YANMAR
SERVICE MANUAL

DIESEL TRACTOR

MODEL

YM169

YM169D

CONTENTS

FOREWORD

■ MAKING EFFECTIVE USE OF THIS SERVICE MANUAL

This manual discusses the maintenance standards and trouble-shooting procedures to be employed from the standpoint of the repairman, in order that the tractor can perform in top condition through correct servicing procedures.

Repairs conducted by estimations or force of habit could lead to unexpected accidents and serious trouble. Always carry out repairs in a scientific and accurate manner.

■ SERIAL NUMBERS

Do not limit your work merely to the actual repair work alone but always strive to carry out dependable servicing, including such efforts as noting down the servicing history of your tractor and keeping maintenance records.

In order to easily process any claims it is imperative that the full details and serial numbers of parts be clearly written on the prescribed form, and then sent to the dealer for forwarding to the manufacturer.

CHAPTER 7 ELECTRICAL EQUIPMENT

CHAPTER 8 TRACTOR TROUBLESHOOTING

CHAPTER 9 REGULAR INSPECTIONS

CHAPTER 1
GENERAL

1. SPECIFICATIONS

Item					Unit	YM169	YM169D
EN-GINE	Engine block	Engine model				3T72HA-A	
		Type of engine				Diesel engine	
		Number of cylinders				3	
		Cylinder layout				Vertical in line	
		Bore x stroke			in.	2.83 x 2.83 (72mm x 72mm)	
		Cylinder liner type				Wet type	
		Cycle				4-stroke cycle	
		Combustion chamber type				Precombustion chamber	
		Valve system				Overhead valves	
		Displacement			cu. in.	53.6 (879 cc)	
		Compression ratio				23 : 1	
		Maximum output			hp/rpm	16/2600	
		Maximum torque			ft. lbs/rpm	36.8/1800–2200 (5.1 kg-m/1800–2200)	
		Engine weight			lbs	253.3 (115 kg)	
		Pistion rings	Compression rings			2	
			Scraper rings			1	
		Valve timing	Intake valves	Open	degree	21° ± 2° before T.D.C.	
				Closed	degree	50° after B.D.C.	
			Exhaust valves	Open	degree	50° before B.D.C.	
				Closed	degree	20° after T.D.C.	
		Valve clearances	Intake valves		in.	0.0078 (0.2mm)	
			Exhaust valves		in.	0.0078 (0.2mm)	
	Fuel system	Engine starting				Electric starting	
		Ignition				Compression ignition	
		Injection timing			degree	24° before T.D.C.	
		Injection pump type				Yanmar Bosch YPER-0707	
		Injection pump plunger diameter			in.	0.2362 (6mm)	
		Injection plunger stroke			in.	0.2756 (7mm)	
		Injection valve type				Semi throttle type	
		Injection valve diameter			in.	0.1958 (5mm)	
		Injection pressure			psi	2275 (160 kg/cm^2)	
		Injection order				1 – 3 – 2	
		Fuel				Diesel oil	
		Fuel tank capacity			U.S.gal.	4.2 (16ℓ)	
		Speed control method				All speed mechanical type	

Item					Unit	YM169	YM169D
EN-GINE	**Lubri-cating system**	Lubricating pump type				Trochoid	
		Lubricating system				Force feed lubrication	
		Lubricating oil capacity			U.S.gal	0.84 (3.2ℓ)	
	Cooling system	Cooling system				Water-cooled	
		Heat exchange method				Radiator	
	Electrical system	Starter motor type				S114-230 (Hitachi), D.C. motor	
		Starter motor capacity			V-KW	12–1.3	
		A.C. generator type				GP9150 (KOKUSAN) magneto revolving	
		Generator capacity			V-A	12–15	
		Current limiter				RS5114 (KOKUSAN)	
		Battery voltage, capacity			V-AH	12–45	
		Thermostart plug type				SH100-02 (HITACHI)	
		Thermostart capacity			V-A	12.5–13.5	
CHAS-SIS	**Power train**	Clutch	Clutch type			Mechanical dry single plate	
			Facing (outside diam. x inside diam. x thickness		in.	7.09 x 4.92 x 0.33 (180mm x 125mm x 8.4mm)	
			Facing area		sq. in.	20.4 (132cm^2)	
			Static torque capacity		ft. lbs	97.7 (13.5 kg-m)	
		Trans-mission	Transmission type			Mechanical, constant selective mesh gears combination	
			Transmission speeds			6-speed for forward, 2-speed for reverse	
			Travel speed*	[Forward]		MPH (km/h)	
				1st		0.73 (1.17)	0.74 (1.19)*
				2nd		1.23 (1.98)	1.25 (2.01)*
				3rd		1.79 (2.88)	1.82 (2.92)*
				4th		3.67 (5.91)	3.72 (5.99)*
				5th		6.23 (10.03)	6.32 (10.17)*
				6th		9.08 (14.61)	9.21 (14.81)*
				[Reverse]			
				1st		1.01 (1.62)	1.02 (1.64)
				2nd		5.08 (8.18)	5.15 (8.29)
		P.T.O.	Speed	1st		540 at 2255	
				2nd		770 at 2255	
			Shaft rotation			Clockwise viewed from rear	
			Shaft position			Rear end	
	Running gear	Differential				Differential gear	
		One-way clutch				Claw clutch	
		Front axle type				Lemoine-type supported by center pin	

* with 8.3–16 (Goodyear Tire)

Item					Unit	YM169	YM169D
CHAS-SIS	**Running gear**	Rear axle type				Semi-floating	
		Front wheel align-ment	Toe-in		in.	0.16–0.32 (4–8mm)	
			Camber		degree	3°	
			Caster		degree	3°	0°
			Trail		in. (mm)	0.53 (13.5 mm)	0 (0 mm)
			King-pin inclination		degree	7°	8.5°
		Steer-ing system	Steering system			Ball – screw	
			Gear ratio			18.9 : 1	
			Steering wheel diam.		in.	15.8 (400mm)	
			Gear box oil capacity		U.S.gal.	Grease	
		Tires	Front wheels	Tire size		4.50–10–2PR–FSR	5–12–2PR–FSL
				Tire pressure	psi	17.8 (1.25 kg/cm^2)	
				Rims		3.50 x 10GA	4JA–12
		Option-al tires (TURF)	Front wheels	Tire size		6–12–2PR–FD	
				Tire pressure	lb/in^2	17.1 (1.20 kg/cm^2)	
				Rims		5JA–12	
			Rear wheels	Tire size		8–16–4PR	
				Tire pressure	psi	22.8 (1.6 kg/cm^2)	
				Rims		5½k–16	
		Option-al tires (TURF)	Rear wheels	Tire size		8–16–4PR (FD)	
				Tire pressure	psi	22.8 (1.6 kg/cm^2)	
				Rims		5½K–16	
		Brakes	Type of main brakes			Internal expansion mechanical brakes	
			Parking brake type			Locking foot brake	
			Lining surface area		sq. in.	16.1 (104 cm^2)	
			Lining (width x thick-ness x length)		in.	0.98 x 0.16 x 4.09 (25 x 4 x 104mm)	
			Brake drum diameter		in.	4.3 (110mm)	
			Method of activation			Main brakes ····· by foot Parking brake ····· by hand	
	Lifting system	Type				Hydraulic	
		Type of hydraulic pump				Gear pump	
		Position of pump				In front of engine governor chamber	
		Pump drive				Claw coupling	
		Pump discharge capacity			U.S.gal./min	3.43 (13ℓ) at 2600 rpm	

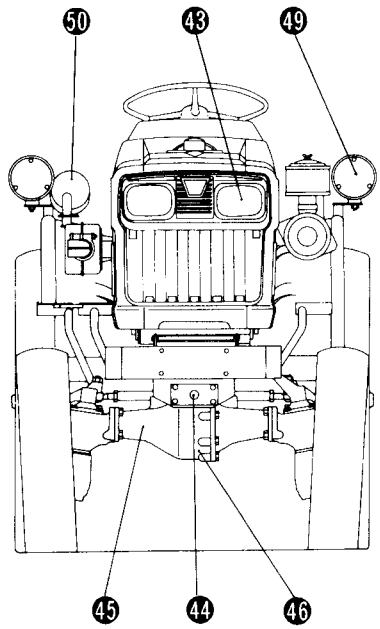
Item				Unit	YM169	YM169D
CHASSIS	Lifting system	Control system	Supplementary oil capacity	U.S.gal.	2.5 (9.5 *l*)	2.4 (9.0 *l*)
			Control system		Hydraulic select control	
		Cylinder	Safety valve cracking pressure	psi	1564 (110 kg/cm^2)	
			Type		Single acting	
			Bore x stroke	in.	2.36 x 3.54 (60mm x 90mm)	
			Total stroke volume	cu. in.	15.50 (254 cc)	
		Lower link hitch point (Max.)		in.	246" (624mm)	
		Lifting power (Lower link)		lbs	1102 (500kg)	
		Implement fitting method			3-point hitch, cat: JIS–0 w/cat: 1. pin	
	Lighting etc.	Water temperature indicator light		V-W	12–3.4	
		Engine oil pressure indicator light		V-W	12–3.4	
		Head light		V-W	12–25/25	
		Turn signal lights		V-W	12–23	
		Work light		V-W	12–20	
		Horn		V-A	12–1.2	
		Rear reflectors			Red reflectors	
	Dimensions	Overall length: With 3-point hitch		in.	98.0" (2490mm)	
		Without 3-point hitch		in.	84.1" (2135mm)	
		Overall width		in.	38.4" (975mm)	
		Overall height To operator's seat		in.	51.0" (1295mm)	
		To hood		in.	41.7" (1060mm)	
		Wheel base		in.	49.4" (1255mm)	
		Tread	Front	in.	30.3" (770mm)	29.3" (745mm)
			Rear	in.	27.6"–33.5" (700mm–850mm)	
		Minimum ground clearance		in.	10.4" (265mm)	9.3" (235mm)

	Item		Unit	YM169	YM169D
CHAS-SIS	Weights	Gross weight	lbs	1190 (540 kg)	1279 (580 kg)
		Front wheel load	lbs	569 (258 kg)	651 (295 kg)
		Rear wheel load	lbs	621 (282 kg)	628 (285 kg)
		Front weights (optional)	lbs	44.1 x 3 pcs = 132.3 (20 x 3 = 60 kg)	
		Rear wheel weights (optional)	lbs	(each wheel) 44.1 + 55.1 = 99.2 (20 + 25 = 50 kg)	
	Performance	Minimum turning radius	ft.	Under unlocking brakes 7.6 (2.3m)	8.2 (2.5m)
		Maximum grade	degree	34°	
		Braking distance	ft.	13.1 (4m)	

2. COMPONENTS

(1) Muffler
(2) Brake pedal
(3) Step
(4) Differential lock pedal
(5) Instrument panel
(6) Fuel tank cap
(7) Bumper
(8) Radiator
(9) Hood
(10) Engine
(11) Air cleaner
(12) Fuel tank
(13) Throttle lever
(14) Steering wheel
(15) Gear shift lever
(16) P.T.O. shift lever
(17) Hydraulic control lever
(18) Hydraulic cylinder case
(19) Assist bar
(20) Operator's seat
(21) Fender
(22) Lift link
(23) Upper link
(24) Upper link hinge
(25) P.T.O. shaft
(26) Lower link
(27) Lift arm
(28) Rear tire
(29) Rear wheel
(30) Brake
(31) Transmission case
(32) Brake rod
(33) Range shift lever
(34) Pitman arm
(35) Clutch pedal
(36) Steering gear box
(37) Clutch housing
(38) Starter motor
(39) Drag rod
(40) Front wheel
(41) Front tire
(42) Battery
(43) Headlight
(44) Front axle center-pin
(45) Front axle
(46) Front differential gear case
(47) Propeller shaft cover
(48) Front drive shift lever
(49) Flashing warning lamp
(50) Work light

Model YM169D



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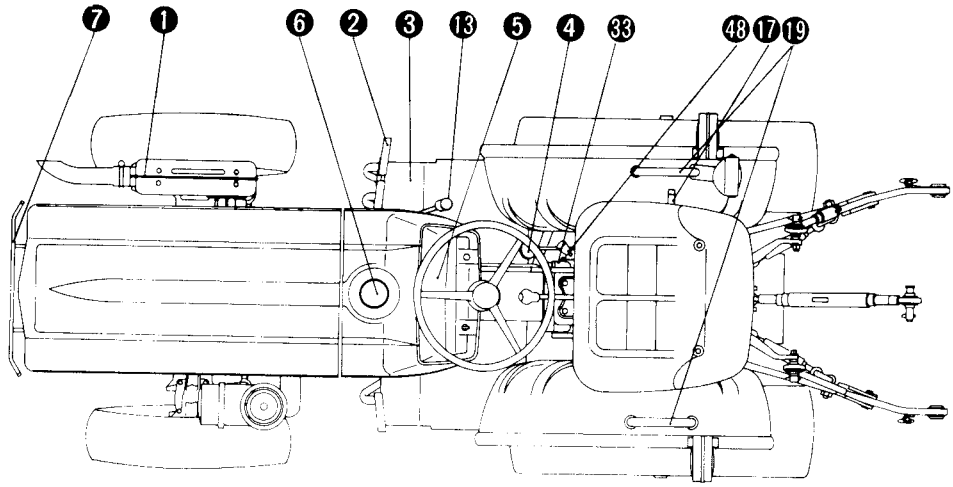

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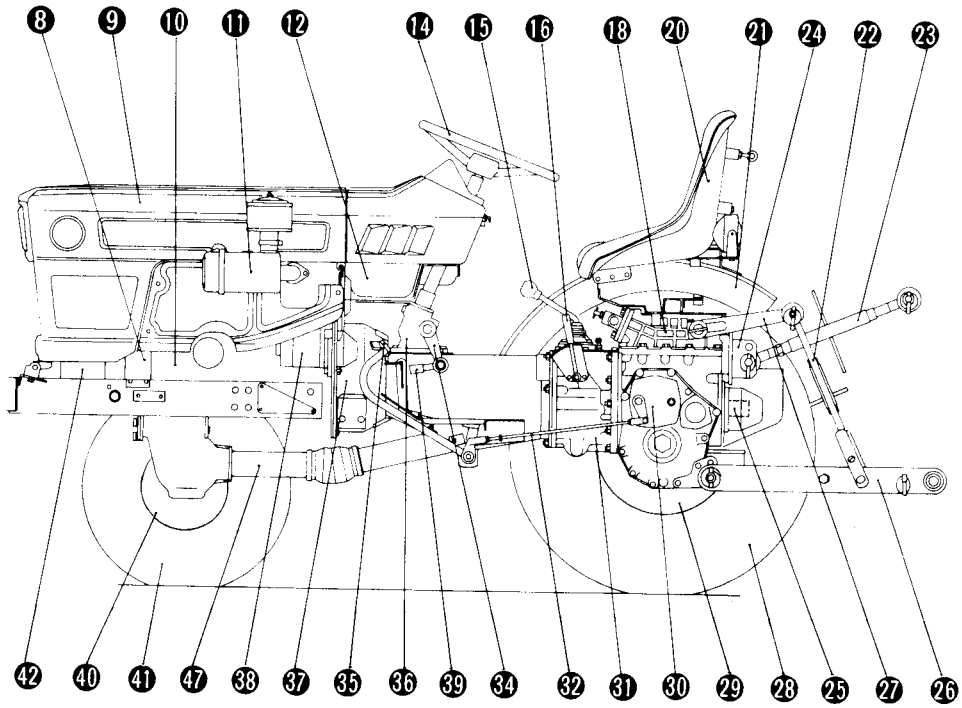

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3. TIGHTENING TORQUE RATINGS

[Unit: ft.lbs (kg-m)]

Item	No.	Tightening torque
[ENGINE]		
Cylinder bolts head nuts	8	80 (11)
Rocker arm support	3	45 – 52 (6.2 – 7.2)
Rod bolts	6	16.6 – 20.2 (2.3 – 2.8)
Main bearing housing	6	15 – 18 (2.0 – 2.5)
Crankshaft pulley	1	76.1 – 86.4 (10.5 – 12)
Flywheel	5	47 – 50 (6.5 – 7.0)
Timing gear case	9	17 – 22 (2.3 – 3.0)
Hydraulic pump	4	17 – 22 (2.3 – 3.0)
Fuel injection valve holder	3	29 – 33 (4.0 – 4.5)
Fuel injection valve cap nut	3	29 – 33 (4.0 – 4.5)
Fuel injection valve nozzle holder body	3	65 – 80 (9.0 – 11.0)
[TRACTOR]		
Differential housing bolts	8	17 – 22 (2.3 – 3.0)
Differential bearing case bolts	4	15 – 22 (2.0 – 3.0)
Front axle bracket bolts	8	58 – 72 (8.0 – 10.0)
Brake drum bolts	2	17 – 22 (2.3 – 3.0)
Brake cover nuts	8	17 – 22 (2.3 – 3.0)
Clutch housing (M12 nuts)	7	43 – 58 (6.0 – 8.0)
(M10 nuts)	2	33 – 43 (4.5 – 6.0)
(M8 bolts)	7	17 – 22 (2.3 – 3.0)
Rear axle housing (M10 bolts)	16	25 – 36 (3.5 – 5.0)
(M12 bolts)	2	43 – 58 (6.0 – 8.0)
(M12 nuts)	4	43 – 58 (6.0 – 8.0)
Drawbar bracket nuts	4	58 – 87 (8.0 – 12.0)
Fender bolts	8	25 – 36 (3.5 – 5.0)
Seat bracket (M10 bolts)	3	15 – 22 (2.0 – 3.0)
(M12 bolts)	2	29 – 43 (4.0 – 6.0)
Transmission case nuts	10	25 – 36 (3.5 – 5.0)
Hydraulic cylinder case bolts	10	25 – 36 (3.5 – 5.0)
Steering gear box bolts	4	33 – 43 (4.5 – 6.0)
Steering nut	1	58 – 87 (8.0 – 12.0)
Clutch pressure plate bolts	6	17 – 22 (2.3 – 3.0)
Transmission front cover bolts	10	9 – 12 (1.3 – 1.7)
Transmission rear cover bolts	7	9 – 12 (1.3 – 1.7)
Top link hinge bolts	4	43 – 58 (6.0 – 8.0)
King pin bolts,	4	76 – 86 (10.5 – 12)
Front axle (YM169D only) (M10 Bolts)	31	45 – 52 (6.2 – 7.2)
(M12 Bolts)	8	76 – 86 (10.5 – 12)
Flange bolts (rear wheel)	4	87 – 108 (12.0 – 15.0)
Front wheel bolts	8	58 – 72 (8.0 – 10)
Rear wheel bolts	12	58 – 72 (8.0 – 10)

[STANDARD OF BOLT TIGHTENING TORQUE]

Bolt size	Cast iron (steel)		Light alloy	
	7T		7T	
	ft-lbs	kg-m	ft-lbs	kg-m
M6	6 – 9	0.8 – 1.2	6 – 9	0.8 – 1.2
M8	17 – 22	2.3 – 3.0	15 – 22	2.0 – 3.0
M10	33 – 43	4.5 – 6.0	25 – 36	3.5 – 5.0
M12	58 – 72	8.0 – 10.0	43 – 58	6.0 – 8.0
M14	87 – 108	12.0–15.0	58 – 8.7	8.0 – 12.0
M16	123–152	17.0–21.0	87 – 123	12.0–17.0
M18	174–210	24.0–29.0	145–195	20.0–27.0
M20	239–297	33.0–41.0	217–253	30.0–35.0

BOLT CODE

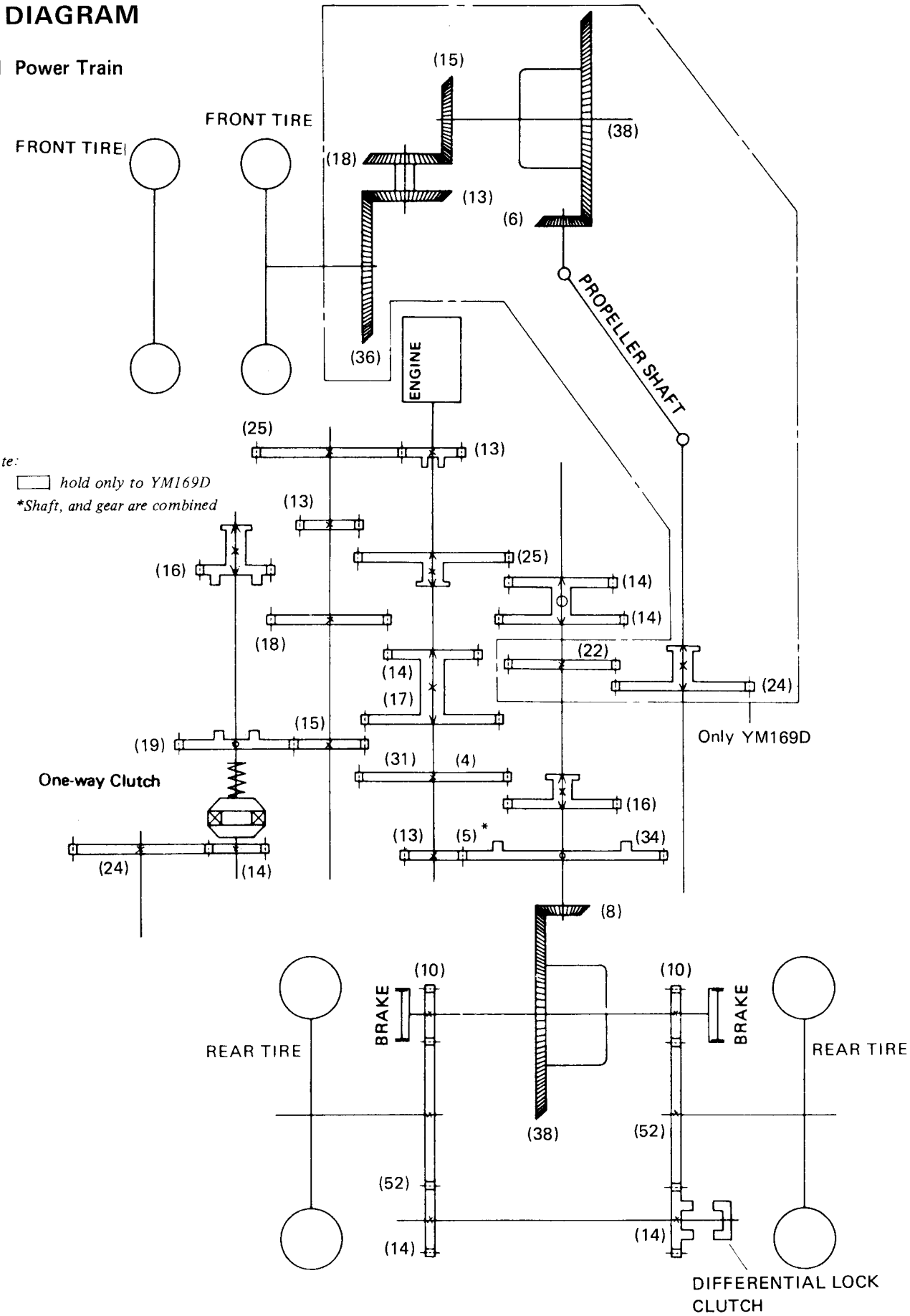
["7" appears on the head of the 7T bolts.]

00000 – 000000

(2) ——— 7T (No electro-deposited coating)
(6) ——— 7T (With electro-deposited coating)

4. DIAGRAM

4-1 Power Train

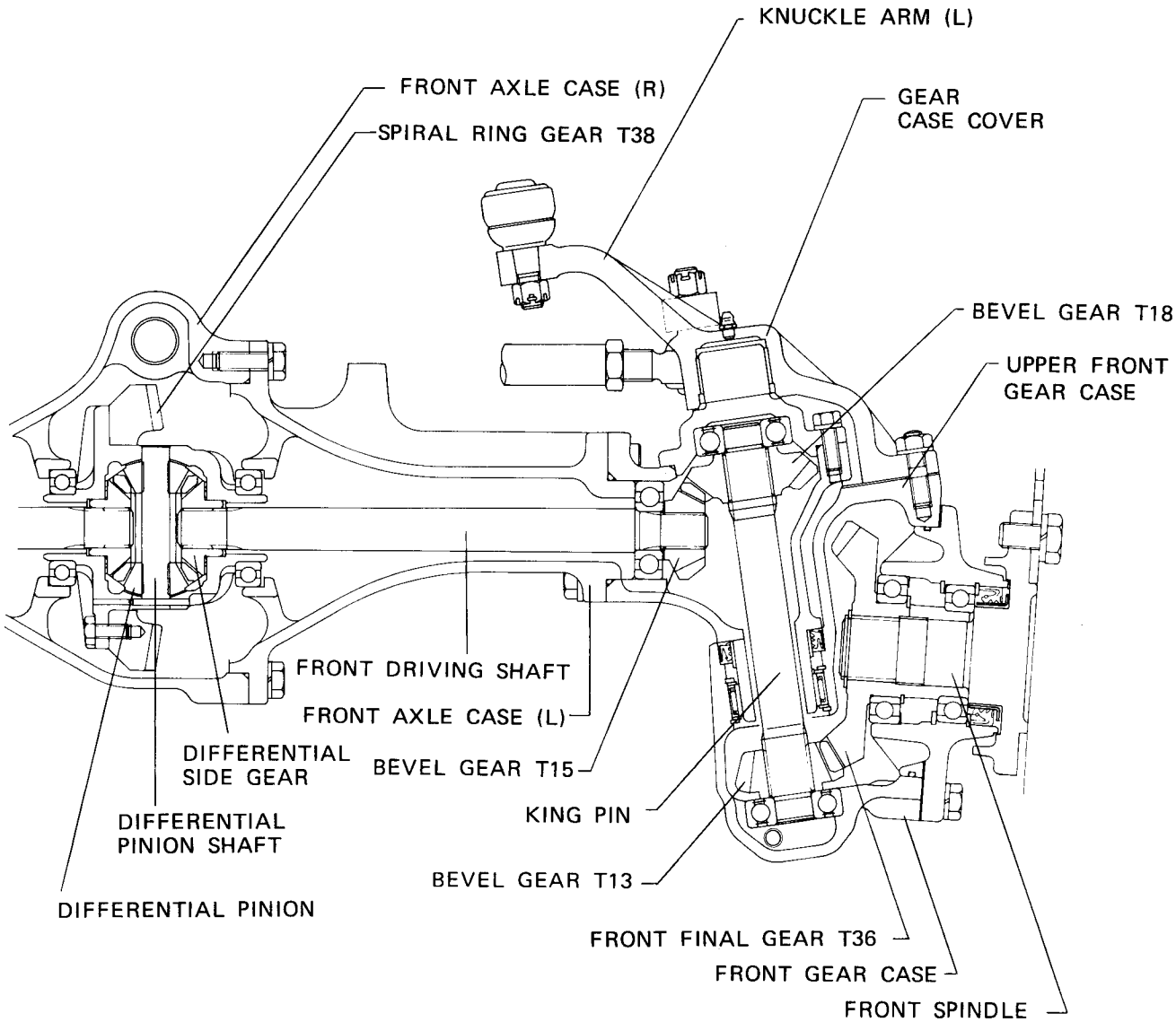


Note:

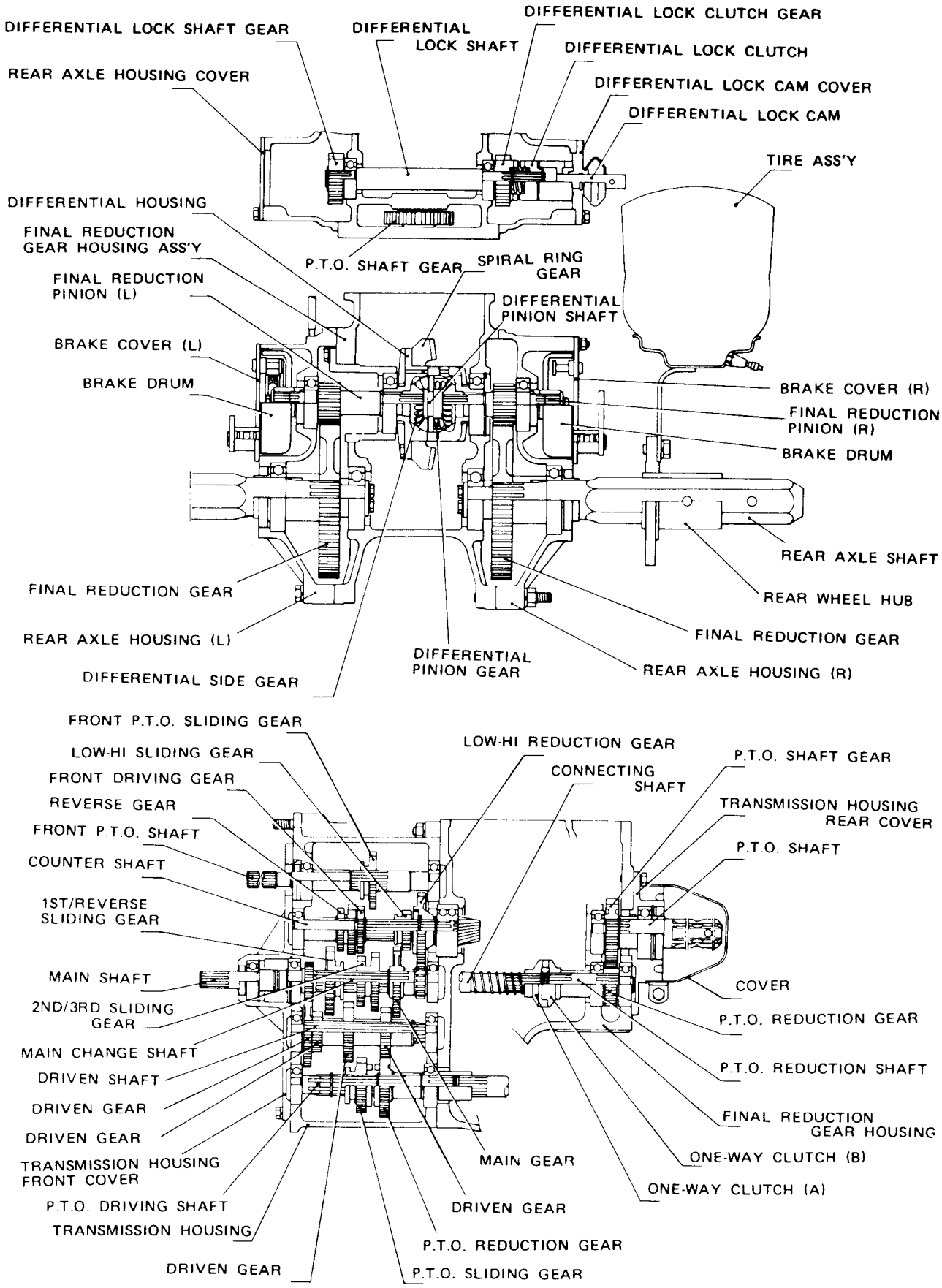
(1) ▭ *hold only to YM169D*

(2) **Shaft, and gear are combined*

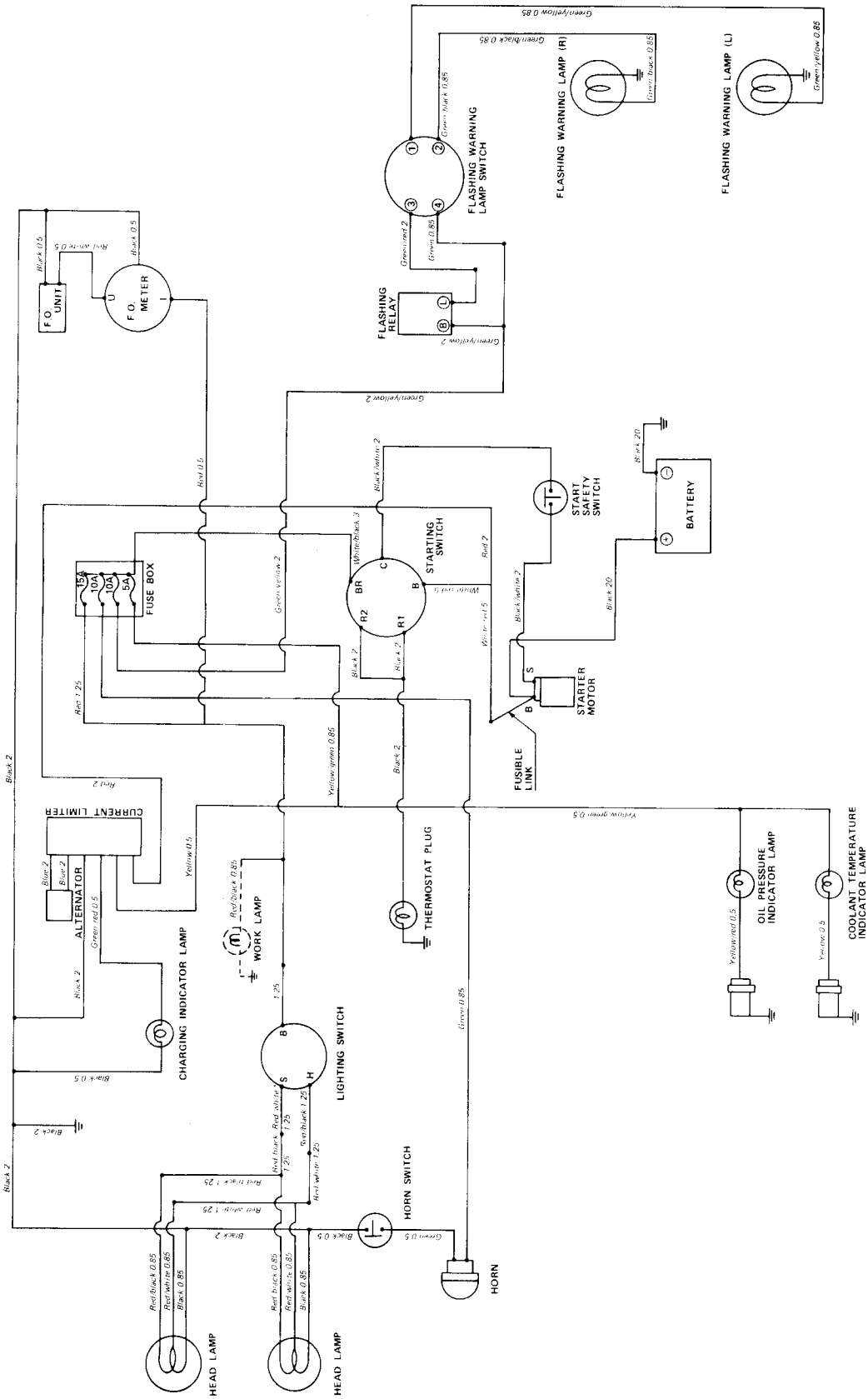
4-2 Sectional View (YM169D)



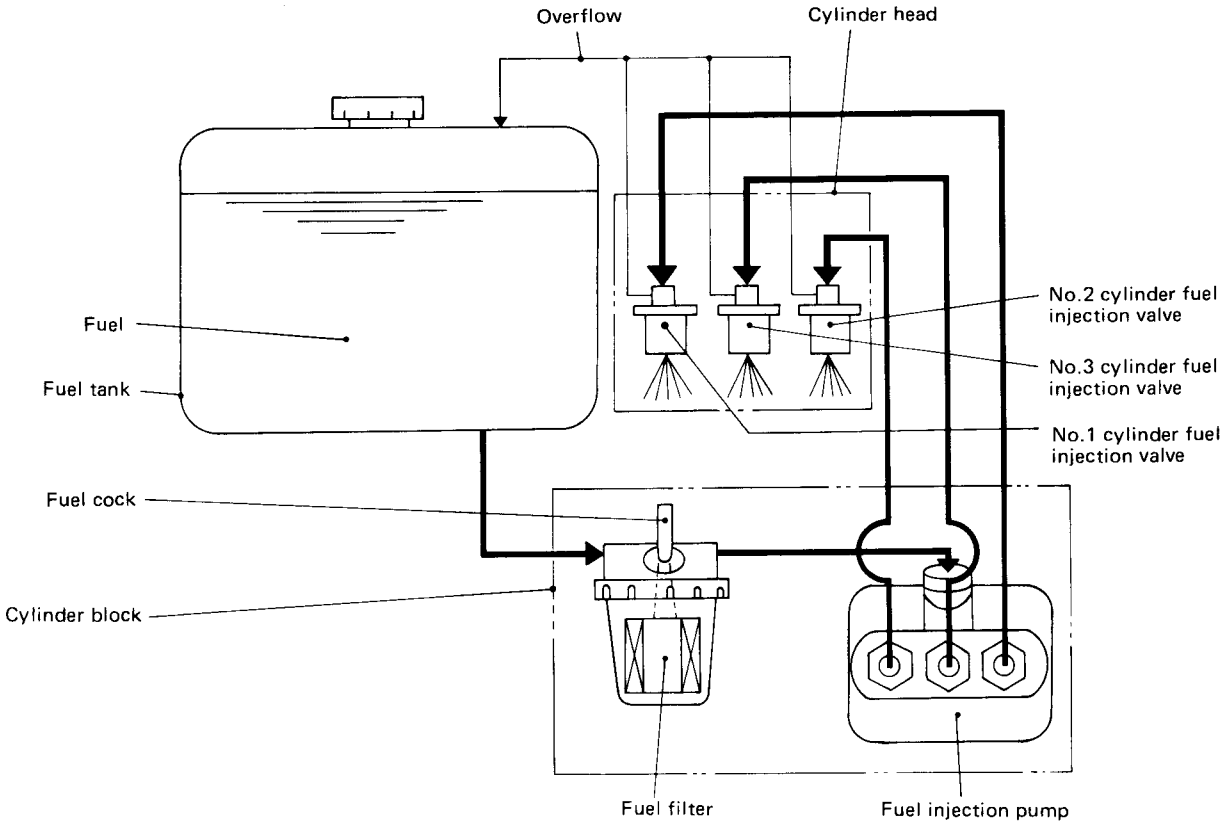
4-3 Transmission Sectional View



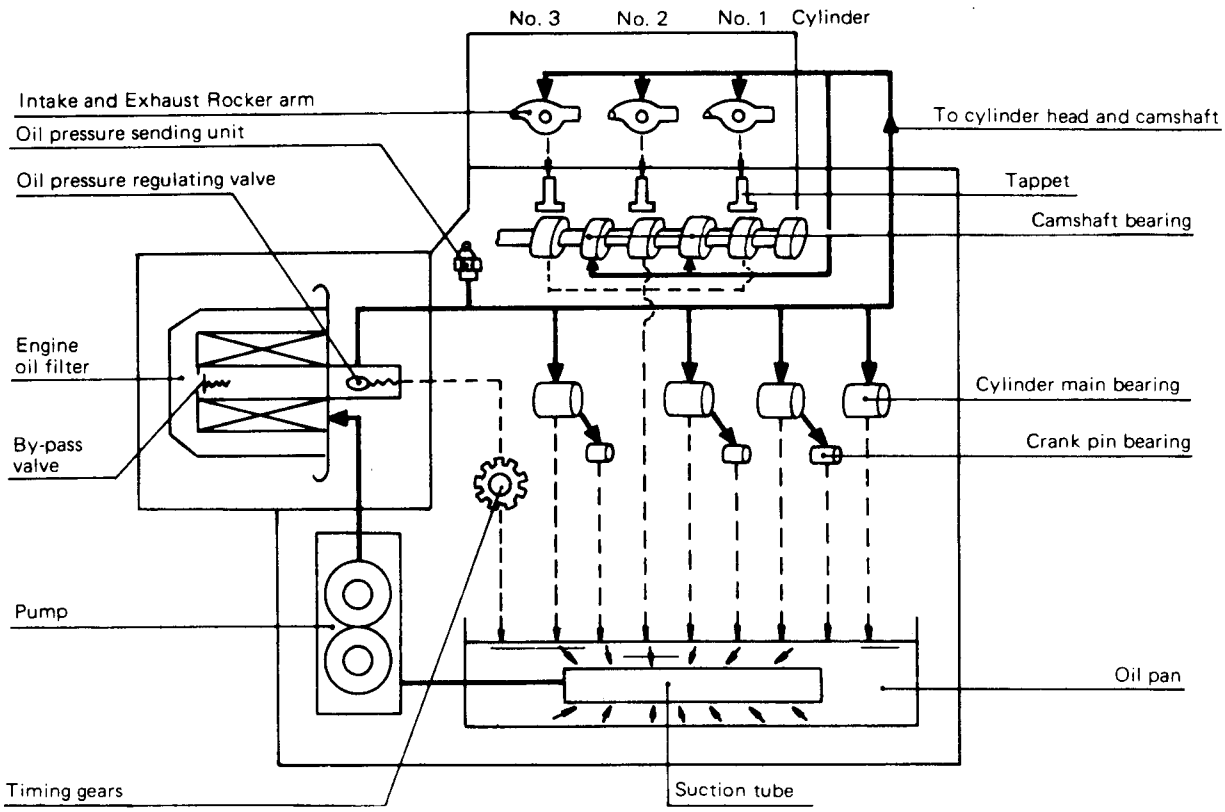
4-4 Electric Wiring



4-5 Fuel System



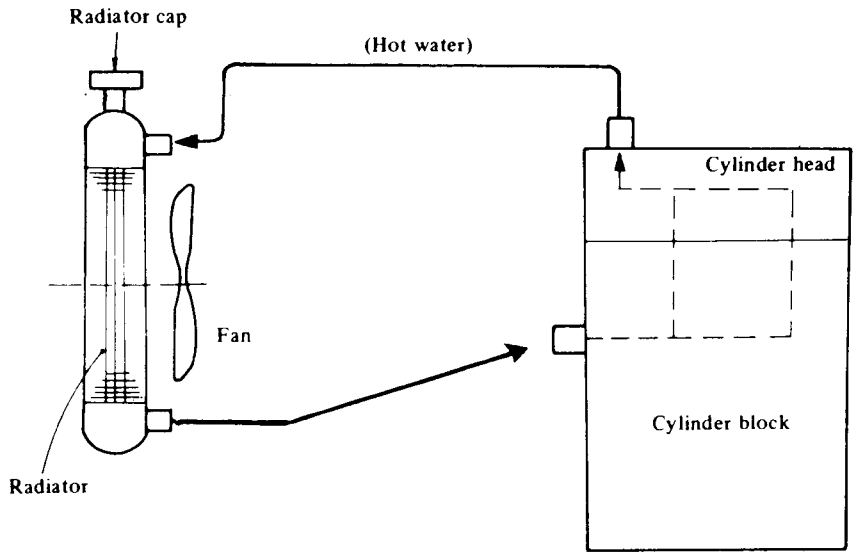
4-6 Engine Lubricating System



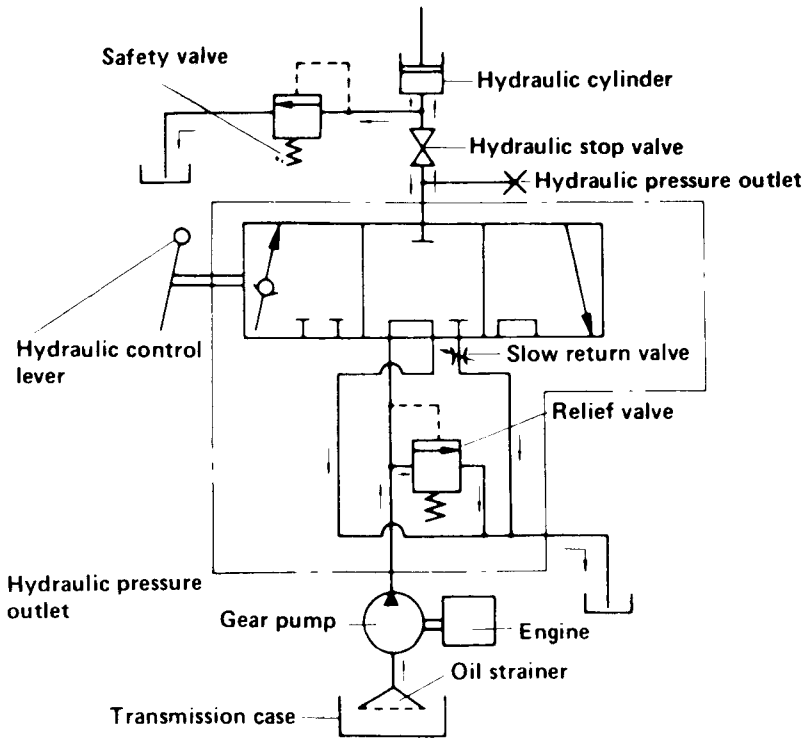
[LIST OF SPECIAL TOOLS FOR DISASSEMBLING/ASSEMBLING]

	Tool	Purpose of usage	Type name (reference)
(1)	Compression gauge	To check engine compression pressure	(0–70 kg/cm^2)
(2)	Cylinder liner polisher	To polish cylinder liner	
(3)	Pump tester for fuel injection	To test fuel injection pump	Type I
(4)	Hydraulic oil tester	To measure hydraulic oil pressure	0–250, 0–35, 0–5 kg/cm^2
(5)	Spring pin removing tool (knock pin punch)	To remove spring pin	(3ϕ, 6ϕ, 8ϕ, 10ϕ)
(6)	Garage Jack	Lifting	(3 ton)
(7)	Grease gun	Greasing	
(8)	Solder	Electrical parts modification	
(9)	Snap ring plier	To remove snap ring	
(10)	Relief valve removing tool	To remove relief valve	
(11)	Steering wheel puller	To remove steering wheel	
(12)	Pitman arm puller	To remove pitman arm	
(13)	Differential lock spring compressor	To install differential lock	

4-7 Cooling System



4-8 Hydraulic System



5. MAINTENANCE EQUIPMENT AND TOOLS

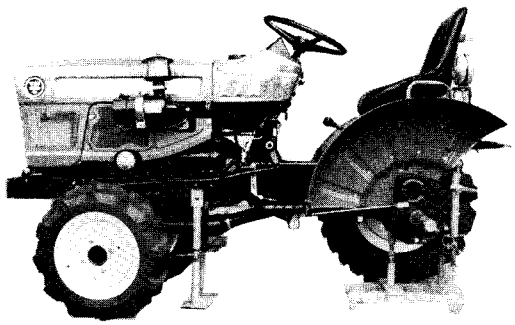
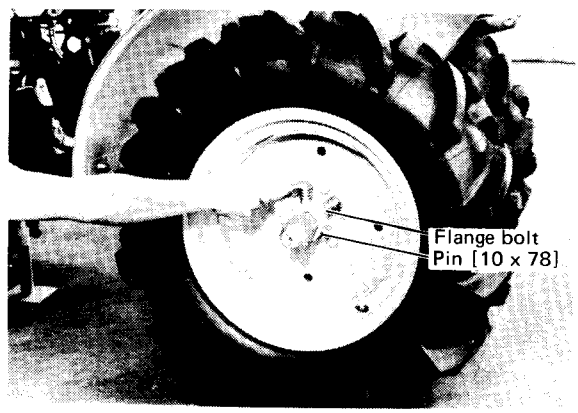
[LIST OF MEASURING TOOLS]

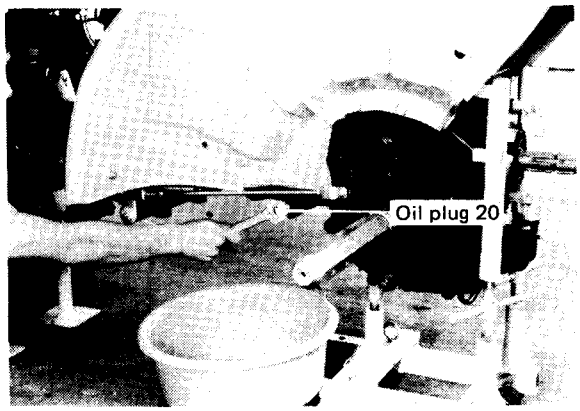
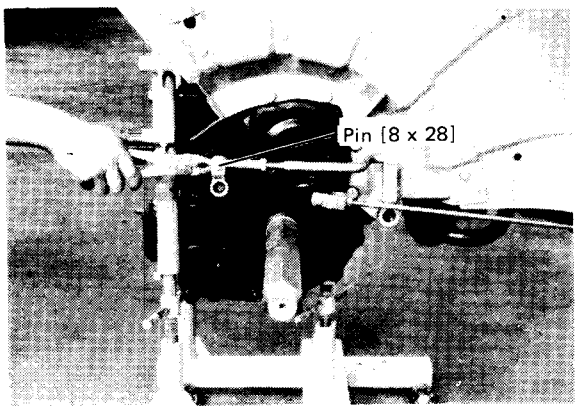
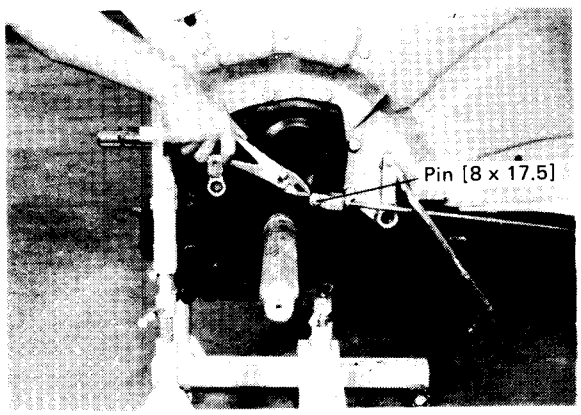
	Tool	Usage	Type name (reference)
(1)	Hydrometer	Specific gravity check	
(2)	Battery charger	To charge the battery	
(3)	Hydrometer for anti-freeze	To measure the specific gravity of water and anti-freeze	
(4)	Calibrator	Parts measurement	200 mm
(5)	Dial gauge	Pinion gear and backlash measurement	0–10 mm
(6)	Universal dial	Parts measurement	
(7)	Circuit tester	Electrical system inspection	20A tester
(8)	Micrometer	Accurate parts measurement	(combination of 0–150 mm)
(9)	Cylinder gauge	Inside diameter measurement	(measuring range: 10–150 mm)
(10)	V-A meter	Voltage and amperage measurement	
(11)	Thermometer	Coolant temp. measurement, and various parts measurement	(0–200°C)
(12)	Tachometer	To check the engine and P.T.O. shaft revolutions	(0–1000 rpm) (0–10000 rpm)
(13)	Tire gauge	To measure the air pressure of the tires	(10 kg/cm^2)
(14)	Toe-in gauge	To measure the toe-in of the front tires	(600–2,100 mm)
(15)	Torque wrench	To measure the bolt and nut torque	920 kg-cm 1300 kg-cm 2800 kg-cm
(16)	Thickness Gauge	To measure parts clearance	65 mm
(17)	Nozzle tester	To check nozzle opening pressure	
(18)	Radiator tester	To check radiator cap and system leakage	

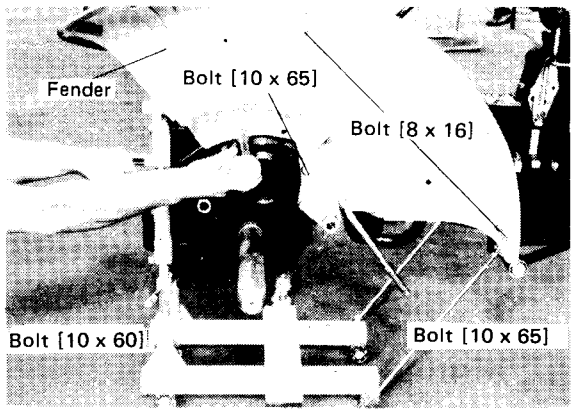
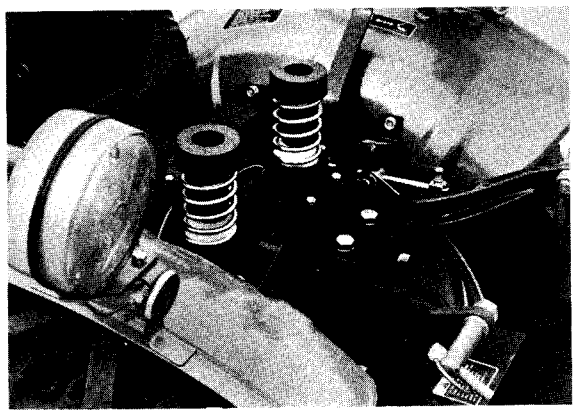
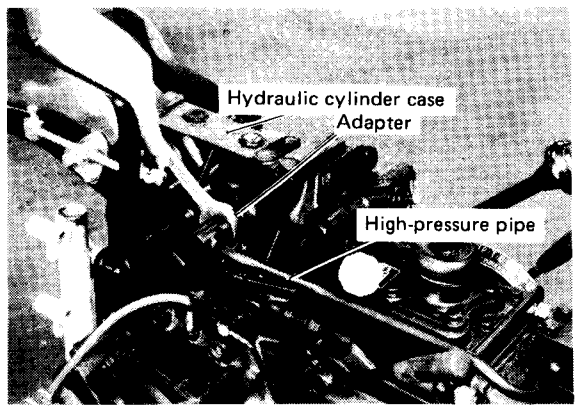
CHAPTER 2

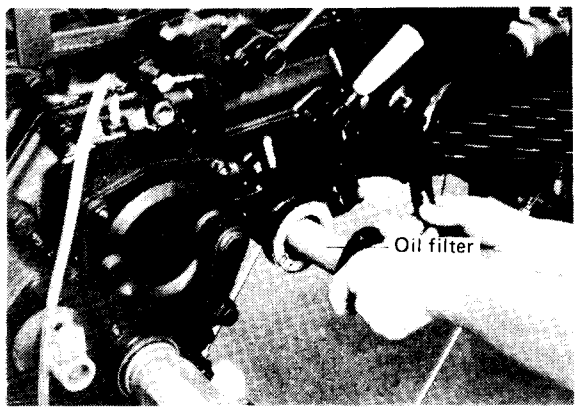
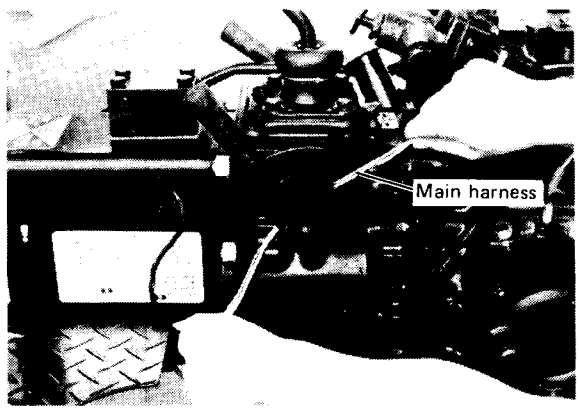
TRACTOR DISASSEMBLY

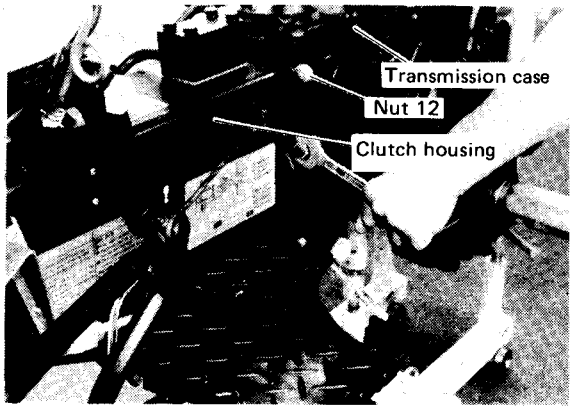
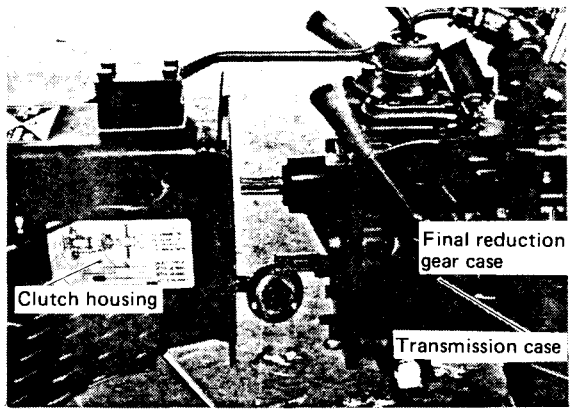
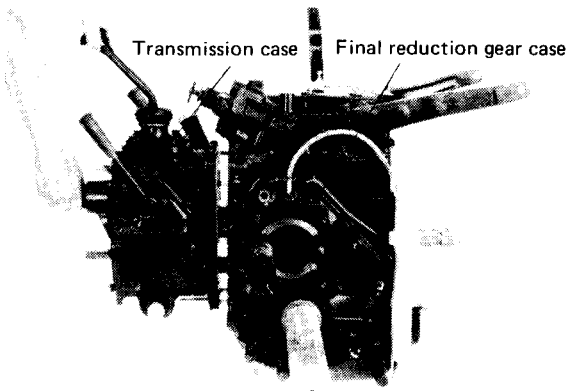
1. DISASSEMBLY SEQUENCE

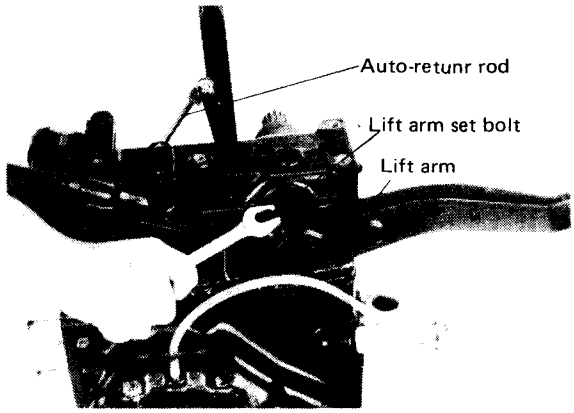
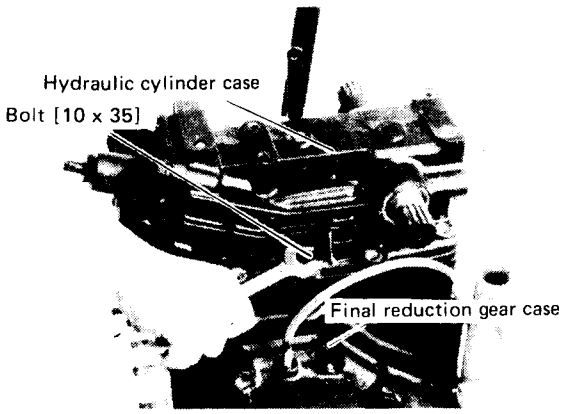
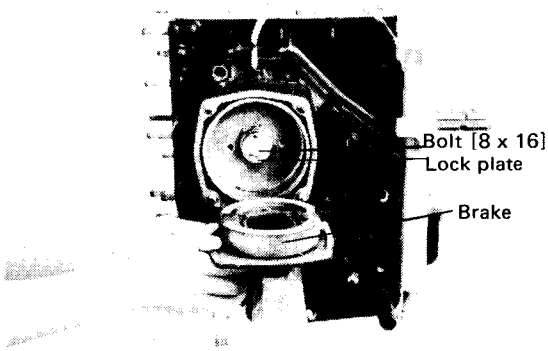
	Division	Part Name	Illustration	Caution/Remarks
1.	Instal-lation stand	Installation stand	 	1) Utilize the top link hinge assembly bolt (12 x 45) to attach the installation stand (B). 2) Utilize the front axle bracket assembly bolt (12 x 30) to attach the disassembly stand (A). 3) Raise the rear tires by turning the adjusting bar of both stands (A) and (B). Prior to this adjustment loosen the flange bolts of the rear tire rim. 4) Be sure to adjust both stands (A) and (B) uniformly to ensure that the tractor remains level. *CAUTION: When attaching the front stand (A) be sure the front tires remain in contact with the ground.*
2.	Tires	Flange bolts Pin 10 x 78		Loosen the two flange bolts and remove the snap pin (10 x 78). The rear tire can then be removed.

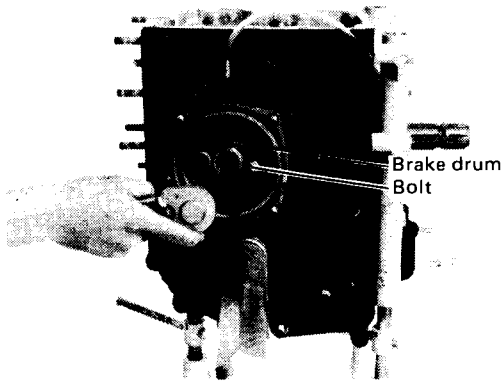
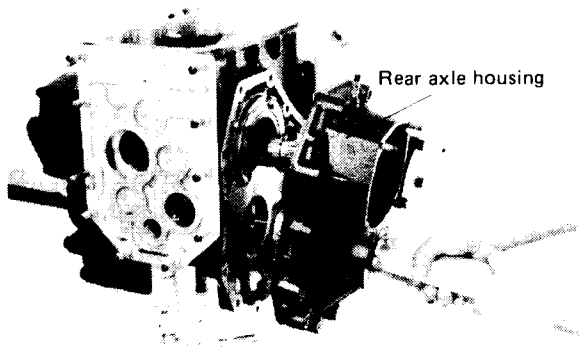
	Division	Part Name	Illustration	Caution/Remarks
3	**Transmission case** **Gear case ass'y final reduction**	**Oil plug 20**		Loosen the oil plug (20) to drain the oil.
4		**Pin 8 x 28 (Differential lock rod)**		Pull out the cotter pin (2.0 x 18) and remove the pin (8 x 28).
5		**Pin 8 x 17.5 (Brake rod)**		Pull out the cotter pin (2.0 x 15) and remove the pin (8 x 17.5).

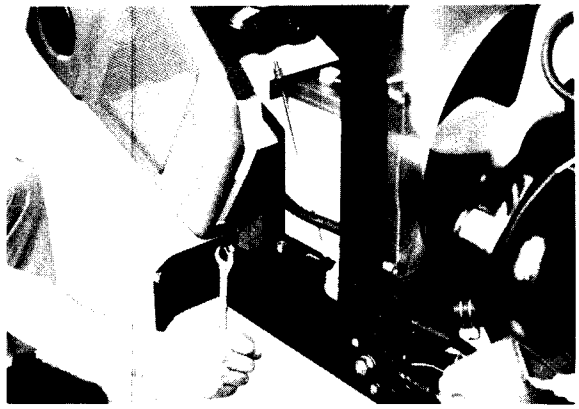
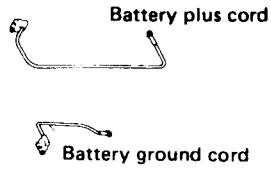
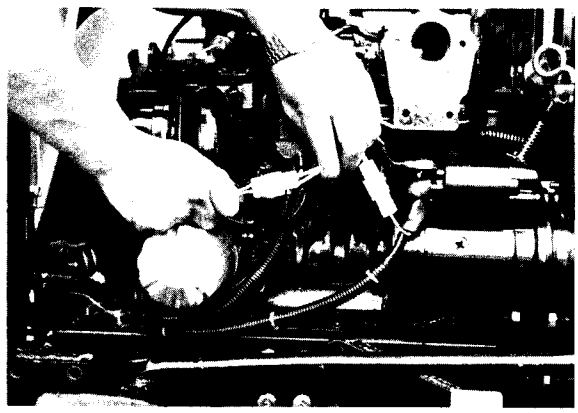
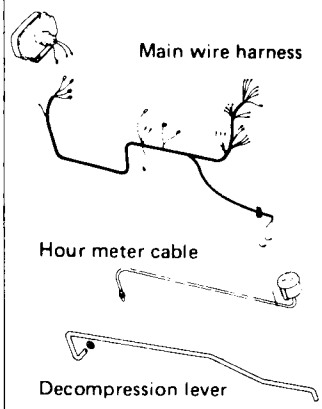
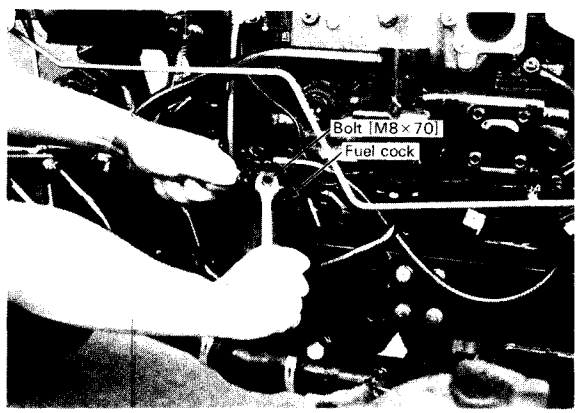
	Division	Part Name	Illustration	Caution/Remarks
6	Fender	Fender (L) (R)		Remove the four bolts (10 x 60), the two bolts (8 x 16), and remove the fender. (L-Side) Remove the two bolts (10 x 65), two bolts (8 x 16), and remove the fender (R-Side)
7	Seat	Operatior's seat bracket		The operator's seat can be removed by removing the two bolts (12 x 25) and the two bolts (10 x 20).
8	Trans-mission case Gear case ass'y final reduction	High-pressure pipe		Loosen the adapter, and remove the high pressure pipe from the hydraulic cylinder case.

