



Service Manual

Groundsmaster[®] 580-D

Preface

The purpose of this publication is to provide the service technician with information for troubleshooting, testing, and repair of major systems and components on the Groundsmaster 580-D.

REFER TO THE TRACTION UNIT AND CUTTING UNIT OPERATOR'S MANUALS FOR OPERATING, MAINTENANCE AND ADJUSTMENT INSTRUCTIONS. Space is provided in Chapter 2 of this book to insert the Operator's Manuals and Parts Catalogs for your machine. Replacement Operator's Manuals are available by sending complete Model and Serial Number to:

The Toro Company
8111 Lyndale Avenue South
Minneapolis, MN 55420

The Toro Company reserves the right to change product specifications or this publication without notice.



This safety symbol means DANGER, WARNING, or CAUTION, PERSONAL SAFETY INSTRUCTION. When you see this symbol, carefully read the instructions that follow. Failure to obey the instructions may result in personal injury.

NOTE: A NOTE will give general information about the correct operation, maintenance, service, testing or repair of the machine.

IMPORTANT: The IMPORTANT notice will give important instructions which must be followed to prevent damage to systems or components on the machine.



Table Of Contents

Chapter 1 – Safety

Safety Instructions	1 – 1
Safety and Instruction Decals	1 – 4

Chapter 2 – Product Records and Maintenance

Product Records	2 – 1
Equivalents and Conversions	2 – 2
Torque Specifications	2 – 3
Maintenance Quick Reference Aid	2 – 4
Lubrication	2 – 5
Equipment Operation and Service History Reports	2 – 9

Chapter 3 – Engine (Model 30580)

General Information	3 – 2
Specifications	3 – 6
Special Tools	3 – 23
Troubleshooting	3 – 26
General Overhaul Instructions	3 – 30
Adjustments	3 – 32
Engine Removal and Installation	3 – 39
Engine Accessory Removal and Installation ..	3 – 43
Cylinder Head and Valves	3 – 48
Flywheel, Timing Gears and Camshaft	3 – 61
Pistons, Connecting Rods, Crankshaft and Crankcase	3 – 73
Inlet and Exhaust Systems	3 – 91
Lubrication System	3 – 106
Cooling System	3 – 112
Fuel System	3 – 116
General Overhaul Information	3 – 126

Chapter 3A – Engine (Model 30581)

General Information	3A – 1
Specifications	3A – 2
Mitsubishi S4S–DT Engine Service Manual	

Chapter 4 – Hydraulic System

Specifications	4 – 2
General Information	4 – 3
Hydraulic Flow Diagrams	4 – 6
Hydraulic Schematic	4–12.1

Special Tools	4 – 13
Troubleshooting	4 – 14
Testing	4 – 22
Adjustments	4 – 29
Traction Drive System Repairs	4 – 31
PTO System Repairs	4 – 36
Auxiliary (Lift/Counterbalance) System Repairs	4 – 42
Steering System Repairs	4 – 52
Hydraulic Reservoir and Filter	4 – 55

Chapter 5 – Electrical System

(Model 30580, S/N Below 30101)

Schematics & Wiring Diagrams	5 – 2
Special Tools	5 – 9
Troubleshooting	5 – 11
Testing	5 – 22
Repairs	5 – 34

Chapter 6 – Wheels, Brakes & Steering

Specifications	6 – 2
General Information	6 – 3
Adjustments	6 – 5
Repairs	6 – 8

Chapter 7 – Cutting Units

Specifications	7 – 1
Adjustments	7 – 2
Repairs	7 – 9

Chapter 8 – Electrical System

(Model 30580 and 30581, S/N 30101 & UP)

Wiring Schematics	8 – 2
Special Tools	8 – 6
Troubleshooting	8 – 8
Component Identification and Testing	8 – 11
Service and Repairs	8 – 12

Chapter 9 – Foldout Diagrams

Model 30580 Wiring Diagrams	1
Model 30581 Wiring Diagrams	5
Hydraulic Schematic	9



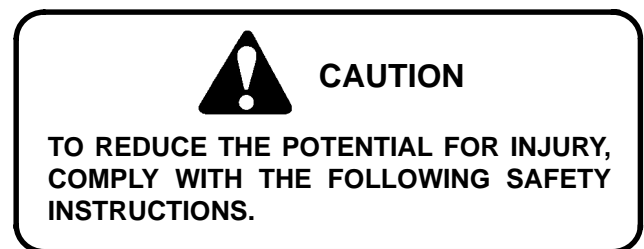
Table of Contents

SAFETY INSTRUCTIONS	1	Maintenance and Service	3
Before Operating	1	SAFETY AND INSTRUCTION DECALS	4
While Operating	2		

Safety Instructions

The GROUNDMASTER® 580-D meets or exceeds the American National Standards Institute's safety standards for riding mowers. Although hazard control and accident prevention partially are dependent upon the design and configuration of the machine, these factors are also dependent upon the awareness, concern, and proper training of the personnel involved in the operation, transport, maintenance, and storage of the machine.

Improper use or maintenance by the operator or owner of the machine can result in injury. Reduce the potential for any injury by complying with the following safety instructions.



Before Operating

1. Read and understand the Operator's Manual before starting and operating the machine. Become familiar with all controls and know how to stop quickly. A free replacement Operator's Manual is available by sending complete Model and Serial Number to:

The Toro Company
8111 Lyndale Avenue South
Minneapolis, Minnesota 55420-1196.

If you have questions about this Service Manual, please contact:

The Toro Company
Commercial Service Department
8111 Lyndale Avenue South
Minneapolis, Minnesota 55420-1196.

2. Never allow children to operate the machine or adults to operate it without proper instruction.

3. Become familiar with the controls and know how to stop the machine and engine quickly.

4. Keep all shields, safety devices and decals in place. If a shield, safety device or decal is malfunctioning, illegible or damaged, repair or replace it before operating the machine.

5. Always wear substantial shoes. Do not operate machine while wearing sandals, tennis shoes, sneakers or when barefoot. Do not wear loose fitting clothing that could get caught in moving parts and possibly cause personal injury.

6. Wearing safety glasses, safety shoes, long pants and a helmet is advisable and required by some local ordinances and insurance regulations.

7. Make sure the work area is clear of objects which might be picked up and thrown by the cutter blades.

8. Do not carry passengers on the machine. Keep everyone, especially children and pets, away from the areas of operation.

9. Since diesel fuel is highly flammable, handle it carefully:

- A. Use an approved fuel container.
- B. Do not remove fuel tank cap while engine is hot or running.
- C. Do not smoke while handling fuel.

D. Fill fuel tank outdoors and only to within an inch (25 mm) from the top of the tank, not the filler neck. Do not overfill.

E. Wipe up any spilled fuel.

10. Be sure interlock switches are adjusted correctly so engine cannot be started unless traction pedal is released – neutral position – and PTO switch is in NEUTRAL position.

While Operating

11. Check interlock switches daily for proper operation. If a switch malfunctions, replace or adjust it before operating the machine. The interlock system is for your protection, so do not bypass it. Replace all interlock switches every two years.

12. Do not run engine in a confined area without adequate ventilation. Exhaust is hazardous and could be deadly.

13. Sit on the seat when starting and operating the machine.

14. Before starting the engine each day, test warning lamps and signal lights to assure proper operation.

15. Pay attention when using the machine. To prevent loss of control:

- A. Mow only in daylight or when there is good artificial light.
- B. Watch for holes or other hidden hazards.
- C. Be extremely careful when operating close to sand traps, ditches, creeks, steep hillsides or other hazards.
- D. Reduce speed when making sharp turns. Avoid sudden stops and starts.
- E. Look to the rear to assure no one is behind the machine before backing up.
- F. Watch for traffic when near or crossing roads. Always yield the right-of-way.
- G. Reduce speed when driving downhill.

16. Keep hands, feet and clothing away from moving parts and the cutting units.

17. This product may exceed noise levels of 85 dB(A) at the operator position. Ear protectors are recommended, for prolonged exposure, to reduce the potential of permanent hearing damage.

18. Do not touch engine, turbo-charger, radiator, muffler or exhaust pipe while engine is running or soon after it is stopped. These areas could be hot enough to cause burns.

19. Before getting off the seat:

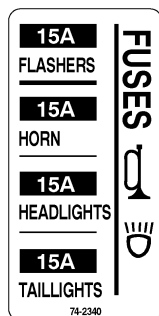
- A. Move traction pedal to neutral.
- B. Set parking brake.
- C. Disengage cutting units and wait for blades to stop.
- D. Stop engine and remove key from switch.
- E. Do not park on slopes unless wheels are chocked or blocked.

20. If a cutting blade strikes a solid object or vibrates abnormally, stop immediately, turn engine off, set parking brake and wait for all motion to stop. Inspect for damage. Repair or replace any damaged parts before operating.

Maintenance and Service

21. Before servicing or making adjustments, stop engine and remove key from the switch.
22. Assure entire machine is properly maintained and in good operating condition. Frequently check all nuts, bolts and screws.
23. Frequently check all hydraulic line connectors and fittings. Assure all hydraulic hoses and lines are in good condition before applying pressure to the system.
24. If the Groundsmaster 580-D loses power and needs to be moved, either by-pass the hydraulic pump or unlock the front wheel hubs. Unlocking the front wheels disables the machine braking system. Block the wheels before unlocking the hubs to keep the machine from moving. To tow the machine, connect to the towing vehicle with a rigid towing device. Do not use chains, cables or other non-rigid devices for towing. Lock the hubs when towing is completed.
25. Keep body and hands away from pin hole leaks or nozzles that eject high pressure hydraulic fluid. Use cardboard or paper to find hydraulic leaks. Hydraulic fluid escaping under pressure can penetrate skin and cause injury. Fluid accidentally injected into the skin must be surgically removed within a few hours by a doctor or gangrene may occur.
26. Before any hydraulic system maintenance, stop engine and lower cutting units to the ground so all pressure is relieved.
27. For major repairs or other assistance, contact your local Toro Distributor.
28. To reduce potential fire hazard, keep engine area free of excessive grease, grass, leaves and dirt.
29. If engine must be running to perform maintenance or an adjustment, keep hands, feet, clothing and other parts of the body away from cutting units and other moving parts. Keep everyone away.
30. Do not overspeed the engine by changing governor setting. Maximum engine speed is 2750 rpm. To assure safety and accuracy, have an Authorized Toro Distributor check maximum engine speed.
31. Shut engine off before checking or adding oil to the crankcase.
32. Disconnect battery before servicing the machine. If battery voltage is required for troubleshooting or test procedures, temporarily connect the battery.
33. For optimum performance and safety, use genuine Toro replacement parts and accessories. Replacement parts and accessories made by other manufacturers could be dangerous and may void the product warranty of The Toro Company.

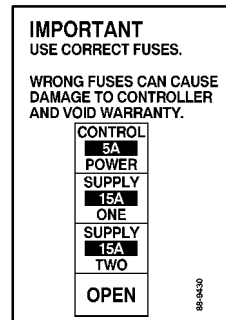
The following safety and instruction decals are mounted on the traction unit. If any decal becomes damaged or illegible, install a new decal. Part numbers are listed below or in your parts catalog.



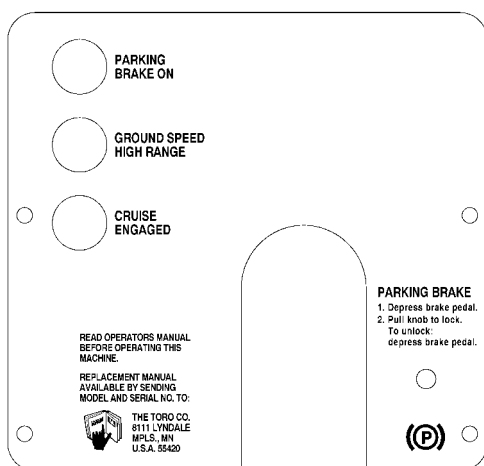
UNDER LOWER CONTROL COVER
(Part No. 74-2340)



ON REAR FENDER AND FRONT FRAME (Part No. 72-4080)



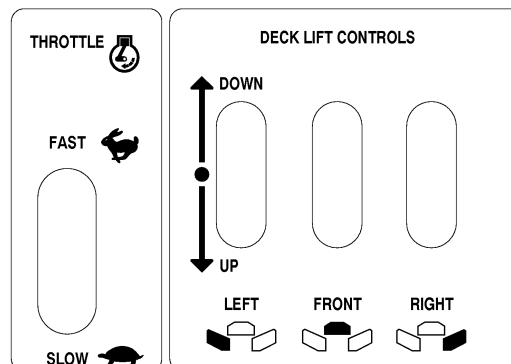
UNDER LOWER CONTROL COVER
(Part No. 88-9430)



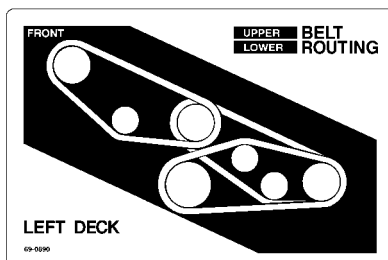
ON STEERING COLUMN SUPPORT (Part No. 69-0970)



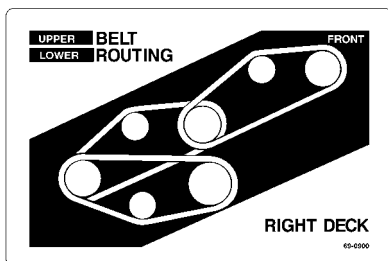
ON CUTTING UNITS, UNDER COVERS (Part No. 67-5360)



ON CENTER CONTROL PANEL (Part No. 69-0980)

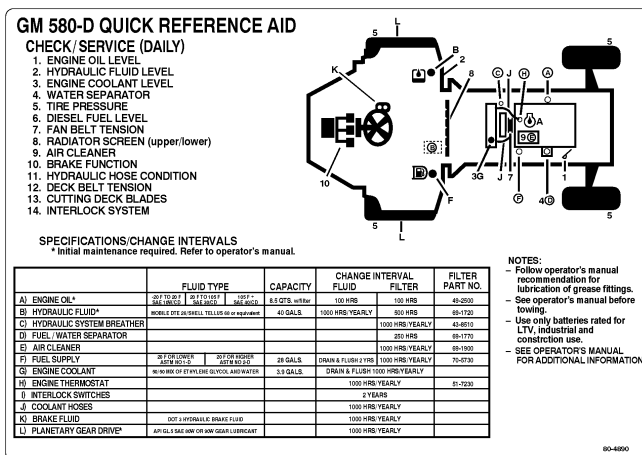


ON DECK, UNDER COVER (Part No. 69-0890)



ON DECK, UNDER COVER


(Part No. 69-0900)




**ON RIGHT SIDE OF SEAT
(Part No. 80-4890)**

TRACTION PEDAL

FORWARD



REVERSE



⚠ CAUTION

FAILURE TO COMPLY WITH THE FOLLOWING SAFETY INSTRUCTIONS MAY RESULT IN PERSONAL INJURY.

1. KEEP PEOPLE AND PETS A SAFE DISTANCE AWAY FROM MACHINE.
2. DISENGAGE DECK DRIVE (PTO) BEFORE TRANSPORTING.
3. KEEP ALL GUARDS IN PLACE.
4. BEFORE LEAVING OPERATOR'S POSITION:
 - A. MOVE TRANSMISSION PEDAL TO NEUTRAL
 - B. SET PARKING BRAKE.
 - C. DISENGAGE DECK DRIVE (PTO).
 - D. SHUT OFF ENGINE.
 - E. REMOVE IGNITION KEY.
5. WAIT FOR ALL MOVEMENT TO STOP BEFORE SERVICING MACHINE.
6. STOP ENGINE BEFORE ADDING FUEL OR LIFTING HOOD.
7. CHECK PERFORMANCE OF ALL INTERLOCK SWITCHES DAILY. SEE OPERATOR'S MANUAL FOR INSTRUCTION. DO NOT DEFEAT INTERLOCK SYSTEM. IT IS FOR YOUR PROTECTION.

READ AND UNDERSTAND OPERATOR'S MANUAL BEFORE OPERATING THIS MACHINE. REPLACEMENT MANUAL AVAILABLE BY SENDING COMPLETE MODEL NUMBER TO: THE TORO COMPANY
8111 LYNDALE AVE.
MINNEAPOLIS, MINN. 55420.

69-0940

**ON FLOOR, FORWARD
OF TRACTION PEDAL
(Part No. 69-0940)**

 **HYDRAULIC OIL ONLY
DO NOT USE ENGINE OIL**

 **SEE OPERATOR'S MANUAL
FOR APPROVED OILS.**

 **Fill to middle of sight glass
located at rear of tank.** 69-0920

**ON FENDER ALONGSIDE HYDRAULIC TANK
(Part No. 69-0920)**

⚠ WARNING 

**ON FAN SHROUD
(Part No. 76-8750)**

⚠ WARNING

**KEEP OFF — DO NOT STEP, SIT OR
RIDE ON THIS TANK.**

MAY RESULT IN SERIOUS INJURY OR DAMAGE TO TANK.



1 INCH (25 mm)

**FILL FUEL TANK TO ONE
INCH BELOW FILLER NECK.**

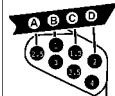
DO NOT OVERFILL.

69-0930

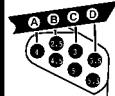
**ON FENDER ALONGSIDE FUEL TANK
(Part No. 69-0930)**

HEIGHT OF CUT

LOW RANGE




HIGH RANGE



69-0820

**ON LEFT REAR OF CUTTING UNIT
(Part No. 69-0820)**

**UPPER BELT ROUTING
LOWER CENTER DECK**






L. WING **R. WING**

82-2560

**ON DECK, UNDER COVER
(Part No. 82-2560)**



IGNITION


OFF  ON 





START


DECK DRIVE / PTO

ENGAGE  DISENGAGE 





GROUND SPEED

HIGH RANGE  LOW RANGE 






CRUISE CONTROL

ON  OFF 



PUSH TO SET


LIGHTS

ON  OFF 



HIGH TEMP. OVERRIDE

ON  OFF 



TO START ENGINE:

1. Be seated.
2. Foot OFF TRACTION pedal (NEUTRAL).
3. Foot ON BRAKE pedal.
4. THROTTLE at SLOW.
5. IGNITION, turn to START and release.

ENGAGE DECK DRIVE:
Lift switch, push forward, release.

IMPORTANT --- TO STOP ENGINE:

1. DISENGAGE DECK DRIVE.
Pull switch back, release.
2. THROTTLE to SLOW.
3. PARKING BRAKE ON.
4. IGNITION, turn to OFF and remove key.

