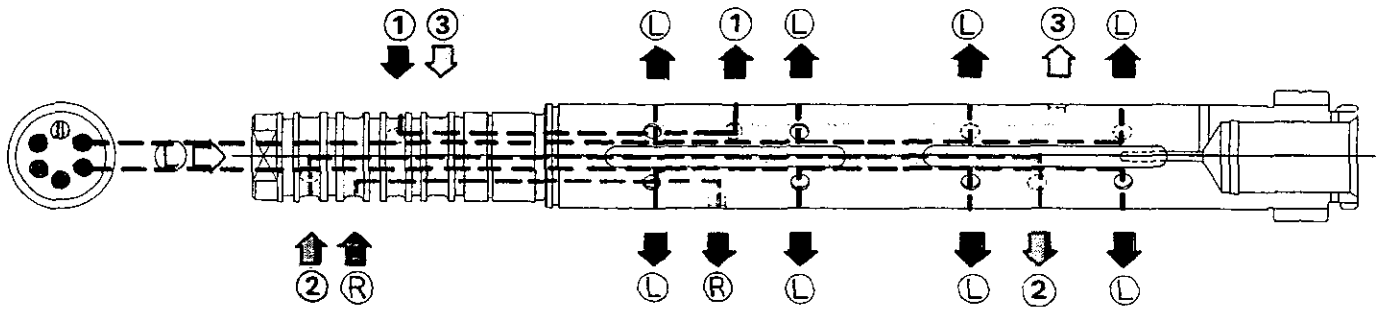
- To 1st Clutch Piston
- To 2nd Clutch Piston
- To 3rd Clutch Piston
- To Reverse Clutch Piston
- To Regulator Case
- To Lubrication

A – Center Plate
B – Power Shift Pump
C – Oil Manifold
D – Power Shift Clutch Shaft

POWER SHIFT CLUTCH SHAFT

Power shift clutch shaft is a kind of hollow shaft and transfer each pressurized oil to the selected clutch pack.

The shaft has six longitudinal holes. The two holes are drilled for lubrication of clutch packs and other four holes for each clutch piston (R, 1, 2 and 3).



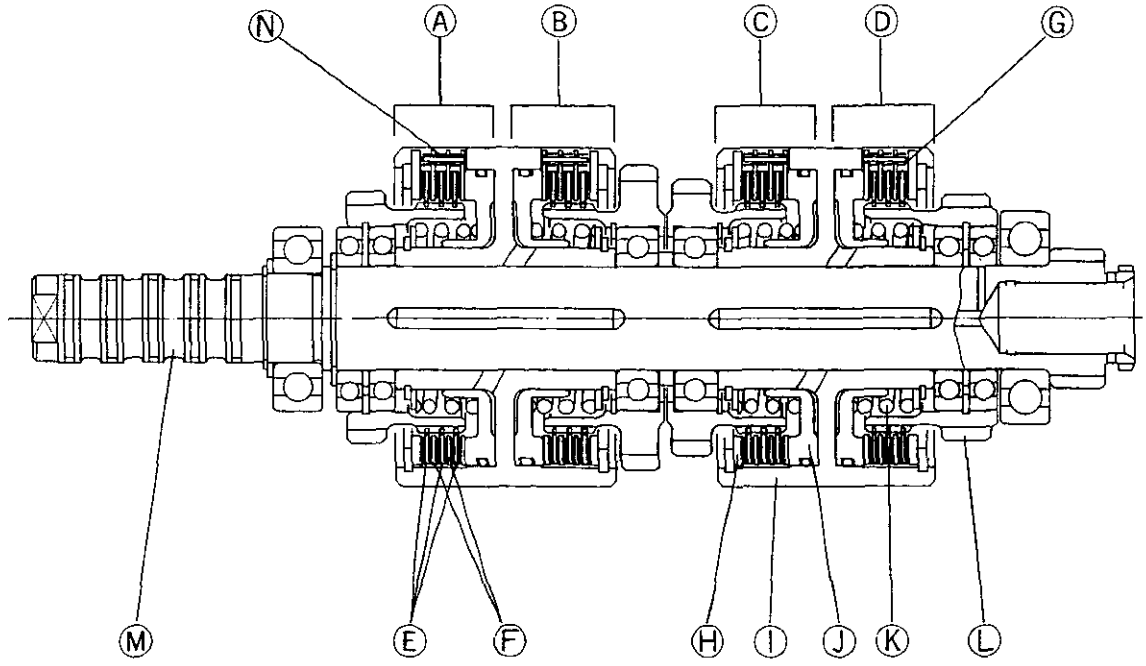
2767044

(1) – To 1st Clutch Piston
(2) – To 2nd Clutch Piston
(3) – To 3rd Clutch Piston
(R) – To Reverse Clutch Piston
(L) – Lubricating Oil

POWER SHIFT COMPONENTS (Continued)

CLUTCH PACK

The clutch pack consists of clutch disks (E), clutch steel plates (F), one backing plate (H), piston (J) and cylinder (I). There are separator springs (G) between steel plates to give a even space for each clutch disk to eliminate clutch draging.

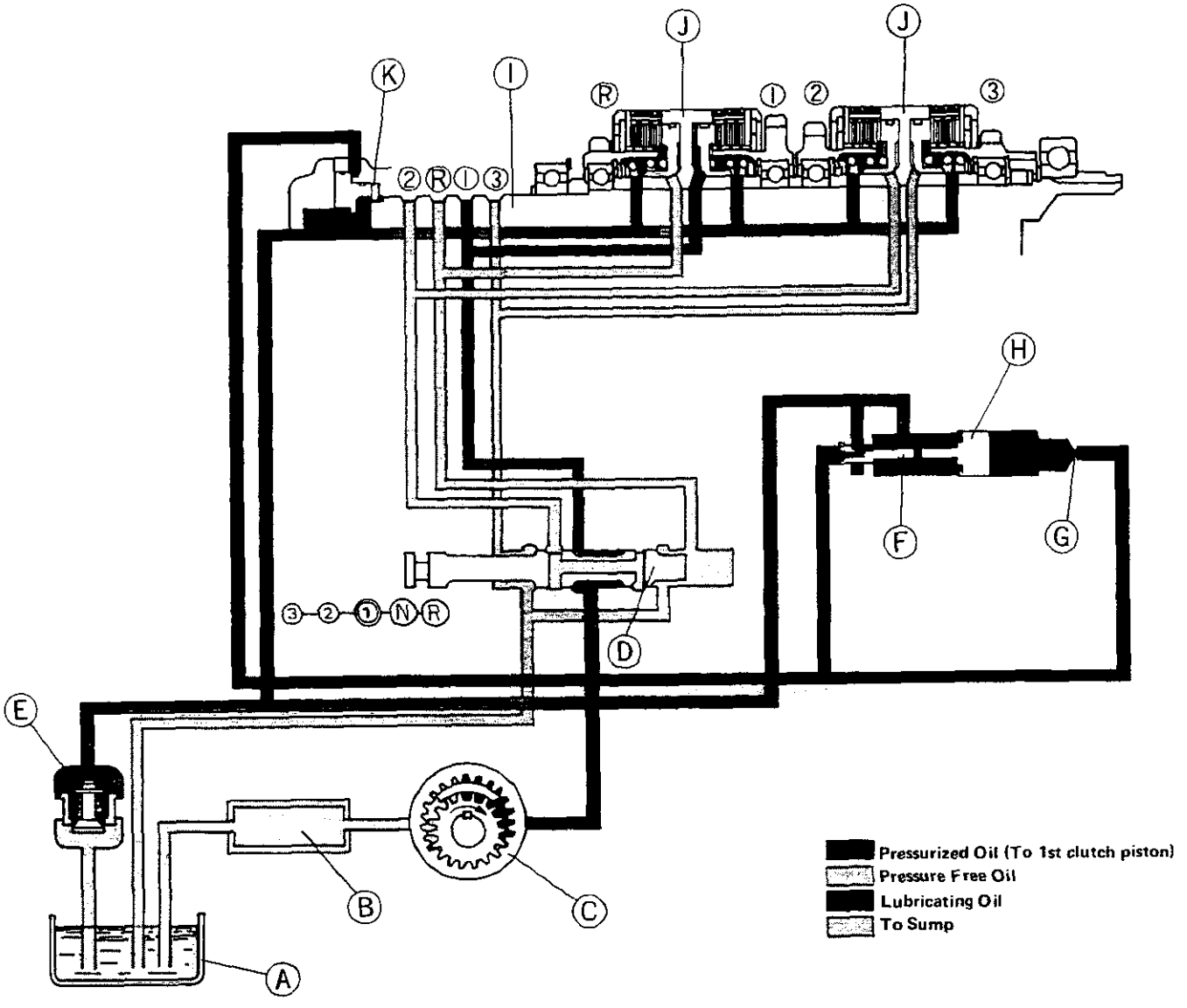


2767022

A – Reverse Clutch Pack
B – 1st Clutch Pack
C – 2nd Clutch Pack
D – 3rd Clutch Pack
E – Clutch Disks
F – Steel Plates
G – Separator Springs
H – Backing Plate
I – Cylinder
J – Piston
K – Piston Return Spring
L – Clutch Hub and Gear
M – Power Shift Clutch Shaft
N – Needle

HYDRAULIC CONTROL SYSTEM

HYDRAULIC CONTROL AND LUBRICATING FLOW (1st Speed Position)



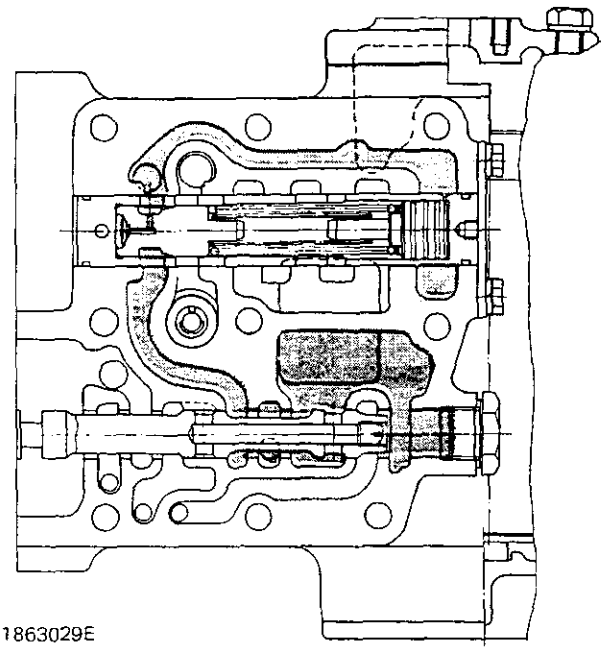
2767029

A – Transmission Oil Sump
B – Suction Screen (Strainer)
C – Power Shift Pump
D – Valve Spool
E – 2nd Relief Valve
F – Main Relief Valve
G – Orifice
H – Delay Relief Valve (DRV)
I – Power Shift Clutch Shaft
J – Clutch Pack
K – Inertia Brake

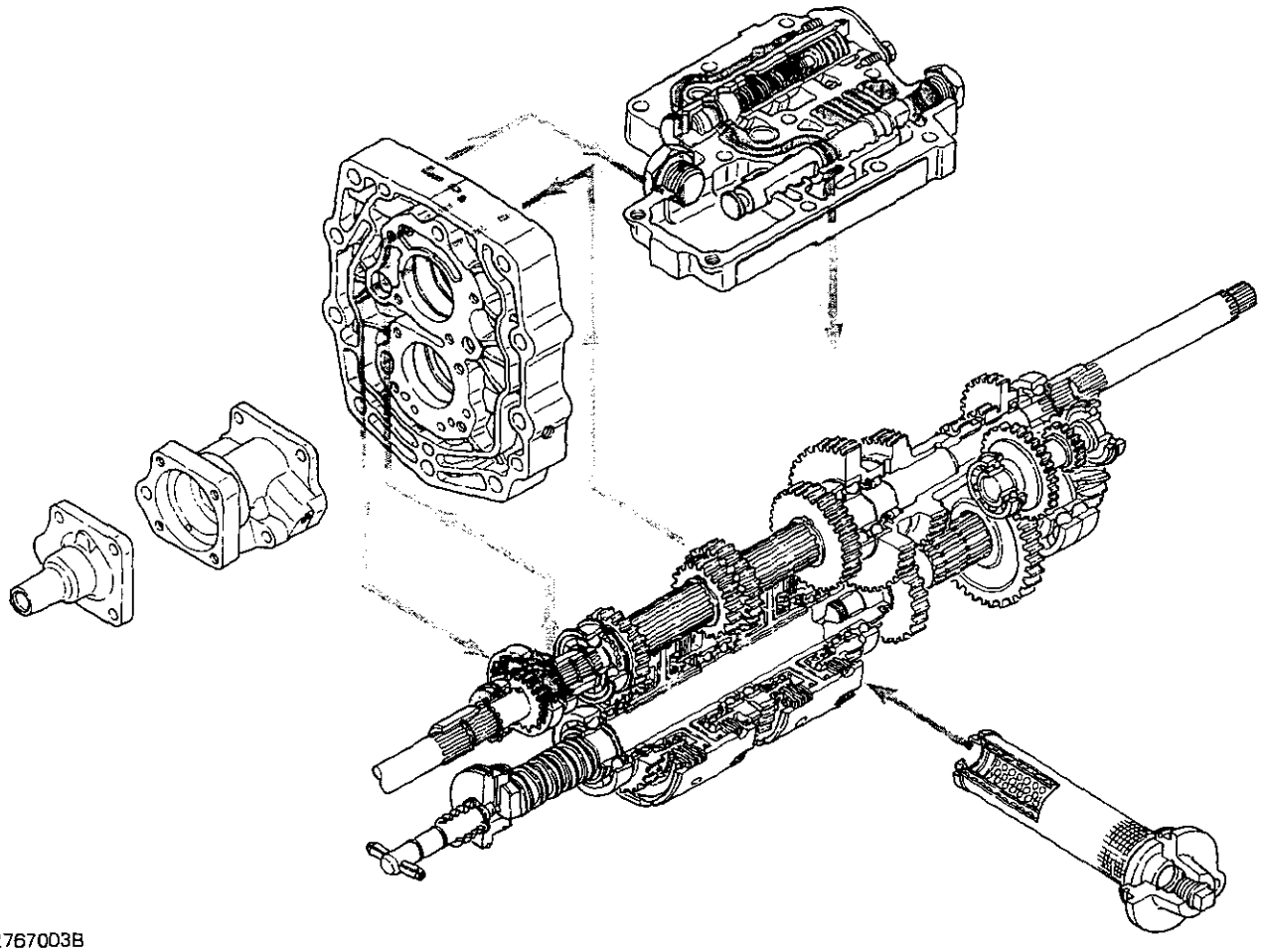
HYDRAULIC CONTROL SYSTEM
(Continued)

NEUTRAL POSITION

Pressure Free Oil



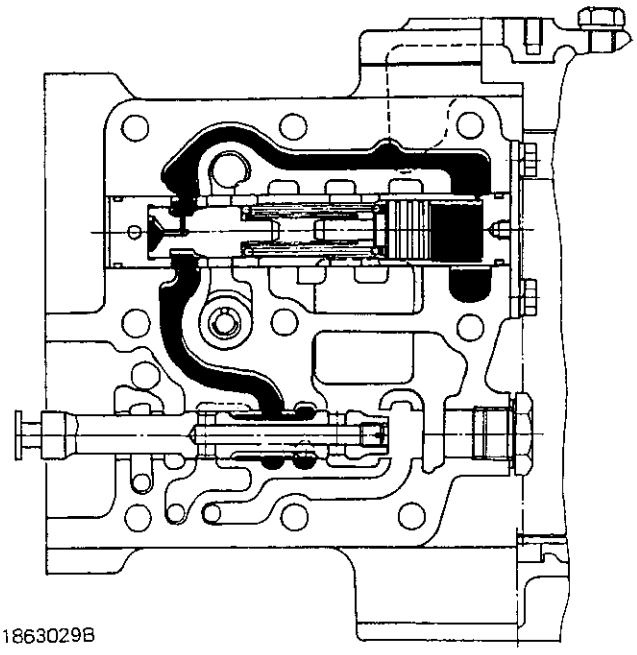
1863029E



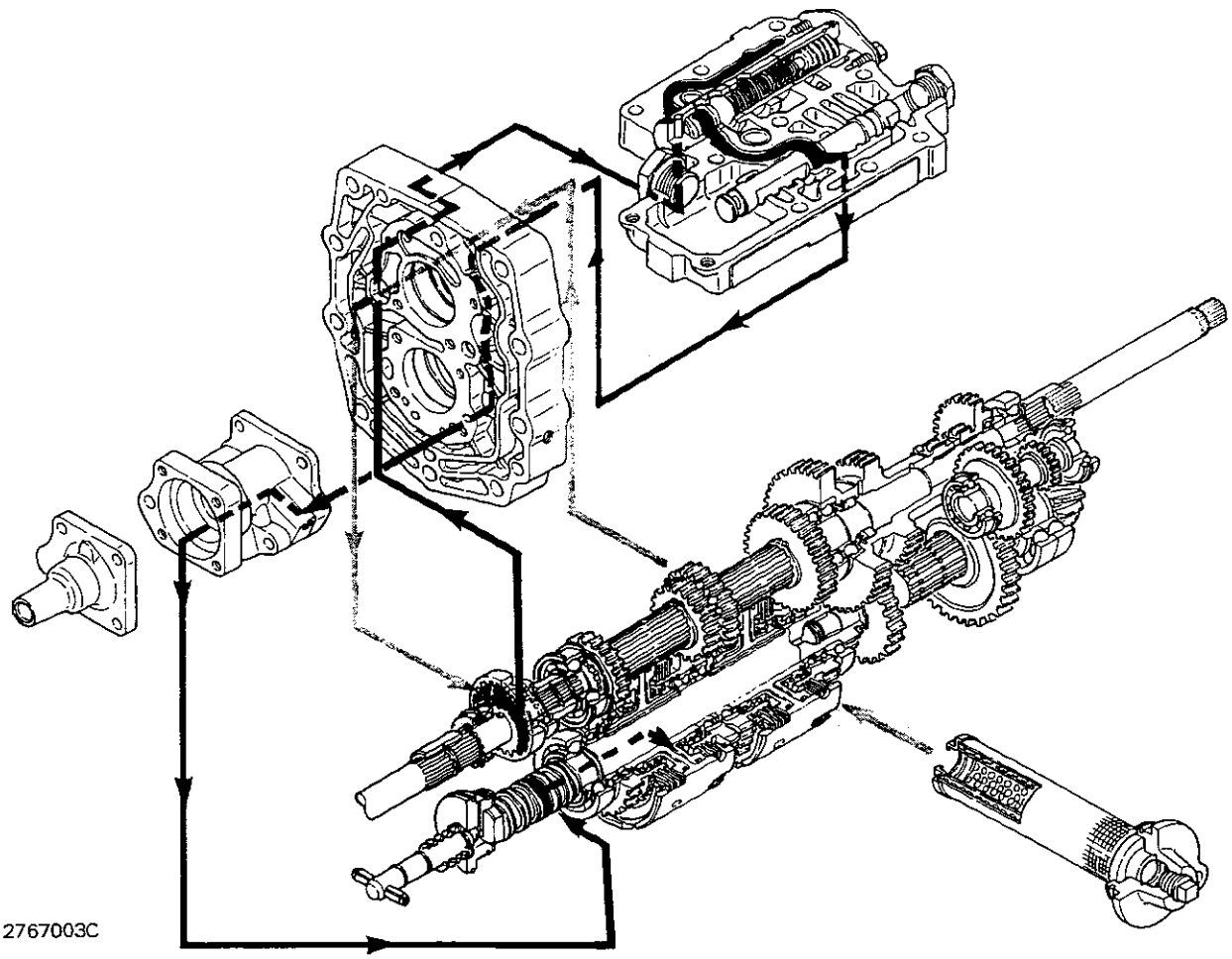
2767003B

1st SPEED POSITION

Pressurized Oil
Pressure Free Oil



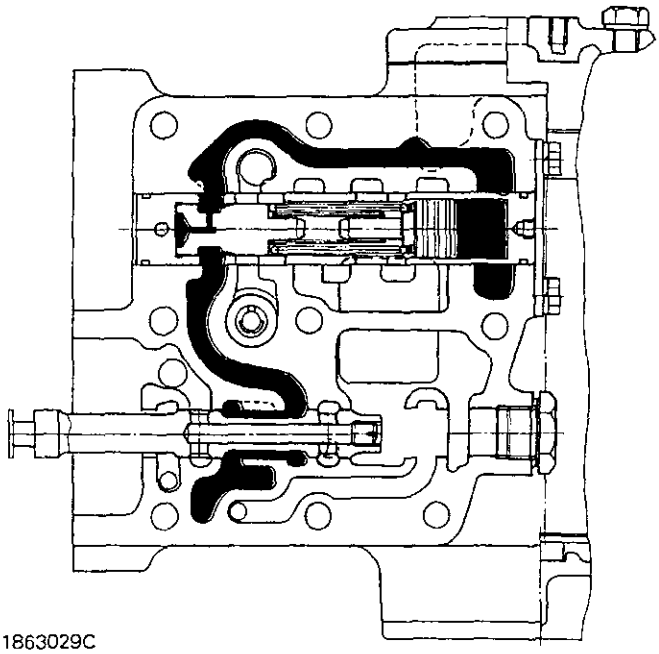
1863029B



2767003C

HYDRAULIC CONTROL SYSTEM
(Continued)

2nd SPEED POSITION



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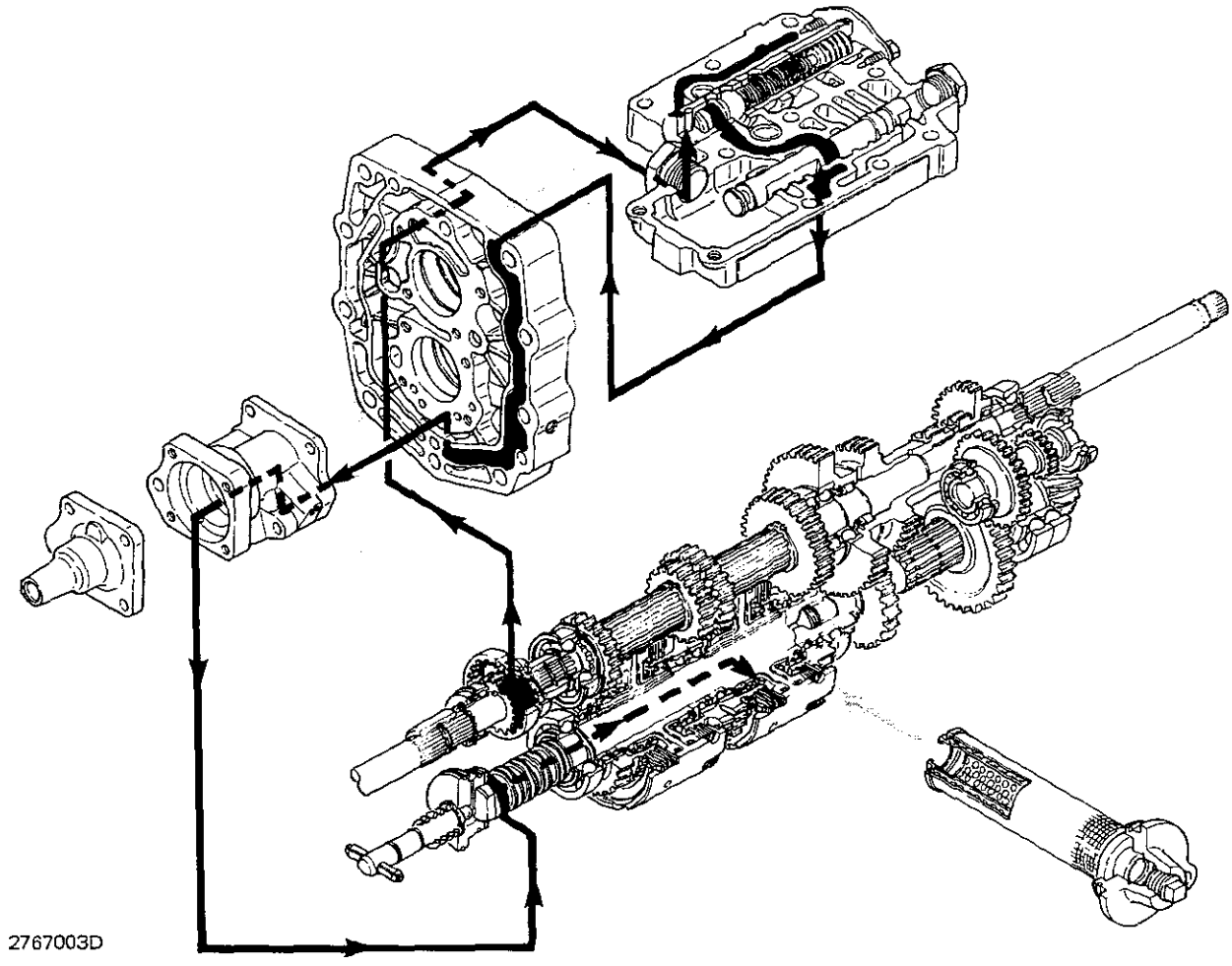
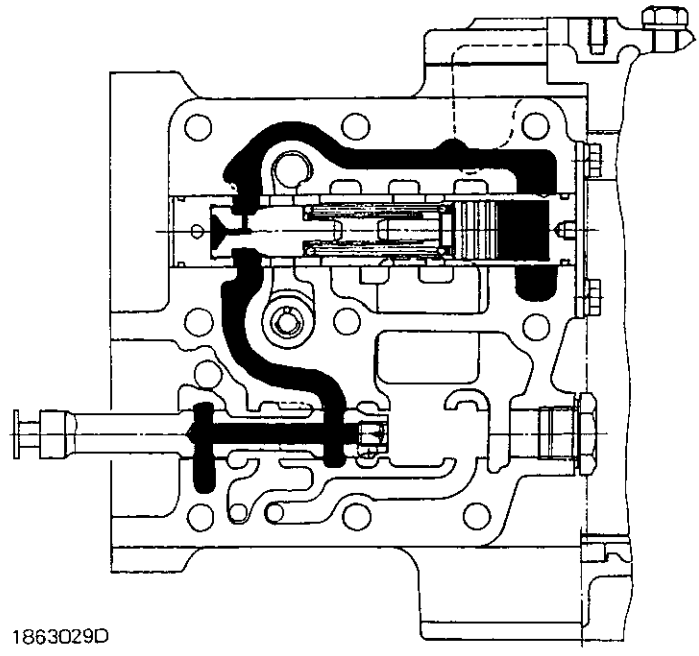


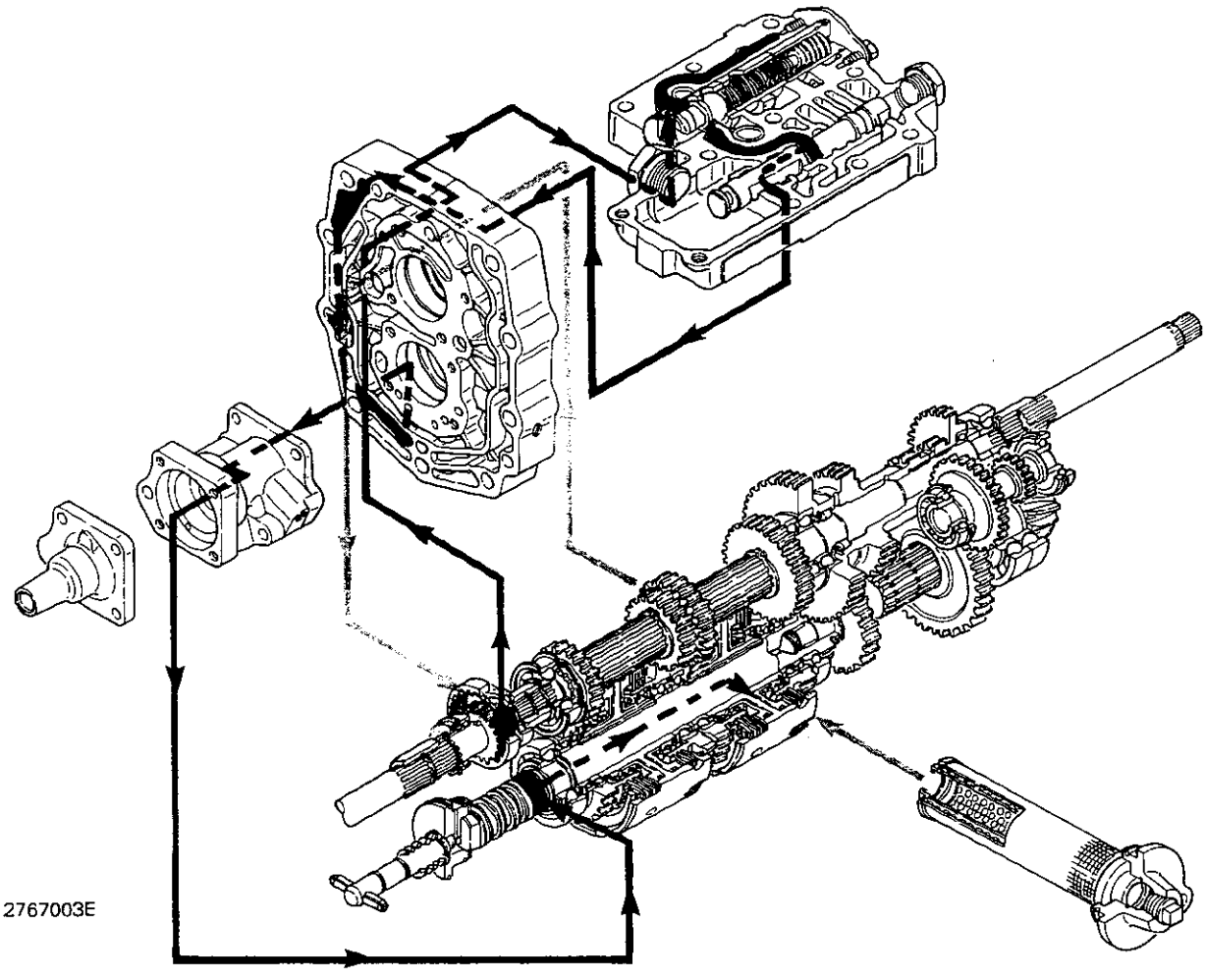
2767003D

3rd SPEED POSITION

Pressurized Oil
Pressure Free Oil



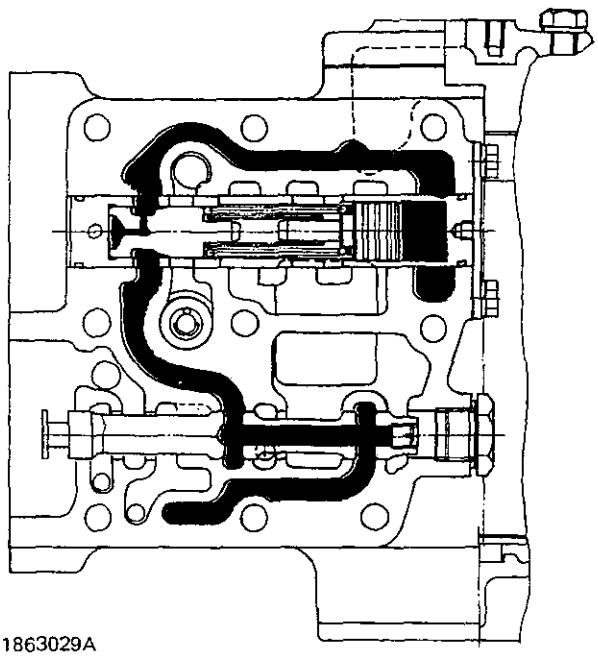
1863029D



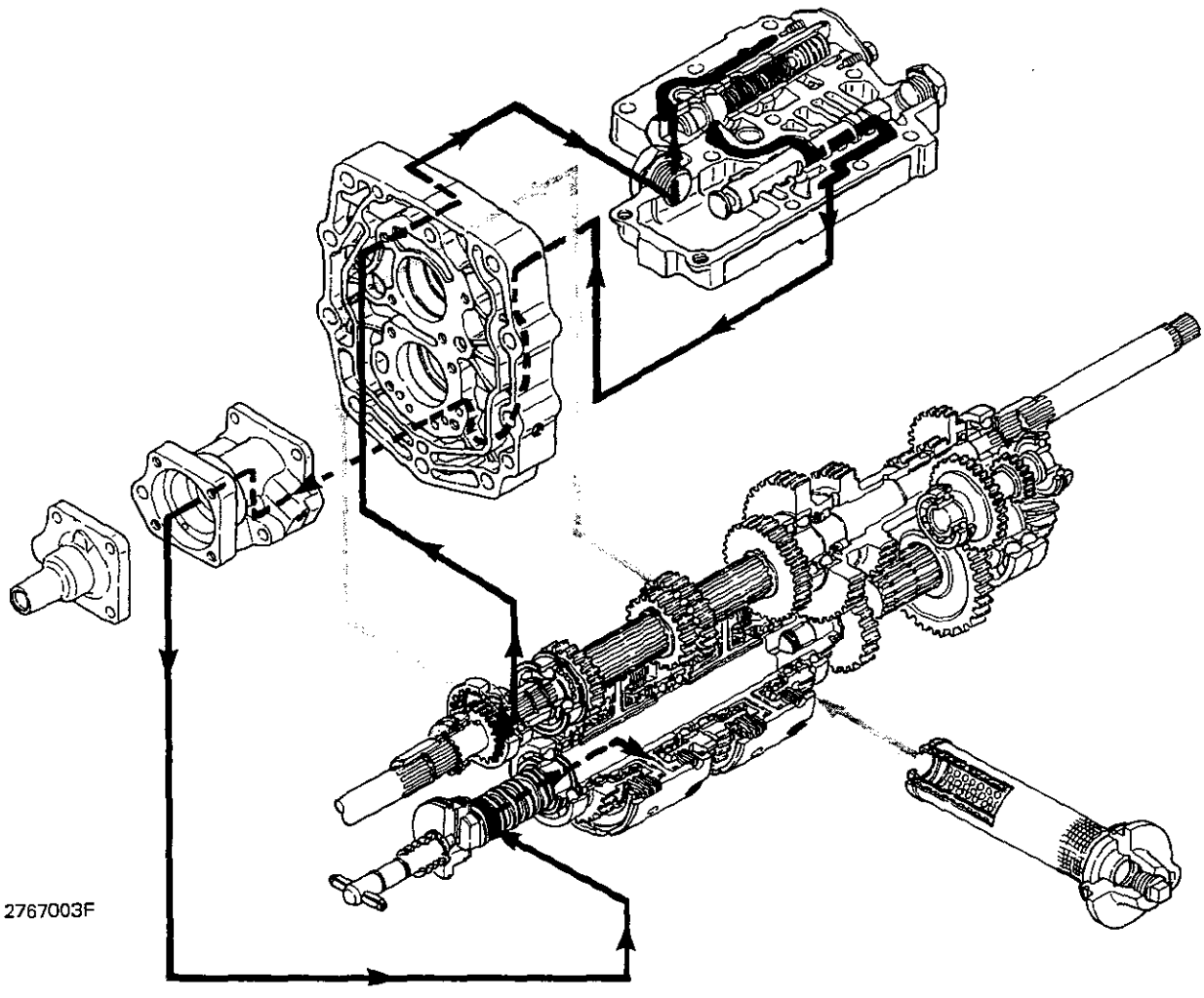
2767003E

HYDRAULIC CONTROL SYSTEM (Continued)

REVERSE SPEED POSITION



1863029A



2767003F

POWER SHIFTING POWER FLOW

Power from the engine flows to the main shaft gears (G, I, J and K).