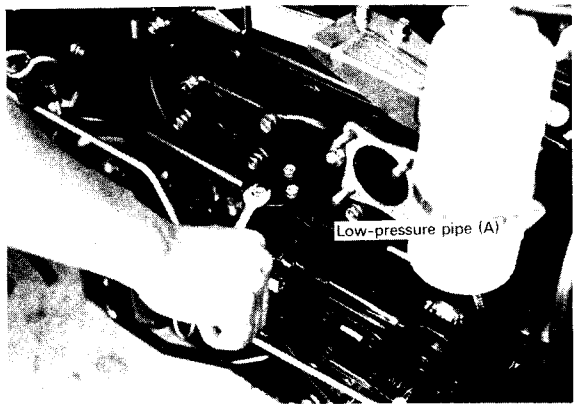
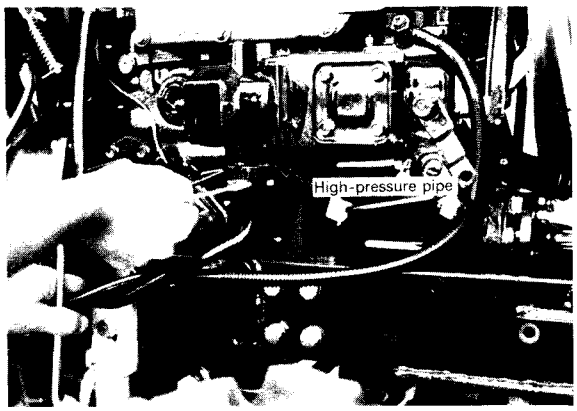
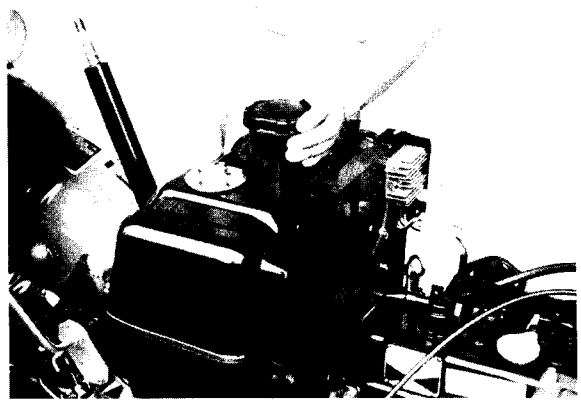
	Division	Part Name	Illustration	Caution/Remarks
9	Transmission case Gear case ass'y final reduction	Low-pressure pipe		Remove the three bolts (6 x 18) and dismantle low pressure pipe. Be sure not to damage the oil filter when dismantling.
10		Filter		Place a container for oil, and remove the oil filter.
11		Electric wire harness		Pull out the wire behind the clutch housing.

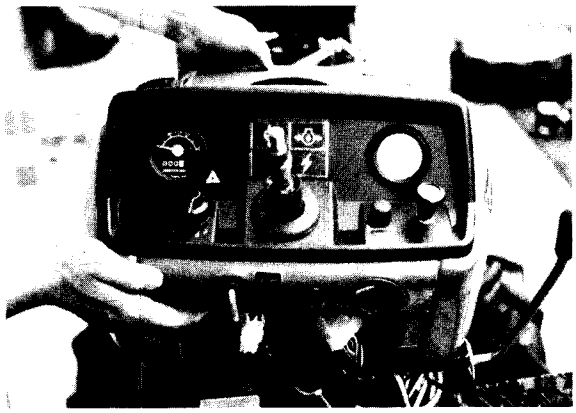
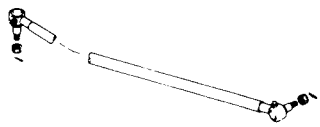
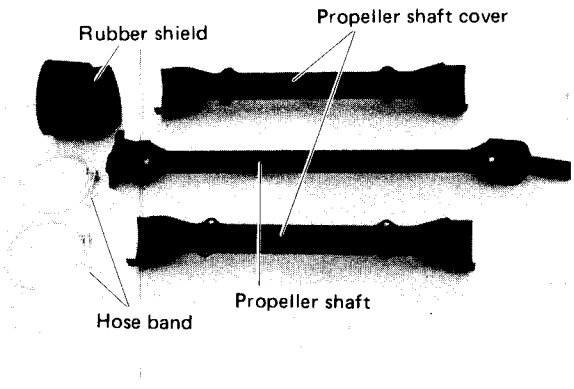
	Division	Part Name	Illustration	Caution/Remarks
12	Transmission case Gear case ass'y final reduction	Dismantling transmission case from clutch housing [Procedure 1]		Remove the seven nuts (12)
13		Dismantling the transmission case from the clutch housing [Procedure 2]		Separate the transmission case from the clutch housing. *CAUTION: Adjust the adjuster in Step 1 so the transmission case and the clutch housing are level.*
14		Separation of transmission case from final reduction gear case		Remove the ten nuts (10) and separate the transmission case from the final reduction gear case. *CAUTION:* *1) When preforming this procedure, if the nuts (on the left and right side) at the arrow mark are hard to remove due to the extruded portion, gradually remove the transmission case and remove the nuts.* *2) Attach these nuts first during assembly.*

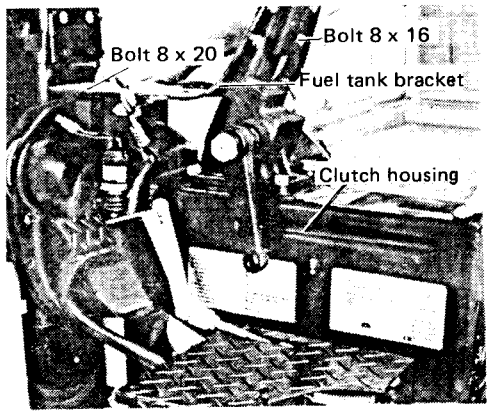
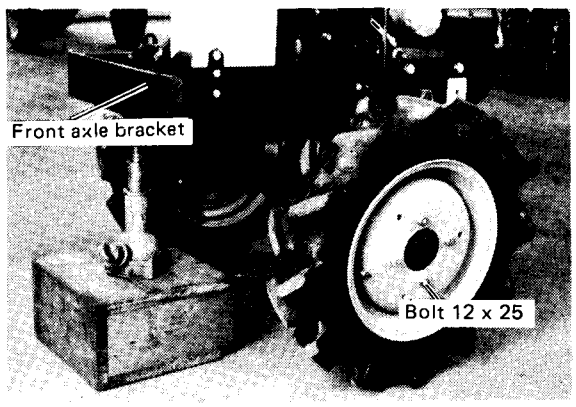
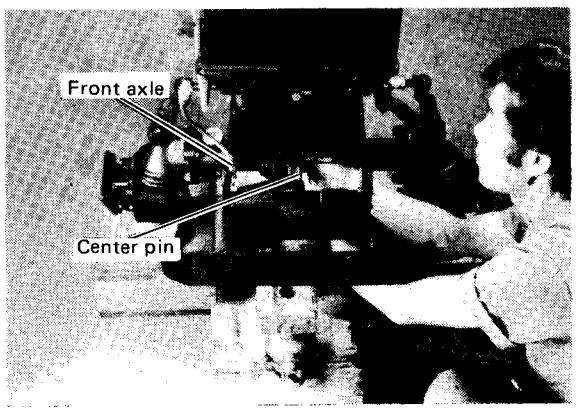
	Division	Part Name	Illustration	Caution/Remarks
15	Housing hydraulic cylinder	Lift arm (L) (R)		1) Lift arm (L) Remove the lift arm set bolt, and force off the lift arm (L). 2) Lift arm (R) a) Remove lift arm set bolt. b) Remove the two bolts (8 x 20), and dismantle the auto-return rod support. c) Lift off the lift arm (R).
16		Hydraulic cylinder housing		Remove the ten bolts (10 x 35), and separate the hydraulic cylinder housing from the final reduction gear case.
17	Brake	Brake (L) (R)		Remove the nuts (8) (on the left & right side), and remove the brake (L) (R).

	Division	Part Name	Illustration	Caution/Remarks
18	Brake	Brake drum		1) Remove the bolt(10x 16) lock plate, washer, and lock plate. 2) Drive the bolt into the brake drum to remove it. *NOTE: For Step 2) use an M8 bolt with a thread length over 1 in (25 mm).* *For example, hydraulic adaptor cover fixing bolt [M8 x 45]*
19	Gear case ass'y, final reduction	Rear axle housing (L) (R)		1) Loosen oil plug (10) and drain the oil. 2) Remove the 8 bolts (10 x 60), and the (12 x 60) bolt, and the two nuts (12). (L-Side) 3) Remove the 6 bolts (10 x 60), 2 bolts (10 x 65), and ..... (R-Side) 4) Use a plastic hammer to loosen the flanged part and bolt parts. Remove with the rear axle shaft as the base.

	Division	Part Name	Illustration	Caution/Remarks
20	Hood, Electric parts Engine parts	Hood ass'y Main wire harness Hour meter cable Decompression lever		 *CAUTION:* *1) Before removing the main wire harness, first dismantle the battery plus (+) cord and the battery ground cord.* *2) When removing the main wire harness, it is recommended for ease of handling not to remove the connection in the instrument panel.*
				
21	F. O. filter	Fuel cock		Pull out the bolt (M8 x 70), and remove the fuel cock.

	Division	Part Name	Illustration	Caution/Remarks
22	Hydraulic pump	Low-pressure pipe		Remove the 3 bolts (6 x 45) and take out the low-pressure pipe (A).
23		High-pressure pipe		Remove the 4 bolts (6 x 45) and take out the high-pressure pipe.
24	F. O. tank	Fuel oil tank		Loosen the 4 nuts (8) to remove the fuel oil tank band, and dismantle the fuel oil tank. *NOTE:* *1) Remove the cock ass'y with the fuel oil tank connected.*

	Division	Part Name	Illustration	Caution/Remarks
25	Instrument panel	**Instrument panel**		Remove the instrument panel in the following sequence: 1) Steering wheel cap 2) Lock nut (14 x 1.5) 3) Steering wheel 4) Fuse box, 2 screws (5 x 10) 5) Current limter, 4 screws (6 x 16) 6) Remove the instrument panel without removing the main wire harness.
26	Steering	**Drag-rod**		When removing the drag-rod, use two plastic hammers and strike the pitman arm end from both sides. 
27	Front drive	**Propeller shaft ass'y [YM169D only]**		Remove the propeller shaft in the following order: 1) Loosen the hose band and shift the setting rubber backward. 2) Take out the 4 bolts (6 x 16) to shift the propeller shaft cover supporter (A) backward. 3) Remove the 4 bolts (8 x 20) to remove the propeller shaft.

	Division	Part Name	Illustration	Caution/Remarks
28	Clutch housing	1) Separating from engine clutch housing 2) Fuel oil tank bracket		1) Remove the 2 nuts (10) and 7 bolts (8 x 16) to separate the engine from the clutch. 2) Remove the 2 bolts (8 x 20) as shown in the photo, togehter with 4 bolts (8 x 16), to remove the fuel tank bracket.
29	Front axle	Front tire Front axle	 	1) Jack up the front axle bracket top and raise the front tires from the ground. 2) Remove the 4 bolts (12 x 25) and remove the front tires. 3) Place a stand under the front axle, so that the center pin is not subjected to any load. 4) Take out the castle nut (16) and extract the center pin. 5) Remove the front axle. *NOTE: Photo shows the procedure for YM169D, but the same disassembling procedure is used for the YM169.*

CHAPTER 3

TRACTOR CONSTRUCTION AND MAINTENANCE

1. CLUTCH AND RELEVANT ITEMS

The clutch serves to engage or disengage the power generated by the engine with the power train, and also serves as a shock absorber protecting the power train and the engine from being subjected to excessive loads.

The clutch fitted on this tractor is a dry, single plate type diaphragm clutch. It can be operated with light pressure and it provides positive engaging and disengaging of the motive power, yet it is also endowed with more than ample durability and capacity.

1-1 Specifications

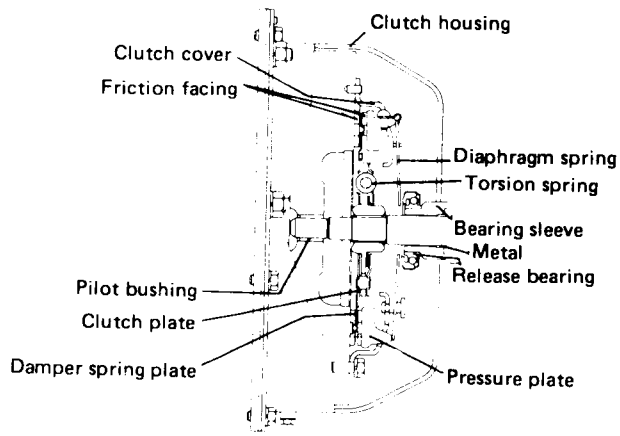
Item	Specifications
Type	Mechanical, dry single plate
Friction disc	Semi-mold type containing wire
Friction disc (outer diameter x inner diameter x thickness)	7.09 x 4.92 x 0.33 in. (180 x 125 x 8.4 mm)
Friction disc surface area	20.4 sq. in. (132 cm^2)
Static torque capacity	97.7 ft.lbs (13.5 kg-m)
No. of clutch plates	1
No. of friction discs	1
Clutch spring	Diaphragm type
No. of torsion springs	6
Release bearing	Oilless bearing
Clutch activation	Mechanical

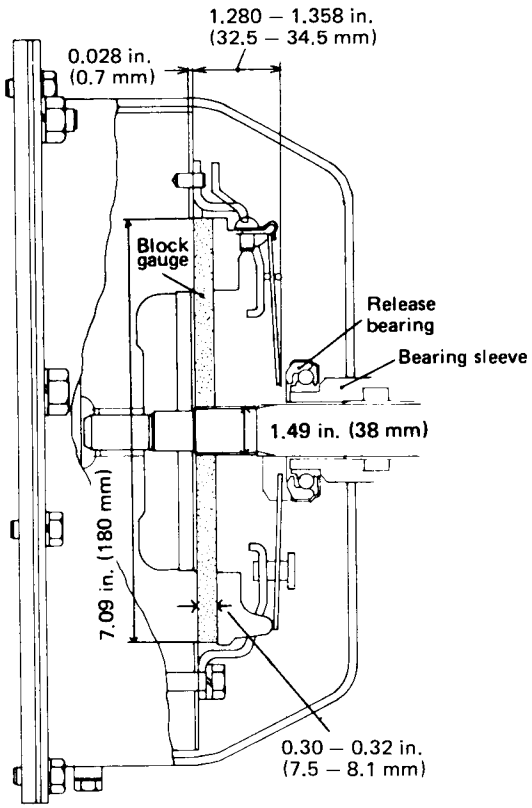
1-2 Operating Principle

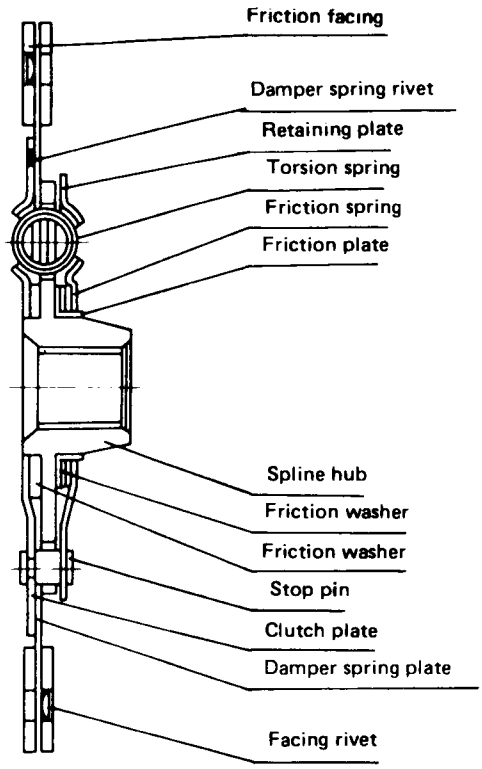
When the clutch pedal is depressed, the bearing sleeve is moved through a clutch pedal consisting of the clutch rod, the clutch release shaft, and the clutch shift yoke.

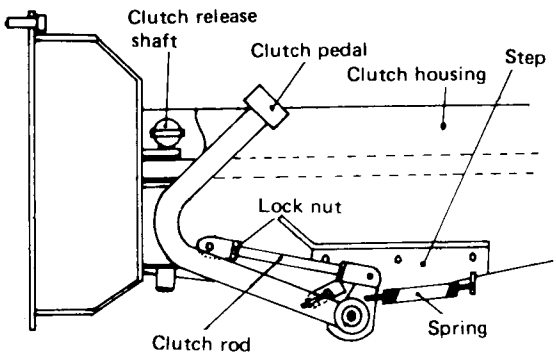
The release bearing moves the diaphragm spring (release lever), weakening the pressure of the diaphragm spring, to disengage the motive power of the engine from the power train.

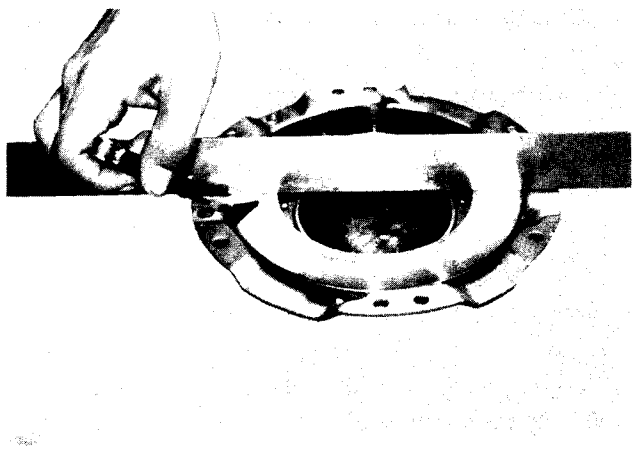
The torsion springs serve to prevent chattering or jerks when starting, and also smoothen the transmission of torque.









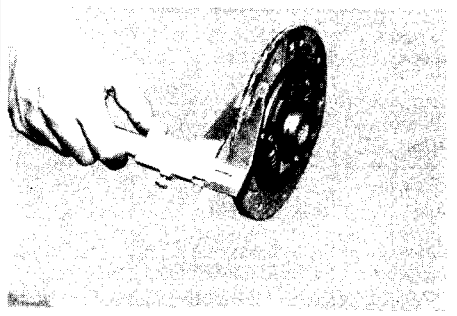
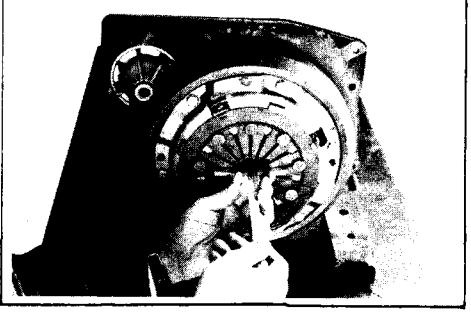


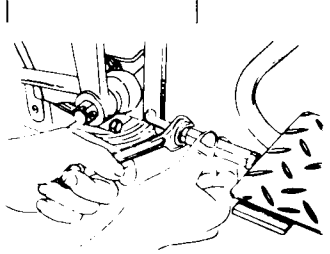
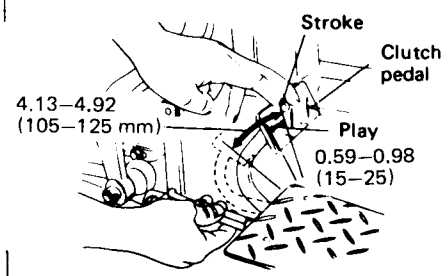
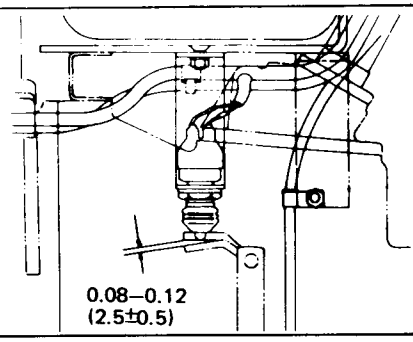
1-3 Visual Inspection

- Check the friction disc for traces of scoring, glazing, burning, discoloring, or oil adherence.
- Check the torsion springs for wear or breakage.
- Check the damper plate for wear.
- Check the splines for wear.
- Check the pressure plate for distortion of friction surface, scratches, or ridge formations.
- Check the release bearing for traces of burning or looseness.

1-4 Inspection by Testing Equipment

Unit: inch (mm)

	Item	Standard specification	Replacement limit	Testing equipment	Illustration
1.	Friction disc thickness (one side)	0.14 (3.5)	–	Calipers	
2.	Depth of rivet head	0.06 (1.5)	0.012 (0.3)	Calipers	
3.	Thickness of assembled clutch disc: [When assembled] [Under pressure]	 0.32–0.34 (8.4±0.3) 0.31 (7.8)	 0.29 (7.4) –	 Calipers	
4.	Disc play: Axial Radial	Within 0.01 (0.3) –	0.03 (0.7) 0.04 (1.0)	Dial gauge	
5.	Friction disc flatness	–	Within 0.016 (0.4)	Dial gauge	
6.	Pressure plate flatness	Within 0.003 (0.07)	0.008 (0.2)	Dial gauge	
7.	Flywheel flatness	Within 0.003 (0.07)	0.008 (0.2)	Dial gauge	
8.	Play in direction of rotations between main drive shaft and disc splines	0.003–0.007 (0.07–0.17)	0.012 (0.3)	Dial gauge	
9.	Main drive shaft end diameter	0.4699–0.4706 ($12^{-0.047}_{-0.065}$)	–	Micrometer	
10.	Inner diameter of flywheel pilot	0.4731–0.4738 ($12^{+0.034}_{+0.016}$)	–	Cylinder gauge	
11.	Clearance between drive shaft and pilot bushings	0.0025–0.0039 (0.063–0.099)	0.012 (0.3)		
12.	Clutch release lever height (after installed)	128 – 1.36 (32.5 – 34.5)	Less than 1.20 (30.5) More than 1.44 (36.5)	Depth Gauge	

	Item	Standard specification	Replacement limit	Testing equipment	Illustration
13.	Inner diameter of clutch release bearing	1.2987–1.2992 ($33^{0}_{-0.012}$)	—	Cylinder gauge	
14.	Outer diameter of the bearing sleeve	1.2990–1.2996 ($33^{+0.011}_{-0.005}$)	—	Micrometer	
15.	Release bearing interference	0.0009– –0.0002 (0.023– –0.005)	Clearance 0.001 (0.025)		
16.	Inner diameter of the metal	0.8819–0.8827 ($22.4^{+0.021}_{0}$)	—	Cylinder gauge	
17.	Outer diameter of the main driving shaft	0.8628–0.8688 ($22^{0}_{-0.084}$)	—	Micrometer	
18.	Clearance between the release bearing bushings and main drive shaft	0.016–0.020 (0.40–0.51)	0.039 (1.0)		
19.	Total stroke of the clutch pedal	4.13–4.92 (105–125)	—	Straight scale	
20.	Clutch pedal play	1.18–1.57 (30–40)			 
21.	Clearance between the clutch release shaft and safety start switch	0.08–0.12 (2.5±0.5)	—	Calipers	

NOTES:

(1) Measure the height of the release lever (diaphragm spring ring), Item 12 above, in the following manner:

- *i) Insert a 0.331 in (8.4 mm) block gauge in place of the friction disc.*
- *ii) Attach the clutch cover to the flywheel face and properly tighten.*
- *iii) The height from the face of the flywheel to the tip of the release lever should be measured with a pair of calipers and a straight scale.*

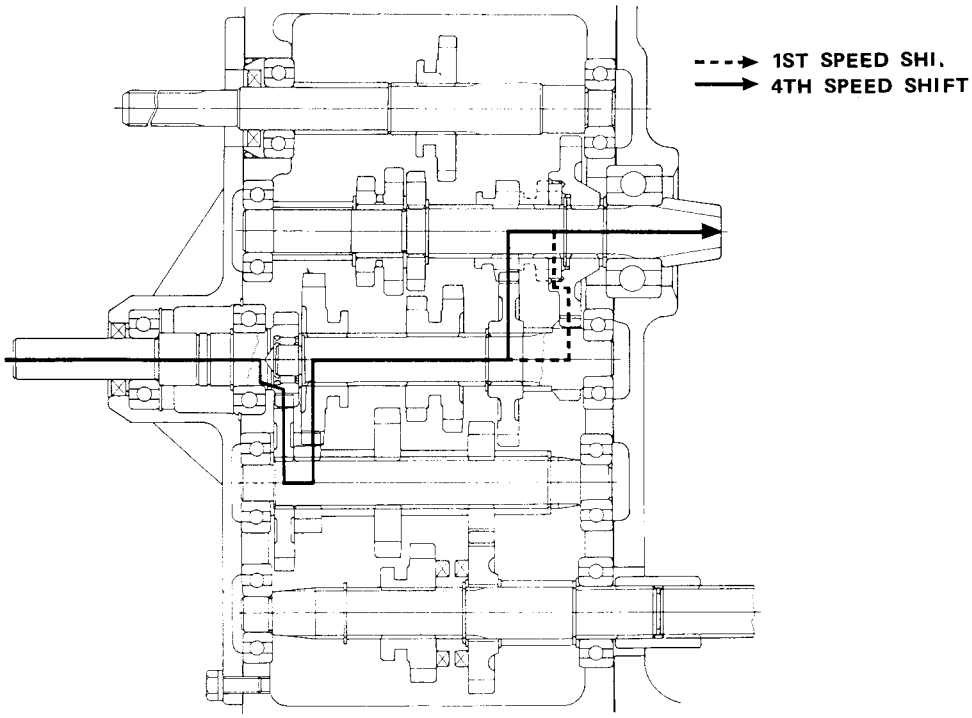
(2) The clearance referred to in Item 21 above is adjusted after the total stroke of the clutch pedal and the clutch pedal play have been properly adjusted.

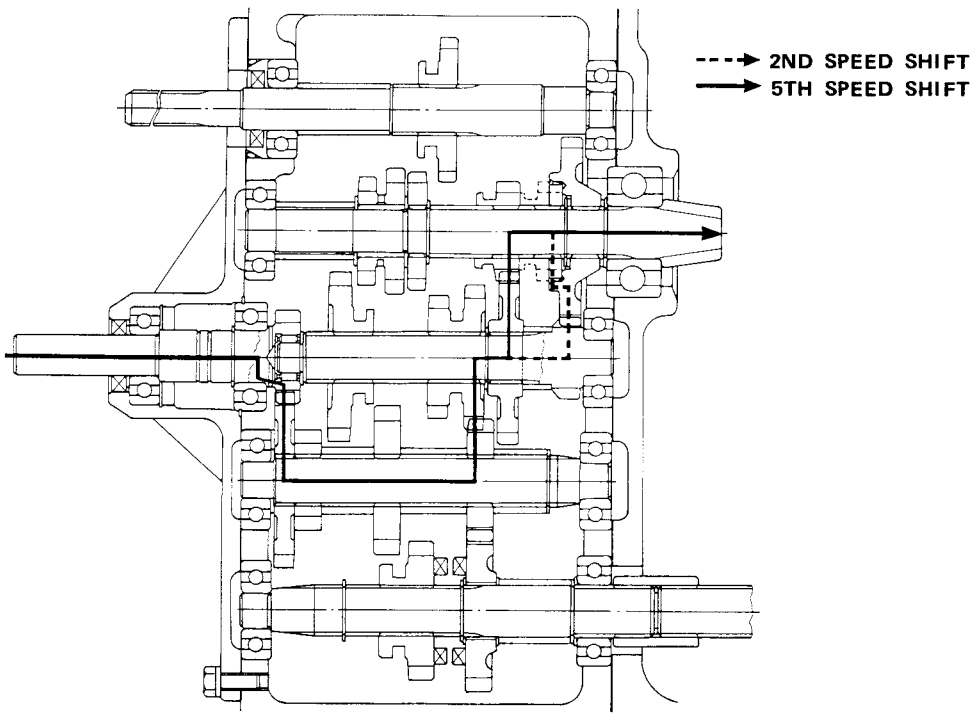
2. TRANSMISSION AND RELATED ITEMS

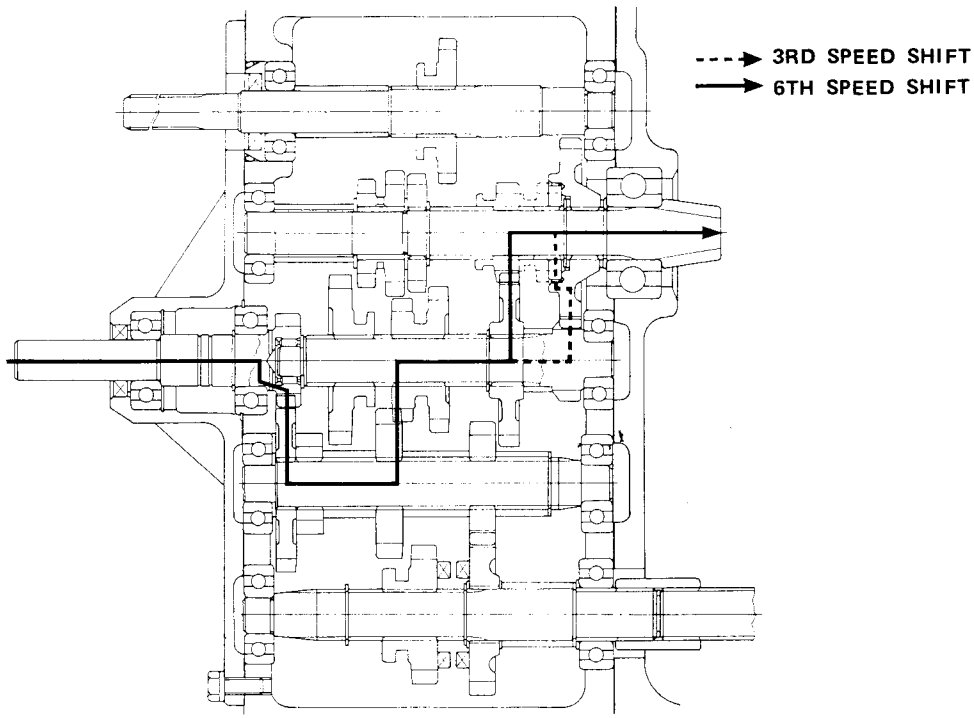
The motive power of the engine is transmitted to the transmission via the clutch.

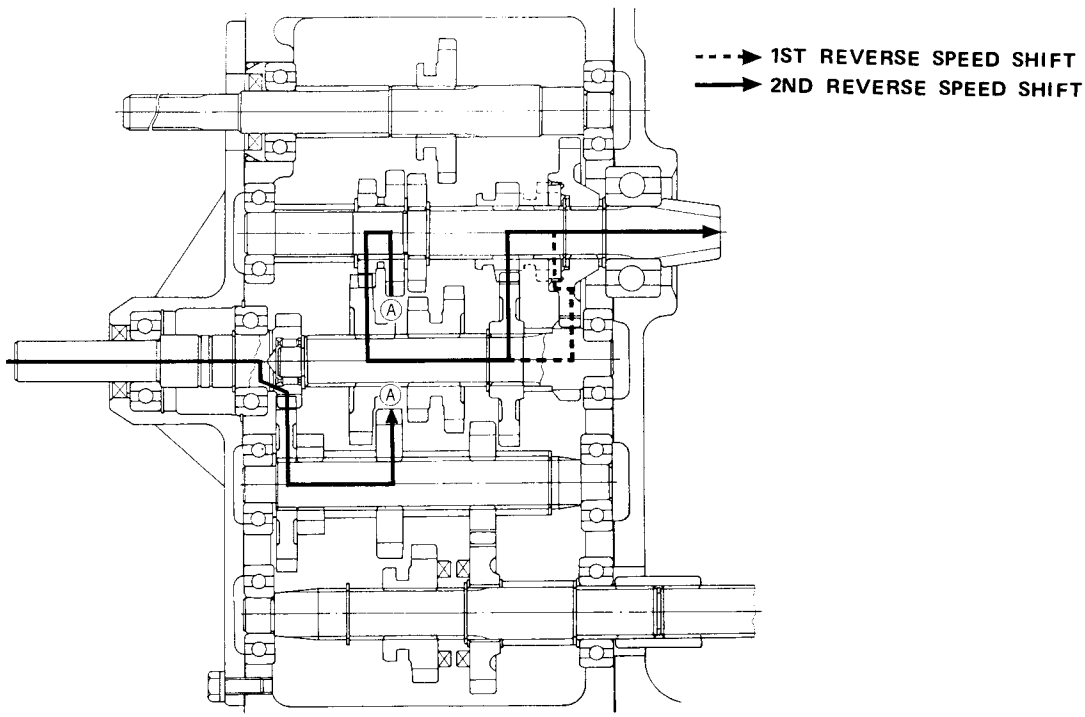
The Model YM169 and YM169D tractors are capable of being operated in a wide range of speeds, (six forward speeds and two reverse speeds), through the combination of its gear shift lever and range shift lever.

[Gear Selection]






3RD SPEED SHIFT
6TH SPEED SHIFT


1ST REVERSE SPEED SHIFT
2ND REVERSE SPEED SHIFT
A
A

2-1 Specifications

Item			Specifications
Transmission	Type		Mechanical; Combination of constant mesh and selective mesh types
	Control levers		Gear shift lever – 1 P.T.O. shift lever – 1 Range shift lever – 1 Front P.T.O. change lever – 1 (YM169D only)
	No. of speeds		Forward–6, reverse–2, P.T.O.–2
	Transmission oil capacity		Upper limit – 2.5 U.S. gals (9.5 *l*) / Lower limit – 2.4 U.S. gals (9 *l*) } YM169D; 2.6 gals (10 *l*) / 2.5 gals (9.5 *l*) } YM169
Reduction gear	Intermediate reduction	Gear type	Spiral bevel gears
		Reduction ratio	6.33
	Final reduction	Gear type	Spur gear
		Reduction ratio	5.2 [YM169, YM169D]
Differential type			Straight bevel gears
Differential lock	Type		Claw clutch
	Control lever		Foot pedal
	Functions		When the foot pedal is activated, the motion is transmitted through a cam to move the differential lock clutch, this locks the differential lock clutch gear and differential lock shaft to the differential assembly.
Over-running clutch			Built-in claw clutch

Model	Speed		Gear shift	Range shift	Total reduction ratio	Transmission gear ratio	Travel speed [Unit: mph (kph)]
YM169 YM169D	Forward	1st	1	L	318.62	9.67	0.73 (1.17)
	"	2nd	2	L	187.66	5.70	1.79 (1.98)
	"	3rd	3	L	128.91	3.91	1.79 (2.88)
	"	4th	1	H	62.85	1.91	3.67 (5.91)
	"	5th	2	H	37.12	1.13	0.23 (10.03)
	"	6th	3	H	25.43	0.77	9.08 (14.61)
	Reverse	1st	R	L	230.05	6.99	1.01 (1.62)
	"	2nd	R	H	45.31	1.38	5.08 (8.18)

2-2 Visual Inspection

1) Check to see that there are no traces of oil leakage or cracks in the transmission housing.

2) Check to see that there are no traces of oil leakage or cracks in the rear axle housing and the final reduction gear housing.

3) Check the gears for uneven wear, chipped teeth or cracks.

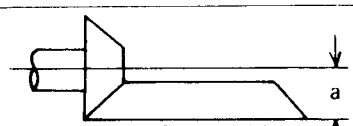
2-3 Inspection by Testing Equipment

Refer to the instructions and detailed drawings in Section 2, Chapter 4 for details on assembling the transmission.

[Servicing Standard for Transmission Section] [Unit: inch (mm)]

No.	Item	Standard specification	Replacement limit	Testing equipment
1.	**[Needle bearing in main shaft]** Outer diameter of main change shaft	0.5902–0.5906 ($15^{0}_{-0.011}$)	—	Micrometer
	Inner diameter of main shaft	0.8270-0.8276 ($21^{+0.020}_{+0.007}$)	—	Cylinder gauge
	Clearance	—	0.006 (0.15)	
2.	**[Reverse gear]** Outer diameter of metal	0.9826–0.9835 ($25^{-0.020}_{-0.041}$)	—	Micrometer
	Inner diameter of reverse gear	0.9843–0.9851 ($25^{+0.021}_{0}$)	—	Cylinder gauge
	Clearance	0.0008–0.0025 (0.020–0.062)	0.0118 (0.3)	
	Outer diameter of countershaft	0.7869–0.7874 ($20^{0}_{-0.013}$)	—	Micrometer
	Inner diameter of metal	0.7882–0.7890 ($20^{+0.041}_{+0.020}$)	—	Cylinder gauge
	Clearance	0.0008–0.0021 (0.020–0.054)	0.0118 (0.3)	
3.	**[Low-hi reduction gear 34]** Outerdiameter of countershaft	0.9835–0.9840 ($25^{-0.020}_{-0.007}$)	—	Micrometer
	Inner diameter of low-hi reduction gear	0.9843–0.9851 ($25^{+0.021}_{0}$)	—	Cylinder gauge
	Clearance	0.0003–0.0016 (0.007–0.041)	0.008 (0.2)	
4.	**[One-way clutch]** Outer diameter of connecting shaft	0.3920–0.3924 ($10^{-0.032}_{-0.043}$)	—	Micrometer
	Inner diameter of bushing	0.3939–0.3945 ($10^{+0.020}_{+0.005}$)	—	Cylinder gauge
	Clearance	0.0001–0.0010 (0.003–0.025)	0.0118 (0.3)	

[Unit: inch (mm)]

No.	Item	Standard specification	Replacement limit	Testing equipment
5.	Backlash for all spur gears	0.006–0.012 (0.15–0.3)	0.02 (0.5)	Dial gauge
6.	Deflection for all shafts, except differential lock shaft	—	0.002 (0.05)	
7.	Width of groove for sliding gears	0.2362–0.2441 ($6^{+0.2}_{0}$)	—	Calipers
	Thickness of shift fork tip	0.2205–0.2283 ($6^{-0.2}_{-0.4}$)	—	Calipers
	Clearance	0.008–0.024 (0.2–0.6)	0.040 (1.0)	
8.	Outer diameter of fork shafts	0.5889–0.5899 ($15^{-0.016}_{-0.043}$)	—	Micrometer
	Inner diameter of shift forks	0.5912–0.5919 ($15^{+0.034}_{+0.016}$)	—	Cylinder gauge
	Clearance	0.0013–0.0030 (0.032–0.077)	0.020 (0.5)	
9.	Free length of shift fork springs	0.6378–0.6575 ($16.2^{+0.5}_{0}$)	0.5906 (15)	Calipers
	Fitted load of shift fork springs	11.66–14.44 lbs (5.29–6.55 kg)	8.33 lbs (3.78 kg)	
	Fitted length of shift fork springs	0.4528–0.4724 (11.5–12)	—	
10.	Free length of low-hi shift fork spring	0.5512–0.5787 ($14^{+0.7}_{0}$)	0.5118 (13)	Calipers
	Fitted load of low-hi shift fork spring	15.50–21.32 lbs (7.03–9.67 kg)	9.04 lbs (4.1 kg)	
	Fitted length of low-hi shift fork spring	0.4488–0.4567 (11.4–11.6)	—	
11.	Backlash of spiral drive pinion (countershaft) and spiral ring gear	0.005–0.007 (0.13–0.18)	0.020 (0.5)	Dial gauge
12.	Backlash between drive pinion and ring gear	 Backlash a: adjusting shims: 0.004 and 0.012 (0.1 and 0.3)	—	Dial gauge
13.	Backlash of differential pinion and differential side gears	0.004–0.008 (0.1–0.2)	0.020 (0.5)	Dial gauge
14.	Inner diameter of differential pinion	*0.5906–0.5925 ($15^{+0.05}_{0}$)	—	Cylinder gauge
	Outer diameter of differential pinion shaft	*0.5892–0.5899 ($15^{-0.016}_{-0.034}$)	—	Micrometer
	Clearance	*0.0013–0.0033 (0.034–0.084)	0.016 (0.4)	
15.	Thickness of the differential pinion liner	0.030–0.034 ($0.8^{+0.065}_{-0.040}$)	0.024 (0.6)	Calipers

[Unit: inch (mm)]

No.	Item	Standard specification	Replacement limit	Testing equipment
16.	Thickness of the differential side gear spacers	0.035 (0.9)	0.028 (0.7)	Calipers
		0.039 (1.0)	0.031 (0.8)	
		0.043 (1.1)	0.035 (0.9)	
		0.047 (1.2)	0.039 (1.0)	
17.	Outer diameter of metal 22 x 27 x 22.5	1.0609–1.0622 ($27^{-0.020}_{-0.053}$)	—	Micrometer
	Inner diameter of the differential housing	1.0630–1.0638 ($27^{+0.021}_{0}$)	—	Cylinder gauge
	Clearance	0.0008–0.0029 (0.020–0.074)	0.012 (0.3)	
18.	Outer diameter of the final reduction pinion	0.8641–0.8654 ($22^{-0.020}_{-0.053}$)	—	Micrometer
	Inner diameter of metal 22 x 27 x 22.5	0.8661–0.8674 ($22^{+0.03}_{0}$)	0.012 (0.3)	Cylinder gauge
	Clearance	0.0007–0.0033 (0.020–0.086)	—	
19.	P.T.O. shaft deflection (at tip)	—	0.012 (0.3)	Dial gauge
20.	Play in direction of rotation between all gears and shaft splines	—	0.012 (0.3)	

NOTES:

(1) Check to see that there is no looseness between the inner and outer faces of the ball bearings and needle bearings. If there is any looseness, or if any abnormal noises are heard when turned, or if it does not turn smoothly, replace.

Particular care should be taken in the case of needle bearings to see that the rollers are not cracked or chipped.

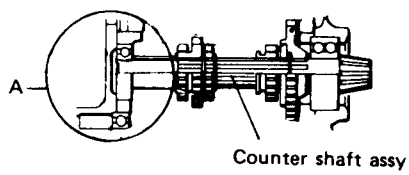
(2) If the gears have any uneven wear, galling, or scoring, they should be repaired or replaced.

1) Item 11 through 16 refer to measurements of the differential assembly; Item 12 is carried out at a point 90° from the axial direction of the motive power rotation shaft. Adjustments should be made in the following manner:

i) When the same drive pinion is reversed, use the shims that were fitted initially.

ii) When using a new ring gear and pinion:

a) Insert shims [(two sizes are available: 0.004, 0.012 in. (0.1, 0.3 mm)] between the transmission case and the transmission case front cover so that there is no space on the



counter shaft.

b) Fit the differential assembly into the final reduction gear case.

c) Insert shims [(two sizes are available: 0.004, 0.012 in. (0.1, 0.3 mm)] between the

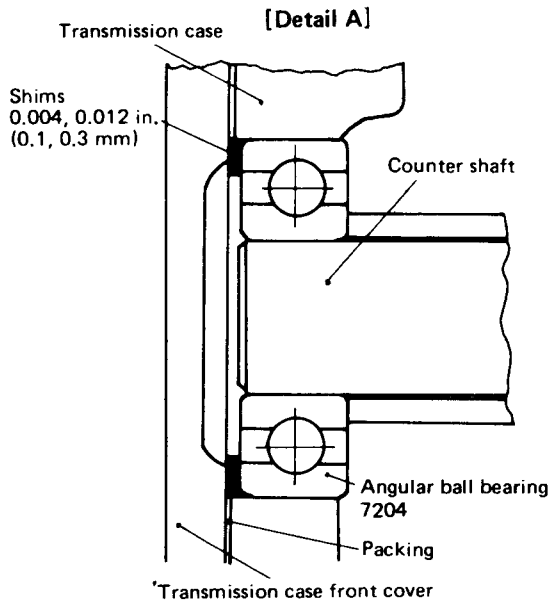
ball bearing 6207 (right hand) and the circlip 72 so that the backlash (Item 11) is 0.005 ~ 0.007 in. (0.13 ~ 0.18 mm).

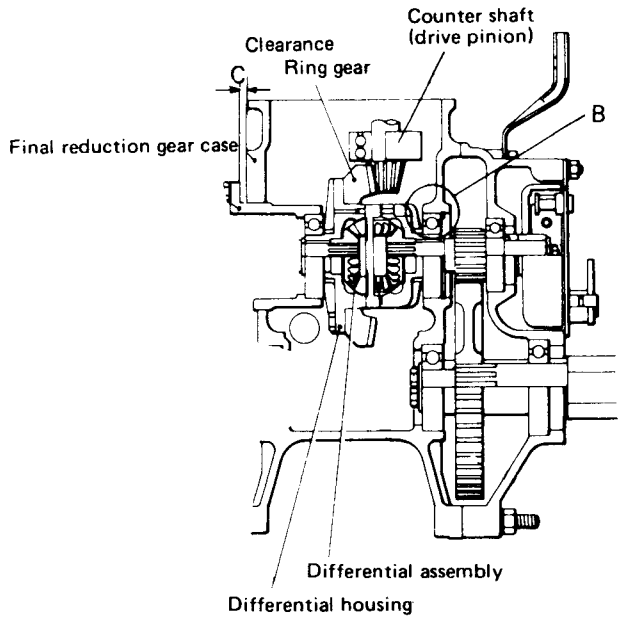
d) At this time take care to see that there is no space between the differential housing and the ball bearing 6207 (both sides), the differential bearing case and the ball bearing 6207 (left hand).

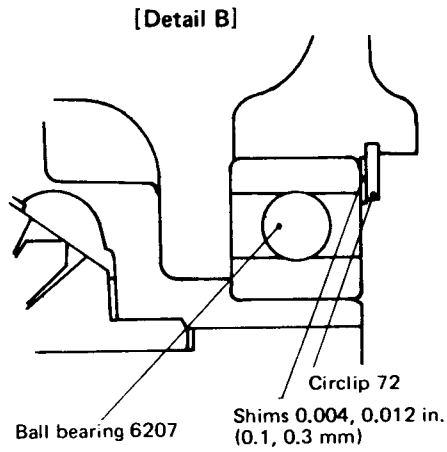
e) Measure the clearance C between the final reduction gear case and differential bearing case without shims, insert shims equivalent to the clearance C and additional shim 0.004 in. (0.1mm).

PARTS

194200–32300 0.004 in. (0.1mm) Shim
194200–32310 0.012 in. (0.3mm) Shim

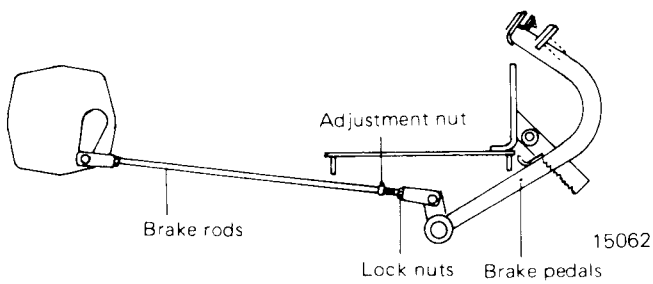






3. BRAKE

The brake serves not only to bring the tractor to a halt when in motion, but the left and right brakes of the tractor operate independently of each other and allow the operator to negotiate tight turns. The brake shaft of the tractor is fitted behind the differential lock shaft and is hermetically sealed to prevent water from entering when the tractor is used in irrigated fields.



The brakes are the internal expansion, mechanical type. Foot pressure forces the brake linings against the brake drum to brake the tractor. The

brake linings/shoes are of the leading-trailing type, and the same amount of braking force is produced for both forward and reverse motion.

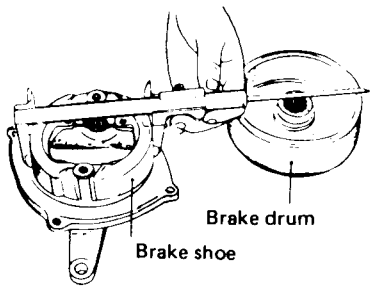
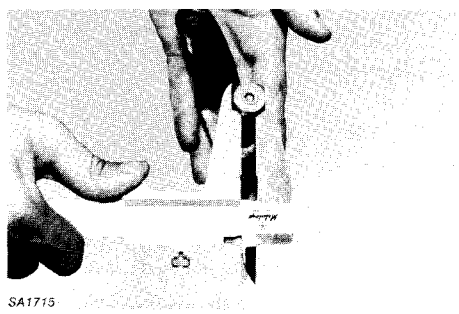
The parking brake consists of a locking device coupled to the foot brake.

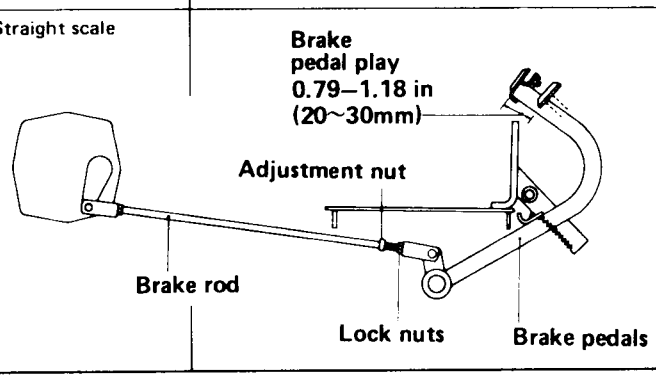
3-1 Specifications

Item	Specifications
Type	Internal expansion mechanical brakes
Method	Anchor pin method
Activation	Foot pressure
Location	Reduction pinion
Functioning	Independent function for left and right sides (may be coupled as needed)
Lining	Specical woven material
Brake design	Leading-trailing shoes
Brake adjustments	Accomplished by adjusting length of the brake rod
Parking brake	Locking of the foot brakes

3-2 Inspection and Maintenance

Unit: inch (mm)

	Item	Stadnard specification	Replacement limit	Testing equipment	Illustration
1.	Inner diameter of brake drums	4.3307–4.3321 ($110^{+0.035}_{0}$)	4.39 (111.5)	Calipers	
	Out side diameter of brake linings	$110^{-0.5}_{-0.8}$	106.2		
2.	Thickness of brake linings	0.157 (4)	0.098 (2.5)	Calipers	
3.	Inner diameter of brake case cam shaft	0.7106–0.7146 ($18^{+0.15}_{+0.05}$)	—	Calipers	
	Outer diameter of brake cam shaft	0.7070–0.7087 ($18^{-0.043}_{0}$)	—	Micrometer	
	Clearance	0.0020–0.0080 (0.05–0.193)	0.12 (0.3)		

	Item	Standard specification	Replacement limit	Testing equipment	Illustration
4.	Inner diameter of brake pedal	0.9921–0.9980 ($25.2^{+0.15}_{0}$)	—	Cylinder gauge	
	Outer diameter of brake pedal shaft	0.9822–0.9843 ($25^{0}_{-0.052}$)	—	Micrometer	
	Clearance	0.0079–0.0158 (0.2–0.402)	0.04 (1.0)		
5.	Sinking of braking surface of linings	–	0.02 (0.5)	Calipers	
6.	Brake pedal play	0.79–1.18 (20–30)	2.36 (60)	Straight scale	

NOTES:

(1) The left and right brake linings are interchangeable, and it is a good practice to rotate them from time to time to have even brake wear.

(2) In adjusting the brakes, adjust the play by extending or reducing the length of the turnbuckle on the brake rod.

(3) Always make sure that the play is the same for each side. Otherwise, if the brakes are interlocked and used to bring the machine to a halt or to reduce speed, the braking forces for the left and right side will be uneven and the tractor will pull to one side, which is extremely dangerous.

4. HYDRAULIC LIFT DEVICE

The hydraulic lift device is for handling implements. The hydraulic oil is the same oil used for the transmission, and contributes greatly to reduced maintenance cost since the operator does not have to maintain various types of lube oils.

The so-called single-action type hydraulic system lifts implements hydraulically but allows them to be lowered by the force of their own weight.

4-1 Specifications

Item		Specifications
1.	Hydraulic pump type	GP1–C–5C
2.	Hydraulic pump discharge volume	3.43 US gals (13ℓ)/min. at RPMs of 2600 [0.0013 US gals/rev (5 cc/rev)]
3.	Low pressure pipe	Dia 0.78 in. x 0.079 in. (22 mm x 2 t)
4.	High pressure pipe	Dia 0.47 in x t 0.059 in (12 mm x 1.5 t)
5.	Hydraulic control relief pressure full flow	1564 psi (110 kg/cm^2)
6.	Hydraulic cylinder bore	2.36 in (60 mm)
7.	Hydraulic piston outer diameter	2.36 in (60 mm)
8.	Hydraulic piston rod	Dia 0.98 in x L 4.57 (25 mm x 116 mm)
9.	Lift crank (length)	2.95 in (75 mm)
10.	Lifting shaft (length)	8.74 in (222 mm)
11.	Lifting capacity at tip of lower link	More than 1210 lbs (550 kg)
12.	Full stroke lift time	1.1 sec at RPMs of 2600
13.	Lift arms (length)	9.84 in (250 mm)

4-2 Inspection and Maintenance

Chapter XI, Section 6 for details on assembling the hydraulic system.

Unit: inch (mm)

No.	Item	Standard specification	Replacement limit	Testing equipment
1.	Relief valve pressure (safety valve pressure)	1564 psi (110 kg/cm^2)	—	
2.	Inner diameter of the lifting shaft bushings (left side)	1.1811–1.1803 ($30^{+0.025}_{0}$)	—	Cylinder gauge
	Outer diameter of the lifting shaft (left side)	1.1795–1.1803 ($30^{-0.020}_{-0.041}$)	—	Micrometer
	Clearance (left side)	0.0008–0.0026 (0.020–0.066)	0.016 (0.4)	
3.	Inner diameter of the lifting shaft bushings (right side)	1.3780–1.3795 ($35^{+0.039}_{0}$)	—	Cylinder gauge
	Outer diameter of the lifting shaft (right side)	1.3756–1.3770 ($35^{-0.025}_{-0.059}$)	—	Micrometer
	Clearance (right side)	0.0010–0.0039 (0.025–0.098)	0.016 (0.4)	

Unit: inch (mm)

No.	Item	Standard specification	Replacement limit	Testing equipment
4.	Hydraulic cylinder bore	2.3622–2.3661 ($60^{+0.1}_{0}$)	—	Cylinder gauge
	Outer diameter of hydraulic piston	2.3598–2.3610 ($60^{-0.060}_{-0.030}$)	—	Micrometer
	Clearance	0.0012–0.0063 (0.030–0.16)	0.012 (0.3)	
5.	Lifting capacity at the tip of lower link	More than 1100 lbs (500 kg)	—	

NOTES:

(1) The components of the hydraulic equipment are fitted selectively and are precision finished by lapping, thus when they have been disassembled for maintenance, the following points should be borne in mind:

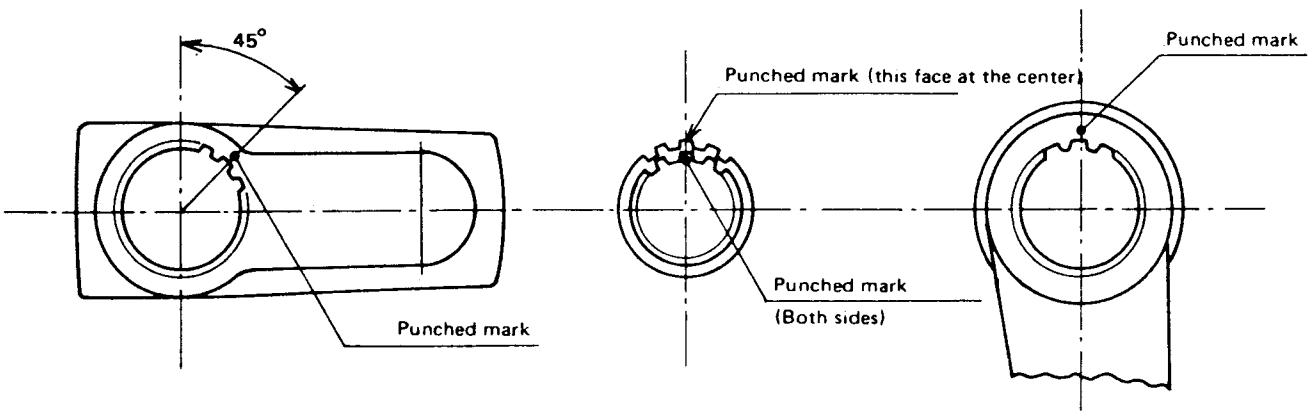
i) Do not interchange spool;
ii) Check beforehand the number of hydraulic pressure adjusting shims fitted, and make sure the correct number are used in assembly.
iii) When assembling, components such as O-rings should always be replaced.

(2) When assembling hydraulic cylinder:

Be sure to align the assembly guide marks on the lift shaft, lift crank, and lift arms.

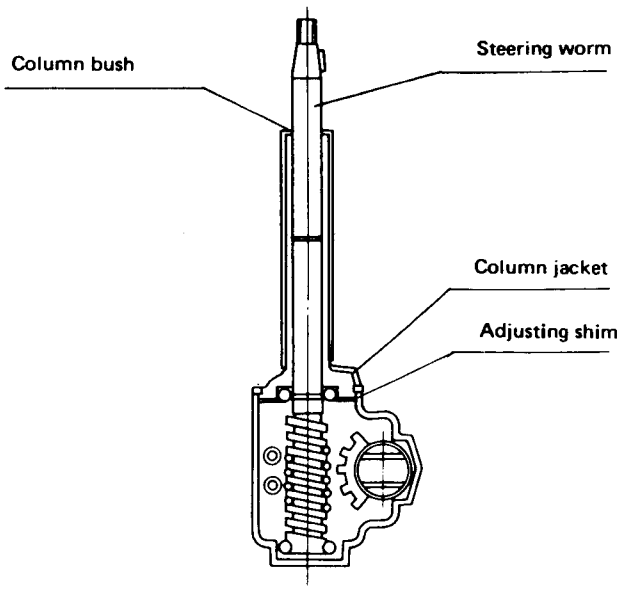
(3) Make sure that each section of the system functions properly as it is assembled.

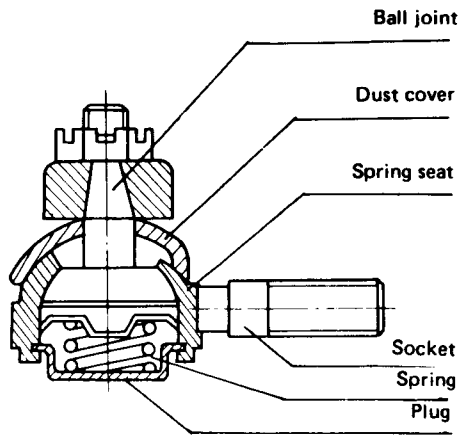
Also check the working pressure of the safety valve with a pressure gauge after the final assembly has been completed.



5. STEERING

The steering system must provide excellent steering performance during operation. This tractor has a ball-nut type steering system.





5-1 Specifications

Unit: inch (mm)

Item	Specifications
Tractor model	**YM169, YM169D**
Type	Ball-screw
Gear ratio	18.9 : 1
Angle of motion of center shaft	2 x 43°
Sector gear module	3.5
No of teeth of sector gear on full circle basis	15
Worm lead	0.344 (8,731)
Direction of twist of the worm gear	Left
Lubrication Oil	Grease
Outer diameter of steering wheel	15.8 (400)
Steering wheel play	1.17–2.0 (30–50) m)

5-2 Inspection and Maintenance

The steering gear box is capable of withstanding heavy use, and there is rarely any need to disassemble it for maintenance work.

Backlash adjustment can be done by varying the number of adjusting shims fitted on the side of the gear box.

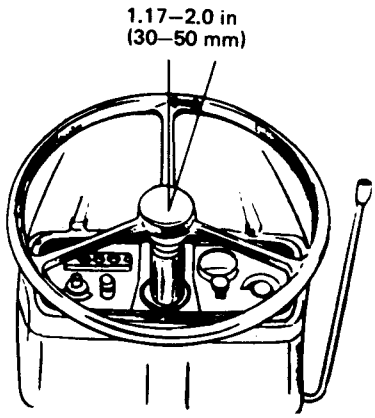
Steering play adjustment can be done by adjusting the backlash of the gears.

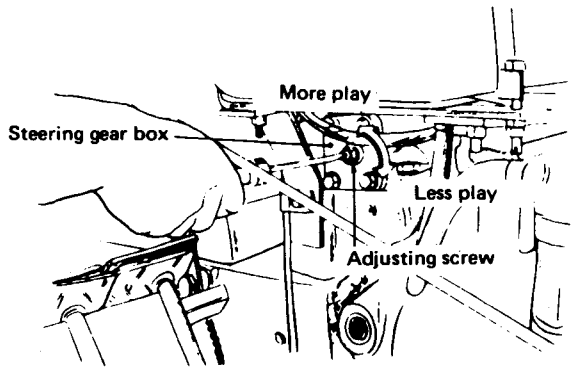
By turning the screw to the right, the amount of play can be reduced. (The standard position for the screw is a quarter-turn back from the point at which the screw suddenly becomes hard to turn.)

NOTES:

(1) Check whether the drag rod is bent.

(2) Check whether the ball joints function smoothly.





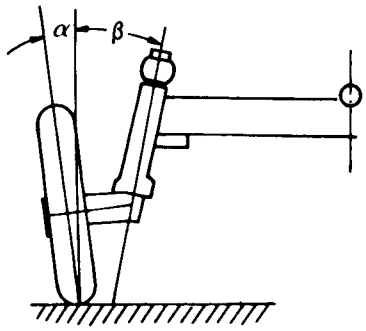
6. FRONT AXLE

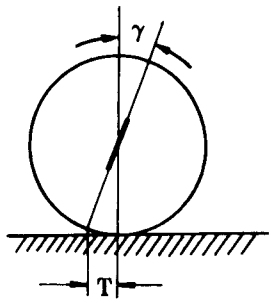
The front axle is a Lemoine type axle supported by a center pin. It serves to keep the front end of the tractor on an even keel when travelling over rough terrain where the left and right wheels go over irregular depressions and mounds, and it also provides good steering qualities. Other features of the Lemoine type axle are that it provides high ground clearance and it is rugged and therefore very durable.

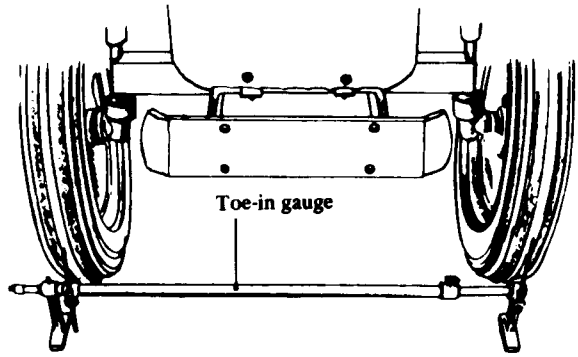
6-1 Specifications

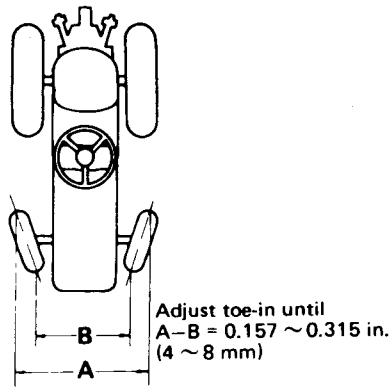
Unit: inch(mm)

Model / Item	YM169	YM169D
Tread	30.3 (770)	29.3 (745)
Tire size	4.50–10–2PR	5–12–2PR
Tire pressure	17.8 psi (1.25kg/cm^2)	17.8 psi (1.25 kg/cm^2)
Toe-in	0.16–0.32 (4–8)	0.16–0.32 (4–8)
Camber	3°	3°
Caster	3°	0°
Trail	0.53 (13.5)	0
King pin inclination angle	7°	8.5°









α: Camber angle – provides stability in steering and straight line performance.

β: King pin inclination – reduces steering effort.

γ: Caster angle – improves directional stability.

T: Trail – distance between point at which an imaginary line extending from the axis of the king pin intersects with the ground and the point at which an imaginary line extending perpendicularly from the axis of the wheel intersects with the ground.

Toe-in: The difference between A and B. Serves to improve directional stability. Because of the camber angle, the left and right front tires each try to roll forward outwardly. This is prevented by the tie-rods, and so a certain amount of slippage is created on the ground surface, and directional stability tends to be impaired. To remedy this, the toe-in should be adjusted.

6-2 Inspection and Maintenance [Model: YM169]

Unit: inch (mm)

No.	Item	Standard specification	Replacement limit	Testing equipment
1.	Inner diameter of king pin bushings	0.9850–0.9871 ($25^{+0.072}_{+0.020}$)	—	Cylinder gauge
	Outer diameter of king pin	0.9822–0.9843 ($25^{0}_{-0.052}$)	—	Micrometer
	Clearance	0.0008–0.0049 (0.020–0.124)	0.016 (0.4)	
2.	Up and down play of king pin	0.0118–0.0421 (0.3–1.07)	Less than 0.07 (2.0)	Dial gauge
3.	Inner diameter of center pin bushings	0.8665–0.8693 ($22^{+0.081}_{+0.010}$)	—	Cylinder gauge
	Outer diameter of center pin	0.8641–0.8661 ($22^{0}_{-0.052}$)	—	Micrometer
	Clearance	0.0004–0.0052 (0.01–0.133)	0.016 (0.4)	
4.	Front and back play of center pin	0	0.020 (0.5)	Dial gauge

NOTES:

(1) The king pin is integrated with the knuckle spindle so the spindle should be checked for cracks.

(2) Replacement of the king pin bushings is done by press-fitting the new ones in.

(3) If there is excessive up and down play of the king pin (Item 2 above), insert additional upper cover(s).

(4) When the front hub bearing becomes worn, the front wheels will develop a shimmy (a steering vibration or flutter in the vicinity of the kingpin), which will impair steering stability, therefore, particular care should be paid to the front hub bearings when the front hub is disassembled.

(5) To adjust the toe-in, first draw lines representing the center of the tire tread and the horizontal center of the tires, and adjust the distance between the two wheels at the front and rear of the tires. The actual adjustment is made by turning the turnbuckle to adjust the length of the tie-rods; after the adjustment has been completed, tighten the locknuts securely.