IMPORTANT --- GROUND SPEED:
Use HIGH RANGE for road travel only. (decks up).

**ON LOWER CONTROL PANEL
(Part No. 69-0990)**



**ON FRONT OF CUTTING UNITS
(Part No. 43-8480)**



**ON BOTH WHEEL HUBS
(Part No. 72-4070)**

CAUTION

BLADE RETAINING BOLTS MUST BE TORQUED TO 140-165 ft-lbs.
CHECK BLADE BOLT TORQUE AFTER STRIKING ANY SOLID OBJECT.

69-0880

ON CUTTING UNIT CASTOR ARMS
(Part No. 69-0880)

DANGER

ROTATING BLADES UNDER ENTIRE MOWER DECK.
KEEP HANDS and FEET AWAY.
THROWN OBJECTS ARE DANGEROUS.
KEEP DEFLECTOR IN PLACE. KEEP BYSTANDERS AWAY.

66-1340

ON CUTTING UNITS
(Part No. 66-1340)

SPACERS

LOW
HIGH

RANGE HEIGHT OF CUT

1 1.5 2 2.5 3 3.5 4
2.5 3 3.5 4 4.5 5 5.5

71-4260

ON FRONT AND REAR CUTTING
UNITS MOTOR MOUNT PLATES
(Part No. 71-4260)

RIGHT SIDE NEAR TEST PORTS
(Part No. 69-0960)



Product Records and Maintenance

Table of Contents

PRODUCT RECORDS	1	QUICK REFERENCE MAINTENANCE AID	4
EQUIVALENTS AND CONVERSIONS	2	LUBRICATION	6
Decimal and Millimeter Equivalents	2	OPERATION AND SERVICE HISTORY REPORT .	9
U.S. to Metric Conversions	2		
TORQUE SPECIFICATIONS	3		
Capscrew Markings and Torque Values – U.S. . .	3		
Capscrew Markings and Torque Values – Metric .	3		

Product Records

Record information about your Groundsmaster 580–D on the OPERATION AND SERVICE HISTORY REPORT form. Use this information when referring to your machine.

Insert Operator's Manuals and Parts Catalogs for your Groundsmaster 580–D at the end of this section.

Equivalents and Conversions

Decimal and Millimeter Equivalents

Fractions	Decimals	mm	Fractions	Decimals	mm
1/64	0.015625	— 0.397	33/64	0.515625	— 13.097
1/32	0.03125	— 0.794	17/32	0.53125	— 13.494
3/64	0.046875	— 1.191	35/64	0.546875	— 13.891
1/16	0.0625	— 1.588	9/16	0.5625	— 14.288
5/64	0.078125	— 1.984	37/64	0.578125	— 14.684
3/32	0.09375	— 2.381	19/32	0.59375	— 15.081
7/64	0.109275	— 2.778	39/64	0.609375	— 15.478
1/8	0.1250	— 3.175	5/8	0.6250	— 15.875
9/64	0.140625	— 3.572	41/64	0.640625	— 16.272
5/32	0.15625	— 3.969	21/32	0.65625	— 16.669
11/64	0.171875	— 4.366	43/64	0.671875	— 17.066
3/16	0.1875	— 4.762	11/16	0.6875	— 17.462
13/64	0.203125	— 5.159	45/64	0.703125	— 17.859
7/32	0.21875	— 5.556	23/32	0.71875	— 18.256
15/64	0.234375	— 5.953	47/64	0.734375	— 18.653
1/4	0.2500	— 6.350	3/4	0.7500	— 19.050
17/64	0.265625	— 6.747	49/64	0.765625	— 19.447
9/32	0.28125	— 7.144	25/32	0.78125	— 19.844
19/64	0.296875	— 7.541	51/64	0.796875	— 20.241
5/16	0.3125	— 7.938	13/16	0.8125	— 20.638
21/64	0.328125	— 8.334	53/64	0.828125	— 21.034
11/32	0.34375	— 8.731	27/32	0.84375	— 21.431
23/64	0.359375	— 9.128	55/64	0.859375	— 21.828
3/8	0.3750	— 9.525	7/8	0.8750	— 22.225
25/64	0.390625	— 9.922	57/64	0.890625	— 22.622
13/32	0.40625	— 10.319	29/32	0.90625	— 23.019
27/64	0.421875	— 10.716	59/64	0.921875	— 23.416
7/16	0.4375	— 11.112	15/16	0.9375	— 23.812
29/64	0.453125	— 11.509	61/64	0.953125	— 24.209
15/32	0.46875	— 11.906	31/32	0.96875	— 24.606
31/64	0.484375	— 12.303	63/64	0.984375	— 25.003
1/2	0.5000	— 12.700	1	1.000	— 25.400
1 mm = 0.03937 in.			0.001 in. = 0.0254 mm		

U.S to Metric Conversions


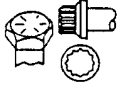
	To Convert	Into	Multiply By
Linear Measurement	Miles	Kilometers	1.609
	Yards	Meters	0.9144
	Feet	Meters	0.3048
	Feet	Centimeters	30.48
	Inches	Meters	0.0254
	Inches	Centimeters	2.54
	Inches	Millimeters	25.4
Area	Square Miles	Square Kilometers	2.59
	Square Feet	Square Meters	0.0929
	Square Inches	Square Centimeters	6.452
	Acre	Hectare	0.4047
Volume	Cubic Yards	Cubic Meters	0.7646
	Cubic Feet	Cubic Meters	0.02832
	Cubic Inches	Cubic Centimeters	16.39
Weight	Tons (Short)	Metric Tons	0.9078
	Pounds	Kilograms	0.4536
	Ounces (Avdp.)	Grams	28.3495
Pressure	Pounds/Sq. In.	Kilopascal	6.895
	Pounds/Sq. In.	Bar	0.069
Work	Foot-pounds	Newton-Meters	1.356
	Foot-pounds	Kilogram-Meters	0.1383
	Inch-pounds	Kilogram-Centimeters	1.152144
Liquid Volume	Quarts	Liters	0.9463
	Gallons	Liters	3.785
Liquid Flow	Gallons/Minute	Liters/Minute	3.785
Temperature	Fahrenheit	Celsius	1. Subtract 32°
			2. Multiply by 5/9

Torque Specifications

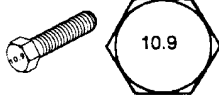

Use these torque values when specific torque values are not given. DO NOT use these values in place of

specified values. Torque values listed are for lubricated threads. Plated threads are considered to be lubricated.

Capscrew Markings and Torque Values - U.S. Customary

SAE Grade Number	5				8			
Capscrew Head Markings								
Capscrew Body Size	Capscrew Torque - Grade 5				Capscrew Torque - Grade 8			
	ft-lb	Cast Iron Nm	Aluminum Nm	ft-lb	ft-lb	Cast Iron Nm	Aluminum Nm	ft-lb
1/4-20 -28	7 9	9 12	6 7	8 9	11 13	15 18	9 10	12 14
5/16-18 -24	15 17	20 23	12 14	16 19	22 24	30 33	18 19	24 25
3/8-16 -24	30 30	40 40	20 25	25 35	40 45	55 60	30 35	40 45
7/16-14 -20	45 50	60 65	35 40	45 55	65 70	90 95	50 55	65 75
1/2-13 -20	70 75	95 100	55 60	75 80	95 110	130 150	75 90	100 120
9/16-12 -18	100 110	135 150	80 85	110 115	140 155	190 210	110 125	150 170
5/8-11 -18	135 155	180 210	110 120	150 160	190 215	255 290	150 170	205 230
3/4-10 -16	240 270	325 365	190 210	255 285	340 380	460 515	270 300	365 410
7/8-9 -14	360 390	490 530	280 310	380 420	550 610	745 825	440 490	600 660
1-8 -14	530 590	720 800	420 480	570 650	820 890	1100 1200	660 710	890 960

Capscrew Markings and Torque Values – Metric

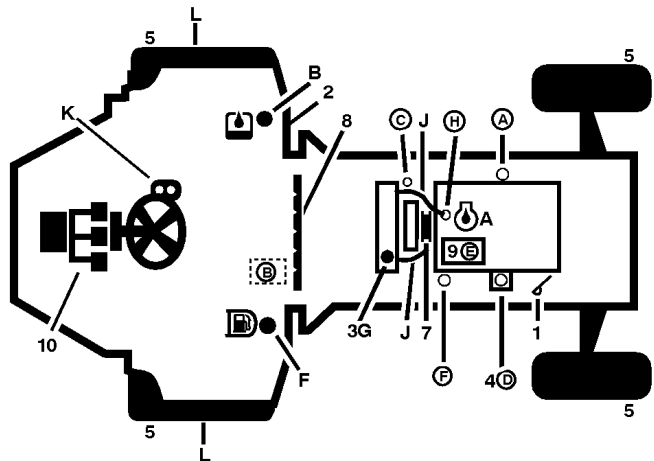
Commercial Steel Class 8.8					10.9				12.9			
Capscrew Head Markings												
Thread Diameter mm	Capscrew Torque - Class 8.8				Capscrew Torque - Class 10.9				Capscrew Torque - Class 12.9			
	ft-lb	Cast Iron Nm	Aluminum Nm	ft-lb	ft-lb	Cast Iron Nm	Aluminum Nm	ft-lb	ft-lb	Cast Iron Nm	Aluminum Nm	ft-lb
6	5	9	4	7	9	14	7	11	9	14	7	11
7	9	14	7	11	14	18	11	14	18	23	14	18
8	18	25	14	18	23	32	18	25	27	36	21	28
10	30	40	25	30	45	60	35	45	50	70	40	55
12	55	70	40	55	75	105	60	80	95	125	75	100
14	85	115	65	90	120	160	95	125	145	195	110	150
16	130	180	100	140	175	240	135	190	210	290	165	220
18	170	230	135	180	240	320	185	250	290	400	230	310

Quick Reference Maintenance Aid

GM 580-D QUICK REFERENCE AID

CHECK/ SERVICE (DAILY)

1. ENGINE OIL LEVEL
2. HYDRAULIC FLUID LEVEL
3. ENGINE COOLANT LEVEL
4. WATER SEPARATOR
5. TIRE PRESSURE
6. DIESEL FUEL LEVEL
7. FAN BELT TENSION
8. RADIATOR SCREEN (upper/lower)
9. AIR CLEANER
10. BRAKE FUNCTION
11. HYDRAULIC HOSE CONDITION
12. DECK BELT TENSION
13. CUTTING DECK BLADES
14. INTERLOCK SYSTEM



SPECIFICATIONS/CHANGE INTERVALS

* Initial maintenance required. Refer to operator's manual.

	FLUID TYPE			CAPACITY	CHANGE INTERVAL FLUID	FILTER	FILTER PART NO.
A) ENGINE OIL*	-20 F TO 20 F SAE 10W/CD	20 F TO 105 F SAE 30CD	105 F + SAE 40/CD	8.5 QTS. w/filter	100 HRS	100 HRS	49-2500
B) HYDRAULIC FLUID*	MOBILE DTE 26/SHELL TELLUS 68 or equivalent			40 GALS.	1000 HRS/YEARLY	500 HRS	69-1720
C) HYDRAULIC SYSTEM BREATHER						1000 HRS/YEARLY	43-8510
D) FUEL / WATER SEPARATOR						250 HRS	69-1770
E) AIR CLEANER						1000 HRS/YEARLY	69-1900
F) FUEL SUPPLY	20 F OR LOWER ASTM NO 1-D	20 F OR HIGHER ASTM NO 2-D		28 GALS.	DRAIN & FLUSH 2 YRS	1000 HRS/YEARLY	70-5730
G) ENGINE COOLANT	50/50 MIX OF ETHYLENE GLYCOL AND WATER			3.9 GALS.	DRAIN & FLUSH 1000 HRS/YEARLY		
H) ENGINE THERMOSTAT					1000 HRS/YEARLY		51-7230
I) INTERLOCK SWITCHES					2 YEARS		
J) COOLANT HOSES					1000 HRS/YEARLY		
K) BRAKE FLUID	DOT 3 HYDRAULIC BRAKE FLUID				1000 HRS/YEARLY		
L) PLANETARY GEAR DRIVE*	API GL-5 SAE 80W OR 90W GEAR LUBRICANT				1000 HRS/YEARLY		

NOTES:

- Follow operator's manual recommendation for lubrication of grease fittings.
- See operator's manual before towing.
- Use only batteries rated for LTV, industrial and construction use.
- SEE OPERATOR'S MANUAL FOR ADDITIONAL INFORMATION.

80-4890

Lubrication

The following must be lubricated regularly with No. 2 general purpose lithium or molybdenum base grease. The chart below lists service intervals based upon normal operating conditions. However, lubricate more frequently under extreme conditions. The left column numbers correspond with numbers in Fig. 1.

Component	No. of Fittings	Service interval
Center Cutting Unit		
1. Castor Wheel Bearings	4	Every 8 hours or daily.
2. Castor Fork Shaft Bushings	2	Every 8 hours or daily.
3. Spindle Shaft Bearings	5	Every 50 hours.
4. Idler Pulley Bushings	2	Every 50 hours
5. Deck Hinge Pivot Bushings	2	Every 50 hours.
Right & Left Hand Cutting Units		
6. Castor Wheel Bearing	8	Every 8 hours or daily.
7. Castor Fork Shaft Bushings	8	Every 8 hours or daily
8. Spindle Shaft Bearings	6	Every 50 hours.
Front Lift Arm Assemblies		
9. L.H. & R.H. Lift Arm	3	Every 50 hours.
10. Hydraulic Cylinder Pivot Bushings	4	Every 50 hours.
11. Lift Arm Ball Joints	2	Every 50 hours
Outboard Cutting Unit Lift Assemblies		
12. Lift Arm Pivots	4	Every 50 hours.
13. Anti-sway Arm Bushings	2	Every 50 hours.
14. Lift Arm Elbow Shaft Bushings	4	Every 50 hours.
15. Latch Ball Joints	4	Every 50 hours.
16. Hydraulic Cylinder Pivot Bushing	4	Every 50 hours.
17. Lift Clevis Pivot Bushings	2	Every 50 hours.
Traction Unit		
18. Steering Brake Pedal Arms	2	Every 50 hours.
19. Engine Water Pump Assy.	1	Every 50 hours.
20. Engine to Pump Drive Yoke	3	Every 50 hours.
21. Rear Wheel Spindle Bushings	2	Every 50 hours.
22. Rear Axle Pivot Bushings	1	Every 50 hours
23. Steering Tie Rod Ball Joint	2	Every 50 hours.
24. Service Brake Pivot Bushings	1	Every 50 hours.
25. Hydraulic Steering Cylinder Ball Joints	2	Every 50 hours.
26. Rear Wheel Bearings	2	Repack every 1000 hours

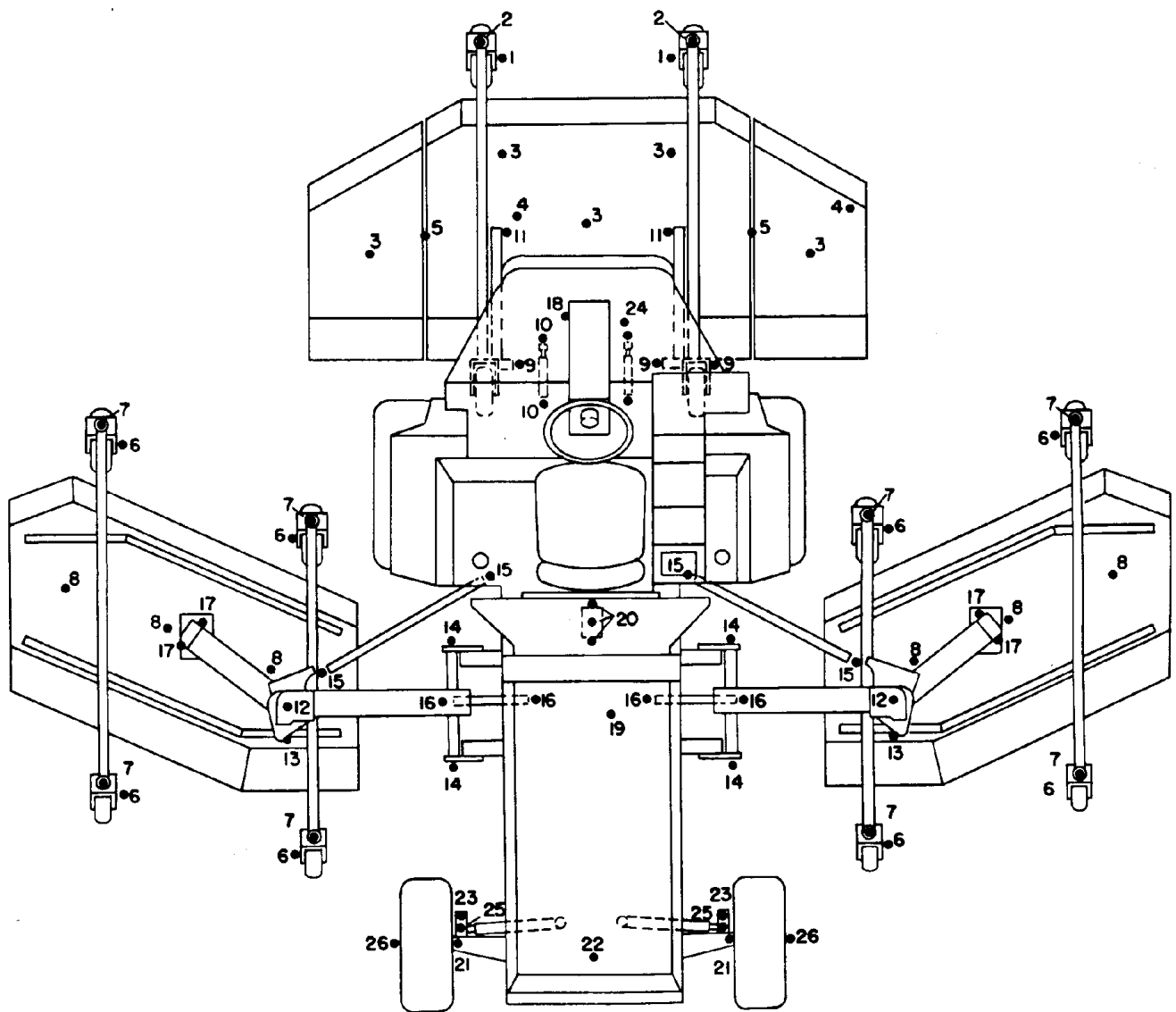


Figure 1



EQUIPMENT OPERATION AND SERVICE HISTORY REPORT
for
GROUNDMASTER® 580-D

TORO Model and Serial Number: _____-_____

Engine Numbers: _____

Transmission Numbers: _____

Drive Axle(s) Numbers: _____

Date Purchased: _____ Warranty Expires _____

Purchased From: _____

Contacts: Parts _____ Phone _____

 Service _____ Phone _____

 Sales _____ Phone _____

Groundsmaster® 580–D Maintenance Schedule

Maintenance Procedure	Maintenance Interval & Service				
<div> <div> Lubricate All Grease Fittings Inspect Air Filter, Dust Cup, and Baffle Clean Under Cutting Unit Belt Covers Check Cutting Unit Drive Belt Adjustment </div> <div> Every 50hrs A Service </div> </div> <div> <div> ‡ Change Engine Oil and Replace Filter † Check Fan and Alternator Belt Tension Inspect Cooling System Hoses </div> <div> Every 100hrs B Service </div> </div> <div> <div> Service Air Filter Replace Fuel/Water Separator Filter † Torque Wheel Lug Nuts </div> <div> Every 200hrs C Service </div> </div> <div> <div> Check Battery Level/Cable Connections ‡ Replace Hydraulic Filter ‡ Torque Head and Adjust Valves ‡ Check Engine RPM (idle and full throttle) </div> <div> Every 400hrs D Service </div> </div> <div> <div> ‡ Change Planetary Gear Drive Fluid Check Rear Wheel Toe-In </div> <div> Every 800hrs E Service </div> </div>					
† Initial break in at 10 hours ‡ Initial break in at 50 hours					
<div> Change Brake Fluid Change Fuel Filter Change Thermostat Replace Safety Switches Flush Cooling System and Replace Hoses Fuel Tank– Drain/Flush Change Hydraulic Oil </div> <div> Annual Recommendations: Items listed are recommended every 1000 hours or 2 years, whichever occurs first. </div>					