The four main gears (G, I, J and K) on the main shaft are meshed with each coupled gears (B, C, E and F) on the power shift clutch shaft (H). These gears mesh constantly and rotate.

The gears on clutch shaft mesh with gears and rotate at each individual speed, but not transmit power when power shift lever is in neutral position.

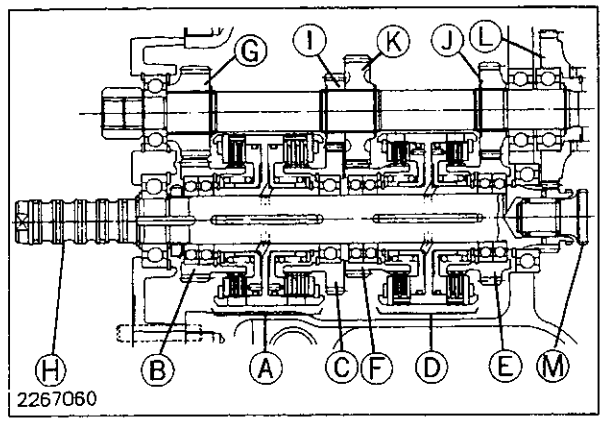
When shifting the power shift lever in 1st speed position, the 1st clutch piston compressed clutch disks and plate to connect 1st clutch gear (B) to the clutch cylinder (A). Since the clutch cylinder is fixed with key to clutch shaft.

The power from the engine flows to main gears, clutch pack and to counter gear (L) or differential drive shaft (M).

Refer to power flow arrows on page 250-10-16, 250-10-17 for 2nd and 3rd speed ranges.

There is a reverse idle gear (Not illustrated) between the gear (G) and (B).

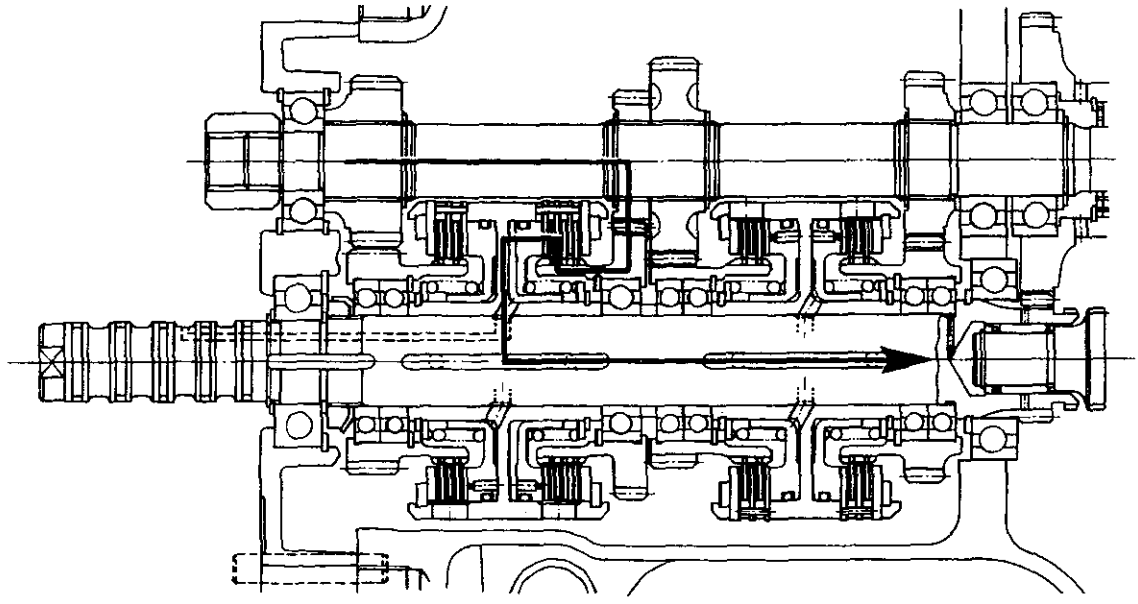
When shifting power shift lever to reverse position, the reverse clutch is engaged and power flows to the counter gear (L) through reverse idle gear, reverse clutch gear (B) and clutch shaft (H). The rotational direction of clutch shaft is clockwise viewing from rear end of clutch shaft and it gives reverse direction of tractor movement.



A – Reverse-1st Clutch Pack
B – Reverse Clutch Gear
C – 1st Clutch Gear
D – 2nd-3rd Clutch Pack
E – 3rd Clutch Gear
F – 2nd Clutch Gear
G – Reverse Main Gear
H – Power Shift Clutch Shaft
I – 1st Main Gear
J – 3rd Main Gear
K – 2nd Main Gear
L – Counter Gear
M – Differential Drive Shaft

POWER SHIFTING POWER FLOW (Continued)

1st SPEED POSITION



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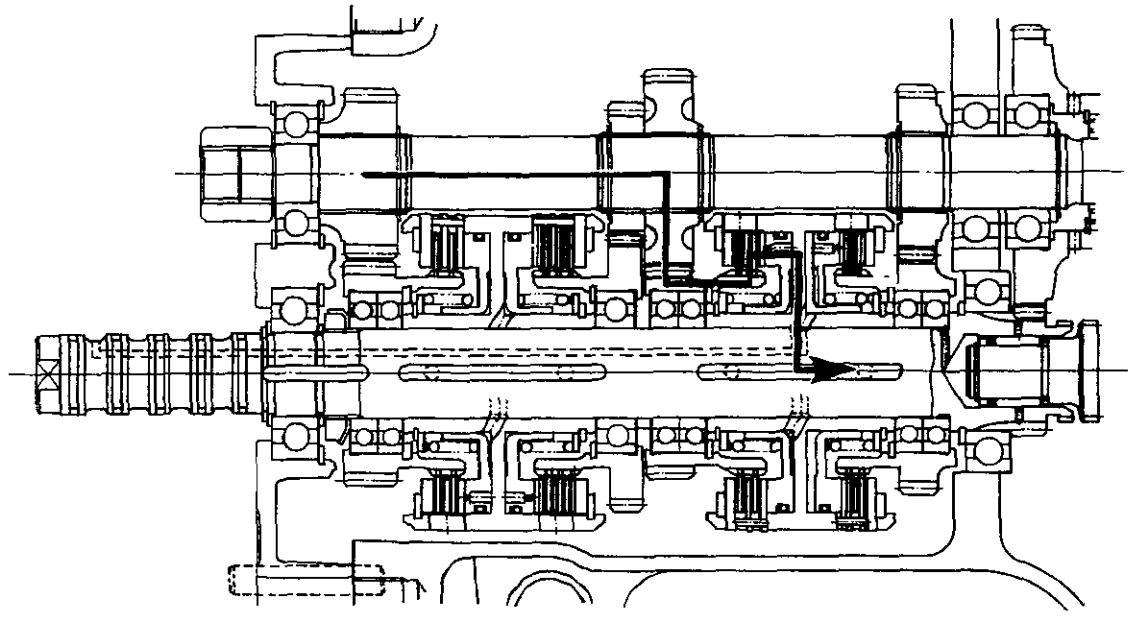
2nd SPEED POSITION



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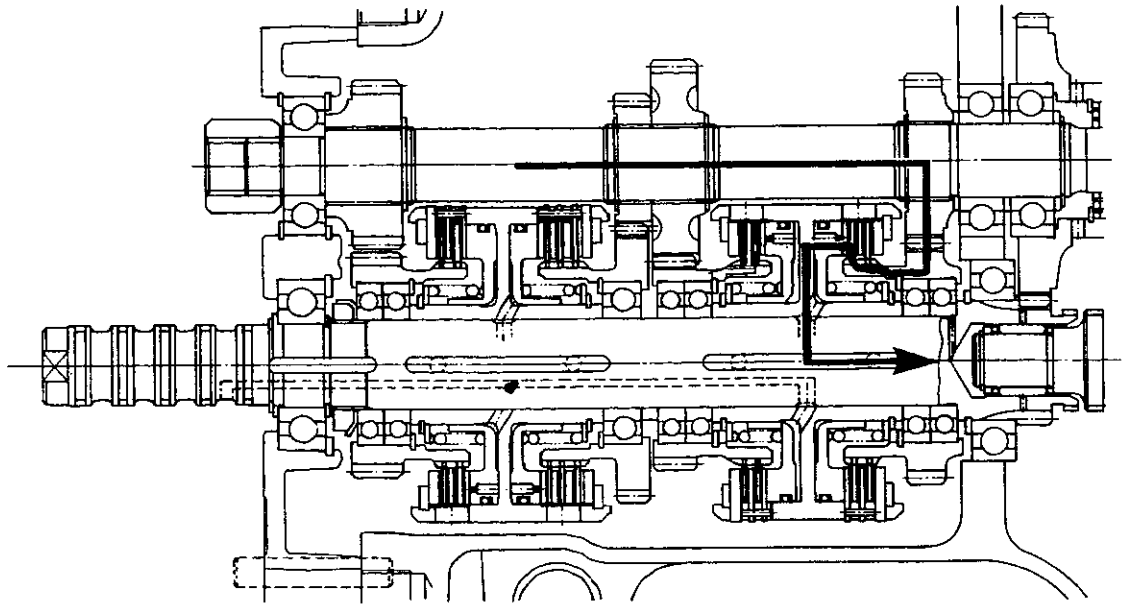
3rd SPEED POSITION



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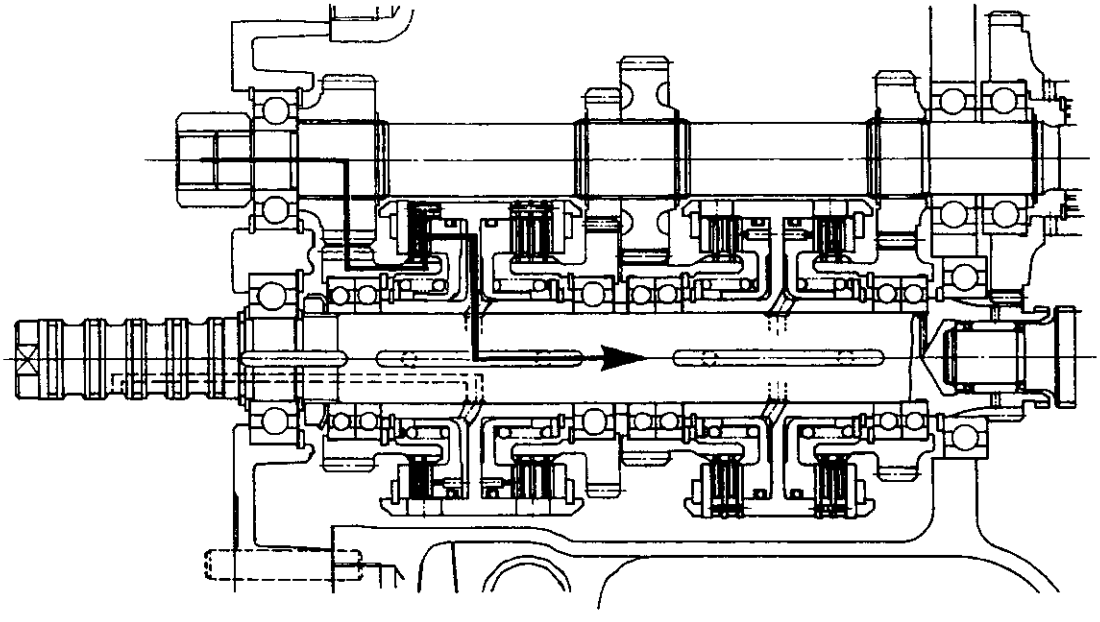
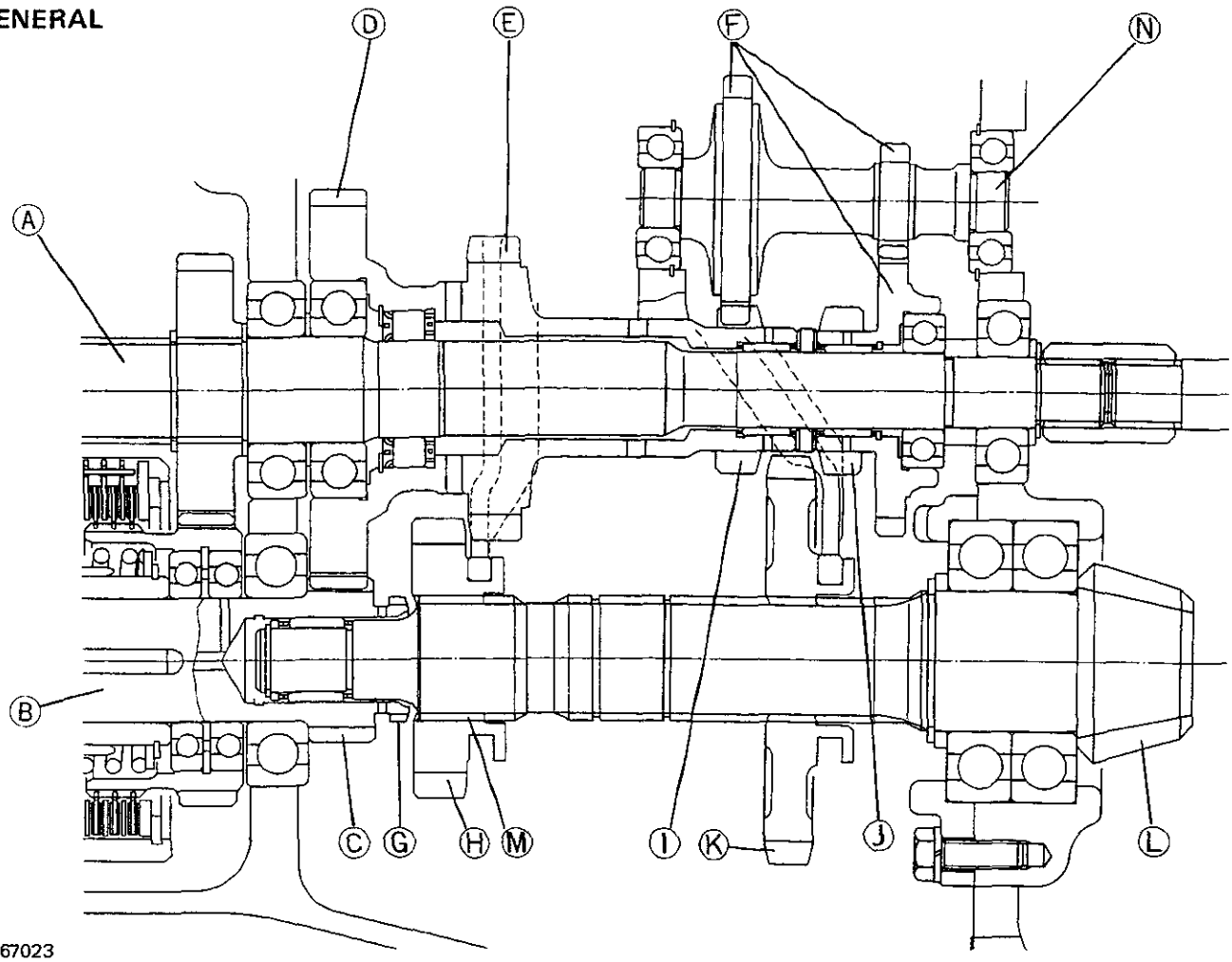
REVERSE SPEED POSITION



2267064A

RANGE SHIFTING POWER FLOW

GENERAL



2767023

A – Main Shaft
B – P.S. Clutch Shaft
C – Clutch Shaft Gear
D – Counter Shaft Gear
E – 2nd Counter Gear
F – Creep Gears
G – 3rd Counter Gear
H – 2nd Sliding Gear
I – 1st Counter Gear
J – Creep Counter Gear
K – Creep-1st Sliding Gear
L – Differential Drive Shaft
M – 3rd Sliding Gear
N – Creep Gear Shaft

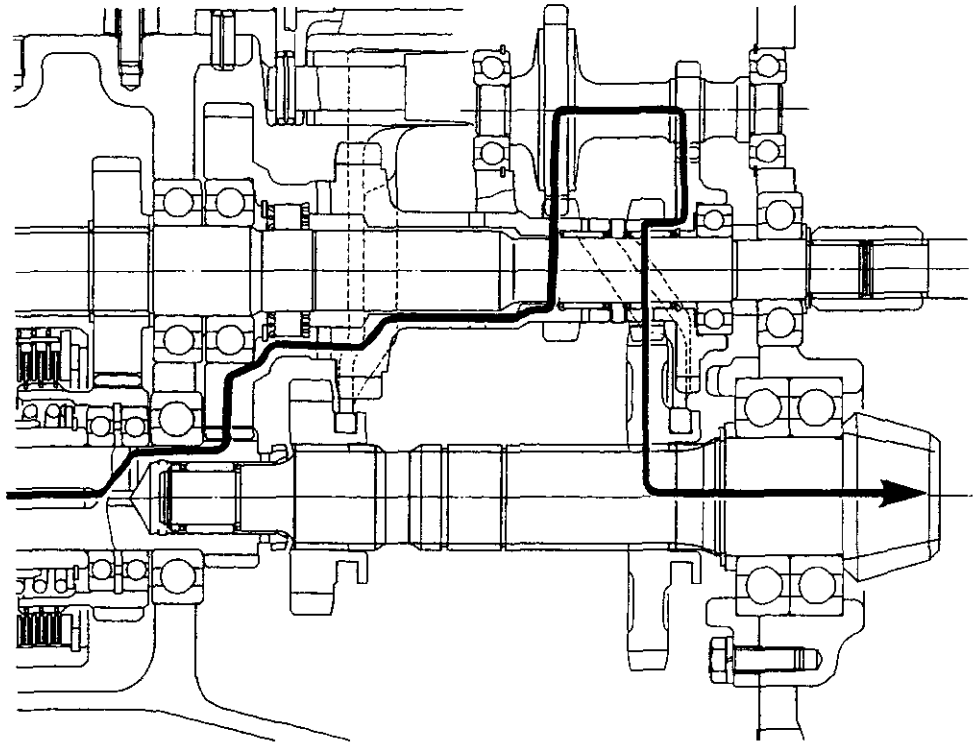
The range shift transmission has three parallel shafts. Main shaft (A) which is one of parallel shafts has counter cluster gear on it. Differential drive shaft (L) has a sliding gear (H & K). Creep gear shaft (N) provides a creep speed ranges. Sliding spur gears (H & K) provide three speed ranges. Since sliding gear speed does not synchronize with counter gears, the tractor must be stopped while shifting.

The counter cluster gear has five gears (D, E, F, I & J). This counter cluster gear is just rotating on the main shaft (A).

The gear (D) meshes constantly with clutch shaft gear (C), and power flows to creep, 1st and 2nd ranges through this counter shaft gear (D).

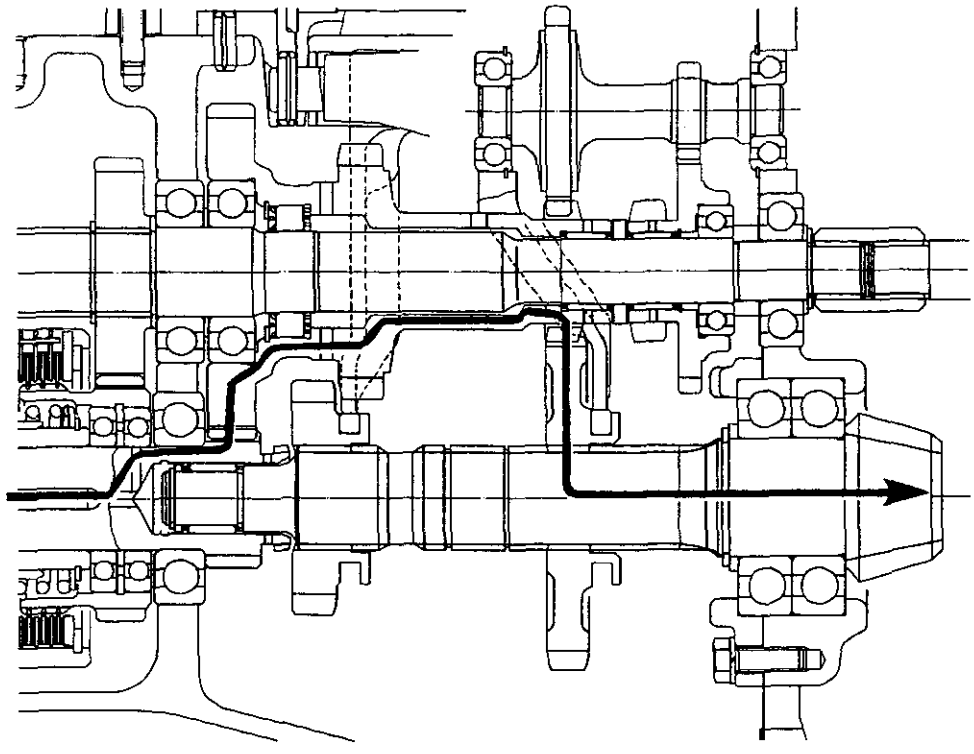
3rd range is provided by meshing gear (G) of power shift clutch shaft and gear (M) of sliding gear.

CREEP SPEED RANGE



2767023A

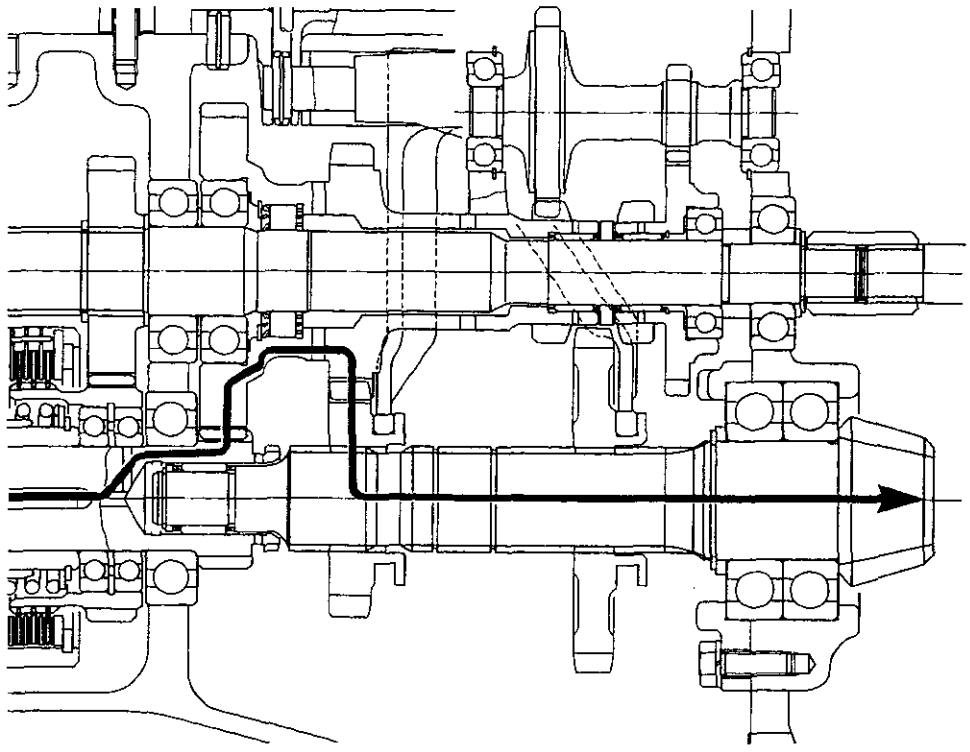
1st SPEED RANGE



2767023B

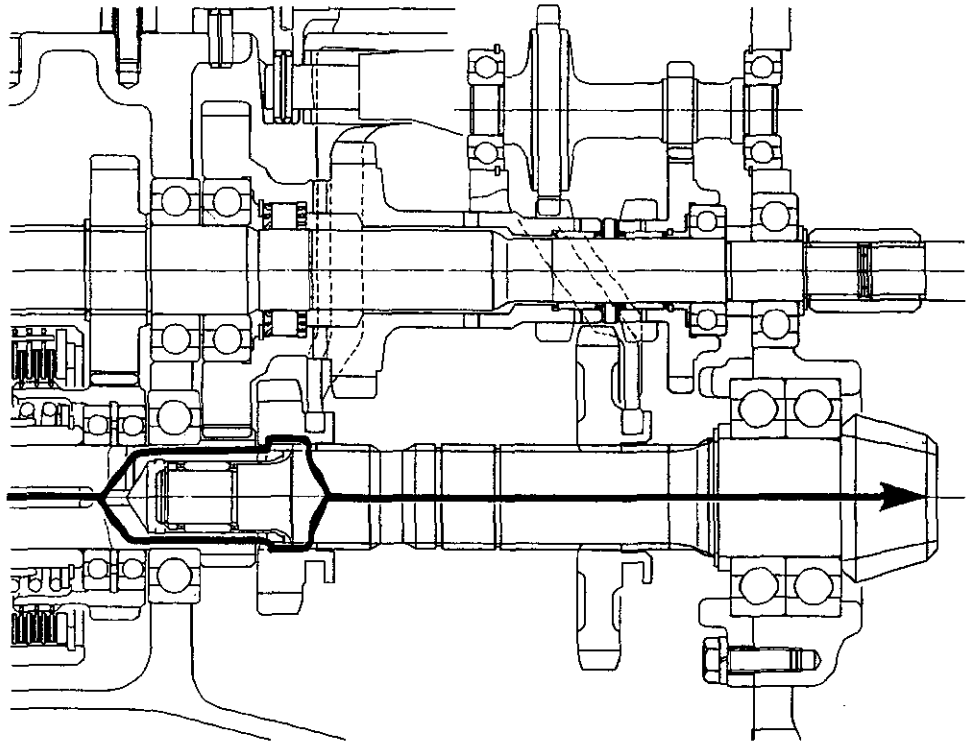
RANGE SHIFTING POWER FLOW (Continued)

2nd SPEED RANGE



2767023C

3rd SPEED RANGE



2767023D

SYSTEM TESTS AND DIAGNOSIS

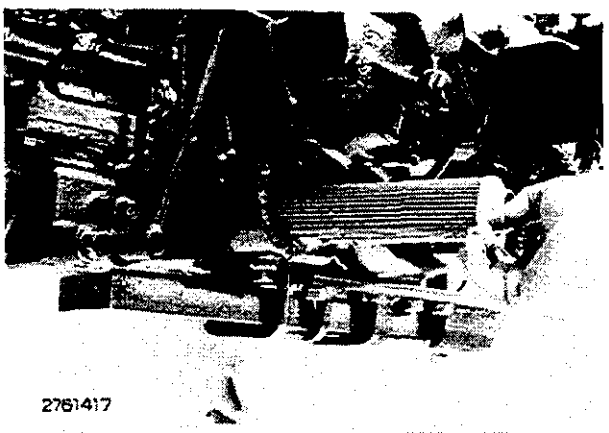
POWER SHIFT PRESSURE TESTS

CAUTION: Escaping fluid under pressure can have sufficient force to penetrate the skin, causing serious personal injury. Before disconnecting lines, be sure to relieve all pressure. Before applying pressure to system, be sure all connections are tight and that line, pipes and hoses are not damaged.
Fluid escaping from a very small hole can almost be invisible. Use a piece of cardboard or wood, rather than hands, to search for suspected leaks. If injured by escaping fluid, see a doctor at once. Serious infection or reaction can develop if proper medical treatment is not administered immediately.