6-3 Inspection and Maintenance [Model: YM169D]

Unit: inch (mm)

No.	Item	Standard specification	Replacement limit	Testing equipment
1	Inner diameter of center pin bushings	0.8665–0.8693 ($22^{+0.081}_{+0.010}$)	—	Cylinder gauge
	Outer diameter of center pin	0.8641–0.8661 ($22^{0}_{-0.052}$)	—	Micrometer
	Clearance	0.0004–0.0052 (0.01–0.133)	0.016 (0.4)	
2	Up and down play in king pin	0.0004–0.0118 (0.1–0.3)	0.0187 (0.5)	Dial gauge
3	Fore and aft play of center pin	0	0.0187 (0.5)	Dial gauge
4	Inner diameter of king pin bevel gear			
	Outer diameter of inner collar			
	Clearance			

No.	Item	Standard specification	Replacement limit	Testing equipment
5	Backlash of drive pinion and ring gear	0.004–0.006 (0.1–0.15)	0.020 (0.5)	Micrometer
6	Backlash of differential pinion and differential side gear	0.004–0.008 (0.1–0.2)	0.020 (0.5)	Micrometer
7	Inner diameter of differential pinion	*0.5906–0.5925 ($15^{+0.05}_{0}$)	—	Cylinder gauge
	Outer diameter of differential pinion shaft	*0.5892–0.5899 ($15^{-0.016}_{-0.034}$)	—	Micrometer
	Clearance	*0.0013–0.0033 (0.034–0.084)	0.016 (0.4)	
8	Thickness of differential pinion liner	0.030–0.034 ($0.8^{+0.065}_{-0.040}$)	0.024 (0.6)	Calipers
9	Thickness of differential side gear spacers	0.035 (0.9)	0.028 (0.7)	Calipers
		0.039 (1.0)	0.031 (0.8)	
		0.043 (1.1)	0.035 (0.9)	
		0.047 (1.2)	0.039 (1.0)	

is carried out at a point 90° from the axial direction of the motive power rotain shaft, and the adjustments are made in the following manner:

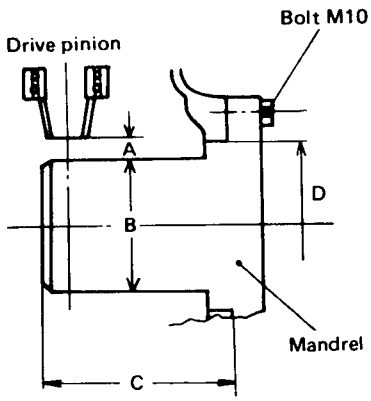
i) When the same drive pinion and ring gear are to be reused, remember without fail to use the shims that were fitted initially.

ii) When using a new ring gear and pinion:

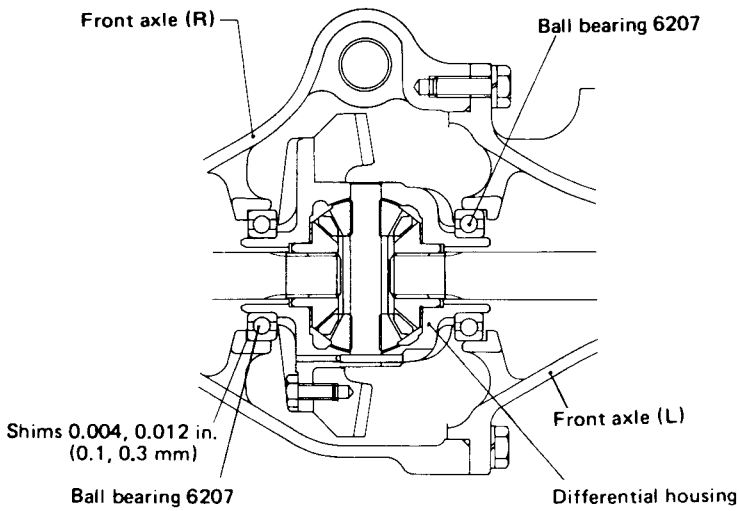
a) Use a mandrel instead of the differential carrier and use the shims [(two sizes available: 0.004, 0.012 in (0.1, 0.3 mm)] between the front axle and front axle case cap to adjust the reading for A to 0.6280 ~ 0.6319 in (16 ± 0.05 mm).

b) Fit the differential assembly with the front axle case.

c) Insert shims [two sizes available: 0.004, 0.012 in (0.1, 0.3 mm)] between the front axle (L) and between ball bearing 6207 so that the backlash (Item 6) is 0.005 – 0.007 in (0.13 –0.18 mm).



A: 0.6280–0.6319 in. (16±0.05 mm)
B: 2.8343–2.8316 in. ($72^{0}_{-0.01}$ mm)
C: 2.362 in. (60 mm)
D: 6.0614–6.0630 in. ($154^{0}_{-0.04}$mm)



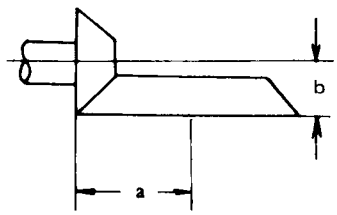
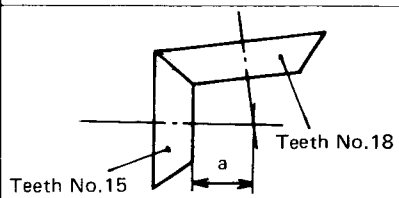
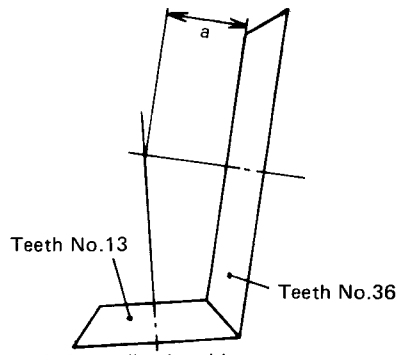
d) At this time, be sure that there is no space between the differential housing and the ball bearing 6207 (both sides), the front axle (L) and ball bearing 6207 (lighthand).

e) Insert shims [0.004, 0.012 in (0.1, 0.3 mm)] between the front axle (R) and front axle case so that there is no space at the places mentioned in Item (d).

f) Item 11 through 14 refer to measurements for the bevel gears in the front-gear cases; the adjustments are made in the following manner:

(1) When using the same bevel gears, remember without fail to use the shims that were fitted initially.

Unit: inch (mm)

	Item	Standard specification	Replacement limit	Testing equipment
10	Backlash between drive pinion and ring gear	 Backlash a: adjusting shims 0.004 and 0.012 (0.1 and 0.3) Backlash b: adjusting shims 0.004 and 0.012 (0.1 and 0.3)	—	Dial gauge
11	Backlash of bevel gear 15 and bevel gear 18	0.004–0.012 (0.1–0.3)	0.024 (0.6)	Dial gauge
12	Backlash of bevel gear 13 and bevel gear 36	0.004–0.012 (0.1–0.3)	0.024 (0.6)	Dial gauge
13	Backlash between bevel gear 15 and king pin bevel gear 18	 Backlash a: adjusting shims 0.004–0.012 (0.1–0.3)	—	Dial gauge
14	Backlash between the kingpin bevel gear and the bevel gear	 Backlash a: adjusting shims 0.004–0.012 (0.1–0.3)	—	Dial gauge
15	Play in direction of rotation between all gears and shaft splines	—	0.012 (0.3)	

NOTES:

(1) Check to see that there is no looseness between the inner and outer laces of the ball bearings and needle bearings. If this is the case, or if they emit abnormal noises when turned, or do not turn smoothly, replace.

Particular care should be taken in the case of needle bearings to see that the rollers are not cracked or chipped.

(2) As for the gears, if there is any uneven wear, galling, or scoring, they should be repaired to replaced.

(3) Item 5 through 10 refer to measurements for the differential assembly; Item 10

CHAPTER 4

TRACTOR ASSEMBLY

(2) When using new bevel gears,

i) Insert shims [two sizes available: 0.004, 0.012 in (0.1, 0.3 mm)] between the bevel gear 15 and ball bearing 6304 so that the backlash (Item 12) of the bevel gear 15 and king pin bevel gear 18 is 0.004–0.012 in (0.1–0.3 mm).

ii) Insert shims [two sizes available: 0.004, 0.012 in (0.1, 0.3 mm)] between the front gear box and front bearing case so that the backlash (Item 13) of the bevel gear 36 and bevel gear 13 is 0.004–0.012 in (0.1–0.3 mm).

CAUTION:

1) Figures at the end of gear indicate the number of teeth.

7. REAR AXLE

7-1 Specifications

Model / Item	YM169/169D
Rear axle type	Half-floating type
Tread adjustment	4-stage: 27.6–33.5 in (700–850 mm)
Tire size: Standard	8–16–4PR F.S.L.
Optional	8–16–4PR F.D (Turf tire)
Standard air pressure: Standard	22.8 psi(1.6 kg/cm^2)
Optional	22.8 psi(1.6 kg/cm^2) (Turf tire)

7-2 Inspection and Maintenance

No.	Item	Standard specification	Replacement limit	Testing equipment
1	Final pinion shaft outer diameter at outer bearing	–	0,983–0.984 (24.987–25.003)	Micrometer
	Final pinion shaft outer diameter at inner bearing	–	0.866–0.868 in. (22.000–22.033)	Micrometer

1. GENERAL ASSEMBLY

1) Attach the clutch disc and pressure plate to the main drive shaft, insert the shaft in the flywheel, center it, and then secure the pressure plate to the flywheel with bolts.

NOTE: Make sure that there is no oil on the mounting surfaces of the flywheel and pressure plate.

2) Fit the main drive shaft into the clutch housing.

3) Move the tractor towards the engine, and attach the engine and tractor.

NOTE: Check to be sure the PTO main drive shaft is correctly joined to the joint.

4) Assemble the tachometer cable, drag rod, throttle rod, and decompression rod.

NOTE: All split pins should be replaced with new ones.

5) Attach the fuel oil pipe to the fuel pump. Open the filter cock. Bleed the fuel system of air at the fuel pump. Attach the return pipe to the fuel injection valves.

NOTE: Replace the copper packing.

6) Attach the hydraulic pipes.

NOTES; Replace the copper packing on the tractor side; make sure that O-rings are in position on the engine side.
a) Attach high and low pressure pipes to the tractor side.
b) Attach high and low pressure pipes to the engine.
c) Secure pipes with pipe clamps.

7) Mount the battery. Connect the positive and negative terminals.

NOTES;
a) Be sure the cushioning inserts are in position.
b) Secure the battery clamp firmly in position.

8) Attach the front grille.

9) Carry out electrical wiring (refer to the wiring diagram).

10) Attach the hood.

11) Attach the muffler.

12) Put in transmission lube oil.

[ASSEMBLY CAUTIONS]

1) When assembling the gears, fork, and fork shaft be sure to pay close attention to the color direction and position. Pay close attention to the illustration so that they are put in properly.

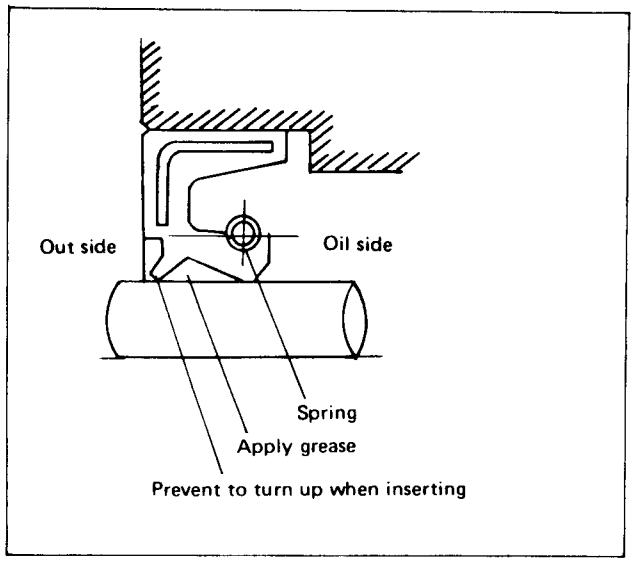
2) The last figure of the gears indicates the No. of gear teeth.

3) In the event that there are no instructions for installing the oil seal, it should be installed so it is flush with the outer edge as shown in the illustraion.

4) Oil Seal Lip. To prevent damage to the O-ring, installation should begin only after the shaft and hole have been checked for any sharp edges. In the event that there are sharp edges they should be removed.

5) Be sure that the spring is completely installed inside the oil seal. Check that it does not slip out of the slot in the inside of the oil seal.

6) When inserting the oil seal in the shaft be sure that the lip does not turn up. If the lip turns up, pull it out of the shaft a little. Insert the seal in the shaft again turning it lightly with your fingers, it should return to its correct conditions.



7) Be sure to apply grease to the inside of the oil seal lip to prevent damage to the lip. Also before installing apply grease to both the lip and the shaft.

8) Be sure to apply grease to the O-ring and to the O-ring oil seal, and to the slot, shaft and hole before installing.

9) Press-fit: To prevent deforming the bushings and bearings during press fitting be sure to use either a mandrel or an appropriate press fitting tool for this operation.

10) When assembling the bearings do not hit them directly with a hammer. Use a drive-in tool and plate as much as possible and hit them with a hammer if needed.

11) When assembling the gear and stepped collar, be sure to put them in the right direction. Pay special attention to the direction of the gear chamber.

12) Tighten the bolts and nuts to their specified tightening torque. The screws are made of light alloy and should not be overtightened.

13) Use caution when unpacking, get rid of the old packing, and completely remove any oil that is on the surface with thinner. After it has completely dried apply bond.

14) Apply the proper amount of bond to the packing, and be sure that none gets on the inside of the case or the surface of the teeth. It can lead to a clogged oil strainer or its malfunction.

15) Apply bond to both sides of the packing.

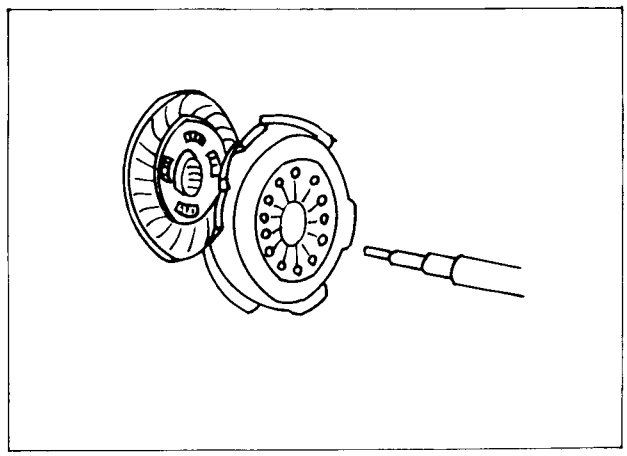
16) The circular ring and circlips sometimes become weak after they have been removed, consequently check them before assembly.

17) The following points should be observed when connecting the "housing assembly clutch" to both the transmission case and the gear case assembly final reduction:

a) When the main transmission is in the neutral position the P.T.O. transmission is in either 1 or 2.

b) It is connected to the P.T.O. shaft when the latter moves clockwise.

18) When assemblying the clutch disc assembly, six bolts 8 x 20 should be attached after they have passed through the shaft and main driving.



19) When bending the cotter pin downwards, bend it completely, along the nut or set pin. Even when the set pin diameter is small, making the procedure difficult, bend and set it so that it does not exceed the washer diameter.

20) Drive-in Direction of the Roll Pin: Set the crack at a 90° position from the load direction. When driving in dually, the inside roll pin crack should be positioned at 180° from the outside roll pin crack.

2. TRANSMISSION ASSEMBLY

2-1 P.T.O. Driving Shaft Assembly

1) Fit the (2) circlip 25 to the (1) P.T.O. driving shaft.

2) Fit the (1) P.T.O. driving shaft into the transmission case from the final-reduction gear case side, while fitting on the (3) collar 25.5 x 32 x 32.2, (4) liner 25 x 33 x 1.6, (5) P.T.O. reduction gear 19 , and the (6) liner 25 x 33 x 1.6. Fit on the (7) circlip 25.

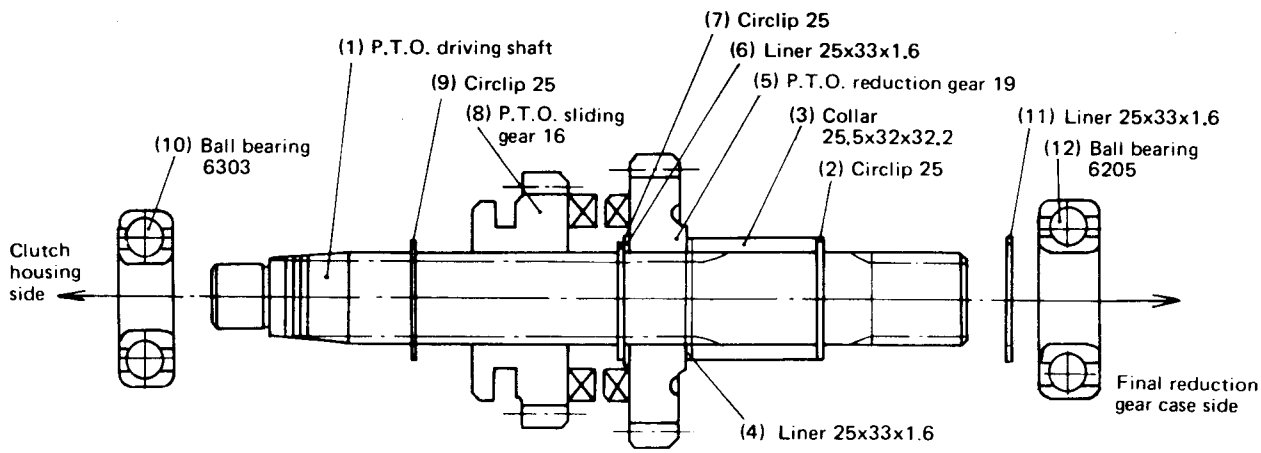
3) Fit on the (8) P.T.O. sliding gear 16 and fit on the (9) circlip 25.

4) To the assembled parts of (1)–(3), fit on the (11) liner 25 x 33 x 1.6 and press-fit the (10) ball bearings 6303, and (12) 6205.

NOTES:

a) Apply grease to the inner surface of the (5) P.T.O. reduction gear.

b) Construction Difference in the (1) P.T.O. Driving Shaft.

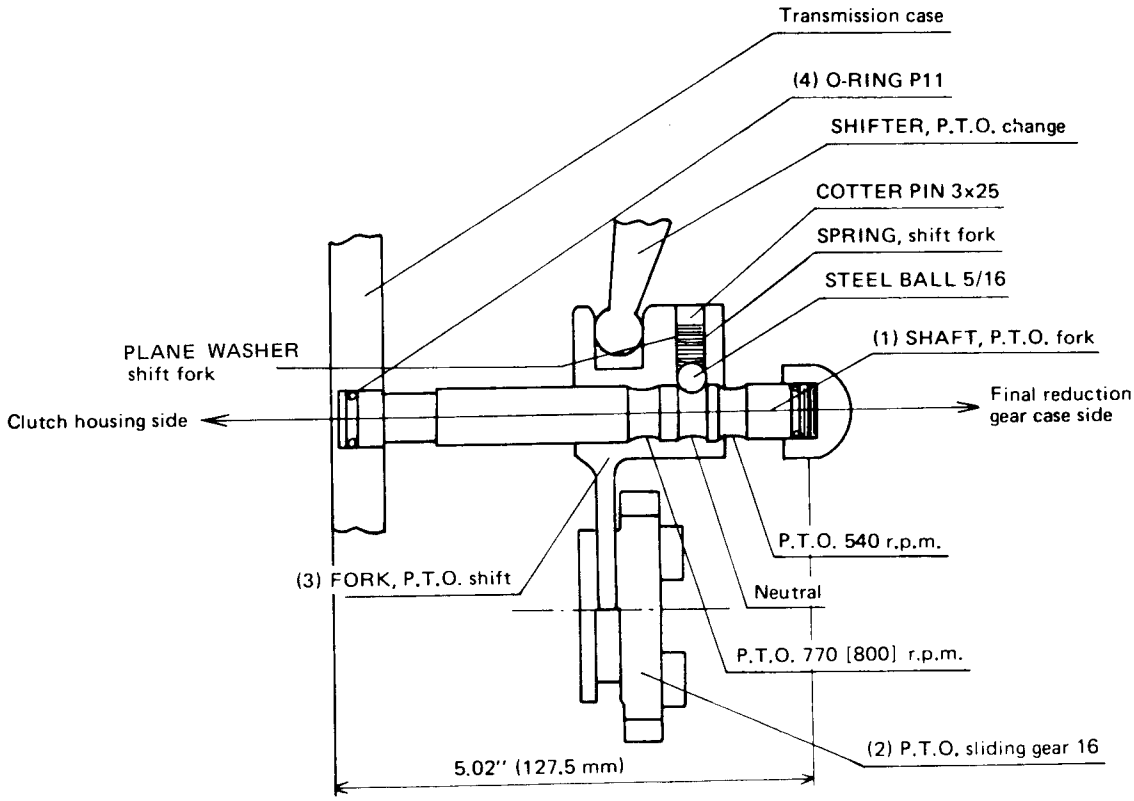


2-2 P.T.O. Fork Shaft Assembly

1) Attach the (4) O-ring P11 to the (1) P.T.O. fork shaft.

2) Insert the fork of the (3) P.T.O. shaft fork into the slot on the (2) P.T.O. sliding gear.

3) Attach the items in step (1) and (2) from the clutch housing side. Put the (3) P.T.O. shaft fork in the center position.



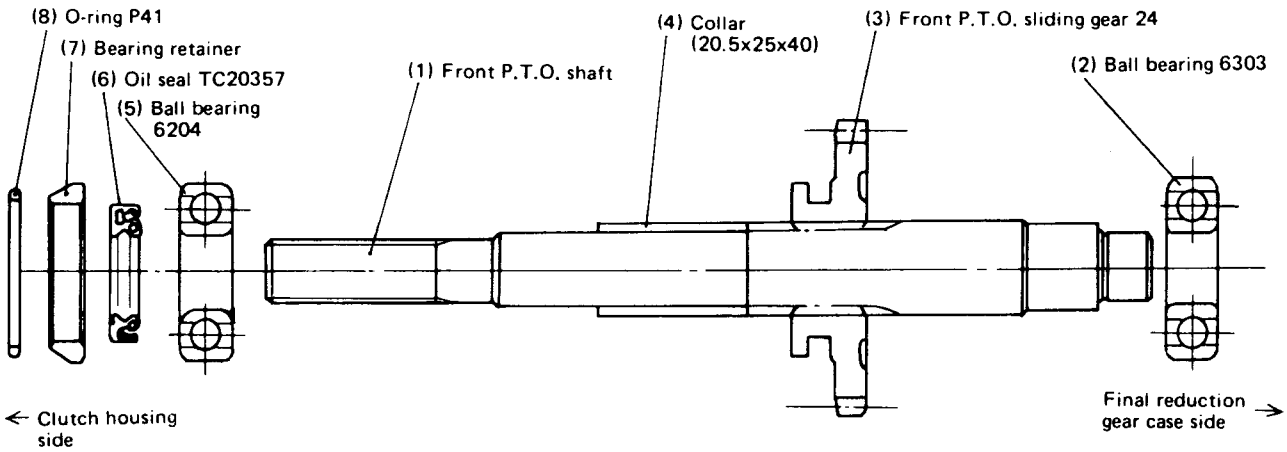
2-3 Front Drive Shaft Assembly (YM169D)

1) With the (1) front P.T.O. shaft in the transmission case, insert on it the (3) front P.T.O. sliding gear the (4) collar 20.5 x 25 x 40, and press-fit the (2), (5) ball bearings 6303 and 6204.

2) Insert the (7) bearing retainer in the transmission case, and then insert the (6) oil seal TC20357, and the O-ring P-41.

NOTES:

a) Be sure to check the gear direction, bearing position and shaft direction.



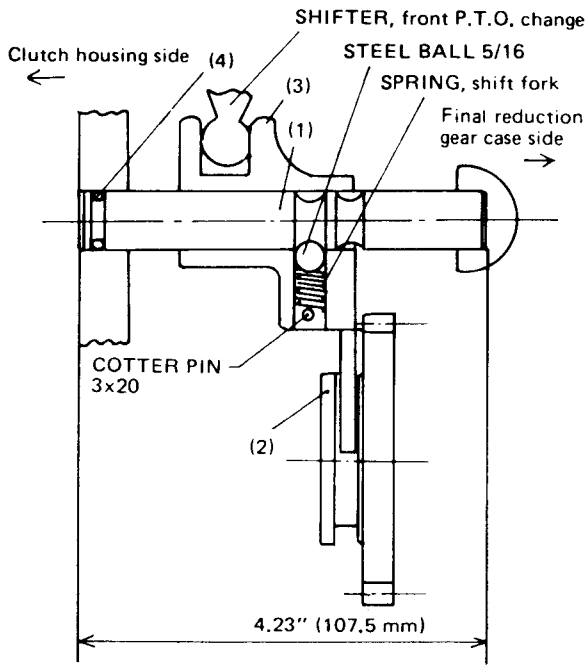
2-4 Front Drive Shift Shaft Assembly (YM 169D)

1) Fit the (4) O-ring P11 to the (1) front P.T.O. shift shaft.

2) Place the (3) front P.T.O. shift fork into the slot of the (2) front sliding gear.

3) Assemble the parts in step 1 and 2 from the clutch housing side.

(1) SHAFT, front P.T.O. shift
(2) Front sliding gear 25
(3) FORK, front P.T.O. shift
(4) O-RING P11



2-5 Driven Shaft Assembly

1) Fit the (3) circlip 25 to the (1) driven shaft.

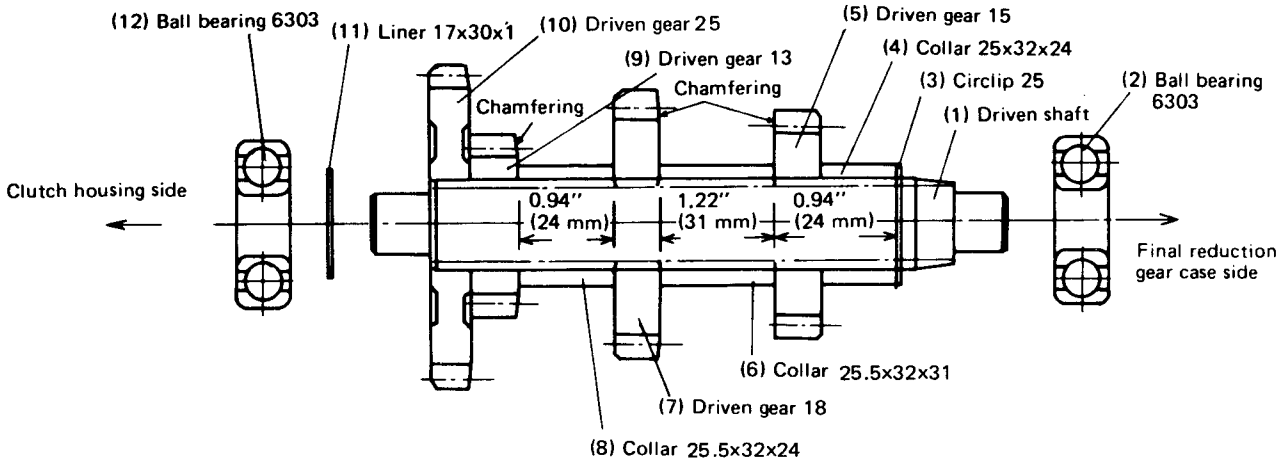
2) After step 1, with the driven shaft in the transmission gear case, insert the following from the final reduction gear case side: (4) collar 25.5 x 32 x 24, (5) driven gear 15, (6) collar 25.5 x 32 x , (7) driven gear 18, (8) collar 25.5 x 32 x 24 (9) driven gear 13, (10) driven gear 25 and the (11) liner 17 x 30 x 1.

3) Press fit the (2), (12) ball bearings 6303.

NOTES:

a) It is easy to drop the (11) liner during assembly so handle it securely.

b) Be sure to install the (5), (7) and (9) gears in the correct direction since they perform chamfering on one side.



2-6 Counter Shaft Assembly

1) Insert the (2) double row angular ball bearings in the (1) counter shaft, and attach the (3) circlip 25.

2) Following step 1, with the (1) counter shaft in the transmission case, attach the following from the final reduction gear case side: (4) liner 25 x 33 x 1.6, (5) low-high reduction gear 34, and (6) liner 25 x 33 x 1.6. Attach the (7) circlip 25. Then put in the (8) low-high sliding gear16 and attach the (9) circlip 25. Put in the (10) front driving gear (11) liner 20 x 35 x 1, (12) metal 20 x 25 x 22, (13) reverse gear (14) liner 20 x 35 x 1 and the (15) collar 21 x 27 x 36.5.

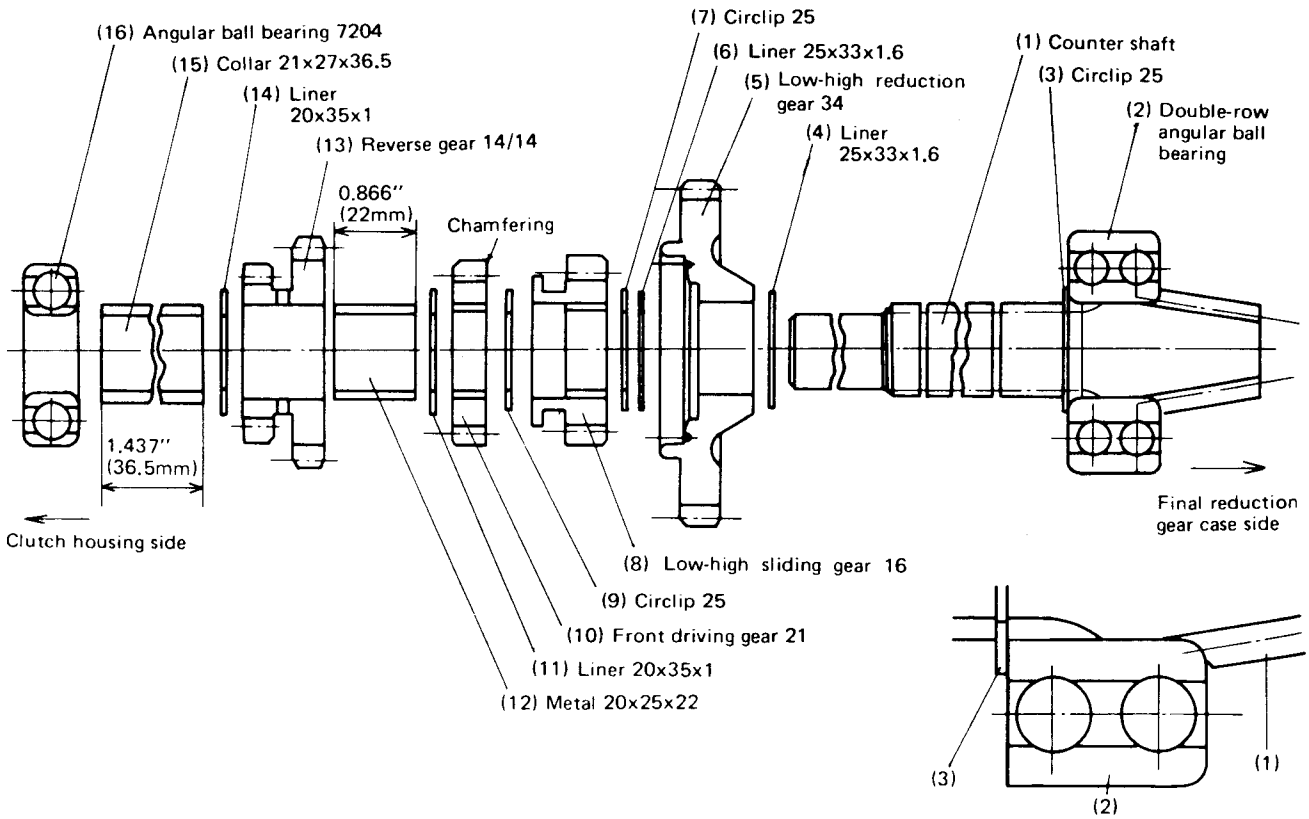
3) Press fit the (16) angular ball bearings 7204.

NOTES:

a) The (10) front driving gear is only for the YM165D, for the YM165 use collar 25 x 32 x 9.

b) The left and right surface of the inner lace of the (2) double row ball bearings are different. Insert the bigger side next to the pinion side as shown in the illustration.

c) Be sure to apply grease to the inside of the (5) low-high reduction gear 34 and the (13) reverse gear as well as to the outside of the (12) metal 20 x 25 x 22.



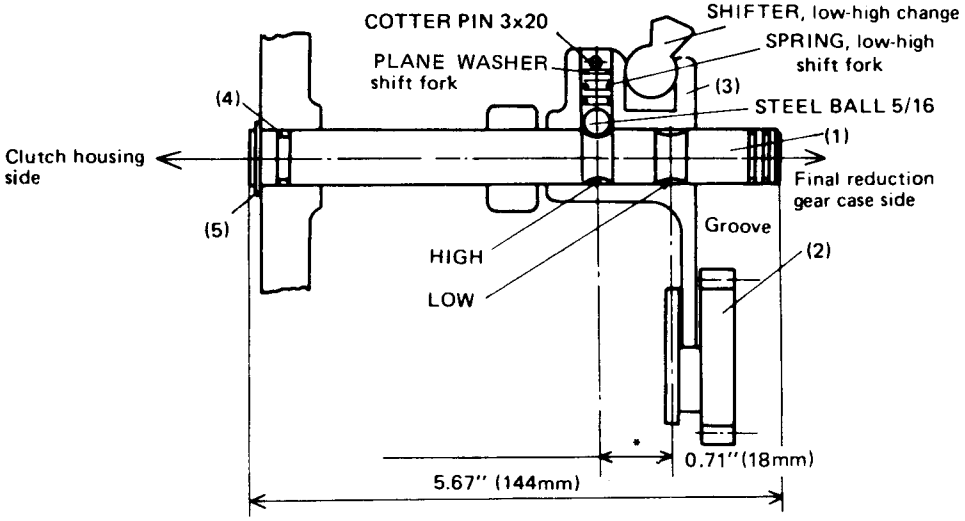
2-7 Low-High Shift Shaft Assembly

1) Fit the (4) "O" ring P11 to the (1) low-high shift shaft.

2) Place the (3) low-high shift fork into the groove of the (2) low-high sliding gear 16.

3) Attach the (5) circlip 15 to the (1) low-high shift shaft (step 1) from the clutch housing side.

(1) SHAFT, low-high shift
(2) Low-high sliding gear 16
(3) FORK, low-high shift
(4) O-RING P11
(5) CIRCLIP 15



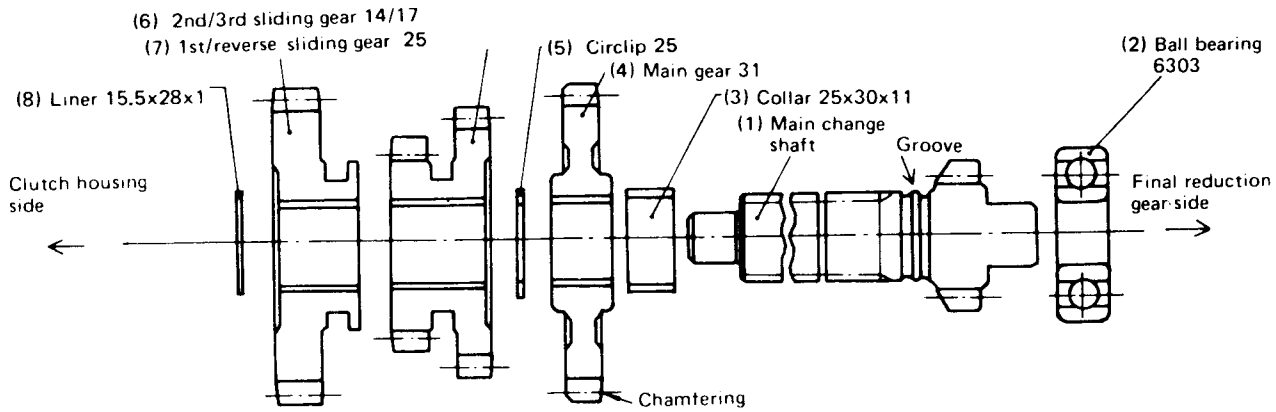
2-8 Main Change Shaft Assembly

1) Onto the (1) main change shaft put the (3) collar 25 x 30 x 11, and the (4) main gear 31, fit on the (5) circlip 25; and then put on the (6) 2nd/3rd gear (7) 1st/reverse sliding gear (refer to Note 'b'), and the (8) liner 15.5 x 28 x 1.

2) Press-fit the (2) ball bearings 6303.

NOTES:

a) Differences in construction of the (1) main shaft:



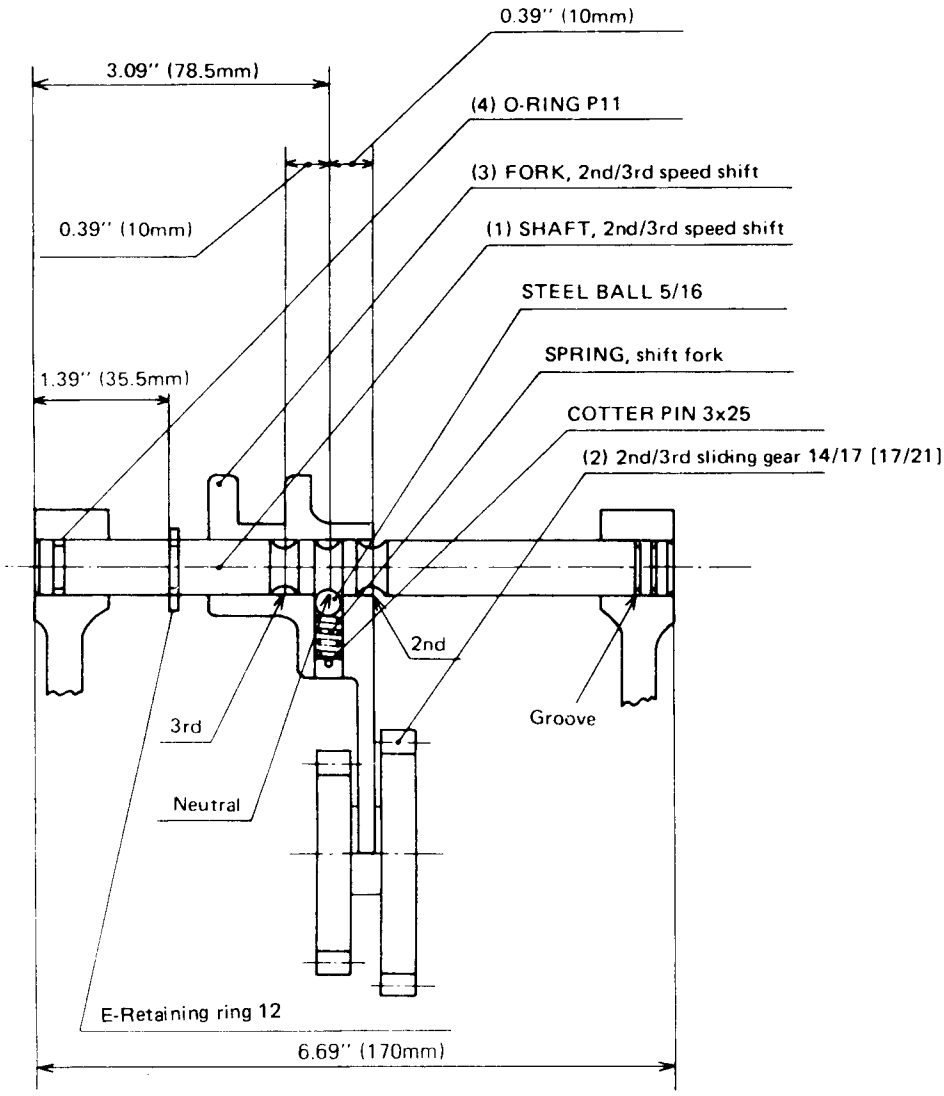
2-9 The Fork of the 2nd/3rd Speed Shift Shaft Assembly

1) Attach the (4) "O" ring P11 to the (1) 2nd/3rd speed shift.

2) Place the (3) 2nd/3rd speed shift fork into the slot of the (2) 2nd/3rd sliding gear.

3) To the assembled parts of step 1, attach the (5) E-Retaining ring 12.

4) Place the (3) 2nd/3rd speed shift fork into the center position.



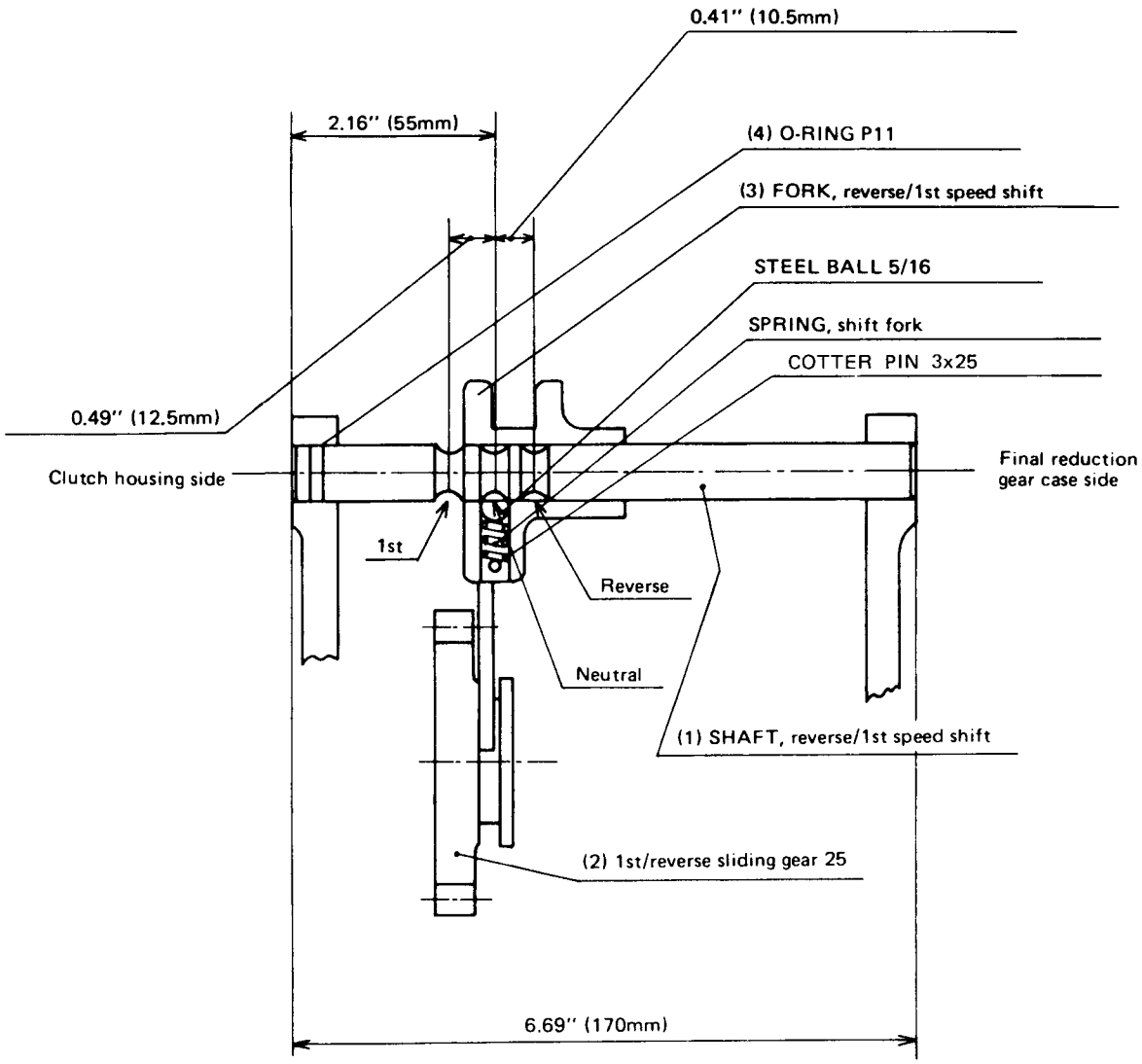
2-10 Reverse/1st Speed Shift Shaft Assembly

1) Attach the (4) "O" ring P11 to the (1) Reverse/1st speed shift shaft.

2) Place the (3) Reverse/1st speed shift fork into the slot of the (2) Reverse/1st sliding gear.

3) Insert the part in step 1 from the clutch housing side.

4) Place the (3) Reverse/1st speed shift fork into the neutral position. (center slot).



2-11 Main Shaft and Transmission Front Cover Assembly

1) Insert the (3) liner 16 x 21 x 1, and the (4) needle bearing into the (2) main shaft.

2) To the assembled parts of step 1, press fit the (5) ball bearing 6205NR, and attach the (6) circlip 25.

3) Press-fit the (7) ball bearing 6204 into the (1) transmission case front cover.

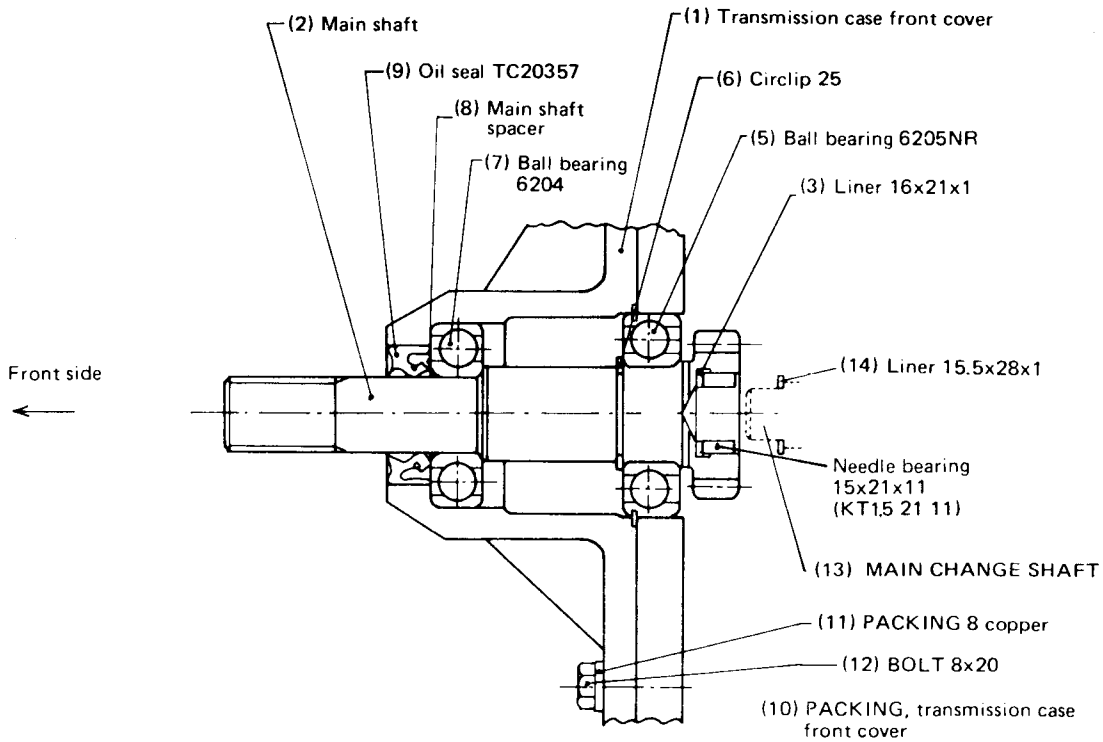
4) To the assembled parts of step 1 and 2 insert the assembled parts of step 3. From the front insert the (8) main shaft spacer and the (9) oil seal TC20357.

5) Apply packing to the transmission case.

6) Attach the assembled parts above (step 1–4) to the transmission case, and secure with (11) copper packings (10 pcs) and (12) bolts 8 x 20 (10 pcs).

NOTES:

a) During step (6) it is easy to drop the (13) main change shaft's (14) liner 15.5 x 28 x 1 and the (4) needle bearing. It is therefore recommended that grease be applied to them to prevent dropping them. Also be sure that the (4) needle bearing will bear the load weight evenly.



2-12 Gear Shift Lever Assembly

1) Insert the (4) gear shift ball onto the (2) gear shift lever, and secure it with the spring pins 5 x 40, 3 x 40.

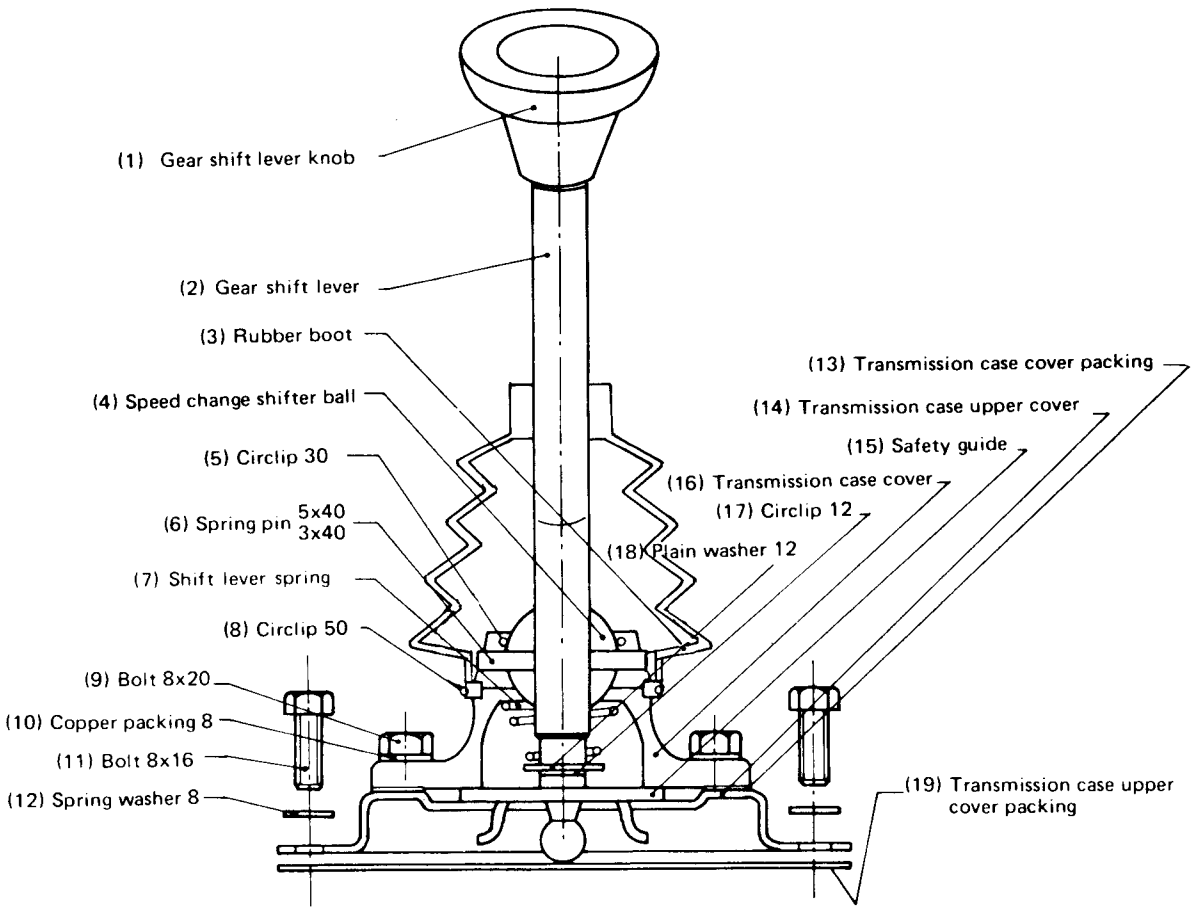
2) Attach the parts assembled above to the (16) transmission case cover. Put the (7) gear shift lever spring and (18) plain washer 12 on the (2) gear shift lever, and attach the (5) circlip 30, and (17) circlip 12.

3) Place the (15) safety guide into the (14) transmission case upper cover slot.

4) Insert (13) packing between the assembled parts of steps 1, 2 and 3, and secure with the (10) copper packing 8 (4 pcs), and (9) bolts 8 x 20 (4 pcs).

5) Place the (3) rubber boot in the position shown in the illustration, and secure it with the (8) circlip 50. Attach the (1) gear shift lever knob.

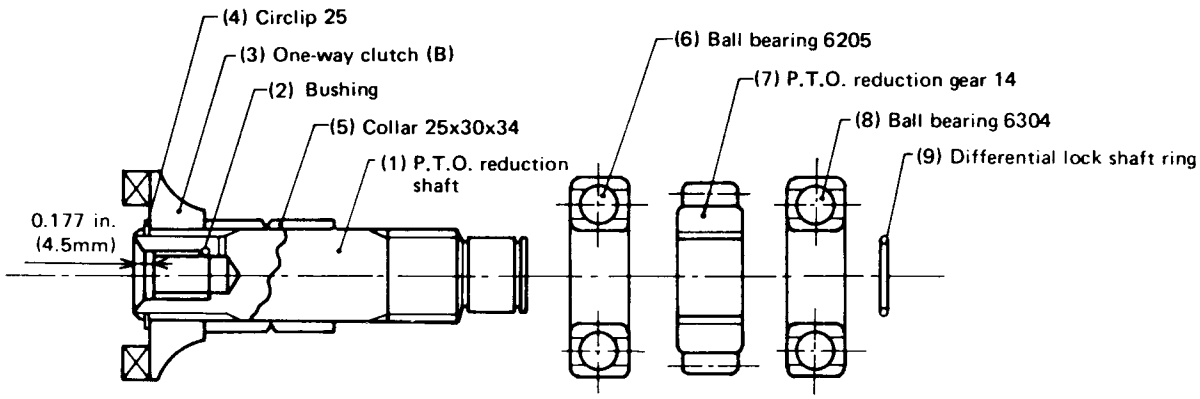
6) Insert the (19) transmission case upper cover packing between the assembled parts (step 1–5) and the transmission case. Secure it with the (12) spring washers and (11) bolts 8 x 16 (8 pcs).



2-13 P.T.O. Reduction Shaft Assembly

1) Insert the (2) bushing into the (1) P.T.O. reduction shaft as shown in the illustration. Put the (3) one-way clutch (B), and (5) collar 25 x 30 x 34 on the (1) P.T.O. reduction shaft, and attach the (4) circlip 25.

2) Press-fit the (6) ball bearing 6205 into the final reduction gear case. From inside the final case, put the (7) P.T.O. reduction gear through the parts assembled above. Press fit the (8) ball bearing 6304 from outside, and attach the (9) differential lock shaft ring.

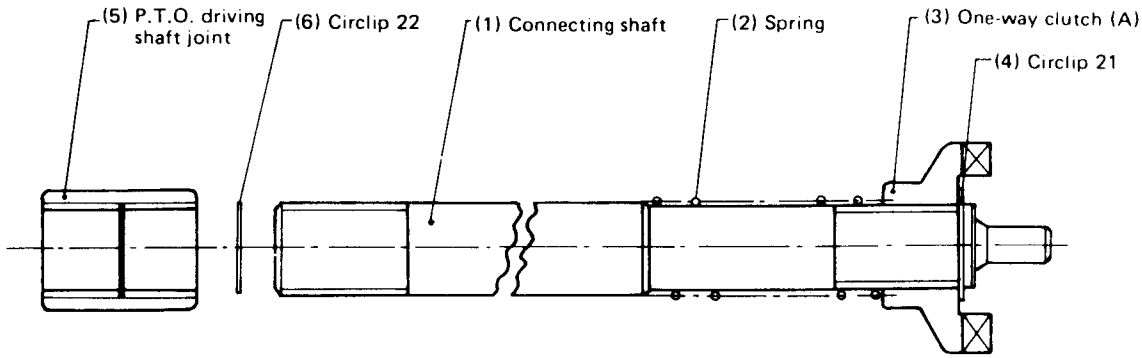


2-14 Connecting Shaft Assembly

1) Place the (2) spring, and (3) one-way clutch A on the (1) connecting shaft, and attach the (4) circlip 21.

2) Attach the parts above (step 1) to the P.T.O. reduction shaft (step 2–13).

3) Fit the (6) circlip to the middle of the (5) P.T.O. driving shaft joint. Insert the (1) connecting shaft.



2-15 P.T.O. Shaft Assembly

1) Press-fit the (10) ball bearing 6205 into the center of the final reduction gear case.

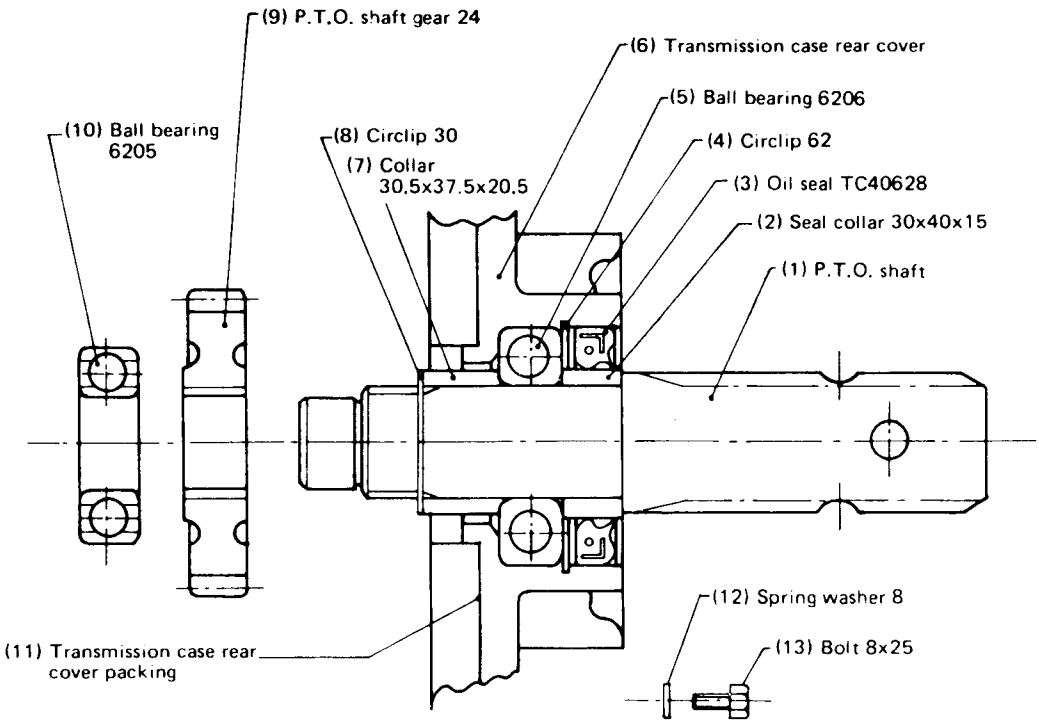
2) Engage the (9) P.T.O. shaft gear 24 onto the P.T.O. reduction gear

3) Insert the (2) seal collar 30 x 40 x 15 on the (1) P.T.O. shaft, then press-fit the (5) ball bearing 6206 and (7) collar 30.5 x 37.5 x 20.5, and attach the (8) circlip 30.

4) Insert the (6) transmission case rear cover to the parts assembled in step 3. Attach the (4) circlip 62, and insert the (3) oil seal TC **40628**.

5) Attach the (11) transmission case rear cover packing to the final reduction gear case.

6) To the assembled parts of step 3 and 4 fit the (9) P.T.O. shaft gear 24 and the (1) spline slot of the P.T.O. shaft. Attach the final reduction gear case, and secure it with the (12) spring washer 8 and the (13) bolt 8 x 25.

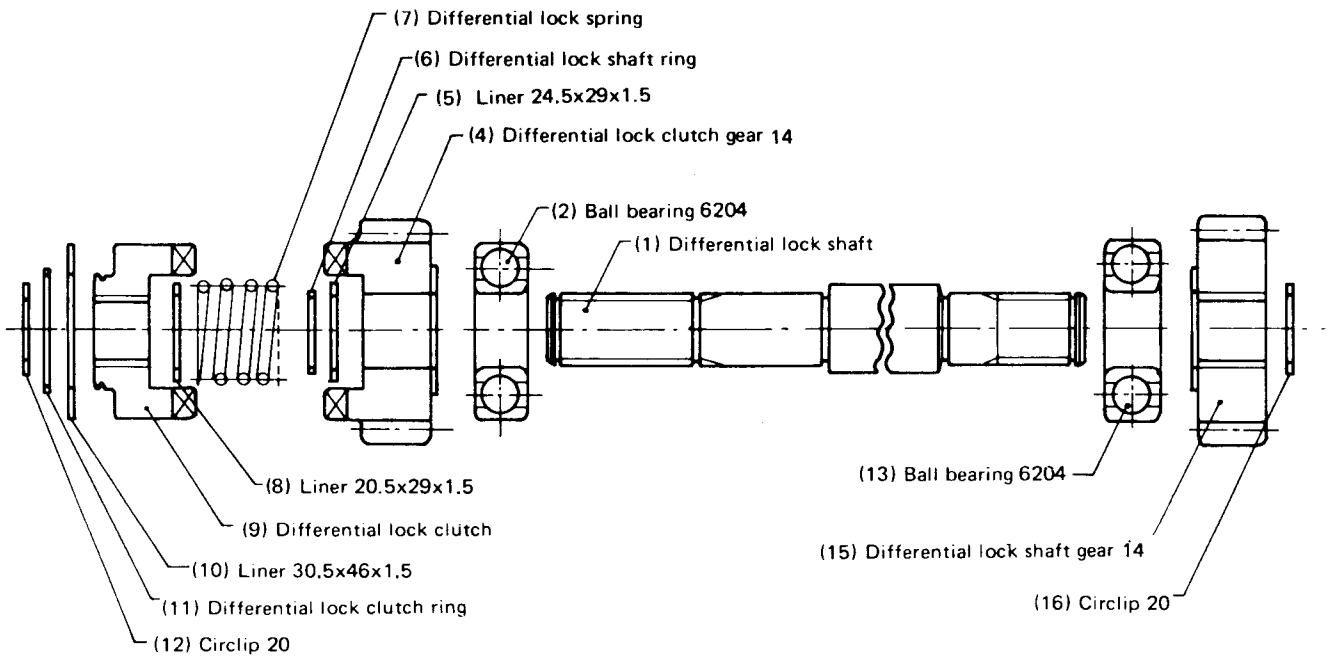


2-16 Differential Lock Shaft Assembly

1) Onto the (1) differential lock shaft insert the (13) ball bearing 6204, and the (15) differential lock shaft gear Fit on the (16) circlip 20. Looking at the parts assembled from the back, attach the final reduction gear case from the left hand side.

2) To the other side of the (1) differential lock shaft insert the (2) ball bearing 6204, (4) differential lock clutch gear (refer to Note), and the (5) liner 20.5 x 29 x 1.5. Attach the (6) differential lock shaft ring, and then insert the (7) differential lock spring, (8) liner 20.5 x 29 x 1.5, and (9) differential lock clutch.

3) Insert the (10) liner 30.5 x 46 x 1.5 on the (9) differential lock clutch, and then attach the (11) differential lock clutch ring, and the (12) circlip 20.



2-17 Final Reduction Pinion and Rear Axle Shaft Assembly

I. Final Reduction Pinion

1) Press-fit the (4) ball bearing 6206, (6) "O" ring P25, and the (7) seal collar 25 x 35 x 11 on the (1) final reduction pinion.

2) Insert the items assembled in step 1 into the (24) rear axle housing.

3) Insert the (3) liner 22.5 x 30 x 1, and metal 22 x 27 x 22.5 onto the (1) final reduction pinion.

4) Insert the (5) oil seal TC35508 into the (24) rear axle housing.

NOTES:

a) Attach the (7) seal collar 25 x 35 x 11 to the inside of the "O" ring slot.

b) Fit the oil seal TC35508 so it is flush with the edge of the (24) rear axle housing.

c) i) Length of the final reduction pinion (L): 6.91 in. (175.5 mm)

ii) Length of the final reduction pinion (R): 5.41 in. (137.5 mm)

d) No. of teeth on the final reduction pinion: 10

II. Rear Axle Shaft Assembly

1) Fit the (16) ball bearing 45 x 80 x 18, (17) collar 40 x 55 x 39, (19) final reduction gear, (20) collar 30.2 x 45 x 10, and the (18) ball bearing 6306 on the (13) rear axle shaft.

2) Attach the (21) bolts 8 x 16 (2 pcs) with a (22) rear axle shaft washer, and (23) locking 46 to the (13) rear axle shaft.

3) Attach the (13) rear axle shaft (steps 1–2) to the (24) rear axle housing.

4) Be sure that there is no "play" between the (24) rear axle housing, and the following parts: (16) ball bearing 45 x 80 x 18, (17) collar 40 x 55 x 39, and the (19) final reduction gear.

5) Use the (12) special tool to fit the (16) ball bearing 45 x 80 x 18 so they are in contact as shown in the illustration.

6) Be sure that there are no sharp edges on the (13) rear axle shaft's hexagonal part, if there are any sharp edges remove them completely.

Fit the (15) oil seal TC507010 on the (13) rear axle shaft to the front edge as shown in the illustration.

NOTES:

a) Be sure to attach the (17) collar 40 x 55 x 39 and (20) collar 30.2 x 45 x 10 facing the correct direction.