Groundsmaster® 580–D Daily Maintenance Check List

Unit Designation: _____

TORO ID #: _____–_____

Daily Maintenance: (duplicate this page for routine use)

Check proper section of Operator's Manual for fluid specifications

Maintenance Check Item ➡	Daily Maintenance Check For Week Of _____						
	MON	TUES	WED	THURS	FRI	SAT	SUN
✓ Safety Interlock Operation							
✓ Brake Operation							
✓ Engine Oil Level							
✓ Cooling System Fluid Level							
Drain Water/Fuel Separator							
✓ Air Filter/Pre–Cleaner Condition							
✓ Radiator & Screen for Debris							
✓ Unusual Engine Noises							
✓ Unusual Operating Noises							
✓ Height of Cut							
✓ Hydraulic System Oil Level							
✓ Hydraulic Hoses for Damage							
✓ Fluid Leaks							
✓ Tire Pressure							
✓ Instrument Operation							
✓ Condition of Blades							
Lubricate All Grease Fittings ²							
Touch–up Damaged Paint							

¹=Immediately after every washing, regardless of the interval listed.

Notation for areas of concern: Inspection performed by _____

Item	Date	Information
1		
2		
3		
4		
5		
6		
7		

Check proper section of Operator's Manual for fluid specifications

Groundsmaster® 580-D Maintenance Supervisor Work Order

Date: _____

(Duplicate this page for routine use.)

Unit Designation:	TORO I.D. #: _____	
Hours:	Service to perform (circle): A B C D E Other	
Technician:		

Remarks:

A – Service (every 50 hours)

- ☐ Lubricate All Grease Fittings
- ☐ Inspect Air Filter, Dust Cup, and Baffle
- ☐ Clean under Cutting Unit Belt Covers
- ☐ Check Cutting Unit Drive Belt Adjustment
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

B – Service (every 100 hours)

- ☐ Change Engine Oil and Filter
- ☐ Inspect Cooling System Hoses
- ☐ Check Fan and Alternator Belt Tension
- ☐ **A-Level Service Required**
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

C – Service (every 200 hours)

- ☐ Service Air Filter
- ☐ Replace Fuel/Water Separator Filter
- ☐ Torque Wheel Lug Nuts
- ☐ **A and B – Service Required**
- ☐ _____
- ☐ _____

D – Service (every 400 hours)

- ☐ Check Battery Level/Cable Connections
- ☐ Replace Hydraulic Filter
- ☐ Torque Head and Adjust Valves
- ☐ Check Engine RPM (idle and full throttle)
- ☐ **A, B, and C – Service Required**
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

E – Service (every 800 hours)

- ☐ Change Planetary Gear Drive Fluid
- ☐ Check Rear Wheel Toe-in
- ☐ **A, B, C, and D – Service Required**
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

Other – Annual Service & Specials

- ☐ Change Brake Fluid
- ☐ Change Fuel Filter
- ☐ Change Thermostat
- ☐ Replace Safety Switches
- ☐ Flush Cooling System and Replace Hoses
- ☐ Drain/Flush Fuel Tank
- ☐ Change Hydraulic Oil
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____



Table of Contents

NOTE: This Chapter provides information for **TORO Model 30580**.

See Chapter 3A for **Model 30581**.

GENERAL INFORMATION	3	FLYWHEEL, TIMING GEARS AND CAMSHAFT . .	61
Engine Serial Number Location	3	Disassembly	61
Engine External Views	4	Inspection and Repair	64
Engine Sectional Views	5	Reassembly	70
SPECIFICATIONS	6	PISTONS, CONNECTING RODS,	
Definition of Terms	6	CRANKSHAFT & BLOCK	73
General Specifications	7	Disassembly	73
Service and Overhaul Standards	11	Inspection and Repair	76
Tightening Torques	20	Reassembly	86
Sealants	22	INLET AND EXHAUST SYSTEMS	91
SPECIAL TOOLS	23	Description	91
TROUBLESHOOTING	26	Exhaust Manifold	92
GENERAL OVERHAUL INSTRUCTIONS	30	Turbocharger	93
Determining When To Overhaul The Engine	30	LUBRICATION SYSTEM	106
Disassembly Precautions	30	Description	106
Reassembly Precautions	30	Oil Pump	107
Testing Compression Pressure	31	Oil Filter	111
ADJUSTMENTS	32	Relief Valve	111
Valve Clearance	32	COOLING SYSTEM	112
Priming / Bleeding Fuel System	33	Water Pump	112
Fuel Injection Timing	34	Thermostat	115
No-Load Minimum and Maximum Speed	35	Radiator, Fan and Fan Belt	115
Throttle Lever and Control Cable Adjustment	37	FUEL SYSTEM	116
Fuel Stop Solenoid Adjustment	38	Description	116
Fan Drive Belt Inspection and Adjustment	38	Fuel Injection Nozzles	117
ENGINE REMOVAL AND INSTALLATION	39	Fuel Feed Pump	120
ACCESSORY REMOVAL AND INSTALLATION	43	Fuel Injection Pump	122
Preparatory Steps	43	Governor	124
Engine Accessory Removal	43	GENERAL OVERHAUL INFORMATION	125
Engine Accessory Installation	47	Oil Seals	125
CYLINDER HEAD AND VALVES	48	O-Rings	126
Disassembly	48	Bearings	126
Inspection and Repair	50	Lock Plates	127
Reassembly	57	Split Pins and Spring Pins	127

General Information

This chapter gives information about specifications, maintenance, troubleshooting, testing and repair of the diesel engine used in the Groundmaster® 580-D mower.

Most repairs and adjustments require tools which are commonly available in many service shops. Special tools are described in the Special Tools section. The use of some specialized test equipment is explained, however, the cost of the test equipment and the specialized

nature of some repairs may dictate that the work be done at a qualified diesel engine repair facility.

The engine used in the Groundmaster® 580-D mower is manufactured by Mitsubishi Heavy Industries Limited. Service and repair parts for Mitsubishi engines are supplied through TORO Distributors. Repair parts may be ordered by TORO Part Number. If no parts list is available be sure to provide your dealer or distributor with the TORO Model Number and Serial Number.

Engine Serial Number Location

The engine serial number is stamped on the side of the crankcase (Fig. 1).

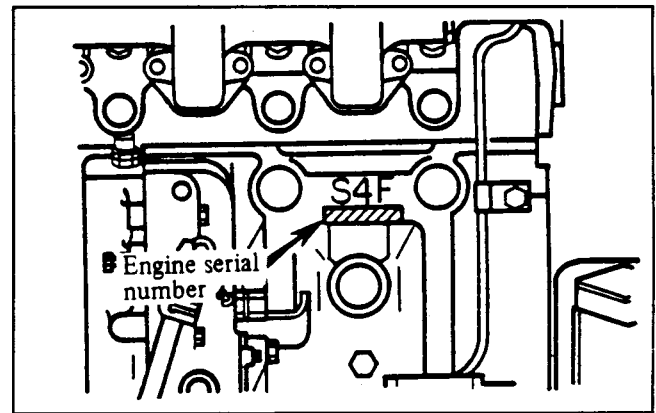


Figure 1

Engine External Views

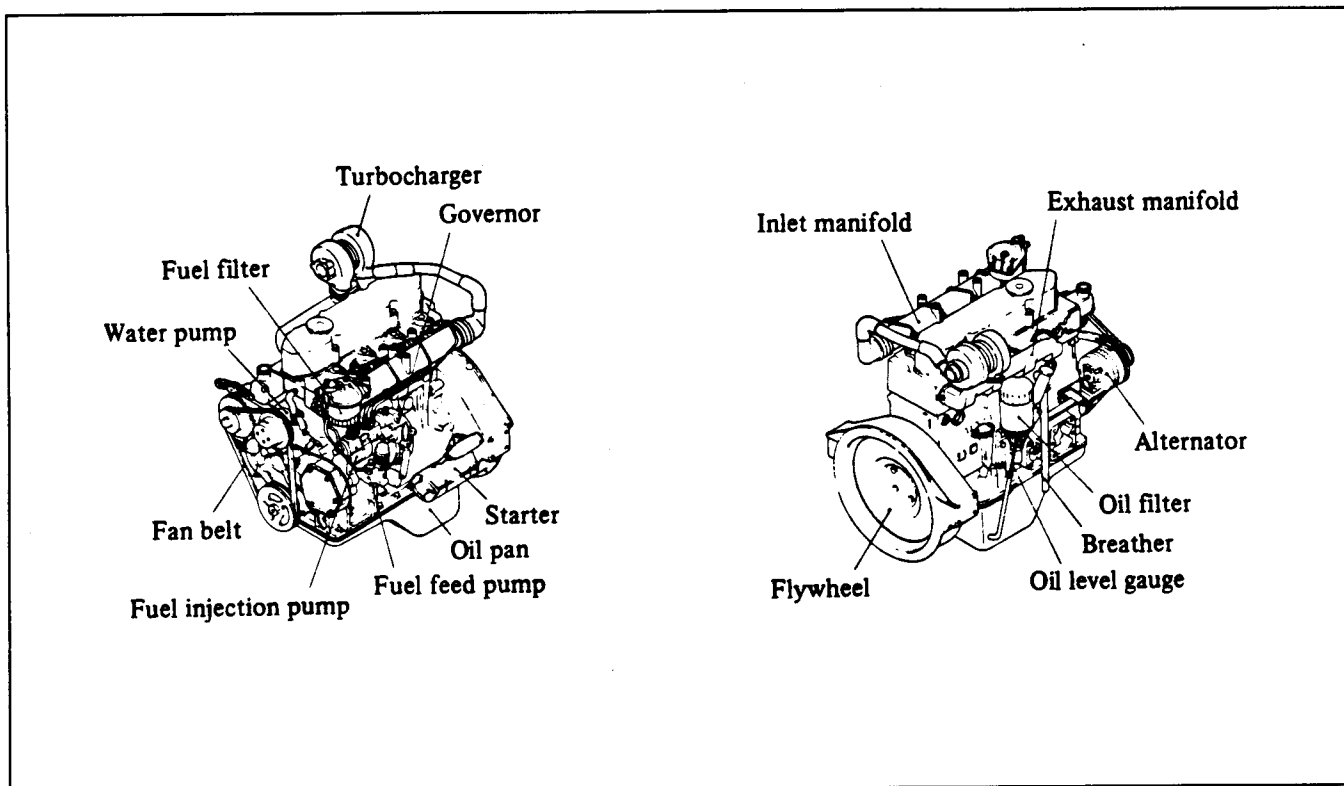


Figure 2

Engine Sectional Views

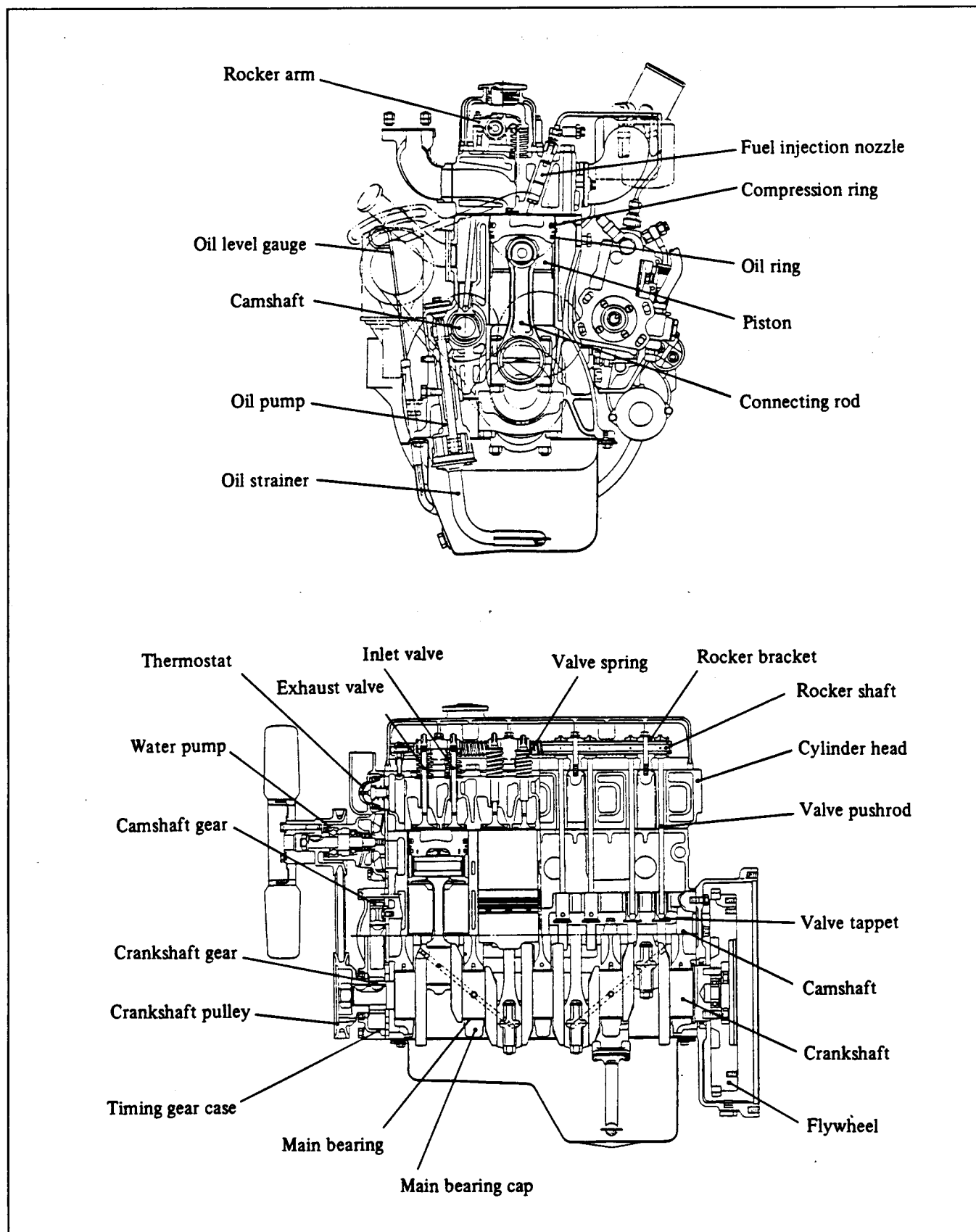


Figure 3

Specifications

NOTE: Some specifications are included in the service procedures later in this chapter.

Specifications, standards and measurements are listed as: **metric (U.S.)**.

Definition of Terms

The following terms are used when listing dimensions and specifications:

NOMINAL VALUE – Indicates the standard dimension of a part.

ASSEMBLY STANDARD – Indicates the dimension of a part, the dimension to be attained at time of reassembly, or for standard performance.

STANDARD CLEARANCE – Indicates clearance to be attained between mating parts at time of reassembly.

REPAIR LIMIT – A part that has reached this limit must be repaired or adjusted.

SERVICE LIMIT – A part which has reached this limit must be replaced.