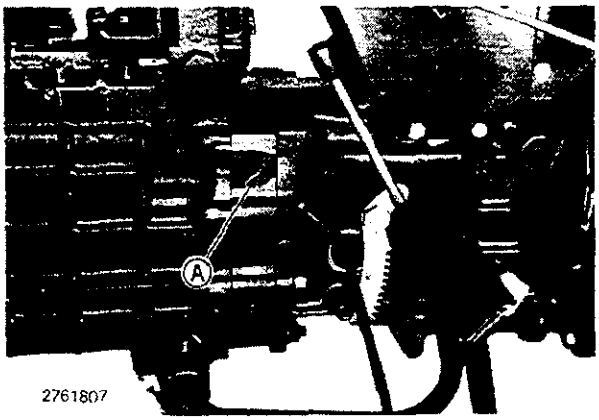
Preliminary Checks

If an operator complains of transmission malfunction, ask the operator about all related operations. For ALL transmission malfunctions — before any further diagnosis is attempted, FIRST:

1. Check oil level, filter and condition and correct if necessary. Also look for signs which may indicate a problem area, such as, a burned odor, metal or packing fragments, and discoloration of the oil.
2. Operate the tractor:
   a) Inspect for external leaks with engine running and at rest.
   b) Unusual noise at 1000 rpm could indicate leakage.
   c) Hot oil lines could indicate internal leakage.
   d) Note all operating and shifting characteristics.
   e) Operate function control levers, noting any problems which may help isolate a hydraulic problem.
3. See Chapter 270 for hydraulic test procedures, procedure for heating hydraulic oil.



SYSTEM TESTS AND DIAGNOSIS (Continued)

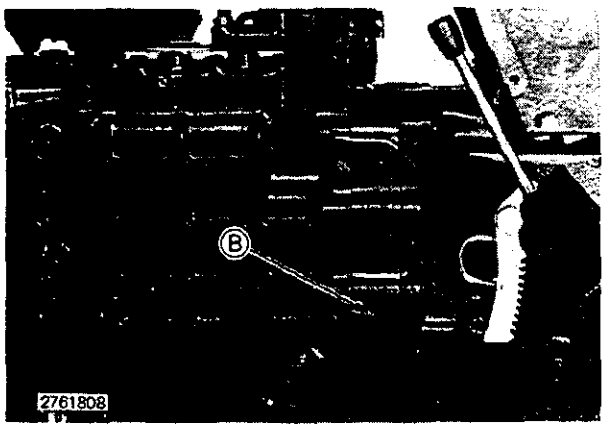


Testing System Pressure

Use the following procedure to test for a malfunction in the transmission control system or excessive pressure oil leakage.

1. Start engine and operate at 1500 rpm until transmission oil reaches operating temperature 40–50°C (104–122°F).
2. Stop engine and place power shift lever and range shift lever in neutral position.
3. Remove the upper plug (A) in the right side regulator case and install hydraulic pressure gauge (3500 kPa or 35 kg/cm^2).
   Start engine.
4. With range shift lever in neutral position, check pressure on the gauge at the power shift lever is in R, 1, 2 and 3 speed positions.
   The pressure gauge should indicate 1500 to 1600 kPa (15.0 to 16.0 kg/cm^2) (213 to 227 psi.). Determine the cause using trouble shooting table on page 250-10-23, 250-10-24, 250-10-25 if does not.
5. After checking pressure, install the plug (PT 1/8) with seal tape.

Do not wrap tape on plug head to avoid the tape trashes plug relief valve.



Testing Lubricating Pressure

To check lubricating oil pressure, use the following procedure.

1. Start engine and operate at 1500 rpm until transmission oil reaches operating temperature 40–50°C (104–122°F).
2. Stop engine and place power shift lever and range shift lever in neutral position.
3. Remove the lower plug (B) in the right side regulator case and install hydraulic pressure gauge (3500 kPa or 35 kg/cm^2).
   Start engine.
4. With range shift lever in neutral position, check pressure on the gauge at the power shift lever is in R, 1, 2 and 3 speed positions.
   The pressure gauge should indicate 20 to 40 kPa (0.2 to 0.4 kg/cm^2) (2.8 to 5.7 psi.). 0 pressure at Neutral Position. Determine the cause using trouble shooting table on page 250-10-23, 250-10-24, 250-10-25 if does not.
5. After checking pressure, install the plug (PT 1/8) with seal tape.

Do not wrap tape on plug head to avoid the tape trashes plug relief valve.

POWER SHIFT TRANSMISSION TROUBLE SHOOTING

1. TRACTOR DOES NOT MOVE WHEN POWER SHIFT LEVER IN ALL POSITIONS (1st, 2nd, 3rd and Reverse)

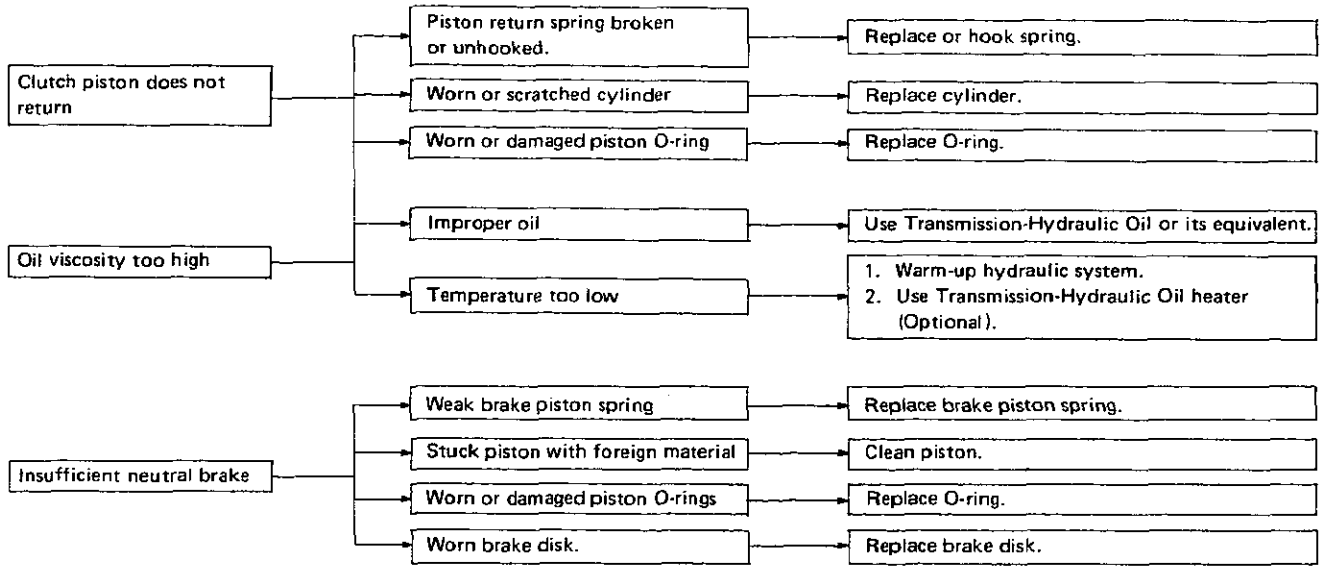
Main relief valve pressure (System pressure) is low at all speed positions.	Hydraulic-Transmission oil level too low	Check oil level. If it is low, add John Deere Type 303 or Hy-Gard Transmission-Hydraulic oil or its equivalent.
	Oil filters clogged	Clean Transmission oil filter (Suction screen). This filter must be cleaned every 600 hours or annually at the same time which the transmission oil is replaced.
	Weaken relief valve spring	Adjust spring tension using adjusting shims. Replace if necessary.
	Worn internal gear pump	Replace pump.
	Stuck main relief valve or DRV valve (Delay relief valve)	Clean valves or replace if necessary.
	Damaged O-rings for suction pipe.	Replace O-rings.
	Oil leakage from regulator case packing.	Replace packing.
	Seal rings at clutch shaft worn or broken.	Replace seal rings.
	Power shift linkage adjustment is not proper.	Adjust shifting linkage length. Rotate turnbuckle.
Main relief valve pressure (system pressure) is correct at all speed position.	Worn or broken gears	Check the following gears: a) Sliding gears b) Idle gear c) Counter gears d) Reduction gears e) Differential gears f) Final reduction gears

2. TRACTOR DOES NOT MOVE WHEN POWER SHIFT LEVER IN A CERTAIN SPEED POSITION

Main relief valve pressure (system pressure) is too high.	Main relief valve stuck or its pilot hole pluged, or wrong spring or shims installed.	Check main relief valve, springs and adjusting shims.
Main relief valve pressure (System pressure) is low at a certain speed position.	Seal ring at clutch shaft worn or broken.	Replace seal ring.
	Worn or scratched cylinder	Replace cylinder.
	Worn or broken piston O-ring	Replace O-ring.
	Broken cylinder	Check main relief valve pressure in the other speed position. If the pressure is too high, check main relief valve pilot hole for clog. Clean it and replace cylinder.

POWER SHIFT TRANSMISSION TROUBLE SHOOTING (Continued)

3. TRACTOR MOVE SLOWLY WHEN POWER SHIFT LEVER IS PLACED IN "NEUTRAL" AND RANGE SHIFT LEVER IS PLACED IN CERTAIN POSITION.



4. TRANSMISSION SHIFTS TOO FAST

Main relief valve pressure setting too high	Adjust main relief valve 1500 to 1600 kPa (15 to 16 kg/cm^2) (213 to 227 psi.).
Stuck main relief valve with foreign material	Clean main relief valve and check system pressure.
Stuck delay relief valve (DRV) with foreign material	Clean delay relief valve (DRV).
Worn O-ring on delay relief valve (DRV)	Replace O-ring.

5. TRANSMISSION SHIFTS TOO SLOW

Low Transmission-Hydraulic oil level	Add John Deere Type 303 or Hy-Gard Transmission-Hydraulic Oil or its equivalent.
Clogged oil filter (Suction screen) in a transmission case.	Clean filter (Suction screen). This filter must be cleaned every 600 hours of annually at the same time which the transmission oil is replaced.
Main relief valve pressure setting too low	Adjust main relief valve 1500 to 1600 kPa (15 to 16 kg/cm^2) (213 to 227 psi.).
Stuck main relief valve.	Clean main relief valve and check system pressure.
Worn internal gear pump	Replace pump.

6. 2ND RELIEF VALVE PRESSURE (LUBRICATING PRESSURE) IS TOO LOW BUT MAIN RELIEF VALVE PRESSURE IS CORRECT

2nd relief valve body or seat worn	Replace valve or seat.
2nd relief valve spring weaken or damaged	Replace spring.
Internal leakage in lubricating system	Check the followings: a) Regulator case packing b) Clutch shaft seals c) Center plate and oil gallery plate packing d) Oil manifold packing

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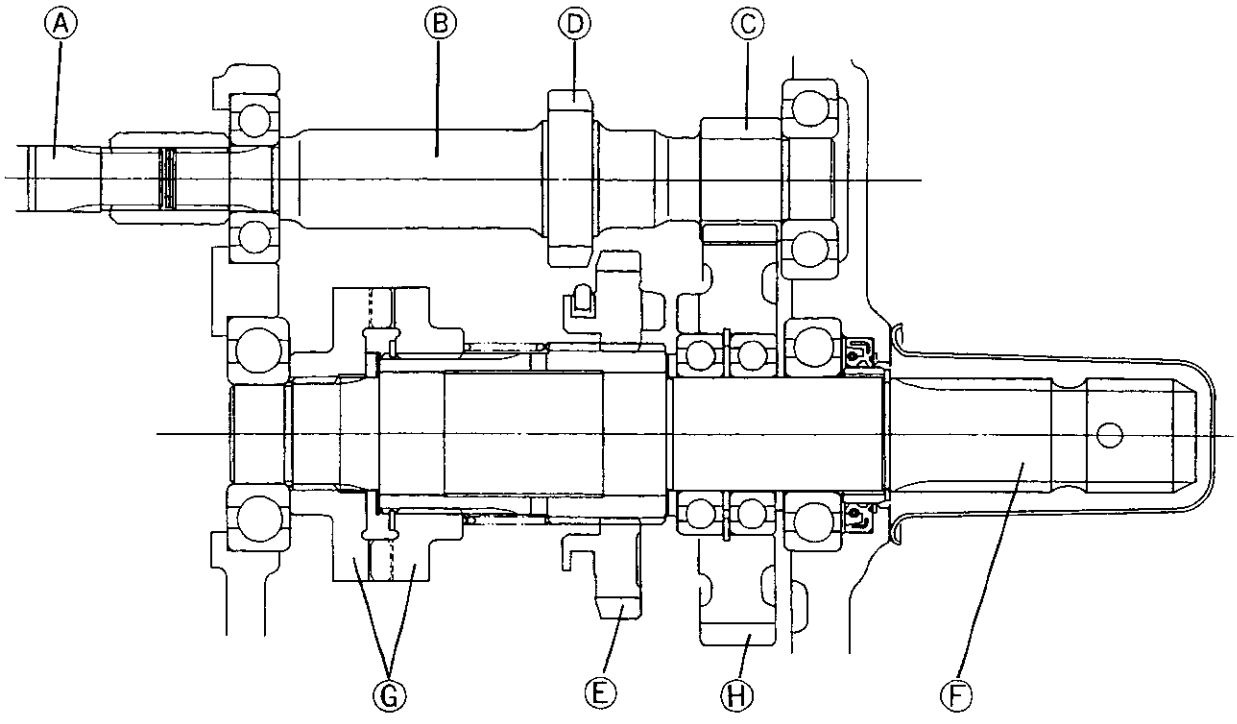
DUAL SPEED PTO

GENERAL



2767024

A – Connecting Shaft
B – PTO Pinion Shaft
C – 540 RPM Drive Pinion
D – 1000 RPM Drive Pinion
E – Sliding Gear (540 RPM Driven Gear)
F – PTO Shaft
G – Clutch Claws (One-way Clutch)
H – 540 RPM Driven Gear

The PTO provides two speeds shifting PTO shift lever.

540 rpm speed can be obtained when the lever is moved forward from neutral position. 1000 rpm speed can be obtained when the lever is moved rearward from neutral position.

1000 rpm speed can not be used for heavy operation. 540 rpm speed is mostly used for PTO driven implements which have a 540 rpm input shaft.

The PTO gear train is located in the rear portion of the transmission case. The transmission driven PTO receives power from the transmission main shaft.

The PTO connecting shaft (A) is coupled to the transmission main shaft. Therefore whenever the engine clutch is engaged, the PTO connecting shaft turns in the same direction as the main shaft (Counterclockwise).

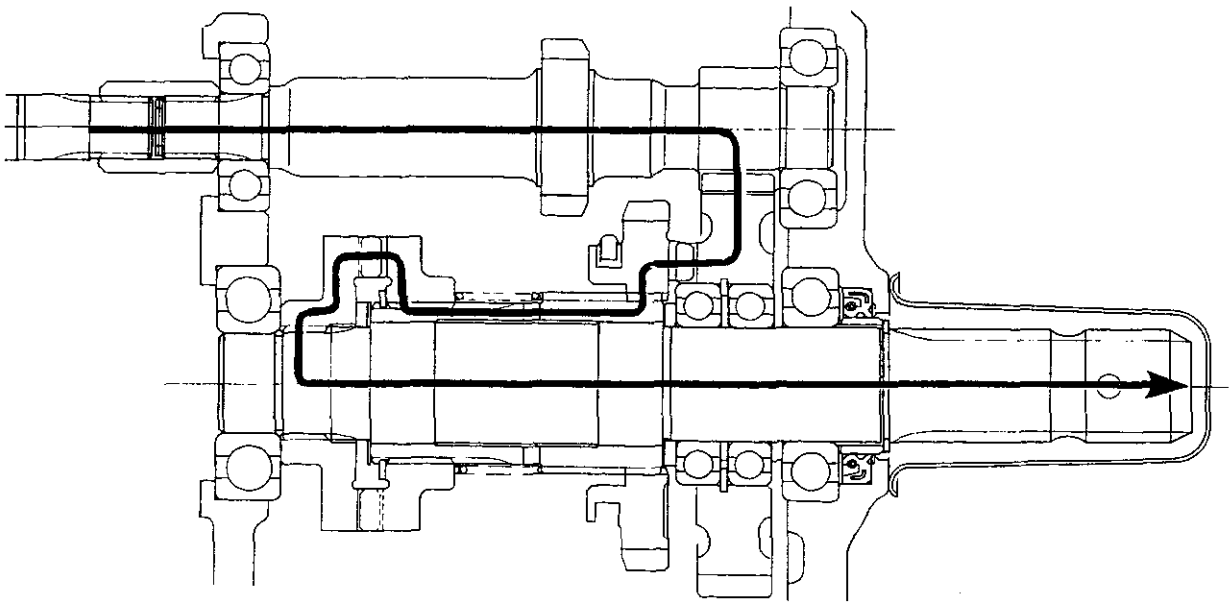
The PTO connecting shaft (A) transmits power to the PTO pinion shaft (B). The rear pinion gear (C) on the pinion shaft meshes with the PTO gear (H) on the PTO shaft (F).

540 rpm is given when PTO shift lever is moved forward. The PTO shift arm moves rearward so that shift fork would be pushed rearward. The fork slides sliding gear (E) to mesh into PTO gear (H).
Since the sliding gear is splined to sleeve, and the splined sleeve has one way clutch, the gear (H) turns through sliding gear (E), sleeve and one-way clutch, and the PTO shaft rotates clockwise at reduced speed (540 rpm) at 2258 engine rpm.

1000 rpm is given by moving PTO shift lever rearward to mesh sliding gear (E) to gear (D).
The power from connecting shaft is transmitted through sliding gear (E) and one way clutch to the PTO shaft (F). At this time, the PTO shaft rotates 1000 rpm at engine 2294 engine rpm.

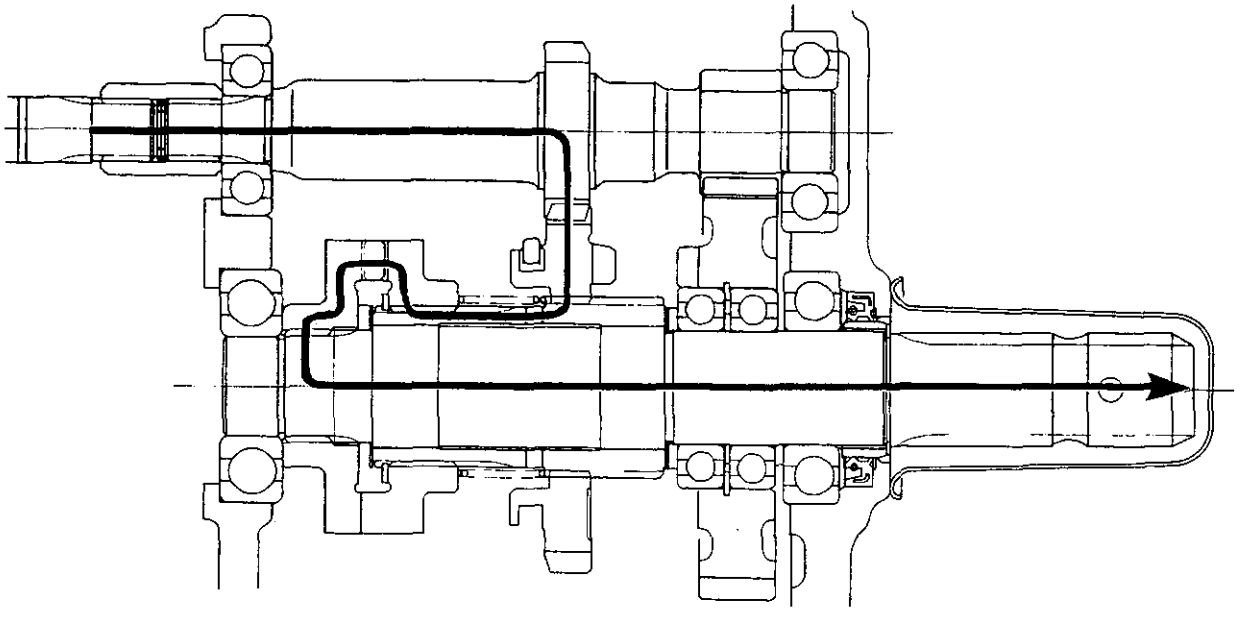
DUAL SPEED PTO (Continued)

540 RPM



2767024A

1000 RPM



2767024B

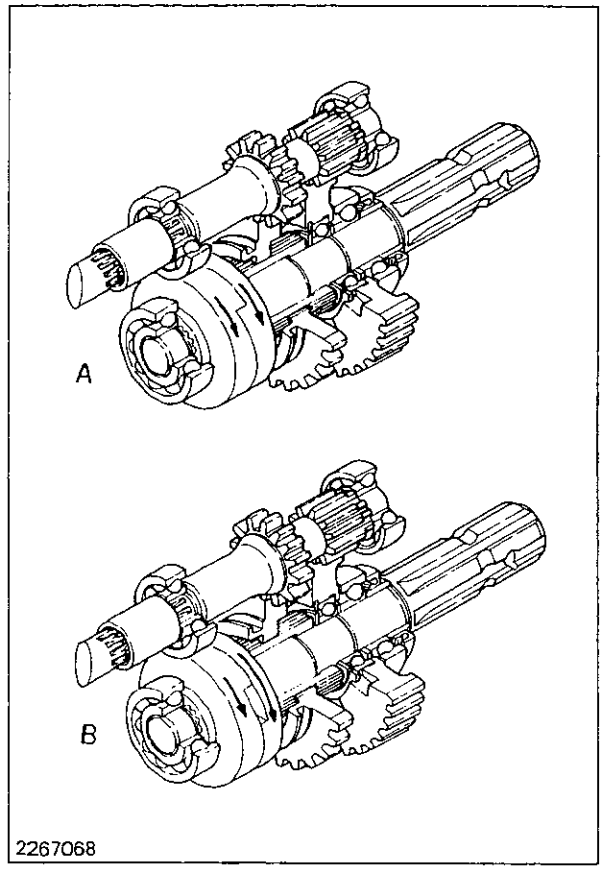
PTO ONE-WAY CLUTCH

A one-way clutch allows power to flow through the PTO train toward the rear of the tractor only. (Fig. A)

If the PTO shaft overspeeds turning the PTO gears faster than the PTO pinion shaft, the rear clutch claw is forced to the rear compressing the clutch spring. The clutch is disengaged and power flow is interrupted. (Fig. B)

This protects the transmission and engine by permitting the PTO shaft and PTO pinion shaft to freewheel if the PTO shaft overspeeds. This could occur during engine clutch disengagement or sudden engine deceleration – particularly when operating a heavy, PTO-driven implement.

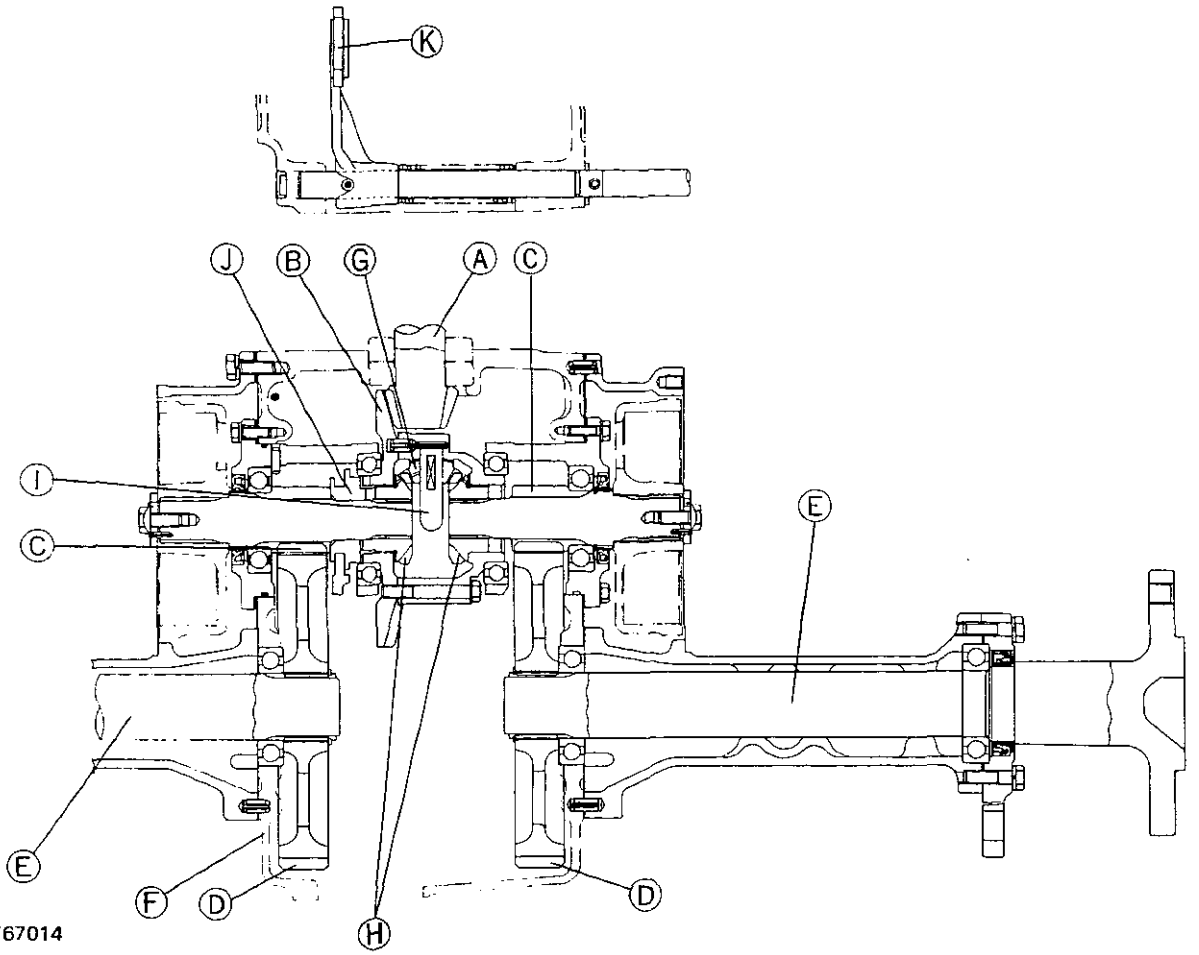
As soon as the speed of PTO shaft clutch claw and PTO sleeve claw equalizes, the clutch spring forces the rear clutch claw forward on the shaft to engage with the PTO shaft clutch claw.



LUBRICATION

Since the PTO pinion shaft turns whenever the engine clutch is engaged and the PTO gear turns constantly on the PTO shaft, splash lubrication is available to the PTO train at all times.

Return oil from the hydraulic system provides further lubrication of the PTO gears and bearings.



2767014

A – Spiral Bevel Pinion
B – Ring Gear
C – Final Reduction Pinions
D – Final Reduction Gears
E – Rear Axle Shafts
F – Differential Housing
G – Differential Pinion Gears
H – Differential Side Gears
I – Differential Pinion Shaft
J – Differential Lock Slider
K – Differential Lock Fork

DIFFERENTIAL

The differential transmits power from the spiral bevel pinion (A) to the final reduction pinion (C). It allows each drive wheel to rotate at varying speeds and still pull its own load.

The differential housing is located in the center compartment of the transmission.

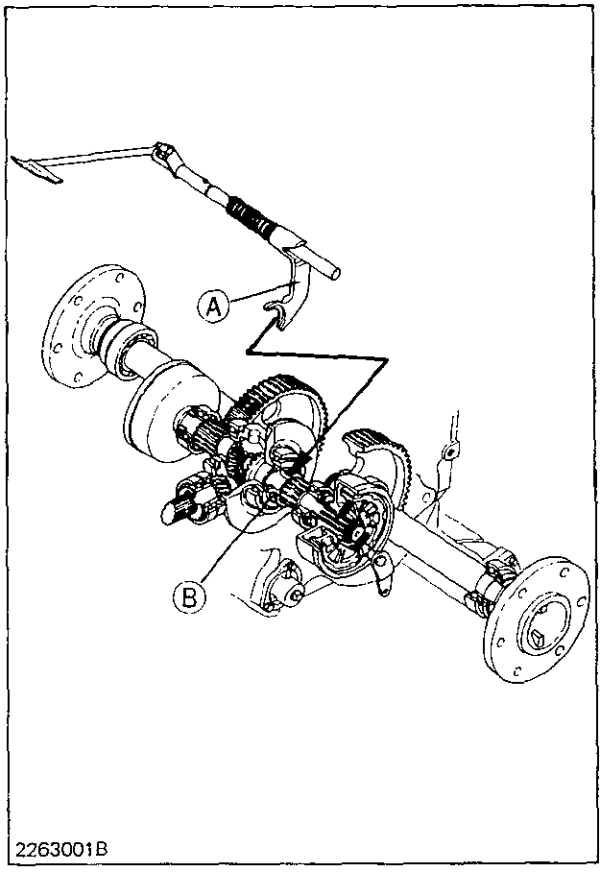
Power from the spiral bevel pinion to the differential carrier ring gear (B) flows through a two bevel pinion gears (G) arrangement to the bevel side gears (H) as a unit.

When the tractor turns sharply, one axle is held stationary. Therefore, the bevel pinions (G) rotate on their own axis (I) and "walk around" the stationary axle bevel gears (H). The turning ring gear (B) transmits power through the pinion to the opposite bevel gear.

FINAL DRIVE

Power from the differential flows to the final drive pinion shaft (C). The pinion shaft (C) has an final pinion which meshes with the final reduction gear (D) at the inner end of the axle shaft (E).

Since the final reduction gear is splined to the axle shaft, the axle rotates at the speed reduction created by the final drive gear.



2263001B

DIFFERENTIAL LOCK

A mechanical differential lock prevents traction loss when one wheel is slipping causing differential traction.

A foot pedal allows the operator to compress the lock release spring sliding the lock shift fork (A) to the right. The fork slides the lock slider (B) to the right.

The lock clutch slider (B) has three claws on its side which align with differential lock gear in the differential carrier. When the lock slider is engaged, the both rear axis are locked together and rotate at a same speed.

When the drive wheels regain equal traction, the lock will disengage automatically since the shift fork has loaded spring to release the torsional forces.

The lock can be engaged "on the go." It should be disengaged before turning the tractor since both rear wheels are locked together at the same speed.