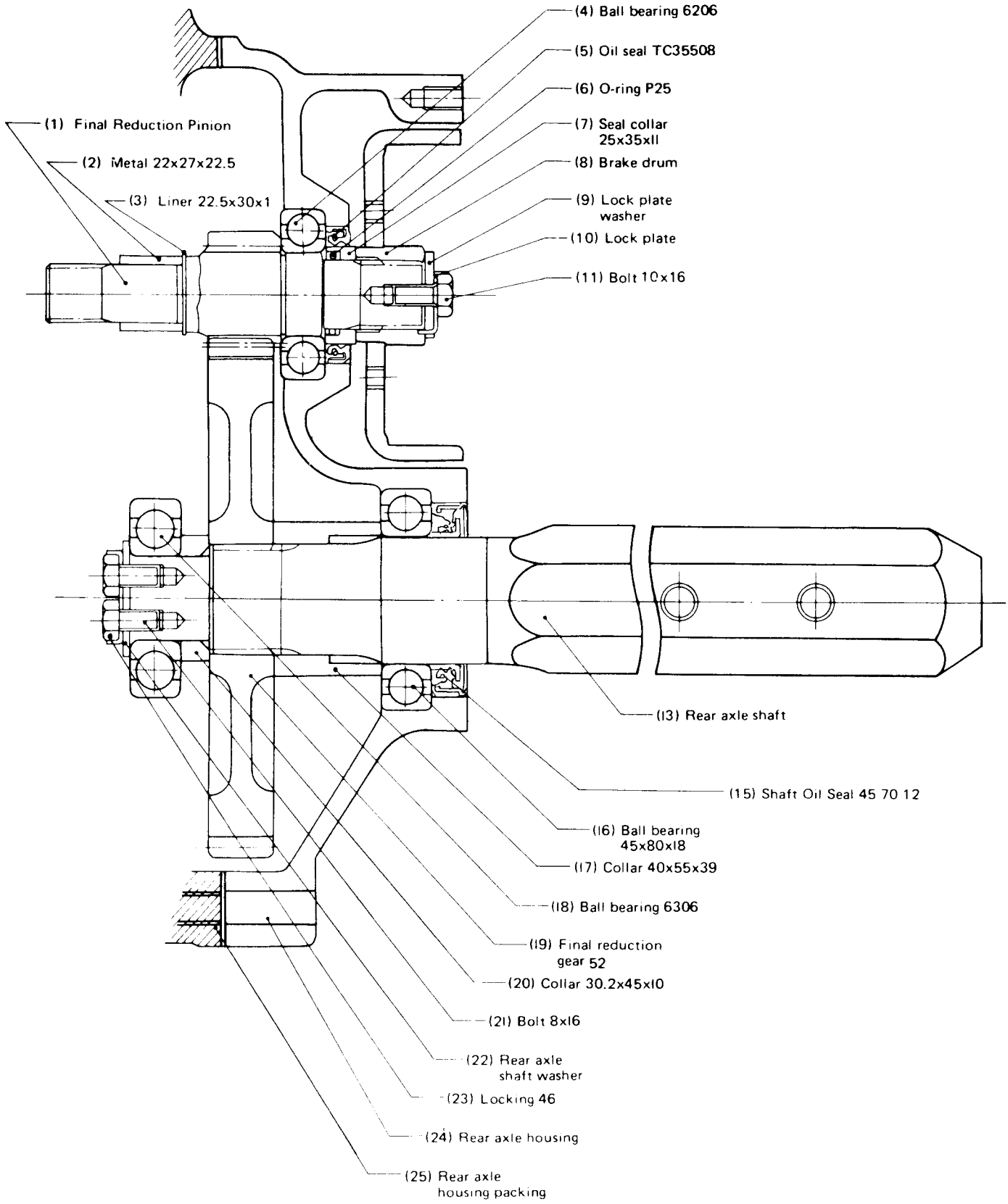
b) Clean the (13) rear axle shaft, and remove any grease from the hexagonal part before fitting on the (15) oil seal TC507010.

c) (13) rear axle shaft length: 16.4 in. (416.5 mm)

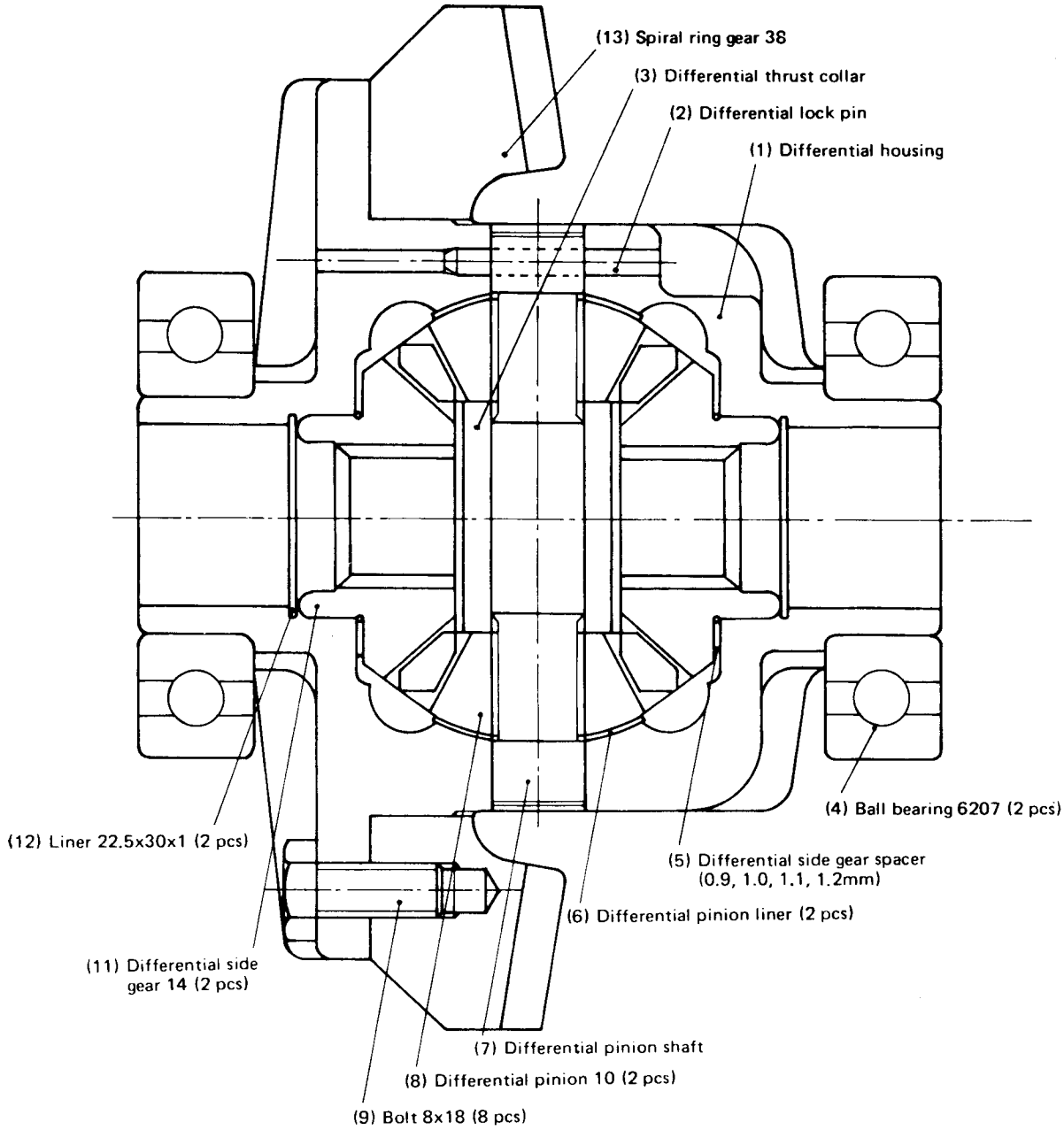
d) No. of teeth on the (19) final reduction gear: 52

e) Be sure to bend down the (23) locking 46 on the head of the (21) bolts 8 x 16 (2 pcs).

f) Tightening torque of the (21) bolts 8 x 16: 9–12 ft-lbs (1.3–1.7 kg-m)


(1) Final Reduction Pinion
(2) Metal 22x27x22.5
(3) Liner 22.5x30x1
(4) Ball bearing 6206
(5) Oil seal TC35508
(6) O-ring P25
(7) Seal collar 25x35xll
(8) Brake drum
(9) Lock plate washer
(10) Lock plate
(11) Bolt 10x16
(13) Rear axle shaft
(15) Shaft Oil Seal 45 70 12
(16) Ball bearing 45x80xl8
(17) Collar 40x55x39
(18) Ball bearing 6306
(19) Final reduction gear 52
(20) Collar 30.2x45xl0
(21) Bolt 8xl6
(22) Rear axle shaft washer
(23) Locking 46
(24) Rear axle housing
(25) Rear axle housing packing

2-18 Differential Device



1) Fit the following into the (1) differential housing, the (6) differential pinion liners (2 pcs), (8) differential pinion 10, (12) liner 22.5 x 30 x 1, the (5) differential side gear spacers (2 pcs), (11) the differential side gear 14 (2 pcs), and the (3) differential thrust collar. Be sure to put in the right and left (12) liners 22.5 x 30 x 1 (2 pcs), the (5) differential side gear spacers (2 pcs), and the (11) differential side gear 14 (2 pcs) at the same time.

2) Fit the (7) differential pinion shaft into place after passing it through the (1) differential housing, (6) differential pinion liners (2 pcs) the (8) differential pinion 10 (2 pcs), and the (3) differential thrust collar.

3) Be sure that the gears rotate smoothly. Adjust the backlash, if needed, with the (5) differential side gear spacers so it is within 0.004–0.008 in. (0.1–0.2 mm).

4) Drive in the (2) differential lock pin through the holes of the (1) differential housing and the (7) differential pinion shaft.

5) Put the (13) spiral ring gear 38 on the (1) differential housing, and fasten with the (9) bolts 8 x 18 (8pcs).

6) When the (9) bolts 8 x 20 (8pcs) are removed, clean the bolt and screw hole with solvent and apply lock-tiet then tighten them to prevent from loosening.

7) Fit the (4) ball bearings 6207 (2 pcs) on the differential housing.

NOTES:

a) When performing step 2, be careful to line up the shaft and liner hole carefully to prevent damage to the (6) differential pinion liner.

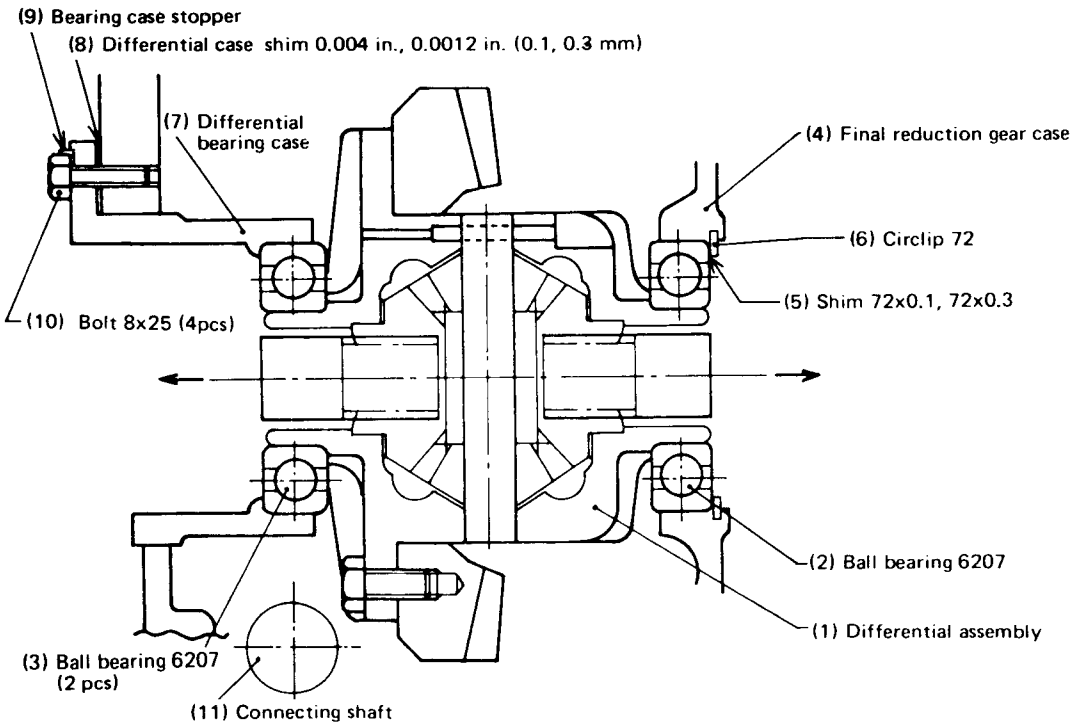
b) Apply grease to the outside of the (7) differential pinion shaft, and the (11) differential side gear 14 (2 pcs).

c) Tightening torque for the (9) bolts 8 x 18: 17-22 ft-lbs (2.3-3 kg-m).

d) There are four kinds of (5) differential side gear spacers:

i. 0.035 in. (0.9 mm)
ii. 0.039 in. (1.0 mm)
iii. 0.043 in. (1.1 mm)
iv. 0.047 in. (1.2 mm)

(a) Disassembly



1) Take out the (11) connecting shaft.

2) Remove the (10) bolts 8 x 25 (4 pcs).

3) Remove the (6) circlip 72.

4) Use a hammer and plate, to remove the (2) ball bearing 6207 out to the left of the (1) differential assembly.

5) Separate the (3) ball bearing 6207 from the (1) differential assembly and the (7) differential bearing case with a hammer and plate.

6) Take out the (1) differential assembly.

(b) Assembly

1) Insert the (1) differential assembly in the (4) final reduction gear case.

2) Fasten the (6) circlip 72 on the (4) final reduction gear case, and then insert the (7) differential bearing case.

3) Use (5) shims 72 x 0.1, 72 x 0.3 to adjust the pinion and ring gear backlash to within 0.005-0.007 in. (0.13-0.18 mm).

4) Insert the (8) differential case shims 0.004 in., 0.012 in. (0.1, 0.3 mm) to the position shown in the illustration. There should not be any play in the (1) differential assembly in the arrow direction shown in the illustration.

5) Attach the (9) bearing case stopper, and (10) bolts 8 x 25 (4 pcs) to the position shown in the illustration.

NOTES:
a) Be sure to bend down the (9) bearing case stopper on the head of the (10) bolts 8 x 25 (4 pcs).

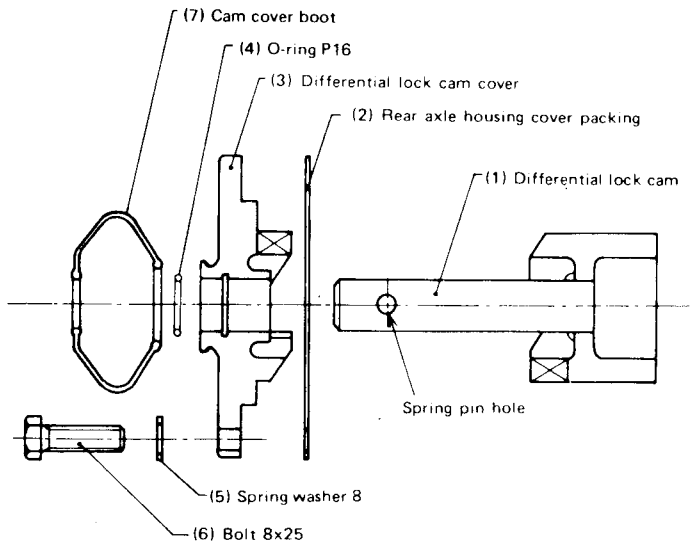
b) Tightening torque for the (10) bolts 8 x 25 (4 pcs): 15-22 ft lbs (2.0-3.0 kg m).

2-19 Cam, Differential Lock Assembly

1) Attach the (4) O-ring to the slot in the (3) differential lock cam cover. Insert the (1) differential lock cam, and attach the cam cover boot to the (3) differential lock cam cover.

2) Attach the (2) rear axle housing cover packing to the assembled parts in step 1. Attach the final reduction gear case, and secure it with the (6) bolts 8 x 25.

NOTES:
a) Attach the (1) differential cam lock so the spring pin hole is in the horizontal position.



3. FRONT AXLE ASSEMBLY

3-1 4-Wheel Drive (YM169D)

1) Assemble (1) front axle case (R) and (2) spiral ring gear, 38T assy.
Remarks: Backlash of Spiral ring gear should be 0.1~0.3 mm.
Four shim thicknesses are available as under mentioned.
Shim thickness (A): 0.1 mm x 2 pcs.
Shim thickness (B): 0.3 mm x 2 pcs.

2) Assemble (1) Front axle case (R) with (2) spiral ring gear, 38T and Drive pinion shaft assy.
Remarks: Backlash of Drive pinion should be 0.1~0.15 mm.
Four shim thicknesses of pinion holder are available as under mentioned.
Shim A: 0.1 mm x 2 pcs.
Shim B: 0.3 mm x 2 pcs.

3) Assemble (3) Front spindle, (4) Front Bearing Case and Front Final Gear.

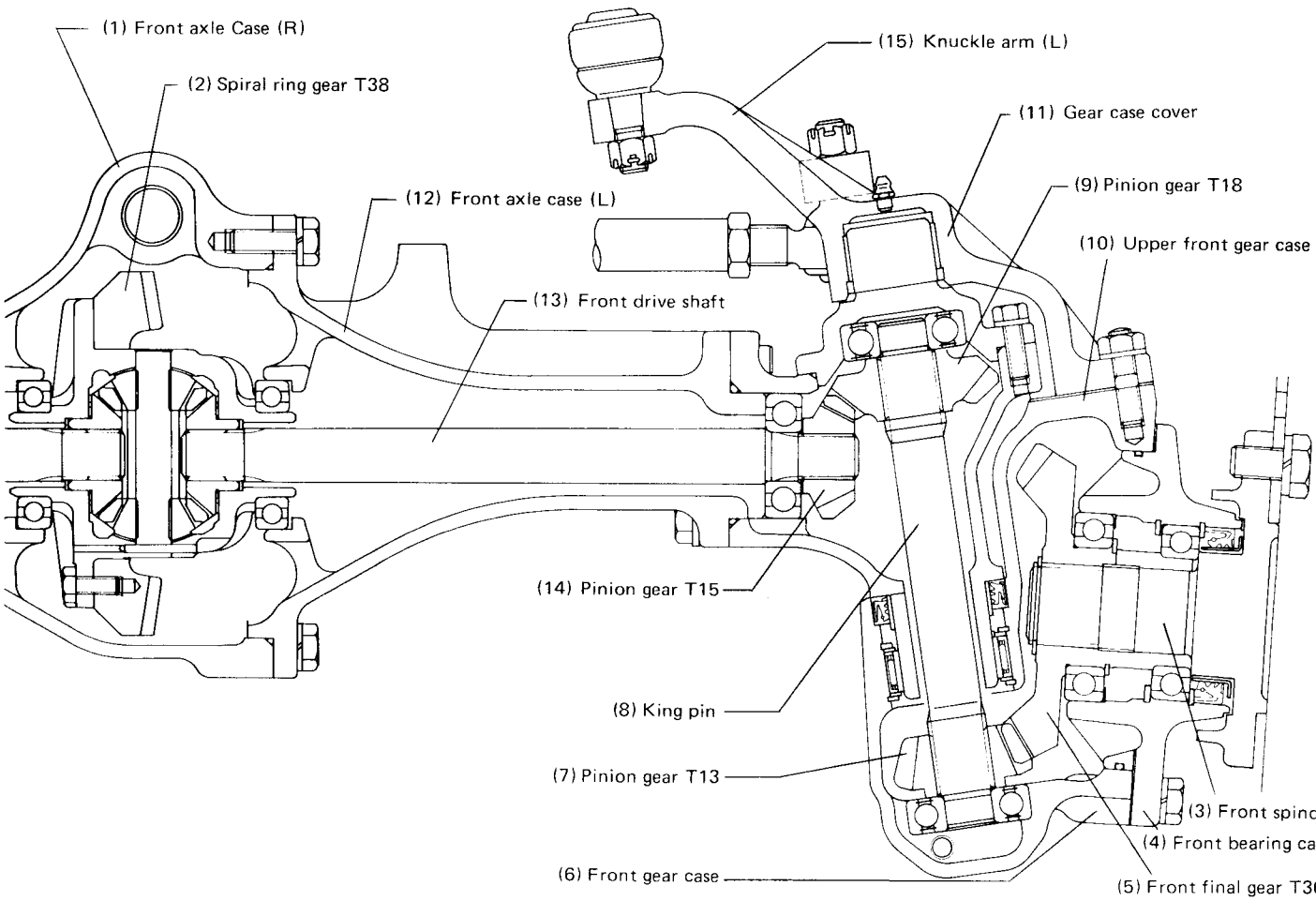
4) Assemble (6) Front gear case, (7) Pinion gear, T13, (8) King pin, (9) Pinion gear, T18, (10) Upper front gear case and (11) Gear case cover.

5) Assemble (6) front gear case assy. (Assembling step: 4) and (4) Front Bearing case assy. (Assembling step: 3).
Remarks: Backlash of Front Final Gear, T36 should be 0.1~0.3 mm.
Be adjusted by Shim A & B
Shim A: 0.1 mm
Shim B: 0.3 mm

6) Assemble (1) front axle case (R) Assy. (Assembling Step: 2) and (12) front axle case (L) with (14) Pinion Gear, T15.

7) Assemble front axle case (L) & (R) assy. and (6) front gear case (L) & (R) assy.

8) Assemble (10) upper front gear case and (15) knuckle arm (L) and (R).



3-2 2-Wheel Drive (YM169)

1) Assemble (1) front wheel hub, (2) ball bearing 6205, (3) washer 42x51.8x1 and (4) oil seal.

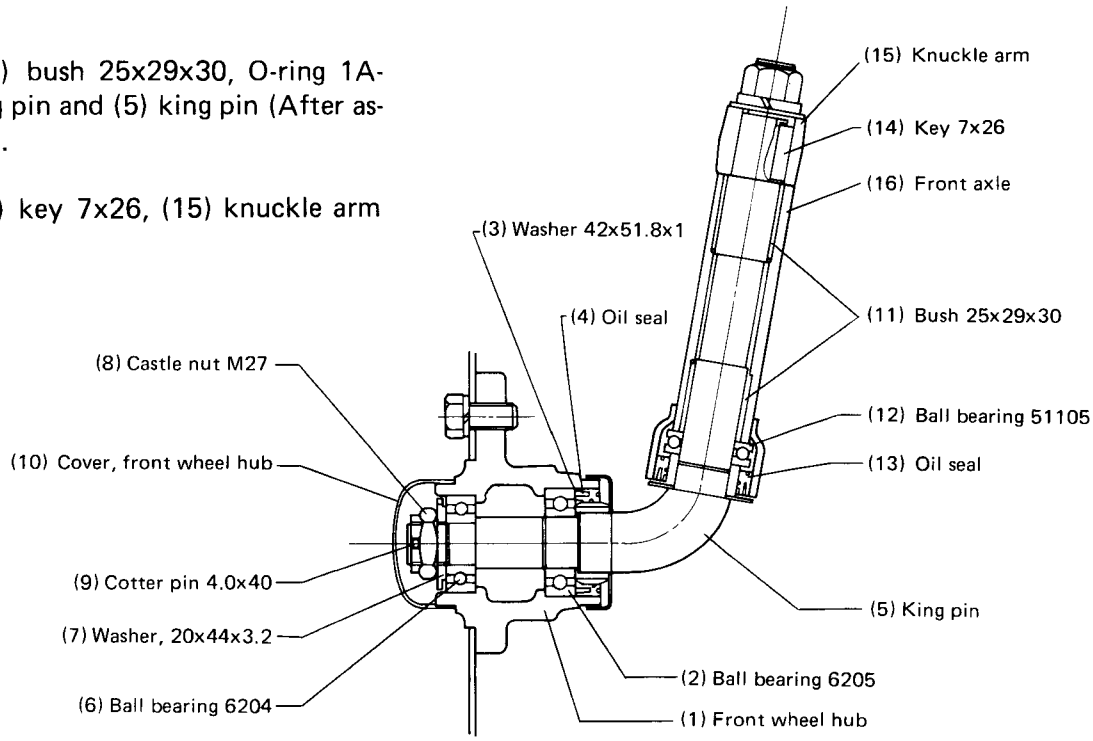
2) Assemble (1) front wheel hub, assy. (Assembling Step: 1) and (5) king pin.

3) Assemble (6) ball bearing 6204, (7) washer 20x44x3.2, (8) castle nut, M20 (9) cotter pin 4.0x40, (10 cover, front wheel hub (5) and king pin.

4) Assemble (11) bush 25x29x30, (12) ball bearing 51105 and (13) oil seal into Front Axle case.

5) Assemble (11) bush 25x29x30, O-ring 1A-2025, cover of king pin and (5) king pin (After assembling step 1~4).

6) Assemble (14) key 7x26, (15) knuckle arm and (5) king pin.



3-3 Differential Device Assembly (YM165D, front axle)

1) Attach the (2) ball bearing 6305 and the (3) circlip 25 to the (1) spiral pinion shaft.

2) Attach the (4) ball bearing 5304, (6) oil seal TC30458, (7) "O" ring G60, and (8) circlip 52 to the (5) front axle case cup.

3) Attach the (5) front axle case cup (step 2) to the (1) spiral pinion shaft.

4) Insert the (1) spiral pinion shaft (step 3) into the (9) front axle case.

5) Use a mandrel to determine the position of the (1) spiral pinion shaft. To adjust use front axle shims 0.004, 0.012 in. (0.1, 0.3 mm)

6) Attach the (11) bolts 8 x 30 (3 pcs), (15) universal flange, (12) lock plate washer, (13) lock plate, and (14) bolt 8 x 16 as shown in the illustration.

7) Insert the (16) differential assembly into the (9) front axle case.

8) Use (17) shims A to adjust the pinion and ring gear backlash to within 0.004–0.012 in. 0.1–0.3 mm).

9) Attach the (18) front axle (L) to the (9) front axle case.

10) Attach the (19) front axle (R) to the (9) front axle case.

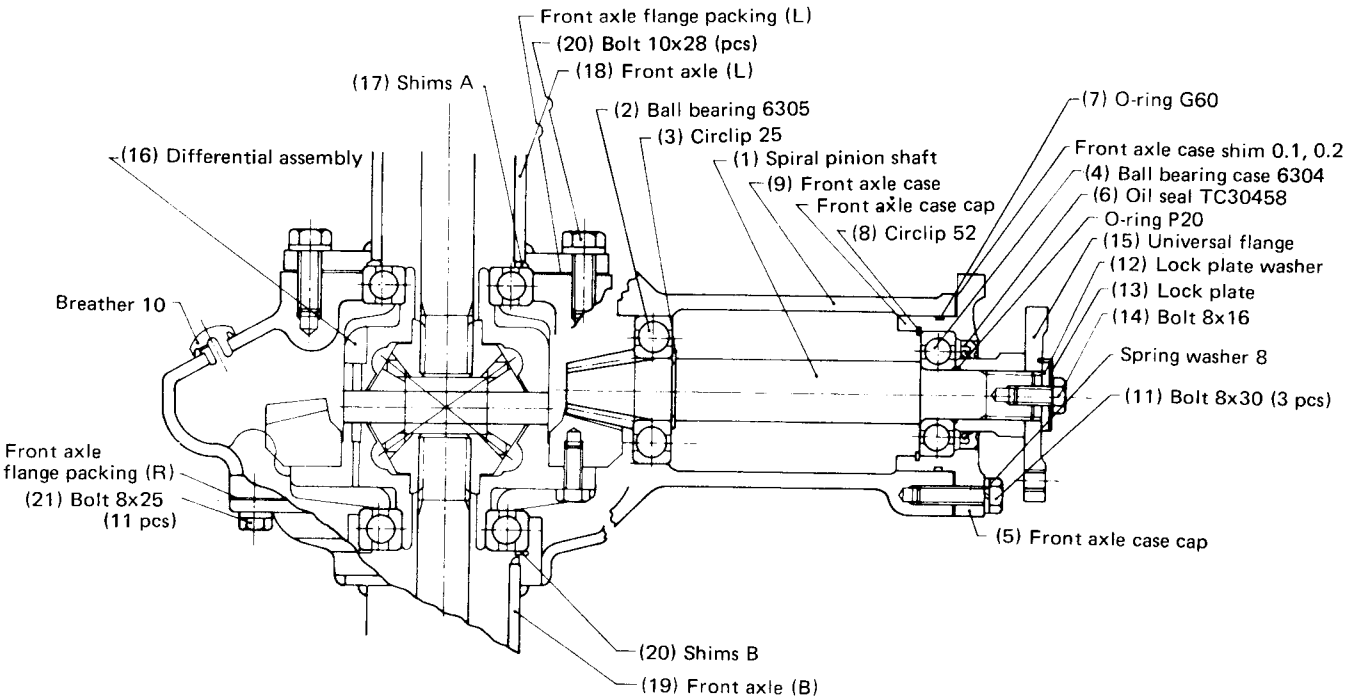
11) Insert shims B into the position shown in the illustration to eliminate play between the (16) differential assembly and the (18) front axle (L) and the (19) front axle (R).

NOTES;

a) Insert the (6) oil seal TC 30458 so it is flush with the end of the (5) front axle case.

b) Tightening torque:
(11) bolt 8 x 30: 9–12 ft-lbs (1.3–1.7 kg-m)
(13) bolt 8 x 16: 17–22 ft-lbs (2.3–3.0 kg-m)
(20) bolt 10 x 28: 33–43 ft-lbs (4.5–6.0 kg-m)
(21) bolt 8 x 25 : 17–22 ft-lbs (2.3–3.0 kg-m)

c) Shims A & B: shim 72 x 0.1 mm
shim 72 x 0.3 mm



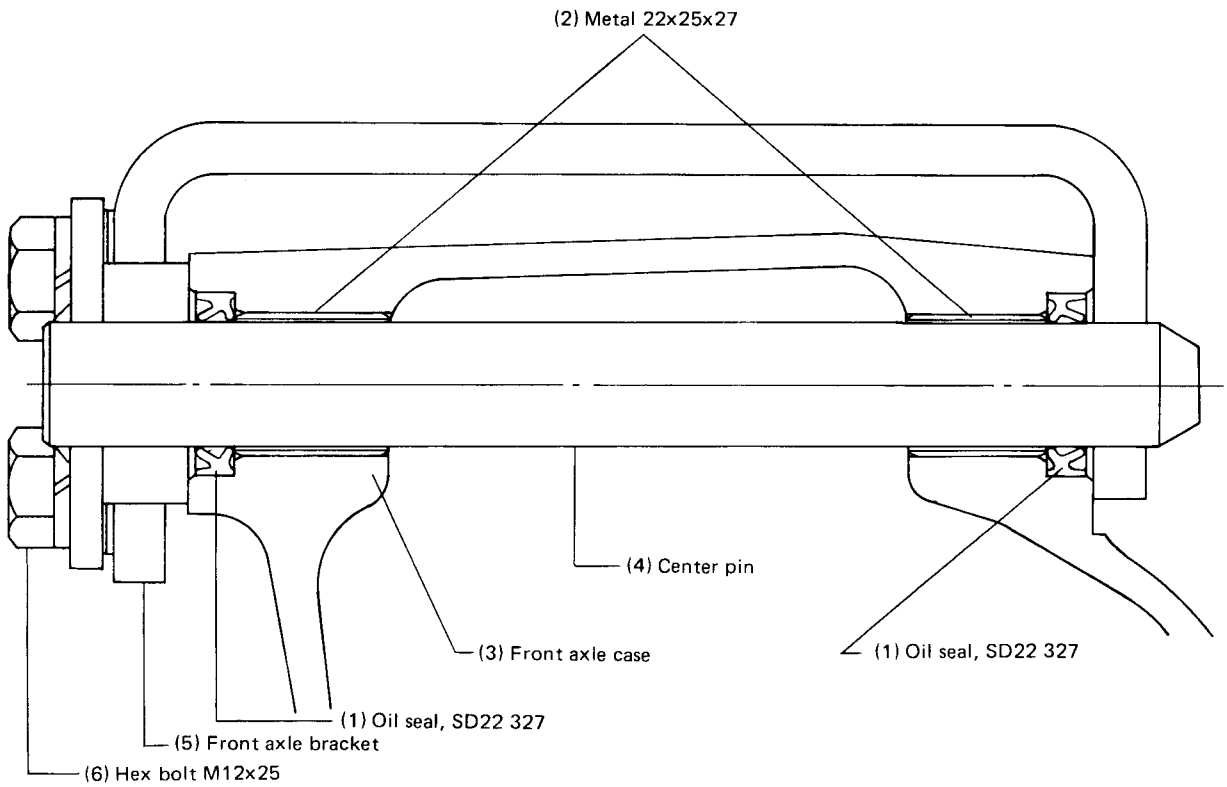
4. CENTER PIN ASSEMBLY

4-1 For 4-Wheel Drive (YM169D)

1) Press-fit two sets of (1) oil seal, SD22327 and (2) metal, 22x25x27 into (3) front axle case.

2) Insert (4) center pin through (5) front axle bracket and (3) front axle case.

3) Tighten (4) center pin to (3) front axle case with (6) hex-bot, M12x25.

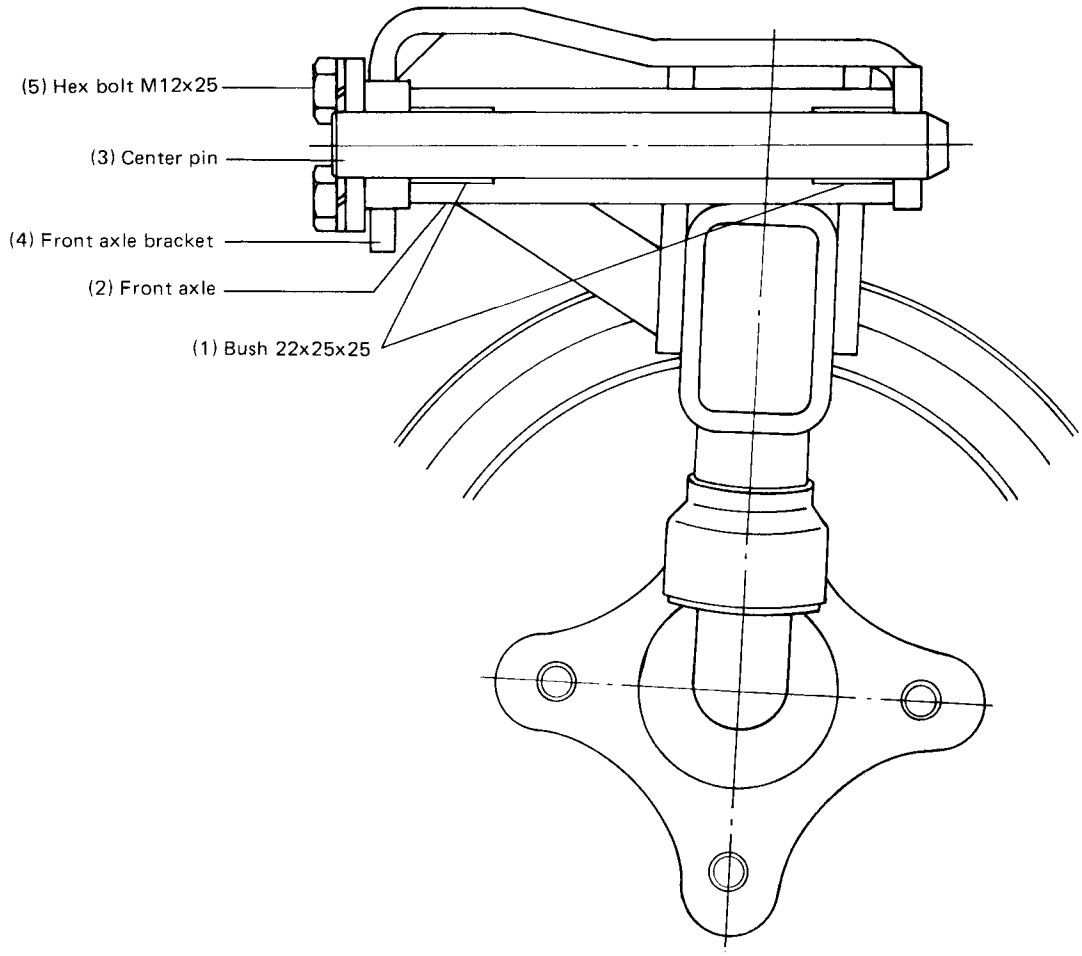


4-2 For 2-Wheel Drive (YM169)

1) Press-fit two pcs. of (1) bush, 22x25x25 into (2) front axle.

2) Insert (3) center pin through (4) front axle bracket and (2) front axle.

3) Tighten (3) center pin to (2) front axle bracket with (5) hex-bolt, M12x25.



5. BRAKE DRUM ASSEMBLY

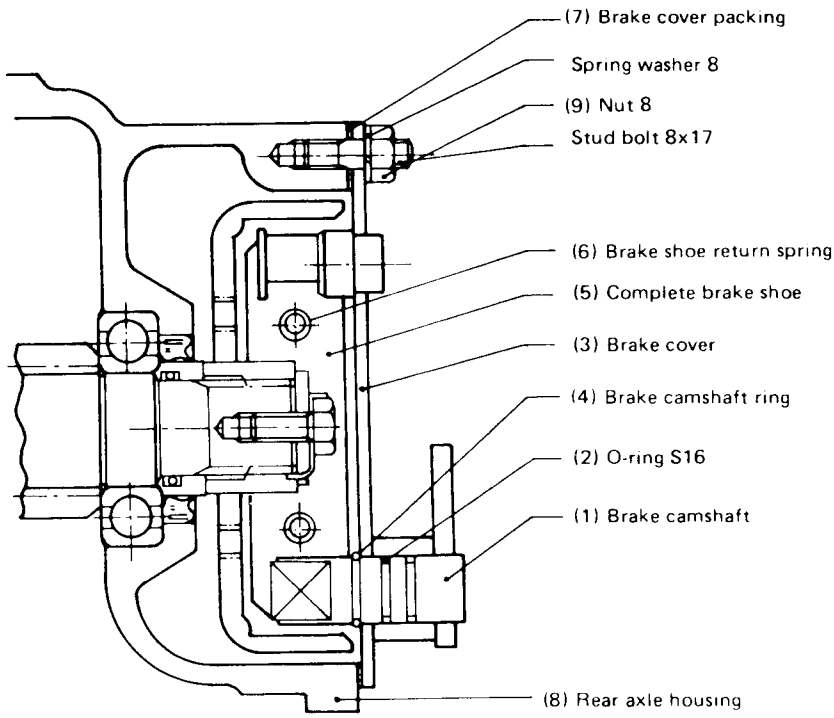
1) Attach the (2) "O" ring S 16 to the (1) brake cam shaft. Insert the (3) brake cover, and attach the (4) brake cam shaft ring.

2) Attach the (6) brake shoe return spring to the (5) complete brake shoe. Attach the brake cam shaft (step 1) to the brake shoe (step 2).

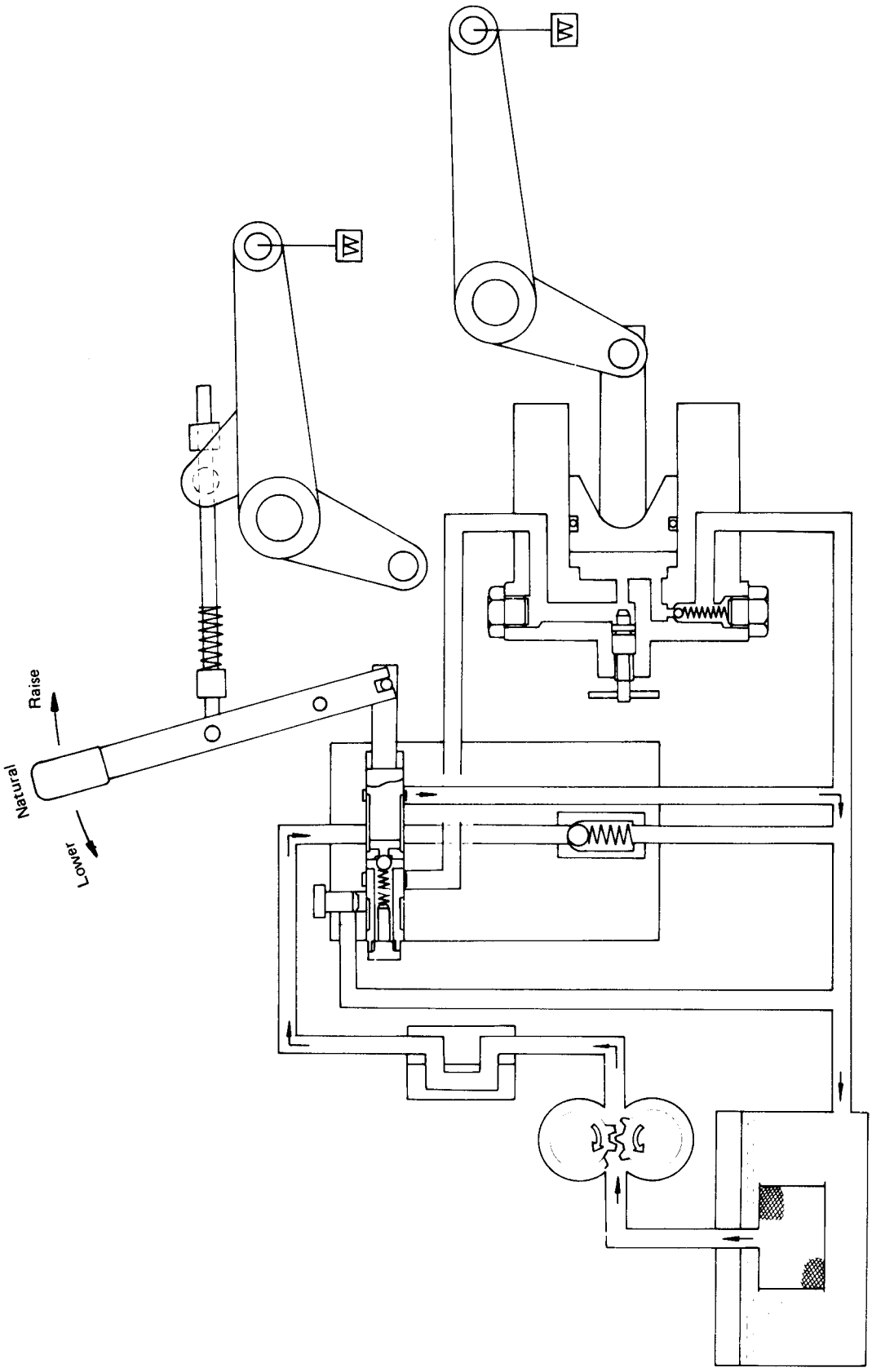
3) Insert the (7) brake cover packing between the step 1 and step 2 parts. Attach the (8) rear axle housing, and secure it with the (9) nut 8.

NOTES:
a) Tightening torque for the (9) nut 8: 9-12 ft lbs (0.13-0.17 kg m).

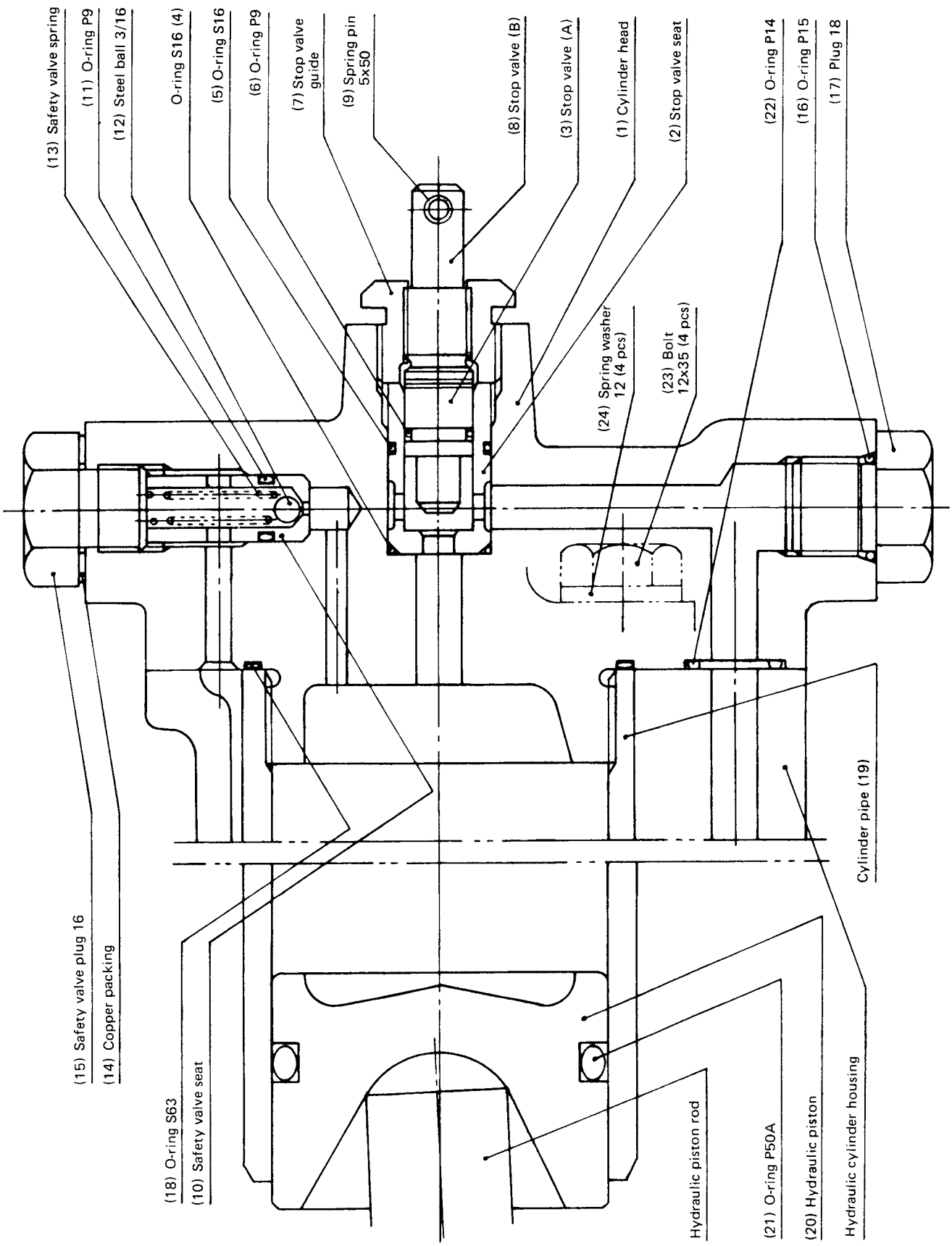
b) There is no need to apply sealent to the (7) brake cover packing.



6.HYDRAULIC SYSTEM ASSEMBLY



6-1 Cylinder Head Assembly



(Refer to the diagram on page 4-28.)

1) Stop Valve

a. Insert the (4) (5) "O" ring S16, and the (6) "O" ring P9 into the (1) cylinder head, (2) stop valve seat, and (3) stop valve A.

b. Screw in the (8) stop valve B from the inside of the (7) stop valve guide, and attach the (9) spring pin 5 x 50. The (8) stop valve B should extend out to the position shown in the illustration.

c. Insert the (2) stop valve seat and (3) stop valve A into the (1) cylinder head.

d. Screw in the stop valve guide (step b) into the (1) cylinder head.

2) Safety Valve

a. Insert the (10) safety valve seat with the (11) "O" ring P9 into the (1) cylinder head.

b. Insert into the assembled parts of step a. the (12) steel ball 3/16, and the (13) safety valve spring.

c. Attach the (14) copper packing 16 and (15) safety valve plug 16 to the (1) cylinder head.

3) Plug 18

Insert the (16) "O" ring P15 into the cylinder head and attach the (17) plug 18.

4) Cylinder Pipe, Hydraulic Piston

a. Insert the (18) "O" ring S 63 into the (1) cylinder head, and attach the (19) cylinder pipe.

b. Insert the (20) hydraulic piston with the (21) "O" ring P 50 A into the assembled parts above.

c. Insert the (22) "O" ring P14 into the (1) cylinder head. Insert the (24) spring washer 12 (4 pcs) in the (23) bolts 12 x 35 (4 pcs), and attach the parts assembled above to the hydraulic cylinder housing.

NOTE:

Parts	*Tightening torque ft-lb (kg-m)*
(7) Stop valve guide	*25 – 36 (3.5 – 5.0)*
(15) Safety valve plug 16 *(17) Plug 18* *(23) Bolt 12 x 35 (4 pcs)*	*58 – 72 (8.0 – 10.0)*
(19) Cylinder pipe	*Screw in completely to the (1) cylinder head*

6-2 Lifting Shaft Lift Arms, Lift Crank, Hydraulic Piston Rod Assembly

(Refer to the diagram on page 4-30.)

1) Insert the (2) bush 30 x 30 and (3) bush 35 x 30 into the (1) hydraulic cylinder case to the position shown in the illustration.

2) Attach the (5) hydraulic piston rod, (6) lift crank pin, (7) spring pin 5 x 28, and (8) spring pin 3 x 28 to the (4) lift crank.

3) Place the assembled parts in section 2 into the (1) hydraulic cylinder case, and insert the (9) lifting shaft.

4) Fit the center groove of the (9) lifting shaft to the center of the (4) lift crank, and fasten the (10) lift crank set bolts.

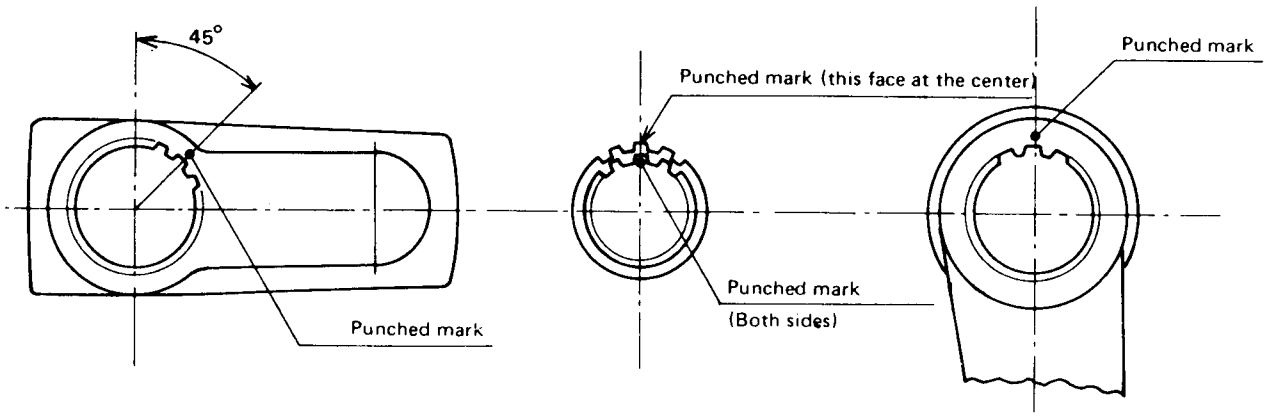
5) Insert (11) liner 30.5 x 45 x 1 (2 pcs), the (15) "O" ring P30 (2 pcs), the (12) lift arm (L) and the (13) lift arm (R) on the (9) lifting shaft.

6) Attach the (14) bolts 10 x 45 (2 pcs) so there is no play between the (1) hydraulic cylinder case and the (12) lift arm (L) and the (13) lift arm (R).

7) Attach the (16) cylinder case protector to the (1) hydraulic cylinder case by the (18) copper packing 8 (3 pcs) and (17) bolts 8 x 22 (3 pcs), and lock the (17) bolts 8 x 22 (3 pcs) in place with (19) wire 0.8 x 220.

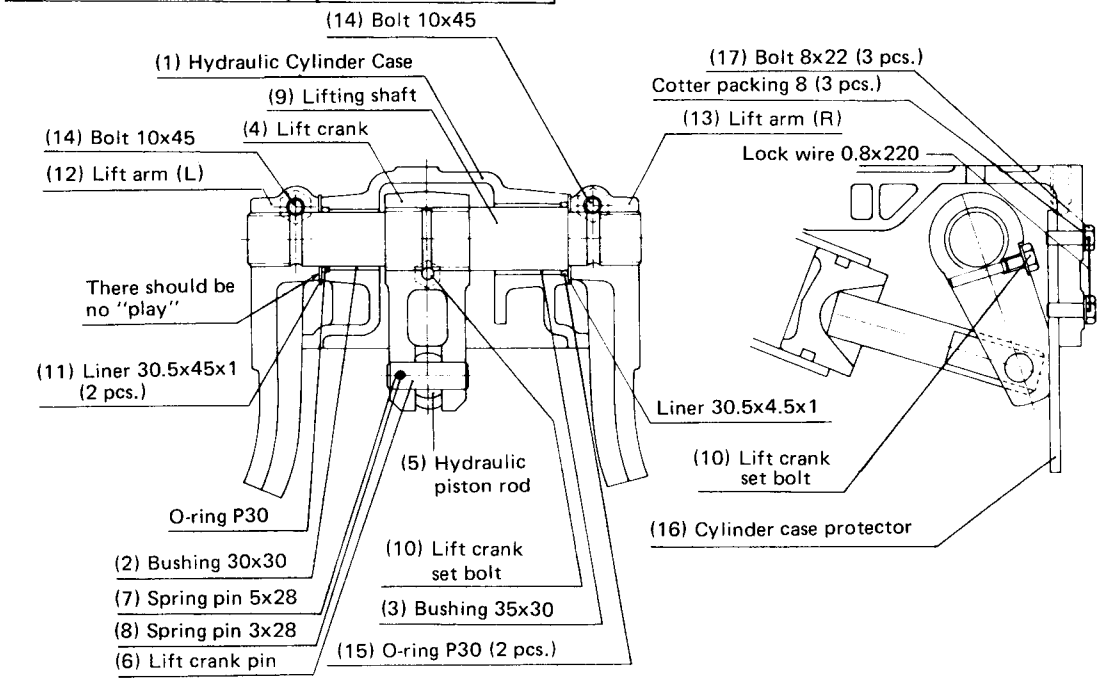
NOTES:

a) Set the punch mark for the step 3 and step 5 fitting.



b) Tightening torque:

Parts	*Tightening torque ft-lbs (kg-m)*
(10) Lift crank set bolt	*17- 22 (2.3–3.0)*
(14) Bolt 10 x 45 (2 pcs)	*33- 43 (4.5–6.0)*



NOTE:

[1] Before step 1, align the center of the hole for the (2) bushing with the center groove line of the (1) hydraulic cylinder case.

[2] Be sure there is no "play" between the (6) lift crank pin and either the (4) lift crank or the (5) hydraulic piston rod; and between the (6) lift crank pin and the (7) spring pin 5 x 28.

6-3 Control Valve Assembly

1) Insert the (2) seal washer and the (3) "O" ring P14 into the (1) hydraulic cylinder case.

2) Insert the (5) "O" ring P14 (2 pcs) into the (4) control valve.

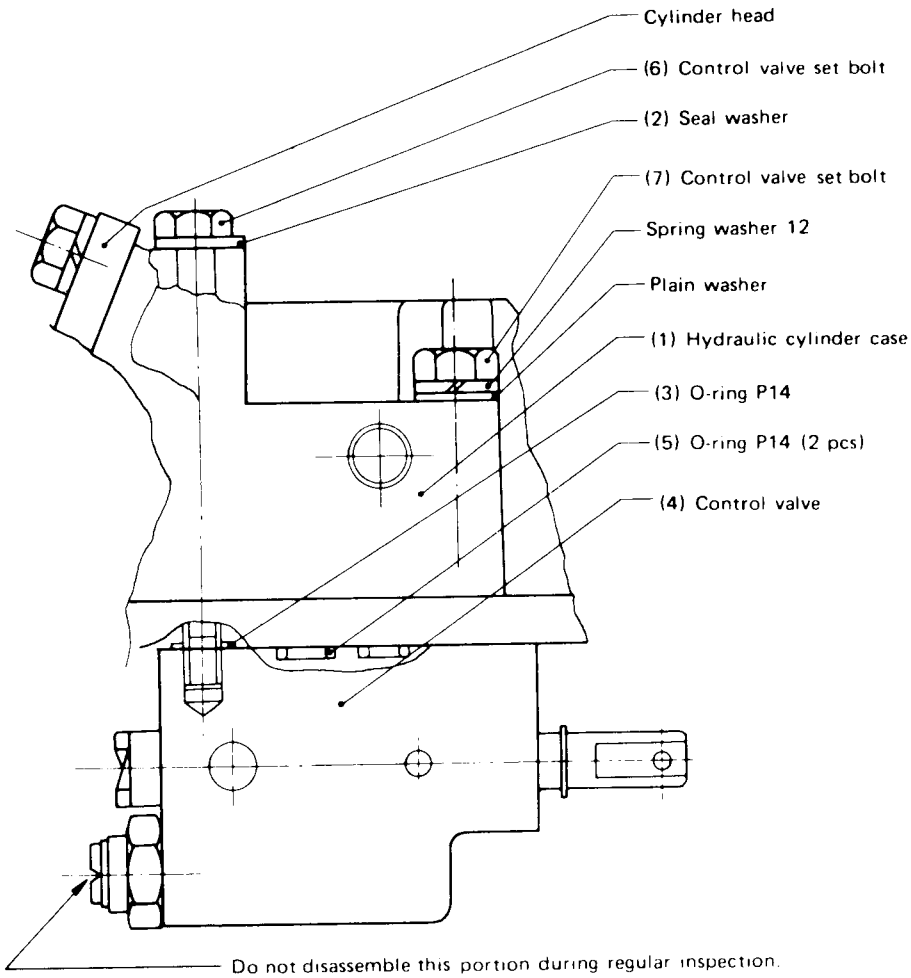
3) Attach the assembled parts of step 2 to the parts of step 1, and secure with the (6) (7) control valve set bolts (2 pcs).

NOTES:

a) Tighten the (6) (7) control valve set bolts (2 pcs) uniformly to the required torque.

b) Torque for the (6) (7) control valve set bolts:
33–40 ft-lbs (4.5–5.5 kg-m)

c) DO NOT turn or take apart the nut or spindle that is attached to the bottom of the (4) control valve.



6-4 Hydraulic Control Fork, Hydraulic Control Lever Assembly

1) Attach the (2) circlip 14 to the (1) hydraulic control lever, and insert the (3) control lever liner and the (4) "O" ring S12.

2) Place the (5) hydraulic control fork in the (6) hydraulic cylinder case. Insert the assembled parts in step 1 in the (6) hydraulic cylinder case, and the (5) hydraulic control fork. Be sure to place the (8) spring pin 6 x 25 of the (7) control

valve spool on the slot of the (5) hydraulic control fork.

3) Screw-in the (9) nut 6 on the (10) set bolt 6 x 30, and then attach it to the (5) hydraulic control fork.

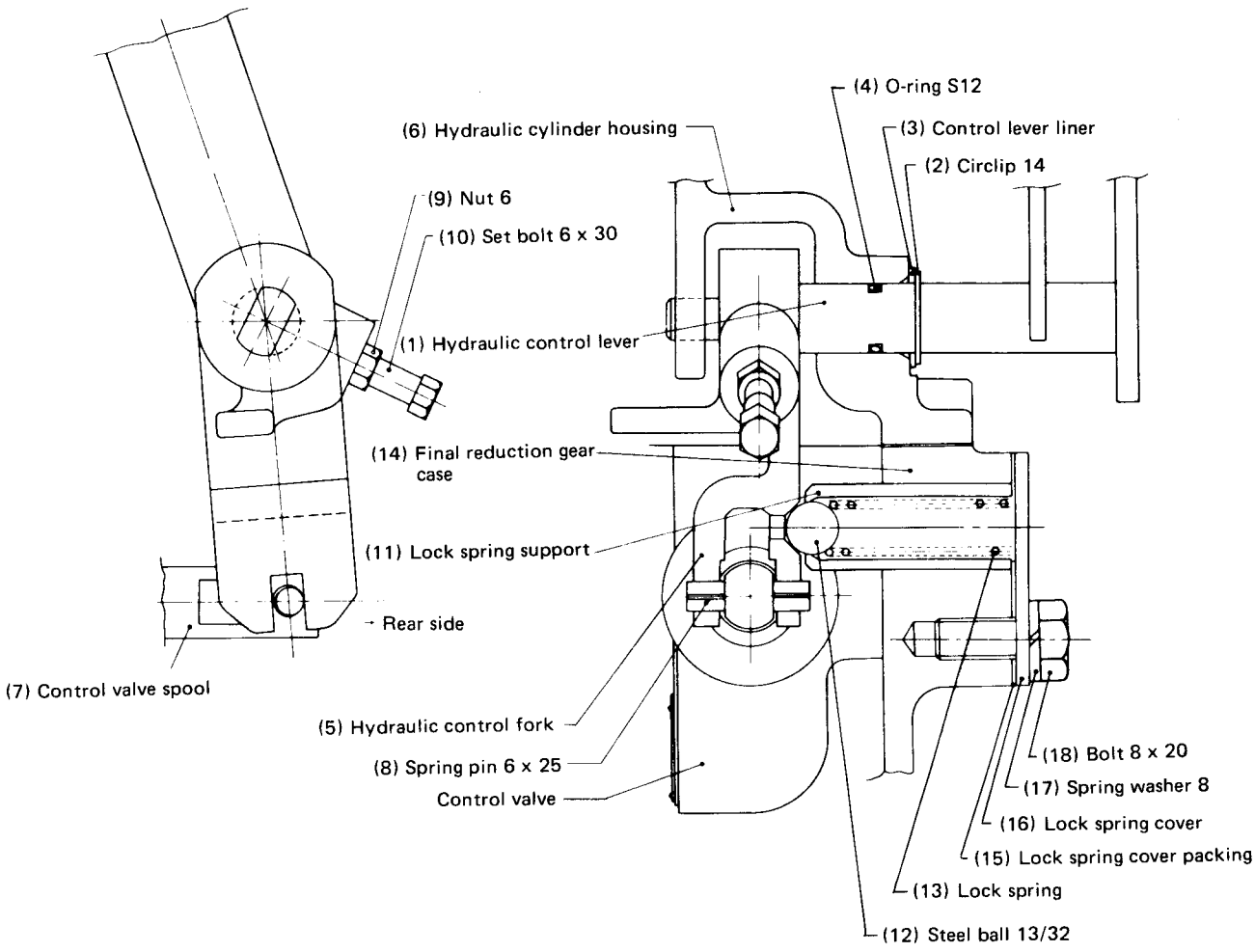
4) Insert the (12) steel ball 13/32 and (13) lock spring on the (11) lock spring support.

5) Insert the assembled parts of step 4 into the (14) final reduction gear case.

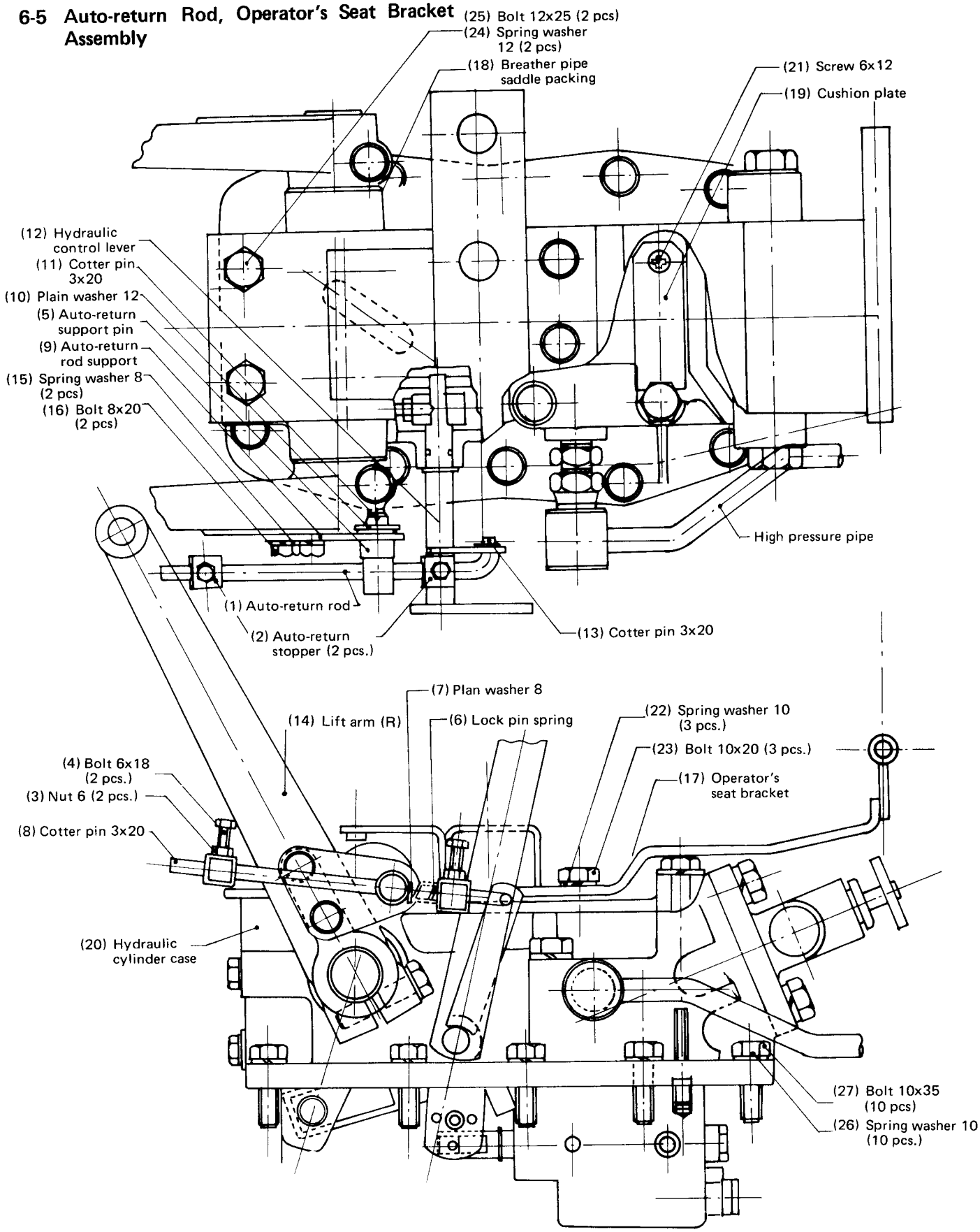
6) Attach the (15) spring cover packing and (16) lock spring cover to the (14) final reduction gear case. Secure it with the (17) spring washer 8 (2 pcs) and (18) bolts 8 x 20 (2 pcs).

NOTE:

Parts	*Tightening torque ft-lb (kg-m)*
(10) Set bolt 6 x 30	*6–9 (0.8–1.2)*
(9) Nut 6	*4–5 (0.5–0.7)*
(18) Bolt 8 x 20	*9–12 (1.3–1.7)*



6-5 Auto-return Rod, Operator's Seat Bracket Assembly



1) Insert the (2) auto-return stoppers with (3) nut 6, (4) bolt 6 x 18 (2 pcs) (5) auto-return support pin, (6) lock pin spring, (7) plain washer 8 on the (1) auto return rod, as shown in the illustration. Attach the (8) cotter pin 3 x 20.

2) Attach the (9) auto-return rod support, (10) plain washer 12, and (11) cotter pin 3 x 20 to the (5) auto-return support pin.

3) Insert the (1) auto-return rod in the hole of the (12) hydraulic control lever, and attach the (13) cotter pin 3 x 20.

4) Attach the (9) auto-return rod support to the (14) lift arm (R) with the (15) spring washer 8 (2 pcs) and the (16) bolts 8 x 20 (2 pcs).

5) Place the (18) breather pipe packing in the bottom of the breather of the (17) operator's seat bracket.