General Specifications – Mitsubishi S4FT

General	Type		Water-cooled, 4-stroke cycle, diesel	
	No. of cylinders – arrangement		4-in line	
	Type of combustion chamber		Direct injection	
	Valve mechanism		Overhead – special heat resistant alloy	
	Bore x stroke	mm (in.)	98 x 98 (3.86 x 3.86)	
	Piston displacement	liter (cu in.)	2.96 (180.6)	
	Compression ratio		17:1	
	Fuel (ASTM specification)		Grade No. 2 diesel fuel	
	Firing order		1-3-4-2	
	Direction of rotation		Counterclockwise as viewed from flywheel side	
	Dimensions	Overall length mm (in.)		806 (31.73)
Overall width mm (in.)		524 (20.63)		
Overall height mm (in.)		853 (33.58)		
Weight (dry)		kg (lb)	275 (606)	
Engine proper	Type of cylinder sleeves		cast iron	
	No. of piston rings	Compression ring	2	
		Oil ring	1 (w/spring expander)	
	Valve timing	Inlet valves	Open	B.T.D.C. 10°
			Close	A.B.D.C. 50°
		Exhaust valves	Open	B.B.D.C. 54°
			Close	A.T.D.C. 10°
	Starting system		Electric starter	
Inlet/ exhaust systems	Air cleaner	Type	Paper element	
	Turbocharger	Type	TC06	
Lubrication system	Type		Pressure feed by gear pump	
	Engine Oil	API service classification		CD
		Refill capacity – incl. filter	liter (qt.)	8 (8.4)

Lubrication system	Oil pump	Type	Trochoid
		Speed ratio to crankshaft	0.5
		Delivery capacity liter/min (gpm) at 1800 engine rpm	23 (6.1)
	Relief valve	Type	Piston valve
		Opening pressure kg/cm (psi)	3 ± 0.2 (42.7 ± 2.8)
	Oil filter	Type	Full flow cartridge type, paper element
	Oil filter relief valve	Opening pressure kg/cm (psi)	1.0 ± 0.2 (14.2 ± 2.8)
Cooling system	Oil jet check valve	Opening pressure kg/cm (psi)	$1.2^{+0.3}_{-0.2}$ ($17^{+4.3}_{-2.8}$)
	Refill capacity liter (U.S. gal)		4.6 (1.2)
	Water pump	Type	Centrifugal
		Speed ratio to crankshaft	1.3:1
		Delivery capacity liter/min (gpm) at 3000 engine rpm	180 (11.5)
	Fan belt	Type	Low-edge, cog, B type V-belt
	Thermostat	Type	Expanding wax type
		Valve opening temperature °C (°F)	77 °C (170 °F)
Fuel system	Injection pump	Type	Bosch A – Inline
		Manufacturer	NIPPONDENSO
		Diameter of plunger mm (in.)	9.0 (0.354)
	Feed pump	Type	Bosch, piston
		Manufacturer	NIPPONDENSO
		Cam lift mm (in.)	1.5 (0.059)
	Governor	Type	Bosch mechanical
		Manufacturer	NIPPONDENSO

Fuel system	Injection nozzles	Type of nozzle holder	Bosch, hole
		Type of nozzle tip	Bosch DLLA (multi-hole)
		Manufacturer	NIPPONDENSO
		No. of spray holes	4 each
		Diameter of spray hole mm (in.)	0.3 (0.01)
		Spray angle	155 °
		Valve opening pressure kg/cm (psi)	220 (3128) or 180 (2560)
	Fuel filter	Type	Cartridge, paper element
Electrical system	Voltage – polarity		12 V – negative ground
	Starter	Manufacturer	MITSUBISHI ELECTRIC
		Type	Solenoid – Pinion shift
	Alternator	Type	35 amp with internal regulator
		Manufacturer	MITSUBISHI ELECTRIC

Service & Overhaul Standards

Unit: mm (in.)

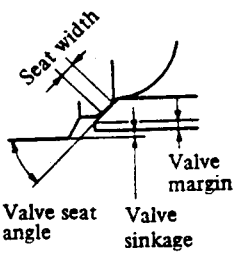
Inspection point	Specification	Serviceable limits	Remarks
Maximum rpm (no load)	2750 ± 50 rpm		Adjust governor setting
Minimum rpm	1150 ± 50 rpm		Adjust governor setting
Compression	27 kg/cm (384 psi) at 150–200 rpm	24 kg/cm (341 psi)	Oil and water temp. 20 – 30° C (68 – 86° F)
Lube oil pressure	3–4 kg/cm (43–57 psi) at 1500 rpm	2 kg/cm (28.4 psi)	Oil temperature 60 – 70° C (140 – 158° F)
	1 kg/cm (14.2 psi) minimum at idling	0.5 kg/cm (7 psi)	
Valve timing [with 3-mm clearance on valve side]	In. valves open In. valves close Ex. valves open Ex. valves close	28° A.T.D.C. 12° A.B.D.C. 19° B.B.D.C. 25° B.T.D.C. ± 3° (crank angle)	Values are only for checking valve timing. Actual timing during operation will differ.
Valve clearance	0.25 (0.0098)		Both inlet and exhaust valves check cold.
Fuel injection timing	16° B.T.D.C.		
Fan drive belt tension	12 (1/2) deflection at point midway between alternator and water pump pulleys.		Adjust at alternator

In.: Inlet Ex.: Exhaust

Unit: mm (in.)

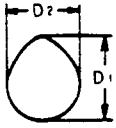
Inspection point			Standard specification	Serviceable limits	Remarks
Crankcase	Warp of gasketed surface		0.05 (0.0020), maximum	0.20 (0.0079)	Resurface if minor.
Cylinder sleeves	Inside diameter		98.000 – 98.035 (3.8583 – 3.8596)	99.200 (3.9055)	Refinish replacement sleeves to +0.25 (+0.0098) or +0.50 (+0.0197) oversize honing. Use match- ing oversize pistons and pis- ton rings.
	Out-of-round		0.015 (0.00059), maximum		
	Taper		0.05 (0.0020), maximum		
Main bearings	Journal oil clearance		0.050 – 0.115 (0.0020 – 0.0045)	0.200 (0.0079)	If service limit is reached, regrind journals and use undersize bearings: Undersize bearings: –0.25 (–0.0098), –0.50 (–0.0197) and –0.75 (–0.0295)
	Journal end play		0.100 – 0.264 (0.0039 – 0.0104)	0.300 (0.01181)	Replace thrust plate.
Tappet guides	Inside diameter		22.000 – 22.021 (0.8661 – 0.8670)	22.100 (0.8701)	
	Side clearance on tappets		0.035 – 0.086 (0.0014 – 0.0034)	0.120 (0.00472)	If replaced tappets do not bring specification into tolerance the bore is worn ex- cessively.
Camshaft bushings	Clearance on journals		0.04 – 0.09 (.0016 – 0.0035)	0.15 (0.0059)	
Cylinder head	Warp of gasketed surface		0.05 (0.002), maximum	0.20 (0.008)	Resurface if minor.
Valves and valve guides	Diameter of valve stems	Inlet valves	7.955 – 7.940 (0.3132 – 0.3126)	7.900 (0.3110)	
		Exhaust valves	7.940 – 7.920 (0.3126 – 0.3118)	7.850 (0.3091)	
	Stem and guide clearance	Inlet valves	0.055 – 0.085 (0.0022 – 0.0034)	0.150 (0.0059)	
		Exhaust valves	0.070 – 0.105 (0.0028 – 0.0041)	0.200 (0.0079)	

Unit: mm (in.)

Inspection point			Nominal value	Assembly standard [standard clearance]	Serviceable limits	Remarks	
Valve seats	Angle		30°				
	Valve sinkage		Inlet: 0.4 (0.016)	0.2 – 0.6 (.008 – .024)	1.1 (0.043)		
			Exhaust:0.5 (0.020)	0.3 – 0.7 (.012 – .028)			
	Width		1.2 (0.047)	1.06 – 1.34 (.0315 – .0525)	1.6 (0.063)		
	Valve margin			2.13 (0.0839)	Refacing is permissible up to 1.2 (0.047)		
Valve springs	Outer springs	Free length	56.40 (2.2205)		55.00 (2.1654)		
		Squareness			2° , maximum		Difference in angle between ends with respect to center line.
		Test force/length under test force			23.9 ± 1.2 kg/44 (52.7 ± 2.6 lb/1.73)	21.2 kg/44 (46.7 lb/ 1.73)	
	Inner springs	Free length	40.8 (1.606)			39.8 (1.567)	
		Squareness			1.5° , maximum		Difference in angle between ends with respect to center line.
		Test force/length under test force			6 ± 0.3 kg/36.5 (13 ± 0.7 lb/1.437)	4.6 kg/36.5 (10 lb/1.437)	
Rocker arms	Inside diameter of rocker bushings			20.000 – 20.021 (0.78740 – 0.78823)			
	Diameter of rocker shafts			19.984 – 19.966 (0.78677 – 0.78606)			
	Clearance of bushings on shaft		20 (0.79)	[0.016 – 0.055] (0.00063 – 0.00217)	[0.070] (0.00276)		

Inspection points		Nomi- nal value	Assembly standard [standard clearance]	Repair limit [clearance]	Service limit [clearance]	Remarks
Valve pushrods	Runout (bend)		0.4 (0.016), maximum			Runout measured with pushrod supported at centerlines of its spherical ends.
Crankshaft	Runout		0.02 (0.0008), maximum	0.05 (0.0020)		
	Diameter of journals	75 (2.95)	- 0.03 (- 0.0012) - 0.05 - 0.0020	- 0.15 (- 0.0059)	- 0.90 (- 0.0354)	
	Diameter of crankpins	5.8 (2.28)	- 0.035 (- 0.00138) - 0.055 - 0.00217	- 0.20 (- 0.0079)		
	Center to center between journal and crankpin	49 (1.93)	± 0.05 (± 0.0020)			
	Parallelism between journal and crankpin		Runout: 0.01 (0.0004), maximum (over crankpin length)			
	Out-of-roundness of journals and crankpins		0.01 (0.0004), maximum	0.03 (0.0012)		
	Taper of journals and crankpins		0.01 (0.0004), maximum	0.03 (0.0012)		
	Filler radius of journals and crankpins	3R (0.12)	± 0.2 (± 0.008)			
	End play	37 (1.46)	[0.100 - 0.264] (0.00394 - 0.01039)	[0.300] (0.01181)		If repair limit is reached, replace thrust plates. If repair limit is exceeded, use oversize thrust plates: Oversize thrust plates: + 0.15 (+0.0059), + 0.30 (+0.0118) and + 0.45 (+0.0177)

Inspection point			Nominal value	Assembly standard [standard clearance]	Repair limit [clearance]	Service limit [clearance]	Remarks
Pistons	Outside diameter (at skirt)	Standard	98 (3.86)	97.975 – 97.945 (3.85728 – 3.85609)		97.760 (3.84881)	At right angles to piston pin at skirt.
		0.25 (0.0098) oversize		98.225 – 98.195 (3.86712 – 3.86594)		98.010 (3.85865)	
		0.50 (0.0197) oversize		98.475 – 98.445 (3.87696 – 3.87578)		98.260 (3.86850)	
	Protrusion above crank case			0.65 – 1.05 (0.0256 – 0.0413)			Check bearing clearance.
	Variance in weight per engine			± 3 gram (± 0.1 oz)			
Piston rings	Side clearance in ring grooves	No.1 ring	2.5 (0.098)	[0.030 – 0.070] (0.00118 – 0.00276)	[0.200] (0.00787)		If repair limit is reached, replace piston rings. If repair limit is exceeded, replace piston.
		No. 2 ring	2.0 (0.079)	[0.025 – 0.060] (0.00098 – 0.00236)	[0.150] (0.00591)		
		Oil ring	4.5 (0.177)	[0.025 – 0.060] (0.00098 – 0.00236)	[0.150] (0.00591)		
	End gap			0.35 – 0.50 (0.0138 – 0.0197)		1.50 (0.0591)	
Piston pins	Outside diameter			32.000 – 31.984 (1.25984 – 1.25921)			
	Clearance in piston		32 (1.26)	[0 – 0.016] (0 – 0.00063)	[0.050] (0.00197)		If repair limit is reached, replace pin. If repair limit is exceeded, replace piston.
	Clearance in bushing		32 (1.26)	[0.020 – 0.051] (0 – 0.00201)	[0.080] (0.00315)		Replace pin or bushing. Ream if necessary.
Connecting rod	Inside diameter of bushings			32.048 – 32.020 (1.26173 – 1.26063)			
	Twist/bend			0.05/100 (0.0020/3.94), maximum	0.15 (0.0059)		
	Clearance of connecting rod bearings on crankpins		58 (2.28)	[0.035 – 0.100] (0.00138 – 0.00394)	[0.200] (0.00787)		If repair limit is reached, replace bearings. If repair limit is exceeded, regrind crankpins and use under-size bearings.

Inspection point		Nominal value	Assembly standard [standard clearance]	Repair limit [clearance]	Service limit [clearance]	Remarks
Connecting rod	End play	40 (1.57)	[0.15 – 0.35] (0.0059 – 0.0138)		[0.50] (0.020)	Replace connecting rod.
	Variance in weight per engine		± 5g (± 0.2 oz)			
Fly- wheel	Radial runout		0.15 (0.0059), maximum	0.50 (0.020)		
	Face runout		0.15 (0.0059), maximum	0.50 (0.020)		
Camshaft	Runout		0.02 (0.0008), maximum	0.50 (0.020)		Straighten by cold working or replace.
	Cam lift	Inlet	D_1 46.911 ^{+0.1} _{-0.3} (1.84689 ^{+0.004} _{-0.012})	$D_1 - D_2$ = 6.689 (0.26335)	$D_1 - D_2$ = 6.189 (0.24366)	
		Exhaust	D_1 46.256 ^{+0.1} _{-0.3} (1.82110 ^{+0.004} _{-0.012})	$D_1 - D_2$ = 7.344 (0.28913)	$D_1 - D_2$ = 6.844 (0.26945)	
	Diameter of journals	No. 1, 2	54 (2.13)	53.96 – 53.94 (2.1244 – 2.1236)	53.90 (21.220)	
		No. 3	53 (2.09)	52.96 – 52.94 (2.0850 – 2.0842)	52.90 (2.0827)	
	End play		5 (0.20)	[0.050 – 0.112] (0.00197 – 0.00441)	[0.300] (0.01181)	Replace thrust plates.
	Clearance of shaft in bushing		36 (1.42)	[0.025 – 0.075] (0.0098 – 0.00295)	[0.100] (0.00394)	Replace bushing.
Camshaft idler gear	End play		[0 – 0.10] (0 – 0.0039)	[0.35] (0.0138)		
	Length of thrust journal of shaft and boss	26 (1.02)	[0.05 – 0.20] (0.0020 – 0.0079)	[0.40] (0.0157)		Replace thrust plates.

Inspection point			Nominal value	Assembly standard [standard clearance]	Repair limit [clearance]	Service limit [clearance]	Remarks
camshaft idler gear	Fit of shaft in crankcase bore		30 (1.18)	[0.009T – 0.045T] (0.00035T – 0.00177T)			
Timing gear backlash				[0.03 – 0.17] (0.0012 – 0.0067)	[0.25] (0.0098)		Replace gears.
Oil pump	Outer rotor to inner rotor clearance			[0.013 – 0.150] (0.00051 – 0.00591)		[0.250] (0.00984)	
	Rotor to cover clearance			[0.04 – 0.09] (0.0016 – 0.0035)	[0.15] (0.0059)		
	Outer rotor to case clearance			[0.20 – 0.28] (0.0079 – 0.0110)		[0.50] (0.0197)	
	Diameter of main shaft			13.000 – 12.985 (0.51181 – 0.51122)			
	Clearance of main shaft in pump case			[0.032 – 0.074] (0.00126 – 0.00291)		[0.150] (0.00591)	
Relief valve	Opening pressure		3.0 kg/cm ² (42.7 psi) [294 kPa]	± 0.2 kg/cm ² (± 2.8 psi) [± 19.6 kPa]			Make shim adjustment. Pressure varies by 0.15 kg/cm ² (2.1 psi) per 1 mm (0.04 in.) thickness of shim.
Water pump	Fit of bearing inner races on pump shaft	Front	17 (0.67)	[0.01T – 0.017T] (0.0004T – 0.00067T)			Replace pump case or pump assembly.
		Rear					
	Fit of bearing outer races in pump case	Front	47 (1.85)	[0.011L – 0.025L] (0.00043L – 0.00098L)			
		Rear	40 (1.57)				
	Radial clearance of bearings		17 (0.67)	0.010 – 0.025 0.010 – 0.022 (0.00039 – 0.00098) 0.00039 – 0.00087		0.045 (0.00177)	Replace bear- ings if they fail to rotate smoothly when slowly turned.
	Inside diameter of spacer for shaft		17 (0.67)	[0.001 – 0.017] (0.00004 – 0.00067)			
	Clearance of impeller on both sides		0.5 – 1.0 (0.020 – 0.039)				Replace impeller if any sign of rubbing contact is noted.
	Unit seal	Protrusion of carbon	1.5 (0.059)			0	
Height (free state)		21.8 (0.858)	± 1 (± 0.04)				
Thermo- stat	Valve opening temp./valve lift at 90° C (194° F)		76.5° C (169.7° F)/ 9 (0.35)	± 2°C (± 3.6° F)			

Unit: mm (in.)

Inspection point		Nominal value	Assembly standard [standard clearance]	Repair limit [clearance]	Service limit [clearance]	Remarks
Injection nozzles	Valve opening pressure	220 or 180 kg/cm ² (3128 or 2560 psi)	+5 – +15 kg/cm ² (+71 – +213 psi)			Make shim adjustment. Pres- sure varies by 10 kg/cm ² (142.2 psi) per 0.1 mm (0.004 in.) thick- ness of shim.
	Spray angle	155°				Test by means of hand tester, using diesel fuel, at 20°C (68° F). If spray pattern is poor even after nozzle is washed in clean diesel fuel, replace noz- zle tip.
	Oil-tightness of needle valve seat	Seat shall hold a test pressure 20 kg/cm ² (284.4 psi) lower than valve opening pressure for 10 seconds.				Wash or replace nozzle tip

Inspection Point		Nominal value	Assembly standard [standard clearance]	Repair limit [clearance]	Service limit [clearance]	Remarks			
Starter	Diameter of commutator		32 (1.26) [38.7 (1.524)]			31 (1.22) [37.7 (1.484)]			
	Brush	Length	18 (0.71) [17 (0.67)]			11 (0.43)			
		Spring pressure kg (lb)	3.5 (7.7) [2.5 (5.5)]			2.3 (5.1) [1.8 (4.0)]			
	Thrust gap of pinion shaft		0.5 (0.020)	0, minimum					
	Pinion gap		0.5 – 2.0 (0.020 – 0.079) [0.1 - 2.5 (0.004 - 0.098)]						
Alternator	Brush length	18 (0.71)			8 (0.31)				
	Brush spring tension				210 grams (0.5 lb)				
	Outside diameter of slip ring	33 (1.30)			32.4 (1.276)				
		No-load characteristics			Locked characteristics		Magnetic switch operating voltage		
		Voltage V	Current A	Speed rpm	Voltage V	Current A	Torque kg.m (lb.ft)	Switch-in voltage V	Switching off
Starter		11	130, max.	4000	3	1000, max.	2.8 (20.3), min.	8, max.	Shall turn off upon turning off of starter switch.