A – Lock Shift Fork
B – Lock Slider

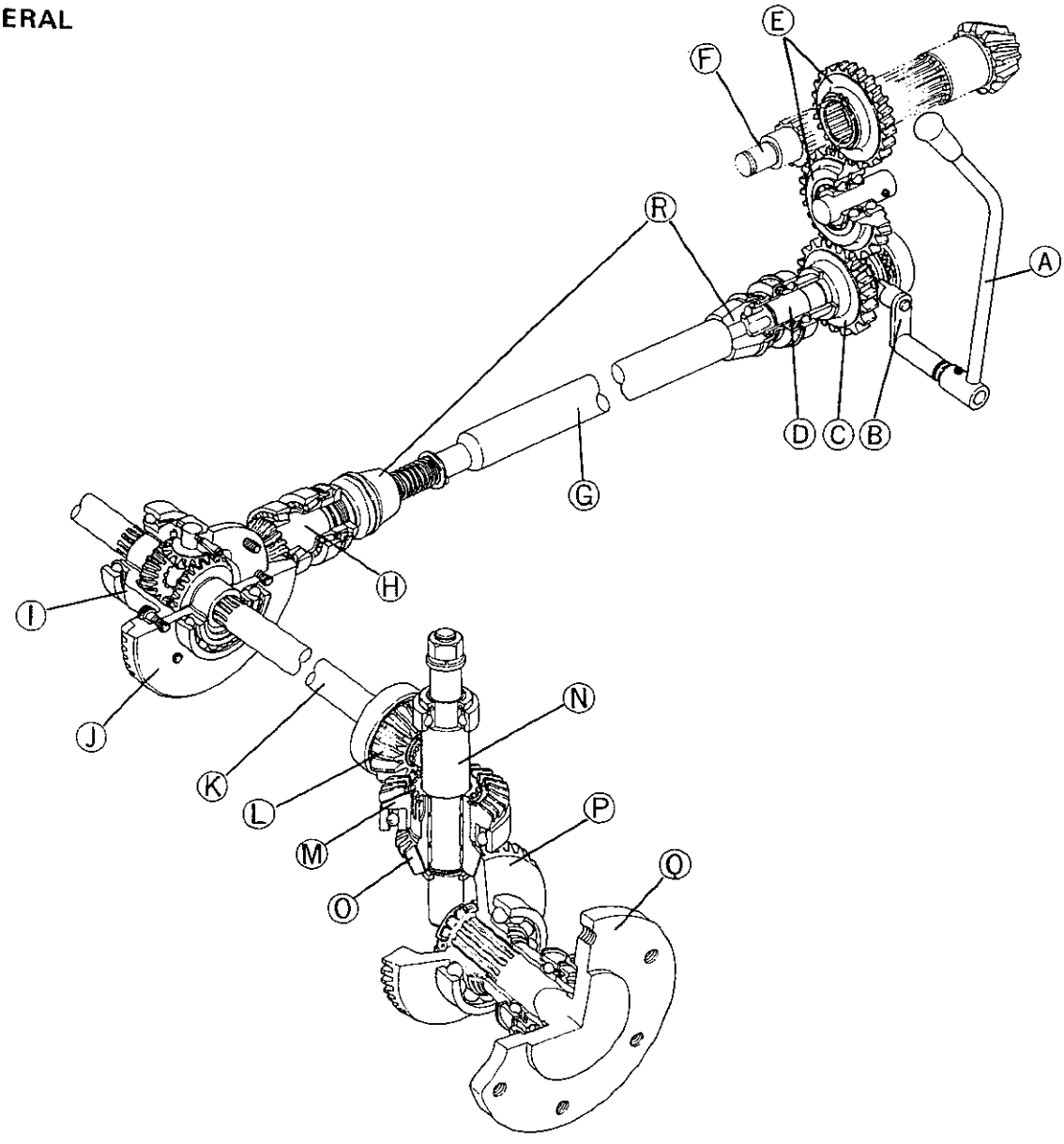
LUBRICATION

When the differential ring gear turns, oil is splashed over the entire housing assembly.

Since the spiral bevel pinion and lower portion of the differential carrier are submerged in oil, the moving parts are constantly lubricated.

Return oil from the hydraulic system also lubricates the differential area.

GENERAL



2767005

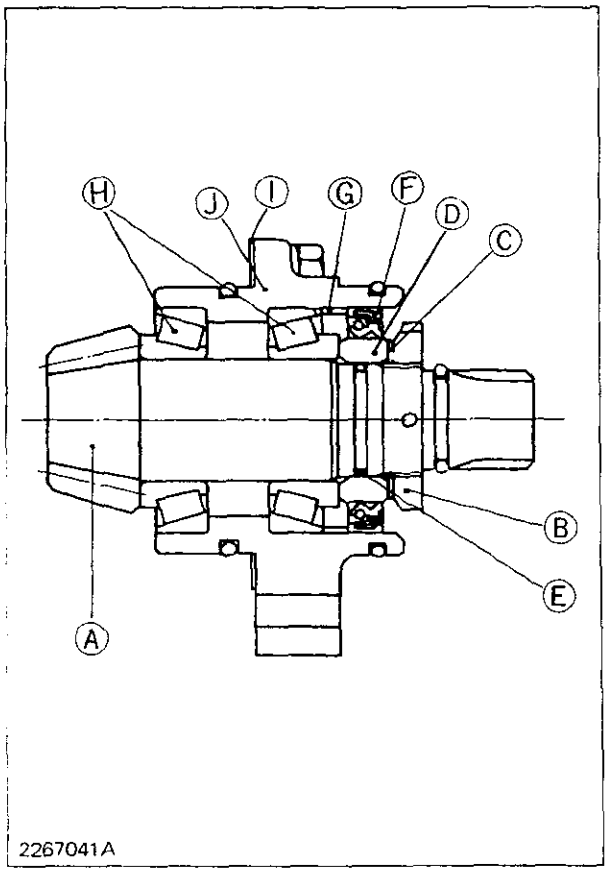
A – Shift Lever
B – Shift Arm
C – Sliding Gear
D – Front Drive PTO Shaft
E – Front Drive Gears
F – Differential Drive Shaft
G – Propeller Shaft
H – Front Differential Drive Shaft
I – Front Differential
J – Ring Gear
K – Front Drive Shaft
L – Drive Shaft Pinion
M – Upper Bevel Gear
N – Spindle Shaft
O – Lower Bevel Gear
P – Final Reduction Gear
Q – Front Wheel Hub
R – Ball Coupler Joints

When front wheel drive shift lever (A) is moved forward to "ON" position of front wheel drive, shift arm (B) pushes sliding gear (C) forward to engage front wheel drive.

This gear, which is splined to front wheel drive PTO shaft (D), rotates propeller shaft (G) through ball coupler joint (R). This power is transmitted to front differential drive shaft (H), ring gear (J) and drive shaft pinion (L).

Drive shaft pinion (L) meshes with upper bevel pinion (M) and this upper bevel pinion is on lower bevel pinion (O). Both upper and lower bevel pinion rotate with needle bearings over spindle shaft (N).

Lower bevel pinion meshes with final reduction gear (P). The power from lower bevel pinion is transmitted to front wheel hub (Q) through final reduction gear (P).



2267041A

DIFFERENTIAL DRIVE SHAFT

The front differential drive shaft is supported at the front and rear by two taper roller bearing assemblies (H).
Drive shaft cone point adjustment is made through the use of shims (I) between the bearing housing (I) and front differential housing. The slotted retaining nut (B) is adjusted for pre-load of roller bearings (H). An oil seal (F) and O-ring (E) seal the drive shaft and bearing housing.

A – Front Differential Drive Shaft
B – Retaining Nut
C – Lock Washer
D – Seal Collar
E – O-ring
F – Oil Seal
G – Spacer Ring
H – Taper Roller Bearings
I – Shims
J – Bearing Housing

GENERAL INFORMATION

PRELIMINARY CHECKS AND ADJUSTMENTS

Prior to attempting to specifically diagnosis any power train problem, the following checks and adjustments should be performed to help isolate the problem.

1. Ask the operator about all complaints or symptoms. Be sure the operator is using the tractor properly.
2. Check the transmission oil.
   a) If oil level is low, check for leakage as instructed on page 250-50-2. Replenish after the repair is made.
   b) If oil level is high, check to see if high oil level has caused seal leakage and repair as necessary. Drain oil to the proper level.
   c) If oil is contaminated, drain oil and remove the filter screen. Check for parts fragments that may indicate damage to gears or bearings. Remove transmission covers to visually determine area of damage. Separate and repair as necessary and replenish with clean oil.
   d) If oil appears to have overheated, be foamy or discolored, see Chapter 270 to determine main hydraulic system problem. Be sure proper type of oil has been applied. After problem has been corrected, clean filter screen and replenish with clean oil.
3. Visually inspect the tractor.
   a) Note any leakage due to damaged housings or covers, leaking gaskets or seals. Repair as necessary.
   b) Check all linkage and operating levers and pedals for damage or binding.
4. Check clutch pedal free play. If incorrect, adjust to 15 to 25 mm (0.591 to 1 in.).

ISOLATING THE PROBLEM TO CLUTCH HOUSING, TRANSMISSION, PTO, FINAL *DRIVE OR FRONT WHEEL DRIVE*

The following procedure assumes noise accompanies a drive malfunction. If noise is minimum but a power transmission problem exists, use of a mechanic's stethoscope may help. Otherwise use the procedure noting all operating characteristics to systematically trace the mulfunction.

Noise Isolation

1. All shift levers in Neutral position.
   a) Place the power shift, range, PTO, and front wheel drive shift levers in their neutral positions. Also, be sure the differential lock pedal is in its disengaged positions.
   b) Engage the engine clutch and vary engine speed from 800 to 2600 rpm.
   c) If the noise or vibration occurs, lock for a problem –
      - In the flywheel or clutch housing?
      - In the main shaft bearings?
      - In the clutch gear bearings?
      - In the PTO drive and pinion shafts bearings?
      - Power shift pump?
      - In the power shift pump bearings?
      - In the counter shaft bearings?
      - Main gears and clutch gears broken?
2. Power shift lever is in each position, but other levers in neutral positions.
   a) Engage the engine clutch and vary engine speed from 800 to 2600 rpm.
   b) If the noise or vibration occurs, look for a problem
      - In the flywheel or clutch housing?
      - In the main shaft bearings?
      - In the PTO drive and pinion shafts bearings?
      - Power shift pump?
      - In the power shift pump bearings?
      - In the counter shaft bearings?
      - Main gears and clutch gears broken?
      - Clutch shaft bearings and needle bearings broken?
      - Counter shaft gear and counter gears broken?

Noise Isolation (Continued)

3. Disengage the range shift lever and engage the PTO shift lever to 540 rpm.
   - If the noise occurs (but did not occur previously), the noise is probably located in the PTO shaft bearings.

4. Engage the PTO shift lever to 1000 rpm, and other levers in neutral positions.
   - If the noise occurs (but did not occur previously), the noise is probably located in the PTO shaft bearings or sliding gear broken.

⚠ **CAUTION: When operating the tractor, be sure to follow all safety procedures as given in the tractor Operation Manual.**

5. Shift range shift lever in the 1st speed position and move power shift lever to each power shift speed position.

   Engage the engine clutch and vary engine speed from 800 to 2600 rpm.

   a) If the noise or vibration occurs when shifting to 1st speed position, the noise is probably located—
      - In the counter gear or counter shaft bearings.
      - In the 1st clutch gear, bearings or clutch shaft bearings.

   b) If the noise or vibration occurs when shifting to 2nd speed position, the noise is probably located—
      - In the counter gear or counter shaft bearings.
      - In the 2nd clutch gear, bearing or clutch shaft bearings.

   c) If the noise or vibration occurs when shifting to 3rd speed position, the noise is probably located—
      - In the counter gear or counter shaft bearings.
      - In the 3rd clutch gear, bearing or clutch shaft bearings.

   d) If the noise or vibration occurs when shifting to reverse speed position, the noise is probably located—
      - In the counter gear or counter shaft bearings.
      - In the reverse clutch gear, bearings or clutch shaft bearing.
      - In the reverse idle shaft bearings or idle gear.

   e) Change range shift lever in the 2nd, 3rd and creep speed position and follow the above procedures to make sure which counter gear broken?

   f) If the noise is located the rear part of the transmission case, the noise comes from—
      - Final reduction pinion or gear broken.
      - Spiral bevel pinion or ring gear broken.
      - Differential drive shaft bearings or differential.
      - Carrier bearings.
      - Rear axle bearings.
      - Differential bevel pinions or side bevel gears.
      - Differential gear bushings or pinion shaft.
      - Differential lock slider.
      - Final pinion shaft bearings.

6. Engage front wheel drive, and range shift lever in 1st speed range and power shift lever in 1st speed position.

   Engage the engine clutch and vary engine speed from 800 to 2600 rpm.

   If the noise or vibration occurs, the noise is probably located—
   - In the front drive gears and bearings.
   - In the propeller shaft ball joints.
   - In the front differential gears or bearings.
   - In the bevel gears or their shaft bearings.

Isolating Oil Leakage

1. Visually inspect the entire tractor for leakage at housing gaskets, seals, and O-rings. Also check for cracked housings or loose drain plugs and cap screws.

2. Operate the hydraulic components and check for leakage as instructed in Section 270.

3. Check the hole on bottom of clutch housing.

   a) If oil is present and transmission oil level is low, the front seals on the transmission case are leaking.

   b) If oil is present and the engine oil level is low, the engine crank shaft oil seal is leaking.

4. Remove lower plugs from each brake cover. If oil is present, the final drive pinion shaft oil seal is leaking.

DIAGNOSING CLUTCH MALFUNCTIONS

PROBLEM	POSSIBLE CAUSE	SUGGESTED REMEDY
Clutch Slips	• Oil or grease on facing	Clean or replace disk
	• Worn or glazed facing	Replace disk
	• Warped disk	Replace
	• Warped pressure plate	Replace
	• Warped flywheel	Replace
	• No pedal play	Increase pedal free play
	• Operating levers binding or sticking	Clean or replace clutch
	• Pressure plate binding or operating bolts	Clean or replace necessary
	• Operator riding clutch pedal	Instruct operator (See Operation Manual)
Clutch Drags	• Warped disk	Replace disk
	• Warped pressure plate	Replace
	• Warped flywheel	Replace
	• Excessive clearance between release lever plate and bearing	Decrease pedal free play
	• Disk binding on shaft splines	Replace as required
	• Pilot bushing binding on shaft	Replace as necessary
	• Release sleeve assembly sticking	Replace as necessary
	• Disk or facing broken	Replace
	• Clutch assembly rusty or dirty	Clean or replace
	• Engine idling too fast	Adjust
Clutch Does Not Engage	• Disk facings scored, worn or burned	Replace
	• Disk hub damaged	Replace
	• No clearance between release lever plate and bearing	Increase free play
	• Release bearing sleeve seized	Replace
Clutch Grabs	• Oil or grease on facing	Clean or replace disk
	• Facing worn or glazed	Replace disk
	• Disk hub sticking on shaft	Repair as necessary
	• Operating levers binding	Clean or replace
	• Pressure plate binding on operating bolts	Clean or replace as necessary
	• Pedal armshaft or linkage sticking	Repair as necessary
	• Clutch dirty	Clean
	• Excessive transmission backlash	Repair as necessary
Clutch Squeak	• Pilot bushing needs lubrication	Lubricate
	• Release bearing assembly needs lubrication	Lubricate
	• Failed release bearing	Replace
Clutch Does Not Release	• Clutch sticking to flywheel	Free and clean surfaces (when storing tractor for a long time, use a lock lever to keep pedal in the disengaged position)

DIAGNOSING CLUTCH MALFUNCTIONS (Continued)

PROBLEM	POSSIBLE CAUSE	SUGGESTED REMEDY
Clutch Chatters	• Oil or grease facings	Clean or replace disk
	• Worn or glazed facings	Replace disk
	• Warped disk	Replace
	• Warped pressure plate	Replace
	• Warped flywheel	Replace
	• Pressure plate cracked or scored	Replace
	• Flywheel cracked or scored	Replace
	• Operating levers sticking	Repair as necessary
	• Hub or shaft splines worn or damaged	Replace
	• Dirty or rusty clutch	Clean and replace as necessary
	• Clutch springs worn	Replace clutch
	• Clutch shaft bent or damaged	Replace
	• Axle worn or loose	Replace
	• Excessive transmission backlash	Repair as required
Clutch Rattles	• Hub loose on disk	Replace
	• Torsional springs damaged or loose	Replace
	• Release bearing assembly damaged or broken.	Repair as necessary
	• Worn pilot bushing	Replace
	• Shaft or splines worn	Replace
	• Bent shaft	Replace
	• Release lever adjustment changed	Inspect and replace as necessary
Noisy Engagement	• Worn drive shaft pilot	Replace
	• Disk rivets loose	Repair as necessary
	• Drive shaft spline worn	Replace
	• Flywheel loose	Retighten
Excessive Vibration	• Flywheel loose	Retighten
	• Clutch shaft bent or damaged	Replace
	• Worn on damaged disk or pressure plate	Replace
	• Dirty clutch	Clean
	• Improper assembly	Assemble properly
	• Clutch spring worn or damaged	Replace
Pedal Does Not Return	• Return springs worn or damaged	Replace
	• Worn or damaged pedal or shaft	Replace
	• Release bearing sleeve seized	Replace
	• Yoke armshaft spring pin sheared or missing	Replace
Pedal Loose	• Worn shaft	Replace
	• Yoke armshaft spring pin sheared or missing	Replace
Pedal Pulsates	• Broken or missing return spring	Replace
	• Clutch shaft bent	Replace
	• Flywheel not seated properly	Repair as necessary
Jerky or Rough Power Transmission	• Torsional springs worn or damaged	Replace disk
	• Pressure plate, flywheel or disk facings worn unevenly	Replace as necessary

DIAGNOSING TRANSMISSION MALFUNCTIONS

PROBLEM	POSSIBLE CAUSE	SUGGESTED REMEDY
Low Oil Level (Excessive Oil Leakage)	• Improper oil	Drain and replenish
	• Damaged or missing gasket	Replace
	• Cracked housing	Inspect and replace as required
	• Leaking oil seals	Inspect and replace as required
	• Loose drain plug	Retighten
	• Loose cover or housing cap screws	Retighten
	• Hydraulic system leakage	See Chapter 270
Gears Will Not Engage, or Hand To Shift or Excessive Gear Clash	• Operator attempting to shift too fast	Instruct operator
	• Operator attempting to shift with tractor in motion	Instruct operator
	• Clutch pedal not fully depressed	Instruct operator
	• Improper clutch adjustment	Adjust
	• Shift detents worn or damaged	Replace
	• Shifter worn or damaged	Replace
	• Fork bent, worn or broken	Replace
	• Damaged gears	Replace
	• Gears assembled improperly or damaged	Assembly properly Replace
Two Speeds Engage Together	• Missing or improperly assembled interlock plate	Install correctly
	• Damaged gears	Replace
	• Improper gear or shifter assembly	Assembly properly
	• Worn or damaged shifters	Replace
Will Not Stay In Gear	• Shifter detent missing or weak spring	Replace
	• Damaged gears or bearings	Replace
	• Bent or worn shifter fork	Replace
	• Oil level low or dirty oil	Replenish with clean oil and clean filter screen
	• Shafts or gears splines worn	Replace
Noisy Transmission Operation	• Shaft or gear splines worn	Replace
	• Damaged or worn gears (backlash or cone point unacceptable)	Repair as required
	• Bearings or bushings worn or damaged	Repair as required
	• Damaged or bent fork	Replace
	• Loose or damaged gears or gear bearings	Replace

DIAGNOSING TRANSMISSION MALFUNCTIONS (Power Shift)

(Refer to page 250-10-23, 250-10-24, 250-10-25 for detailed diagnosis on power shift)

PROBLEM	POSSIBLE CAUSE	SUGGESTED REMEDY
Transmission Shifts Slowly	• Low system pressure	Test system pressure
	• Low power shift pump output	Repair pump
Erratic Shifting	• Valve spool malfunction	Test operating pressure
	• Control linkage out of adjustment	Adjust shift linkage
Tractor Will Not Move In Any Gear	• Low system pressure	Test system pressure
	• Shift linkage unhooked, bent, or broken	See shifter repair
	• Range shift transmission broken	Repair transmission
	• Low oil level	Add oil
	• Clogged oil strainer (Suction screen)	Clean strainer
Transmission Creeps	• Low the pressure and normal system pressure (results in element damage)	Test system pressure and test lube pressure
	• Valve spool leakage	Test operating pressure in creeped speed position
Transmission Slips	• Low system pressure	Test system pressure
	• System internal leakage	Test system pressure

DIAGNOSING PTO MALFUNCTIONS

PROBLEM	POSSIBLE CAUSE	SUGGESTED REMEDY
PTO Noisy	• Oil level low or dirty oil	Replenish with clean oil and clean filter screen
	• Damaged or worn gear or collar	Replace
	• Shaft or shaft splines worn or damaged	Replace
	• Damaged or worn bearings	Replace
	• One-way clutch spring weak or broken	Replace
	• Improper clutch assembly	Assembly properly
	• Noise transmitted from implement	Remove implement and check (Repair as required)
PTO Hard To Engage	• Operator attempting to shift too fast	Instruct operator (See Operation Manual)
	• Operator attempting to shift with tractor in motion	Instruct operator (See Operation Manual)
	• Clutch pedal not fully depressed	Instruct operator (See Operation Manual)
	• PTO sliding gear or shaft spline damaged	Replace
PTO Will Not Operate	• Improper clutch adjustment	Adjust free play of pedal
	• Worn or damaged gear or collar	Replace
	• Damaged shifter	Replace
	• Excessive implement load on shaft	Instruct operator
	• One-way clutch claws or spring broken	Replace
PTO Will Not Stay	• Improper assembly	Assemble properly
	• One-way clutch worn or damaged	Replace
	• One-way clutch assembled wrong or spring weak or broken	Replace spring and assemble clutch properly
	• PTO shaft or collar splines worn	Replace
	• Damged gear or collar	Replace
	• Weak or broken detent spring	Replace
	• One-way clutch spline worn or damaged	Replace

STEERING/BRAKES OPERATION AND TESTS 260

SPECIFICATIONS

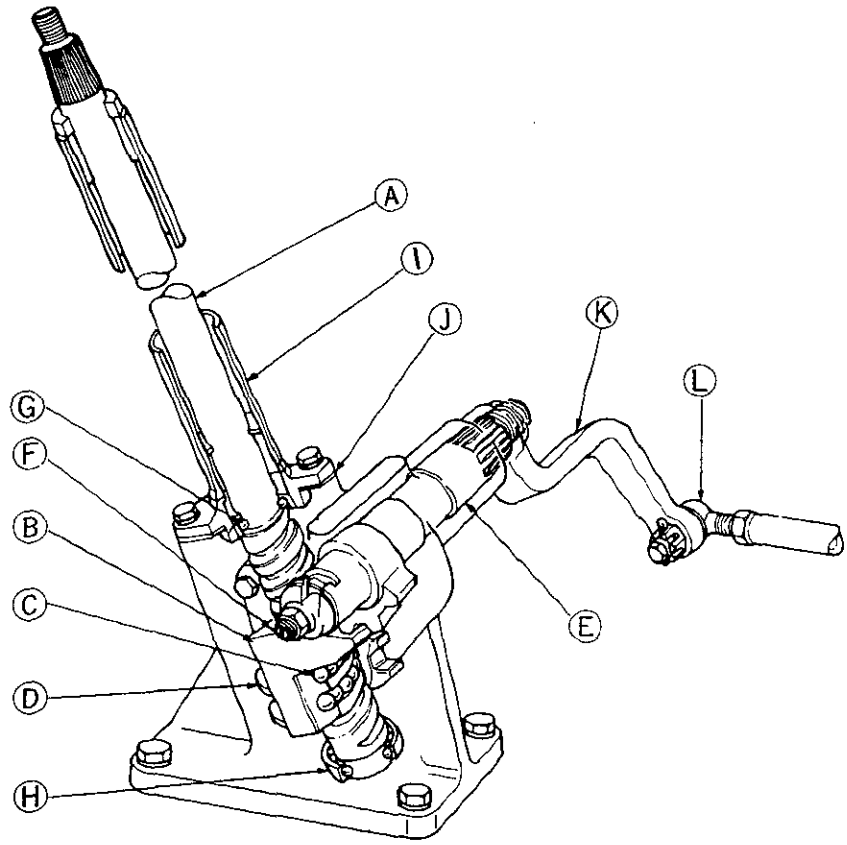
Steering

ITEM	NEW PART SPECIFICATINS	WEAR LIMIT
Steering Wheel Free Travel	25–40 mm (0.984 – 1.575 in.)	50 mm (1.969 in.)

Brakes

ITEM	NEW PART SPECIFICATIONS	WEAR LIMIT
Brake Pedal Free Travel	20 – 30 mm (0.787 – 1.181 in.)	50 mm (1.969 in.)

HOW THE STEERING WORKS



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A – Steering Shaft
B – Ball Nut
C – Recirculating Balls
D – Ball Return Tube
E – Sector Shaft
F – Adjusting Screw
G – Upper Ball Bearing
H – Lower Ball Bearing
I – Steering Column
J – Shim
K – Pitman Arm
L – Drag Rod

The steering gear box is designed to multiply the operator's turning torque so that the front wheels may be turned easily and resist the transfer of road shock to the operator. The torque developed by the operator is multipled through gears, then is transmitted to the wheel spindle assembly via linkage.

The type of gear box is recirculating ball worm and nut. This type use a nut (B) that rides up and down the worm portion of steering shaft (A). Balls (C) ride half in the worm and half in the nut. When the worm is turned, the balls impart an axial thrust to the ball nut (B). As the nut is prevented from turning, it will then travel up or down, depending on the worm direction.

As the balls roll along and one by one, come to the end of groove in the nut, they are forced through a return tube (D). Eventually, they reenter the nut groove at the opposite end, which accounts for the name, recirculating ball worm and nut.

One side of the nut has gear teeth cut into it. The pitman arm sector shaft (E) gear teeth engage the nut teeth. When the nut travels up and down, the sector shaft is forced to rotate.

HOW THE STEERING WORKS (Continued)

The steering motion is transmitted by the steering wheel shaft (A) and the ball nut (B) to the steering sector shaft (E) which is connected to the steering linkage leading to the front wheels.

The steering shaft (A) is supported by a bearing at the bottom of the steering column (I) and one in the bottom of the steering sector (G, H).

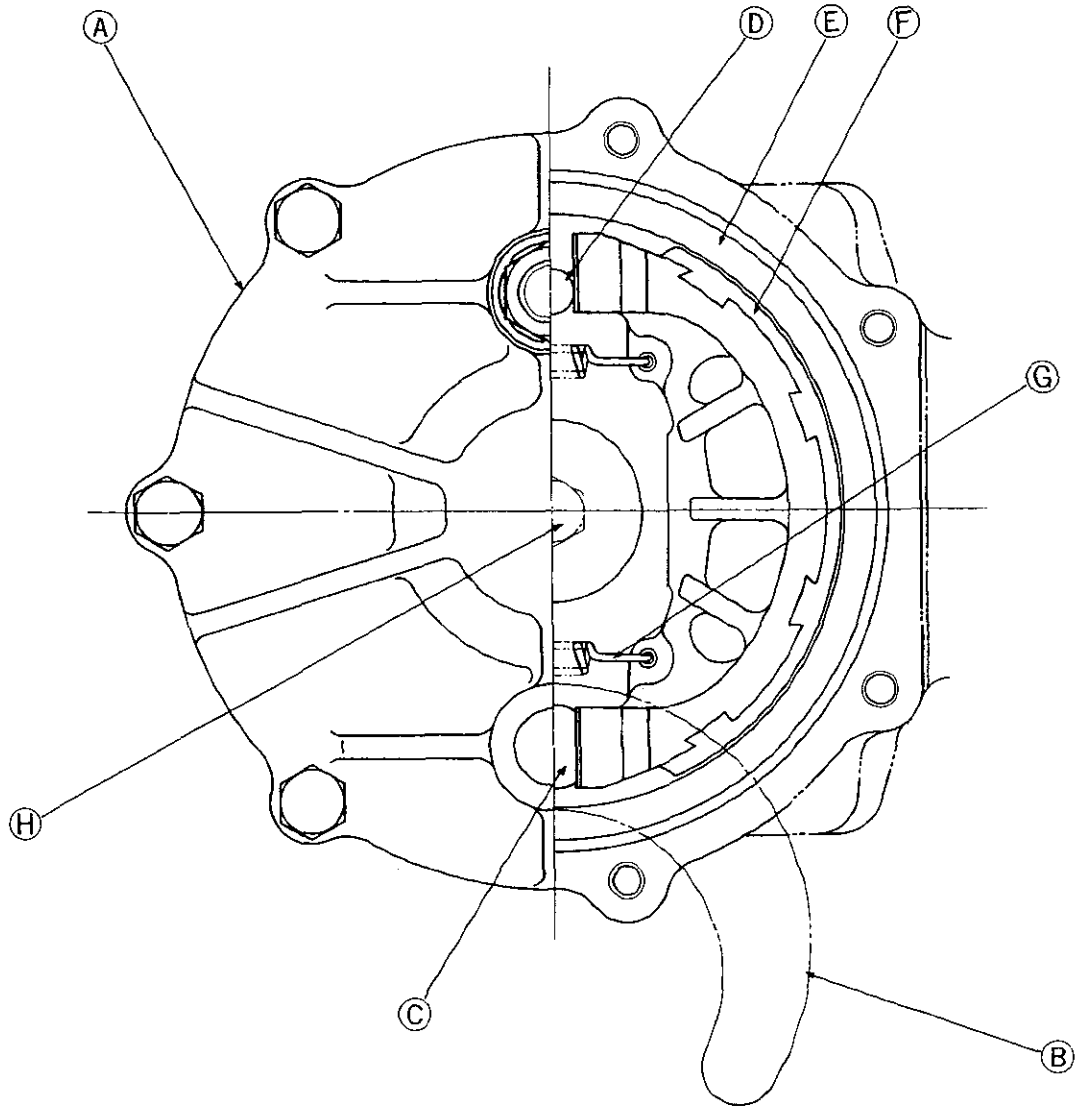
As the steering wheel is turned to the right, the nut (B) is threaded upward by the steering shaft worm (A). The gear teeth on the nut are in mesh with the gear teeth on the sector shaft (E) therefore, as the ball nut moves upward, the sector shaft is rotated moving the pitman arm (K), which is connected to the drag rod, turning the wheels to the right.

Turning the wheel to the left threads the nut downward, rotating the sector shaft to the opposite direction, turning the wheels to the left.

DIAGNOSING MALFUNCTIONS

PROBLEM	POSSIBLE CAUSE	SUGGESTED REMEDY
Steering Pulls to One side	• Improper front alignment	Adjust front alignment
	• Tie rod or drag rod bent	Correct or replace
	• Unequal tire pressures	Adjust (See page 10-05-14)
	• Implement fitted improperly	Adjust
Hard Steering	• Tire pressure too low	Inflate correctly
	• Improper front alignment	Adjust front alignment
	• Tie rod bent	Correct or replace
	• Insufficient grease in gear box	Add grease
	• *Tractor front end too heavily* weighted	Reduce front weight by adding rear counter weight
	• Recirculating balls broken	Replace ball nut assembly with shaft
	• Front or rear tire pressure too low	inflate correctly
	• Improper tires are installed on front or rear axle	Install correct tires
	• Front drive train failure	Inspect front bevel gear train and repair as required
Excessive Play in Steering	• Excessive backlash in steering gear box	Adjust sector shaft adjusting screw
	• Worn ball joints of tie rod or drag rod.	Replace
	• Center pin bushing worn out	Install new bushings
	• Center pin end play improperly adjusted	Adjust
	• Worn steering arm bushing (4-Wheel Drive)	Replace bushing
	• Loosen steering arm-to-final gear case cap screws (4-Wheel Drive)	Tighten cap screws
Front Tire Shimmy	• Faulty front bearing hubs	Correct or replace
	• Excessive up and down play in king pin	Replace
	• Center pin bushing worn	Replace

HOW THE BRAKES WORK



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A – Brake Cover
B – Brake Lever
C – Operating Cam
D – Anchor Pin
E – Brake Drum
F – Brake Shoe
G – Return Springs
H – Final Pinion Shaft

The brakes are internal expansion mechanical. Foot pressure expands the brake shoes (F) against the brake drums (E) to slow or stop the tractor. Each brake assembly is sealed to prevent water from entering the assembly.