6) Attach the (19) cushion plate to the (20) hydraulic cylinder case with the (21) screw 6 x 12.

7) Attach the (17) operator's seat bracket to the (20) hydraulic cylinder case with the (22) spring washer 10 (3 pcs), (23) bolts 10 x 20 (3 pcs) and the (24) spring washer 12 (2 pcs) and (25) bolts 12 x 25 (2 pcs).

8) Attach the items assembled in steps 1-7 to the final reduction gear case with the (26) spring washer 10 (10 pcs) and the (27) bolts 10 x 35 (10 pcs).

9) To make the (2) auto-return stoppers operate, adjust the lift arms (R) and (L) to the desired height and tighten the (2) auto-return stoppers with the (3) nut 6 (2 pcs) and (4) bolts 6 x 18 (2 pcs).

NOTE:

	Parts	*Tightening torque ft-lb (kg-m)*
(3)	*Nut 6 (2 pcs)*	*4 - 5 (0.5 - 1.7)*
(4)	*Bolt 8 x 18 (2 pcs)*	*6 - 9 (0.8 - 1.2)*
(23)	*Bolt 10 x 20 (3 pcs)*	*15 - 22 (2.0 - 3.0)*
(25)	*Bolt 12 x 25 (2 pcs)*	*29 - 43 (4.0 - 6.0)*
(27)	*Bolt 10 x 35 (10 pcs)*	*25 - 36 (3.5 - 5.0)*

6-6 Slow Return Valve Assembly

1) Insert the (2) "O" ring S12.5 into the (1) slow return plug 16, and then screw in the (1) slow return plug 16 into the (3) final reduction gear case.

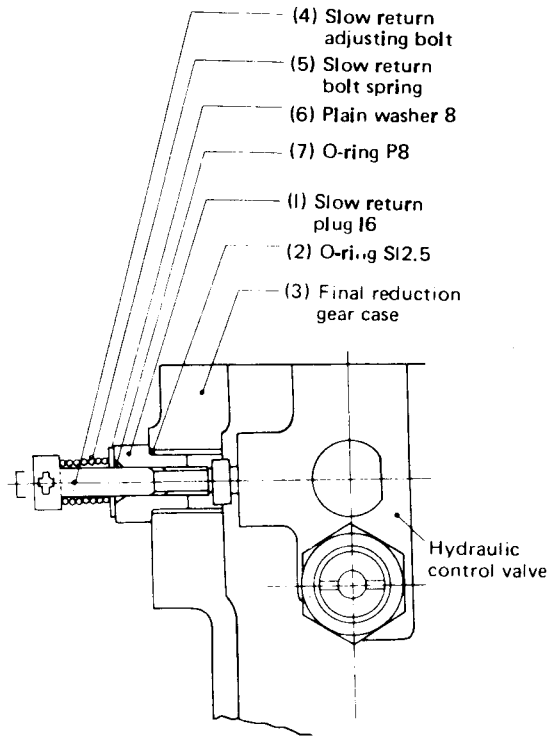
2) Insert the (5) slow return spring, (6) plain washer 8, and (7) "O" ring P8 into the (4) slow return adjusting bolt.

3) Screw in the (4) slow return adjusting bolt (step 2) into the (3) final reduction gear case (step 1).

NOTE:

a) When screwing in the part with the (2) "O" ring S12.5 and the (7) "O" ring P8 be sure not to damage them.

b) (1) slow return plug 16 tightening torque: 51 - 62 ft-lb (7.0 - 8.5 kg-m) *see text.*

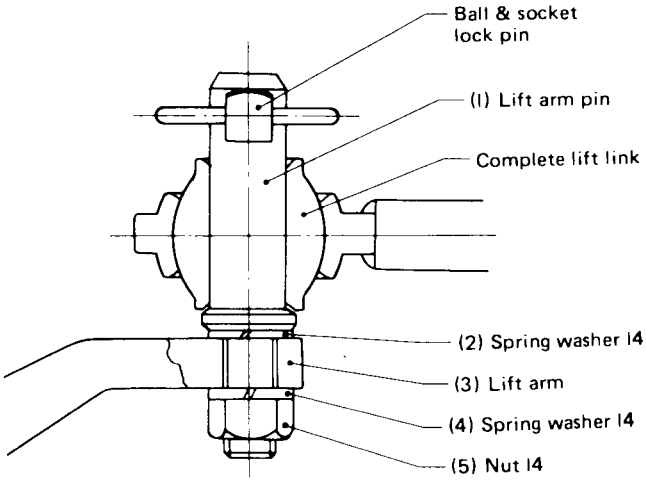


6-7 Lift Arm Assembly

1) Insert the (2) spring washer 14 in the (1) lift arm pin and tighten.

2) Insert the (4) spring washer 14 into the (1) lift arm pin, and retighten the (5) nut 14.

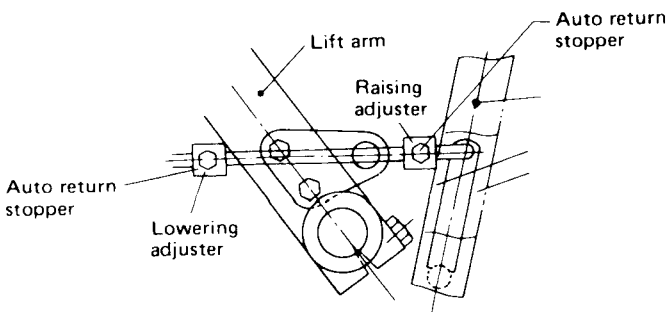
NOTE: Be sure to attach the (2) (4) spring washers to both sides of the (3) lift arm.



6-8 Operational Precaution Points

1) Auto Return Rod

The hydraulic control fork's protruding part and the edge of the hydraulic piston will act to stop the lift arms when they are placed in their furthest position, and the lever will return to its center position. For the desired lift arm height adjust the position of the auto return stopper.

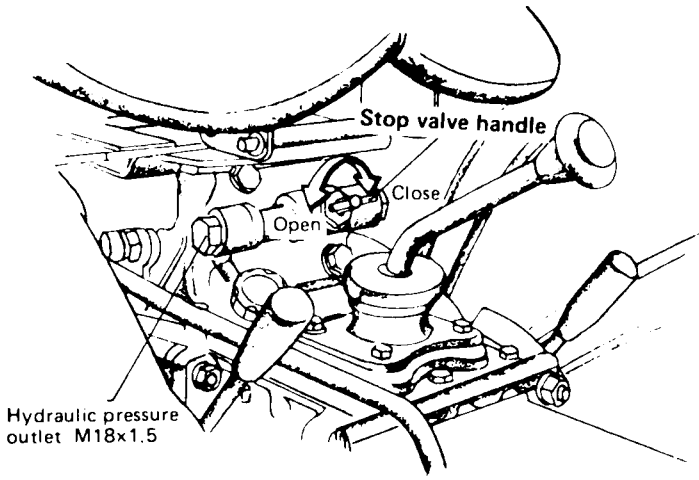


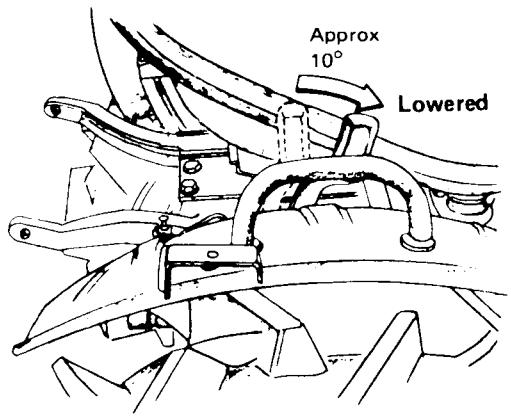
2) Hydraulic Pressure Outlet (M18 x 1.5)

Be sure to follow the following steps when releasing pressure from the hydraulic oil outlet:

a) Move the lift arms a little (about 10°) from the top position (with the implement attached to the 3 point hitch), completely tighten the stop valve, and secure the lift arms.

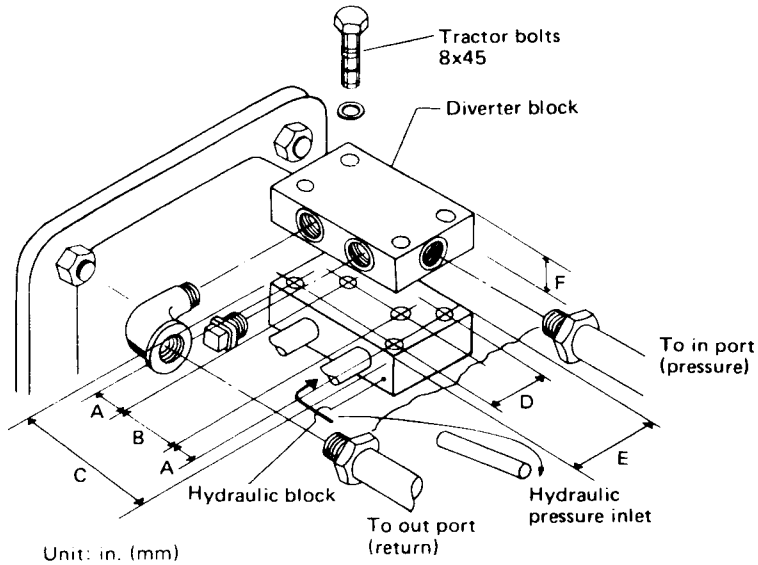
b) Put the hydraulic control lever in the top position.





3) Hydraulic Pressure Divider

For the hydraulic pressure divider dimensions refer to the following illustration:



Unit: in. (mm)

A : 0.531 (13.5)
B : 1.378 (35)
C : 3.228 (82)
D : 1.181 (30)
E : 1.969 (50)
F : 0.906 (23)

CHAPTER 5

TRACTOR ADJUSTMENT

TRACTOR ADJUSTMENT

Adjusting procedures have been explained item by item in Chapter 3, Tractor Construction and Maintenance. Please refer to this chapter for details.

1. CLUTCH AND RELATED ITEMS

(1) Height of release lever (See page, 3–2)

(2) Clutch pedal stroke and play adjustment (See page, 3–4)

(3) Instructions for attaching the safety switch (See page, 3–4)

2. PTO AND RELATED ITEMS

(1) Attaching 3-point hitch

1) Loosen check chain so the lower link can move freely.

2) Back up the tractor to line up the center of the tractor and the implement.

3) Couple the left lower link.

4) Adjust the height of the right lift link, and couple the right lower link.

5) Attach the tractor side of the top link, adjust the length of the link, and couple the implement. The top link adjusting lock nut should be on the tractor side.

6) Couple the universal joint of the implement to the P.T.O. shaft of the tractor. (Check to make certain that the stopper pin is inserted properly.)

7) Raise the implement by setting the control lever to the "Raise" position, and adjust the check chain to control any side movement of the implement so that the tires will not come in contact with the lower links.

8) Adjust the lift link to a length most appropriate for the work involved. (The right link is an adjustable one).

3. BRAKE AND RELATED ITEMS

(1) Adjusting the brake pedal free play (See page, 3–13)

4. HYDRAULIC EQUIPMENT

(1) Adjusting the slow return valve

1) Turn the slow return adjusting bolt clockwise to move lift arm slowly, and counterclockwise to move lift arm quickly.

(2) Adjusting the control lever stroke (See page, 4–34)

5. STEERING SYSTEM

(1) Adjusting toe-in (See page, 3–18)

(2) Adjusting the steering wheel free play (See page, 3–17)

CHAPTER 6
ENGINE

1. DISASSEMBLY SEQUENCE

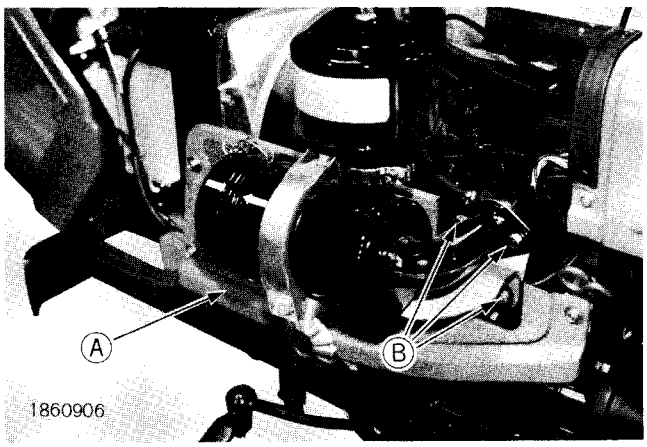
Complete disassembly of the engine should be carried out in the following sequence:

1-1 Radiator and Air Cleaner

1) Remove pre-cleaner.

2) Remove side cover (A) and air cleaner mounting cap screws (B).

3) Remove air cleaner assembly.

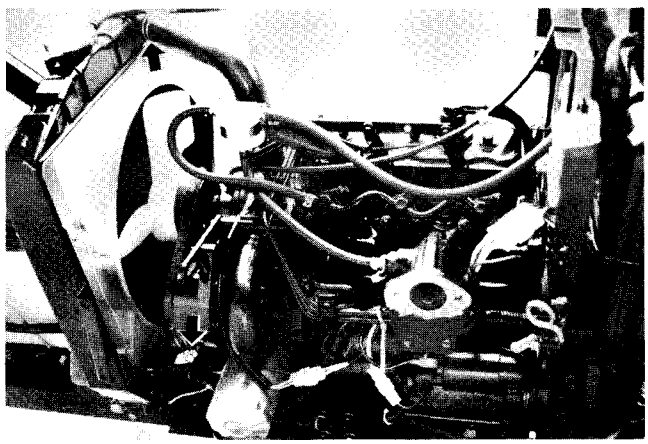


A — Side Cover B — Cap Screws

4) Drain coolant from radiator and cylinder block.

5) Disconnect radiator hoses.

6) Remove radiator from tractor.



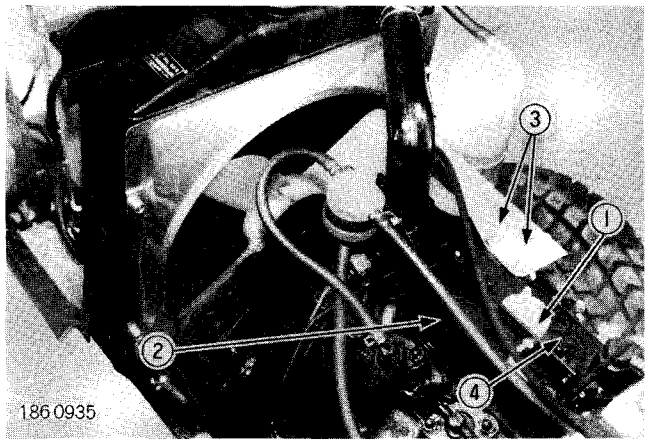
1-2 Rocker Arm Assembly

1) Disconnect decompression linkage.

2) Remove thermostart fuel cup support mounting screws.

3) Remove radiator overflow tank (Sub-tank) bracket cap screws.

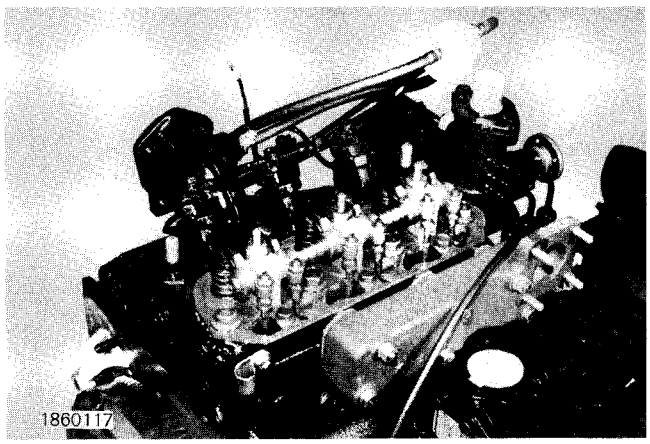
4) Remove cylinder head cover cap screws, and remove cylinder head cover.



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

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

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



1-3 Cylinder Head

1) Remove exhaust manifold with muffler.

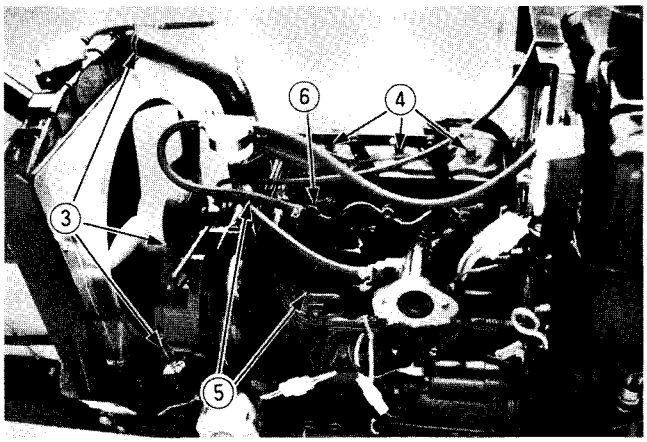
2) Remove intake manifold with air cleaner.

3) Remove fan belt and radiator hoses.

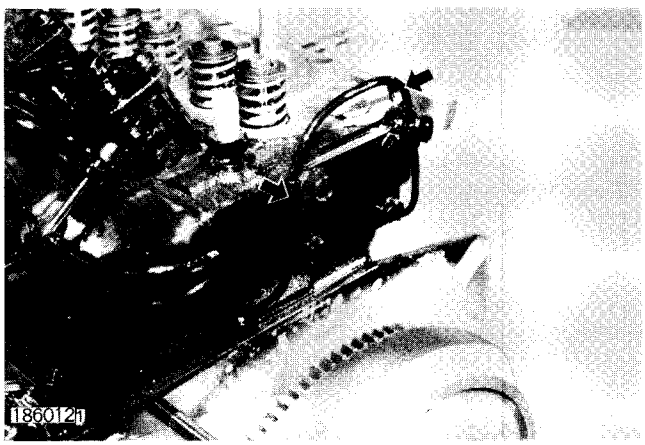
4) Remove cylinder head cover and rocker arm assembly.

5) Remove excess fuel (fuel leak-off) and injection lines.

6) Remove injection nozzles.



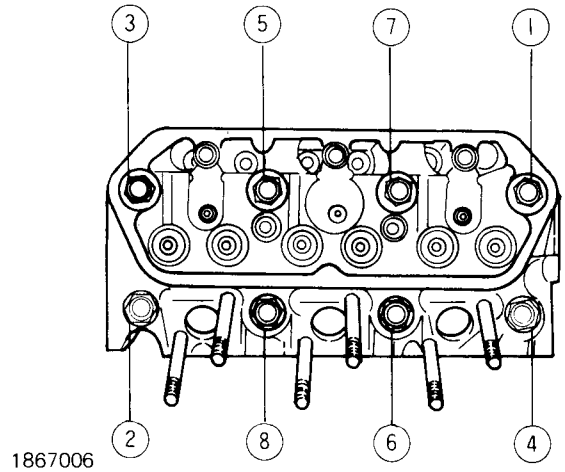
7) Remove cylinder head lubricating oil line connecting screws.



8) Remove cylinder head assist bolts.

9) Remove cylinder head bolts by following loosening sequence as illustrated.

10) Use a valve spring compressor to remove valves from head.



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1-4 Timing Gear Cover

1) Separate tractor front end from engine.

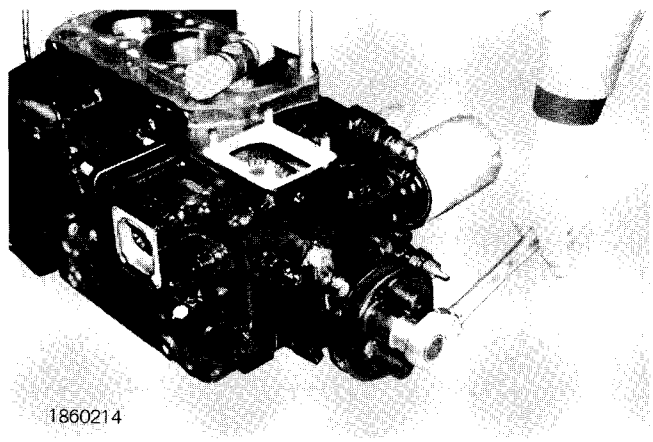
2) Remove radiator fan and fan belt.

3) Disconnect hourmeter drive cable from housing.

4) Remove nut on crankshaft pully, and remove pully by using puller.

5) Remove injection pump cover plate and injection pump as instructed in disassembly of injection pump.

6) Remove timing gear cover cap screws and remove timing gear cover.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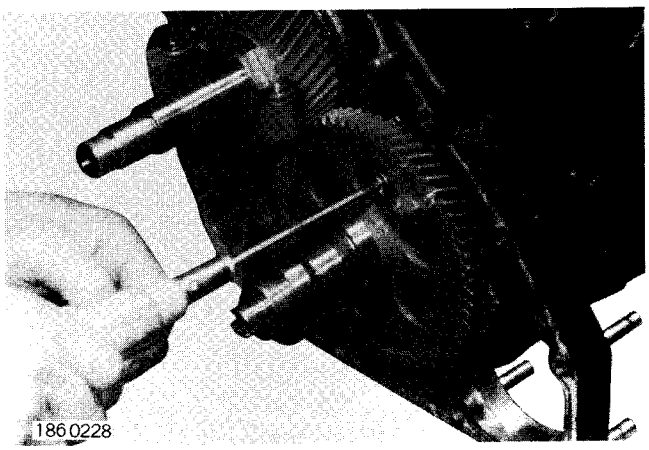
1-5 Camshaft

1) Remove tractor front end and timing gear cover as previously indicated.

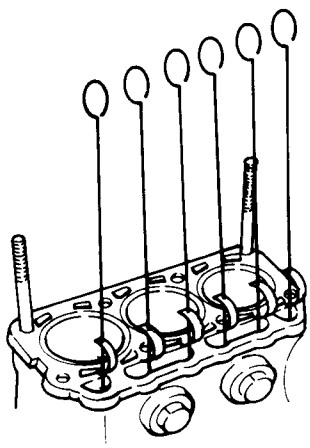
2) Remove rocker arm cover and cylinder head as previously indicated.

3) Remove camshaft bearing retainer screw.

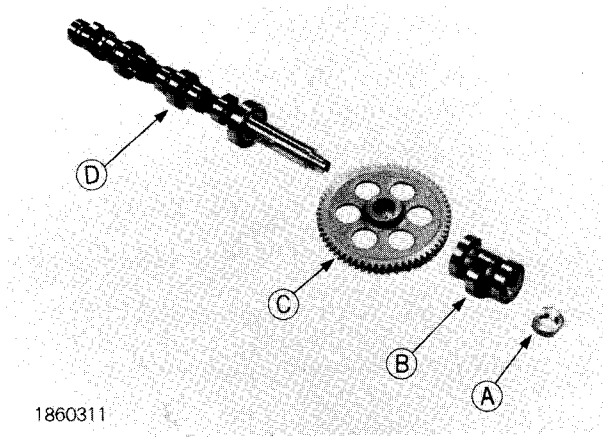


4) Use Magnetic Holding Tool or its equivalent to hold tappets away from camshaft lobes during removal.

5) Carefully remove camshaft from cylinder block so that camshaft lobes do not drag in bores.



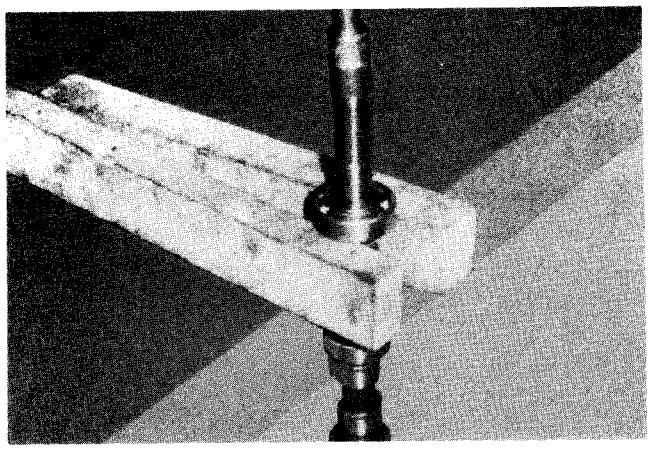
6) Loosen Nut (A) and Remove injection pump drive cam (B) and camshaft gear (C).
Nut (A) has left-hand threads.



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

7) Support camshaft bearings in a press.

8) Press camshaft from bearings.



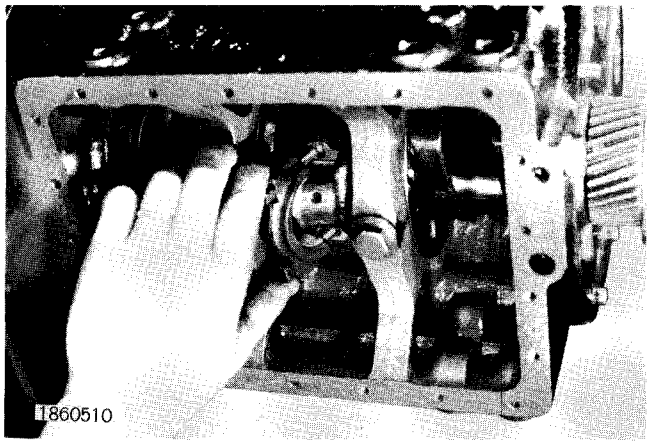
1-6 Pistons

It is not necessary to remove the engine to service pistons, rods and liners.

1) Remove cylinder head as previously instructed.

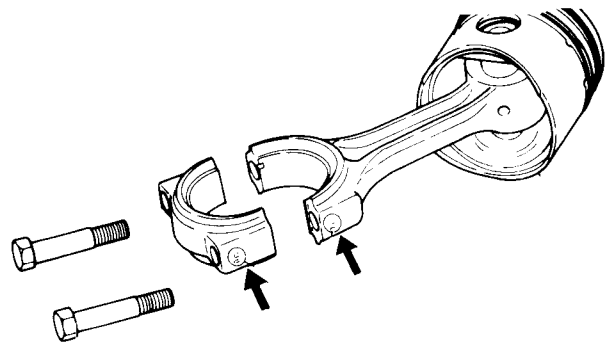
2) Remove oil pan.
It is not necessary to remove the front drive propeller shaft to remove piston.

3) Remove connecting rod bolts and rod caps.



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

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.



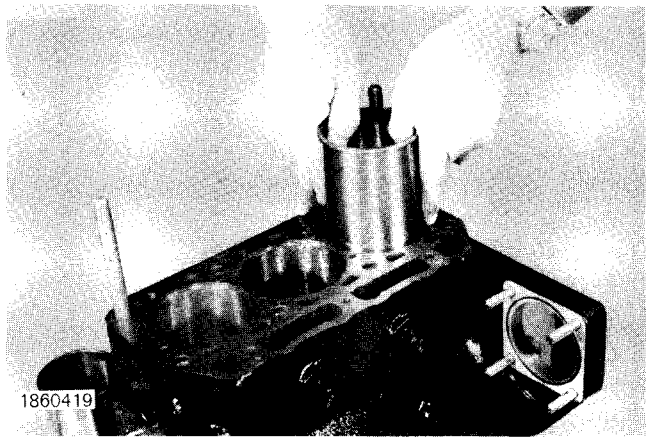
1-7 Liners

1) Remove cylinder head and piston as previously instructed.

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

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

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

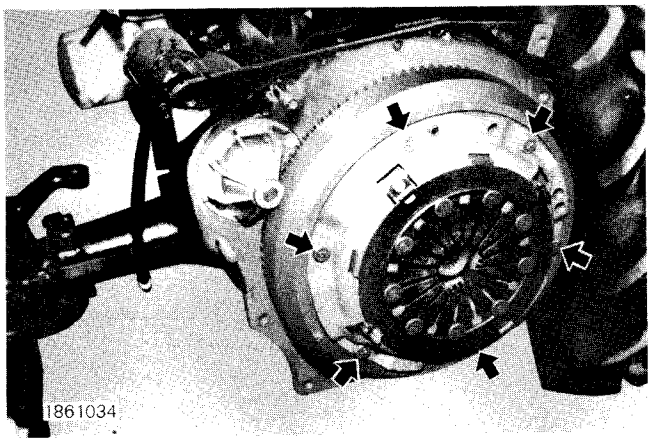


1-8 Flywheel

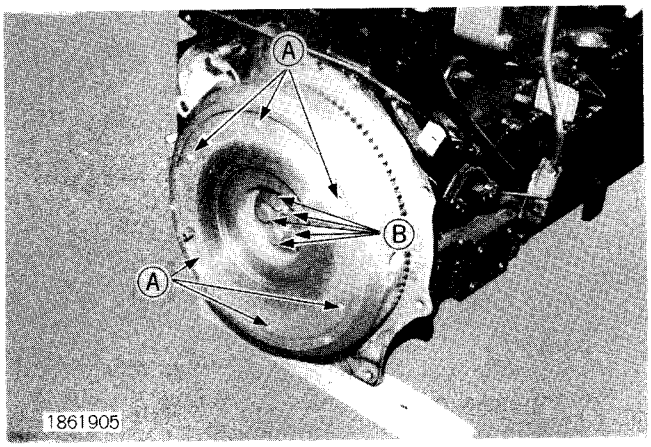
1) Separate the engine from the clutch housing.

2) Remove clutch assembly retaining cap screws, and remove clutch assembly from flywheel.

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



3) Remove five cap screws (B) and flywheel.



A – Clutch Mounting Holes
B – Flywheel Mounting Cap Screws

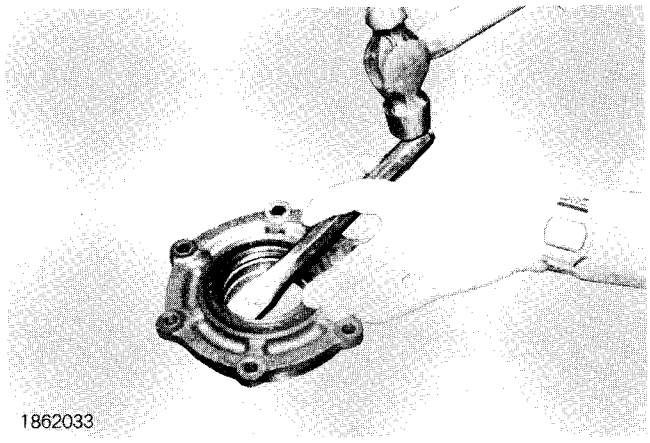
1-9 Rear Oil Seal and Rear Main Bearing

1) Separate the engine from clutch housing.

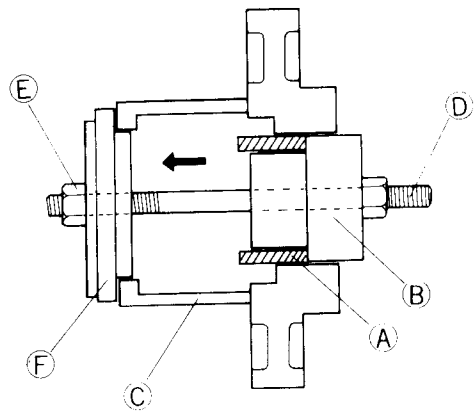
2) Remove flywheel as previously instructed.

3) Remove rear main bearing housing from cylinder block.

4) Use a pry bar to remove oil seal.

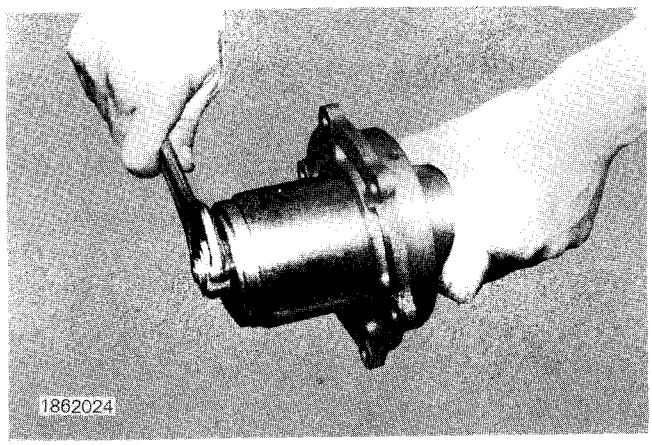


5) Remove bearing by using "Crank Shaft Main Bearing Removal and Installation Tool Kit".



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

6) To remove bearing, tighten nut.



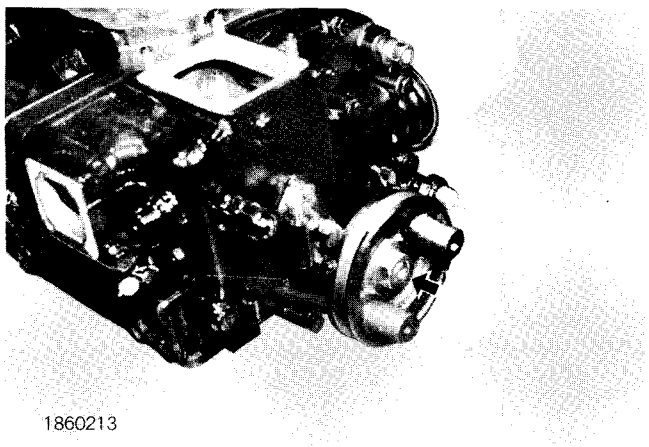
1-10 Crankshaft and Main Bearings

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

1) Remove engine.

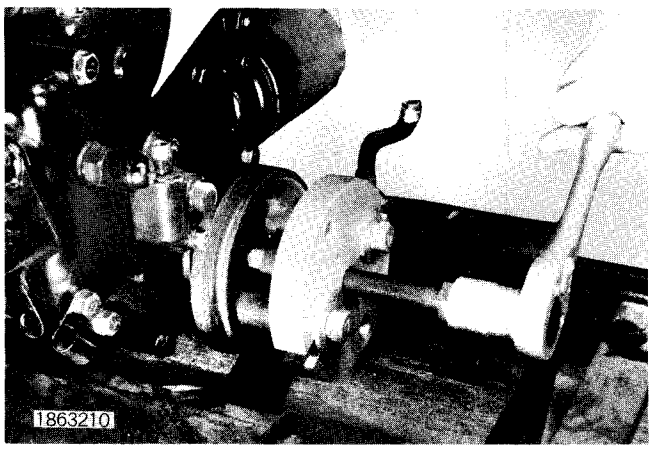
2) Remove cylinder head, pistons and flywheel as previously instructed.

3) Remove crankshaft pulley retaining nut.


1860213

4) Use a puller to remove pulley.

5) Remove timing gear cover as previously instructed.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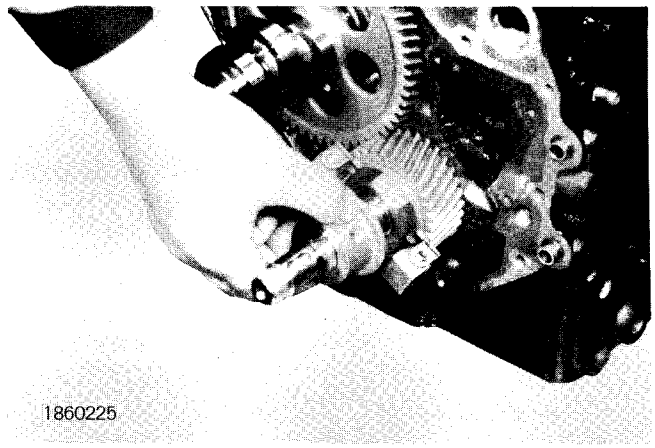
6) Remove governor sleeve from crankshaft.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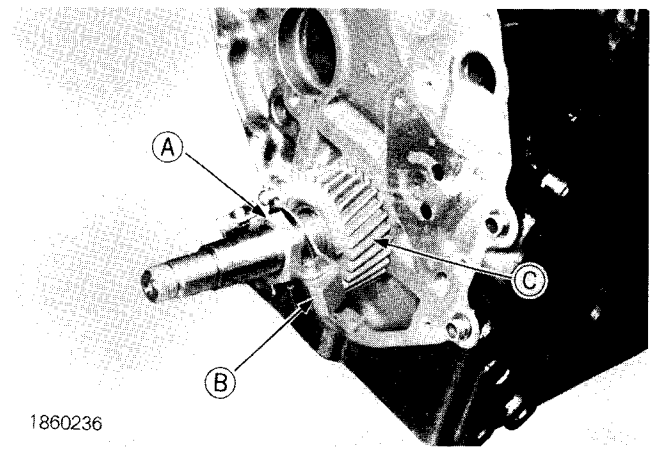
7) Remove nut (A) and governor weight assembly (B) to remove crankshaft gear (C).

8) Remove crankshaft gear (C).



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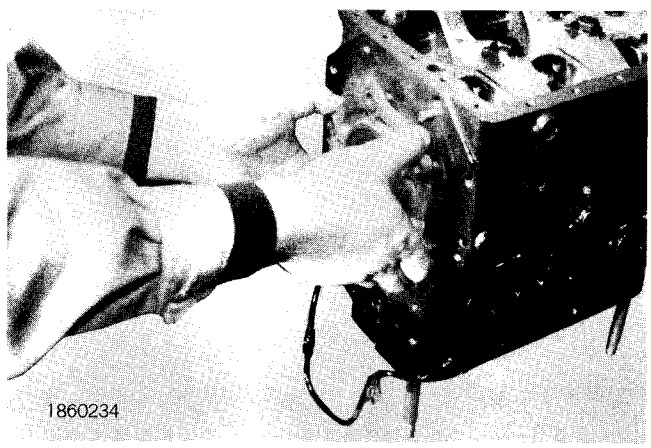
A – Nut
B – Governor Weight
C – Crankshaft Gear

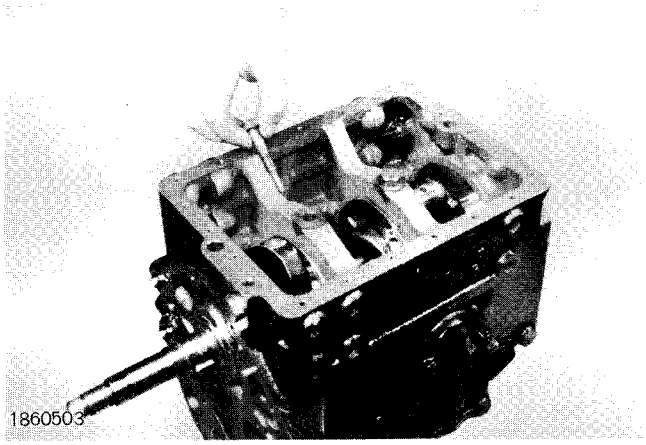
9) Invert cylinder block and remove rear main bearing housing and mounting flange.


1860234

10) Secure a chain hoist to crankshaft.

11) Remove the two set bolts from intermediate main bearing housings.

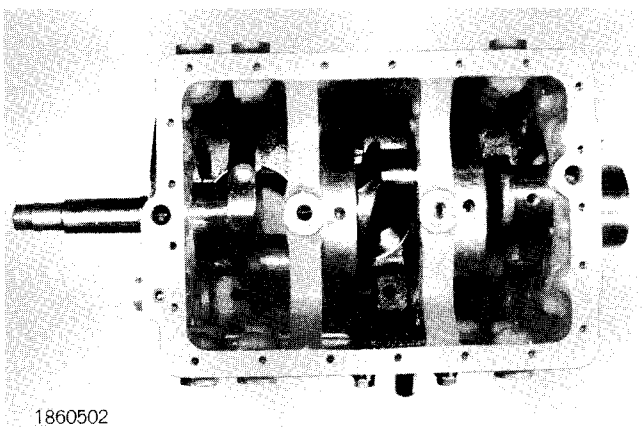
12) Carefully lift crankshaft from block.



1860503

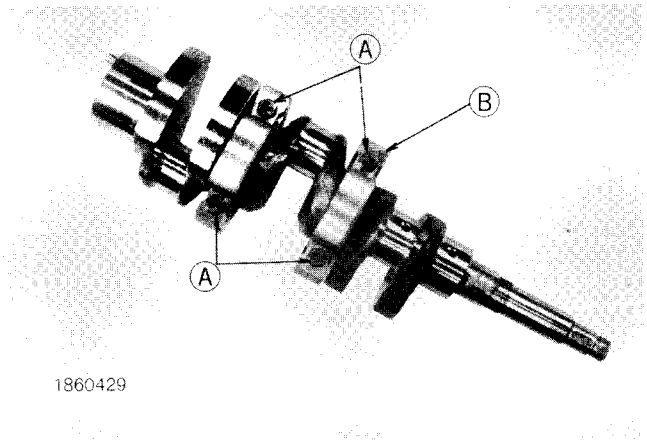
13) Carefully pull crankshaft out of cylinder block.

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



1860502

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



1860429

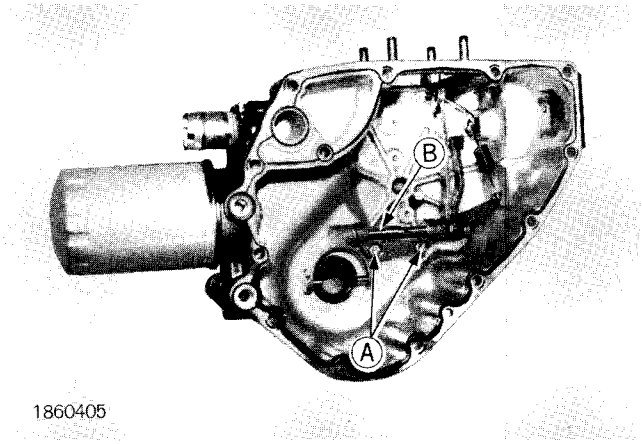
A — Housing Cap Screws B — Bearing Housings

1-11 Front Oil Seal

1) Remove timing gear cover.

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

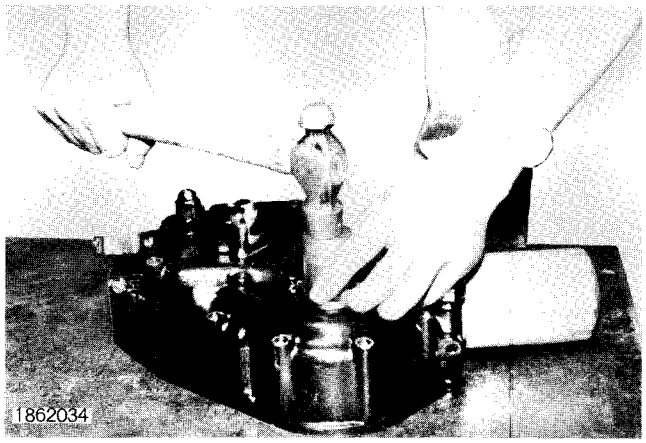
3) Check oil seal for wear or deterioration.



A — Cap Screws B — Governor Linkage

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

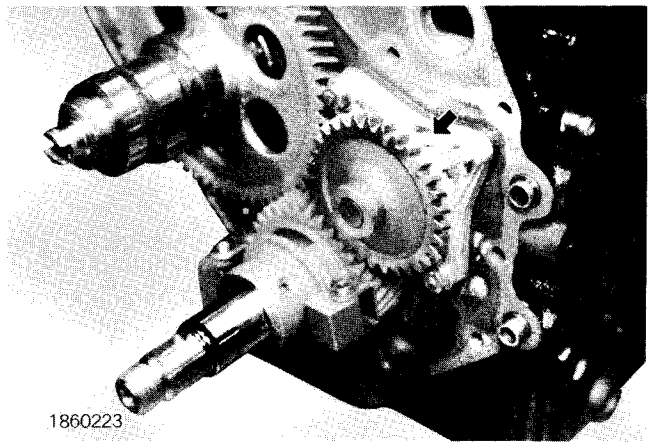
Replace oil seal with new one if it was removed from cover.



1-12 Oil Pump

1) Remove timing gear cover as previously instructed.

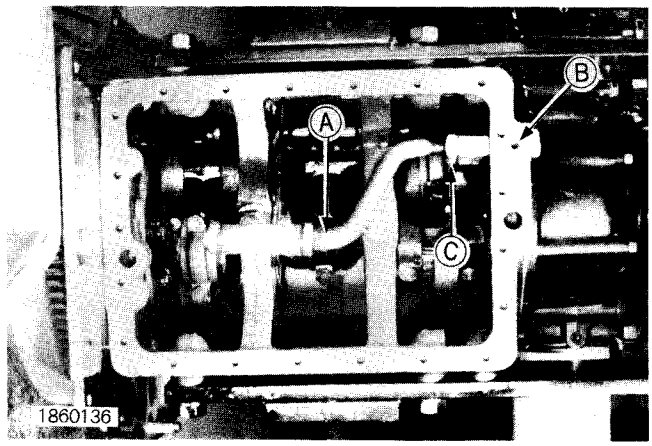
2) Remove three cap screws securing pump body to block and remove pump.



1-13 Lube Oil Suction Tube and Screen

1) Drain engine oil and remove oil pan.

2) Loosen lock nut and remove suction tube.

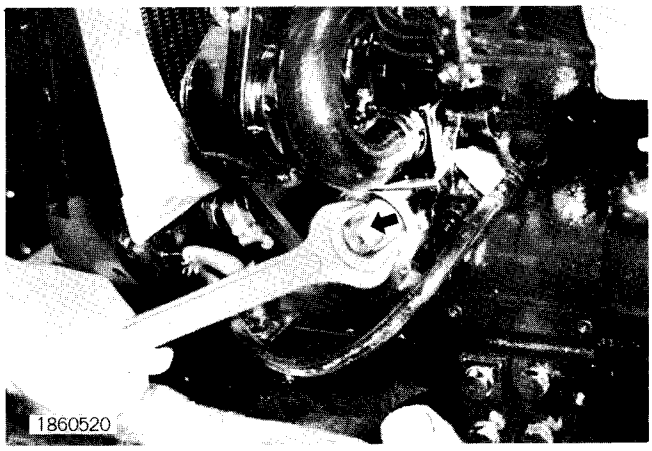


A — Suction Tube C — Lock Nut
B — Oil Passage

1-14 Oil Pressure Regulating Valve

1) Remove oil filter.

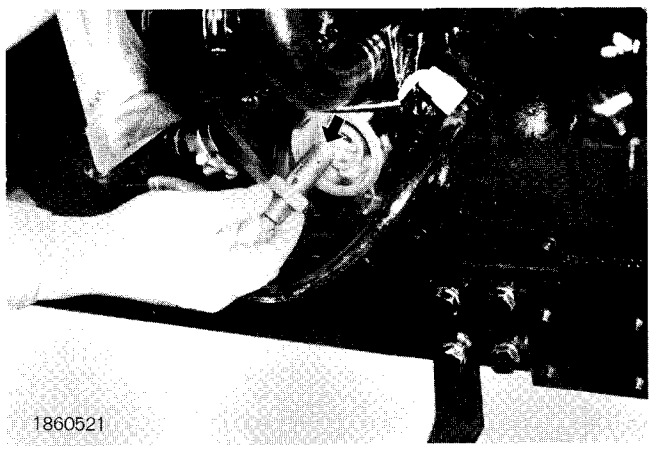
2) Remove oil pressure regulating valve body.



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 2.6 psi (0.17 Bar) (0.18 kg/cm^2).



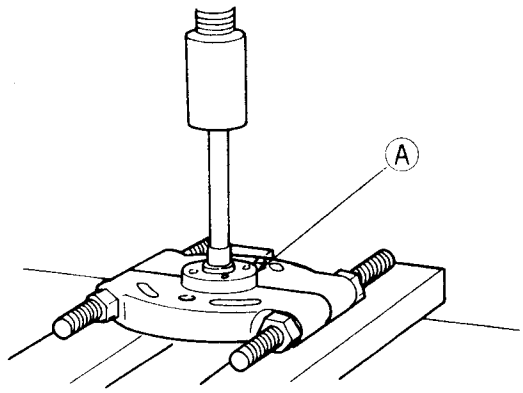
1-15 Water Pump

1) Drain cooling system.

2) Remove fan belt, and water pump hoses from water pump.

3) Remove water pump-to-thermostat housing bolts (5 bolts) and remove water pump.

4) Use a press to push fan hub from bearing shaft.



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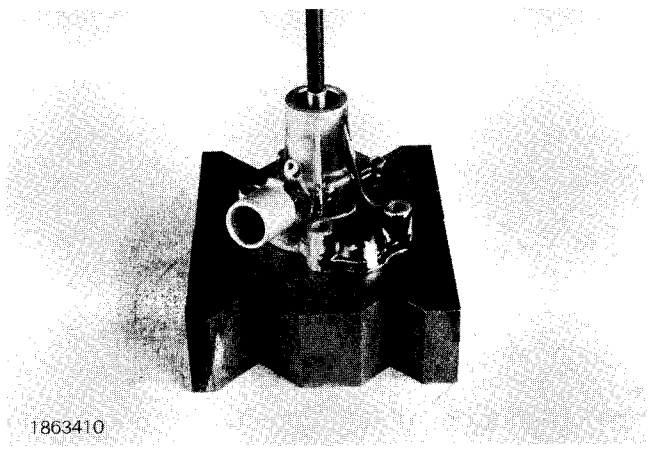
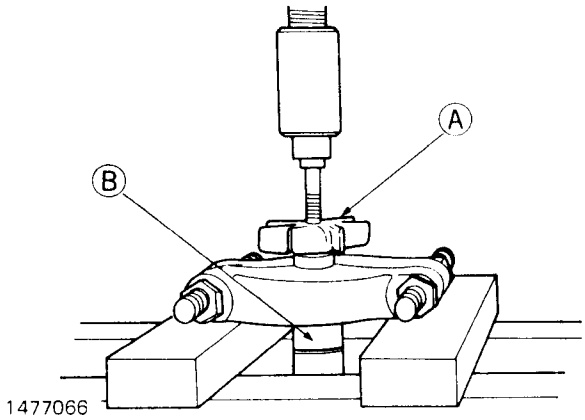
A – Fan Hub

5) Support water pump in press. Press bearing shaft with impeller from water pump housing.



6) Support impeller on fan hub and press impeller from bearing shaft.

Inspect seal and impeller before removing. If damaged, replace.

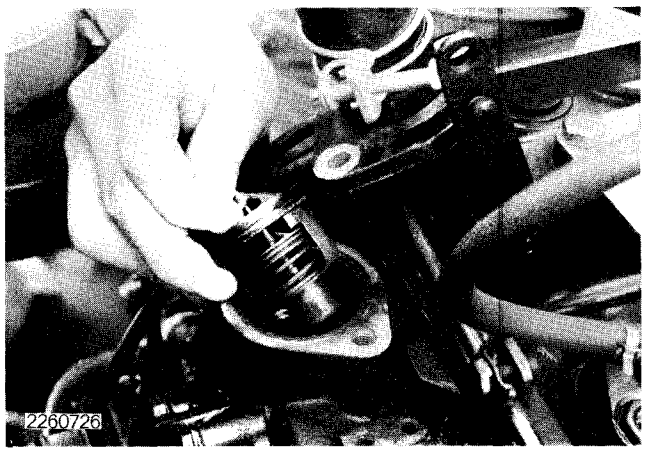


A – Impeller B – Bearing Shaft

1-16 Thermostat

1) Remove radiator hose and thermostat cover.

2) Remove thermostat.



1-17 Fuel Injection Pump

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

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.

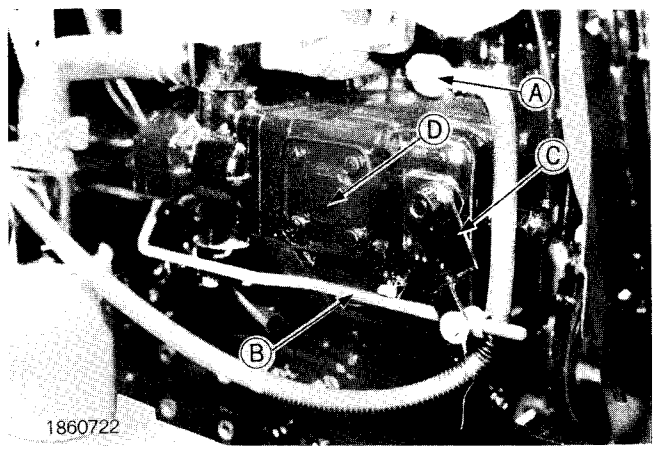
1) Close the fuel shut-off valve at fuel filter.

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

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.



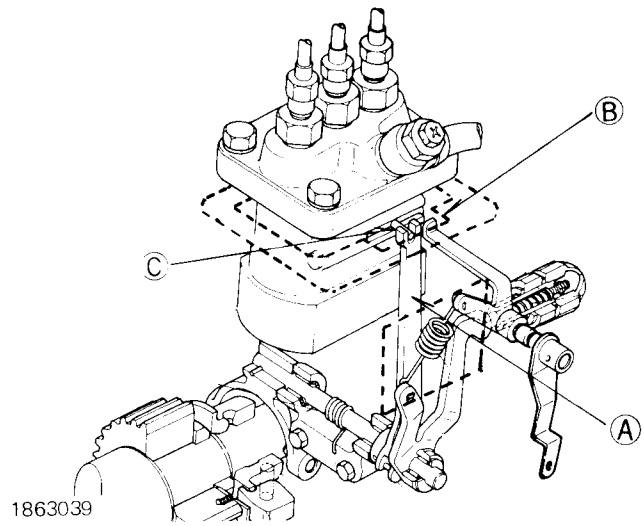
A – Banjo Fitting C – Regulator Handle
B – Control Rod and Swivel D – Cover Plate

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

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 number and thickness of shims under mounting flange of pump to facilitate pump installation.



A – 2nd Governor Lever
B – Opening
C – Pump Control Rack

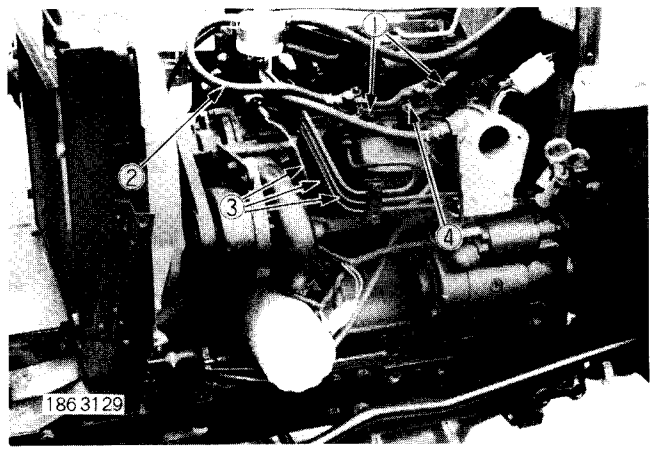
1-18 Fuel Injection Nozzles

1) Disconnect excess fuel lines (leak-off hoses) 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.

2. CONSTRUCTION AND MAINTENANCE

2-1 Cylinder Liners

Cylinder liners must provide a good fit with pistons and piston rings, provide good heat dissipation, and must also have ample wear resistance.

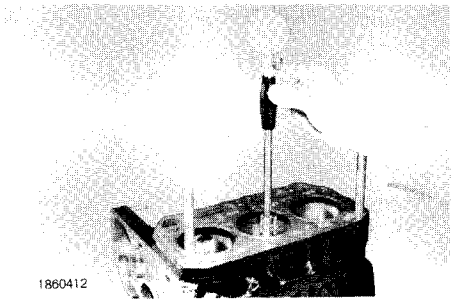
The 3T72HA-A, engine employes "HAND PRESS FIT-DRY LINER" made of special cast iron.

(1) Visual Inspection

The cylinder liner should be replaced when there are visible scratches, traces of rust, or corrosion.

(2) Inspecting by Testing Equipment

[Unit: in (mm)]

	Item	Standard dimension	Replacement limit	Testing equipment
1.	Inner diameter of cylinder liner	2.8346-2.8358 (72.00–72.03)	2.842 (72.18)	Cylinder gauge 
2.	Roundness	Within 0.0012 (0.03)	–	Cylinder gauge
3.	Height of cylinder liner	0.0002–0.0029 (0.05–0.075)	–	Dial gauge 

NOTES:

(1) Measure the inner diameter of the cylinder liner in the axial direction of the crankshaft and in the direction of the piston at the following places: a) at the upper part of the liner [1.1811 in. (30 mm) below the top of the liner], b) at the center of the liner, and c) at the lower part of the liner.

(2) Whether the roundness of the cylinder liner is within the allowable limits is determined by studying the differences in readings obtained in Item 1.

(3) The cylinder liner height is necessary in order to reduce distortion of the cylinder liner and also to provide a good fit with the gasket when the cylinder head is tightened. Accordingly, check to see that the required height is provided.

2-2 Pistons

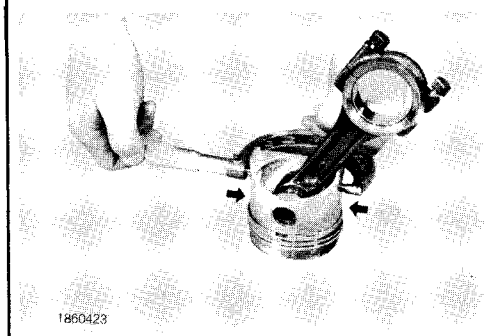
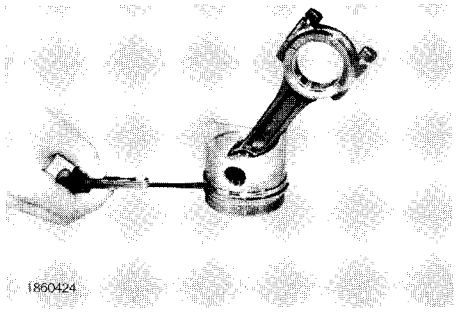
The oval type pistons are made from LOW-X material (Aluminum alloy) which has good heat dissipation properties.

(1) Visual Inspection

Check the pistons for scoring or cracks. Also check the piston ring grooves for chips or any wear in their edges.

(2) Inspecting by Testing Equipment

[Unit: in (mm)]

	Item	Standard dimension	Replacement limit	Testing equipment
1.	Outer diameter of piston	2.8303–2.8315 (71.89–71.92)	2.827 (71.81)	 1860423
2.	Clearance between piston and cylinder	0.003–0.005 (0.08–0.14)	0.012 (0.30)	
3.	Piston ring grooves clearance:–			Feeler gauge  1860424
	Top ring	——	0.012 (0.30)	
	Second ring	——	0.010 (0.25)	
	Oil ring	——	0.010 (0.25)	

NOTES:

(1) Measure the outer diameter of the piston at the piston skirt section, at right angles to the axis of the piston pin.

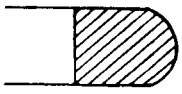
(2) Measure the clearance between the piston and the cylinder liner by comparing the outer diameter of the piston and the inner diameter of the cylinder liner. The clearance is the difference between the minimum clearance figure obtained and the outer diameter of the piston.

2-3 Piston Rings

The piston rings have Teflon® coatings in order to achieve good break-in properties.

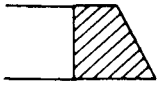
The piston rings are as follows:

- **Top ring**



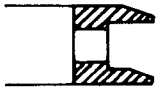
Barrel face type:
Provides and maintains good sealing properties and carbon crushing properties; also prevents carbon sticking. Is chrome plated to achieve good wear-resisting properties.

- **Second ring**



Taper face type:
Provides and maintains good sealing properties and oil scraping effects.

- **Oil ring**



Bevel cutter type:
An oil ring, in which the emphasis is upon oil scraping effects, is used.

(1) Visual Inspection

Check rings for uneven wear or abnormal wear.

(2) Inspecting by Testing Equipment

[Unit: in (mm)]

	Item	Standard dimension	Replacement limit	Testing equipment	Illustration
1.	Piston ring grooves and ring clearance	*[Refer to section on pistons]*			
2.	Piston ring gap All rings	0.001–0.02 (0.03–0.5)	0.06 (1.5)	Feeler gauge	

NOTES:
(1) To measure the piston ring end clearance, the cylinder liner is placed on a surface table, the ring is fitted in the skirt section, and after making sure that the ring is not askew, the end clearance is measured with a thickness gauge.

(2) When the piston rings are being fitted in the piston, be sure that the marking on the ring is facing up.

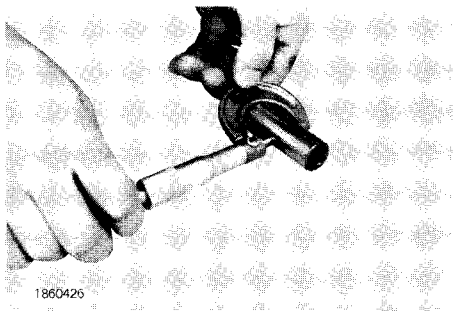
2-4 Piston Pin

(1) Visual Inspection

Check to make sure that there are no traces of scoring, or uneven wear.

(2) Inspecting by Testing Equipment

[Unit: in (mm)]

	Item	Standard dimension	Replacement limit	Testing equipment	Illustration
1.	Outer diameter of piston pin	0.7870–0.7874 (19.991–20.00)	0.783 (19.90)	Micrometer	 1860426

2-5 Connecting Rods

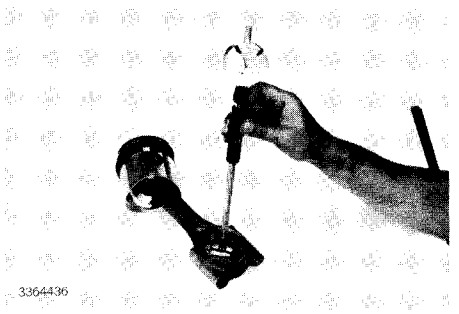
The connecting rods are stamp forged, and the big end sides have square cuts. The piston pin bushings are made of sintered copper and lead alloy, and the large end side has kelmet bearings.

(1) Visual Inspection

The bushings are checked to see whether there is any scoring or peeling.

(2) Inspecting by Testing Equipment

[Unit: in (mm)]

	Item	Standard dimension	Replacement limit	Testing equipment	Illustration
1.	Rod alignment	0–0.0020 (0–0.05)		Connecting rod analyzer	
2.	Inner diameter of piston pin bushings (after assembly)	0.788–0.789 (20.025–20.038)	0.791 (20.10)	Cylinder gauge	
3.	Clearance between piston pin and piston pin bushings	0.001–0.002 (0.02–0.05)	0.006 (0.15)		
4.	Inner diameter of rod bearings *	1.575–1.576 (40.00–40.04)	1.579 (40.10)	Cylinder gauge	 3364436
5.	Clearance between rod bearings and crankshaft *	0.001–0.003 (0.04–0.09)	0.005 (0.15)		

(*Refer to Note on following page)

Item		Standard dimension	Replacement limit	Testing equipment	Illustration
6.	Connecting rod side play *	0.008–0.016 (0.20–0.40)	0.020 (0.50)	Feelre gauge	

(*Refer to Note below)

NOTES:

(1) To replace the piston pin bushings, press-fit in new bushings. During the operation be sure that there is no peeling or contraction of the bushings. Measure the inner diameters after the new bushings have been press-filled in position. If the diameter is too small, it should be corrected, using a reamer. When press-fitting new bushings into position, be sure to align the oil passages of the bushings with those of the connecting rod.

(2) The clearance referred to in Item 3 above is the difference between the outer diameter of the piston pin and the inner diameter of the bushings obtained by measurements.

(3) The measurements referred to in Item 4 above are to be taken after rightening the connecting rod bolts to a torque of 16.6 – 20.2 ft-lbs (22.5 to 27.4 Nm) (2.3 to 2.8 kgm).

(4) The clearance referred to in Item 5 above is the difference between the inner diameter of the big end bearing and the outer diameter of the crankshaft obtained by measurements conducted using an oil clearance gauge and/or a cylinder gauge.

As in the case of Item 4, the measurements are to be taken after the bolts have been tightened to the prescribed torque.

(5) The measurements referred to in Item 6 are to be taken using a feeler gauge, after first securing the connecting rods to the crankshafts and tightening the bolts to the prescribed torque and then moving the connecting rod to one side.

(6) At least 75% of the total area of the crankshaft bushings must be in contact with the crankshaft itself.

2-6 Crankshaft

The crankshaft used in the engine is a solid three-throw type, stamp forged and equipped with balance weights.

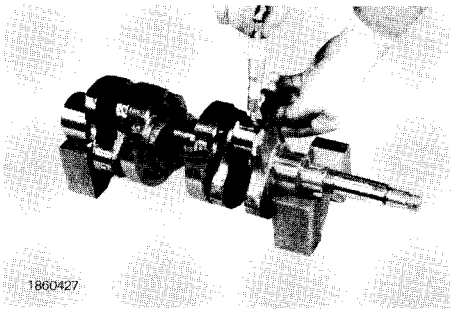
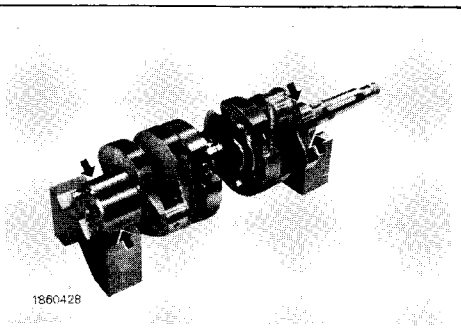
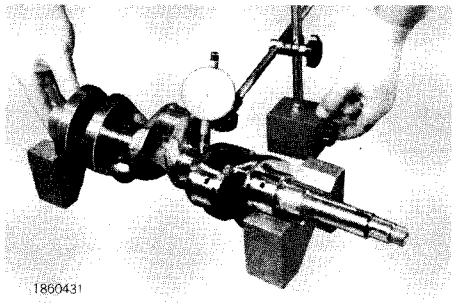
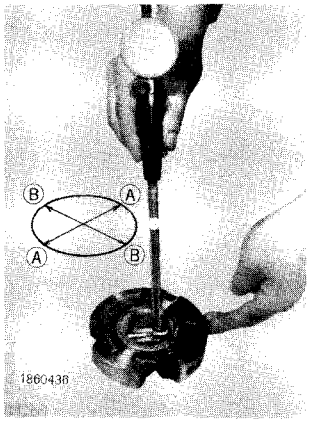
Extra overlap is provided at the journal sections and pin sections, for increased durability of the crankshaft.

(1) Visual Inspection

Check the crankshaft visually to see whether there are any traces of scoring, marring, or cracks.