Tightening Torque

Important Bolts and Nuts

Secured part or component	Thread dia.-pitch mm	Width across flats	Tightening torque			Remarks
			kg.m	lb.ft	N.m	[Wet]
Cylinder head bolts	12 - 1.75	19	12 ± 0.5	87 ± 4	118 ± 5	
Rocker shaft brackets	8 - 1.25	12	1.5 ± 0.5	11 ± 4	15 ± 5	[Wet]
Main bearing caps	14 - 2	22	10.4 ± 0.5	75 ± 4	102 ± 5	[Wet]
Connecting rod caps	12 - 1.25	17	8.5 ± 0.5	61 ± 4	83 ± 5	
Flywheel	12 - 1.25	17	8.5 ± 0.5	61 ± 4	83 ± 5	
Camshaft thrust plate	8 - 1.25	12	1.8	13	18	
Front plate	10 - 1.5	14	1	7	10	
Timing gear case bolts	10 - 1.5	14	1	7	10	
Timer cover	8 - 1.25	12	1.3 ± 0.3	9 ± 2	13 ± 3	
Crankshaft pulley	24 - 1.5	36	40 ± 0.5	289 ± 4	392 ± 5	
Idler thrust plate	10 - 1.25	14	3.5	25	34	
Oil pan	8 - 1.25	12	0.7	5	7	
Oil pan drain plug	12 - 1.25	19	10 ± 0.5	72 ± 4	98 ± 5	
Oil pump mounting bolts	12 - 1.75	17	5.5 ± 0.5	40 ± 4	54 ± 5	
Nozzle gland	8 - 1.25	12	2.2	16	22	
Injection nozzle retaining nuts	15 - 0.5	14	3	22	29	
Injection pump delivery valve holders	10 - 1.5	14	3.5 - 4.0	25 - 29	34 - 39	
Injection pump gear			8.5 - 10.0	61 - 72	83 - 98	
Starter B terminal	8 - 1.25	12	1.0 - 1.2	7 - 9	10 - 12	

Remarks: apply engine oil to threads of parts specified as [Wet] in Remarks column.

General Bolts and Nuts

Screw thread		Tightening torque					
Diameter	Pitch	With spring washer			Without spring washer		
		kg.m	lb.ft	N.m	kg.m	lb.ft	N.m
8 mm	1.0	1.8	13	18	2.2	16	22
	1.25	1.8	13	18	2.1	15	21
10 mm	1.25	3.6	26	35	4.2	30	41
	1.5	3.4	25	33	4.0	29	39
12 mm	1.25	6.5	47	64	7.6	55	75
	1.75	6.0	43	59	7.1	51	70
14 mm	1.5	10.4	75	102	12.2	88	120
	2.0	9.8	71	96	11.5	83	113
16 mm	1.5	15.8	114	155	18.6	135	182
	2.0	15.0	108	147	17.6	127	173
18 mm	1.5	22.9	166	225	26.9	195	264
	2.5	20.7	150	203	24.4	176	239

Sealants

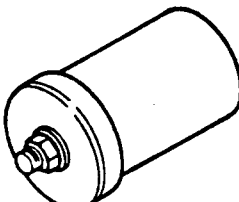
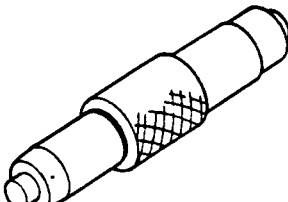
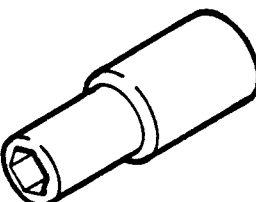
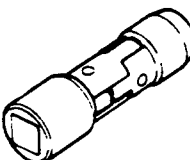
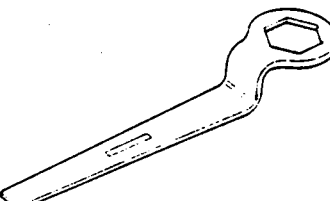
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Oil pan gasket	Front and rear bearing cap seats of crankcase	ThreeBond 1104 Permatex No. 2	Apply to front and rear lower sides (bearing cap seats).
<ul style="list-style-type: none"> Plugs for water and oil holes in crankcase Plug for water hole in cylinder head 	<ul style="list-style-type: none"> Crankcase Cylinder head 	Hermeseal H-1 Loctite 567 Thread Sealant	Apply to holes before installing plugs.
Screw plug for crankcase main oil gallery (taper plug)	Crankcase	Loctite 271	Apply to threads.
Water bypass hose and pipe	Thermostat cover, elbow and water pump	Loctite 271	Apply to threads.
Front and rear bearing cap side seals of crankcase	Bearing caps (front and rear side seal contact surfaces)	ThreeBond 1105D Permatex No. 2	Apply to crankcase before installing front and rear bearing caps.
Timing gear case gasket	Timing gear	ThreeBond 1102 Permatex No. 2	Apply to gasket surface of timing gear case.

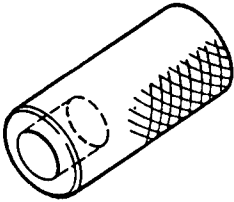
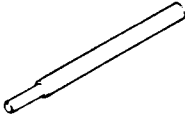
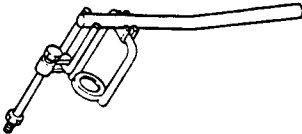
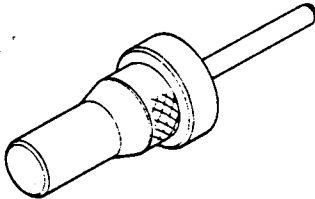
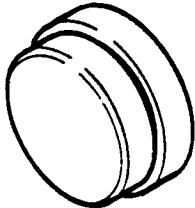
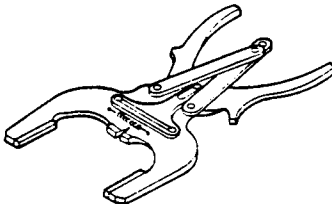
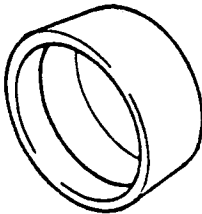
Special Tools

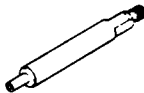
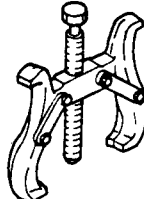
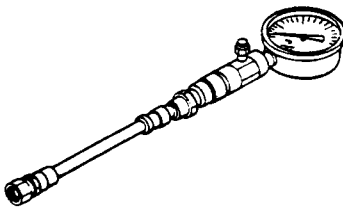
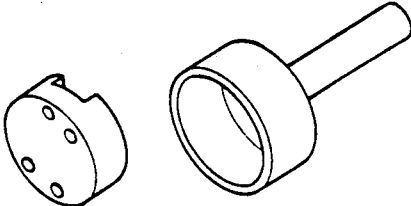
Part numbers for special tools listed in this manual are Mitsubishi part numbers. Contact a local Mitsubishi Engine Distributor or:

Mitsubishi Engine North America
610 Supreme Drive
Bensonville, IL 60106

Some special tools can also be ordered from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*. Some tools may also be available from a local supplier.

Tool name	Mitsubishi Part No.	Shape	Use
Idler shaft puller	34491-02300		Idler shaft removal
Idler bushing puller	30091-07300		Idler bushing removal/installation
Socket	34491-00300		Camshaft thrust plate removal/installation
Universal extension	30091-01101		PE-A type fuel injection pump removal/installation
Cranking handle	30691-11800		Engine cranking

Tool name	Mitsubishi Part No.	Shape	Use
Valve guide installer	34491-00400		Valve guide installation
Valve guide remover	31391-10500		Valve guide removal
Valve spring pusher	30691-04500		Valve spring removal/ installation
Insert caulking tool	(For exhaust) 36791-00200 (For inlet) 36791-00300 (For exhaust)		Valve seat installation
Sleeve installer	34491-02100		Cylinder sleeve installation
Piston ring pliers	31391-12900		Piston ring removal/installation
Piston guide	34491-02200		Piston installation

Tool name	Mitsubishi Part No.	Shape	Use
Adaptor	36791-00100		Engine compression pressure measurement
Puller assembly	64309-12900		Crankshaft gear, camshaft gear, crankshaft pulley and water pump pulley removal
Compression gauge	33391-02100		Compression pressure measurement
Crankshaft sleeve installer	30691-13010		Oil seal sleeve on crankshaft rear side installation

Troubleshooting

Giving immediate attention to any indication of a problem can prevent major failures, and increase the life of the engine.

Never make more than one adjustment at a time, then locate the trouble by a process of elimination. Remember the cause is usually SIMPLE, rather than mysterious and complicated.

Engine Fails to Start

Problem/ Probable Cause	Possible Correction
<ul style="list-style-type: none"> Slow cranking speed. Engine oil viscosity too high. Battery is discharged. Battery plates sulfated. Battery terminal dirty or poor connection Starter Failure. 	Use correct oil. Charge the battery. Replace the battery. Clean the terminals/repair tighten cables. Repair or replace starter.
<ul style="list-style-type: none"> Fuel not reaching injection pump. Fuel lines clogged or damaged. Fuel filter or fuel/water separator clogged. Air in fuel system. Fuel feed pump filter clogged. Defective check valve in fuel feed pump. Piston spring in fuel feed pump broken. Push rod or tapped in fuel feed pump sticking. 	Clean or replace fuel lines. Replace filter element(s). Bleed system; correct cause of air in system. Clean or replace filter. Repair or replace check valve. Replace spring. Repair or replace push rod or tappet.
<ul style="list-style-type: none"> Fuel injection pump. Faulty throttle cable connection.. Control rack defective or sticking. Damaged camshaft bearing. Plunger worn or sticking. 	Repair and adjust throttle cable. Inspect and repair control rack. Replace camshaft bearing. Correct or replace plunger.
<ul style="list-style-type: none"> Fuel injection nozzle Fuel leakage; loose nozzle retaining bolt. Low nozzle opening pressure. Nozzle pressure spring broken. Nozzle pressure pin worn or damaged. Clogged or damaged nozzle tip. 	Replace gasket if necessary. Tighten retaining bolt. Adjust nozzle. Replace spring. Replace pressure pin. Clean or replace nozzle tip.
<ul style="list-style-type: none"> Injection pump out of timing. Improperly retarded injection timing. Incorrect timing; improper installation of pump. Pump camshaft key damaged. Improper tappet adjustment. 	Adjust injection timing. Check timing to engine and correct. Replace key. Adjust tappets to get specified timing.
<ul style="list-style-type: none"> Low compression. Valve clearance incorrect. Valve seat surface rough, or burnt. Valve spring broken. Leaking cylinder head gasket. Piston rings seized. Piston rings and cylinder worn. 	Adjust valve clearance. Finish surface by lapping. Replace valve and guide. Replace the spring. Replace the gasket. Overhaul the engine. Overhaul the engine.
<ul style="list-style-type: none"> Governor lever position incorrect. 	Adjust governor lever.
<ul style="list-style-type: none"> Governor spring broken or disconnected. 	Repair governor spring.

Low Power

Problem/ Probable Cause	Possible Correction
<ul style="list-style-type: none"> • Low compression. 	Refer to Engine Fails to Start - Low compression.
<ul style="list-style-type: none"> • Injection pump out of timing. Excessively advanced timing (knocking). Excessively retarded timing (black smoke). 	Check and adjust timing. Check and adjust timing.
<ul style="list-style-type: none"> • Lack of fuel. Air in fuel system. Filter(s) clogged. Fuel tank is contaminated. Feed pressure too low. 	Inspect fuel line connections. Clean/replace filters. Clean the fuel tank. Repair or replace fuel feed pump.
<ul style="list-style-type: none"> • Fuel injection nozzle Fuel leakage; loose nozzle retaining bolt. Low nozzle opening pressure. Nozzle pressure spring broken. Nozzle pressure pin worn or damaged. Clogged or damaged nozzle tip. 	Replace gasket if necessary. Tighten retaining bolt. Adjust nozzle. Replace spring. Replace pressure pin. Clean or replace nozzle tip.
<ul style="list-style-type: none"> • Fuel injection pump faulty. Fuel leakage from delivery valve holder. Defective fuel delivery valve seat. Delivery valve spring broken. Plunger worn or damaged. Large spread in fuel delivery. Injection delivery not at specified intervals. Tappet roller worn. Camshaft bearing worn or damaged. Governor full load stopper out of adjustment. 	Replace gasket if necessary and tighten. Repair or replace delivery valve. Replace spring. Replace plunger. Adjust fuel delivery. Adjust fuel injection pump delivery timing. Replace roller. Replace bearing. Adjust full load stopper.
<ul style="list-style-type: none"> • Air cleaner is clogged. 	Service air cleaner.
<ul style="list-style-type: none"> • Engine overheats. Low or incorrect coolant level. Improper belt tension. Defective water pump. Radiator and/or screen clogged. Injection timing incorrect. Engine oil level is low. Defective thermostat. 	Check coolant. Adjust belt tension. Replace water pump. Clean/repair radiator/screen. Inspect hoses and cap. Adjust injection timing. Add engine oil. Replace thermostat.
<ul style="list-style-type: none"> • Turbocharger/exhaust system. Leaking exhaust gas. High back pressure; carbon build up in muffler. Boost air leaking. Dirty compressor. Rotor does not spin. 	Check line from manifold to turbocharger gas inlet. Decarbon muffler. Check air hoses from turbocharger to intake manifold. Clean compressor. Clean, repair or replace turbocharger.

Abnormal Engine Noises

Problem/ Probable Cause	Possible Correction
<ul style="list-style-type: none"> Unusually loud knocking. Improper injection timing. Faulty fuel nozzle spray pattern; after dribble. High nozzle opening pressure. Incorrect fuel delivery to a some nozzles. Poor compression or overcooled engine. 	<p>Check and adjust timing. Clean and/or repair nozzle. Adjust opening pressure. Adjust fuel delivery. Refer to Engine Fails to Start - Low compression.</p>
<ul style="list-style-type: none"> Turbocharger Damaged bearings. <p>Rubbing parts.</p>	<p>Repair or replace turbocharger. Could be caused by continual use of deteriorated engine oil or inadequate oil supply because of clogged filter or pipe. Can also be cause by excessive quick cold starting or hot engine shut-downs.</p> <p>Repair or replace turbocharger. Evidence of rubbing contact on rotating parts indicates loss of balance in rotating mass or a distorted shaft, caused by worn bearing or airborne or gasborne object hitting compressor or turbine wheel.</p>
<ul style="list-style-type: none"> Crankshaft and main bearing. Worn crankshaft. Worn or damaged bearings. 	<p>Repair or replace crankshaft; inspect bearings. Replace bearings; inspect crankshaft.</p>
<ul style="list-style-type: none"> Connecting rod and bearings. Connecting rod bearing worn. Worn crankpin. Twisted connecting rod. 	<p>Replace bearing; inspect crankshaft. Repair or replace crankshaft; inspect bearing. Replace connecting rod.</p>
<ul style="list-style-type: none"> Piston, piston pin, and piston rings. Cylinder is worn. Piston pin is worn. 	<p>Overhaul engine. Replace piston and pin, inspect cylinder rod, and rings.</p>
<ul style="list-style-type: none"> Rocker arm mechanism and relative parts. Camshaft is worn. Excessive valve clearance. Worn timing gear. 	<p>Replace camshaft. Adjust the valve clearance. Replace the timing gear; inspect mating gears.</p>

Excessive Oil Consumption

Problem/ Probable Cause	Possible Correction
<ul style="list-style-type: none">Oil leaks.<ul style="list-style-type: none">Oil seals worn.Gaskets leaking.Loose fasteners.Drain plug is loose.Pipe plugs at oil pump loose.Oil leak from turbocharger gas outlet pipe or inlet air pipe.	<ul style="list-style-type: none">Check for wear, and replace of worn.Replace the gasket.Retighten fasteners.Tighten the plug.Tighten the plugs.Service air cleaner; clogged air cleaner causing negative pressure on suction side, drawing in lubricating oil.
<ul style="list-style-type: none">Burning oil.<ul style="list-style-type: none">Ring end gaps in wrong position.Connecting rod bend or twisted.Piston rings worn.Faulty valve stem seal.Valves or valve guides worn.	<ul style="list-style-type: none">Stagger end gaps properly.Overhaul the engine.Replace the rings. Overhaul the engine.Replace valve stem seal.Replace valves or valve guides.

Engine Runs Rough

Problem/ Probable Cause	Possible Correction
<ul style="list-style-type: none">Injection pump mechanism.<ul style="list-style-type: none">Irregular injection pump volumeFaulty control rack function.Worn delivery valve.Faulty injection nozzle.	<ul style="list-style-type: none">Repair or replace injection pump.Repair or replace injection pump.Replace delivery valve.Repair or replace nozzle.
<ul style="list-style-type: none">Governor mechanism.<ul style="list-style-type: none">Governor lever binding.Stretched or weak governor spring.	<ul style="list-style-type: none">Inspect/repair governor.Replace the spring.

Excessive Smoke

Problem/ Probable Cause	Possible Correction
<ul style="list-style-type: none">Black smoke.<ul style="list-style-type: none">Excessive fuel delivery.Excessively advanced fuel injection.Intake air restriction.Large spread in fuel delivery.Faulty spray pattern from injector nozzle.	<ul style="list-style-type: none">Adjust fuel delivery.Check and adjust timing.Service air cleaner.Adjust fuel delivery.Clean and/or repair nozzle.
<ul style="list-style-type: none">White smoke<ul style="list-style-type: none">Excessively retarded fuel injection timing.Water in fuel.Lubricant entering engine combustion chamber.Overcooled engine.	<ul style="list-style-type: none">Check and adjust fuel injection timing.Check and clean fuel system.Check turbocharger for lubricant leakage from damaged turbocharger piston ring.Replace thermostat.

General Overhaul Instructions

Determining When to Overhaul the Engine

Engine compression is the most common means of determining when to overhaul the engine, although constant monitoring of the engine oil and fuel consumption may limit the repair required by catching the need for repair earlier.

The following items will be noted when compression pressure drops:

- A. Low power or loss of power.
- B. Increase in fuel consumption.
- C. Increase in lubricating oil consumption.

D. Excessive blowby through breather due to worn cylinder sleeves, pistons, etc.

E. Excessive blowby due to poor seating of worn inlet and exhaust valves.

F. Hard starting.

G. Excessive abnormal noise.

Among the items listed above, B. and F. symptoms alone may be caused by a fuel injection pump improperly adjusted with respect to injection quantity or injection timing, worn injection pump plungers, faulty injection nozzles, or poor care of the battery, starter, and alternator. Item C. could be caused by a misadjusted valve on an engine with limited use.

Disassembly Precautions

- 1. Use the right tools and instruments.
- 2. Place the disassembled and cleaned parts in the order in which they were removed in preparation for reassembly.

3. Pay attention to orientation marks on assemblies, components and parts. If necessary, mark items to aid reassembly.

4. Carefully check each part's condition during removal or cleaning.

5. Use a hoist, jack, or some other means of assistance when lifting or carrying heavy or awkward components.

Reassembly Precautions

- 1. Use the right tools and instruments.
- 2. Clean all engine parts before reinstalling.
- 3. Use only quality and clean lubricating oils and greases during assembly.