The brake drums (E) are splined to individual pinion shafts (H) which are in mesh with the final drive gear. Brake shoes (F) are the leading-trailing type. The same amount of braking force is produced for both forward and reverse motion. The parking brake consists of a locking device coupled to the foot pedal.

The left and right brakes operate independently of each other of can be locked together to allow uniform braking action. Pressure against the foot pedals is transferred through the brake rod to the brake lever (B). Movement of the lever causes the brake cam shaft to rotate, expanding the brake shoes outward against the brake drum.

As the shoes are pressed against the drums, pinion rotation is retarded, which in turn stops or slows final drive gear rotation.

DIAGNOSING MALFUNCTIONS

PROBLEM	POSSIBLE CAUSE	SUGGESTED REMEDY
Brakes Do Not Work	• Oil soaked linings	Check for oil leak and repair (See page 60-15-6) Clean linings with chlorothane
	• Shoes heavily worn	Replace (See page 60-15-6)
	• Adjustment incorrect	Adjust (See page 60-05-5)
Uneven Brake Force from Left to Right	• Different amount of pedal play from right to left wheel	Adjust (See 60-15-5)
	• Oil soaked one side linings	Clean linings and repair
Vibration through Brake Pedals	• Faulty brake shoe springs	Replace (See 60-15-8)
	• Excessive or uneven brake shoe wear	Replace (See page 60-15-8)
	• Unever brake drum wear	Replace (See page 60-15-8)
	• Brake shaft rod worn	Replace (See page 60-15-4)
Brake Pedals Do Not Return	• Pedal return spring broke or worn	Replace (See page 60-15-4)

HYDRAULIC OPERATION AND TESTS 270

SPECIFICATIONS

General

ITEM	SPECIFICATIONS
Hydraulic Oil Capacity	
YM276	18.0 ℓ (4.76 U.S. gal.)
YM276D	18.5 ℓ (4.89 U.S.gal.)
Type of Oil	YTF 300 (See page 10-15-3 for equivalents)

Hydraulic Pump

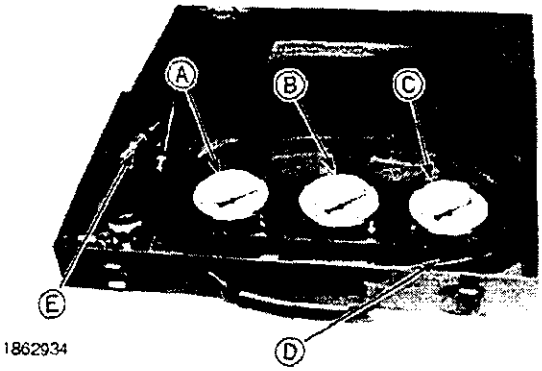
ITEM	SPECIFICATIONS
Hydraulic Pump Output at 2600 rpm	31.2 ℓ/min (8.24 GPM)
Pump Speed	
Maximum	3000 rpm
Minimum	500 rpm
Pump Pressure at 1000 rpm	12.3 MPa (125 kgf/cm^2) (1778 psi)

Hydraulic Lift and Implement Hitches

ITEM	SPECIFICATIONS
Pressure Relief Valve Setting	14.7 – 15.7 MPa (150 – 160 kg/cm^2) (2133 – 2275 psi)
Safety Valve (Surge Relief Valve) Setting	16.7 – 18.6 MPa (170 – 190 kg/cm^2) (2417 – 2702 psi)
Hydraulic Lift Cycle Time	2 seconds at 2600 rpm
Hydraulic Lifting Capacity	
At lower link end	650 kg (1433 lbs)
At 24 in. behind lower link end (SAE, OECD)	630 kg (1389 lbs)
Hydraulic Cylinder Leakage (during 5 minutes)	Less than 20 mm with 536 kg load on 610 mm behind lower link end (Less than 0.8 in. with 1182 lbs load on 24 in. behind lower link end)
Hydraulic Cylinder Displacement (DxL-Displacement)	80 x 89 mm – 0.447 ℓ (3.15 x 3.50 in. – 27.3 cu. in.)

SPECIAL TOOLS

Hydraulic Pressure Gauge Kit (TOL 91000000)



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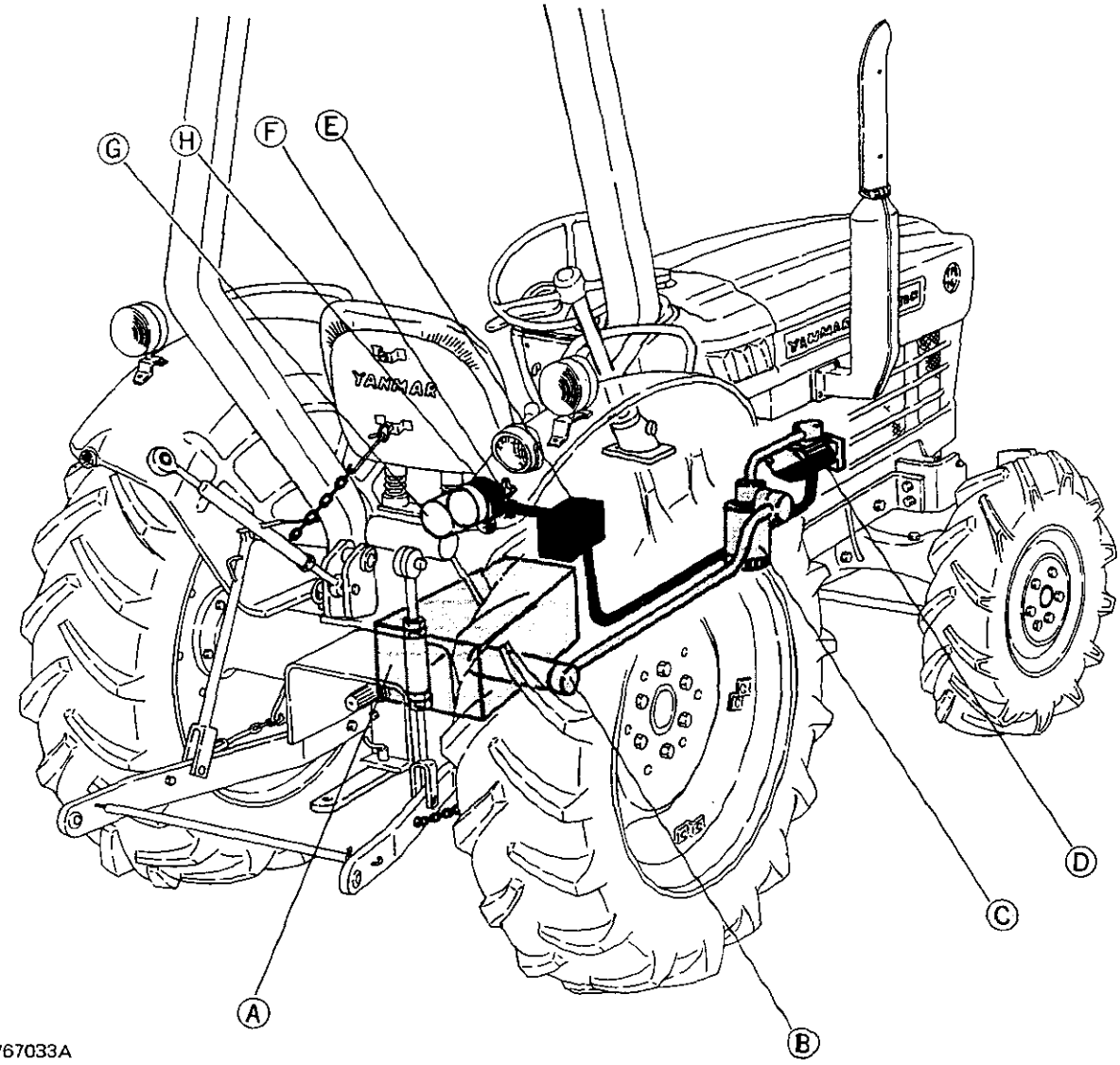
Pressure checking
- Hydraulic Lift System
- Engine Lubrication System

A – 0–250kg/cm²
B – 0–35 kg/cm²
C – 0–5 kg/cm²
D – Hose with Quick Coupler
E – Adapters with Quick Coupler

GENERAL



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A – Reservoir (Sump)
B – Filter Screen
C – Paper Cartridge Filter
D – Hydraulic Pump
E – Control Valve
F – Relief Valve
G – Lifting Cylinder
H – Safety Valve
-Pressurized Oil
-Pressure Free Oil

The hydraulic system of the tractor includes an oil reservoir (Transmission case) (A), filter screen (B), hydraulic oil filter (cartridge type) (C), hydraulic pump (D), hydraulic control valve (E), relief valve (F), hydraulic lift cylinder (G) and safety valve (H).

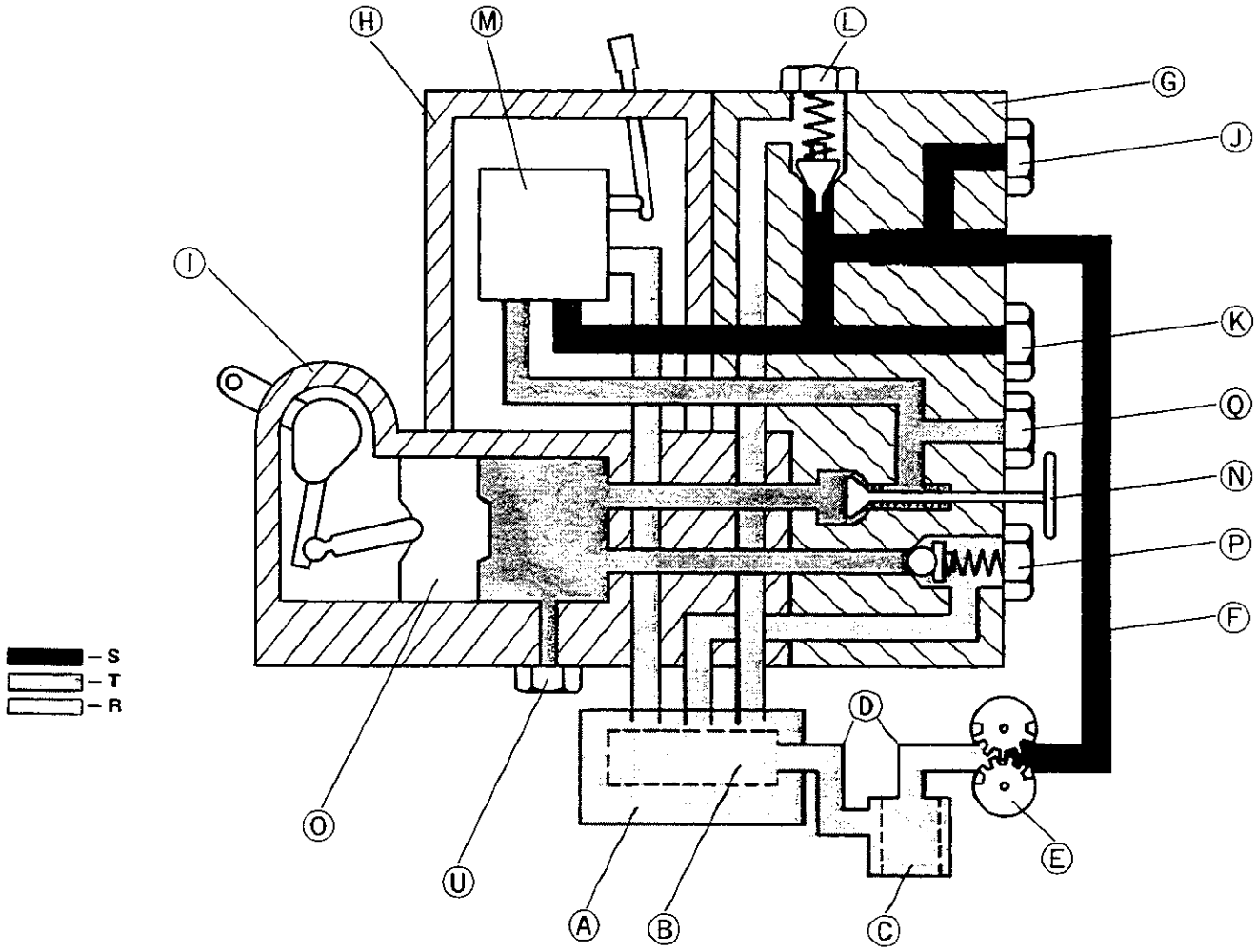
The transmission case serves as the hydraulic reservoir. A mesh screen in the filter housing, located on the bottom of the transmission case, filters the hydraulic oil.

A replaceable paper cartridge type filter, located on the hydraulic inlet line, further filters the hydraulic oil filtered by the mesh screen.

The hydraulic pump (D) draws oil through the two filters from the reservoir. The pump then feeds oil through the hydraulic cylinder head to the hydraulic control valve (E). A pressure relief valve (F) located in the hydraulic cylinder head protects the system from excessive oil pressure.

With the hydraulic control valve in neutral position, all oil flows through the valve to the reservoir. When the control valve is moved rearward to raise the hydraulic lift, oil is diverted to the hydraulic cylinder. Upon completion of the hydraulic lift operation, the valve is again neutralized and all oil is routed to the reservoir.

GENERAL(Continued)



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A – Reservoir
B – Filter Screen
C – Filter (Cartridge)
D – Suction Line
E – Hydraulic Pump
F – Pressure Line
G – Hydraulic Cylinder Head
H – Side Cover

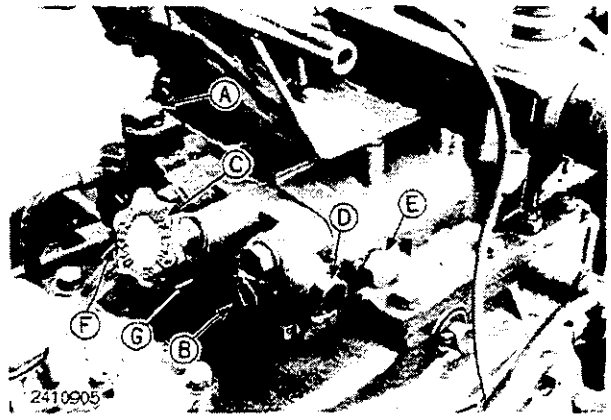
I – Hydraulic Cylinder Case
J – Auxiliary Outlet
K – Auxiliary Inlet
L – Main Relief Valve
M – Control Valve
N – Slow Return & Stop Valve
O – Hydraulic Piston

P – Safety Valve
Q – Auxiliary Outlet for Single Action Cylinder
R – Pressure Free Oil
S – Pressurized oil
T – Trapped Oil
U – Safety Valve Pressure Check Port

CYLINDER HEAD

The hydraulic cylinder head is located under the operator's seat in front of the hydraulic cylinder case. The hydraulic cylinder head has the following main parts:

- MAIN RELIEF VALVE
- SAFETY RELIEF VALVE
- SLOW RETURN & STOP VALVE
- AUXILIARY OUTLET FOR SINGLE ACTING CYLINDER
- AUXILIARY OUTLET & INLET FOR DOUBLE ACTING CYLINDER



A – Main Relief Valve
B – Safety Relief Valve
C – Slow Return & Stop Valve
D – Auxiliary Outlet (1) (for single action cylinder)
E – Safety Valve Pressure Check Port
F – Auxiliary Outlet for Double Action Cylinder
G – Auxiliary Inlet for Double Action Cylinder

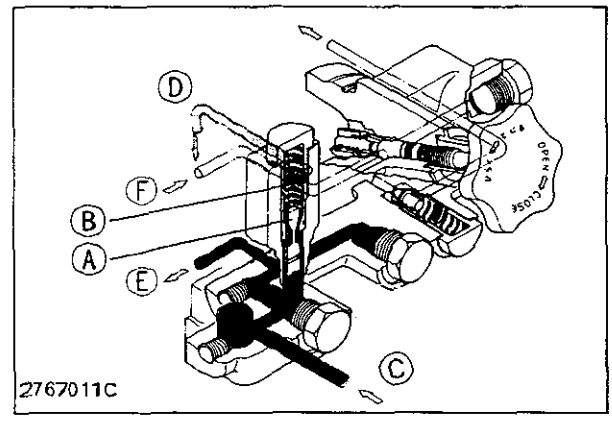
PRESSURE RELIEF VALVES

Relief valves are used to protect the hydraulic system from damage due to high pressure caused by; blockage in the system, temperature expansion of the oil or excessive implement weight. All relief valves described below operate in the same way.

The tractor has two relief valves, a main relief valve located in the hydraulic cylinder head and a safety relief valve (surge relief valve) also located in the cylinder head. The main relief valve releases at 14.7–15.7 MPa (150–160 kg/cm^2) (2133–2275 psi). The safety relief valve releases at 16.7–18.6 MPa (170–190 kg/cm^2) (2417–2702 psi). The valves, if opened, return oil to the reservoir.

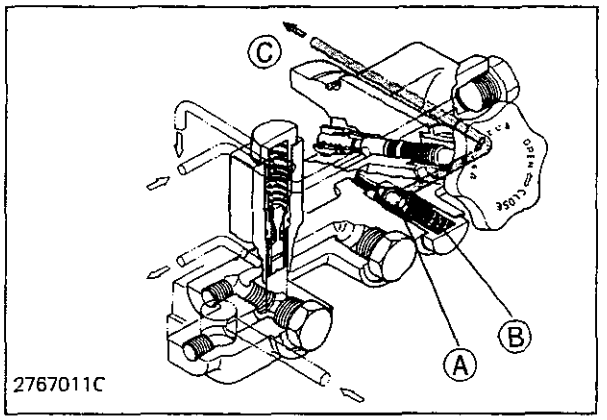
Main Relief Valve

The main relief valve is located in the cylinder head. This is the first valve oil reaches after it leaves the hydraulic pump. If pressure in the system becomes greater than the specified value, the relief valve poppet moves off its seat, allowing oil to return to the reservoir. This valve maintains normal oil flow in the hydraulic system, and protects hydraulic components from excessive pressure.



A – Main Relief Valve
B – Spring
C – from Pump
D – To Reservoir
E – To Control Valve
F – From Control Valve
– Pressurized Oil
– Pressure Free Oil

CYLINDER HEAD(Continued)



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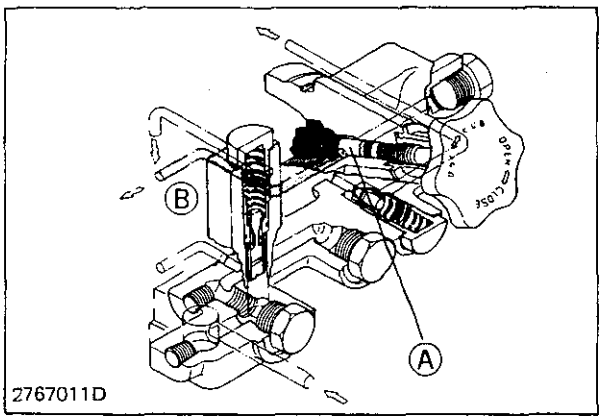
Safety Relief Valve

The safety relief valve (A) is located in the cylinder head. With the stop valve open or closed, the safety relief valve protects the hydraulic lift assembly from extreme pressure due to heavy implement bounce. If pressure becomes too great, oil pressure forces the poppet off its seat, allowing oil to return to the reservoir.

A — Safety Relief Valve
B — Spring
C — To Reservoir
■ -Pressurized Oil
□ -Pressure Free Oil



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SLOW RETURN & STOP VALVE

A slow return and stop valves are located in the cylinder head. It controls the rate of oil flowing from the hydraulic cylinder to the reservoir and by turning the knob clockwise completely until it stops the hydraulic cylinder can be isolated from the hydraulic system.

By turning the knob counterclockwise, the valve opens and allows faster oil flow which lowers the lift arm faster.

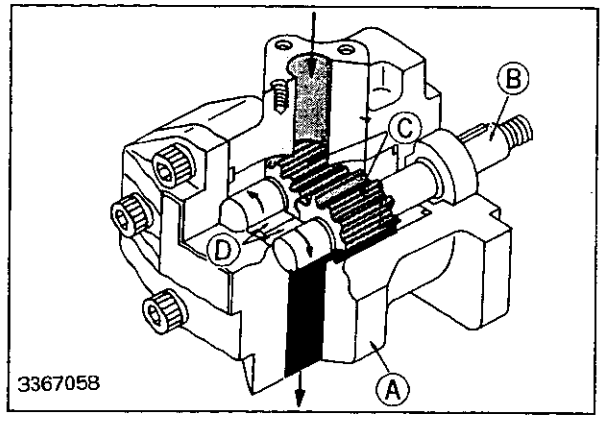
The stop valve may be used to hold the lift arms in raised position by first setting the lift arms to the desired position then turning the stop valve clockwise until it seats. The oil in the hydraulic cylinder is then trapped between the piston and stop valve. This trapped oil holds the lift arms in position.

A — Slow Return & Stop Valve
B — Returning Oil Flow from Cylinder
■ -Pressurized Oil
□ -Pressure Free Oil

HYDRAULIC PUMP

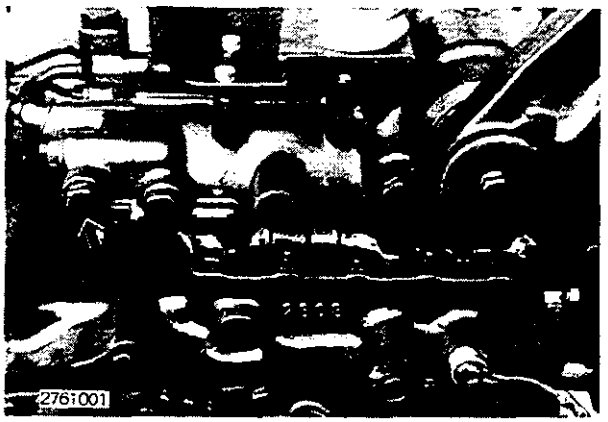
The hydraulic pump is a positive displacement gear pump that pumps a fixed volume of hydraulic fluid with every revolution of the drive shaft. The only way to change the pump output is to change the speed of the drive shaft.

Inside the housing (A) are two gears (C) meshed together with minimum clearances between themselves and the walls of the chamber. This tight fit effectively divides the pump chamber in two: the inlet and outlet chambers. As the drive shaft (B) rotates the gear attached to it—which, in turn, rotates the other one—the grooves in the gear teeth trap hydraulic fluid and carry it around to the outlet chamber.



Once there, the hydraulic fluid has nowhere to go but through the outlet port. It cannot go full circle because the gear teeth mesh with the opposing gear. Each turn of the gears brings more fluid into the outlet chamber. The pressure soon builds up high enough to force the fluid through the system.

A – Hydraulic Pump Housing
B – Drive Shaft
C – Gears
D – Bushings
– Pressurized Oil
– Pressure Free Oil

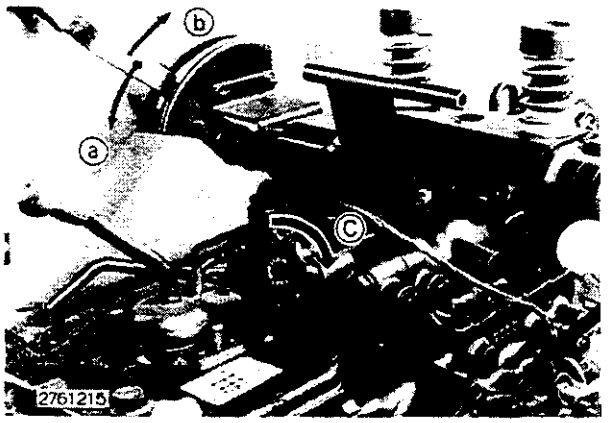


AUXILIARY OUTLET [I]

(For Single Action Cylinder)

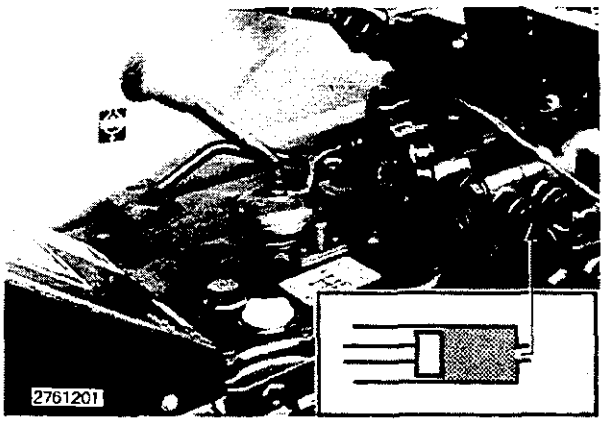
There is an outlet on the left side of the hydraulic cylinder head which permits the operation of a remote, single action cylinder — for example, in a dump trailer — with the lever located on the right side of the operator's seat. Simply connect the cylinder's hydraulic line to this port with an adapter.

Adapter: 3/4-16UNF-2B



1) Adjusting Position Control Lever

a) Place position control lever all the way forward.
b) Pull the position control lever slowly rearward until the lower link is horizontal.
c) Close the stop valve.



2) Extending the Cylinder

Move the control lever rearward. The cylinder will continue to extend until the piston reaches the end of its stroke or the control lever is returned manually to the neutral position.

3) Retracting the Cylinder

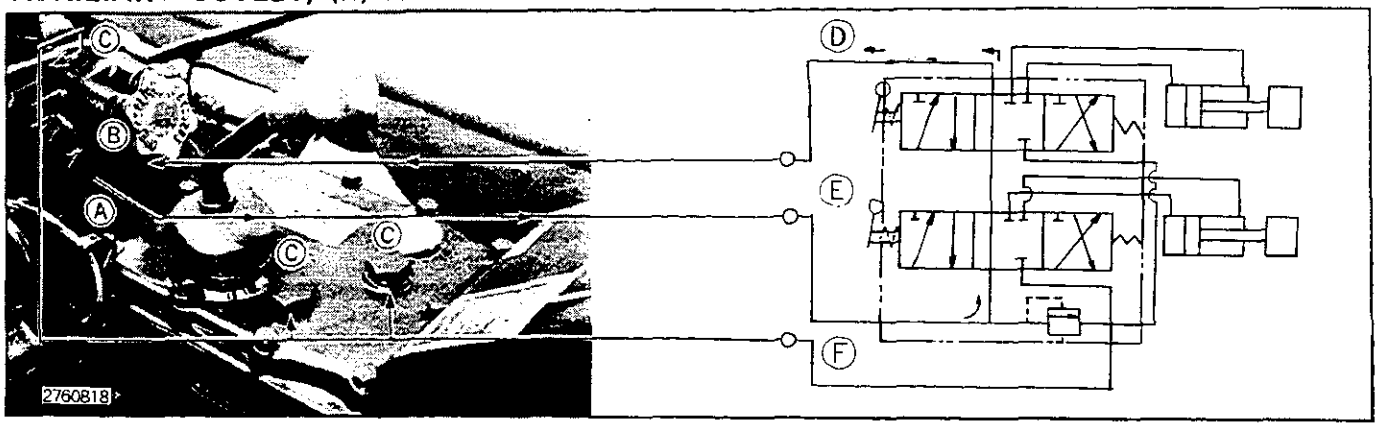
Move the lever forward. The cylinder will continue to retract until the piston reaches the end of its stroke or the control lever is returned manually to the neutral position.

The 3-point hich cannot be used when the tractor's control lever is being used to operate a remote cylinder.

⚠ CAUTION: The hydraulic system on this tractor can withstand a maximum pressure of 14.7–15.7 MPa (150–160 kg/cm^2) (2133–2275 psi). This may exceed the capability of some remote cylinders so check the manufacturer's specifications before connecting.

⚠ CAUTION: When using the auxiliary outlet, the slow return valve of tractor is inoperable as the valve must remain in the stop position.

AUXILIARY OUTLET, (II) AND RELATED PORTS

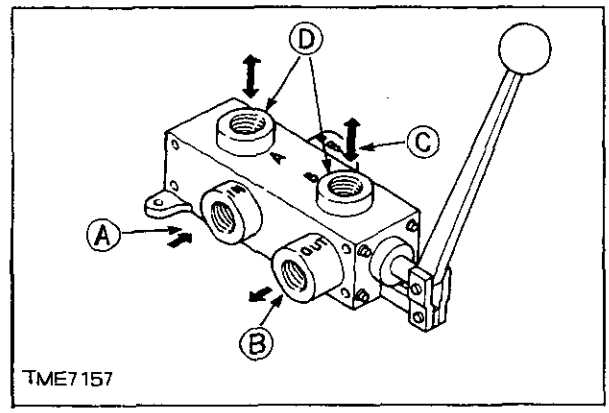


A – Outlet Port
B – Inlet Port
C – Oil Return Ports
D – PBY Port
E – IN on Control Valve
F – OUT on Control Valve

AUXILIARY VALVE

The auxiliary valve should have five ports (IN (A), OUT (B), PBY (C), (D) and (B)), or a selector valve. The hydraulic return line from the "T" or the "OUT" port of the auxiliary valve must be connected to the return oil plug (3/4-16UNF–2B with O-ring).

A – From Pump
B – To Reservoir
C – To Pump Port of Other Valve
D – To (or from) Cylinders

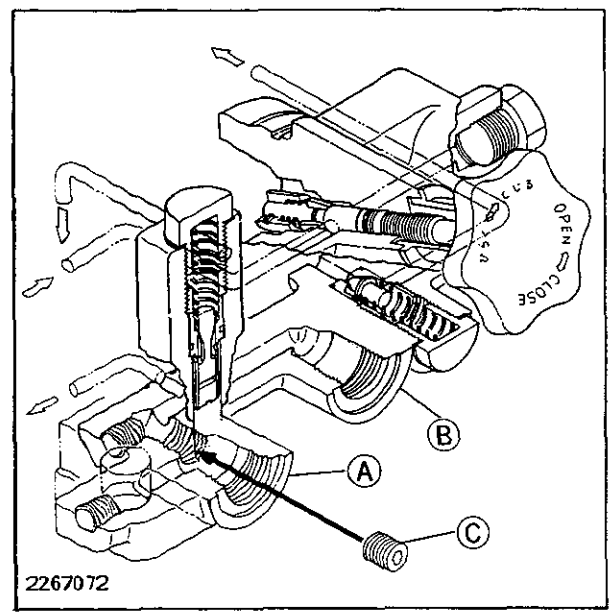


When using these ports for implements, passage in the hydraulic cylinder head outlet (A: Pump side) and Inlet ports (B: Hydraulic lift side) must be blocked with the headless plug (C) (1/4-18 NPTF) supplied with the implement.