(2) Inspecting by Testing Equipment

Unit: in (mm)

	Item	Standard dimension	Replacement limit	Testing equipment	Illustration
1.	Outer diameter of crank pin	1.5728–1.5732 (39.95–39.96)	1.5716 (39.92)	Micrometer	 1860427
2.	Outer diameter:			Micrometer	 1860428
	Front journal	1.730–1.731 (43.95–43.96)	1.729 (43.92)		
	Intermediate journal	1.730–1.731 (43.95–43.96)	1.729 (43.92)		
	Rear journal	2.360–2.361 (59.94–59.96)	2.359 (59.92)		
3.	Deflection of crankshaft	Less than 0.0008 (0.02)		Dial gauge	 1860431
4.	Inner diameter:			Cylinder gauge	 1860436
	Front main bearings	1.732–1.734 (44.00–44.05)	1.737 (44.12)		
	Intermediate main bearings	1.732–1.734 (44.00–44.05)	1.737 (44.12)		
	Rear main bearings	2.362–2.364 (60.00–60.05)	2.357 (59.88)		

Unit: in. (mm)

	Item	Standard dimension	Replacement limit	Testing equipment	Illustration
5.	Clearance between outer diameter of crank journal and inner diameter of main bearings (all)	0.001–0.003 (0.04–0.09)	0.004 (0.10)		
6.	Crankshaft end play	0.0035–0.0075 (0.09–0.19)	0.013 (0.33)	Dial gauge	

NOTES:

(1) After conducting the measurements given in Item 1 above, be sure to measure the clearance between the crank pin bearings and the crank pin. (Refer to Item 5 in the section on measurements on the connecting rods for the prescribed dimensions).

(2) If, after measuring the crankshaft for deflection, it is found that machining of the crankshaft is necessary, do not forget to adjust the fillet sections of the crank pins after the machining is completed. Measure the deflection by placing the crankshaft on a supporting stand.

(3) Item 5 will be the difference between Item 2 and Item 4 obtained through measurements.

(4) Measuring of end play is conducted after the crankshaft has been fitted into position as prescribed.

(5) The roundness of the main bearings is checked by measuring the inner diameter in two directions at right angles to each other and comparing the two readings obtained.

(3) Replacing the Main Bearings

Whenever the readings for the main bearings exceed the repairable limit, they must be replaced.

When fitting the main bearings in the main bearing housing and cylinder block, observe the following points:

a) To extract and insert bearings, always use the bearings removing and installing tools.

b) When inserting new bearings, be sure that the oil passages are aligned.

c) After the new bearings have been installed, measure the inner diameter of the main bearings to check that they are properly aligned, and not contracted.

2-7 Camshaft

A single, integrated camshaft, incorporating the intake and exhaust cams, and the fuel cams, is used.

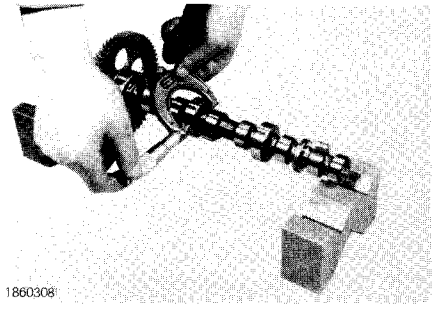
The fuel cams have straight flank and convex curves while the intake and exhaust cams have parabolic acceleration curves, in order to reduce the shock of inertia force, this also serves to effectively reduce noise.

(1) Visual Inspection

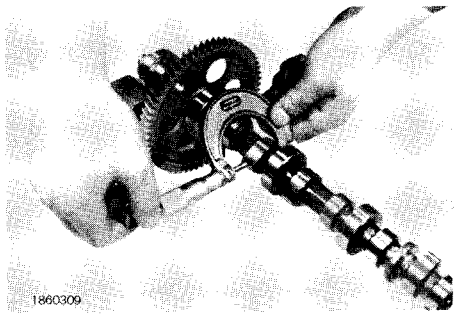
Check the crankshaft for marring or uneven wear. Be sure that the supporting function correctly, and that no abnormal noises are generated.

(2) Inspecting by Testing Equipment

Unit: in (mm)

	Item	Standard dimension	Replacement limit	Testing equipment	Illustration
1.	Camshaft – check for distortion	Less than 0.002 (0.05)		Dial gauge	
2	Outer diameter of journal:			Micrometer	 1860308
	Flywheel side	1.061–1.062 (26.94–26.96)	—		
	Intermediate	1.730–1.731 (43.95–43.96)	1.727 (43.86)		

Unit: in (mm)

	Item	Standard dimension	Replacement limit	Testing equipment	Illustration
3.	Clearance between outer diameter of camshaft journal and inner diameter of bearings				
	Flywheel side	0.002–0.005 (0.05–0.12)	0.006 (0.15)		
	Intermediate	0.001–0.004 (0.036–0.092)	0.006 (0.15)		
4.	Cam heights:			Micrometer	 1860309
	Intake and exhaust valves	1.378 (35.00)	1.358 (34.50)		
	Fuel injection	1.772 (45.00)	1.768 (44.90)		

NOTES:

(1) To conduct the measurements referred to in Item 1 above, the camshaft is secured to a supporting stand, and the amount of run-out is measured using a dial gauge.

(2) The cam journal clearance referred to in Item 3 is the difference in the readings obtained by measurements of the two components taken using a micrometer and a cylinder gauge.

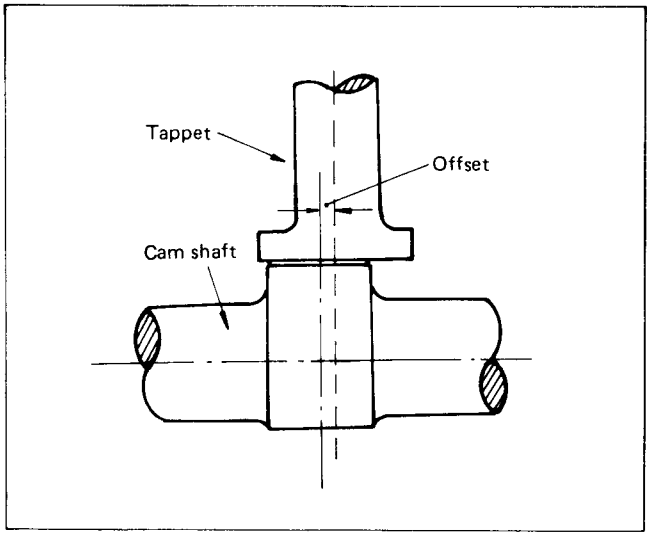
(3) Valve timing and fuel injection timing is shown below.

(4) Replacement of the camshaft bearings is conducted by pressing the old bearing and press-fitting the new ones in position.

2-8 Tappet and Push Rod

(I) Tappet

Tappets come in the form of a 'stem mushroom' in order to increase wear resistance, and are out of alignment with the cam to prevent uneven wear.



a) Tappet Disassembly

When disassembling the camshaft and the tappets, note down the cylinder No. they belong with, and put them with their respective intake and exhaust valve.

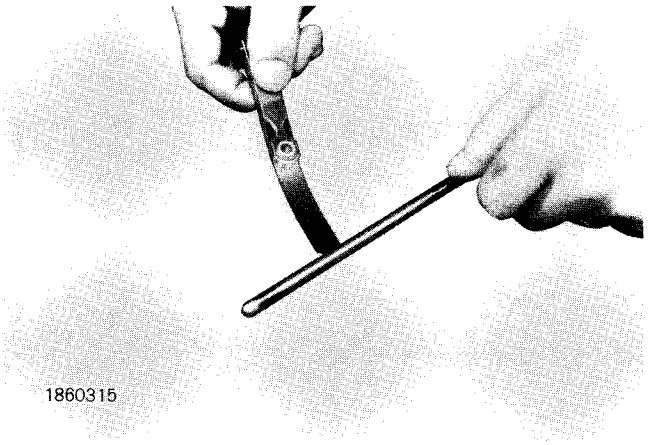
b) Tappet Wear and Fitting

Measure the outside diameter of each tappet. If the wear of any tappet has exceeded the specified limit, or if any tappet shows signs of excessive asymmetrical fitting or of excessive deformation, replace it.

Item	Standard size	Limit size
Outside diam. of the tappet	0.3929 (9.98)	0.3909 (9.93)
Inside diam. of the cylinder hole for the tappet	0.3933–0.3945 (9.99–10.02)	—
Clearance between tappet and cylinder tappet hole	0.0004–0.002 (0.01–0.04)	0.004 (0.10)

(II) Push Rod

If the push rod is bent beyond the specified limit, replace it.



Item	Standard size	Limit size
Push rod bend	0.0012 (0.03)	0.012 (0.3)

2-9 Cylinder Head

A cylinder head integrating three cylinders into one and made by high precision quality casting is used.

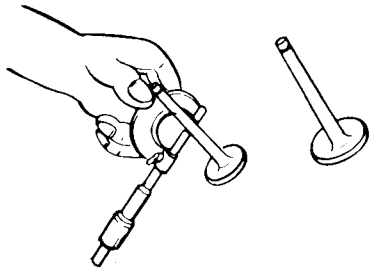
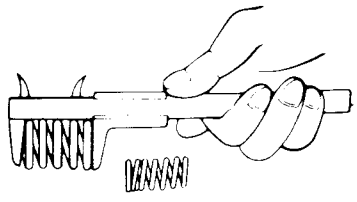
Both the intake ports and the exhaust ports are integrated in the cylinder head.

(1) Visual Inspection

The surface of the head is checked to see if there are any traces of coolant or gas leakage. The inside of the head is checked to ascertain that it is not clogged up anywhere by accumulated debris and that there is no corrosion.

(2) Inspecting by Testing Equipment

Unit: in (mm)

	Item	Standard dimension	Replacement limit	Testing equipment	Illustration
1.	Inner diameter of valve guides (after assembly)	0.2758–0.2764 (7.00–7.02)	0.279 (7.08)	Inside micrometer	*[Check that the reading is within the standard dimension]*
2.	Outer diameter of valve stems Outer diameter of valve: Intake Exhaust	0.2736–0.2740 (6.95–6.96) 1.26 (32.0) 1.02 (26.0)	0.270 (6.90)	Micrometer	
3.	Clearance between valve guide and valve stem	0.002–0.003 (0.04–0.06)	0.006 (0.15)		
4.	Valve seat width: Intake Exhaust	0.070 (1.77)	—	Calipers	
5.	Amount of valve sinkage	–	0.0197 (0.5)	Calipers	
6.	Valve springs: Inclination Free length	 0 1.44 (36.5)	 2 degrees 1.43 (36.2)	 Calipers	
7.	Valve seat angle. intake/exhaust	45°			

NOTES:

(1) Measure the inner diameter of the valve guides after they have been fitted into position. A press must be used to press-fit the valve guides into position when they are replaced.

If there is insufficient clearance between the valve guides and the valve stems, clearance should be increased to the prescribed dimension by using a reamer.

Before the intake & exhaust valves are installed, coat the valve stems with lub oil.

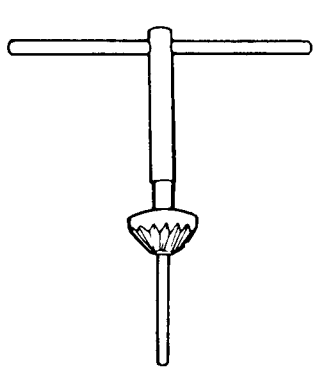
(2) The width of the valve seats is measured by a pair of calipers, and if corrections are necessary, the prescribed valve cutter must be used.

After the valve seats have been dressed using the seat cutters, the valves are lapped.

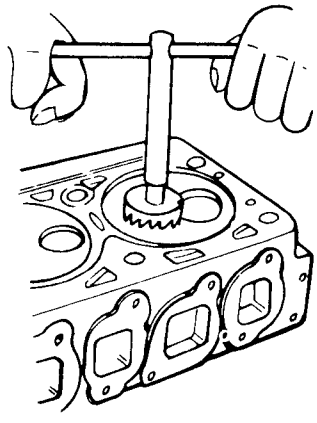
i) Lapping should be done by using valve lapping compound powder.

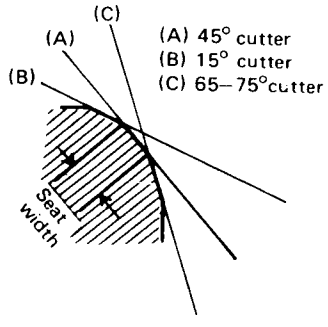
ii) The finishing of the seat should be done by oil lapping.

iii) When fitting the valves back in position, do not mix up the valves for No. 1 cylinder with those of the No. 2 cylinder and No. 3 cylinder. All valves are marked prior to shipment from the factory whether they are intake or exhaust valves, and also whether they are for the No. 1 or No. 2 and/or No. 3 cylinders.



Valve seat cutter





Seat width 0.0696 in.
(1.77 mm)

2-10 Combustion Chambers

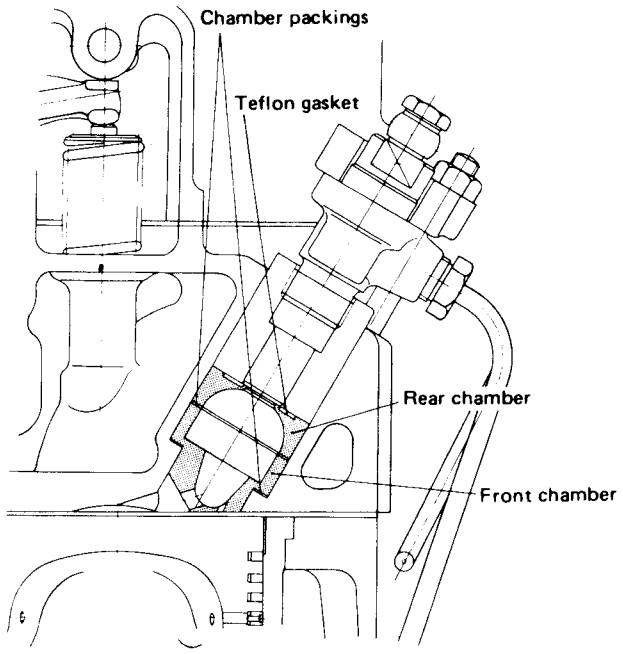
The combustion chambers consist of Yanmar's patented special swirl type pre-combustion chambers. They improve combustion performance and contribute to achieving low fuel consumption.

(1) Visual Inspection

Check the combustion chambers to see that the injection ports are not clogged or that carbon deposits have not formed.

(2) Points to Bear in Mind in Assembling the Combustion Chambers

When assembling the combustion chamber, carry out the work in the following sequence. Note that the front chamber has front and rear sides.



1) Install packings, front chamber, rear chamber and teflon gasket.

2) Install fuel injection nozzle.

The front chamber has a tang which fits into a slot 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.

2-11 Rocker Arm Assembly

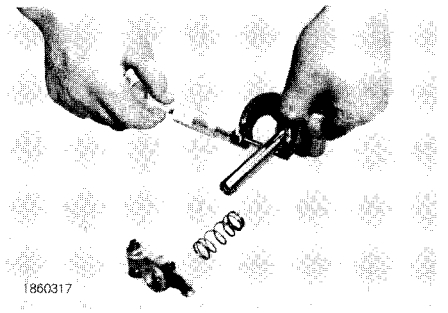
The rocker arm supports are provided for each of the cylinders. Lubrication of the rocker arm is carried out by forced lubrication – lube oil fed under pressure from the lube oil pump.

(1) Visual Inspection

Check the rocker arm support, the shaft, and the rocker arm bushings for cracks.

(2) Inspecting by Testing Equipment

Unit: in (mm)

	Item	Standard dimension	Replacement limit	Testing equipment	Illustration
1.	Outer diameter of rocker arm shaft	0.5504–0.5512 (13.98–14.00)	0.5472 (13.90)	Micrometer	
2.	Inner diameter of rocker arm bushings	0.5520–0.5524 (13.98–14.00)	0.5551 (14.10)	Cylinder gauge	
3.	Clearance between rocker arm shaft and inner diameter of rocker arm bushings	0.0006–0.002 (0.016–0.052)	0.006 (0.15)		
4.	Length of push rods	5.354 (136.0)	5.276 (134.0)	Calipers	

NOTES:

(1) The rocker arm bushings are press-fitted in position and when they are to be replaced they should again be press-fitted. After they have been fitted, measure them to be sure they are not croocked nor is there any contraction.

(2) Place the push rod on a surface table to check them for straightness.

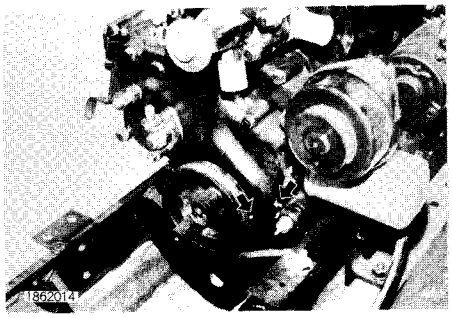
(3) Align the oil-port when replacing bushings

2-12 Injection Pump and Nozzles

An integrated fuel pump, a Bosch YPFR-0707 type manufactured by Yanmar, is ued for the No. 1, No. 2 and No. 3 cylinders.

The nozzles are of semi-throttle type, to achieve lower combustion noise (low rpm knocking) without impairing engine starting performance.

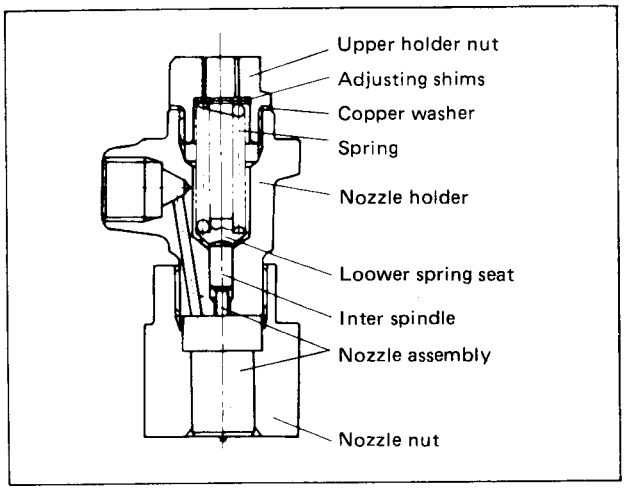
(1) Inspecting by Testing Equipment

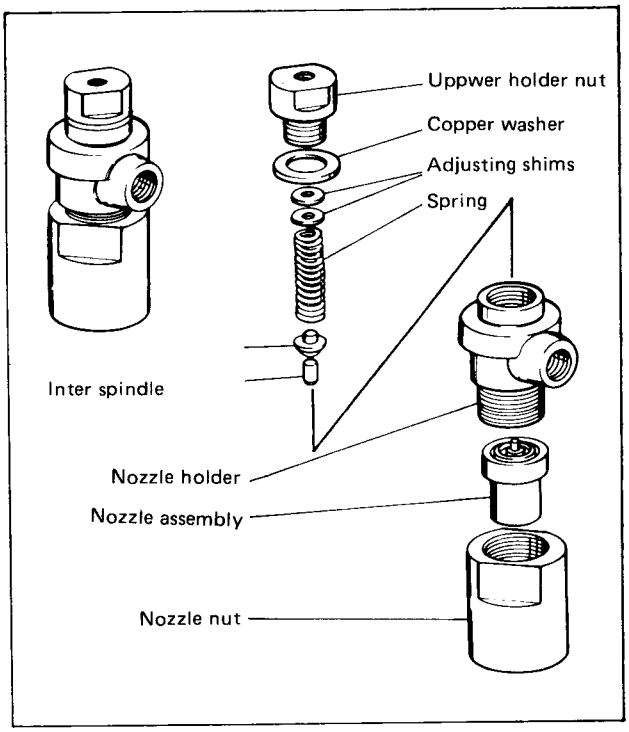
	Item	Standard dimension	Replacement limit	Testing equipment	Illustration
1.	Injection nozzle valve opening pressure	2275 psi (15.68 Mpa) (160 kg/cm²)	1707 psi (11.76 Mpa) (120 kg/cm²)		
2.	Injection volume at 1500 camshaft RPM	17–18mℓ/1000 strokes		Pump tester	
3.	Injection timing	21° before T.D.C.	±2 degree		

(2) Disassembly, Assembly, Adjusting

(2.1) Fuel Injection Nozzles

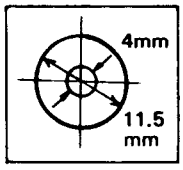
a) The injection nozzle is built as shown in the illustration below.





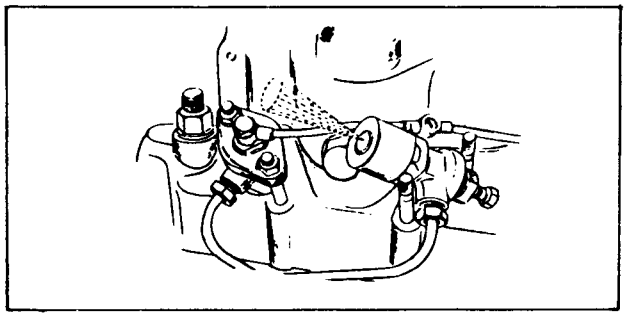
b) Injection pressure is adjusted by varying the thickness of the adjusting shims. Every 0.0039 in. (0.1 mm) of shims provides approximately 142 psi (10 bar) (10 kg/cm^2) variation in the pressure.
Be sure to use shims which have holes in their centers.

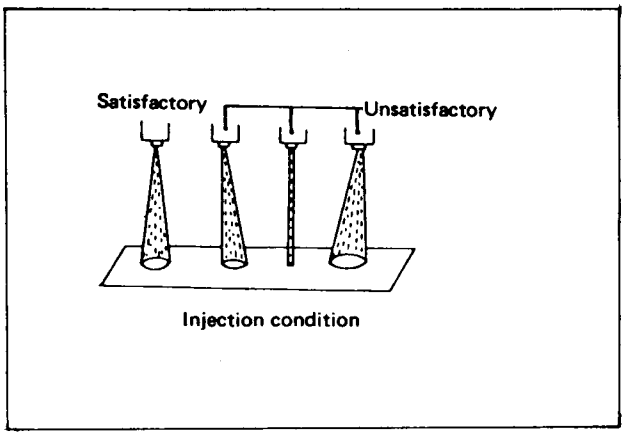
[Adjusting Shim]



t	Part No.	Q'ty/unit
0.1 mm	110250-53400	1
0.2	110250-53410	1
0.3	110250-53420	1
0.5	110250-53430	2

c) The injection pressure 2,275 psi (157 bar) (160 kg/cm^2) is of course important, but be sure to check the fuel is injected correctly as shown below:





Injection condition

(2.2) Fuel Injection Pump

a) Measure the injection volume of each cylinder.

b) Measure the pressure to be generated. (more than 7,000 psi/500 bar/500 kg/cm^2)

c) Whenever any of the plungers have to be replaced because of wear, the disassembly and assembly work is carried out in the following sequence.

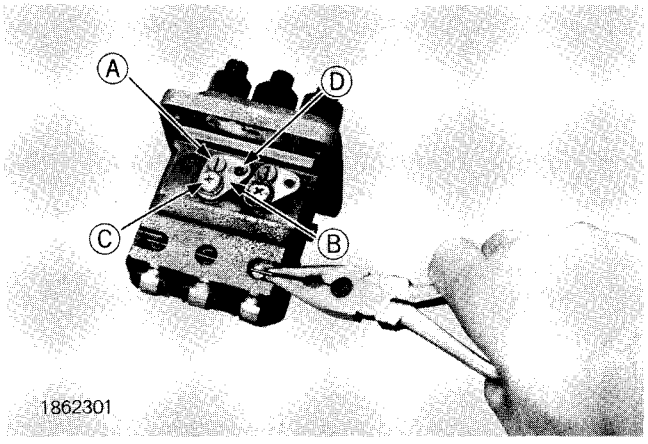
Plunger diameter and cam lift:
0.2362 in x 0.2756 in (6ϕ x 7 mm)

(I) Disassembly Sequence

STOP Never loosen or remove barrel adjust screw (A), adjust plat (B) and adjust plate retaining screw (C).

If they had been removed, the pump must be adjusted for injection volume by pump tester.

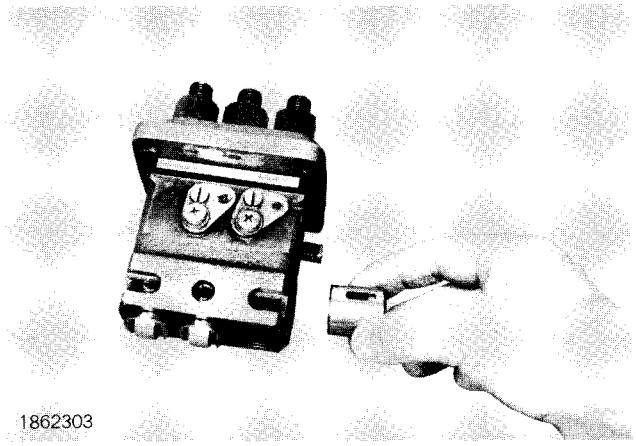
1) Remove plunger guide stopper pin.



A – Adjust Screw
B – Adjust Plate
C – Retaining Screw
D – Pin

2) Remove the plunger guide stooper of No. 1 cylinder.

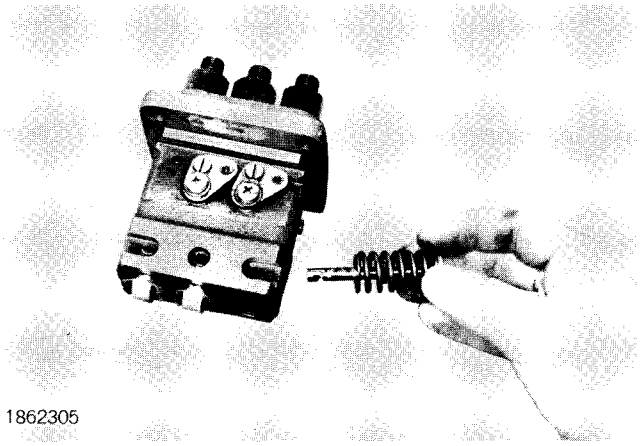
3) Remove plunger guide of No. 1 cylinder.



1862303

When Removing plunger guide, be careful plunger stroke adjusting shims in the plunger guides from missing or mixing them with other cylinders.

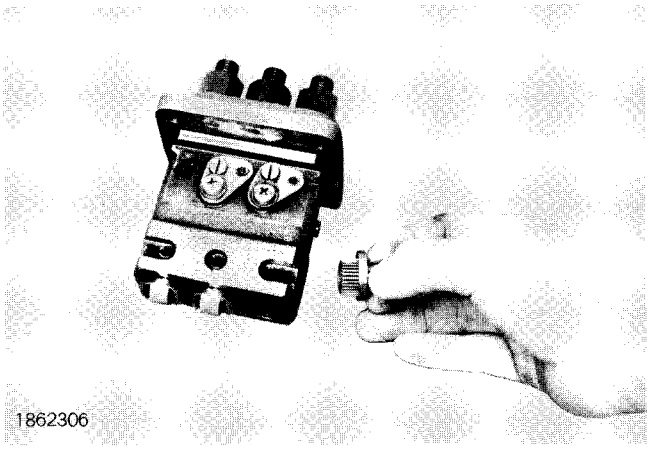
4) Remove plunger, plunger spring, spring lower retainer of No. 1 cylinder.



1862305

When removing plunger, never touch the plunger with fingers for rust prevention.

5) Remove the plunger spring upper retainer and control sleeve of No. 1 cylinder.



1862306

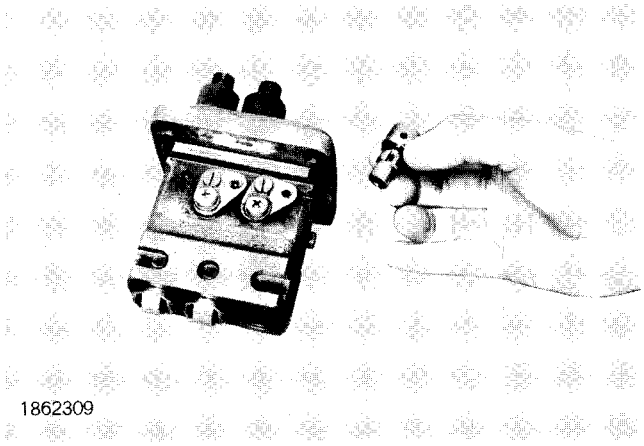
6) Remove the delivery valve holder and spring of No. 1 cylinder.

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.

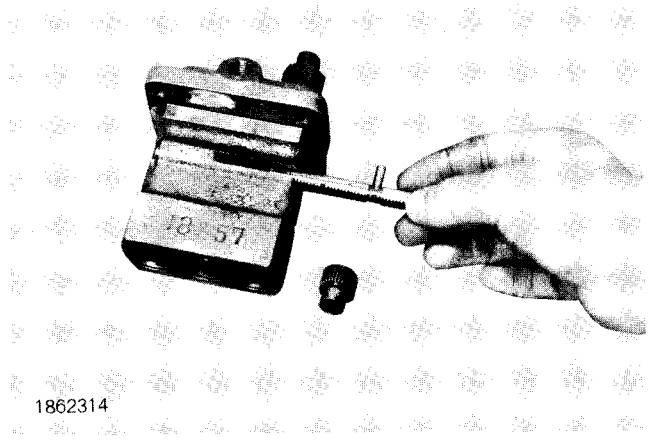


1862309

9) Repeat the same procedure (1 to 8) to remove the center plunger and related parts (No. 2 cylinder).

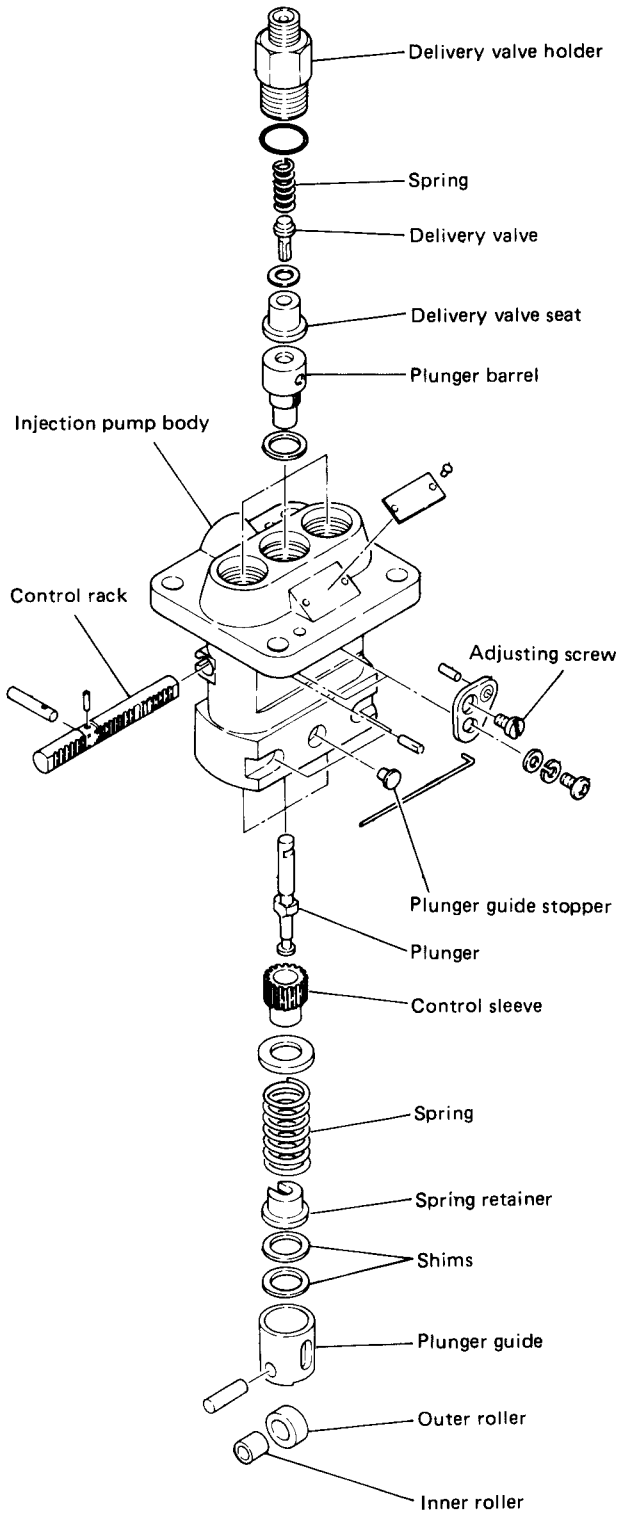
10) Repeat the same procedure (1 to 8) to remove the left plunger and related parts (No. 3 cylinder).

11) Remove the fuel control rack.



1862314

When disassembling the fuel injection pump, do not mix-up the parts for the No. 1 cylinder and No. 2 cylinder. Keep the parts for each cylinder on different trays.

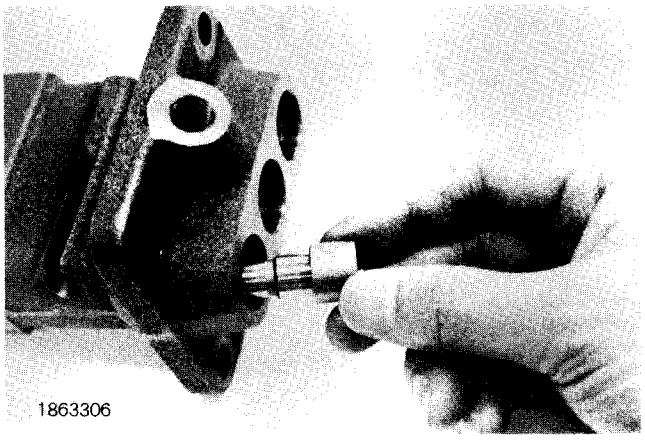


(II) Assembly Sequence

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.

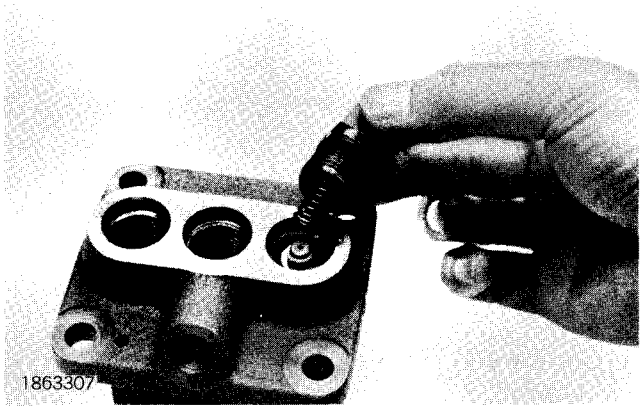
1) Place the plunger barrel packing in position.

2) Install the plunger barrel.

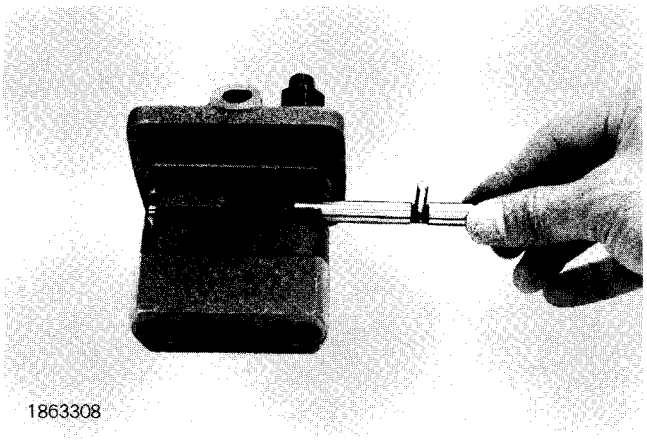

1863306

3) Install the delivery valve assembly and the delivery spring.

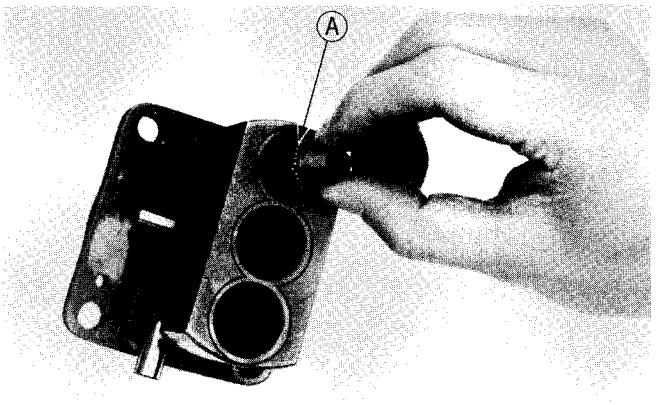
4) Install the delivery valve holder, then tighten it tentatively. The specific torque is 30 ft-lbs (40 Nm) (4.5 kgm).


1863307

5) Install the control rack.


1863308

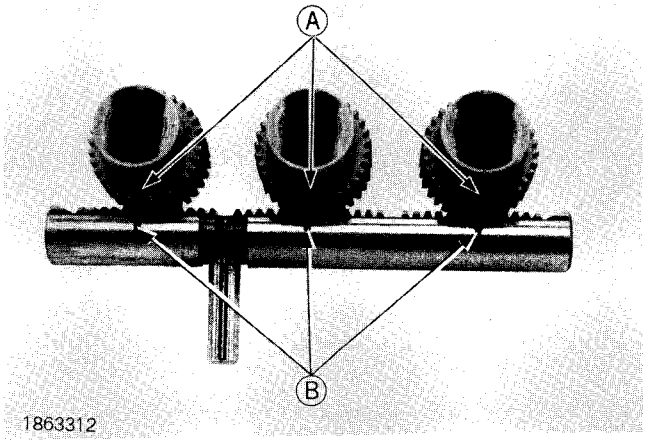
6) Install control sleeve (A) in the plunger guide bore of pump housing.



1863309

A – Sleeve Gear

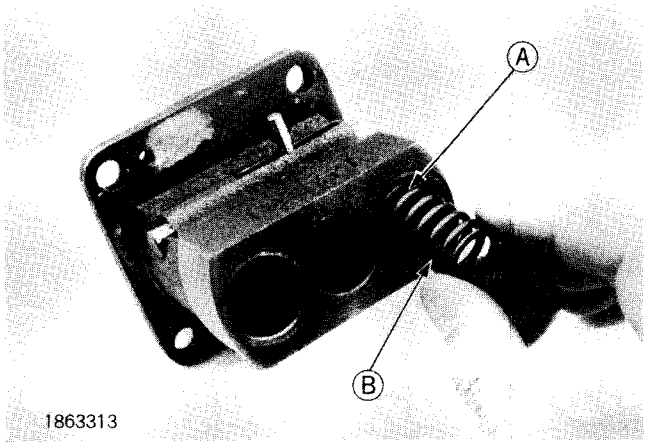
When installing the sleeve, align the punch mark on sleeve gear (A) to the mark (Painted Red) on control rack (B).



1863312

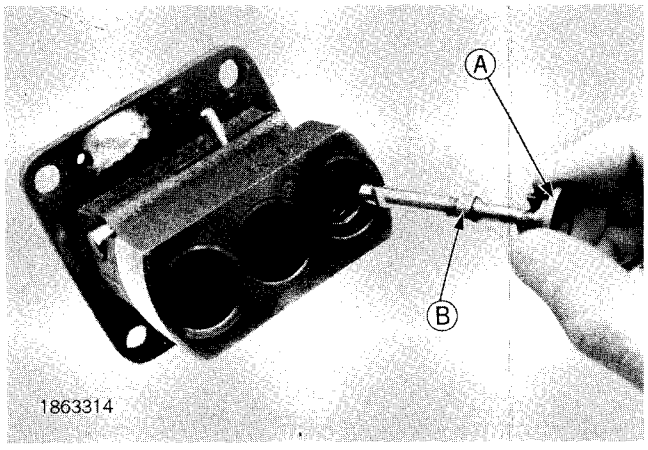
A – Sleeve Gear B – Control Rack

7) Install upper spring retainer (A) and plunger spring (B).



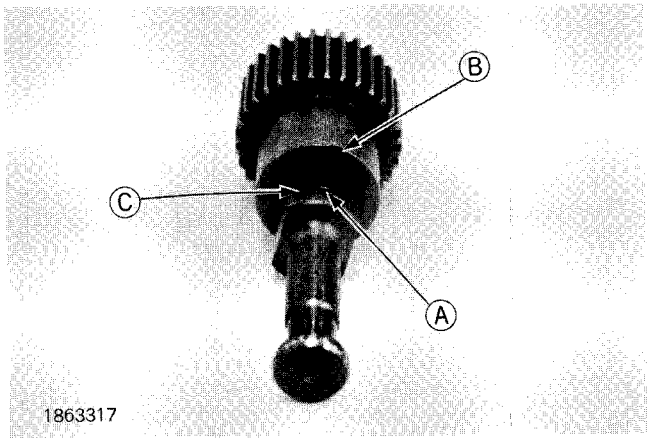
A — Upper Spring Retainer B — Plunger Spring

8) Install the lower plunger retainer (A) to the plunger (B), and install them in the plunger guide bore.



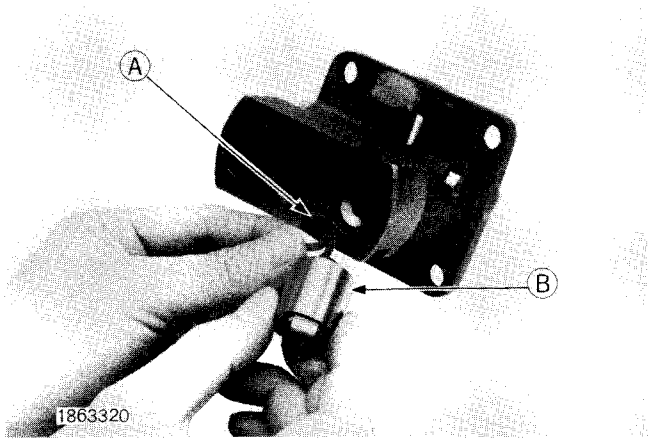
A — Plunger Retainer B — Plunger

When installing plunger, align the punch mark (A) to the mark on control sleeve (B).



A — Punch Mark
B — Control Sleeve
C — Plunger

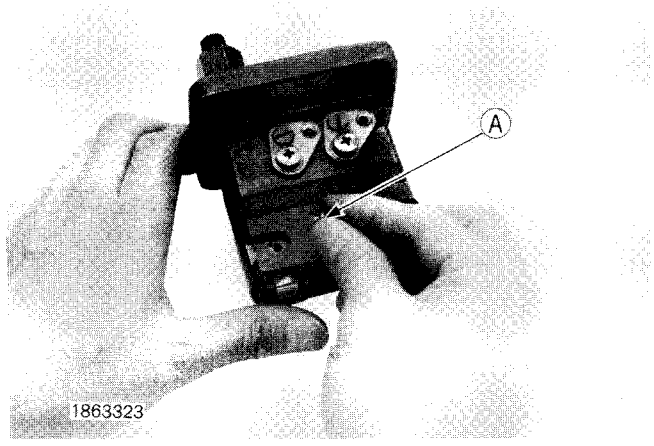
9) Place the plunger height adjusting shim (A), then install the plunger guide (B).



A — Shims B — Plunger Guide

10) 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 (A) can be fixed into the groove of sleeve.)

11) Set the plunger guide stopper pin.



A — Stopper Pin

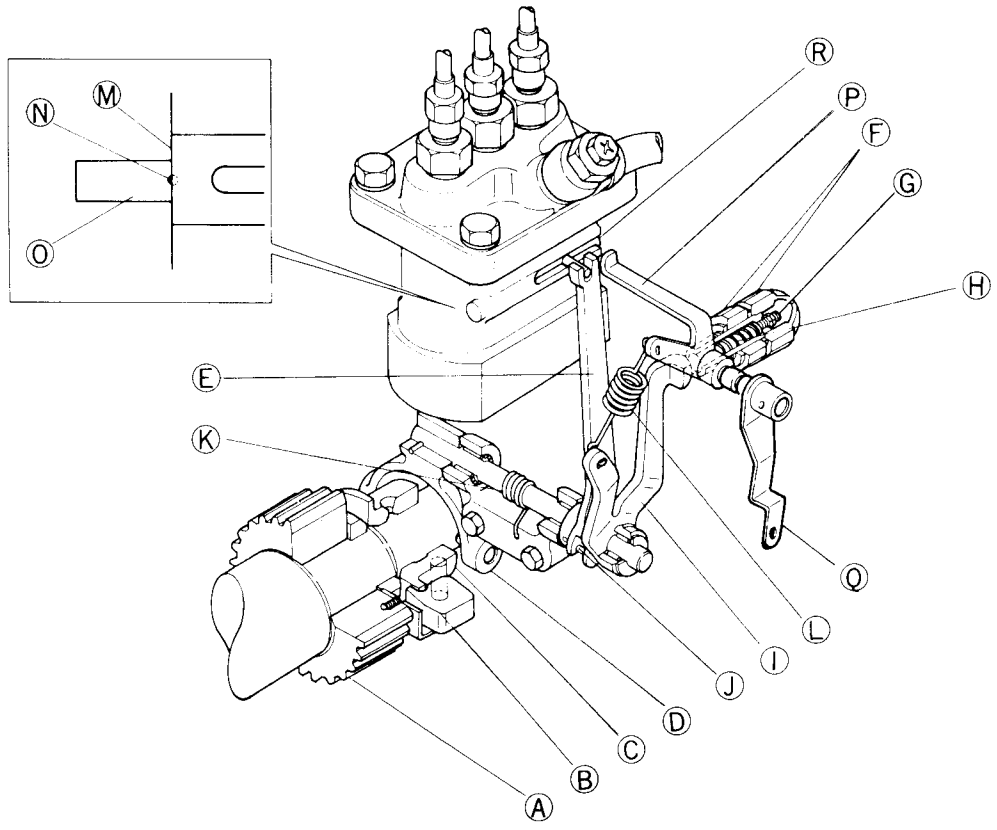
After assembling the fuel injection pump, measure the rack motion resistance. Motion resistance should be less than 0.132 lbs (60 g), measured by a spring scale, or when rack is placed in the vertical position it should be capable of moving its full distance of travel freely by its own weight.

2-13 Governor

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.

The 2nd governor lever (E), connected to the injection pump control rack (O), transmits engine requirements to the injection pump. The regulator spring (L) connects to the regulator lever (P) and control lever (I) together for obtaining a desired speed selection. The 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).



1867031

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

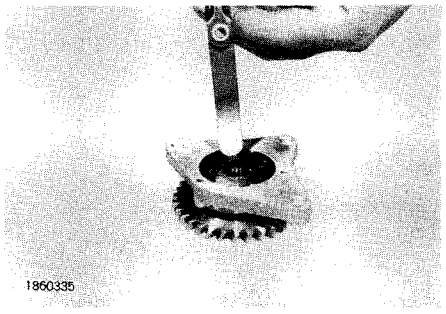
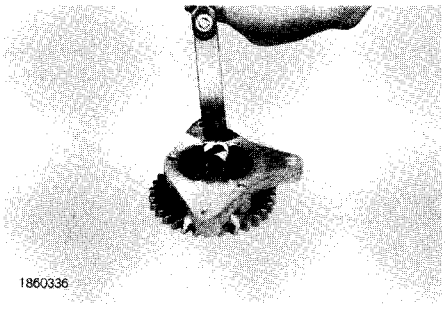
2-14 Lubricating Oil Pump

(1) Pump

A trochoid pump is used for the lubricating oil pump.

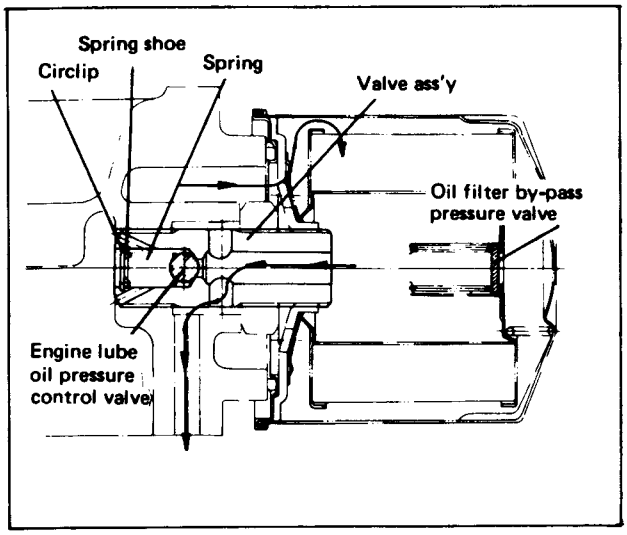
[Inspecting by Testing Equipment]

Unit: in (mm)

Item	Standard dimension	Replacement limit	Testing equipment	Illustration
Clearance between outer rotor and body	0.004–0.006 (0.10–0.16)	0.01 (0.25)	Feeler gauge	 1860335
Clearance between body and inner, outer rotors	0.0012–0.0035 (0.03–0.09)	0.006 (0.15)	Square gauge Feeler gauge	
Claarance between outer rotor and inner rotor	0.004–0.006 (0.10–0.16)	0.01	Feeler gauge	 1860336

(2) Lube Oil Pressure

Oil pressure control valve:
36–57 psi (2.45–3.92 bar) (2.5–4.0 kg/cm^2)



Oil filter by-pass pressure valve activating pressure:
17.1–11.4 psi (0.8–1.2 kg/cm^2)

Lube oil pressure control valve is fitted on lube oil filter.

2-15 Cooling System

(1) Radiator

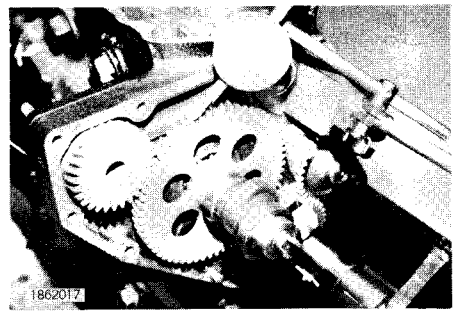
The radiator is pressurized at 13 psi 0.89 bar (1.0) kg/cm^2). Apply pressure to the cooling system to test whether there are any leaks in the system.

2-16 Gears

(1) Measuring Backlash

Fit each of the gears in position, and measure their respective backlash readings.

Unit: in. (mm)

Item	Standard dimension	Replacement limit	Testing equipment	Illustration
Backlash	0.003–0.005 (0.08–0.13)	0.012 (0.030)	Dial gauge Fuse Mircometer	

(2) Visual Inspection

Check the gear tooth faces for pitting and if any gear shows severe pitting replace it.

Check to make sure that the gear unit functions smoothly.

2-17 Oil Seals, O-rings and Ball Bearings

(1) Oil Seals

- Crankshaft – fitted on both ends
  Flywheel side – main bearing housing
  Gear side – gear case

(2) O-Rings

- Decompression shaft
- Regulator handle shaft

(3) Ball Bearings

- Crankshaft
- Camshaft
- Hydraulic pump driven gear shaft

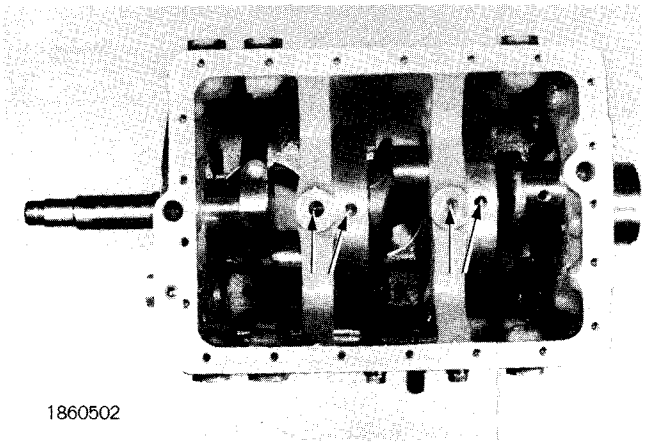
3. ASSEMBLY SEQUENCE

3-1 Crankshaft, Rear Oil Seal and Flywheel

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

1) Stand cylinder block upright, and lower crankshaft into block.

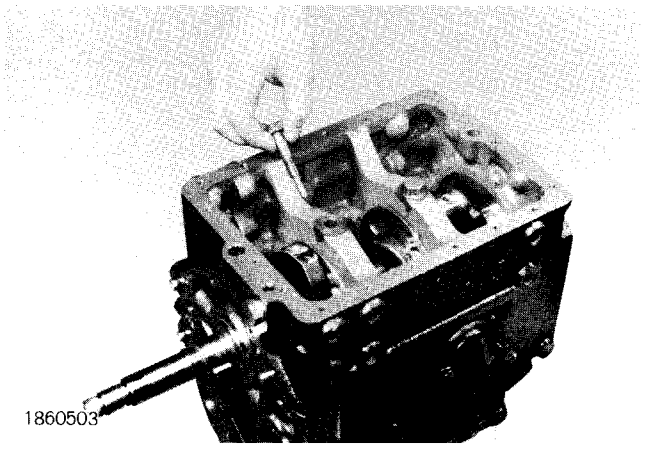
2) Before completely installing, align set screw holes between intermediate main bearing housing and block.



1860502

3) Lightly oil set screws.

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

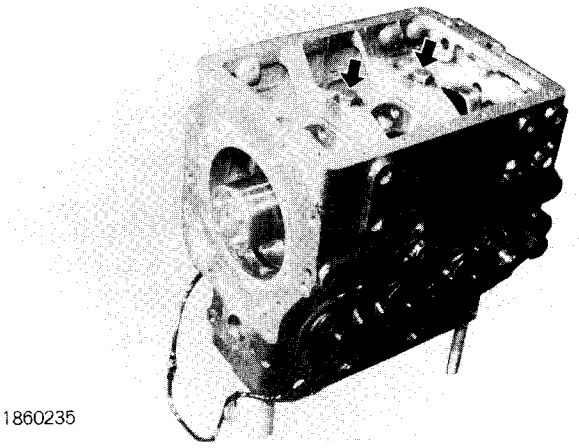


1860503

5) Tighten set screw in bearing housing nearest flywheel first (Thrust bearing housing) to 25.3 ft-lbs (34.3 Nm) (3.5 kgm).

6) Tighten the remaining set screw to 25.3 ft-lbs (34.3 Nm) (3.5 kgm).

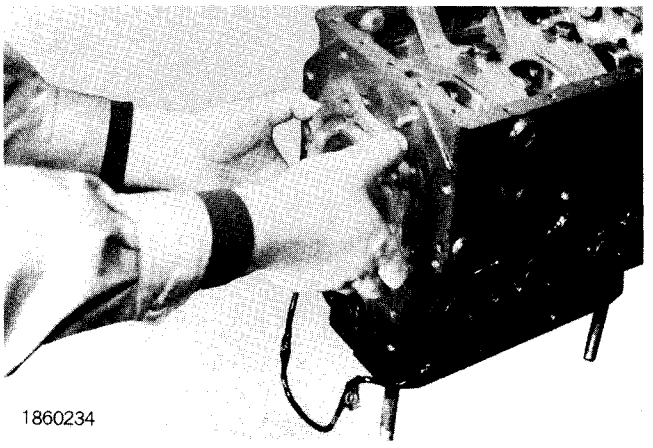
7) After tightening set screws, make sure the crankshaft rotates smoothly.



1860235

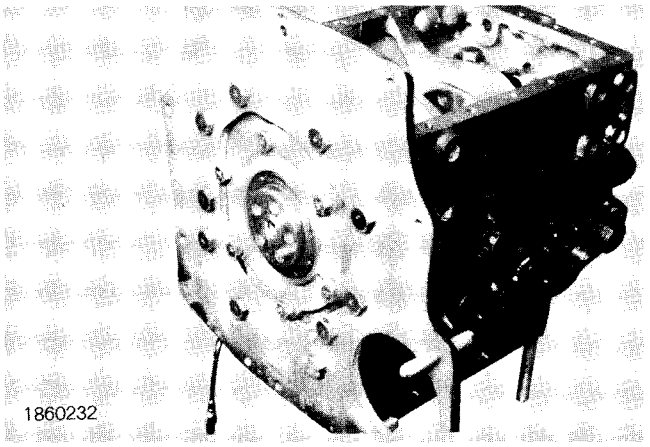
8) When installing rear main bearing housing, make sure oil hole in bearing housing and oil hole in block are aligned. The bolt pattern in bearing housing in not divided qually so that it prevents incorrect installation.

9) Carefully place rear main bearing housing on block and tighten cap screws to 17 to 20 ft-lbs (23 to 27 Nm) (2.3 to 3.0 kgm).

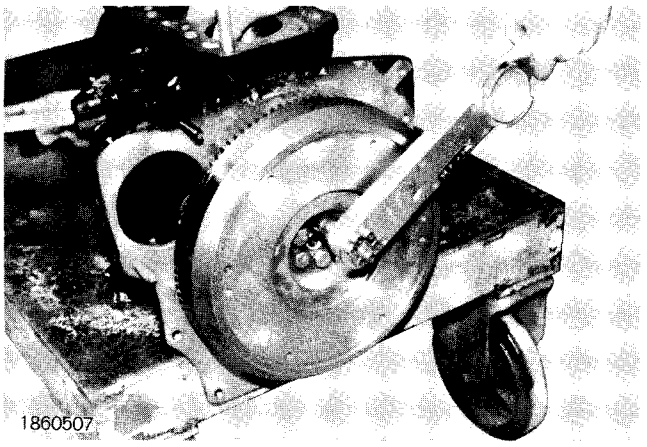


1860234

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



11) Install flywheel and tighten cap screws to 50 ft-lbs (64 Nm) (7 kgm). Do not damage pilot bushing when tightening cap screws.

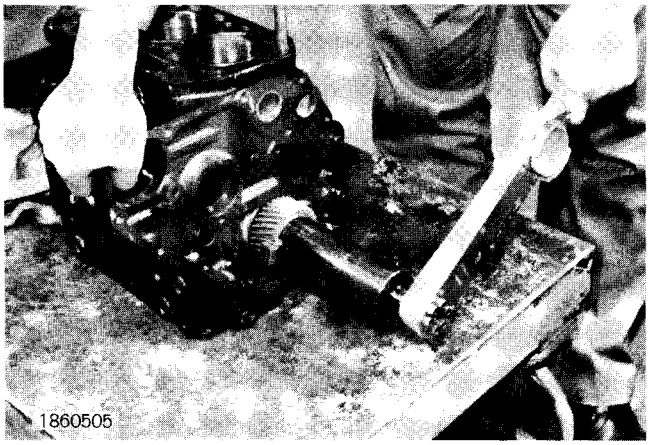


12) Install key in groove in crankshaft before installing crankshaft gear.

13) Align key groove in gear with key on crankshaft.

14) Install governor weight assembly on the gear.

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 58 to 72 ft-lbs (79 to 98 Nm) (8.0 to 10.0 kgm).

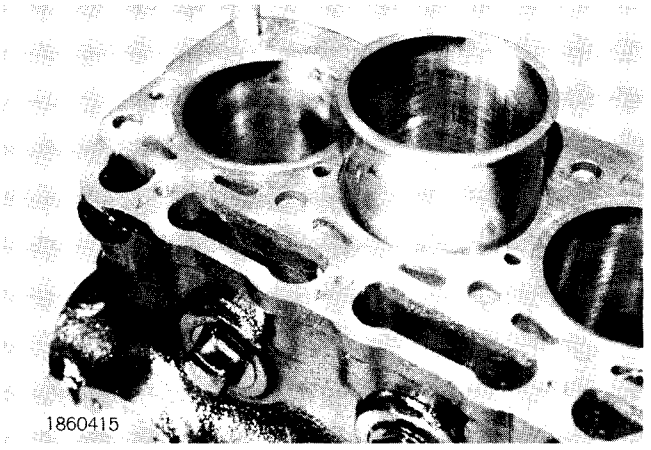


3-2 Cylinder Liners

1) Clean cylinder liners with solvent.

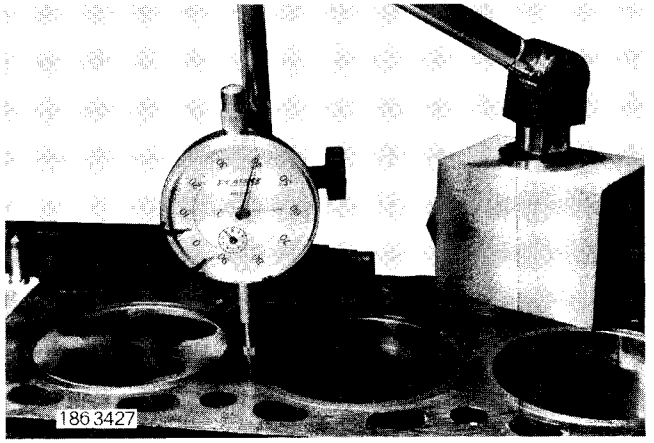
2) Thoroughtly clean inside of bores for liners with solvent. Especially, be careful to clean liner flange seating area of cylinder block.

3) Install cylinder liners into their original bores.



4) Measure liner heights as shown by which sealing face of cylinder liner protrudes over cylinder block sealing face.

   Measure at several places around circumference and compare measurements. Measurements should be 0.0002 to 0.0029 in. (0.05 to 0.075 mm).



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 – 2.9921 to 2.9925 in. (76.00 to 76.01 mm)
B – 2.9917 to 2.9921 in. (75.99 to 76.00 mm)
C – 2.9913 to 2.9917 in. (75.98 to 75.99 mm)

CYLINDER BLOCK BORE I.D. SPECIFICATIONS

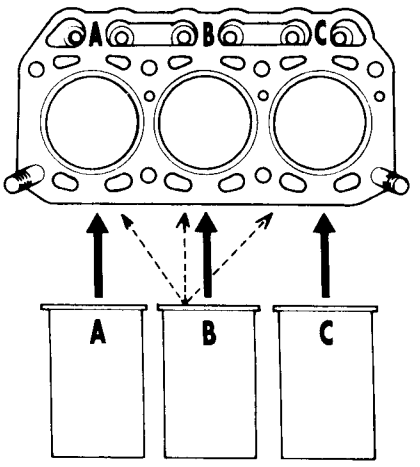
A – 2.9929 to 2.9933 in. (76.02 to 76.03 mm)
B – 2.9925 to 2.9929 in. (76.01 to 76.02 mm)
C – 2.9921 to 2.9925 in. (76.00 to 76.01 mm)

The liner must be installed into the bore has the same mark at 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.



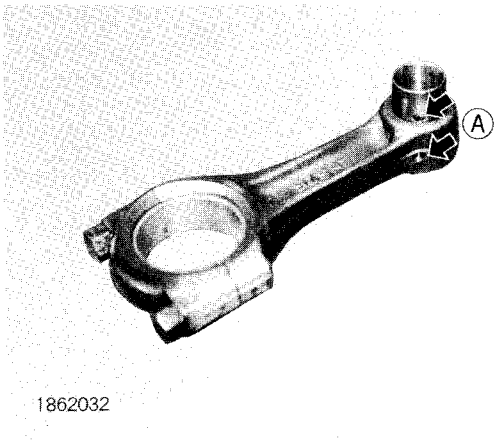
1867014

⟵ Factory Installation
⟵--- Service Parts Installation

3-3 Pistons

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.

Before installing pin bushing, make sure oil holes in bushing and rod end are aligned.



1862032

A – Oil Holes

1) Install pin bushing using Removal and Installation Tool.

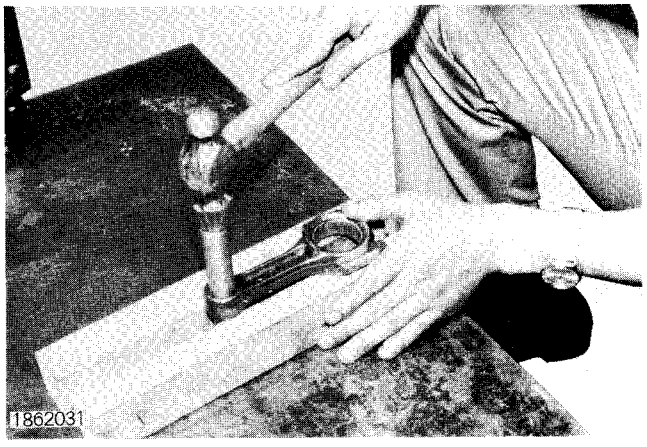
2) Install one pin retaining snap ring in each piston.

3) Coat piston pins with engine oil.

4) Install piston connecting rod and piston pin.

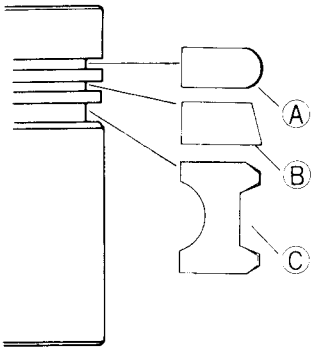
5) Install remaining snap rings.

Make sure connecting rod moves smoothly with piston.



1862031

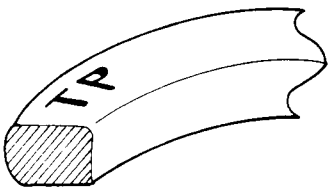
6) Each piston ring has a different shape. Make sure to install correctly.



1864004

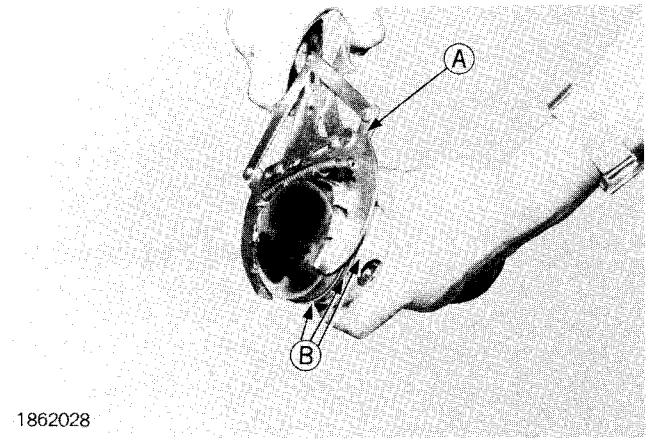
A – First Compression Ring (Barrel Face) Coated with Chrome.
B – Second Compression Ring
C – Oil Ring

7) Manufacture's mark near the ring gap must be faced to the top of piston when assembled.