4. Use a torque wrench to tighten parts when tightening torques are specified.

5. Replace gaskets and O-rings during assembly. Use the proper sealants where specified.

Testing Compression Pressure

1. Remove the injection nozzle from the cylinder to be measured.
2. Attach the gauge adaptor and compression gauge (Fig. 4).
3. Crank the engine and note the compression gauge reading when the engine begins to rotate at the specified speed (150-200 RPM).
4. If the compression pressure is lower than the Repair Limit, the engine should be inspected to find the cause of loss or overhauled.

IMPORTANT: Be sure to measure the compression pressure on all cylinders. Do not measure the compression pressure on two or three cylinders and judge the remaining cylinders from those readings.

The compression pressure varies with change of engine rpm. Always check engine rpm at the time of measuring the compression pressure.

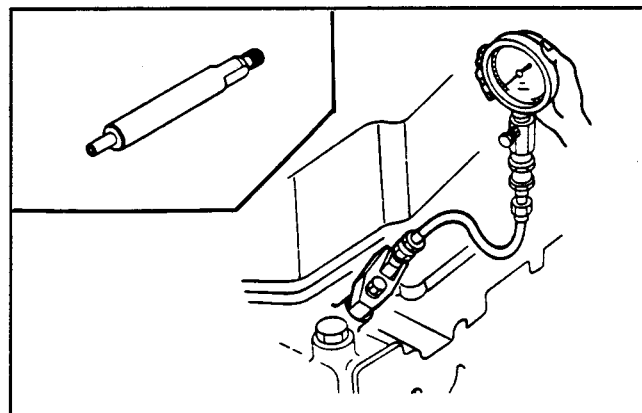


Figure 4

Item	Assembly standard	Repair limit
Compression pressure	27 kg/cm (384 psi)	24 kg/cm (341 psi)

NOTE: Measure the compression pressure with the engine rotating at 150-200 rpm.

IMPORTANT: Take compression readings periodically as part of the regular maintenance routine. Changes in the readings may be used to catch a problem before it becomes severe.

NOTE: The compression readings may be slightly beyond the assembly standard in a new or recently overhauled engine. The readings will stabilize as the rings and valves seat.

Adjustments

Valve Clearance

Inspect and adjust the valve clearance when the engine is cold.

Item		Assembly standard
Valve clearance (cold)	Inlet Exhaust	0.25 mm (0.01 in.)

1. Inspecting valve clearance

A. Inspect valve clearance by firing order. Turn the crankshaft to the specified crank angle in normal direction of rotation to bring the piston to its top dead center on compression stroke.

Firing Order	Crank angle
1-3-4-2	180°

B. Top dead center on the compression stroke of the piston is identified by the timing mark "0" on the crankshaft pulley. With the "0" aligned with the pointer on the gear case, inlet and exhaust valve rocker arms will not be pushed up by their pushrods.

C. Insert a feeler gauge between the rocker arm and valve cap. The valve clearance should be .0098 in (.25 mm).

2. Adjusting valve clearance

A. Loosen the adjusting screw lock nut and adjust the clearance by turning the screw.

B. After adjusting the clearance, tighten the lock nut. Inspect the clearance again to make sure that it has not changed.

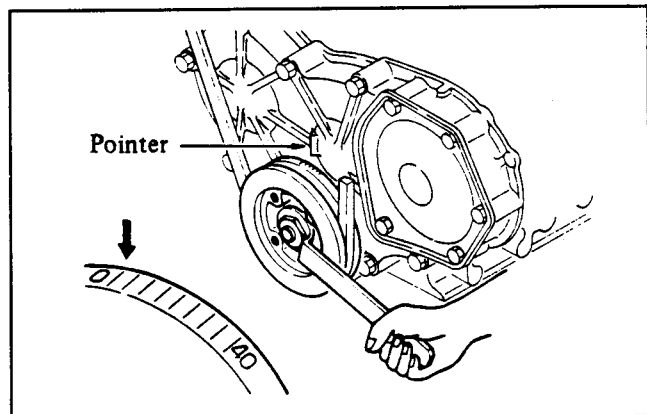


Figure 5

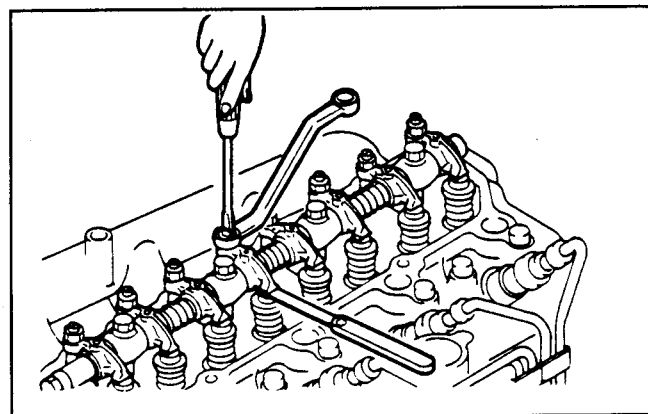


Figure 6

Priming / Bleeding Fuel System

1. Open hood latches, raise hood and secure it in raised position with prop rod (Fig. 7). Open left side panel latch and remove side panel.

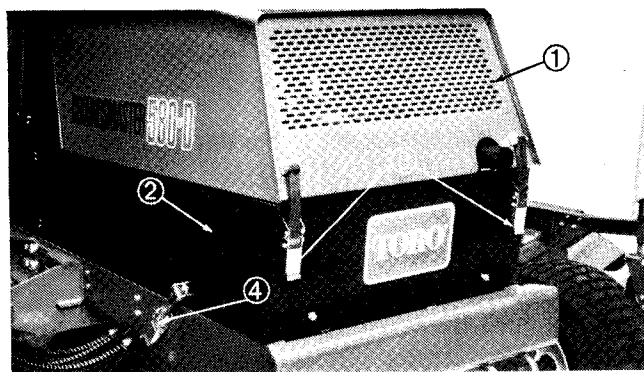


Figure 7

- 1. Engine hood
- 2. Left side panel
- 3. Hood latches
- 4. Side panel latch

2. Loosen air bleed screw at top of fuel filter/water separator (Fig. 8). Fuel will flow out around the screw. When a solid stream of fuel flows out around screw, tighten screw.

NOTE: If fuel tank is over half full, gravity will fill fuel filter and fuel will flow out of fuel bleed screw when open. If tank is less than half full, fill tank.

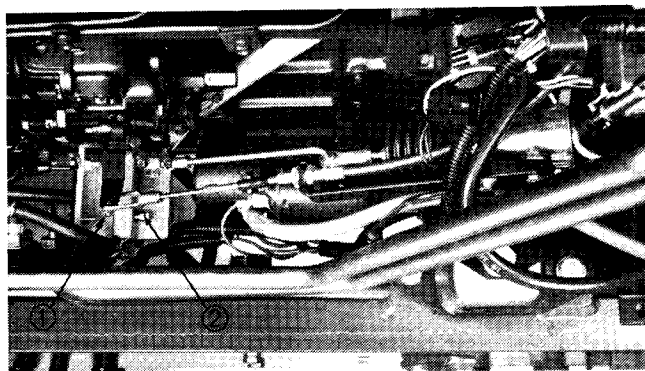


Figure 8

- 1. Fuel filter/water separator
- 2. Bleed screw

3. Loosen air vent plug on engine fuel filter approximately 1-1/2 turns (Fig. 9).

4. Rotate priming pump counterclockwise until spring in pump releases and handle extends. Operate pump up and down until a solid stream of fuel flows out around filter plug, then tighten plug (Fig. 9).

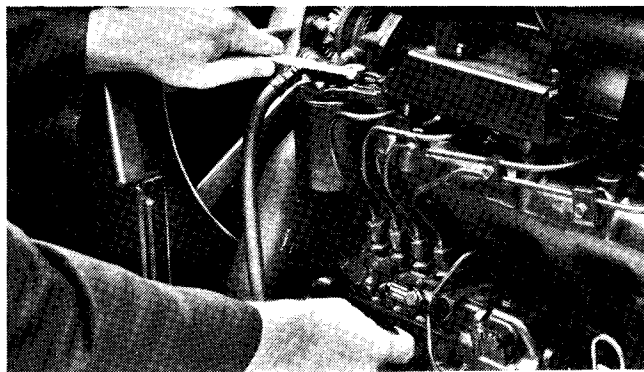


Figure 9

5. Loosen air vent plug on injection pump approximately 1-1/2 turns (Fig. 10). Operate priming pump until solid stream of fuel flows from vent hole, then tighten vent plug.

6. Push priming pump handle down to compress spring and rotate clockwise to lock in closed position.

7. Try to start the engine. If engine starts, install left side panel, lower hood and continue operation. If engine does not start, repeat steps 2 - 6.

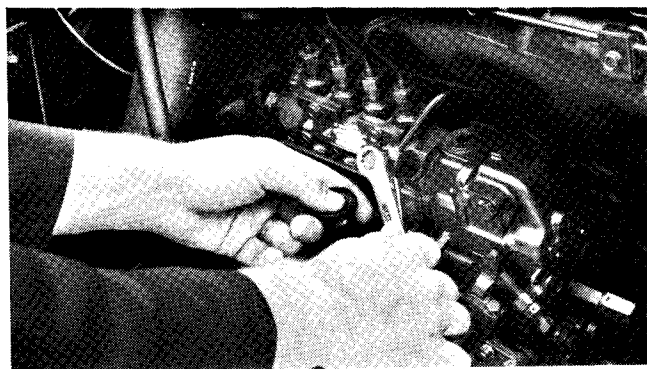


Figure 10

Fuel Injection Timing

1. Bringing No.1 piston to top dead center on compression stroke

A. Rotate the crankshaft in the direction of normal rotation.

B. Stop rotating when the timing mark "O" on the crankshaft pulley is aligned with the pointer.

C. Remove the valve cover and inspect the No. 1 cylinder push rods. The intake and exhaust valve push rods should be loose. If they are under tension, rotate the crankshaft 360 degrees (one full revolution) and check again.

2. Inspecting fuel injection timing

A. Remove the delivery valve holder from No. 1 pumping element of injection pump. Take delivery valve and spring out of the holder and reassemble the holder to the pump. Leave feed line disconnected.

B. Turn the crankshaft to position the No. 1 piston to about 60 degrees before top dead center on the compression stroke.

C. Operate the priming pump to allow fuel to flow out from the delivery valve holder. Slowly move the engine crankshaft in the direction of normal rotation until the fuel just stops flowing.

D. Check that the 16° BTDC timing mark on the crankshaft pulley is aligned with the pointer, indicating that the fuel injection is properly timed.

3. Adjusting fuel injection timing

A. To advance the pump timing, shift the injection pump toward the crankcase. To retard, shift the pump away from the crankcase.

B. Each mark on the injection pump coupling equals 6 degrees of crank angle (Fig. 14).

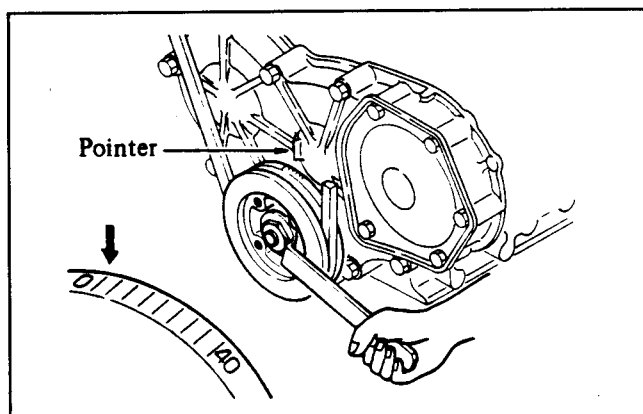


Figure 11

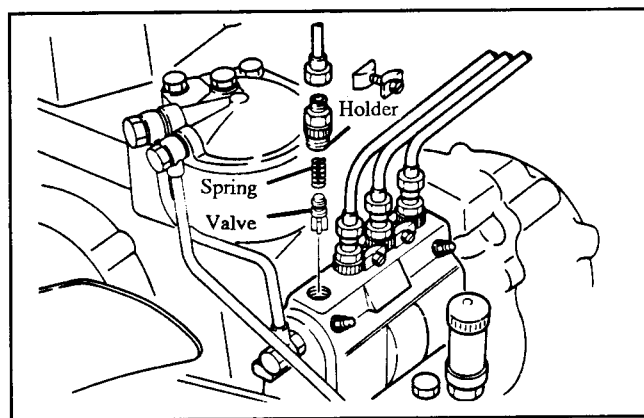


Figure 12

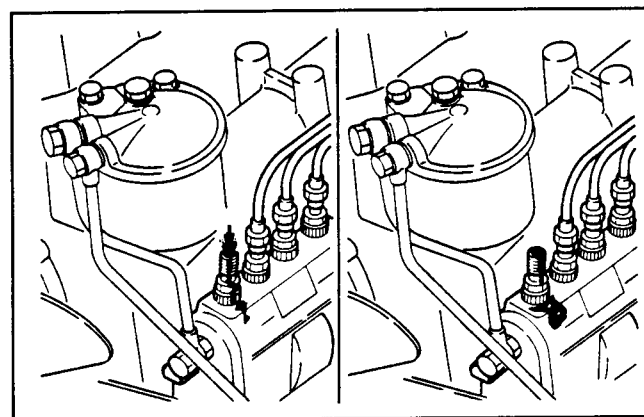


Figure 13

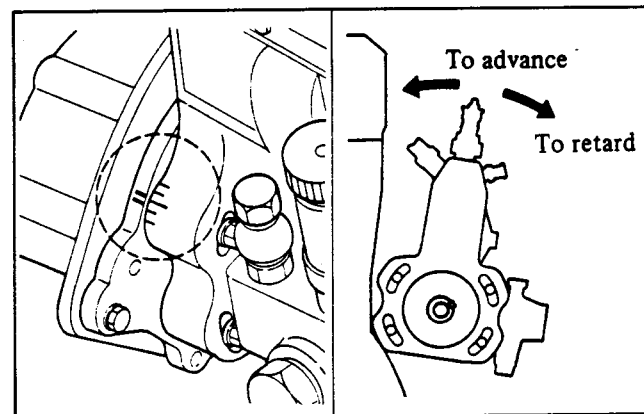


Figure 14

No-load Minimum Idling Speed And Maximum Speed



CAUTION

No-load minimum idling speed and maximum speed set for each engine on the test bench at the factory and the set bolts are sealed. These settings are to be inspected and adjusted at an authorized shop only.

When inspecting and adjusting these settings, be on standby to operate the engine stop lever manually in the event of engine overspeed.

For inspection and adjustment, warm up the engine thoroughly until the coolant and oil temperature rises to 70 degrees C (158 degrees F).

1. Engine starting

A. Move speed control lever to full throttle. Operate key switch to crank the engine.

B. Immediately after the engine starts, move speed control lever to half throttle to warm engine.

C. When the engine is noted to be running with a steady speed, move speed control lever to the idling speed position.

2. Idling set

A. Hold speed control lever at the idle position.

IMPORTANT: If the engine exhibits excessive vibration, shift the idle setting to a lower or higher idling level. The acceptable range is 1100-1200 rpm.

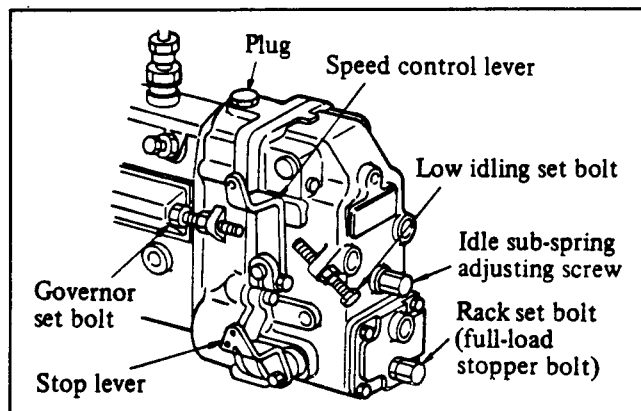


Figure 15

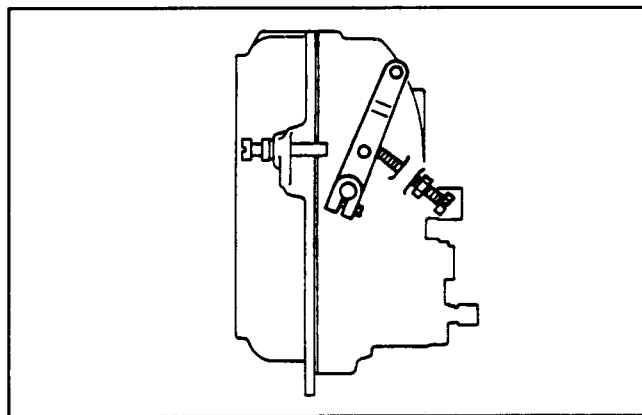


Figure 16

Idle adjusting screw

B. Turning the set bolt clockwise raises the idle speed.

C. If engine speed fluctuates at idle speed, turn the idle sub-spring adjusting screw clockwise to internally make slight contact with tension lever. The speed may rise slightly but should stop fluctuating.

IMPORTANT: When adjusting the screw, be sure to move it just enough to eliminate the unstable condition. Overadjusting the idle sub-spring screw is likely to result in engine overspeeding when the load is disengaged during operation.

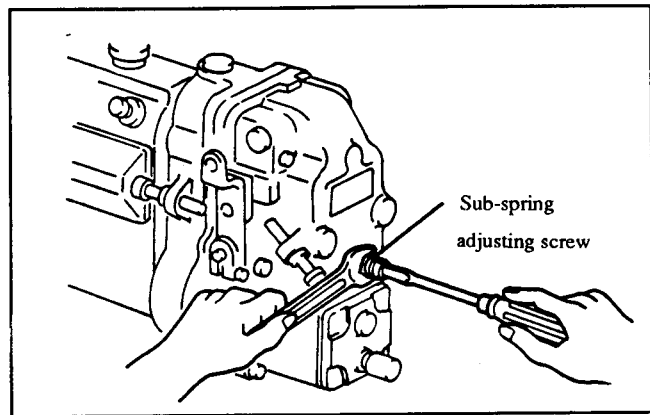


Figure 17

3. Rack set (maximum engine output)

A. Hold speed control lever at the position for the indicated output and speed (2750 rpm).

B. Under this condition, check to be sure that the engine is running in a steady state.

C. With the engine running in a steady condition, adjust the full-load stopper bolt, as follows:

D. Reposition the full-load stopper bolt by tightening or loosening to push in or pull out the fuel control rack in order to find out just where the engine produces the rated output.