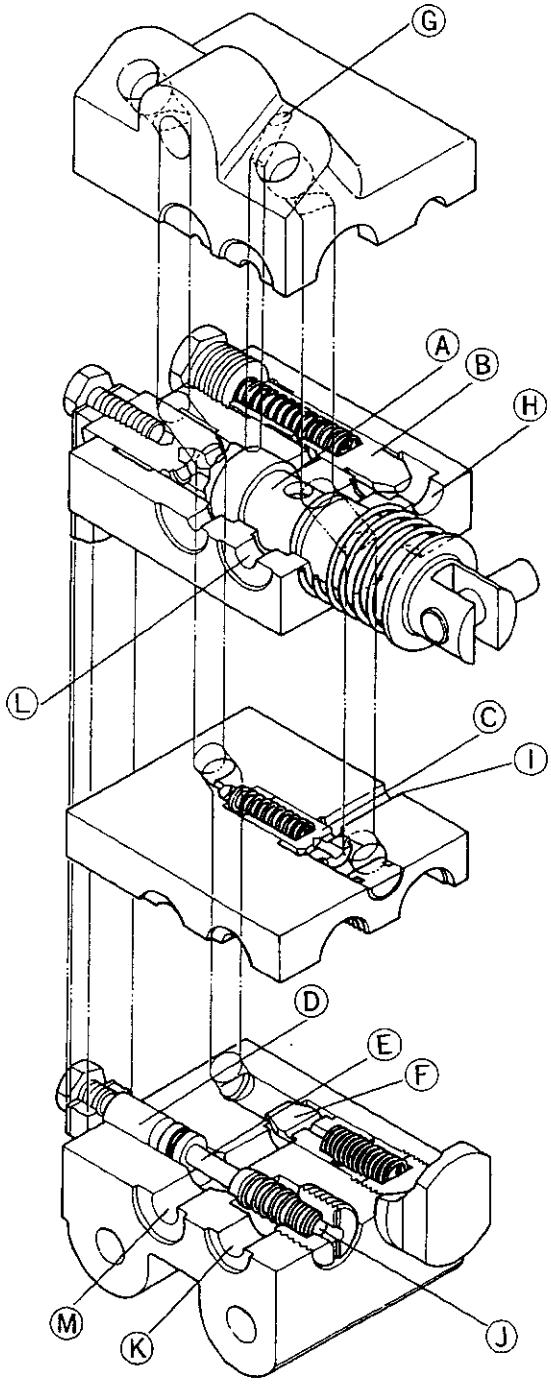
CAUTION: Always remove this plug (C) when disconnecting the implements hydraulic lines from the outlet ports (A); leaving it in place may damage the hydraulic pump.

CAUTION: The volume of hydraulic fluid available to extend the remote cylinder is limited. Check the oil level in the transmission case when the cylinder is fully extended. It should not be below the end of the dipstick.

A – Outlet Port
B – Inlet Port
C – Plug, 1/4-18 NPTF



CONTROL VALVE



2767007A

The control valve is located in the side cover.
The main spool, moved by the control lever, regulates oil flow, thus raising or lowering the lift arm.

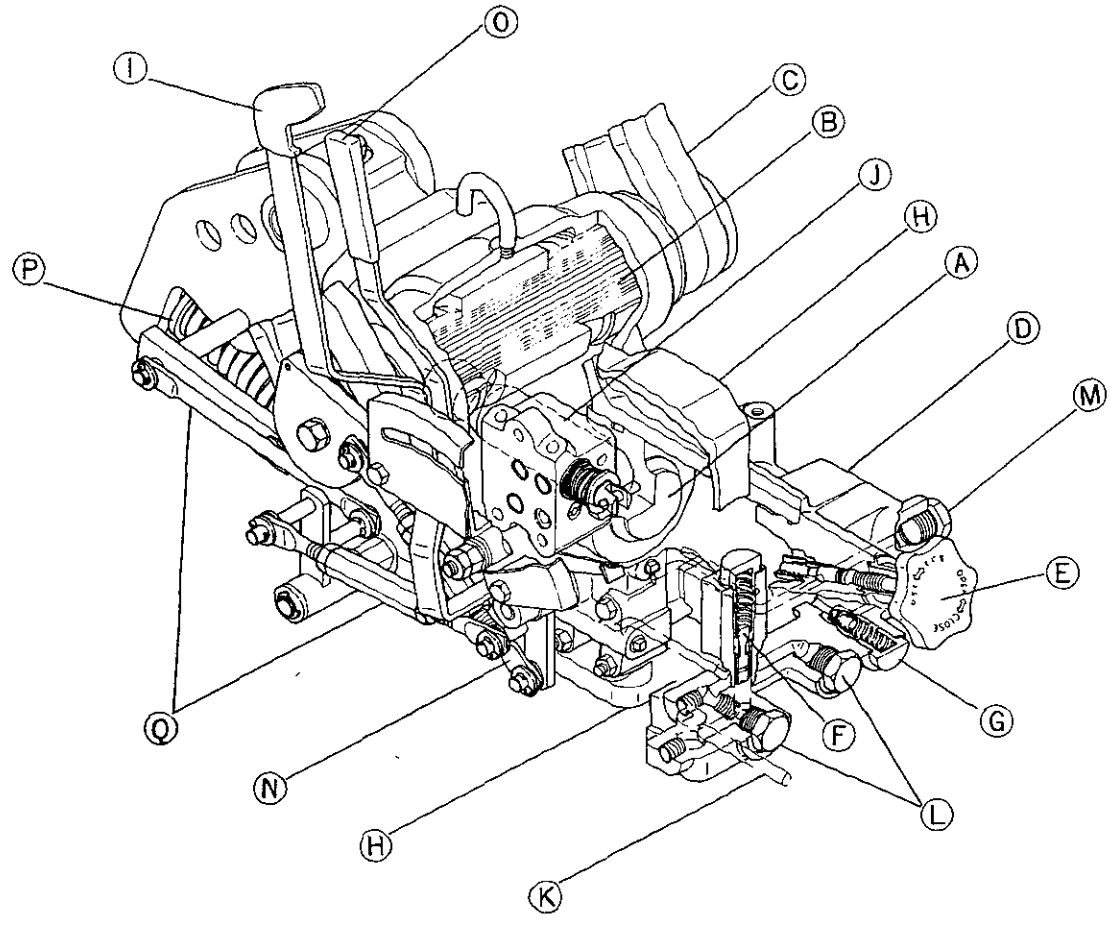
Flow control valve (C) minimizes shock at end of lift arm movement.

Check valve (E) is pushed by rod (D) allowing oil to return from the cylinder to the reservoir when lift arm is lowered.

For valve positions for neutral and raising and lowering of lift arm see chapter 270-10.

A – Main Spool
B – Unload Valve
C – Flow Control Valve
D – Push Rod
E – Check Valve
F – Load Check Valve
G ~ K – Oil Return Outlets
L – Oil Inlet from Pump
M – Oil Port from/to Cylinder

GENERAL



2767006

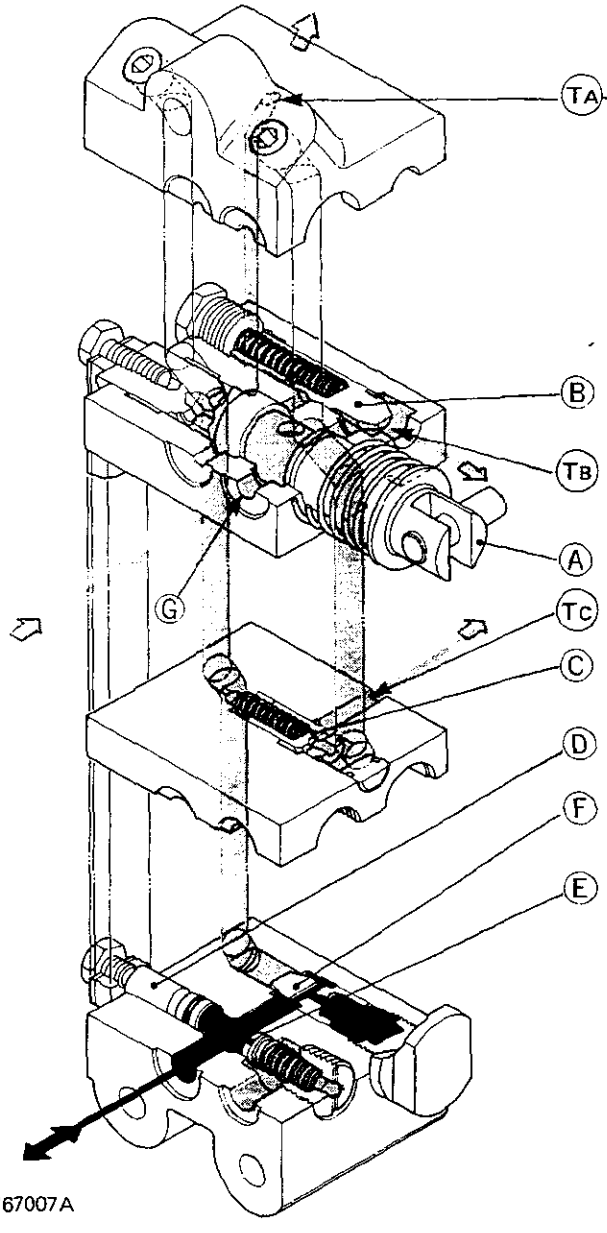
A – Hydraulic Piston
B – Lifting Shaft
C – Lift Arm
D – Cylinder Head
E – Slow Return & Stop Valve
F – Main Relief Valve
G – Safety Valve
H – Hydraulic Cylinder Case
I – Position Control Lever
J – Control Valve
K – Pressure Line
L – Auxiliary Outlet/Inlet Plug
M – Outlet Plug
N – Position Feedback Rod
O – Draft Control Lever
P – Draft Sensing Spring
Q – Draft Feedback Rod

This figure shows the main components of the hydraulic lift. The operator directs the flow of hydraulic fluid through the control lever (I) attached to the control valve (J). In the "raise" position, the control valve allows pressurized hydraulic fluid to enter the cylinder (H), pushing the piston rod which rotates the lifting shaft (B) and raises the lift arms (C). In the "lower" position, the valve (J) simply relieves the pressure on the cylinder, allowing the weight of the implement or hitch to force the fluid inside the cylinder back into the transmission case (reservoir). The control valve spool regulates the flow into the hydraulic cylinder while the "slow return" valve (E) limits the lift's lowering speed.

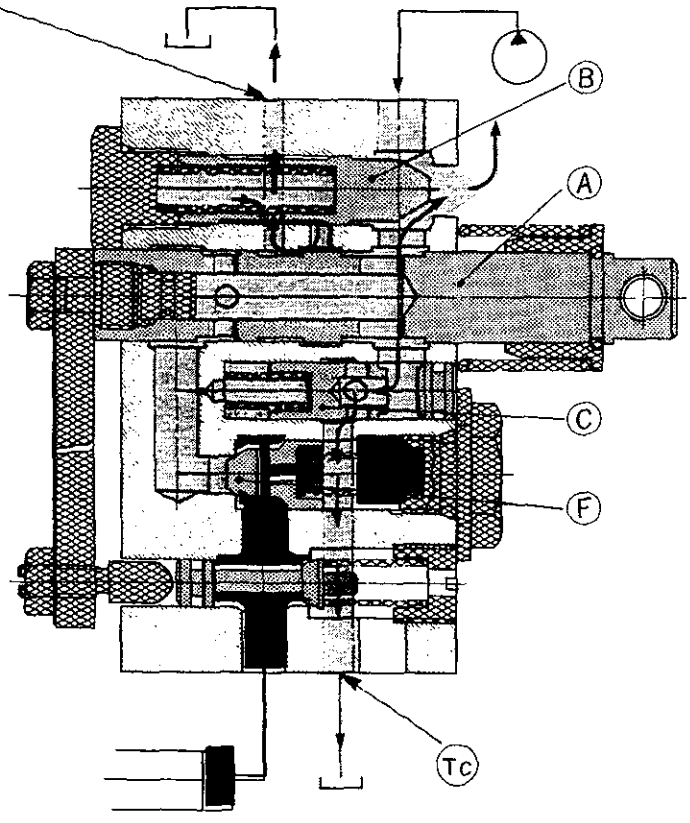
The hydraulic lift assembly also has a safety relief valve (G) and a stop valve (E). The former protects the hydraulic system from sudden excessive pressure caused by a jolt to the equipment. The latter allows the operator to isolate the hydraulic lift from the hydraulic system—in any position desired.

The 3-point hitch is desigend for Category 1 implements. The hitch consists of lower links, lift links, upper link, and check chains.

POSITION CONTROL OPERATION



2767007A



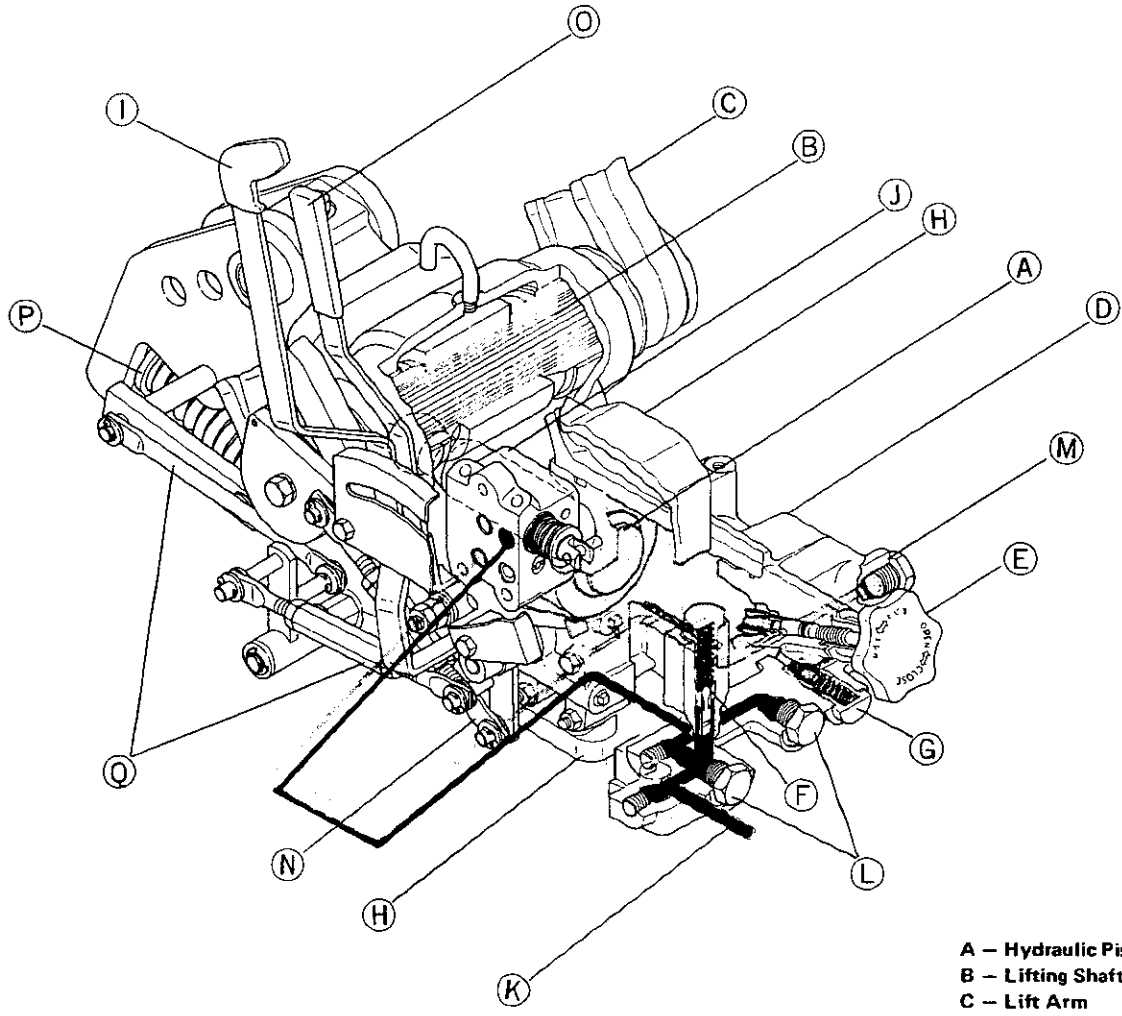
1807012

A – Main Spool
B – Unload Valve
C – Flow Control Valve
D – Push Rod
E – Mechanical Check Valve
F – Load Check Valve
G – Oil Inlet from Pump
T_A – To reservoir
T_B – To reservoir
T_C – To reservoir
– Pressure Free Oil
– Trapped Oil

NEUTRAL (OIL FLOW IN CONTROL VLAVE)

When the main spool (A) is first moved into the NEUTRAL position, the pressurized hydraulic fluid behind the unload valve (B) flows through the groove in the spool to return to the transmission case through the hole (TA) in the top of the valve housing. As the pressure is relieved the unload valve (B) closes its port to the transmission case (TB), routing the still pressurized hydraulic fluid through the flow control valve (C) and the opening (TC) back to the transmission case.

The load check valve (F) and mechanical check valve (E) stay in position which seals off the cylinder circuits and traps fluid in the hydraulic cylinder.

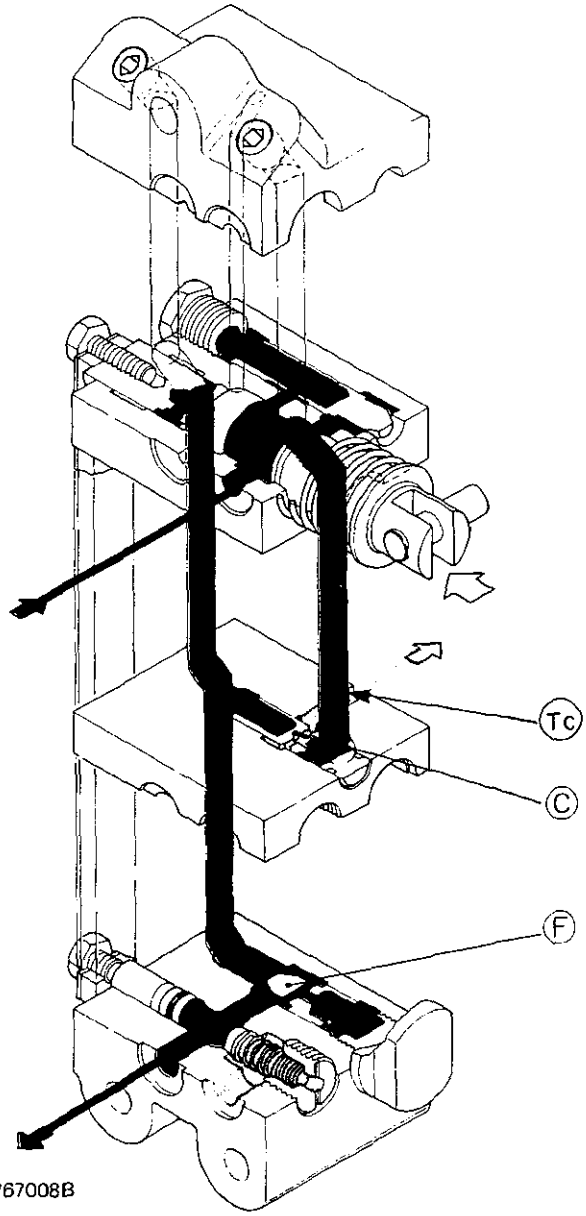


2767006A

NEUTRAL
(OIL FLOW IN HYDRAULIC SYSTEM)

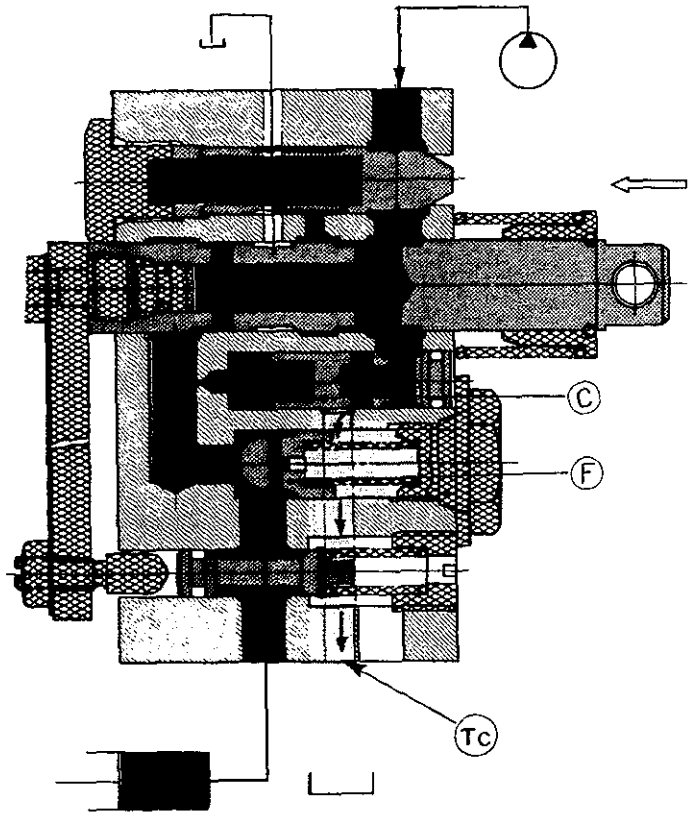
A – Hydraulic Piston
B – Lifting Shaft
C – Lift Arm
D – Cylinder Head
E – Slow Return & Stop Valve
F – Main Relief Valve
G – Safety Valve
H – Hydraulic Cylinder Case
I – Position Control Lever
J – Control Valve
K – Pressure Line
L – Auxiliary Outlet/Inlet Plug
M – Outlet Plug
N – Position Feedack Rod
O – Draft Control Lever
P – Draft Sensing Spring
Q – Draft Feedback Rod
– Pressurized Oil
– Pressure Free Oil
– Return Oil
– Trapped Oil

POSITION CONTROL OPERATION
(Continued)



2767008B

C – Flow Control Valve
F – Load Check Valve
TC – To Reservoir
– Pressure Free Oil
– Pressurized Oil

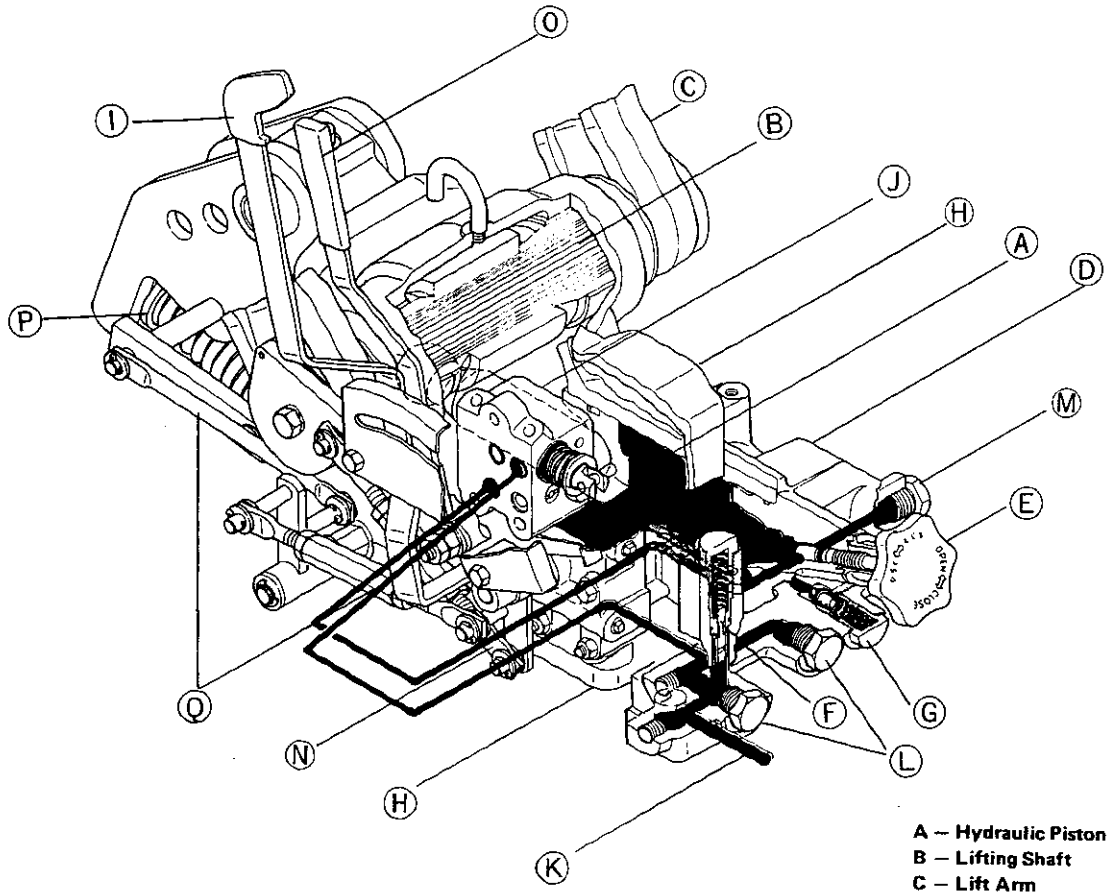


1807012A

SLOW RAISE
(OIL FLOW IN CONTROL VALVE)

Gradually shifting the control lever to the rear allows pressurized hydraulic fluid to flow into the chamber on both sides of the piston of flow control valve (C). The flow to the rear chamber is greater, producing a pressure difference which opens the valve allowing fluid into the hydraulic cylinder. When the pressures on the valve equalize, some of the fluid is allowed to escape through a port (TC) and flow back into the transmission case. This division of the flow from the pump reduces the speed of cylinder operation, slowing the speed at which the lift arms raise, and thus permitting finer implement control.

Even though the raising speed may be lower, the pressure is still sufficient to open the check valve (F) and allow the pressurized hydraulic fluid to flow into the cylinder.

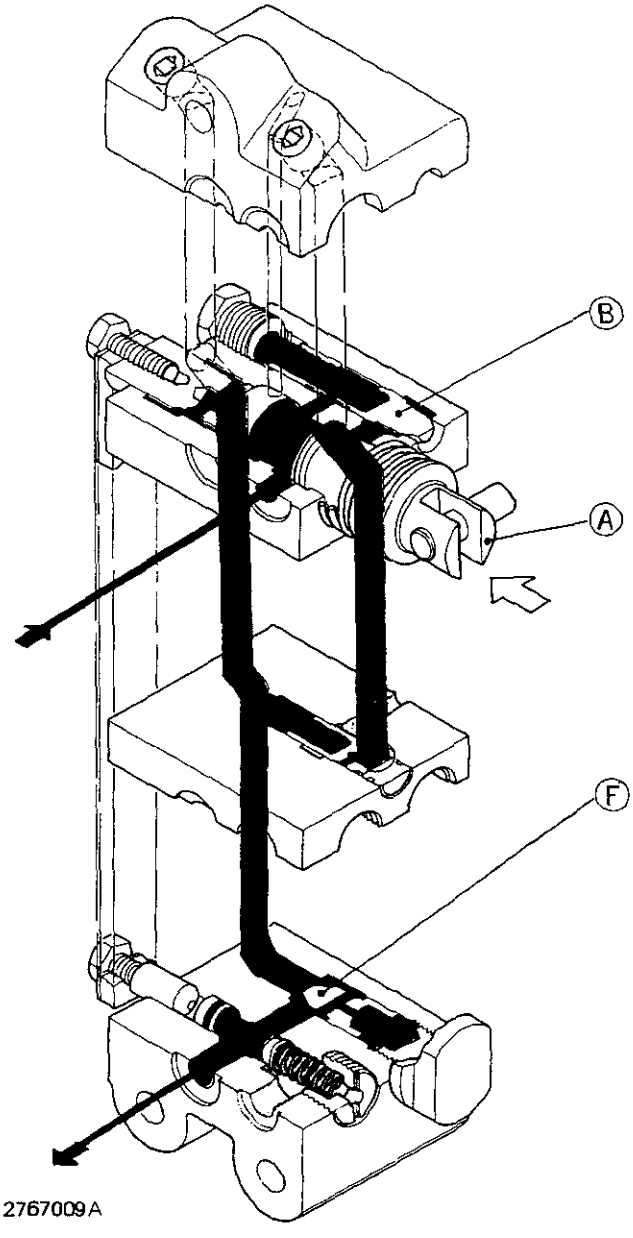


2767006C

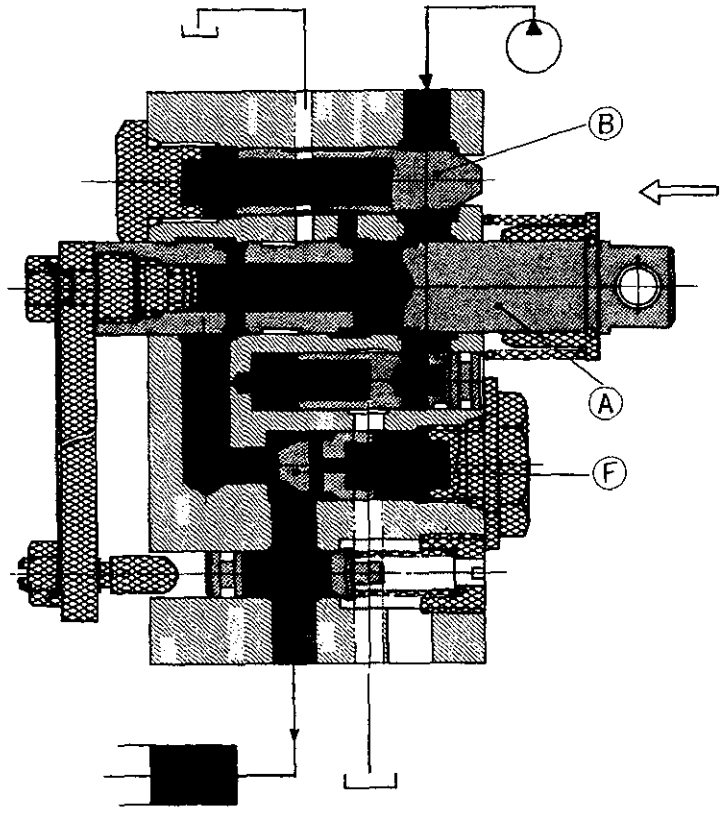
SLOW RAISE
(OIL FLOW IN HYDRAULIC SYSTEM)

A – Hydraulic Piston
B – Lifting Shaft
C – Lift Arm
D – Cylinder Head
E – Slow Return & Stop Valve
F – Main Relief Valve
G – Safety Valve
H – Hydraulic Cylinder Case
I – Position Control Lever
J – Control Valve
K – Pressure Line
L – Auxiliary Outlet/Inlet Plug
M – Outlet Plug
N – Position Feedback Rod
O – Draft Control Lever
P – Draft Sensing Spring
Q – Draft Feedback Rod
– Pressurized Oil
– Pressure Free Oil
– Return Oil
– Trapped Oil

POSITION CONTROL OPERATION (Continued)



2767009A

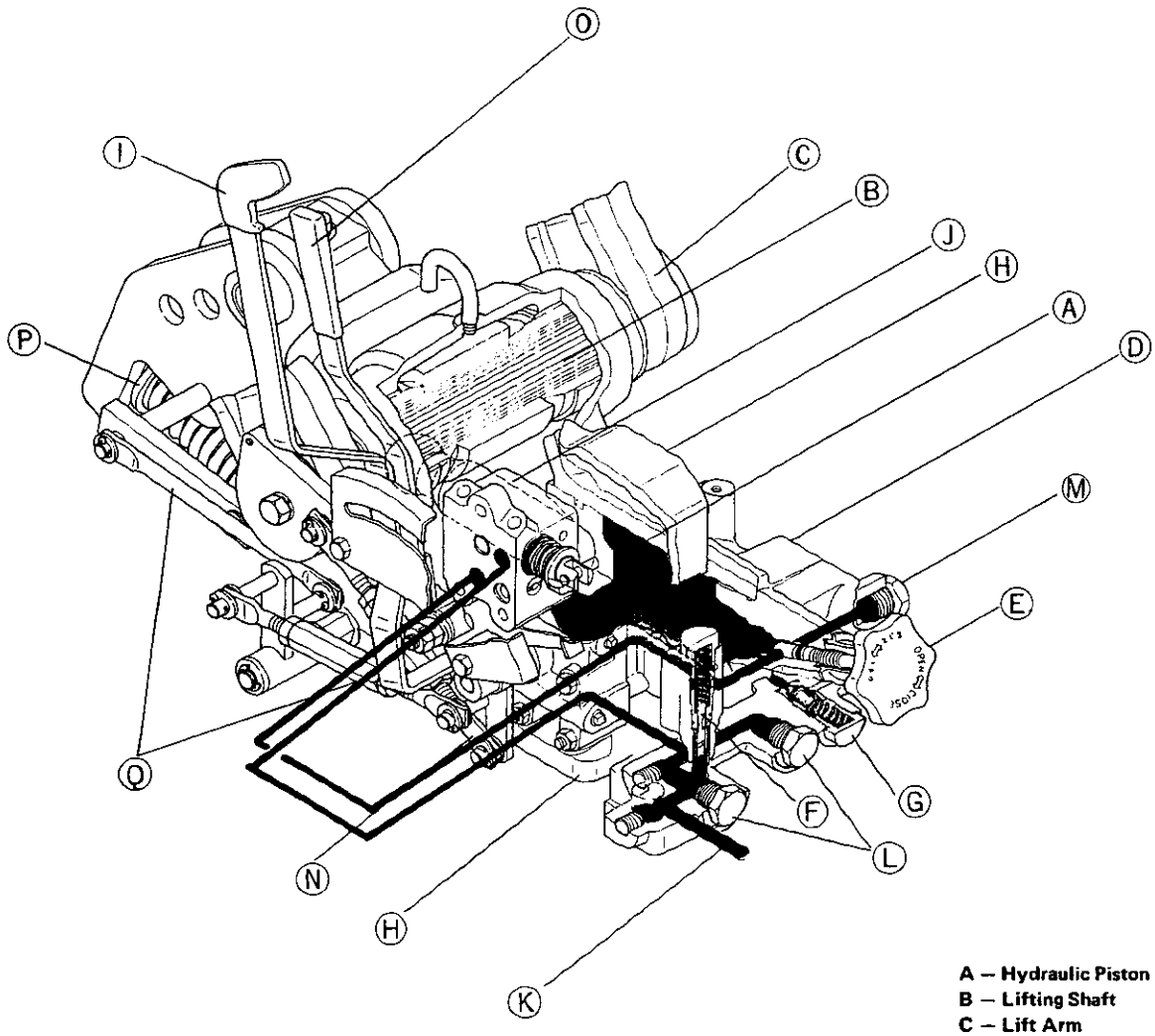


1807012B

A – Main spool
B – Unload vlave
F – Load Check Valve
– Pressure Free Oil
– Pressurized Oil

RAISE (OIL FLOW IN CONTROL VALVE)

Moving the control lever all the way to the rear forces the main spool (A) into the control valve housing. Hydraulic pressure then activates the unload valve (B) closing off its return port. With maximum pump pressure now on the load check valve (F), the valve is forced open and hydraulic fluid is allowed to enter the cylinder. This fluid forces the piston to the rear, raising the lift arms.