1867011

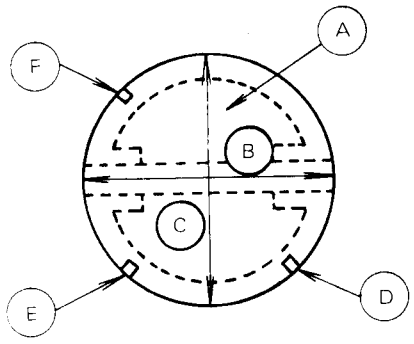
8) Install rings on piston using ring expander.



1862028

A – Piston Ring
B – Ring Expander

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



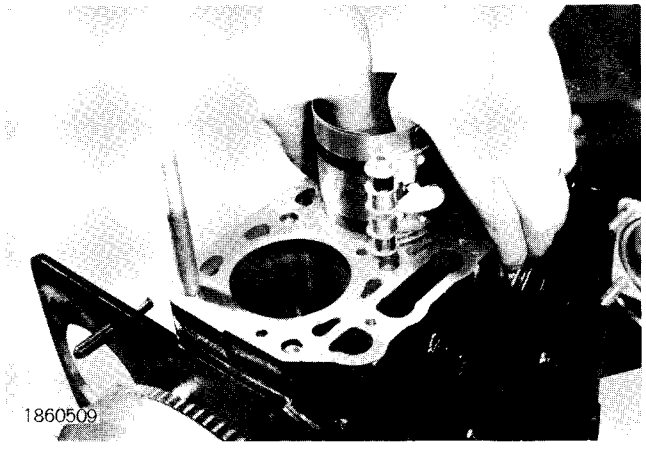
1867012

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.

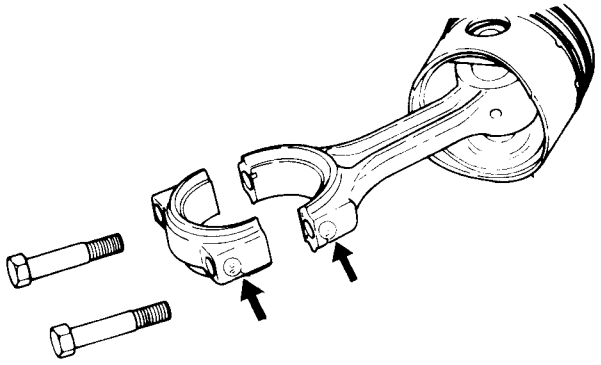
11) Carefully place piston in ring compressor.

12) Carefully place ring compressor with piston and rod over liner.



1860509

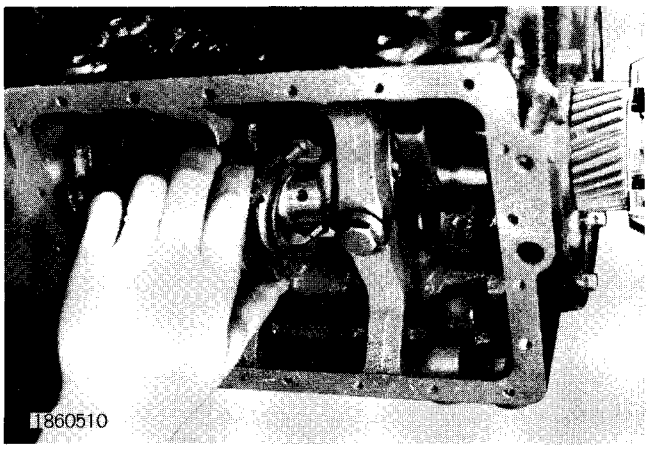
13) Position piston and rod so identification on rod faces to camshaft side of cylinder block.



1865005

14) With piston centered in installing tool and rings staggered correctly, push piston into liner.

15) Install connecting rod caps, and tighten to 16.6 to 20.2 ft-lbs (22.5 to 27.4 Nm) (2.3 to 2.8 kgm).



1860510

3-4 Camshaft

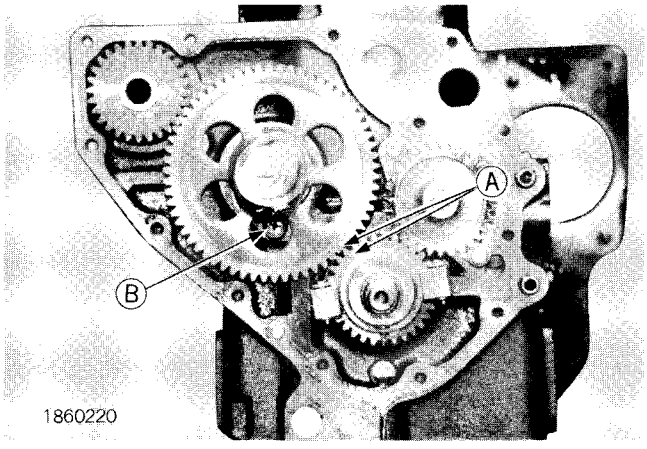
1) Hold tappets away from camshaft bore until camshaft is installed.

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 crankshaft gears during installation (A).

5) Install bearing retaining screw (B).



A – Timing Marks
B – Bearing Retaining Screw

3-5 Oil Pump

1) Install inner rotor-shaft assembly (C) pump body (E).

2) Install outer rotor (B) in pump body.

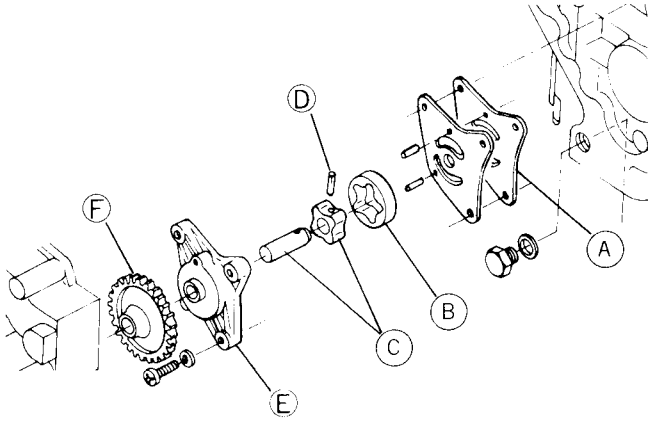
3) Install pin (D) in inner rotor-shaft assembly.

4) Install cap screws in pump body.

5) Install gear (F) on shaft.

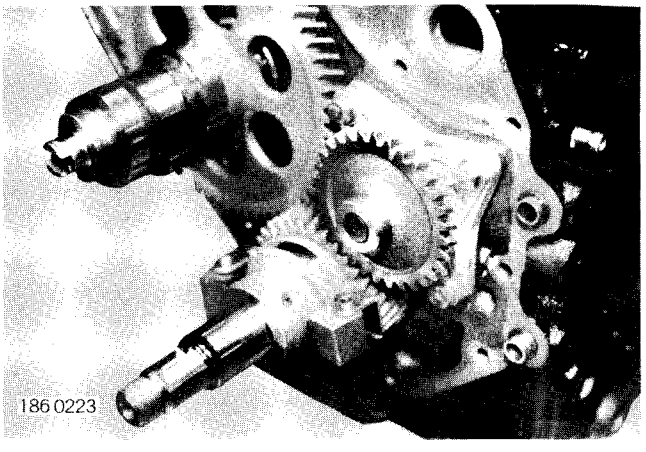
6) Install gasket (A) on pump body.

7) Install pump so spring pin enters hole in block.



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

8) Tighten cap screws to 6 to 8 ft-lbs (8 to 12 Nm) (0.8 to 1.2 kgm).



3-6 Lube Oil Suction Tube and Screen

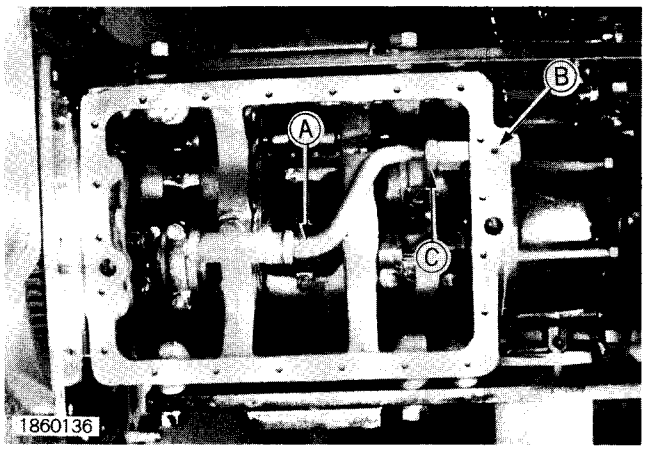
1) Clean thread of tube and cylinder block with solvent.

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).



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

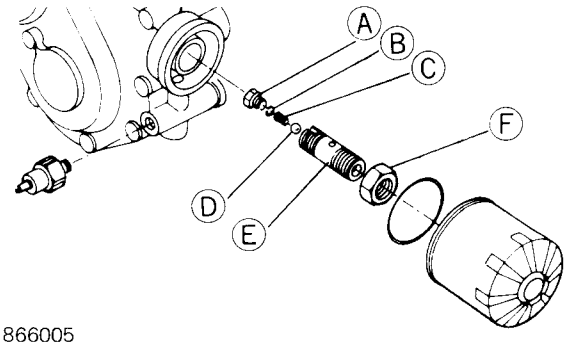
3-7 Oil Pressure Regulating Valve

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 on filter.



1866005

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

3-8 Front Oil Seal

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

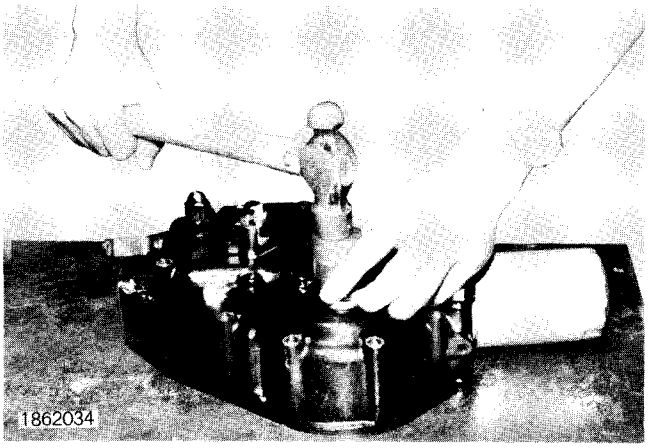
DO NOT apply grease to the lip of seal. This would eliminate seal pumping ability.

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

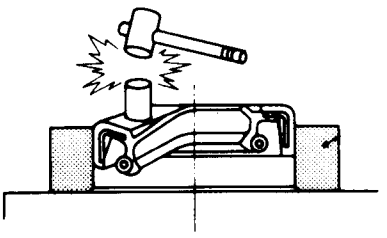
2) Be sure installation direction of oil seal is correct. The open side faces cylinder block side of cover.

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

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



Never tap oil seal directly.

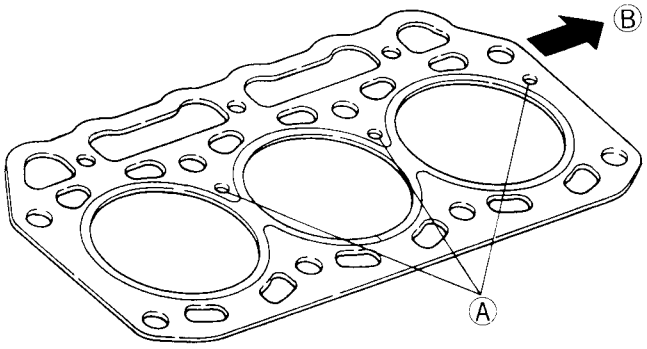


1864003

3-9 Cylinder Head

1) Check cylinder head stud bolts for loosing.

2) Confirm correct alignment of the coolant passage for cylinder head and gasket, and install on cylinder block without sealant.

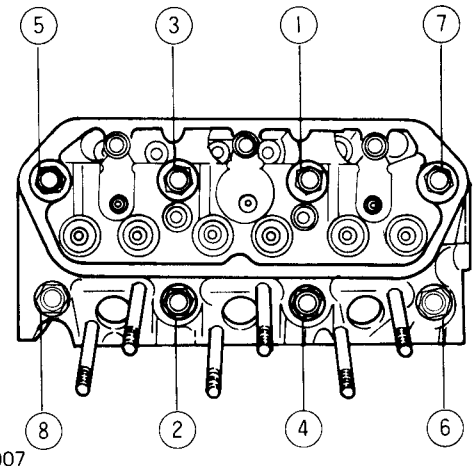


1867005

A – Lubricating Oil B – Flywheel Side

3) Coat studs, cylinder head bolts and nuts with clean engine oil, and tighten in sequence as illustrated to 29 ft-lbs (39Nm) (4.0kgm).

4) Retighten head bolts and nuts in sequence to 58 ft-lbs (78Nm) (8.0kgm) and finally tighten to 72 to79 ft-lbs (78 to 108Nm) (10 to 11kgm).



1867007

5) Tighten three cylinder head assist bolts to 20 ft-lbs (27 Nm) (2.8 kgm).

6) Install wear caps on valves.

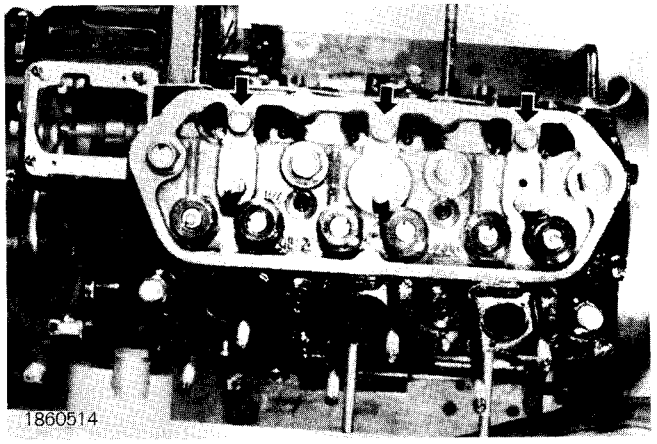
7) Install push rods on valve tappets. Be careful for not falling them into cylinder block.

8) Install rocker arm assembly on head.

9) Tighten rocker arm support nuts to 36 ft-lbs (49 Nm) (5.0 kgm).

10) Set valve clearance using procedure on ENGINE ADJUSTMENT.

11) Install rocker arm cover.

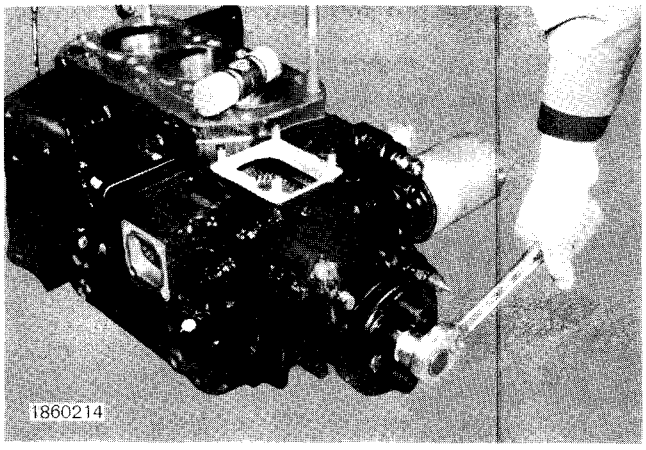


1860514

3-10 Timing Gear Cover

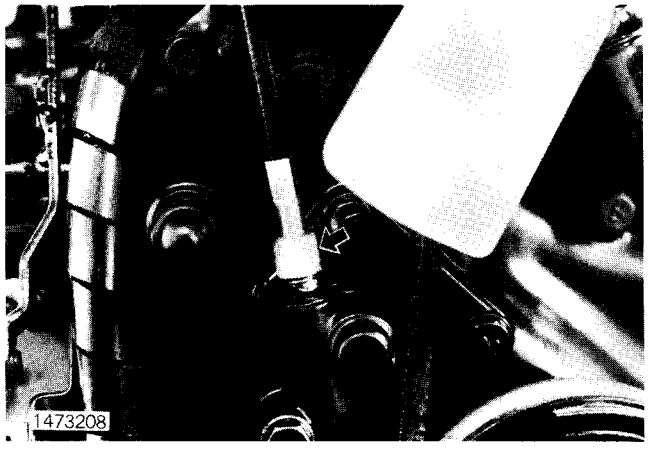
1) Install timing gear cover.

2) Install crankshaft pulley and nut. Tighten nut to 13.0 to 14.4 ft-lbs (176 to 196 Nm) (18.0 to 20.0 kgm).



3) Install fuel injection pump and cover plate as instructed in this page.

4) Connect hourmeter drive cable to gear cover.



3-11 Fuel Injection Pump

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).

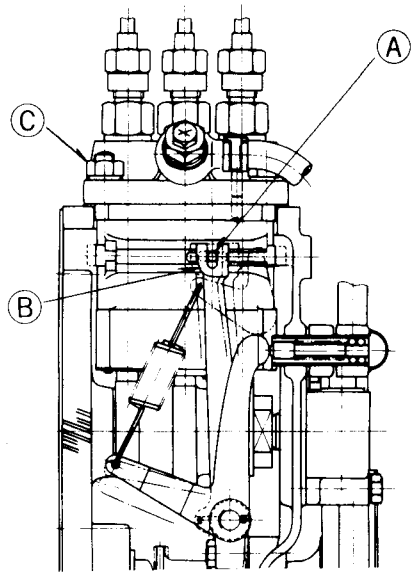
6) Install cover plates.

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.



1863040

A – Control Rack Pin
B – 2nd Governor Lever
C – Nut

3-12 Fuel Injection Nozzle

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.

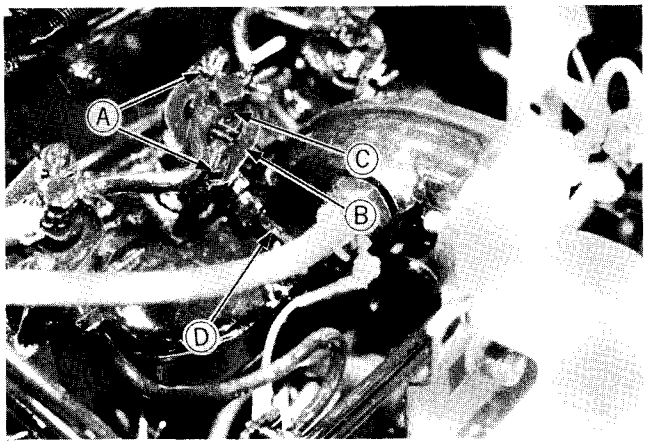
4) Install the lead-off banjo connectors (C) and washers on injection nozzles. Connect rubber hoses.

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.

8) Start the engine and check for leaks.



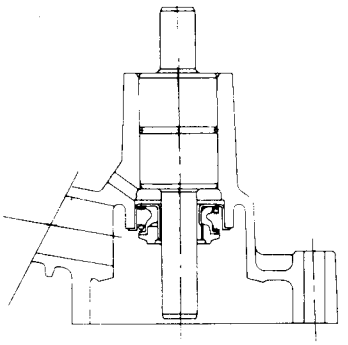
A – Retainer Nuts
B – Retainer
C – Banjo Connectors
D – Fuel Injection Pipe

3-13 Water Pump

1) If removed, use hydraulic press to reinstall seal.

2) Press in water pump bearing until bearing is flush with end of housing.

STOP Heat pump body to 80 – 90°C (176 – 194°F) in hot water before installing bearing shaft.



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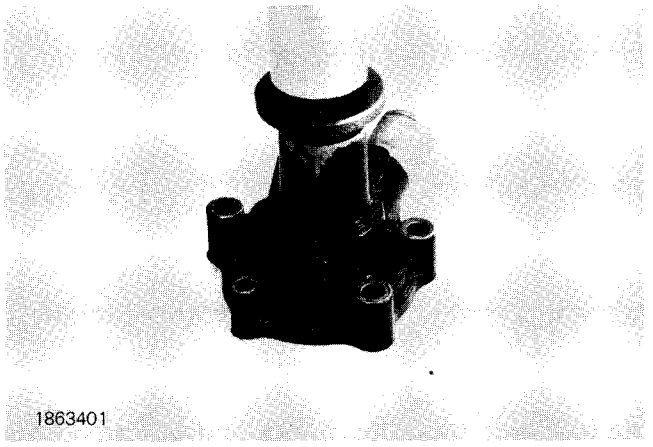
3) Press on hub until hub is flush with end of bearing shaft.

STOP Support shaft with spacer while installing hub.



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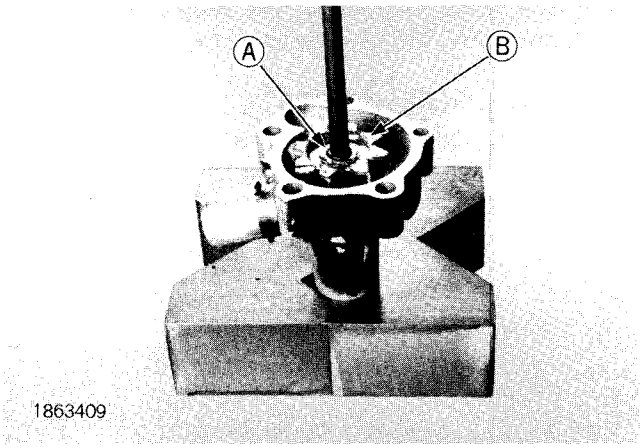
4) Support water pump in a press as shown. Press in impeller until impeller is flush with end of bearing shaft.



A — Bearing Shaft B — Impeller

5) Install water pump assembly to cylinder head.

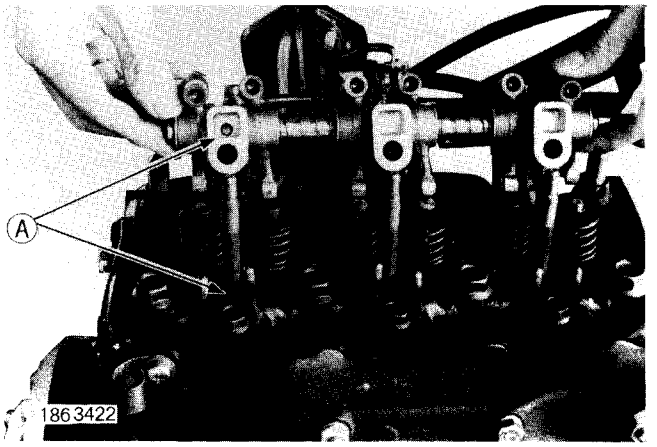
3-14 Rocker Arm Assembly

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 grooves of shaft.

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

4) Tighten rocker arm support nuts to 36 ft-lbs (49 Nm) (5.0 kgm).



A — Lubricating Oil Hole

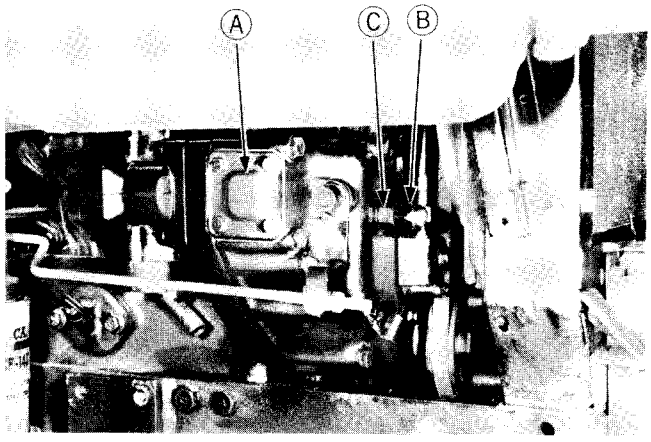
4. ADJUSTMENT

4-1 Fuel Injection Limiter

Use this procedure only if the torque spring shaft has been disassembled or the adjustment has been altered.

1) Remove cover plate (A).

2) Remove cap nut (B) and loosen lock nut (C).



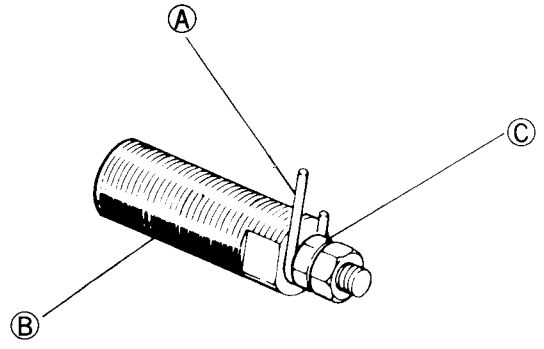
3) Screw the fuel limiter (B) out, and Insert the spacer (C) as described as follows.

(FOR LIMITER WITH WHITE PAINT MARK)

Insert spacer (A) which has the thickness of 0.055 to 0.07 in. (1.4 to 2.0 mm) nut (C), and screw into the timing gear cover.

(FOR LIMITER WITHOUT MARK)

Insert spacer (A) which has the thickness of 0.032 to 0.039 in. (0.8 to 1.0 mm) between limiter screw (B) and lock nut (C), and screw into the timing gear cover.



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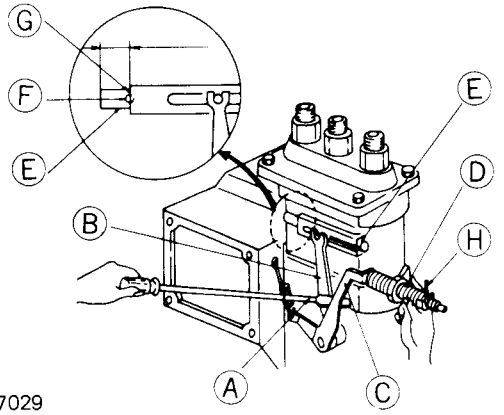
A – Spacer
B – Limiter
C – Look Nut

4) Insert screw driver 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.



1867029

A – Screw Driver
B – Governor Lever
C – Regulator Lever
D – Limiter
E – Control Pack
F – Punch Mark
G – Reference Surface
H – Spacer

5) FOR LIMITER WITH WHITE PAINT MARK)

Remove the screw driver and the spacer, and screw limiter 220° to 230° (5/8 turn) out of timing gear cover.

(FOR LIMITER WITHOUT MARK)

Remove the screw driver and the spacer, and screw limiter 375° to 400° (1-1/8 turns) out of timing gear cover.

6) Turn limiter 120°C (1/3 turn) counterclockwise.

7) Secure adjustment with lock nut and install cap nut.

Be sure for limiter not to be turned when tightening lock nut.

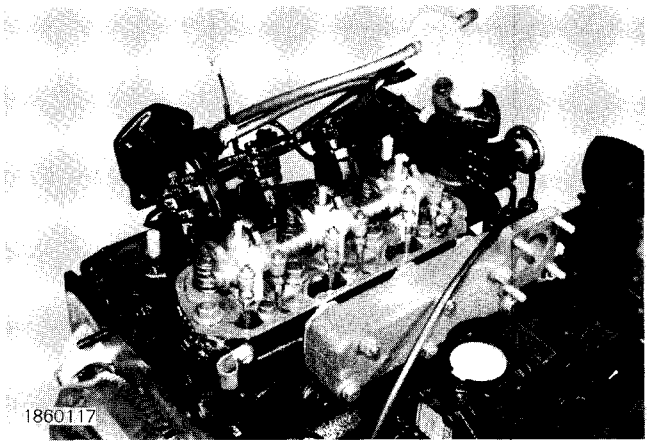
8) Install cover plate to the timing gear cover.

9) Check engine fast idle speed after adjustment.

The fast idle speed should be 2725 to 2775 rpm.

4-2 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.

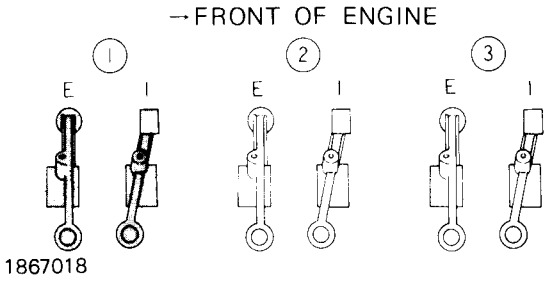
2) Remove thermo-start reservoir support cap screws.

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).

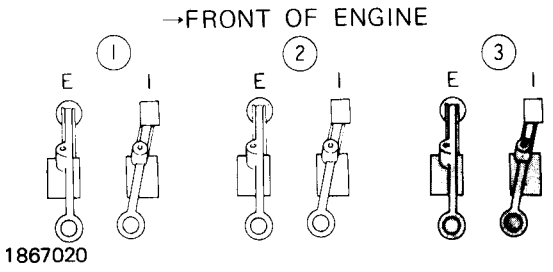
6) Check the intake and exhaust valve clearances of the No. 1 cylinder. **No. 1 CYLINDER IS AT REAR OF ENGINE.**



7) Adjust valve clearance to 0.008 in. (0.2 mm).

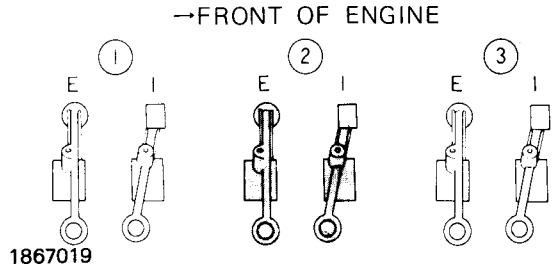
8) Turn the crankshaft clockwise 240° to align the TDC mark of the No. 3 cylinder.

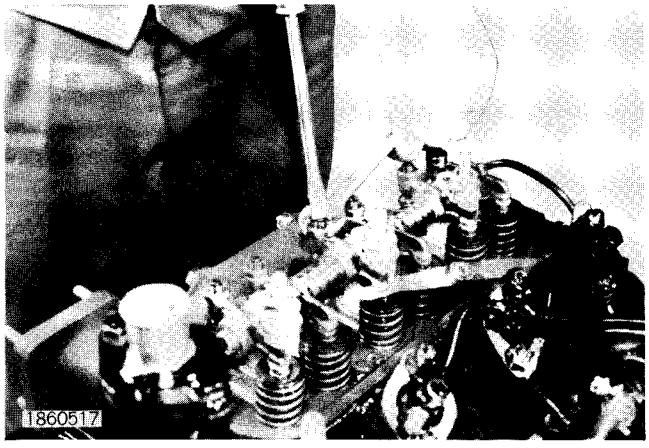
9) Check the valve clearance of the intake and exhaust valves of the No. 3 cylinder, and adjust to proper specification.



10) Turn the crankshaft another 240° clockwise to align the TDC mark of the No. 2 cylinder.

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



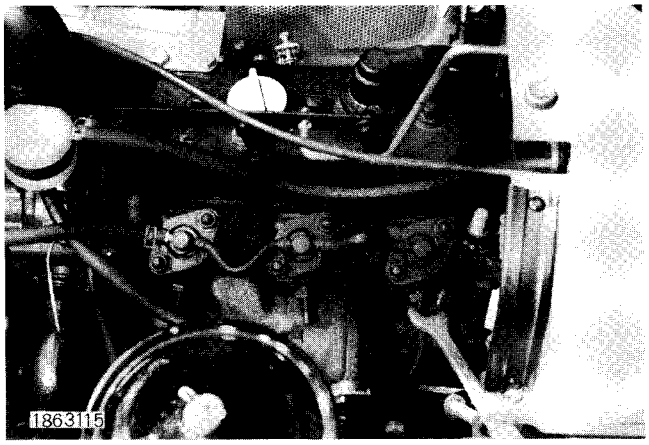


4-3 Fuel Injection Timing

1) Disconnect No. 1 fuel injection pipe (A).

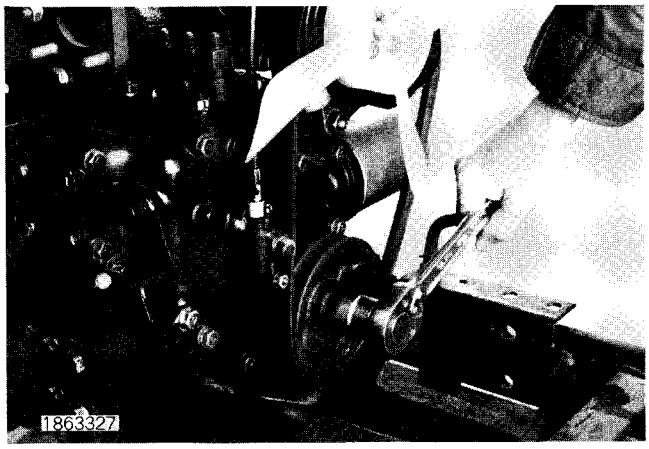
   Remove that No. 1 cylinder or injection pump plunger is the one closest to the engine flywheel.

2) Place throttle lever at maximum speed position and fuel shut-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 until fuel comes up in the delivery valve of No. 1 cylinder.
   Stop rotation of engine as soon as fuel comes out from the delivery valve.

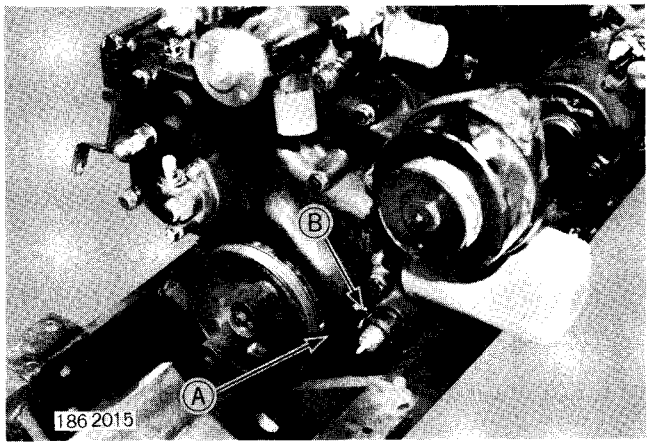
8) Observe injection timing mark (A) on crankshaft pulley. Mark will be aligned with pointer (B) when correct thickness of shims is under pump flange.

   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 20 ft-lbs (27 Nm) (2.7 kgm).

10) Bleed air from fuel system. Start engine and check for leaks.

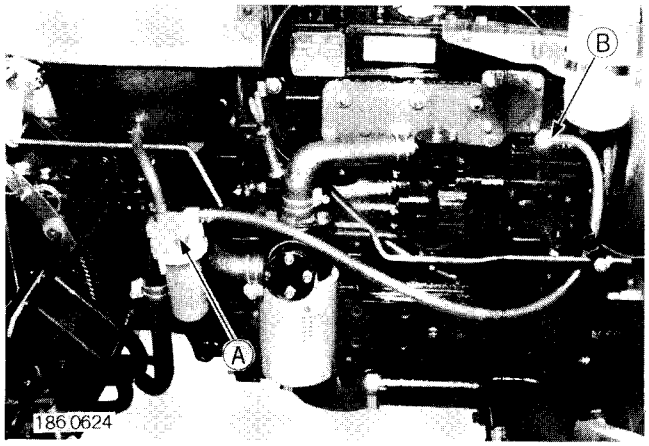
4-4 Bleeding Fuel System

⚠ CAUTION: Escaping diesel fuel under pressure can have sufficient force to penetrate the skin, causing serious personal injuly. 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.

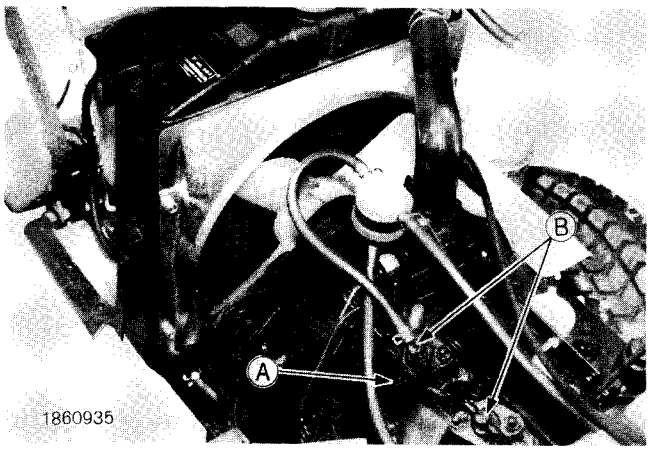
To bleed air from the filter or pump, loosen bleed screws until fuel without air flows from around screws. Tighten screws.



A – Bleed Screws on Filter Housing

B – Bleed Screw on Pump

If the engine will not start, it may be necessary to bleed air from the fuel pipes (A) at the injection nozzles (B). Loosen the fuel pipe connectors at the injection nozzles. Pull the decompression lever out and crank the engine with the starter until fuel (without air) comes out around connectors. Tighten connectors, push decompression handle fully in, and start engine.



A – Fuel Injection Pipes

B – Injection Nozzles

4-5 Fan Belt Tension

Check belt tension. Belt should deflect 3/8 to 5/8 in. (10 to 15 mm) at 20 lbs. (8.86 N) force.

4-6 Other Measurements and Inspections

1) Lube oil pressure: 43–57 psi (2.94 – 3.92 bar). (3.0 – 4.0 kg/cm^2)

Attach a pressure gauge to the fitting of the lube oil pressure switch and measure lube oil pressure.

2) Top clearance:

a) Extract the combustion chamber (rear and front), insert fuse rod through nozzle mounting port, and turn flywheel.

b) Squash the fuse between the cylinder head and the piston crown.

c) Measure the thickness of the squashed fuse using a micrometer.

CHAPTER 7

ELECTRICAL EQUIPMENT

The Model YM169/YM169D tractors are fitted with the following electrical systems:

(1) Starting system

(2) Charging system

(3) Lighting system

(4) Safety system

System	Component	Capacity
Charging system	Battery	12V–45AH
	Charging generator	(GP9150) 12V–15A
	Current limiter	(RS5114) 14.5±0.5V
Starting system	Starter motor	(S114-230) 12V–1.3kW
Lighting system	Headlights	12V–25/25W
	Work lights	12V–20W
Others	Engine oil pressure indicator light	12V–3.4W
	Water temperature indicator light	12V–3.4W
	Flashing warning and turn signal lights	12V–23W
	Horn (MF-12)	1.2A
	Thermostart (SH100-02)	12V–13A

1. BATTERY

1-1 Specifications

Item	Specifications
Model	NS60
Capacity	45 AH (20-hour rate)
Voltage	12V
Electrolyte specific gravity	1.260/68°F (20°C) at full charge
Charging current	3.5A

1-2 Description

The open circuit voltage of a battery measured across its terminals is 2.0 ~ 2.15 volts per cell, and neither the size of the battery nor its number of plates has anything to do with its voltage.

The capacity of a battery is the amount of electricity that can be discharged from a fully charged battery at a constant flow until it reaches its rated discharged terminal voltage.

There are two ways of expressing the capacity

of a battery: by its 'Ampere Hour' electrical capacity (AH) or its 'Watt Hour' electrical capacity (WH). Generally speaking, the 'Ampere Hour Capacity' is used.

Electrical capacity (AH) = discharge current (A) x hours of discharge (H) required for battery to reach discharged terminal voltage

The capacity of a battery will vary according to its discharge current rate, the ambient temperature during discharge, and the time and manner in which the battery is used.

The capacity will also vary according to the temperature of the electrolyte during discharge. The higher the temperature, the larger the capacity; and the lower the temperature, the lower the capacity.

When starting the engine, the battery discharges at a very high current flow rate. Accordingly, it can be readily understood that starting is more difficult when the ambient temperature is very low, because the capacity of the battery is lowered. In addition, the viscosity of the engine oil also increases as the temperature drops.

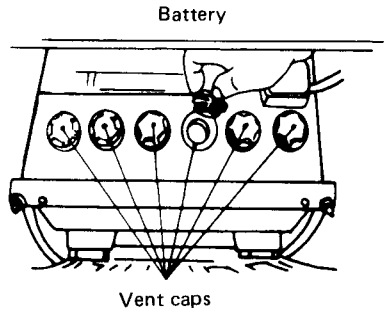
1-3 Inspection

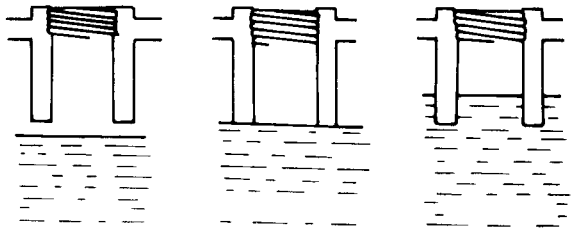
a) Electrolyte Capacity

The water content of the electrolyte will evaporate during use, or will be reduced in volume because of electrolysis. If there is insufficient electrolyte, the battery is liable to sustain damage, and it there is too much, the electrolyte will overflow and damage the body and other parts of the tractor.

Accordingly, the level of the electrolyte in the battery should be inspected regularly, and replenished with distilled water when insufficient. The level of the electrolyte should be sufficient so that the separators of the plates are not exposed.

If the plates are exposed to the atmosphere, sulfation will ensue, and it will no longer be possible to recharge the battery.





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b) Specific Gravity

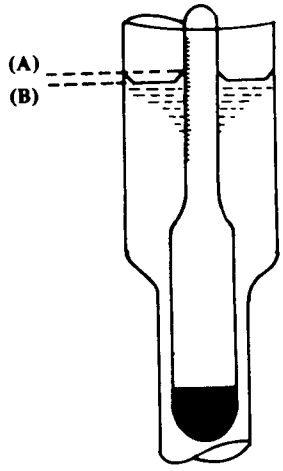
The specific gravity of the electrolyte of a battery varies according to the temperature.

The specific gravity should be adjusted to the specific gravity at 68°F (20°C).

Specific gravity	Condition		
1.260	100%	Charged condition	Usable as is.
1.220	75		
1.160	50	Usable limit	Recharge immediately.
1.090	25	Discharged	
1.080	10		
1.050	0	Fully discharged	

Use a hydrometer to get the specific gravity reading:

Insert the hydrometer into one of the battery holes and suck up enough electrolyte into the glass tube so that the float moves freely. Be sure to hold the glass tube vertically; the reading at (A) is the specific gravity



2. GENERATOR AND CURRENT LIMITER

2-1 Specifications

Generator: GP9150
Current limiter: RS5114

1) Rotating direction	Clockwise (viewed from flywheel side)
2) Operational rotation	1000 rpm – 5000 rpm
3) Allowable rotation	12,000 rpm
4) Charging perofrmance	More than 15A/12V at 4500 rpm
5) Rotation for initial charging	Less than 1300 rpm

2-2 Structure

Name: 12-12 pole magnet revolving type generator
Components:

a) Stator (armature windings)

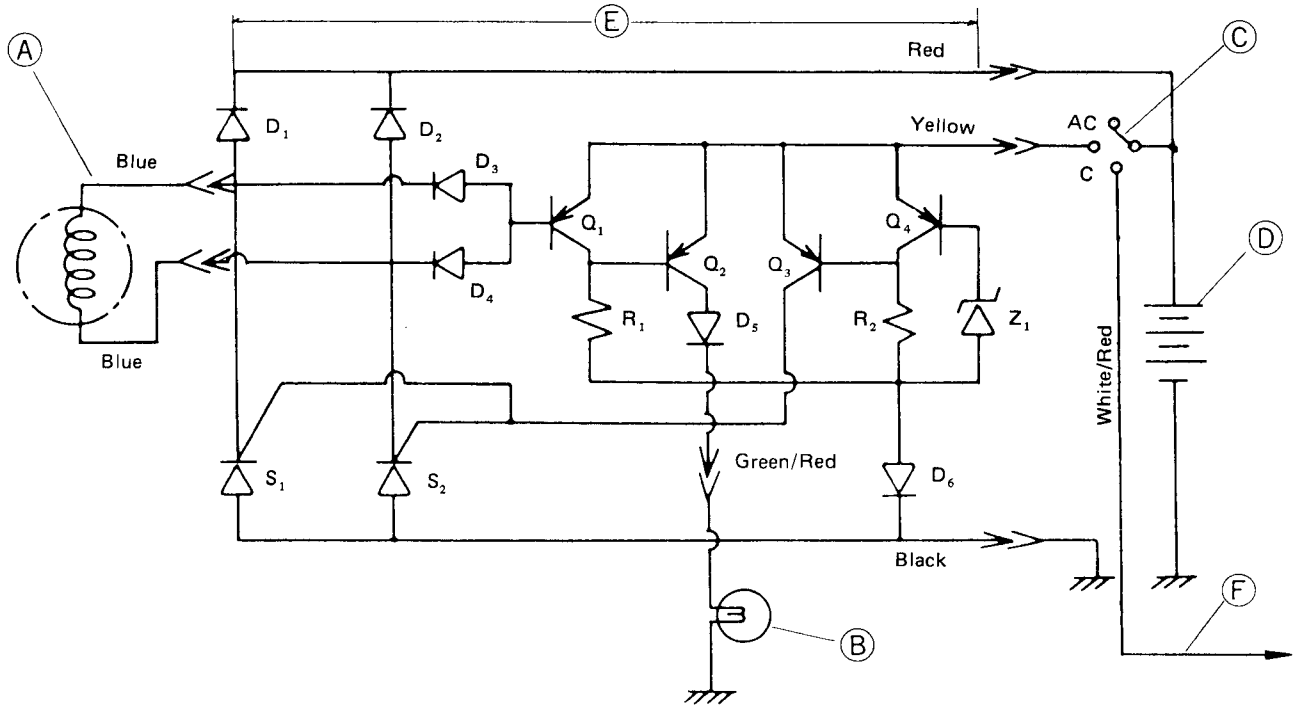
i) Each coil is connected in series. Wire conductors are wound around a 12 pole armature core.

ii) An aluminum die cast plate has rectifying diodes attached to it.

b) Flywheel

The throttled plate flywheel has a ferrite magnet attached to it, and the pulley, shaft and bearings are pressed in.

2-3 Connecting Diagram



1867093

A – Alternator
B – Charging Indicator Lamp
C – Key Switch
D – Battery
E – Regulator
F – To Starter

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 Protection Against Battery Cable Reverse Polarity
R_1, R_2 – Resistors

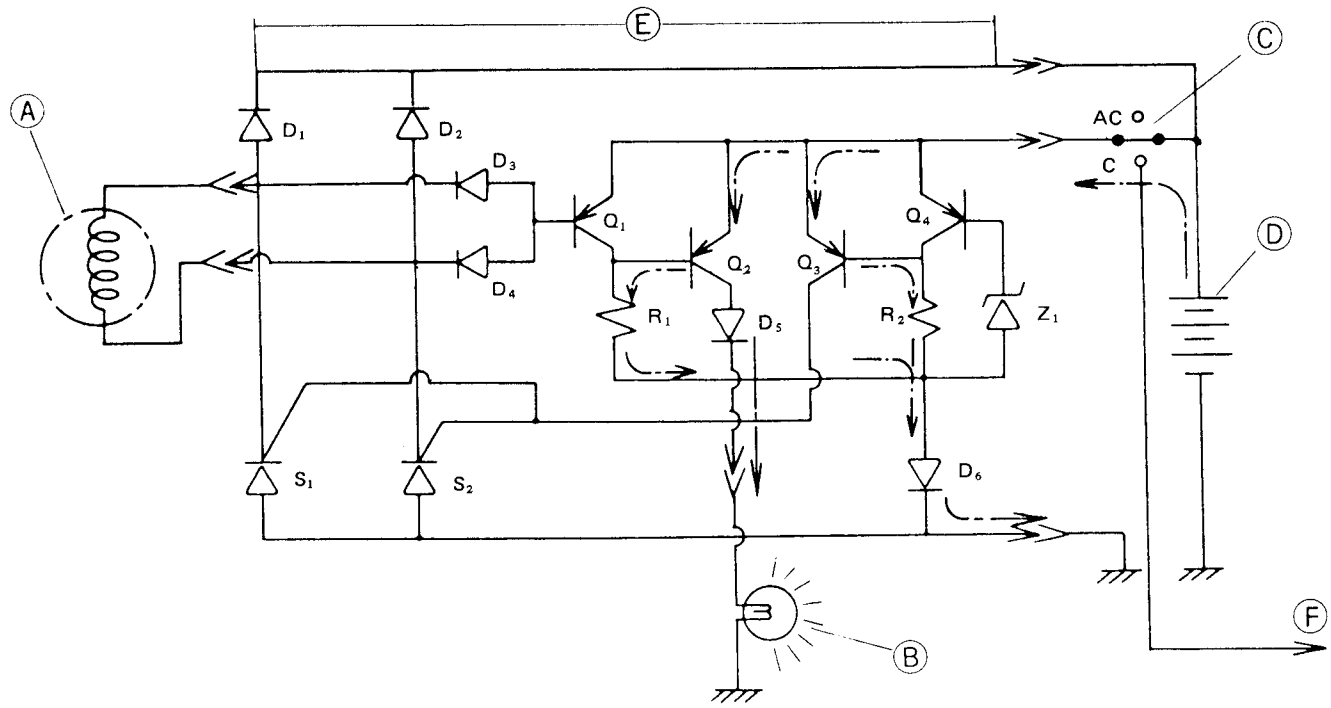
Z_1 – Zener Diode for Controlling Battery Voltage
Q_1 – Transistor for Detecting Generated Voltage
Q_2 – Transistor for Indicator Lamp Relay
Q_3 – Transistor for Controlling Gate Current
Q_4 – Transistor for Detecting Battery Voltage

The transistor type regulator is composed of six diodes, one zener diode, two thyristors and two resistors. D_1 and D_2 rectify a single phase alternating current generated by alternator (A).

Q_1 and Q_2 control charging indicator lamp.

Q_3, Q_4 and Z_1 control current to S_1 and S_2, and adjust charging current and voltage.

(1) Phase 1 – Key Switch in "AC" Position (Alternator Stopped)



1867094

A – Alternator
B – Charging Indicator Lamp
C – Key Switch
D – Battery
E – Regulator
F – To Starter

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 Protection Against Battery Cable Reverse Polarity
R_1, R_2 – Resistors

Z_1 – Zener Diode for Controlling Battery Voltage
Q_1 – Transistor for Detecting Generated Voltage
Q_2 – Transistor for Indicator Lamp Relay
Q_3 – Transistor for Controlling Gate Current
Q_4 – Transistor for Detecting Battery Voltage

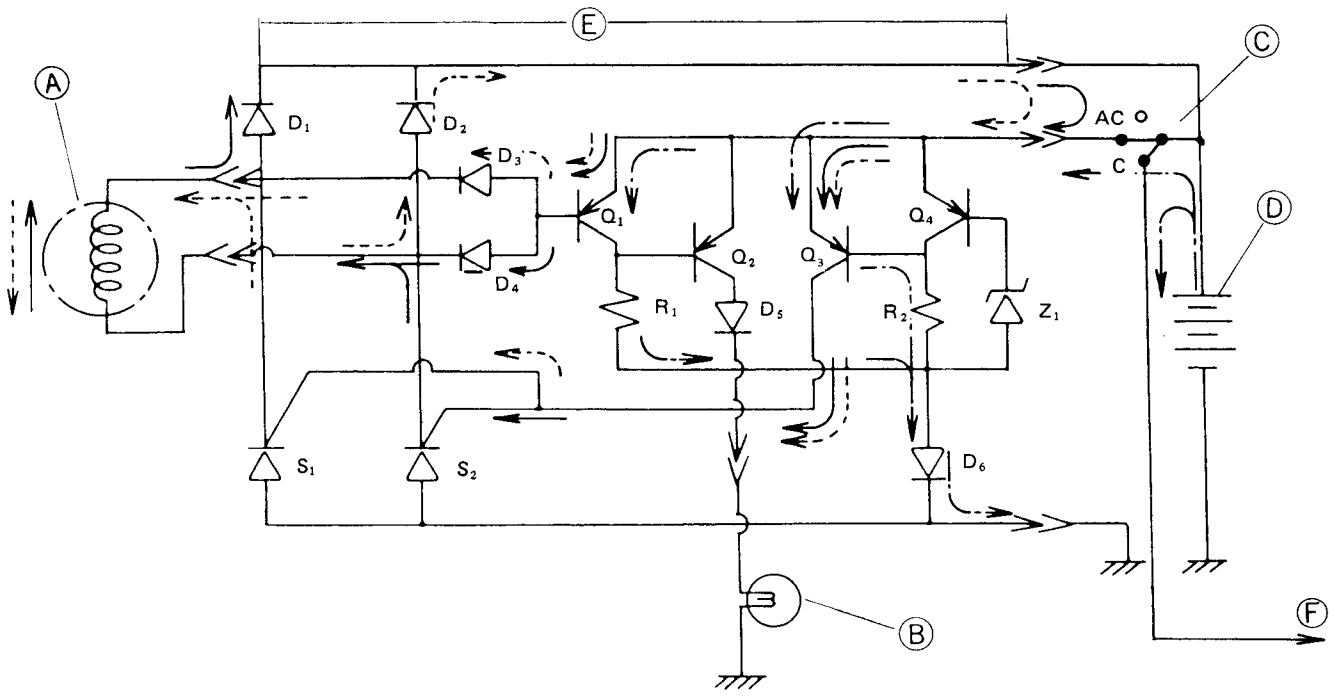
1) With key switch (C) in "AC" position, current from battery (D) flows through key switch → emitter base of transistor (Q_2) → resistor (R_1) → diodes (D_6) and to ground.

   The base current to transistor (Q_2) means a closed circuit in Q_2. This allows current to flow through collector of Q_2 → diode (D_5) → charging indicator lamp (B) (causing the lamp to glow) and to ground.

2) From the key switch, current also flows through emitter base of transistor (Q_3) → resister (R_2) → diode (D_6) and to ground.

   The base current of transistor (Q_3) also flows, but the collector current cannot flow because the alternator is stoped and no generated current is flowing.

(2) Phase 2 – Key Switch in "START" Position (Generated Voltage: Low)



1867095

A – Alternator
B – Charging Indicator Lamp
C – Key Switch
D – Battery
E – Regulator
F – To Starter

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 Protection Against Battery Cable Reverse Polarity
R_1, R_2 – Resistors

Z_1 – Zener Diode for Controlling Battery Voltage
Q_1 – Transistor for Detecting Generated Voltage
Q_2 – Transistor for Indicator Lamp Relay
Q_3 – Transistor for Controlling Gate Current
Q_4 – Transistor for Detecting Battery Voltage

Having started the engine, the alternator begins to generate electricity.

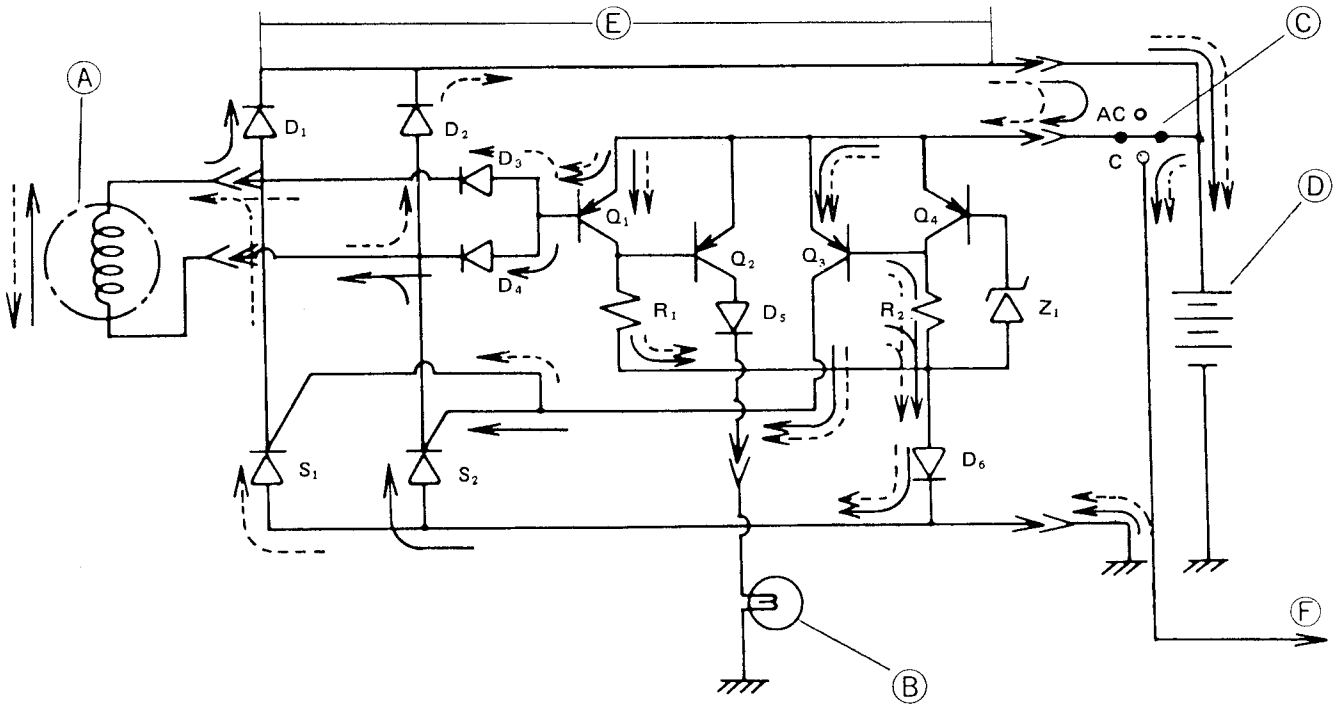
Current circulates from alternator (A) through diode (D_1) → transistor (Q_1) emitter → diode (D_4) to alternator. and from alternator (A) through diode (D_2) → transistor (Q_1) emitter → diode (D_3) to alternator.

The current flow of Q_1 emitter is a short circuit between emitter and base of transistor (Q_2). This turns the indicator lamp off.

For an instant after starting the engine, terminal voltage of battery is lower than 14.5 volts, which is the level of the zener diodes. Therefore, transistor (Q_4) works as an open circuit and current cannot flow. Instead current from battery flows through (Q_3) emitter → R_2 → D_6 and back to the battery.

This allows the collector current of Q_3 to flow to the gate cathodes of S_1 and S_2.

(3) Phase 2 – Key Switch in "START" Position (Generated Voltage: High)



1867096

A – Alternator
B – Charging Indicator Lamp
C – Key Switch
D – Battery
E – Regulator
F – To Starter

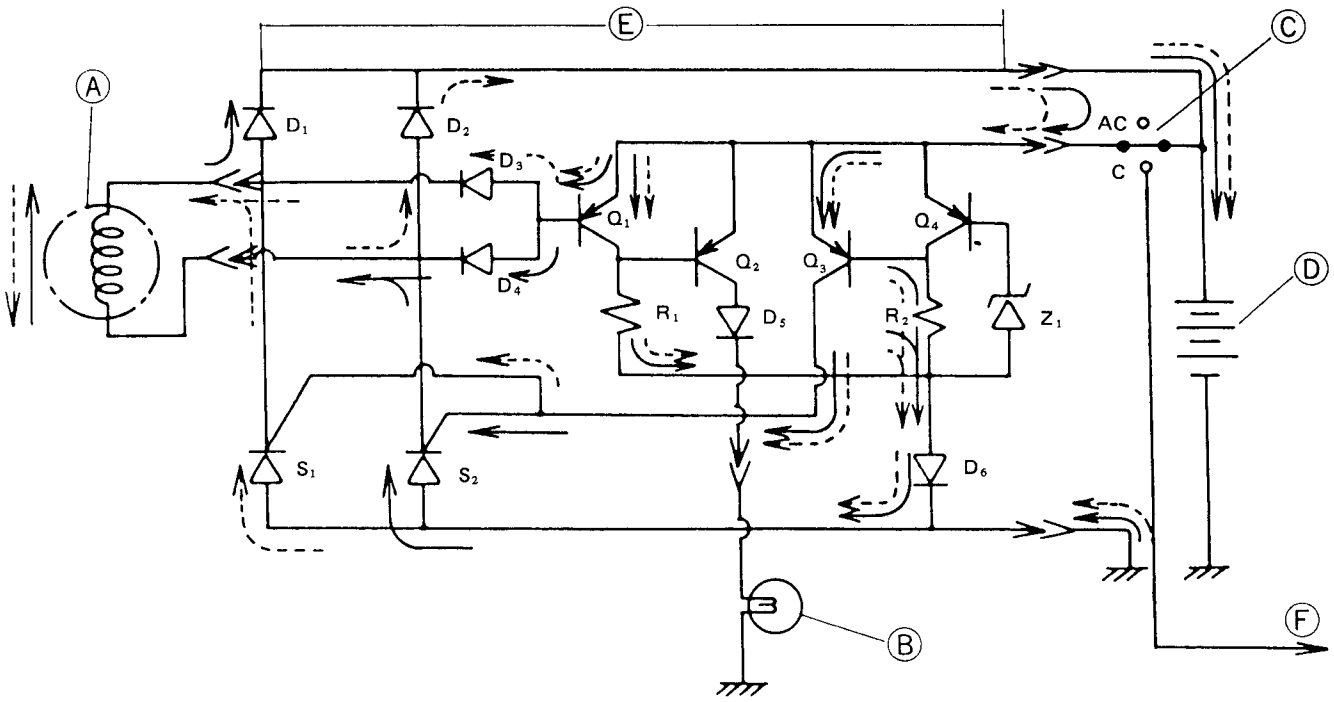
S_1, S_2 – Thyristor for Rectifing Current
D_1, D_2 – Diodes for Rectification
D_3, D_4 – Diodes for Detecting Current
D_5, D_6 – Diodes for Protection Against Battery Cable Reverse Polarity
R_1, R_2 – Resistors

Z_1 – Zener Diode for Controlling Battery Voltage
Q_1 – Transistor for Detecting Generated Voltage
Q_2 – Transistor for Indicator Lamp Relay
Q_3 – Transistor for Controlling Gate Current
Q_4 – Transistor for Detecting Battery Voltage

When the engine speed is increased, the generated voltage becomes higher than the battery terminal voltage. At this point thyristers (S_1 and S_2) close, allowing current to flow through them. Current now flows from the alternator through diode (D_1) → battery (D) → anode and cathode of thyristor (S_1) to the alternator and from the alternator through diode (D_2) → battery (D) → anode and cathode of thyristor (S_2) to the alternator.

With S_1 and S_2 closed (current flowing), the collector current of Q_1 and the base current of Q_3 flow from the alternator instead of the battery.

(4) Phase 3 – Key Switch in "ON" Position (Battery Voltage: Low)



1867097

A – Alternator
B – Charging Indicator Lamp
C – Key Switch
D – Battery
E – Regulator
F – To Starter

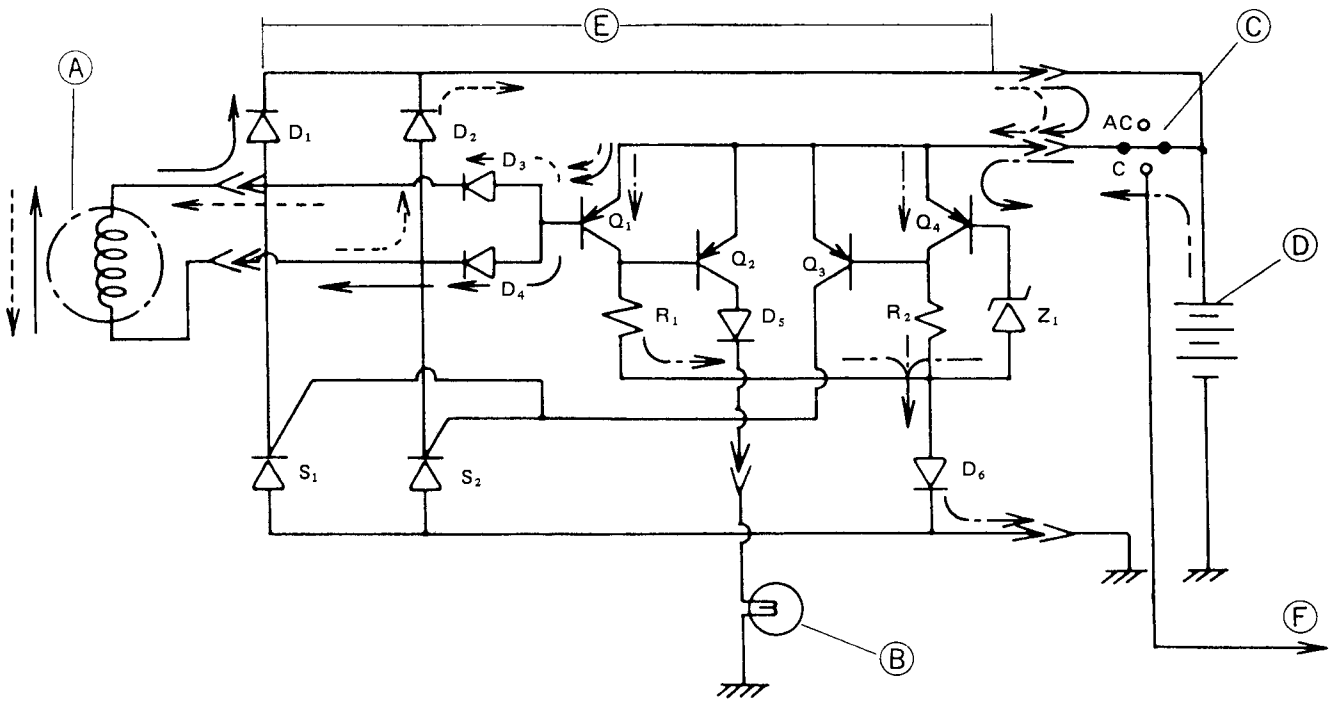
S_1, S_2 – Thyristor for Rectifing Current
D_1, D_2 – Diodes for Rectification
D_3, D_4 – Diodes for Detecting Current
D_5, D_6 – Diodes for Protection Against Battery Cable Reverse Polarity
R_1, R_2 – Resistors

Z_1 – Zener Diode for Controlling Battery Voltage
Q_1 – Transistor for Detecting Generated Voltage
Q_2 – Transistor for Indicator Lamp Relay
Q_3 – Transistor for Controlling Gate Current
Q_4 – Transistor for Detecting Battery Voltage

When the battery terminal voltage is lower than the zener diode level (14 – 15 volts), the battery is charged as illustrated.