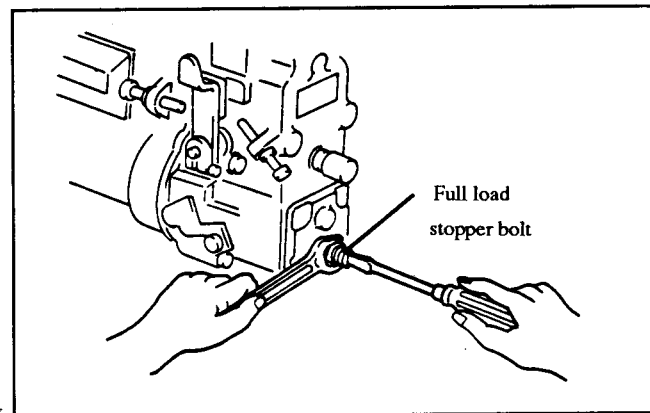


Figure 18

NOTE: Turning the full-load stopper bolt clockwise will increase the injection quantity (engine output).

E. Having positioned the stopper bolt for the rated output, back it off slowly while observing the speed which will be above the rated speed. Stop backing it off just when the speed begins to fall from the rated level. Secure the stopper bolt rack set bolt in that position with its lock nut.

F. At that time, the speed control lever should be at the position mentioned in A. above.

4. Governor set (maximum engine speed)

A. Hold speed control lever at the indicated maximum speed position while applying full load to the engine.

B. Run in governor set bolt maximum speed set bolt slowly until its forward end comes in contact with speed control lever held as above. Secure the bolt right there by tightening its lock nut.

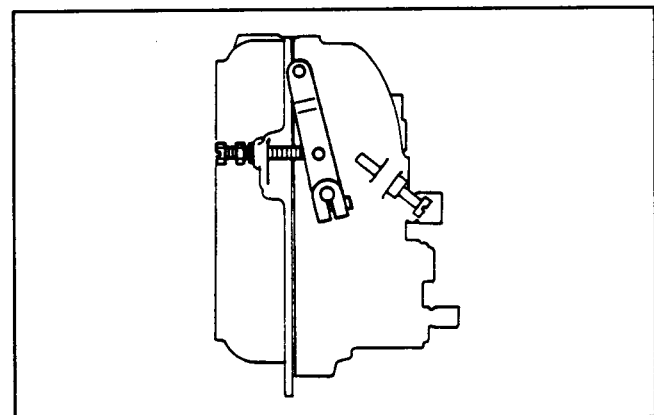


Figure 19

5. Adjustment of speed regulation (governor notch adjustment)

A. This adjustment increases or decreases the pre-tension of the governor spring.

B. To gain access to the adjusting screw, remove the plug at the top of the governor housing. Move speed control lever all the way to the low idle set bolt.

C. Tightening the adjusting screw increases the pre-tension of the governor spring to narrow speed range; loosening it decreases the governor spring pre-tension to widen the speed range.

D. Changing the setting of this adjusting screw affects the governor set for limiting the maximum engine speed. After making a governor notch adjustment, be sure to re-adjust the governor set as explained earlier.

IMPORTANT: The adjustable range is 20-notches 5 rotations. Never loosen the screw by more than 20 notches from the fully tightened position or the control action of the governor may not function.

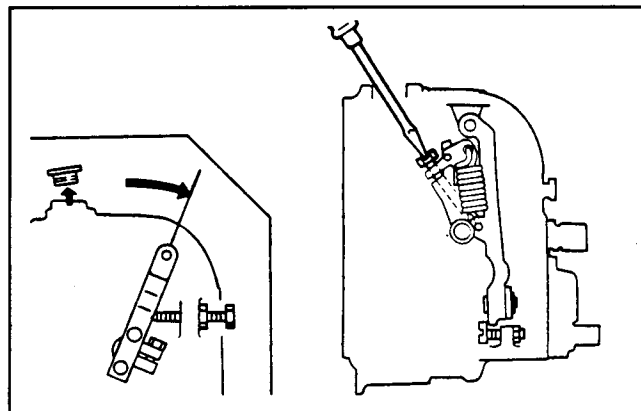


Figure 20

Throttle Linkage Adjustment

The throttle lever must not touch end of the slot during full range of motion from idle (SLOW) to full engine rpm (FAST) (Fig. 21).

1. For proper throttle lever operation, tighten nut so length of spring is 1.75 ± 0.06 in. long (Fig. 22).

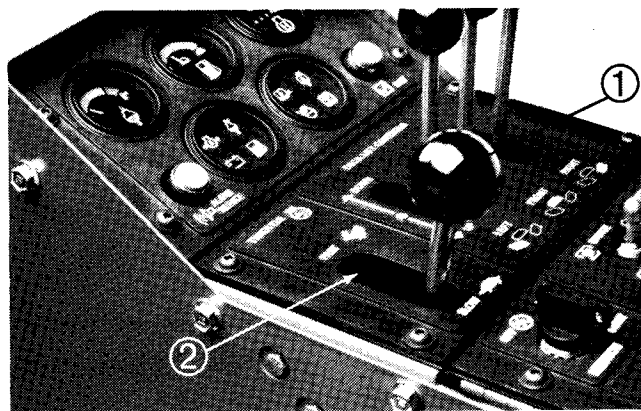


Figure 21

1. Throttle lever

2. Slot

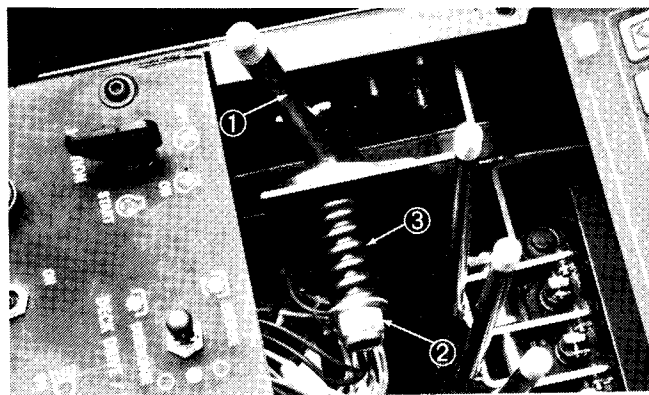


Figure 22

1. Throttle lever
2. Lock nut

3. Spring

2. Loosen jam nut and tighten adjusting nut (Fig. 23) so governor lever touches low and high speed set bolts without throttle lever touching end of slot at either FAST or SLOW position (Fig. 21).

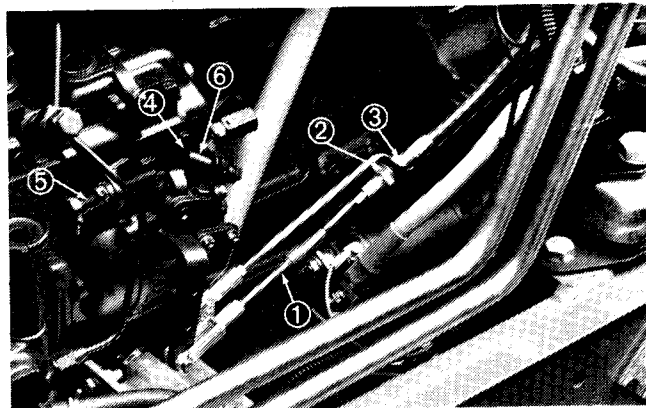


Figure 23

- | | |
|-------------------|------------------------|
| 1. Throttle cable | 4. Governor lever |
| 2. Adjusting nut | 5. Low speed set bolt |
| 3. Jam nut | 6. High speed set bolt |

Fuel Stop Solenoid Adjustment

Loosen jam nut on on front ball joint. With solenoid held IN as far as possible and engine stop lever held BACK as far as possible, adjust rod until it just fits in ball joint on solenoid. Then lengthen rod by turning it counterclockwise three (3) turns.

NOTE: Rod length must be adjusted so solenoid is fully bottomed out when energized or it will not hold in with HOLD coil energized.

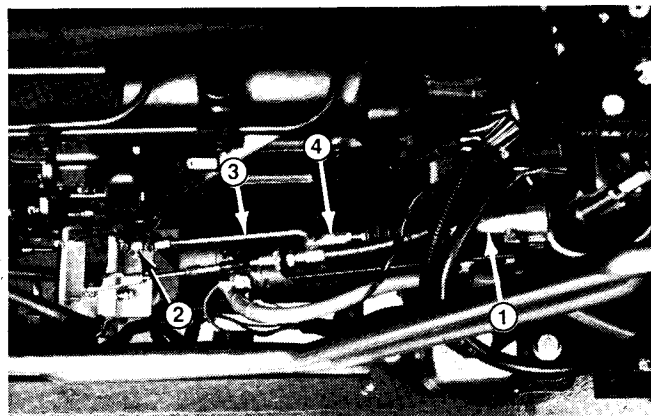


Figure 24

- | | |
|-----------------------|---------------|
| 1. Fuel stop solenoid | 3. Rod |
| 2. Engine stop lever | 4. Ball joint |

Fan Drive Belt Inspection And Adjustment

To inspect belt tension, apply thumb pressure to the belt midway between the pulleys. If the tension is incorrect, loosen the bolt (Item 1), make the adjustment, then tighten the bolt.

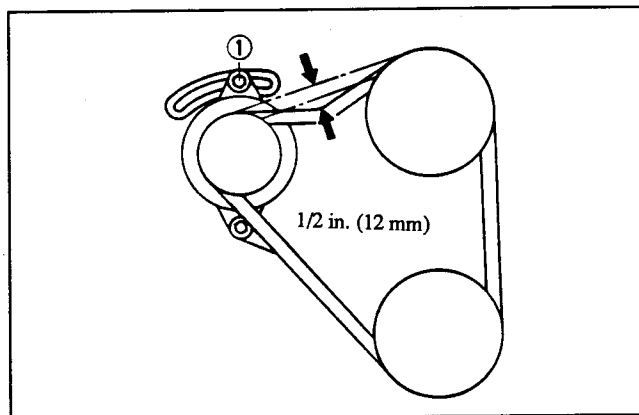


Figure 25

Engine Removal and Installation

Removing Engine

1. Open hood latches, raise hood and secure it in raised position with prop rod (Fig. 26). Open side panel latches and remove side panels.



Figure 26

1. Engine hood
2. Left side panel

3. Hood latches
4. Side panel latch

2. Remove E-clip from each gas spring bracket (Fig. 27). Do not remove gas spring rod end from bracket at this time.

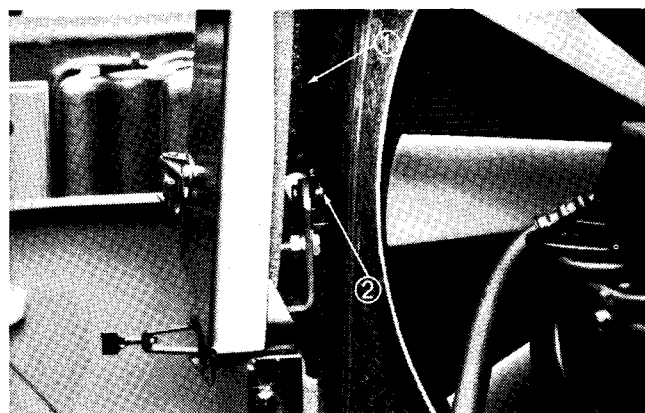


Figure 27

1. Gas spring

2. E-clip

3. Use a hoist or two (2) other people to help hold hood. Remove four (4) capscrews securing hood to hinges (Fig. 28), disconnect gas spring rod ends from brackets and lift hood off of machine.

4. Remove drain plug from oil pan and drain oil from engine. Disconnect two (2) oil cooler hoses from right side of engine near oil filter. Put caps on open hose ends. Remove hose clamps securing oil cooler hoses to engine.

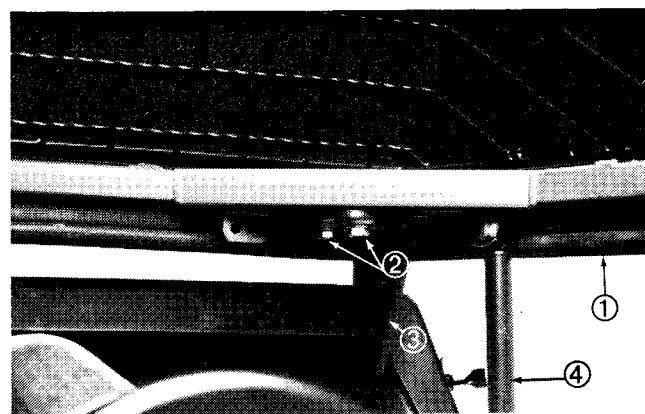


Figure 28

1. Hood
2. Capscrews

3. Hinge
4. Gas spring

5. Drain coolant by opening drain valve or loosening hose clamp and disconnecting lower coolant hose from radiator (Fig. 29). Loosen hose clamps and remove lower radiator hose from engine and radiator. Remove drain plug from left rear of engine block to drain coolant.

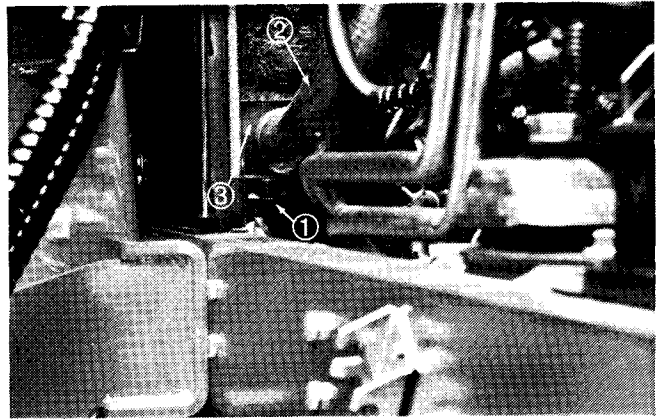


Figure 29

- 1. Drain valve
- 2. Lower coolant hose
- 3. Radiator

6. Remove four (4) capscrews to disconnect drive shaft from engine crankshaft pulley (Fig. 30).

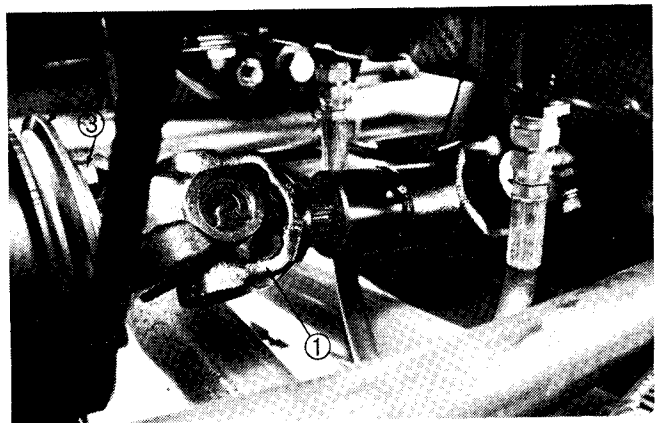


Figure 30

- 1. Drive shaft
- 2. Engine crankshaft pulley
- 3. Capscrew (4)

7. Open drain valve on bottom of fuel tank and drain fuel from tank (Fig. 31).

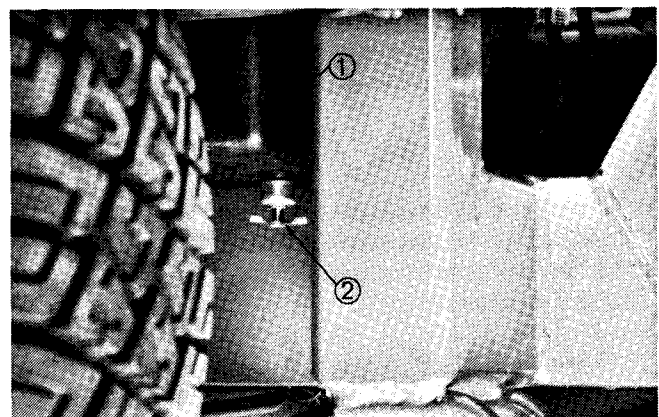


Figure 31

- 1. Fuel tank
- 2. Drain valve

8. Disconnect fuel line from "IN" fitting on fuel filter/water separator (Fig. 32). Disconnect throttle cable from governor lever. Remove two (2) capscrews and keps nuts and remove throttle cable bracket from left rear engine mount. Leave throttle cable attached to bracket. Leave engine run solenoid attached to engine mount.

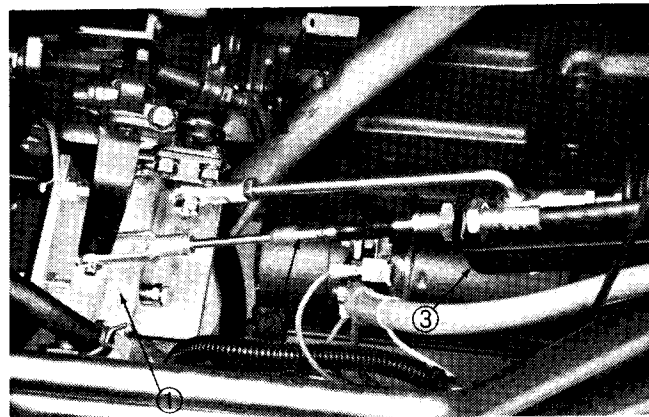


Figure 32

1. Fuel filter/water separator 3. Throttle cable bracket
2. Throttle cable

9. Starting at PTO solenoids, disconnect all wiring harness connectors, ground straps, cables and clamps from engine, brackets and hydraulic PTO manifold block (Fig. 33). Pull wiring harness out from right side of engine.