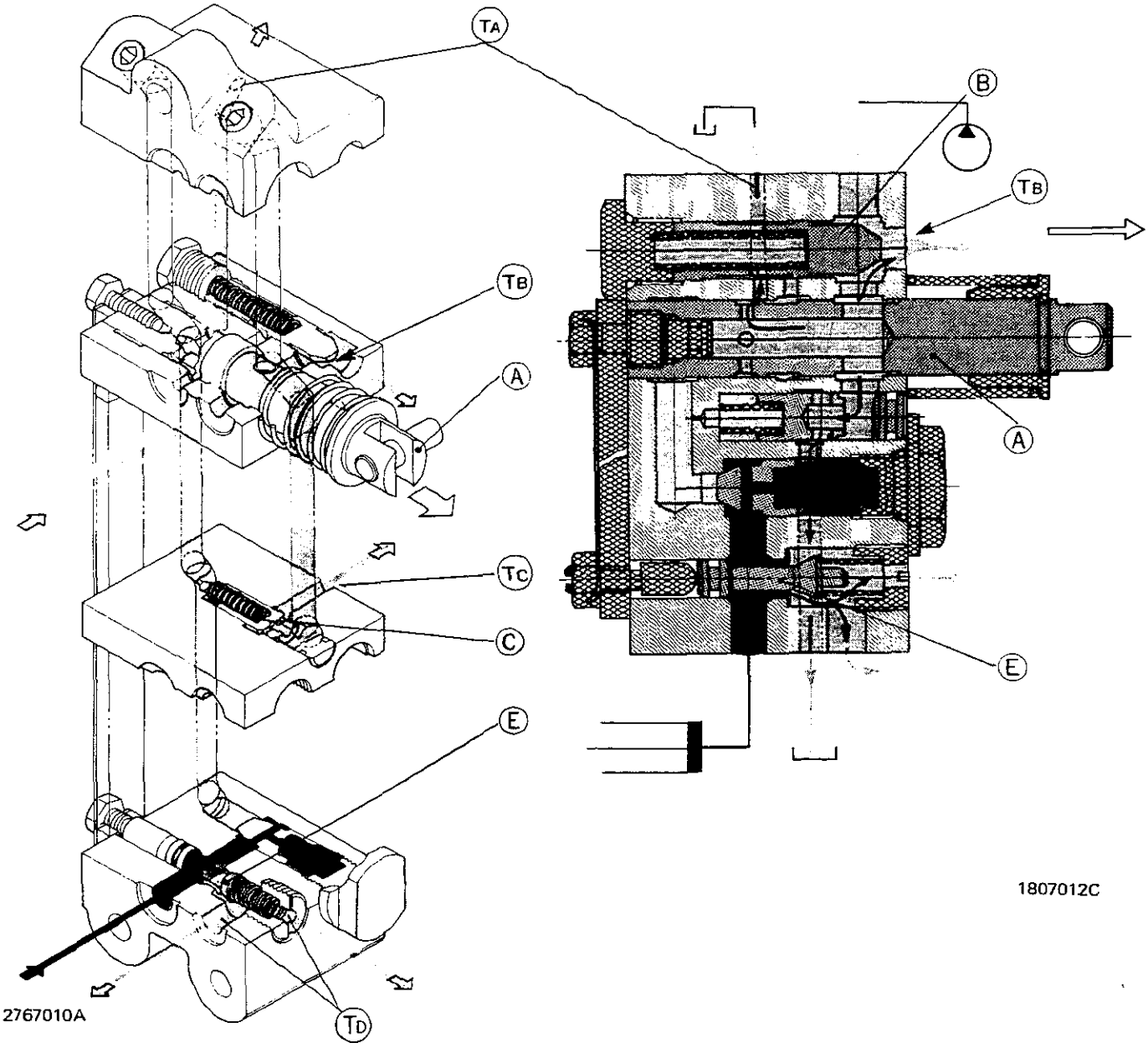


2767006B

RAISE
(OIL FLOW IN HYDRAULIC SYSTEM)

A – Hydraulic Piston
B – Lifting Shaft
C – Lift Arm
D – Cylinder Head
E – Slow Return & Stop Valve
F – Main Relief Valve
G – Safety Valve
H – Hydraulic Cylinder Case
I – Position Control Lever
J – Control Valve
K – Pressure Line
L – Auxiliary Outlet/Inlet Plug
M – Outlet Plug
N – Position Feedback Rod
O – Draft Control Lever
P – Draft Sensing Spring
Q – Draft Feedback Rod
– Pressurized Oil
– Pressure Free Oil
– Return Oil
– Trapped Oil

POSITION CONTROL OPERATION (Continued)



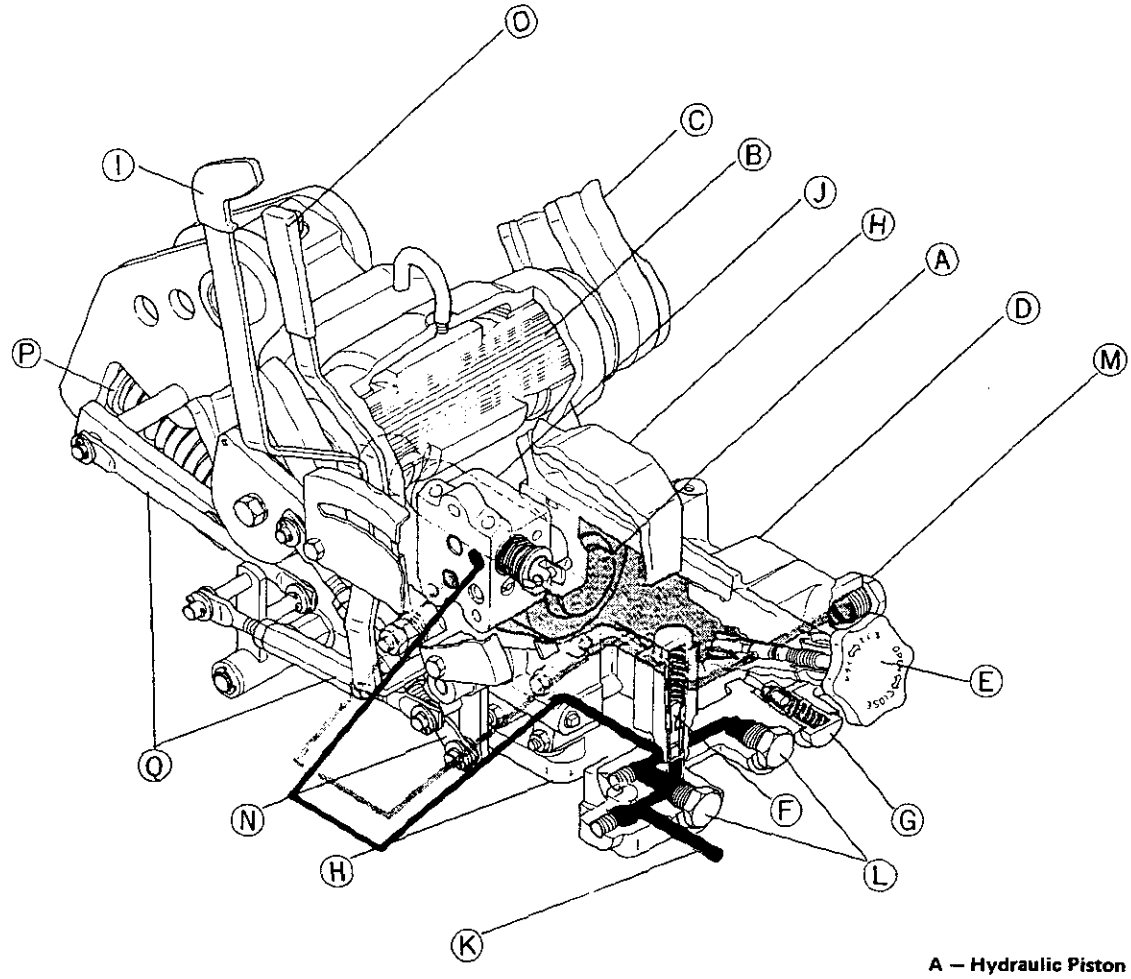
2767010A

1807012C

A – Main Spool
B – Unload Valve
E – Mechanical Check Valve
T_A – Return port
T_B – To reservoir
T_C – To reservoir
T_D – To reservoir
– Pressure Free Oil
– Pressurized Oil
– Trapped oil

LOWER (OIL FLOW IN CONTROL VALVE)

Shifting the control lever forward pulls the main spool (A) out of the control valve housing and presses the push rod against the mechanical check valve (E). This position of the main spool allows the pressurized fluid behind the unload valve (B) to flow through the return port (TB). Similarly, the pressurized fluid from the pump flows back into the transmission case through the return port (TA).

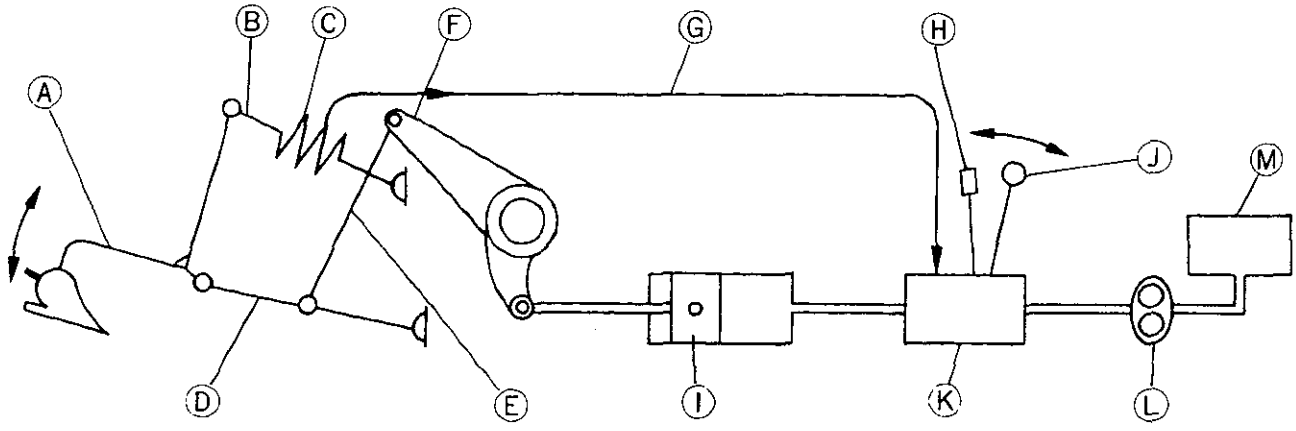


2767006D

LOWER
(OIL FLOW IN HYDRAULIC SYSTEM)

A – Hydraulic Piston
B – Lifting Shaft
C – Lift Arm
D – Cylinder Head
E – Slow Return & Stop Valve
F – Main Relief Valve
G – Safety Valve
H – Hydraulic Cylinder Case
I – Position Control Lever
J – Control Valve
K – Pressure Line
L – Auxiliary Outlet/Inlet Plug
M – Outlet Plug
N – Position Feedback Rod
O – Draft Control Lever
P – Draft Sensing Spring
Q – Draft Feedback Rod
– Pressurized Oil
– Pressure Free Oil
– Return Oil
– Trapped Oil

HOW DRAFT CONTROL WORKS



A – Implement (Plow etc.)
B – Upper Link
C – Draft Sensing Spring
D – Lower Link
E – Lift Links
F – Lift Arm
G – Feedback Mechanism
H – Draft Control Lever
I – Hydraulic Cylinder
J – Position Control Lever
K – Control Valve
L – Hydraulic Pump
M – Reservoir

The hydraulic systems of these tractors are equipped with a draft control system. The purpose of this system is to maintain constant implement height during operation.

The draft force applied to the implement (A) is transmitted to the upper link (B), causing the sensing spring (C) to compress. The change in angle caused by the sensing spring's compression activates a series of control rods (G) which in turn activate the control valve (K). The implement is thus raised or lowered to correspond with the settings of the position control lever (J) and the draft control lever (H).

When the draft force becomes too great for the draft control lever setting, the control valve is switched into the "raise" position, feeding hydraulic fluid to the hydraulic cylinder (I) raising the lift arms (F), thus the implement. As the implement is raised, the draft force is correspondingly reduced until the control valve is returned to the "neutral" position.

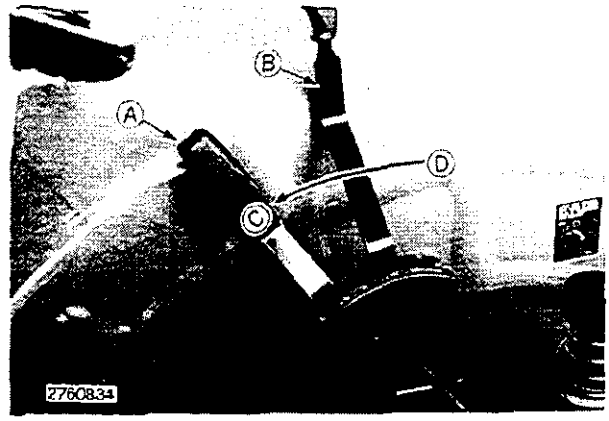
When the draft force becomes too small for the draft control lever setting, the control valve is switched into the "lower" position, returning oil to the sump (M) lowering the lift arms, thus the implement. As the implement is lowered the draft force is correspondingly increased until the control valve is returned to the "neutral" position.

In this way the control valve is maintained in a "neutral" position for each setting of the control levers and constant draft force is maintained.

DRAFT SENSING ADJUSTMENT

Draft control is determined by the settings at the draft control lever (A), the position control lever (B) and the location of the upper link.

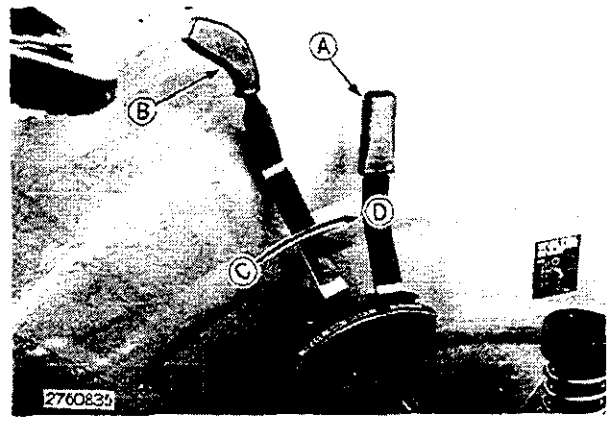
A – Draft Control Lever
B – Position Control Lever
C – Dull Control (Large Draft)
D – Sensitive Control (Small Draft)



1. Draft Control Lever

If the draft control lever (A), is placed in the forward position, the controlled draft is large.

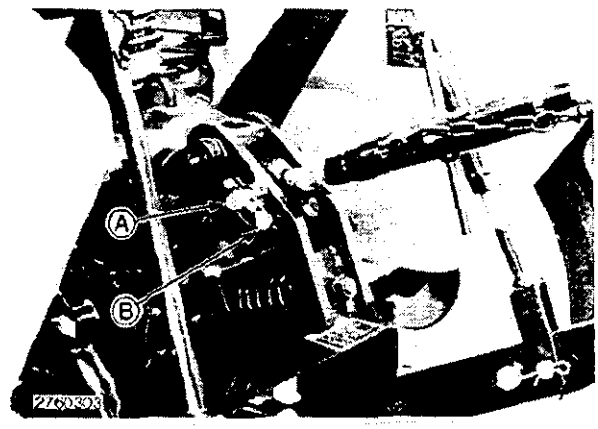
If the draft control lever (A), is placed in the rear position, the controlled draft is small.



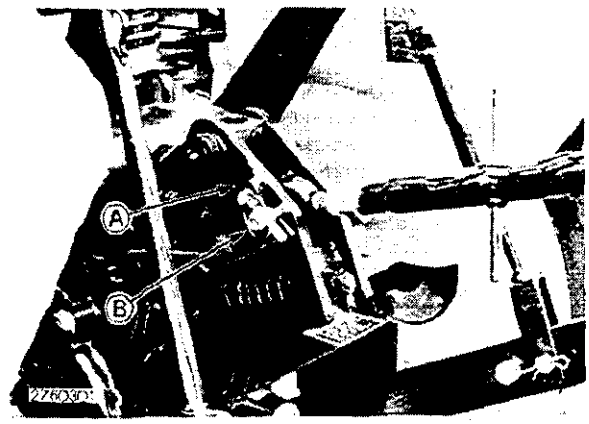
2. Upper Link Location

The degree of sensitivity is determined by positioning the upper link in the upper or lower hole of the sensing spring bracket. For maximum sensitivity, place upper link in lower hole (B). For minimum sensitivity, place upper link in top hole (A).

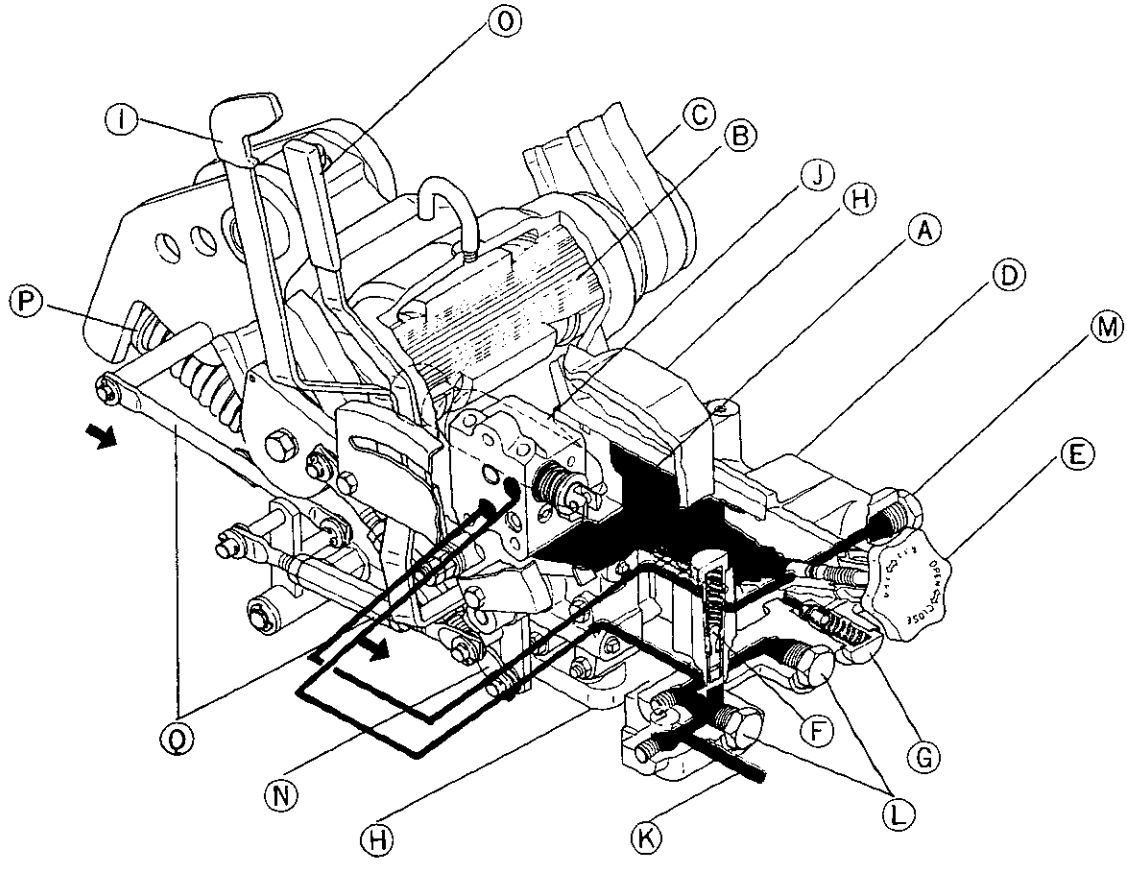
When the upper link is set in the upper position, more load change is required for automatic adjustment.



When the upper link is set in the lower position, less load change is required for automatic adjustment.



DRAFT CONTROL OPERATION



2767006E

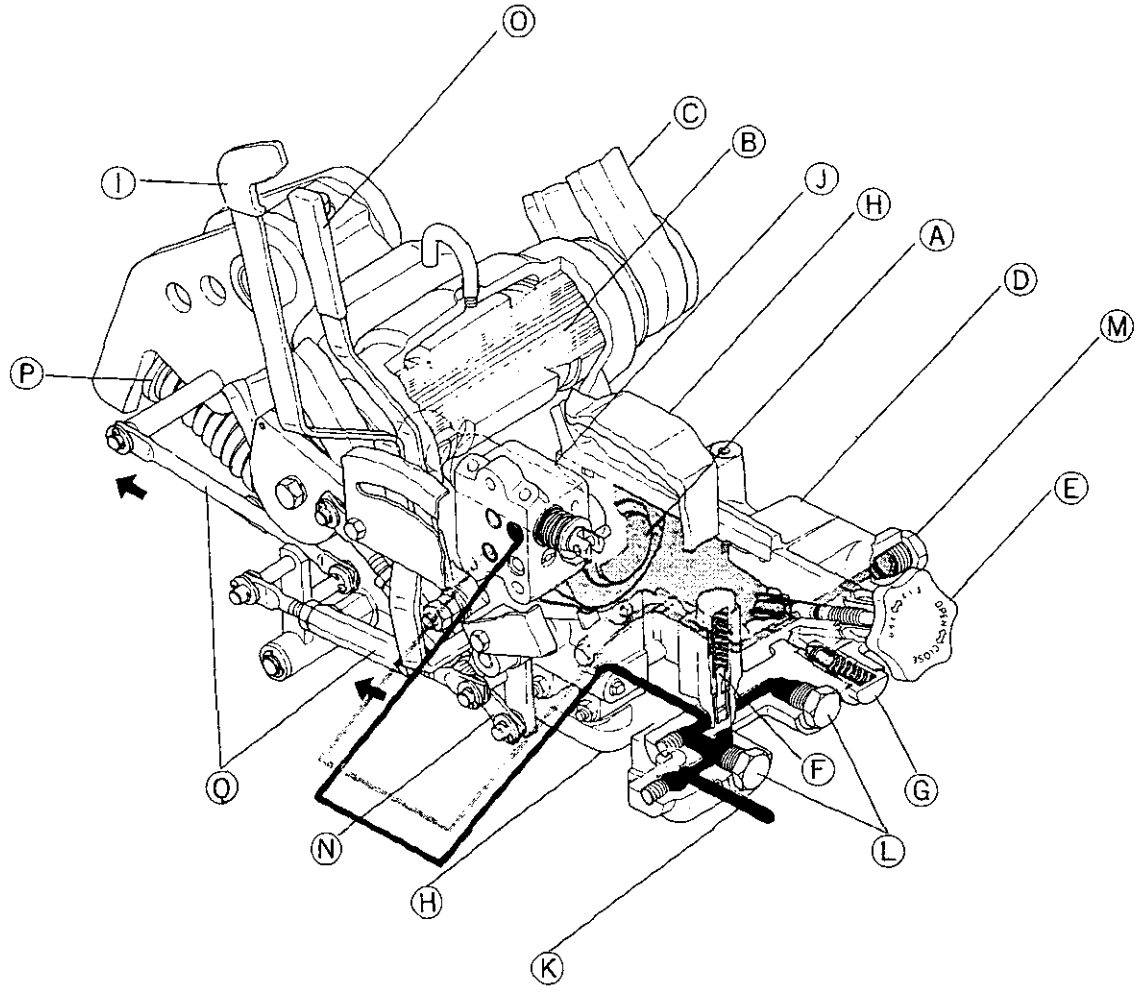
A – Hydraulic Piston
B – Lifting Shaft
C – Lift Arm
D – Cylinder Head
E – Slow Return & Stop Valave
F – Main Relief Valve
G – Safety Valve
H – Hydraulic Cylinder Case
I – Position Control Lever
J – Control Valve
K – Pressure Line
L – Auxiliary Outlet/Inlet Plug
M – Outlet Plug
N – Position Feedback
O – Draft Control Lever
P – Draft Sensing Spring
Q – Draft Feedback Rods
– Pressurized Oil
– Pressure Free Oil
– Return Oil
– Trapped Oil

RAISE

With the draft control lever (O) in the "Draft Control" range in the guide, the draft feedback rods are moved close to the control valve main spool. This allows maximum sensitivity between the sensing spring (P) and the control valve.

Always unlatch the upper link hinge lock plate when using draft control.

When a load is applied to the upper link, the force compresses the sensing spring (P), pushing the draft feedback rods (Q) forward. The rods force the draft feedback arm to pivot the draft feedback shaft in the side cover. This motion pulls the draft control bar rearward pushing the main spool into the control valve. This allows pressurized oil to enter the cylinder raising the lift arms.



2767006F

LOWER

When a load relieves pressure on the sensing spring (P), the sensing spring returns to a normal position. This allows the draft feedback rods (Q) to move rearward, returning the draft feedback arm to its original position. This pulls the draft control bar forward returning the main spool to the neutral position. This allows the lift arms to lower by draining the trapped oil from the hydraulic cylinder.

A – Hydraulic Piston
B – Lifting Shaft
C – Lift Arm
D – Cylinder Head
E – Slow Return & Stop Valve
F – Main Relief Valve
G – Safety Valve
H – Hydraulic Cylinder Case
I – Position Control Lever
J – Control Valve
K – Pressure Line
L – Auxiliary Outlet/Inlet Plug
M – Outlet Plug
N – Position Feedback Rod
O – Draft Control Lever
P – Draft Sensing Spring
Q – Draft Feedback Rods
– Pressurized Oil
– Pressure Free Oil
– Return Oil
– Trapped Oil

GENERAL INFORMATION

The following checks, diagnostis and test procedures are provided to isolate hydraulic system problems.

Starting with preliminary checks, each procedure is designed to isolate the problem to a general area, a particular component or a specific hydraulic circuit.

Use these procedures when there is a "no hydraulics" comlaint, hydraulic functions are slow, or oil is overheated. In all cases, follow the sequence and test specifications as given.

HYDRAULIC OIL TEMPERATURE

To insure test accuracy, it may be necessary to heat the hydraulic oil to a specified temperature. Use the procedure on page 270-20-4 to heat the oil AFTER performing Preliminary Checks on page 270-20-3.