Currnet from the alternator flows as follows:
alternator → D_1 → battery → S_1
and
alternator → D_2 → battery → S_2

(5) Phase 3 – Key Switch in "ON" Position (Battery Voltage: High)



1867098

A – Alternator
B – Charging Indicator Lamp
C – Key Switch
D – Battery
E – Regulator
F – To Starter

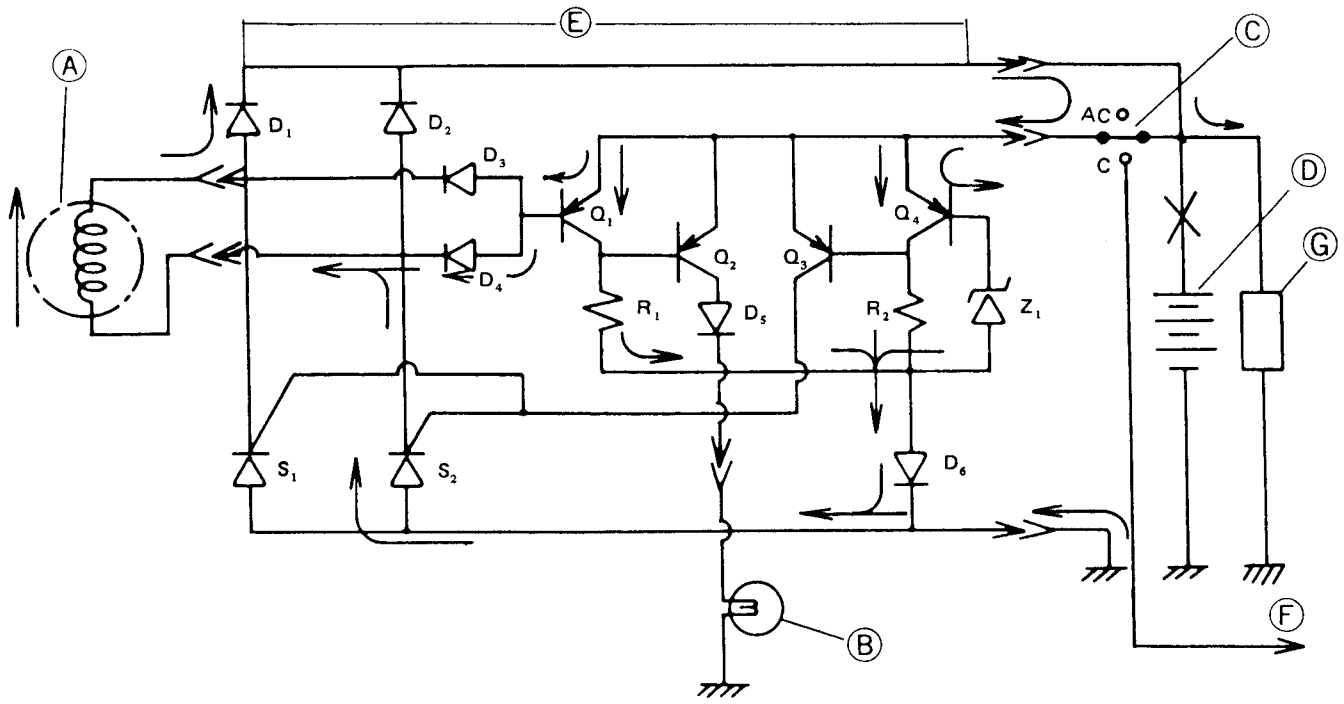
S_1, S_2 – Thyristor for Rectifing Current
D_1, D_2 – Diodes for Rectification
D_3, D_4 – Diodes for Detecting Current
D_5, D_6 – Diodes for Protection Against Battery Cable Reverse Polarity
R_1, R_2 – Resistors

Z_1 – Zener Diode for Controlling Battery Voltage
Q_1 – Transistor for Detecting Generated Voltage
Q_2 – Transistor for Indicator Lamp Relay
Q_3 – Transistor for Controlling Gate Current
Q_4 – Transistor for Detecting Battery Voltage

If battery voltage becomes higher than the zener diode level (14 –15 volts), the battery is not charged.

Current flows as follows:
battery → emitter of transistor (Q_4)
→ zener diode (Z_1) → diode (D_6)
With no current at its base Q_3 is open and, consequently, S_1 and S_2 remain open. Q_2 is also open and so the indicator lamp (B) is not glowing.

(6) Phase 4 — Battery Removed (Immediately Following Removal, Engine Running)



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 Protection Against Battery Cable Reverse Polarity
R_1, R_2 — Resistors

Z_1 — Zener Diode for Controlling Battery Voltage
Q_1 — Transistor for Detecting Generated Voltage
Q_2 — Transistor for Indicator Lamp Relay
Q_3 — Transistor for Controlling Gate Current
Q_4 — Transistor for Detecting Battery Voltage

A characteristic of thyristors is that they remain closed until current flow drops to zero.

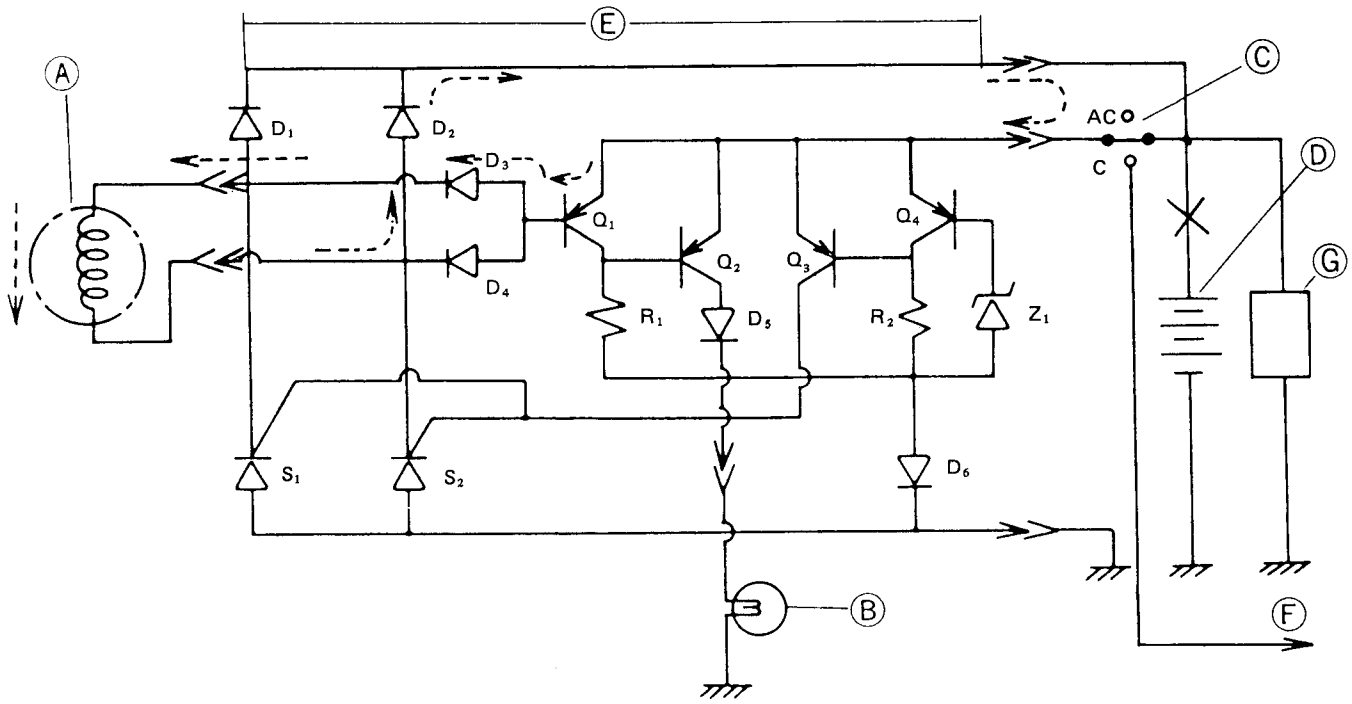
Current flows as illustrated.
alternator → D_1 → load → S_2 → alternator

At this time, Q_2 is open and indicator lamp off.

With battery removed voltage to load becomes higher than 14 — 15 volts.

Therefore, Q_3 is open and current to the S_2 gate is cut.

(7) Phase 4 – Battery Removed (After Removal, Engine Running)



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 Protection Against Battery Cable Reverse Polarity
R_1, R_2 – Resistors

Z_1 – Zener Diode for Controlling Battery Voltage
Q_1 – Transistor for Detecting Generated Voltage
Q_2 – Transistor for Indicator Lamp Relay
Q_3 – Transistor for Controlling Gate Current
Q_4 – Transistor for Detecting Battery Voltage

When S_1 and S_2 are open voltage to the load does not increase and current flows as illustrated.

Current flows as follows:
alternator → D_2 → Q_1 → D_3 → alternator

Base current flows only in transistor (Q_1).

Therefore, this regulator does not allow damage to load (electrical equipment) even if the battery is removed during charging.

2-4 Inspection and Characteristics

(1) Performance test of the generator coupling with current limiter connected

Condition between	Normal	Abnormal	Causes
charge current voltage of battery terminal	1) More than 7A at 14.5V (without current limiter)	1) Current: more than 7A Voltage: more than 15.0V	Current limiter is not operating properly.
	2) More than 15A at 14V (with current limiter)	2) Less than 10A at 14V	Current limiter and generator are not operating properly.
		3) Charging current noted but voltage of battery terminal is low	Battery

(2) Separate inspection of generator

[On Performance]

		Normal	Abnormal	Causes
1.	Tester indication at: non-load voltage [between lead (+) (red) and generator body unit] Operated [N = 400 rpm]	Approx. more than 30V, AC	Approx. less than 30V, AC	1) Diode is bad 2) Open circuit in armature coil
2.	Continuity check by testor [between lead (red) and grounding]	Continuity	Continuity Continuity	Diode is bad
		No continuity	No continuity No continuity	Diode is bad Break of lead
	[Diode check]			
	Diode D_1—lead (red)	No continuity Continuity	Continuity (no continuity) Continuity (no continuity)	
	Diode D_2—lead (red)	No continuity Continuity	Continuity (no continuity) Continuity (no continuity)	Diode is bad (break or short circuit)
	Diode D_3—lead (yellow)	No continuity Continuity	Continuity (no continuity) Continuity (no continuity)	
	Diode D_4—lead (yellow)	No continuity Continuity	Continuity (no continuity) Continuity (no continuity)	Diode is bad (break or short circuit)
	Diode D_5—grounding	Continuity No continuity	Continuity (no continuity) Continuity (no continuity)	
	Diode D_6—grounding	Continuity No continuity	Continuity (no continuity) Continuity (no continuity)	
	[Armature coil] Diode terminal A—B	Continuity	No continuity	Break of circuit

		Normal	Abnormal	Causes
3.	[Insuration resistance] at: 500V Mega tester Lead (red)—grounding	More than 3MΩ	Less than 3MΩ	Bad insulation at armature coil

Rotating Condition of the Flywheel

	Normal	Abnormal	Causes
Flywheel rotated manually	Magnetic stress felt 12 times per rotation. Rotates comparatively smooth.	Noise accompanies rotation	Bearing is bad Distortion of the flywheel
		No magnetic stress is felt. Light rotation	Lowering, or failure of magnetic energy of flywheel

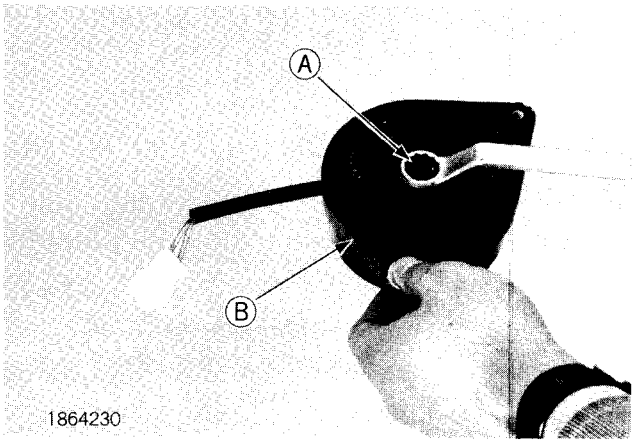
2-5 Cautions during Handling and Assembly

Cautions	Resulting Problems
1. Do not improperly wire to battery, Confirm (+) & (–), and coloring of leads	Short-circuit of battery 1) Burning of generator diode 2) Burning of generator coil 3) Burning of current limiter
2. Do not operate at less than the specified speed	Burning of generator coil Failure of current limiter
3. Do not tighten belt too tight	Broken pulley & bearing of generator
4. Avoid shocks and large stresses on the peripheral of the flywheel	Distortion of the flywheel
5. Do not hang lead wire	Break of lead wire
6. Do not operate out of the specified assembly condition (engine operation must always be under specified wind speed condition by cooling fan)	Burning of current limiter & generator
7. Do not pour water into the generator unit	Short-circuits of generator Damage to bearing
8. During assembly and disassembly, the shaft tightening torque: 250 kg-cm to 300 kg-cm.	Damages to flywheel by the loosening of screws
9. Use rated or genuine Yanmar part for the replacement of bearings	Damages to bearings
10. Use genuine Yanmar parts for the replacement of generator diodes	Burning of diodes

2-6 Instructions for Disassembly and Assembly

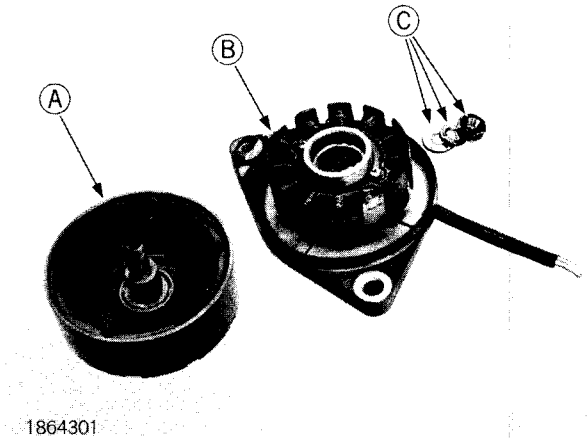
(1) Disassembly Sequence

1) Remove nut (A) from end of shaft



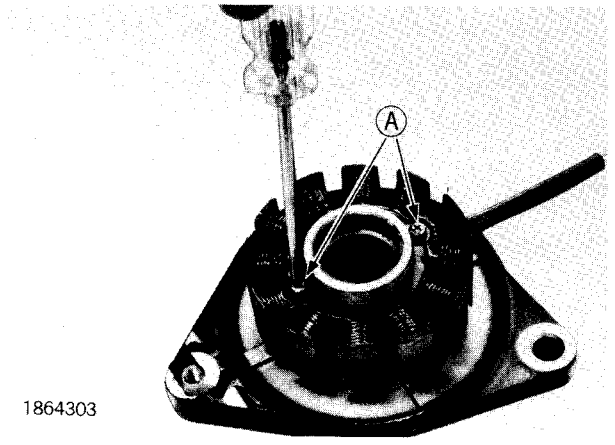
A – Nut
B – Generator Body

2) Pull flywheel (A) with magnets from body of generator (B).



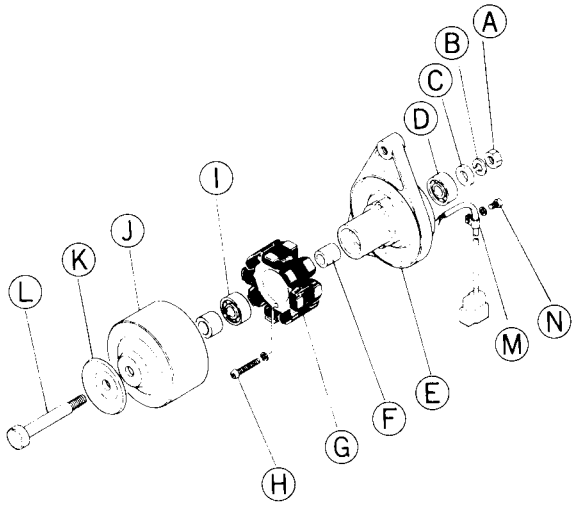
A – Flywheel with Magnets
B – Generator Body
C – Nut and Washers

3) Remove two coil retaining screws (A).



(2) Assembly Sequence

Reverse disassembly steps.



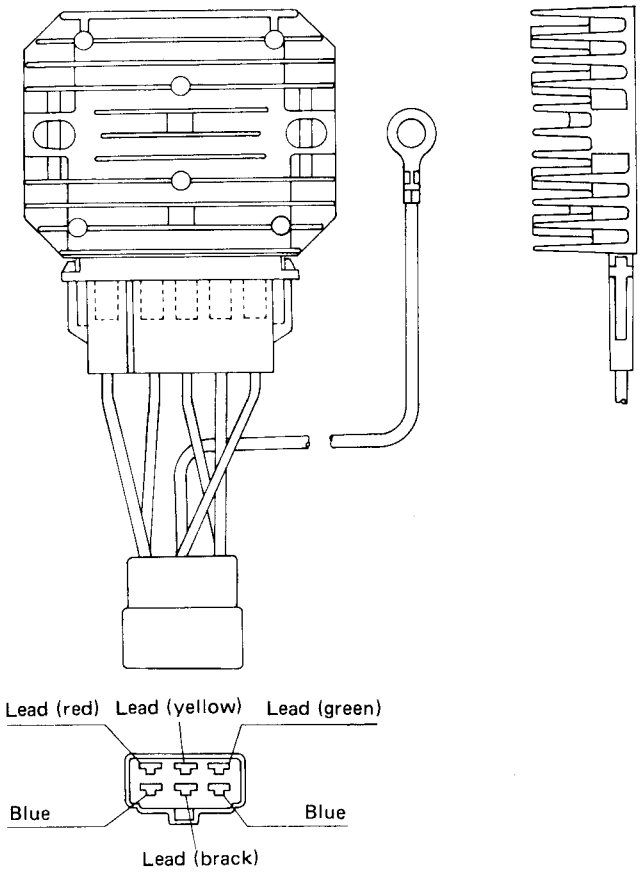
A – Nut
B – Spring Washer
C – Washer
D – Inner Bearing
E – Alternator Body
F – Spacer
G – Stator Coil Assembly
H – Screw
I – Outer Bearing
J – Flywheel with Magnets
K – Pully Half
L – Shaft
M – Wire Lead with Connector
N – Screw

2-7 Maintenance and Inspection

(1) Do not keep the unit in storage under dusty, damp, and high temperature conditions.

(2) In case dust, dirt, water, oil, etc. are deposited on the generator and lead connections, clean the necessary parts before use.

(3) Keep the appropriate belt tension, to avoid belt slippage.



[Current Limiter]

This is used coupled with the generator. Refer to the section on the generator, for the specifications, diagram, and handling instructions.

Current limiter forms one unit contained in resin mold. In the case of a failure, replace current limiter as a unit.

[Inspection of Current Limiter]

Check the continuity between the red lead and black lead with a tester.

Normal	Continuity noted / No continuity	
Abnormal	Continuity noted / Continuity noted	No continuity / No continuity

3. STARTER MOTOR

3-1 Specifications

Item			Specifications
Manufacturer			HITACHI
Manufacturer's code			S114-230
Yanmar's code			124070-77010
Output kW			1.3
Direction of rotation (viewed from pinion side)			Clockwise
Mesh method			Magnetic shift
Light running	Terminal voltage (V)/current (A)		12/less than 60
	Speed (rpm)		Over 6000
Lock torque	Terminal voltage (V)/current (A)		5/less than 540
	Torque (kg-m)		Over 11.56 ft-lb (Over 1.6 kg-m)
Type of clutch			Over-running
Pinion	Diametric pitch or module/No. of gear teeth		DP $\frac{10}{12}$ /11
Brush	Spring tension		
	Standard length/wear limit in. (mm)		0.630/0.157 (16/4)
Magnetic switch resistance at 20°C	Series/Shunt (Ω)		0.324/0.694
Commutator	Outer diameter	Standard outer diameter/minimum length	1.575 in/0.079 in (40 mm/2 mm)
	Difference between maxium diameter and minimum diameter	Correctable limit/correction precision	0.0157 in/0.0020 in (0.4 mm/0.05 mm)
	Depth of mica between commutator bars	Correctable limit/correction precision	0.0079 in/0.0197–0.0315 in. (0.2/0.5–0.8 mm)
Standard dimensions	Brush side bearing	Shaft diameter/hole diameter	0.4909–0.4902 in/0.4932–0.4921 in. ($12.5^{-0.032\ mm}_{-0.050\ mm}$/$12.5^{+0.027\ mm}_{0}$)
	Pinion slide section	Shaft diameter/hole diameter	
	Pinion side bearing	Shaft diameter/hole diameter	
L dimension			0.0118–0.0591 in (0.3–1.5 mm)
Ground polarity			Negative

3-2 Description

The major components of the starter motor are the magnetic switch section, the motor proper section, and the pinion section. The magnetic switch section has a plunger which activates a shift lever to engage and disengage the pinion, and also open and close the main contacts to start and stop the starter motor.

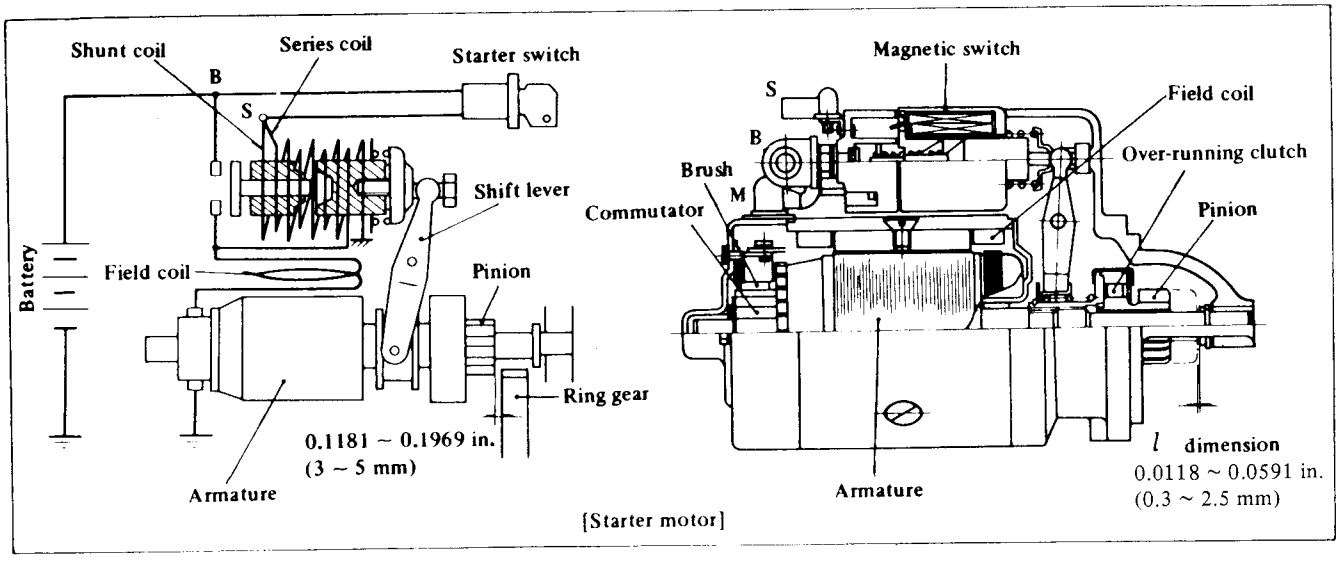
The over-running clutch is provided in order to cut off the motive power from the engine when the engine starts up.

3-3 Before Disassembly

(1) Pinion

1) The pinion will spring out when the magnetic switch is closed.

2) Push the pinion that has sprung out towards the motor to eliminate any axial play, and measure the clearance between the end of the pinion and the pinion stopper. If the clearance *l* is incorrect, it should be corrected by removing and refitting the adjusting plate of the magnetic switch mount.



[Starter motor]

(2) Magnetic Switch

1) Continuity Test for Shunt Coil/Series Coil

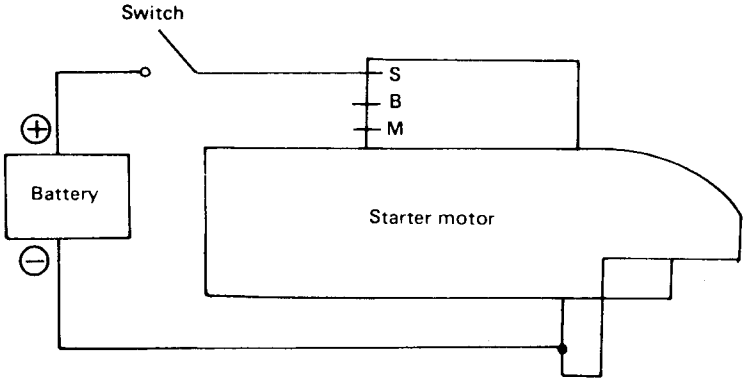
Continuity of the shunt coil is checked by taking a reading between its S-terminal and the body of the magnetic switch. If there is no continuity, then there is a break in the shunt coil winding.

Continuity of the series coil is checked between the S-terminal and the M-terminal.

If there is no continuity, there is a break in the series coil winding.

(3) Performance Test

1) Connections for Continuity Measurement of Dimension *l*.



The diagram above shows connections to be made for the purpose of measuring dimension *l*.

(4) No-Load Test

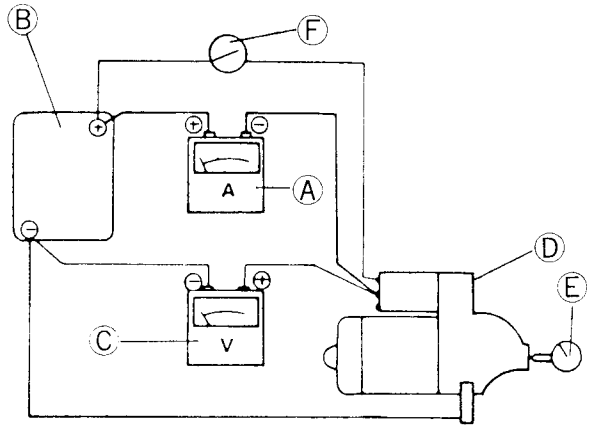
1) Connect positive (+) terminal of ammeter (A) to the battery positive (+) terminal, and negative (–) terminal of ammeter to the starter "S" terminal.

2) Connect battery ground cable to the starter body (D).

3) Connect positive (+) terminal of volt meter (C) to the starter "B" terminal, and negative (–) terminal of volt meter to the starter body or battery ground terminal.

4) Prepare hand tachometer at the starter shaft.

5) Use a screw driver to jump across from battery "B" terminal to switch "S" terminal. Starte should engage and run.



1869001

A – Ammeter
B – Battery
C – Volt Meter
D – Starter
E – Tachometer
F – Key Switch

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, except to 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.

NO LOAD TEST SPECIFICATIONS

Current Draw	Voltage	RPM
60 amps	12 volt	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

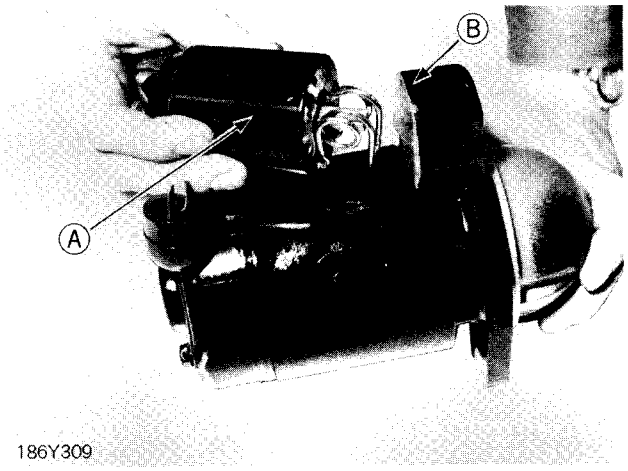
Low Speed, Low Current Draw
High internal resistance
Defective brush contact with commutator

Low Speed, High Current Draw
Excessive friction
Shorted armature
Grounded armature or field windings

High Speed, High Current Draw
Shorted field windings

3-4 Disassembly and Assembly Sequence

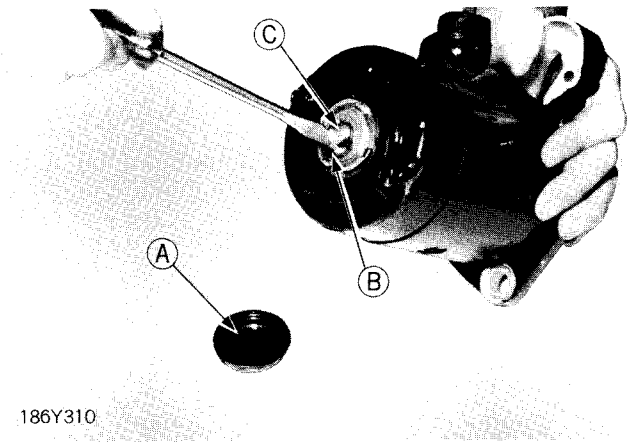
1) Remove solenoid assembly (A) from front cover (B).



186Y309

A – Solenoid
B – Front Cover

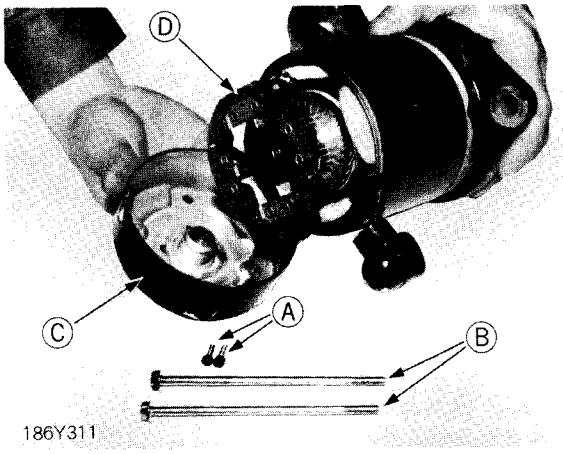
2) Remove dust cover (A) and snap ring (B) from starter shaft (C).



186Y310

A – Dust Cover
B – "E" Type Snap Ring
C – Shaft

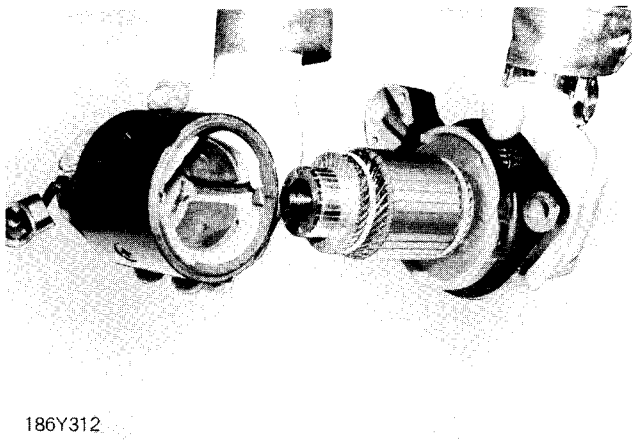
3) Remove two brush holder retaining cap screws (A) and two thru bolts (B) from rear cover. Remove rear cover.



186Y311

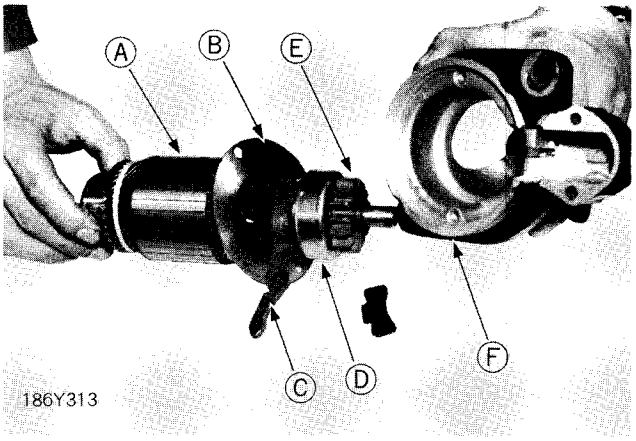
A – Cap Screw (2 used)
B – Thru Bolt (2 used)
C – Rear Cover
D – Brush Holder

4) Remove field coil assembly with brush holder.



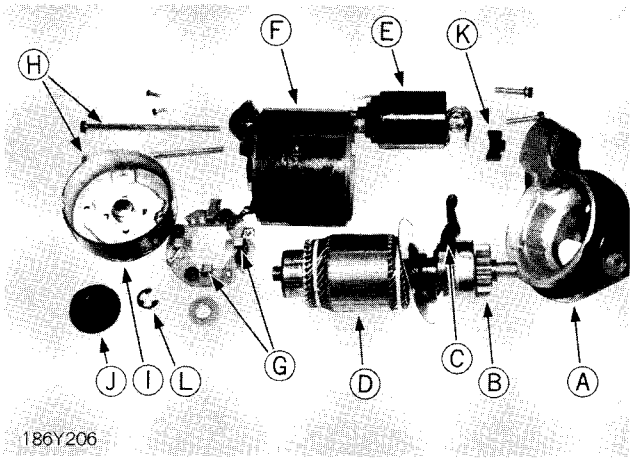
186Y312

5) Removing armature (A) with pinion (E) from front cover (F).



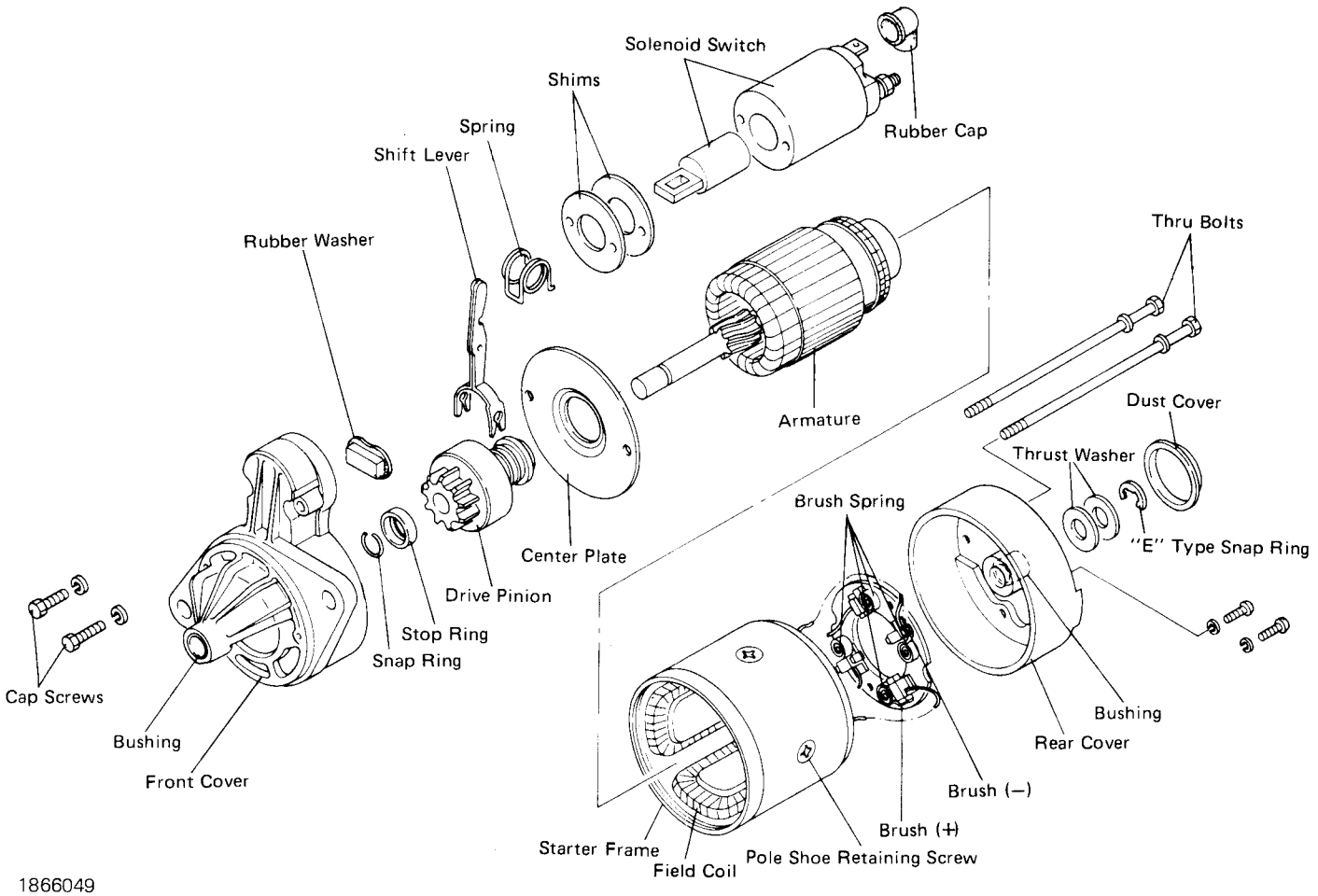
A – Armature
B – Plate
C – Shift Lever
D – Overrunning Clutch
E – Pinion Gear
F – Front Cover

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 – Dust Cover
K – Rubber Washer
L – Snap Ring

7) To assemble starter motor, reverse disassembly steps.



3-5 Inspection and Maintenance

(1) Brushes

Put the brushes in their respective brush holder and measure the spring tension with a spring balancer. Tension should be more than 3.52 lbs (1.6 kg).

2) Length of Brushes

Standard brush length is 0.630 in. (16 mm). If any of them are worn out by more than 0.157 in. (4 mm), it should be replaced with a new one.

After replacing, check that the new brush moves smoothly in the brush holder, and that the end of the brush makes even contact with the commutator surface. If the contact is uneven, correct it.

3) Brush Holder Continuity Test

Carry out a continuity test between the insulated brush holder and the ground.

There should be no continuity.

(2) Armature

1) Measuring Shaft Straightness

Place the shaft upon an end supporting stand, and measure the straightness of the shaft.

If it is distorted by more than 0.0031 in. (0.08 mm), it should be corrected.

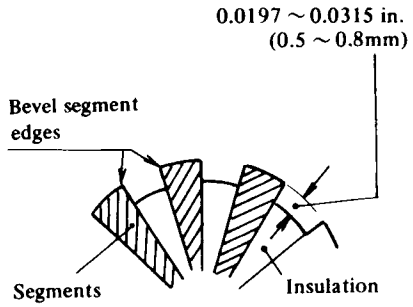
2) Commutator

If the surface is burnt or pitted, it should be polished using #500—#600 sandpaper.

If it is out-of-round by more than 0.0078 in. (0.2 mm), it should be turned down on a lathe.

3) Depth of Mica between Commutator Bars

The amount of under-cut of the insulation (mica between commutator bar segments) should be between 0.0197—0.0315 in. (0.5—0.8 mm). Be sure to bevel the edges of the bar segments.



4) Ground Test

Check conductivity between the commutator and the shaft. If conductivity is indicated, there is a short, so replace.

5) Insulation Test

Shorts in the armature coil are checked with a "growler tester." A "growler tester" is an iron piece applied to the armature core and the armature while the latter is rotated. If the iron piece starts vibrating or "growling", it is an indication that there is a short, and that replacement is necessary.

(3) Field Coil

1) Continuity Test

Check the continuity between the terminals of the field coil. If there is no continuity, it is an indication that there is a break in the winding, so it should be replaced.

2) Ground Test

Check the continuity between either of the terminals of the field coil and the yoke. If there is continuity, it means that the field coil is grounded somewhere and is therefore defective.

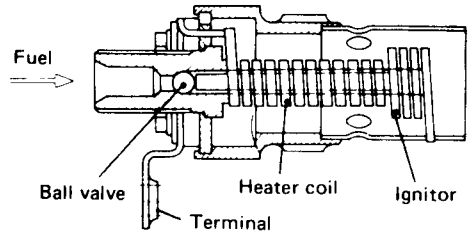
4. THERMOSTART

4-1 Specifications

Item	Specifications
Type	SH100-02 (Hitachi)
Voltage	12V
Current flow	13A

4-2 Description

The thermostart is a starting aid for use in low ambient temperatures. It ignites and burns fuel in the intake manifold to warm the air intake and improve starting qualities. The thermostart, unlike glow plugs, is not exposed to the combustion heat of the engine during operation and therefore provides outstanding durability, and since its electricity requirement is lower than that of glow plugs, the load on the battery is reduced.



a) Thermostart switch is set to ON. This activates the heater coil.

b) Valve stem moves. This opens the ball valve.

c) Fuel flows through ball valve, and volatilizes because of heat from heater coil.

d) Volatilized fuel is ignited by ignitor.

e) Setting thermostart switch to OFF position will switch off the electricity and the heater will cool off. This will close the ball valve.

f) Fuel will cease to flow. Fuel is stored in header tank, and is fed to thermostart plug by gravity.

4-3 Using the Thermostart

a) Throttle lever is set to STOP position.

b) Decompression lever is operated.

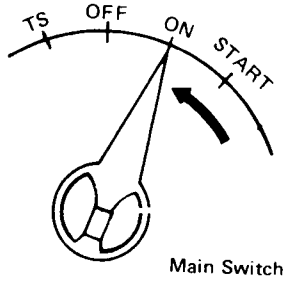
c) Clutch pedal is depressed, and starter motor is operated for five seconds (until lube oil indicating light goes out).

d) Restore decompression lever to position providing compression.

e) Open the throttle about halfway.

f) Turn the main switch to the "TS" position for 5 ~ 10 seconds. Then turn the starter motor.

NOTE As soon as the engine starts up, switch off the thermostart, and of course, remove your hand from the starter key switch (the main switch will automatically move from the START to the ON position).



5. TURN SIGNAL LIGHTS

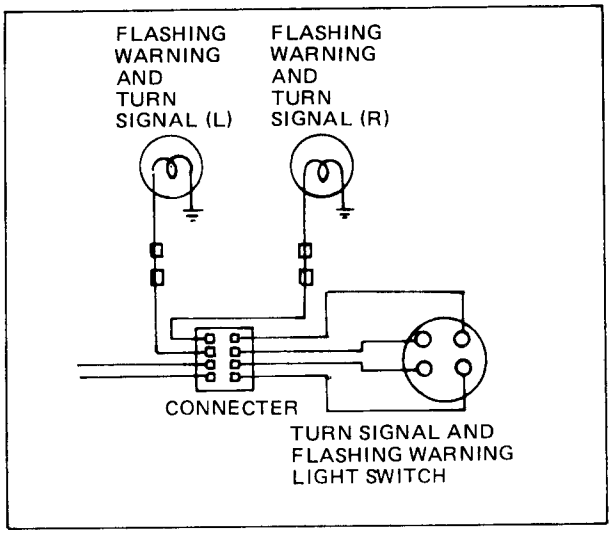
5-1 Specifications

Item	Specifications
Flasher relay	12V-23W heat band snap type
Signal lights	12V-23W

5-2 Description

The turn signal light system is composed of the turn signal switch, the flasher relay, and the signal lights.

The flasher relay, a heat band snap type, opens and closes a pair of contact points through expansion resulting from a rise in temperature of a heat band.



6. WATER TEMPERATURE INDICATOR LIGHT

6-1 Specifications

Item	Specifications
Water temperature indicator light	12V – 3.4 W
Water temperature sensor unit:	
Activating temperature	ON at 248°±5.4°F (120°±3°C) OFF at 233.6°±5.4°F) (112°±3°C)
Electrical capacity	12V – 7A

6-2 Description

A sensor consisting of a substance with a high heat expansion rate is fitted at the tip of the unit, and goes ON when the water temperature reaches 248°F (120°C).

Therefore, it is quite normal for the water temperature indicator light to stay off even if the starting switch is set to the ON position, as long as the engine is cold.

7. ENGINE LUBE OIL PRESSURE INDICATOR LIGHT

7-1 Specifications

Item	Specifications
Oil pressure switch	Activating pressure 2.84 psi (1 kg/cm^2)
Lube oil pressure indicator light	12V – 3.4W

7-2 Description

As described earlier in Chapter V, Section 3 and Chapter VII, Section 5, the lube oil pressure regulating valve, which is fitted inside the lube oil filter (cartridge type) is adjusted to 21.34 – 35.56 psi (3.5 – 4.5 kg/cm^2), while the relief valve is set to activate at a pressure of 17.07 – 11.38 psi (0.2 ± 0.1 kg/cm^2)

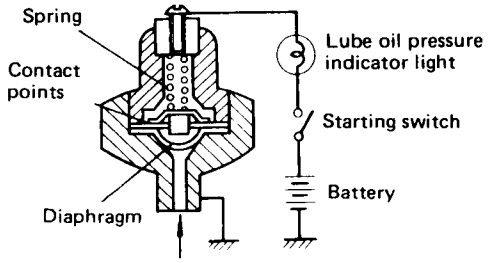
The lube oil switch is fitted in the lower part of the cylinder block, to the left of the lube pipe. It is activated when the lube oil pressure drops, which simultaneously turns on the indicator light.

The oil pressure forces the diaphragm upwards to open the contact points, so that when pressure is normal, the indicator light remains OFF.

When the oil pressure drops, the contact points close to allow electricity to flow to turn ON the indicator light.

Thus, when the starting switch is moved to the ON position, the indicator light goes ON since

there is no oil pressure, but once the engine starts up and pressure rises, the light will go OFF.



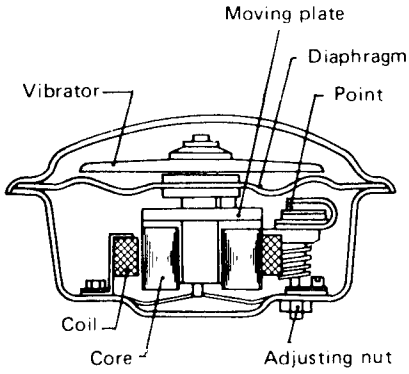
8. HORN

8-1 Specifications

Horn	12V–1.2A

8-2 Description

When the horn button is depressed, electricity flows through the coil of the horn, the core of the coil is magnetized, the moving plate is drawn towards the core, and the diaphragm that is coupled to the plate moves and opens the contact points. The flow of current is therefore cut off. Through a repetition of this cycle, the vibrator vibrates to generate sound.



9. LIGHT

9-1 Headlights

The headlights are high-low beam dual filament bulbs. Switching between low and high beams is accomplished by the lighting switch.

Headlights: 12V – 25W/25W

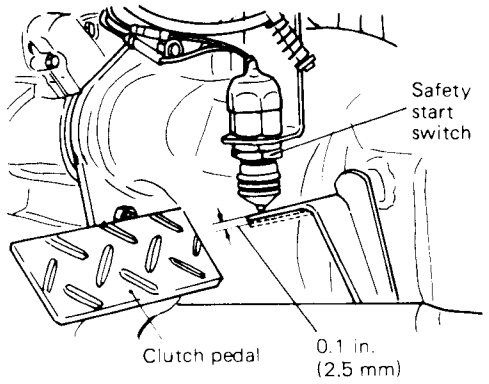
9-2 Work Light

The work light is fitted to the rear part of the left fender.

Work light: 12V – 20W

10. SAFETY START SWITCH

The safety start switch is provided for added safety of the tractor and prevention of accidents. When the clutch pedal is depressed, disengaging the clutch, the safety switch incorporated in the starter motor system circuit closes to facilitate starting of the tractor.



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CHAPTER 8

TRACTOR TROUBLESHOOTING

TRACTOR TROUBLESHOOTING

When asked by a customer to perform repairs and services on a tractor, it is essential that you first find out from the customer the full details of the trouble, diagnose it correctly, and then perform repairs swiftly and in a manner that will fully satisfy the customer.

No customer will want to have a lot of time spent on repairs and services nor will he want the work to cost a lot of money. Therefore, always try to carry out the repairs and services by placing yourself in the customer's shoes.

The trouble-shooting procedures described in this chapter will list the symptoms on a section by section basis, and will explain what to do about them. When the trouble has been pinpointed and you are about to carry out the work, do it properly and completely, in accordance with the maintenance standards described in the preceding chapters.

Poor maintenance work will not only damage the establishment's reputation but could also lead to serious accidents, so after the work has been completed and the tractor is ready to be delivered to the customer, always recheck the work carried out.

Trouble-shooting will be explained in the following order:

(1) Engine and related items
(2) Electrical systems
(3) Brake system
(4) Clutch and related items
(5) Transmission and related items
(6) P.T.O. and related items
(7) Hydraulic system
(8) Steering and suspension systems

1. ENGINE AND RELATED ITEMS

	Trouble	Probable cause	Remedy
1.	**Does not start or hard to start.**	1. No fuel.	Replenish fuel.
		2. Fuel cock closed.	Open fuel cock.
		3. Air in fuel system.	Bleed air.
		4. Faulty delivery valve; valve clogged	Disassemble delivery valve and clean.
		5. Worn plunger.	Replace plunger.
		6. Faulty governor.	Adjust governor.
		7. Sezing of nozzle.	Lap nozzle or replace.
		8. Insufficient nozzle pressure.	Adjust injection pressure or replace nozzle.
		9. Clogged fuel return pipe	Replace fuel pipe; if no hole in the center of injection pressure adjusting plate, replace.
		10. Lube oil of excessively high viscosity.	Select lube oil suitable for ambient temperature and engine.
		11. Low specific gravity of battery electrolyte.	Charge battery.
		12. Faulty starter motor.	(Refer to section on electrical equipment)
		13. Faulty safety switch.	Carry out continuity test on safety switch readjusting height.
2.	**Engine starts, but will not run smoothly.**	1. Unstable fuel supply:	
		Air in fuel system.	Bleed air and retighten.
		Governor linkage not functioning smoothly.	Adjust governor.
		2. Water or dust in fuel.	Replace fuel.
		3. Faulty fuel pump:	
		Dirt in delivery valve.	Clean delivery valve.
		Plunger does not function smoothly.	Disassemble fuel pump.
		Injection timing incorrect.	Adjust injection timing.
		4. Nozzle or verge of seizing.	Lap or replace.
3.	**Insufficient power.**	1. Excessive load.	Reduce load.
		2. Dirty lube oil. Excessive viscosity.	Replace lube oil.
		3. Insufficient compression:	
		Worn rings, pistons, liners.	Replace.
		Head bolts loose.	Tighten.
		4. Valve clearance incorrect.	Adjust valve clearance.
		5. Overheating:	
		Uneven tightening or moving components.	Check and adjust.
		Insufficient coolant.	Add to proper level.
		Insufficient lube oil.	Add to proper level.
		6. Poor fuel oil.	Replace with good quality fuel oil.

	Trouble	Probable cause	Remedy
4.	**Overheats.**	1. Insufficient coolant.	Check radiator and hoses for leaks.; replenish coolant, clean radiator.
		2. Faulty water temp. switch.	Replace water temp. switch.
		3. Insufficient lube oil.	Replenish lube oil.
5.	**Does not warm up sufficiently.**	1. Faulty water temp. switch.	Replace water temp. switch.
		2. Extremely low ambient temperature.	Fit protector to radiator.
6.	**Lube oil pressure indicator light does not go out.**	1. Insufficient lube oil.	Replenish lube oil.
		2. Poor lube oil:	
		Viscosity is too high.	Replace.
		Lube oil is soiled.	Replace.
		3. Lube oil pressure:	
		Faulty lube oil pump.	Replace.
		Lube oil filter clogged up.	Clean or replace.
		Faulty lube oil pressure control. valve.	Check control pressure.
		Faulty lube oil pressure switch.	Check lube oil pressure switch or replace.
		Fault in electrical system.	Check electrical wiring.
7.	**High lube oil consumption**	1. Lube oil viscosity is too low.	Replace lube oil.
		2. Oil leak.	
		3. Overheating.	
		4. Excessive wear of rings, pistons, or liners	Replace.
8.	**High fuel oil consumption**	1. Insufficient fuel oil.	Replace fuel oil.
		2. Faulty fuel pump nozzle.	Replace.
		3. Improper injection timing.	Readjust injection timing.
9.	**Color of exhaust fumes poor.**	1. Improper injection.	Readjust injection timing.
		2. Overheating.	Reduce load.
		3. Faulty nozzle.	Lap or replace.
		4. Excessive lube oil level.	
		5. Engine running too cold:	
		Excessive wear of rings, pistons or liners, etc.	
10.	**Strange noises.**	1. Excessive valve clearance.	Adjust.
11.	**Faulty tachometer**	1. Needle wavers:	
		Faulty cable.	Replace.
		Faulty gauge unit.	Replace.
		Faulty gear unit.	Replace.
		2. Needle stays at 0:	
		Cable severed.	Replace.
		Faulty gear unit.	Replace.
		Faulty coupling.	Replace.

2. ELECTRICAL SYSTEM

	Trouble	Probable cause	Remedy
1.	**Starter motor does not turn.**	1. Faulty starting switch.	Check starting switch.
		2. Breaks or poor contact in the wiring.	Correct or replace.
		3. Insufficient battery power.	Measure specific gravity and recharge.
		4. Faulty magnetic switch:	
		Break in coil windings.	Correct or replace.
		Plunger catches.	Correct or replace.
		5. Faulty safety start switch.	Check switch; also check height at which switch is attached.
		6. Burnt out fuse.	Check the trouble and replace.
2.	**Pinion moves out but does not turn.**	1. Cable connecting battery with terminal B is loose.	Tighten.
		2. Insufficient pinion gap.	Adjust.
		3. Worn brushes.	Replace.
		4. Damaged commutator.	Correct or replace.
		5. Faulty armature.	Correct or replace.
		6. Faulty magnetic switch contacts.	
3.	**Motor starts turning before pinion moves out.**	1. Faulty starter motor clutch.	Correct or replace.
4.	**Starter motor turns after pinion moves out but does not transmit power.**	1. Faulty starter motor clutch.	Correct ore replace.
5.	**Motor does not stop turning after engine starts up (even when starting switch is turned back)**	1. Faulty magnetic switch: Worn or damaged return spring.	Correct or replace.
6.	**Pinion does not move back after engine starts up.**	1. Damage to spline section.	Check meshing of armature shaft splines and spline tube.
		2. Magnetic switch: Poor returning of plunger, or worn or damaged return spring.	

3. BRAKE SYSTEM

	Trouble	Probable cause	Remedy
1.	**Brakes do not work.**	1. Brake shoes:	
		Oil adherence.	Check for oil leakage.
		Shoes heavily worn.	Replace.
		2. Rod.	Adjust amount of play and effective strokes.
2.	**Braking force differs for left and right side; wheels lock.**	1. Different amount of play for left and right side	Readjust.

	Trouble	Probable cause	Remedy
3.	**Vibration can be felt through the brake pedals.**	1. Faulty brake shoe springs; excessive wear; uneven wear. 2. Uneven brake drum wear· foreign matter infiltrated into drums. 3. Excessive wear of brake shaft rod.	Replace. Replace.
4.	**Parking brake does not work.**	1. Faulty parking brake lever, claws worn.	Replace.
5.	**Parking brake does not return when released.**	1. Return spring.	Adjust or replace.
6.	**Brake pedals do not return.**	1. Return spring worn or damaged.	Replace.

4. CLUTCH AND RELATED ITEMS

	Trouble	Probable cause	Remedy
1.	**Clutch does not disengage.**	1. Friction disc scored or burned. 2. No effective clutch rod stroke. 3. Release sleeve bearing seized.	Replace. Adjust. Replace.
2.	**Clutch slips.**	1. Clutch: Oil adhered to friction disc. Friction disc worn. No clearance between release lever and release bearing. 2. Clutch rod: No play.	 Clean. Replace. Adjust. Adjust.
3.	**Clutch pedal does not return.**	1. Return spring worn or damaged.	Replace.
4.	**Power transmission is enough.**	1. Friction plate: Uneven wear of facings. Torsion springs worn or damaged. 2. Flywheel: Face is rough and uneven.	 Replace. Replace. Replace.
5.	**Pedals are loose.**	1. Rod shaft "O" rings worn: Rod is bent.	
6.	**Strange noises heard from the vicinity of clutch (when engaged)**	1. Main drive shaft or splines worn. 2. Friction disc loose (from rivet sections. 3. Flywheel and nut loose.	

5. TRANSMISSION AND RELATED ITEMS

	Trouble	Probable cause	Remedy
1.	**Gears cannot be engaged or are hard to engage; two speeds are engaged together; or tend to fall out of gear.**	1. Operator shifting too quickly, or attempting to shift when tractor is still in motion. Clutch pedal is not depressed fully.	Operator orientation.
		2. Shifter worn, deformed, or damaged.	Replace.
		3. Gears damaged: Assembled incorrectly.	Reassemble.
		Deviation in stroke of sliding gear (too much or not enough)	Readjust.
		4. Clutch adjusted incorrectly.	Adjust.
2.	**Strange noises.**	1. Oil insufficient. Poor quality oil.	Add oil. Change oil type.
		2. Shaft deformed, splines worn.	Replace.
		3. Gears damaged. Backlash of gears incorrect.	Replace. Adjust
		Gears adjusted incorrectly (relative positions of drive pinion and ring gear).	
		4. Fork damaged or bent.	Replace.
3.	**Differential does not function.**	1. Differential clutch does not slide and return.	Adjust.
		2. Differential lock spring damaged.	Replace.
4.	**Differential lock does not function.**	1. Differential lock cam damaged.	Replace.

6. PTO AND RELATED ITEMS

	Trouble	Probable cause	Remedy
1.	**Gears cannot be engaged; tend to disengage; difficult to engage; engage double.**	1. Tractor has not come to a full stop.	Driver orientation.
		2. Clutch pedal is not fully depressed.	Driver orientation.
		3. Clutch pedal not adjusted correctly.	Adjust.
		4. Operator shifts too soon.	Driver orientation.
		5. Gears assembled incorrectly.	Reassemble.
		6. Shifter fork worn or deformed.	Replace.
2.	**Strange noises.**	1. Oil insufficient.	Add oil.
		2. Gear has excessive backlash.	Adjust.
		3. Shaft spline section worn or deformed.	Replace.
		4. Fork deformed.	Replace.

7. HYDRAULIC SYSTEM

	Trouble	Probable cause	Remedy
1.	**Implement cannot be lifted, or lift speed is slow.**	1. Hydraulic pump drive shaft damaged.	Replace drive shaft.
		2. Insufficient hydraulic pump discharge.	Clean or replace.
		3. Hydraulic fluid (Use transmission oil) has excessive viscosity.	Change hydraulic oil.
		Insufficient hydraulic fluid.	Add transmission oil.
		4. Filter clogged.	Clean.
		5. Spool not functioning correctly.	Replace completely.
		6. Faulty stop valve "O" ring.	Replace.
		7. Relief valve (safety valve) worn or damaged.	Replace spring.
		Improper pressure setting.	Adjust setting.
		Dirt in relief valve seat.	Clean.
		Relief valve not meeting correctly.	Adjust.
2.	**Implement does not drop.**	1. Spool does not function correctly.	
		Spool return spring damaged.	Replace spring.
		Push rod does not function smoothly.	Clean or replace.
		2. Stop valve seat seized.	Replace.
		3. Hydraulic cylinder piston seized.	Replace.
3.	**Rate of free descent is too fast.**	1. Spool worn.	
		Insufficient free travel when spool is at a neutral position.	Replace.
		2. Faulty valve seats.	Clean or replace.
		Dirt in valve.	
		Faulty "O" ring.	
		3. Stop valve "O" ring defective.	Replace.
		Faulty seats.	
		4. Hydraulic cylinder piston or cylinder damaged or worn.	Replace.
		Broken "O" ring.	
		5. Safety valve seat seat faulty.	Replace.
		Dirt in valve.	
		Broken "O" ring.	
		Faulty control valve or hydraulic cylinder "O" rings;	
4.	**Strange noises.**	1. Pump gear faulty.	Replace.
		Pump improperly fitted.	
		2. Air being drawn in (cavitation) because of insufficient oil.	Bleed air or change oil.
		Excessively high oil viscosity.	
		3. Control valve lift position regulation is excessive.	Adjust stroke by control lever turnbuckle.

8. STEERING AND SUSPENSION SYSTEMS

	Trouble	Probable cause	Remedy
1.	**Heavy steering.**	1. Tire pressure is too low.	Adjust.
		2. Front alignment: Faulty toe-in; faulty camber angle; faulty caster angle.	Readjust.
		3. Rods: Drag rods deformed; tie-rods deformed; pitman arm or knuckle arm deformed.	
		4. Steering gear box: Insufficient oil or grease.	Add oil or grease.
		5. Grease, insufficient.	Change
2.	**Excessive play in steering.**	1. Joints: Excessive backlash in joints (gear box, pitman arm, drag rods knuckle arm, tie-rods).	Adjust.
3.	**Front tire shimmy.**	1. Faulty front hub bearings.	Correct or replace.
		2. Excessive up-and-down play in kingpins.	Replace.
		3. Center pin worn excessively.	Replace.
4.	**Uneven wear on front tires.**	1. Front alignment: Improper toe-in, camber, or king pin angles; tie-rod(s) deformed.	Readjust.
5.	**Steering pulls to one side.**	1. Front alignment: Improper alignment (toe-in, camber angle, caster angle).	Readjust.
		2. Rods: Pitman arm, drag rod(s) knuckle arms, or tie-rods bent or deformed.	Correct or replace.
		3. Tire pressure: Different tire pressures in the left and right wheels.	Adjust.
		4. Implement fitted improperly.	Attach properly.
		5. Road or surface conditions.	
6.	**Strange noises.**	1. Front wheel hub bearings damaged; front wheel securing bolts loose.	Tighten or replace.
		2. Center pin worn; center pin bracket loose.	Tighten or replace.
		3. Looseness between rear wheel hubs and splines; bolts securing rear wheels loose.	Tighten.

CHAPTER 9

REGULAR INSPECTIONS

REGULAR INSPECTIONS

Periodic inspection and adjustment of the Yanmar Tractor is essential if high level performance is to be maintained.
Regular inspection will also ensure a long service life.
The required service intervals and the kind of inspection to be performed are described on the following page.

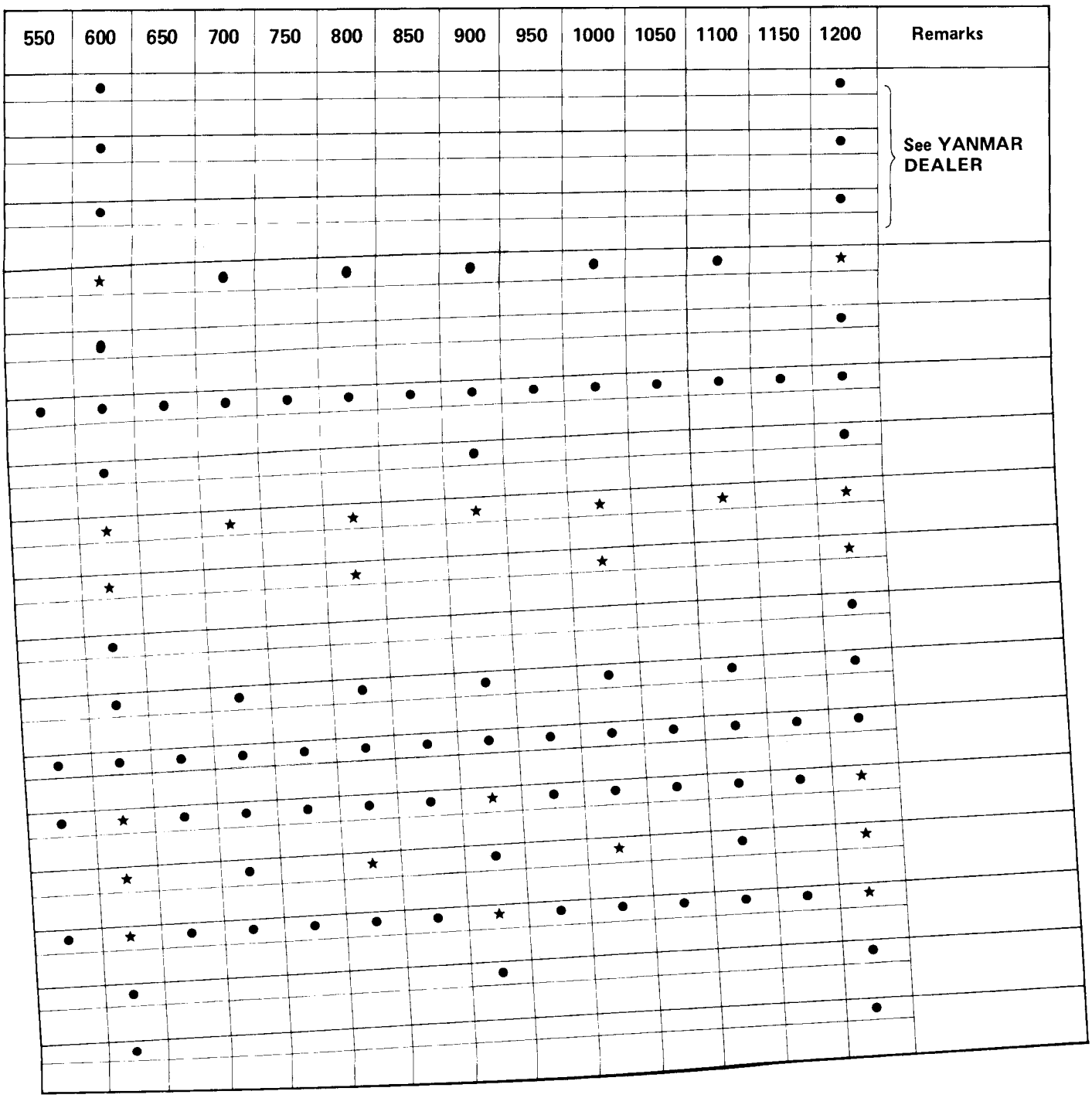
1. CHECK LIST

* Marks:
It is recommended that the inspection and maintenance work listed here be performed under the supervision of a Yanmar dealer.

(Times listed in parentheses are times when inspections should be conducted between 600 to 1,200 hours. Inspection and maintenance work should be performed at the intervals indicated below.)

(● : Checking ★ : Changing)

Items	Hour meter 20	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, cheking		●	●	●	●	●	●	●	●	●	●
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, (Suction screen) cleaning.or changing		●					●				
DATE											
Radiator, Flushing											
DATE											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