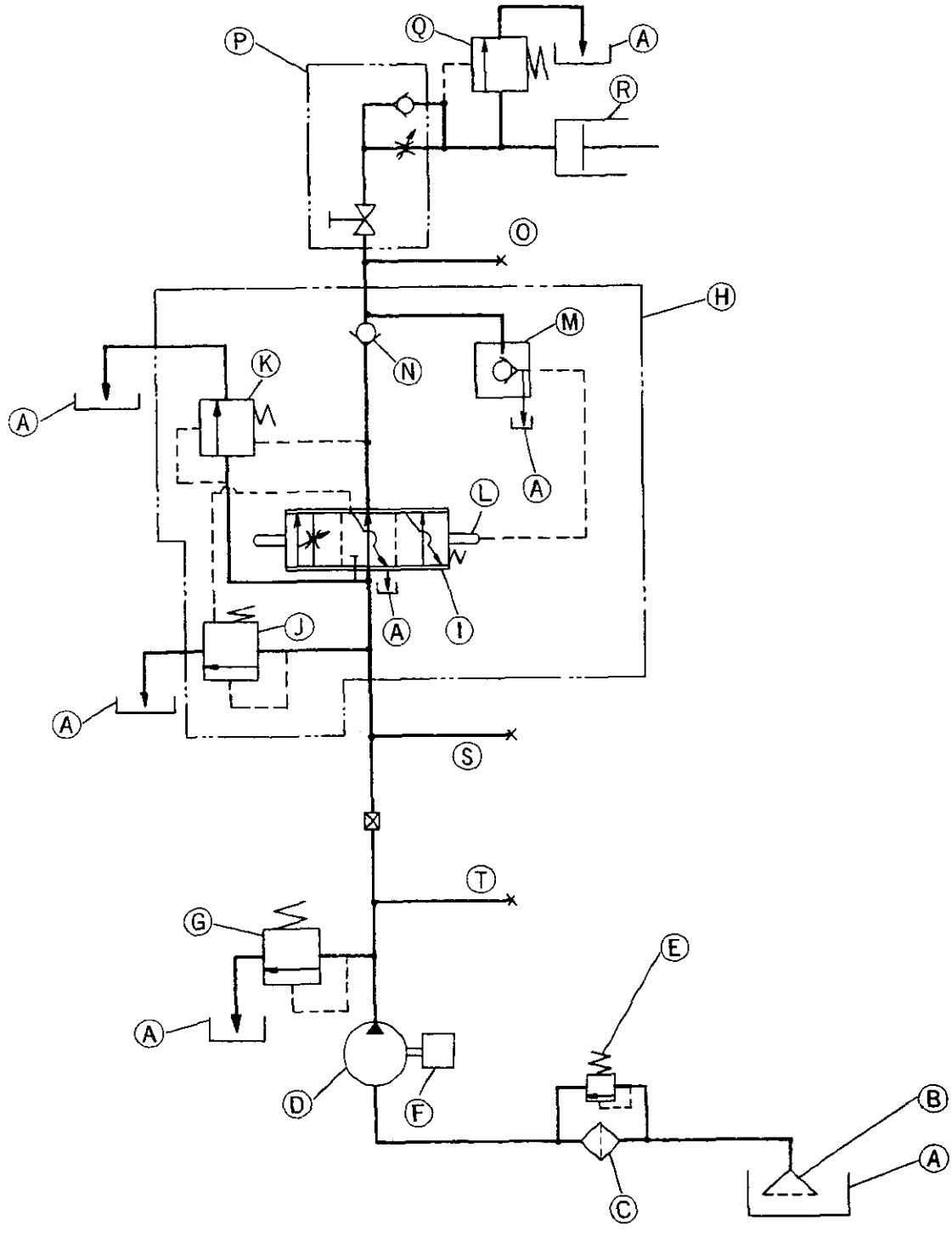
SAFETY INSTRUCTIONS

CAUTION: Escaping fluid under pressure can have sufficient force to penertrate the skin, causing serious personal injury. Before disconnecting lines be sure to relieve all pressure. Before applying pressure to system, be sure all connections are tight and that pipes and hoses are not damaged. Fluid escaping from a very small hole can be almost invisible. Use a piece of cardboard or wood, rather than hands, to search for suspected leaks.
If injured by escaping fluid, see a doctor at once. Serious infection or reaction can develop if proper medical treatment is not administered immediately.

CAUTION: Keep hands away from moving parts. Shut engine off before checking lines near moving parts.

CAUTION: Use care to avoid injury by lift arms or hitches in case valve is operated rapidly or unexpectedly.

HYDRAULIC FLOW CHART



2267074

A – Reservoir
B – Filter Screen
C – Cartridge Filter
D – Hydraulic Pump
E – Filter Bypass Valve
F – Engine
G – Main Relief Valve
H – Control Valve
I – Main Spool
J – Unload Valve
K – Flow Control Valve
L – Push Rod
M – Check Valve
N – Load Check Valve
O – Auxiliary Outlet (I)
P – Slow Return and Stop Valve
Q – Safety Valve
R – Hydraulic Cylinder
S – Auxiliary Inlet (II)
T – Auxiliary Outlet (II)

HYDRAULIC SYSTEM TESTS

Tests:

PRELIMINARY CHECKS BEFORE TESTING

Check Hydraulic Oil Condition:

Condition	Cause
Milky	Water in Oil
Dirty	Filter Failure
Metal Particles	Mechanical Failure
Discolored or Burned Odor	Overheated Oil

Check Hydraulic Oil Level:

Condition	Cause
Oil level low	Improper Fill External Leakage Use of Auxiliary Cylinder

Ask the Operator:

- How is machine performing
- When does it malfunction
- What is machine application

Check Maintenance Records For:

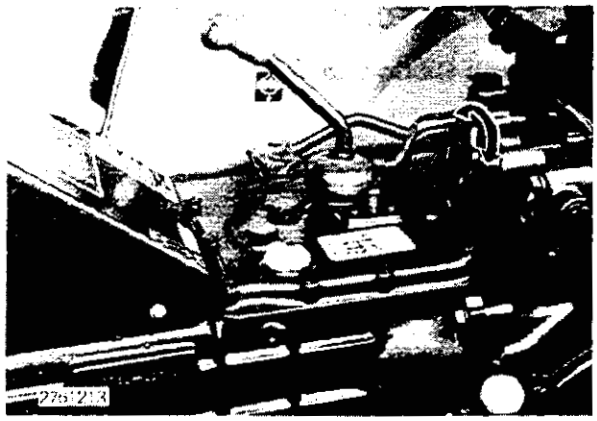
- Service Intervals
- Unusual, Frequent or Similar Failures

Check For:

- Broken or Binding Operating Linkage
- Other Mechanical Failures

Check for External Oil Leaks:

- Engine stopped
- Engine running

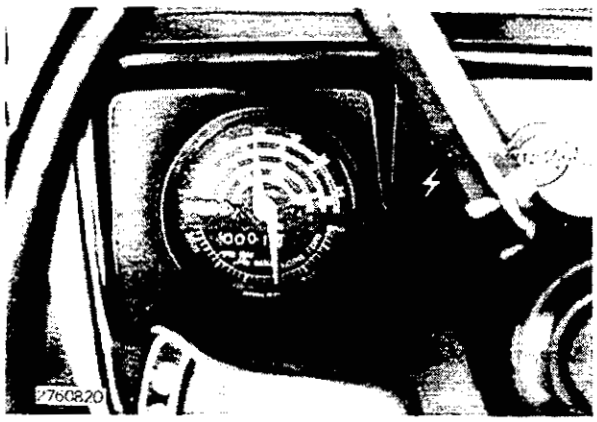


HEATING HYDRAULIC OIL

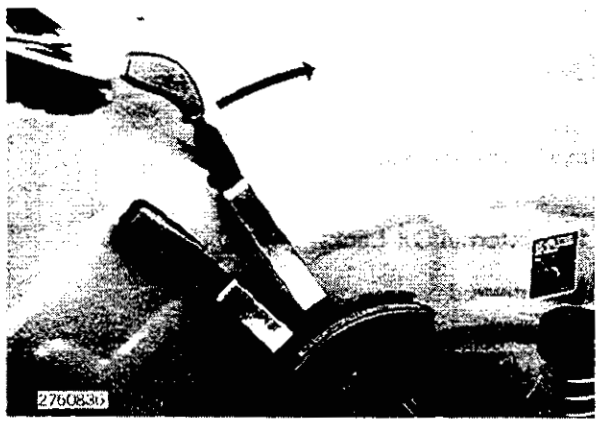
To insure tests accuracy, it may be necessary to heat the hydraulic oil to a specified temperature. Heat oil as follows.

Proceed with the following after Preliminary Checks on page 270-10-3.

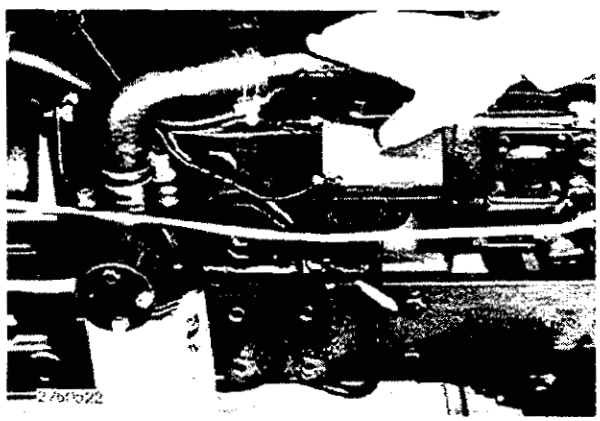
1. Move control lever forward to lower lift arms.
2. Turn stop valve clockwise to close stop valve.



3. Adjust engine speed to 1500 rpm.



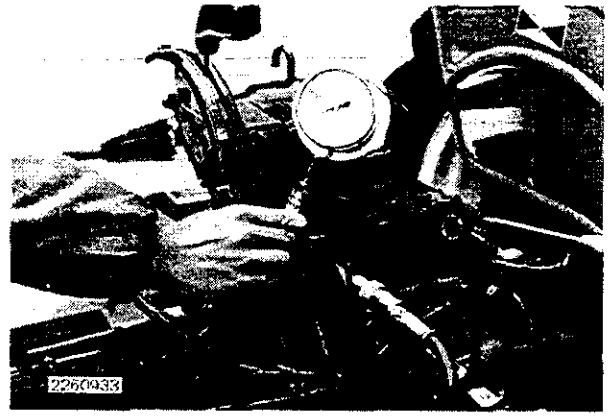
4. Move control lever rearward through the neutral position to the raise position to by-pass oil through the main relief valve.



5. When the pump's inlet pipe (the larger one) is too hot to hold, the hydraulic fluid is at a temperature of 30 to 40°C (86 to 104°F).

MAIN RELIEF VALVE PRESSURE TEST

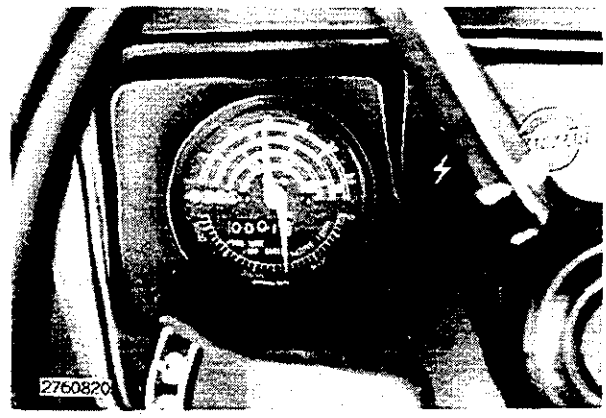
1. Install pressure gauge having 24.5 MPa (250 kg/cm^2) (3000 psi) maximum measuring pressure to inlet port (right hand side) on cylinder head.
2. After checking that all connections are tight, start engine. Operate engine at 1500 rpm.
3. Move control lever forward to lower lift arms.



4. Close stop valve completely.
5. Move control lever rearward to the raise position and read pressure gauge then move lever forward to neutral position.

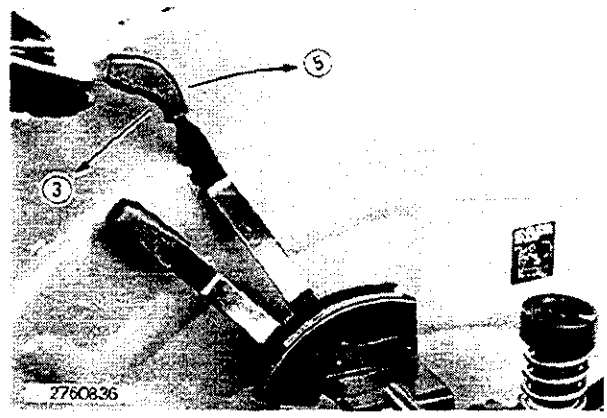
RELIEF VALVE SPECIFICATIONS

Pressure	Engine Speed	Oil Temperature
14.7–15.7 MPa (150–160 kg/cm^2) (2133–2275 psi)	1500 rpm	30–40°C (86–104°F)

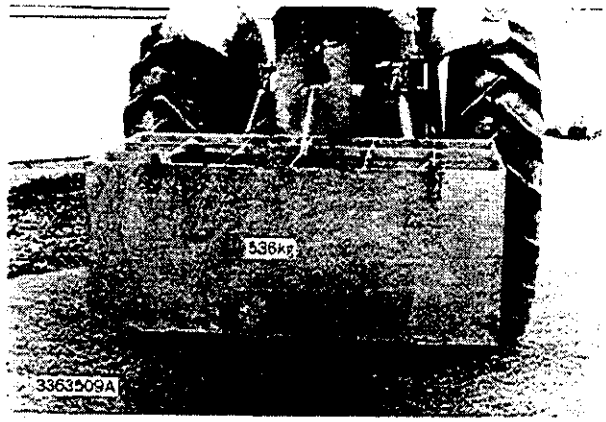


6. If the reading is below specification, go to STEP: HYDRAULIC LIFT LEAKAGE TEST.
7. If the reading is above specification, adjust main relief valve as instructed on page 70-15-4.

   One shim (0.25 mm) adds approximately 363 kpa (3.7 kg/cm^2) (53 psi).

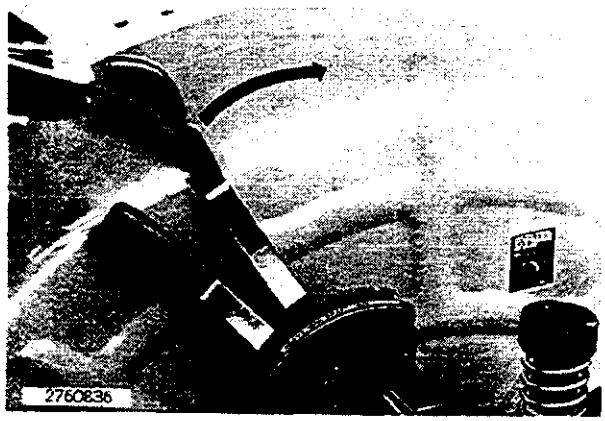


⚠ CAUTION: Never adjust pressure to more than 15.7 MPa (160 kg/cm^2) (2275 psi). *Excessive pressure can damage the system and/or cause personal injury.

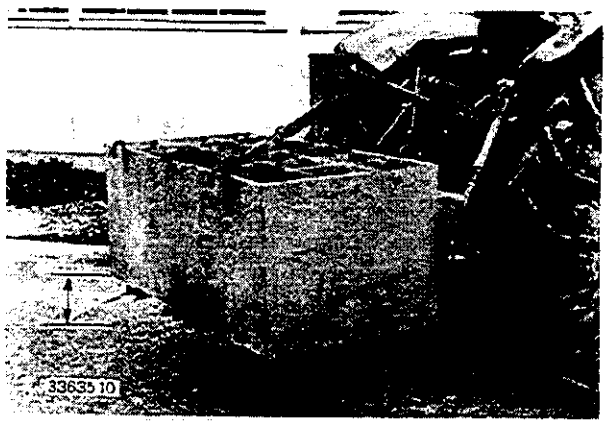


HYDRAULIC LIFT LEAKAGE TEST
(Stop valve open)

1. Attach a 536 kg·(1182 lbs) weight to a point 610 mm (24 in.) behind the lower link hitch point.



2. Start engine and raise hydraulic lift to maximum height.



3. Shut off the engine and note the height of the lower link from level ground.

4. Leave the tractor for 5 minutes and repeat measurement.

HYDRAULIC LEAKAGE SPECIFICATIONS

Lowering Limit	2.5 mm(0.1 in.) in 5 min.

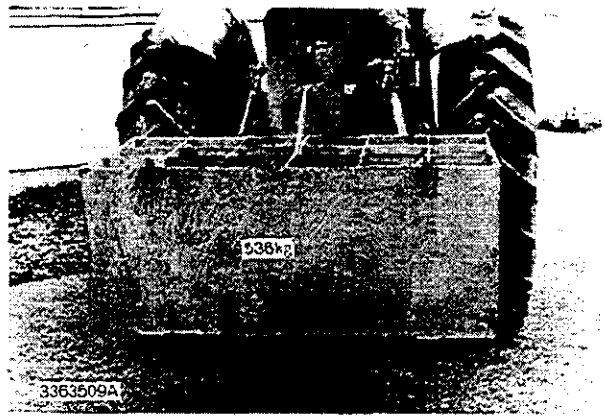
5. If the lowering does not exceed the specification, the system has passed the test. Otherwise, proceed to HYDRAULIC LIFT LEAKAGE TEST (Stop valve closed).

HYDRAULIC LIFT LEAKAGE TEST
(Stop valve closed)

1. Attach a 536 kg (1182 lbs) weight to a point 610 mm (24 in.) behind the lower link hitch point.

2. Start engine and raise hydraulic lift to maximum height, close stop valve completely.

3. More control lever forward to lower position and leave it in that position.

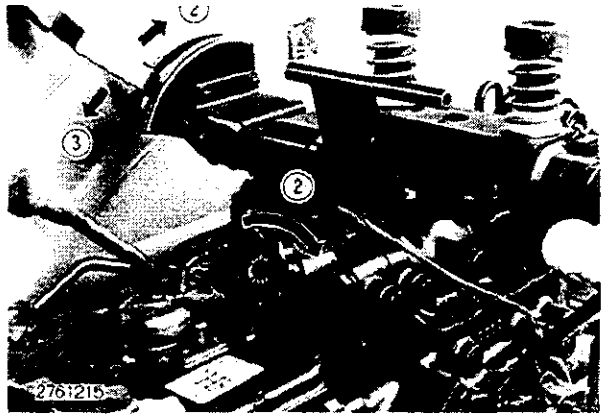


4. Shut off engine and note the height of the lower link from level ground.

5. Leave the tractor for 5 minutes and repeat measurement.

HYDRAULIC LEAKAGE SPECIFICATIONS

Lower Limit	20 mm (0.8 in.) in 5 min.



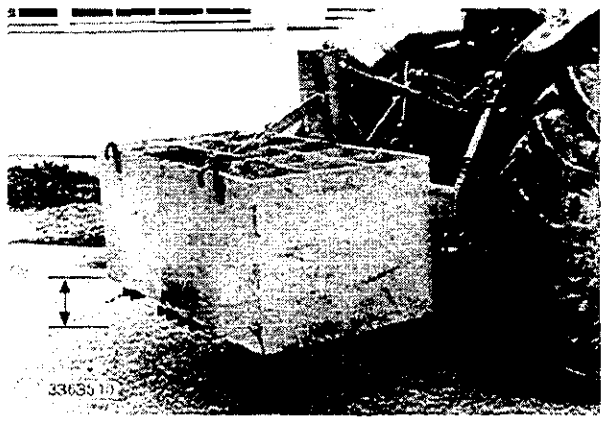
6. A lowering exceeding the specification can mean:

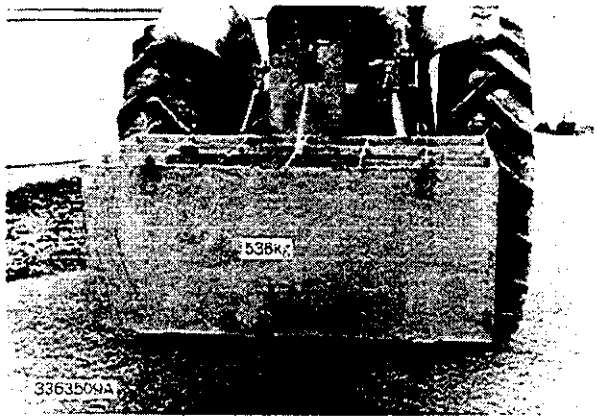
   a) Piston O-ring damaged or worn.
   In either case, proceed to the HYDRAULIC LIFT CYCLE TIME TEST. (See page 270-20-8)

   b) Safety valve seat O-ring broken or debris in valve ball.
   In either case, proceed to the HYDRAULIC LIFT CYCLE TIME TEST. (See page 270-20-8)

7. If the lowering is less than that measured in the preceding: HYDRAULIC LIFT LEAKAGE TEST (Stop Valve Open) and also exceed than specification:

   a) The control valve spool or relief valve leak. Replace valve assembly.





HYDRAULIC LIFT CYCLE TIME TEST

1. Attach a 536 kg (1182 lbs) weight to a point 610 mm (24 in.) behind the lower link hitch point.

2. Completely open the stop valve and run the engine at 2600 rpm.

3. Measure hydraulic lift cycle time. One complete stroke. Should take 2.0 seconds.

4. If the cycle time does not meet specification, follow this sequence.

   a) Check that the stop valve is completely open.

   b) Check oil:
   - Level
   - Color
   - Viscosity
   - Smell

   c) Replace hydraulic oil filter (paper filter cartridge) on the inlet line.

   d) Check filter screen in transmission case. Clean as required.

   e) Check for internal oil leakage, noise, and overheating oil.

   If present, disassemble the hydraulic lift and chek:
   - Pressure Relief Valve and Seat
   - Stop Valve Seat O-ring
   - Stop Valve and Seat
   - Safety Valve Seat O-ring
   - Safety Valve and Seat
   - Piston O-ring and Back-up Ring
   - Cylinder

SAFETY VALVE PRESSURE TEST

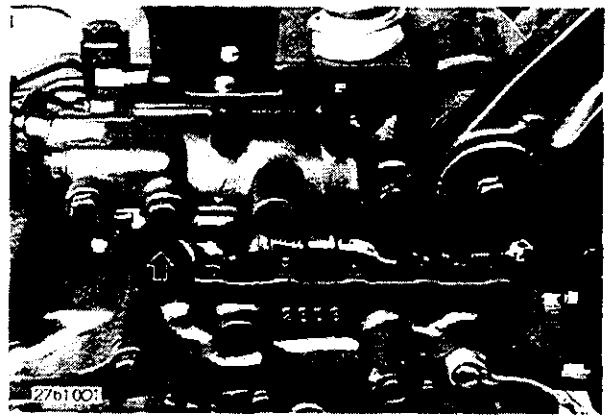
1. Install special adapter (A) to port at left side of cylinder case.
   Port: M18, Pitch 1.5 mm

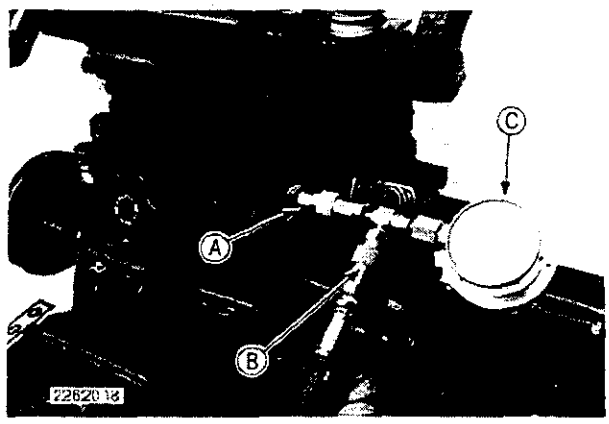
2. Connect pressure line of hand pump (B) to the special adapter (A).

3. Install a pressure gauge measuring 24.5 MPa (250 kg/cm^2) (3000 psi) full-scale to the adapter.

4. Raise hydraulic lift to maximum position. Set the control valve to the neutral position. Close stop valve on cylinder head.

5. Increase pressure in cylinder with the hand pump until the safety relief valve operates to relieve oil pressure.





A – Special Adapter
B – From Hand Pump
C – Pressure Gauge

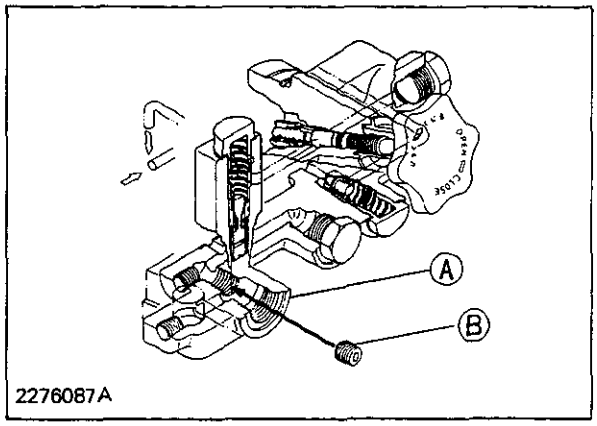
SAFETY VALVE SPECIFICATIONS

Pressure	16.7–18.6 MPa (170–190 kg/cm^2) (2417–2702 psi)

6. If the reading deviates from the specification, adjust with shims, page 70-15-7.
   Two shim thicknesses are available:

0.0078 in. (0.2 mm)
0.0179 in. (0.5 mm)

⚠ CAUTION: Never raise pressure setting above 18.6 MPa (190 kg/cm^2) (2702 psi). Too high a setting defeats the purpose of the safety valve leading to piston damage and/or personal injury.



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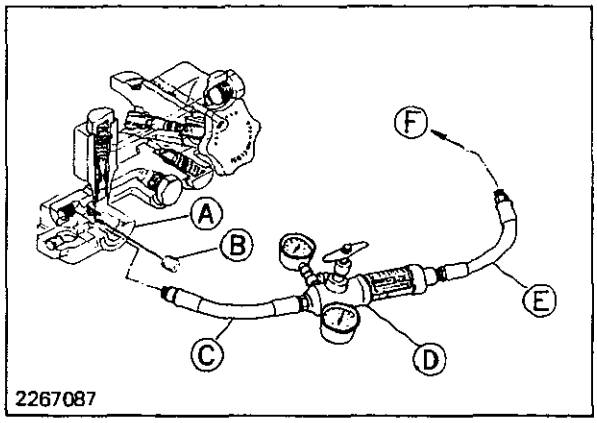

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HYDRAULIC PUMP FLOW TEST

1. Lower the hydraulic lift and relieve any remaining hydraulic pressure.

CAUTION: Fluid Escaping under pressure can have sufficient force to penetrate the skin, causing serious personal injury. Before disconnecting lines, be sure to relive all pressures. Before applying pressure to system, be sure all connections are tight and that pipes are.

Fluid escaping from a very small hole can be almost invisible. Use a piece of cardboard or wood, rather than hands, to search for suspected leaks.

If injured by escaping fluid, see a doctor at once. Serious infection or reaction can develop if proper medical treatment is not administered immediately.

2. Make sure that the stop valve is completely open before performing hydraulic pump flow test.
3. Remove outlet plug (A) from cylinder head and install a 1/4—18 NPTF headless plug (B) to block direct passage to control valve through inlet port.

A — Outlet Plug
B — Plug 1/4—18 NPTF
C — Inlet Hose
D — Flow Meter
E — Outlet Hose
F — To reservoir

4. Remove return port plug (F) located on the left side of transmission case and install flow meter outlet hose (E). Wire the inlet hose (C) in place required.

STOP Two plug holes on cylinder head and return oil plug hole on transmission case have SAE 3/4—16 UNF—2B thread with O-ring boss.

5. Completely open flow meter (D) and operate engine at 2600 rpm.
6. Adjust flow meter control valve to 10.34 MPa (103 kg/cm^2) (1500 psi).
7. Flow should be 31.2 ℓ/min (8.24 US gpm).
8. If flow is low, see page 270-20-13.
9. Remove flow meter and remove headless plug from outlet port of cylinder head. Install plugs with O-rings in outlet ports on cylinder head and return port.

STOP Do not leave the headless plug in the cylinder head outlet port after completing the test.

DIAGNOSIS

HYDRAULIC SYSTEM

PROBLEM	POSSIBLE CAUSE	SUGGESTED REMEDY
Hydraulic lift does not operate or lift speed slow	• Relief pressure too low	Check and adjust
	• Relief valve worn	Replace
	• Piston O-ring blown	Replace O-ring
	• Piston back-up ring broken	Replace back-up ring
	• Clogged filter screen	Clean
	• Clogged cartridge filter	Replace cartridge
	• Hydraulic oil viscosity too high	Check
	• Hydraulic pump gears worn	Replace pump
	• Control valve leakage	Repair
	• Auxiliary hydraulics consume too much oil	Remove or adjust implement
	• Closed stop valve	Open
	• Pilot spool stuck	Replace valve
	• Clogged orifice in control valve spool	Clean
Hydraulic lift does not lower	• Slow-return valve closed or stuck	Open or check
	• Stop valve closed	Open (Counterclockwise)
	• Pilot or control valve spool stuck	Check and replace
	• Mechanical check valve action impaired	Replace valve
Lift arm drops when engine is shut off	• O-ring on piston broken	Replace O-ring
	• Cylinder worn or scored	Replace cylinder
	• O-ring on stop valve seat broken	Replace O-ring
	• Valve spool worn	Replace valve
	• O-ring between cylinder case and control valve housing broken	Replace O-ring
	• Inlet check valve or lowering valve seat leaking	Check and replace
	• Debris in safety valve seat	Clean
	• Safety valve seat worn or O-ring broken	Check and replace
	• Lowering valve worn	Replace valve

PROBLEM	POSSIBLE CAUSE	SUGGESTED REMEDY
Noise from control valve	• Lift arm play improperly adjusted	Adjust upper feedback
	• Oil viscosity too high	Check
	• Relief valve seat damaged	Replace seat
	• Valve leaking internally	Replace valve
	• 3-point hitch over loaded	Remove load
Noise from main relief valve at maximum lift position	• Feedback rods improperly adjusted	Adjust
	• Control valve spool or pilot spool stuck	Check and replace
Lift action not smooth	• Air in system	Check leakage
	• Oil viscosity too high	Check
	• Oil temperature too low	Warm up system
Hydraulic lift movement is not steady (Repeated up and down movement during use)	• Eccentric pin maladjusted	Adjust
Draft response is too sensitive	• Upper link improperly positioned on upper link hinge	Place upper link in upper hole
Draft response insensitive	• Upper link improperly positioned on upper link hinge	Place upper link in lower hole
	• Mast height too low	Use correct implement having Cat-1 fitting
	• Slow return valve closed	Open slow return valve as necessary
	• Main hydraulic pump worn	Replace pump
	• Oil level low	Add oil

HYDRAULIC PUMP

PROBLEM	POSSIBLE CAUSE	SUGGESTED REMEDY
No pump output	• Hydraulic fluid insufficient	Check
	• Pump drive broken	Replace pump drive
	• Pump shaft broken	Replace pump
	• Pump shaft key broken	Replace key
Pump noise	• Hydraulic fluid insufficient	Check
	• Cavitation (air being drawn in)	Check pipe O-ring and rubber connections
	• Pump improperly fitted	Reinstall
	• Oil viscosity too high	Check
	• Pump gear faulty	Replace pump
	• Pump drive connector broken	Replace connector
	• Pump drive gear broken	Replace gear
Low pump output	• Filter screen clogged	Check and clean
	• Cartridge filter clogged	Replace cartridge
	• Pump gears worn	Replace pump
Pump shaft key, connector on pump housing broken	• Pressure relief setting too high	Adjust
	• Auxiliary control valve broken	Replace valve
	• Pump installed 180 degrees off	Reinstall [See arrow or "IN" and "OUT" marks]
	• Auxiliary hydraulic connectors improperly connected	Reconnect

YANMAR DIESEL ENGINE CO.,LTD.

YANMAR DIESEL AMERICA CORP.,

951 CORPORATE GROVE DRIVE BUFFALO GROVE, IL 60089-4508 U.S.A.

TEL : (1) 847-541-1900

FAX : (1) 847-541-2161

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