10. Remove two (2) capscrews and pull battery tray out (Fig. 33). Disconnect cables from batteries.

11. Remove six (6) capscrews and remove rear panel (Fig. 33).

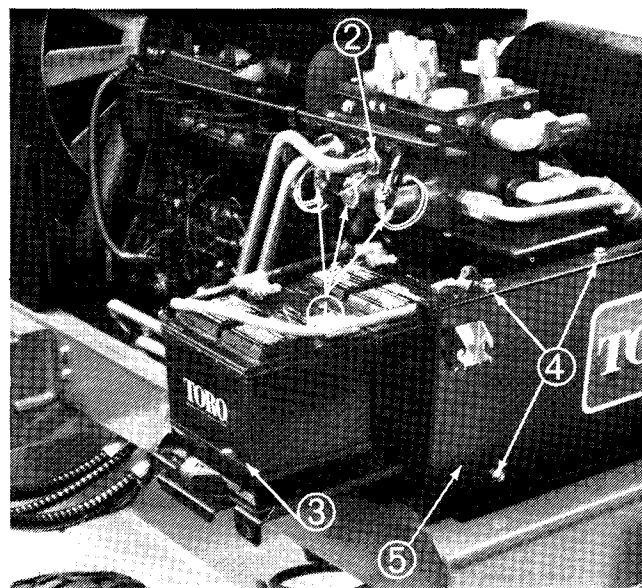


Figure 33

1. PTO solenoid (3) 4. Capscrew (6)
2. Wiring harness 5. Rear panel
3. Battery (2)

12. Push battery tray approximately half way and align tangs on battery tray with notches on rail, then lift up rear of battery tray and pull completely out of machine (Fig. 34).

13. Remove four (4) capscrews from PTO pump and pull PTO pump shaft out of drive coupling (Fig. 34). Leave hydraulic lines attached to pump.

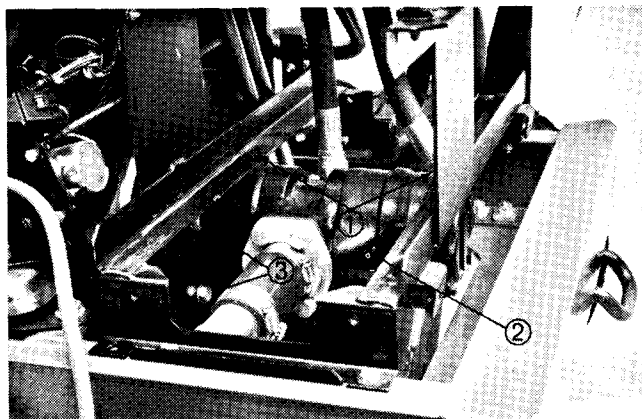


Figure 34

1. Notch on battery tray rail (2) 3. Capscrew (4)
2. PTO hydraulic pump

14. Loosen hose clamps and remove upper radiator hose (Fig. 35). Loosen hose clamps and remove air cleaner intake hose.

15. Remove engine cooling fan and fan coupler (Fig. 35). Remove hydraulic reservoir breather hose clamp from fan shroud. Remove fan shroud.

16. Use two (2) hanger bolts on engine to connect a short length of chain to use as a sling. One bolt is on left rear of engine where ground strap from battery is connected (Fig. 35). Other bolt is at front right of engine next to alternator (Fig. 36).

NOTE: It may be desirable to remove engine accessories before removing engine from chassis. (See Engine Accessory Removal and Installation section of this chapter.)

17. Remove four (4) large capscrews securing engine mount brackets to engine mounts (Fig. 35, 36)

18. Connect hoist or block and tackle chain at center of short section of chain. One person should operate hoist or block and tackle and two (2) other people should help guide engine out of chassis. Remove engine from chassis. Be careful when removing engine to prevent damage to engine, radiator, hydraulic tubing or other parts. Mount engine in an engine rebuilding stand.

19. Put caps or plugs on any hydraulic lines that are disconnected to prevent contamination.

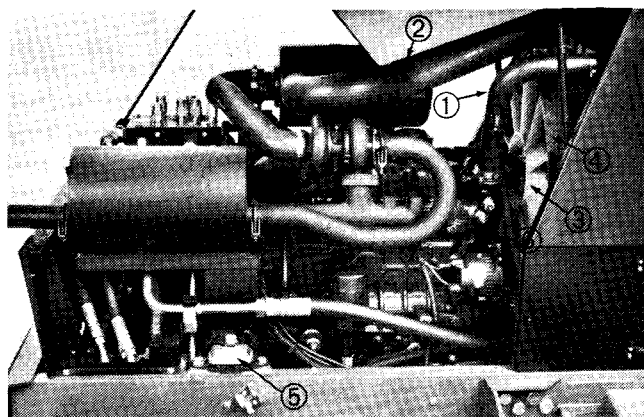


Figure 35

- | | |
|------------------------|-----------------|
| 1. Upper radiator hose | 4. Fan shroud |
| 2. Air intake hose | 5. Engine mount |
| 3. Fan and coupler | 6. Hanger bolt |

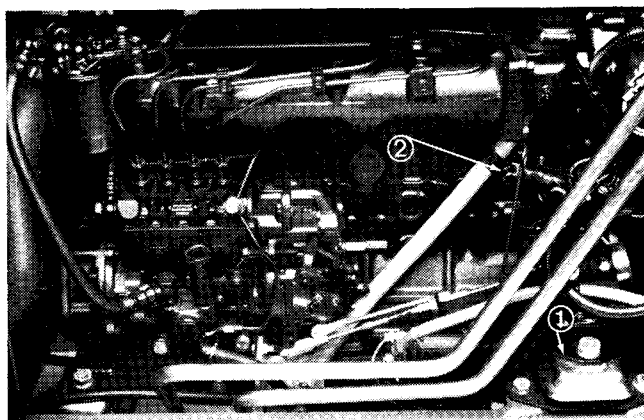


Figure 36

- | | |
|-----------------|----------------|
| 1. Engine mount | 2. Hanger bolt |
|-----------------|----------------|

Installing Engine

1. To install the engine, reverse steps 1 - 19 under Removing Engine.

2. Install a new engine oil filter. Fill engine with correct oil. Fill cooling system with a 50/50 solution of ethylene glycol antifreeze and clean, soft water. Check for oil and coolant leaks and repair as necessary.

3. Fill fuel tank and bleed fuel system.

4. Start engine and check for oil or coolant leaks.

5. Check engine speed and adjust governor lever if necessary for correct idle and maximum engine speed.

Engine Accessory Removal and Installation

This section explains the procedures and tips for removal and installation of the accessories—the preliminary process to go through for overhauling the engine.

Preparatory Steps

- A. Shut off fuel supply and disconnect the electrical wiring from the engine.
- B. Loosen the drain on left rear side of crankcase and drain coolant.
- C. Loosen the oil pan drain plug and drain engine oil.



WARNING

Hot engine fluid can cause personal injury if it contacts the skin. Use caution when draining the fluids.

Engine Accessory Removal

1. Removing turbocharger

- A. Disconnect pipe (2) between turbocharger (1) and air cleaner.
- B. Disconnect turbocharger lubricating oil pipe (3) and drain pipe (4).
- C. Remove turbocharger from exhaust manifold.

2. Removing fuel injection pipes

- A. Remove pipe clamps. Disconnect and remove injection pipes.

IMPORTANT: Be sure to put caps on the openings of the injection pump and nozzle holders to prevent dust from getting into the fuel system.

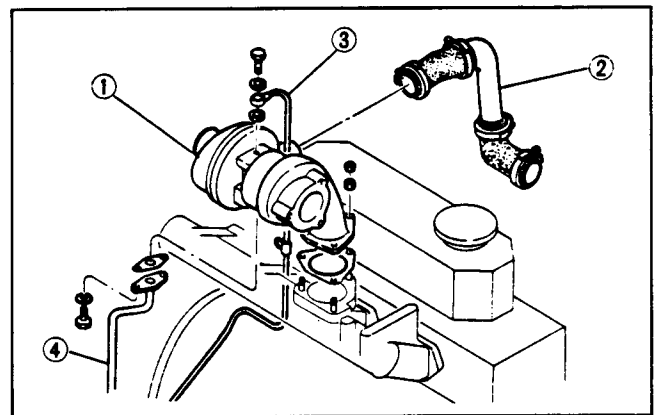


Figure 37

3. Removing fuel injection nozzles

Take off nozzle gland (1) and remove nozzle (2) complete with gasket (3).

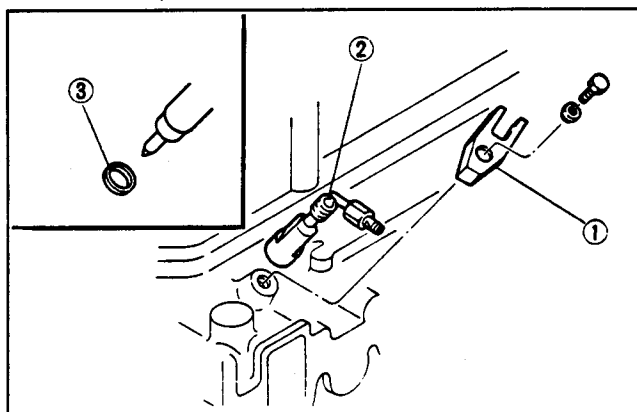


Figure 38

4. Removing fuel filter and inlet and exhaust manifolds

A. Disconnect fuel hose (1) from fuel filter. Remove filter (2) by unscrewing its mounting bolts.

B. Remove inlet manifold (3) and exhaust manifold (4) by unscrewing mounting bolts.

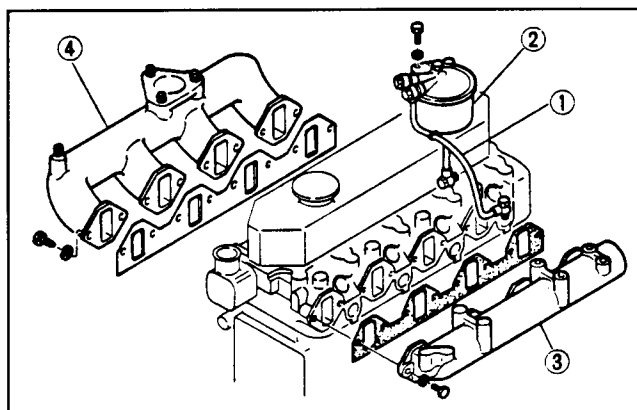


Figure 39

5. Removing fuel injection pump

Disconnect oil feed pipe (1) and remove cover (2). Remove injection pump (4) from the timing gear case by unscrewing two mounting bolts (3).

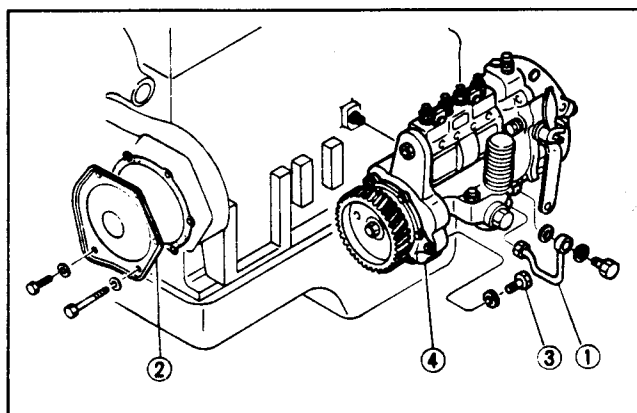


Figure 40

6. Removing thermostat

- A. Disconnect bypass hose (1).
- B. Unscrew elbow attaching bolts, and remove elbow (2), thermostat (3) and gasket (4).

NOTE: At reassembly, install thermostat with its air vent hole facing upward.

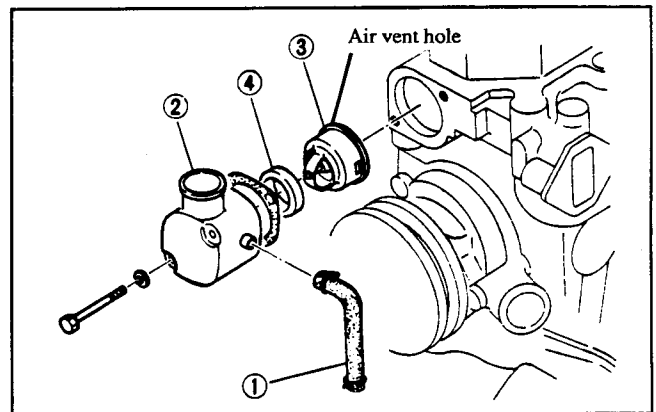


Figure 41

7. Removing water pump

- A. Remove fan (1). Slacken fan belt (2) and remove it from water pump (4).
- B. Disconnect oil pipe (3).
- C. Remove water pump by unscrewing its mounting bolts.

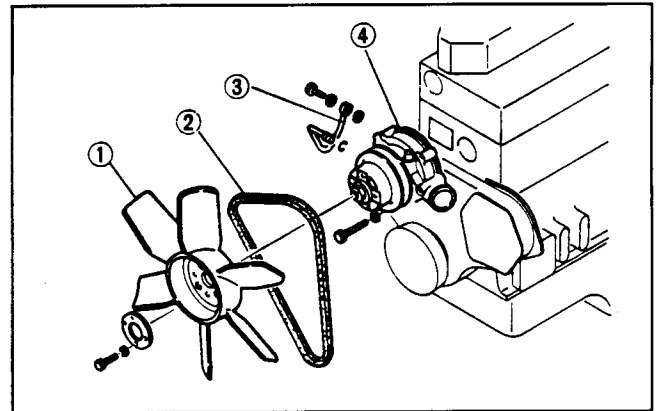


Figure 42

8. Removing alternator

- A. Disconnect harness (1) and unscrew belt adjusting plate bolt (2).
- B. Remove alternator (4) by unscrewing mounting bolts (3).

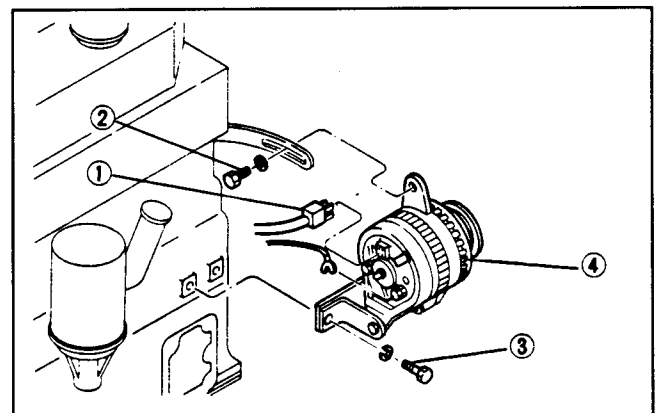


Figure 43

9. Removing starter

- Disconnect harness (1) and remove starter (3) by unscrewing mounting bolts (2).

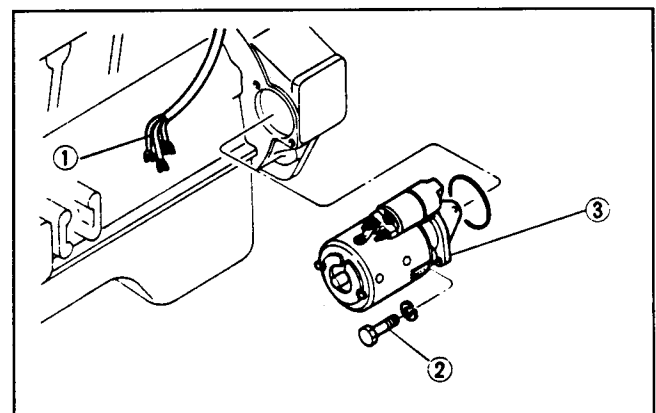


Figure 44

10. Removing oil filter

Remove oil filter (2) complete with its bracket by unscrewing mounting bolts (1).

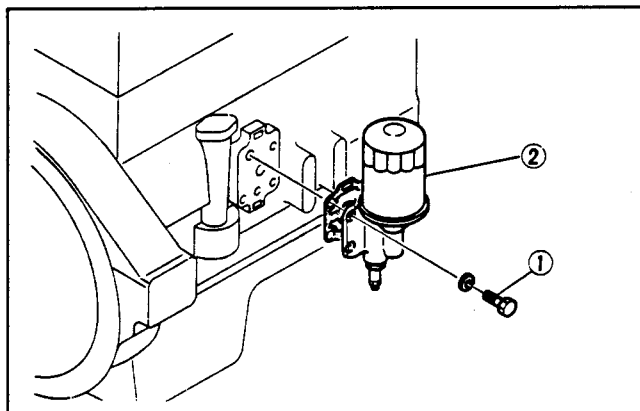


Figure 45

11. Removing oil pan and oil pump

A. Remove oil pan (2) by unscrewing mounting bolts (1).

B. Remove oil pump (4) by unscrewing mounting bolt (3).

NOTE: Camshaft gear may interfere with pump drive gear and hinder removal. Remove pump by turning crankshaft slightly.

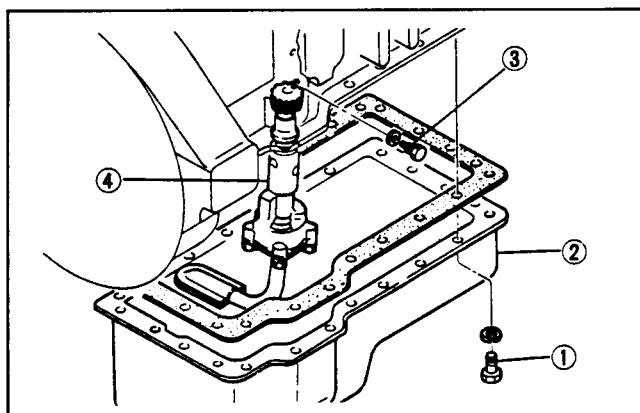


Figure 46

Engine Accessory Installation

To install the engine accessories, use reverse of the removal procedures. After installation take the following steps:

1. Installing fuel injection pump

Make sure that matching marks on pump drive gear and other gears are aligned with those on idler gear as shown.

NOTE: When these matching marks are all aligned, No. 1 cylinder piston is at top dead center on compression stroke.

2. Refill the engine with recommended oil to the specified level.

3. Refill the cooling system with coolant.

4. Check each pipe connection for oil or coolant leaks.

5. Prime the fuel system.

6. After installing the fuel injection pump, inspect and adjust the injection timing.

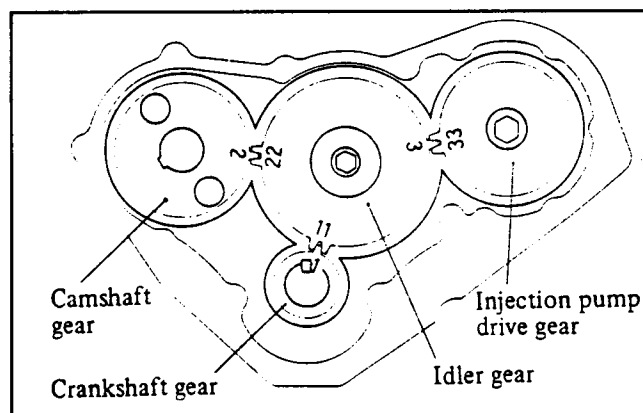


Figure 47

Cylinder Head And Valves

Dissassembly

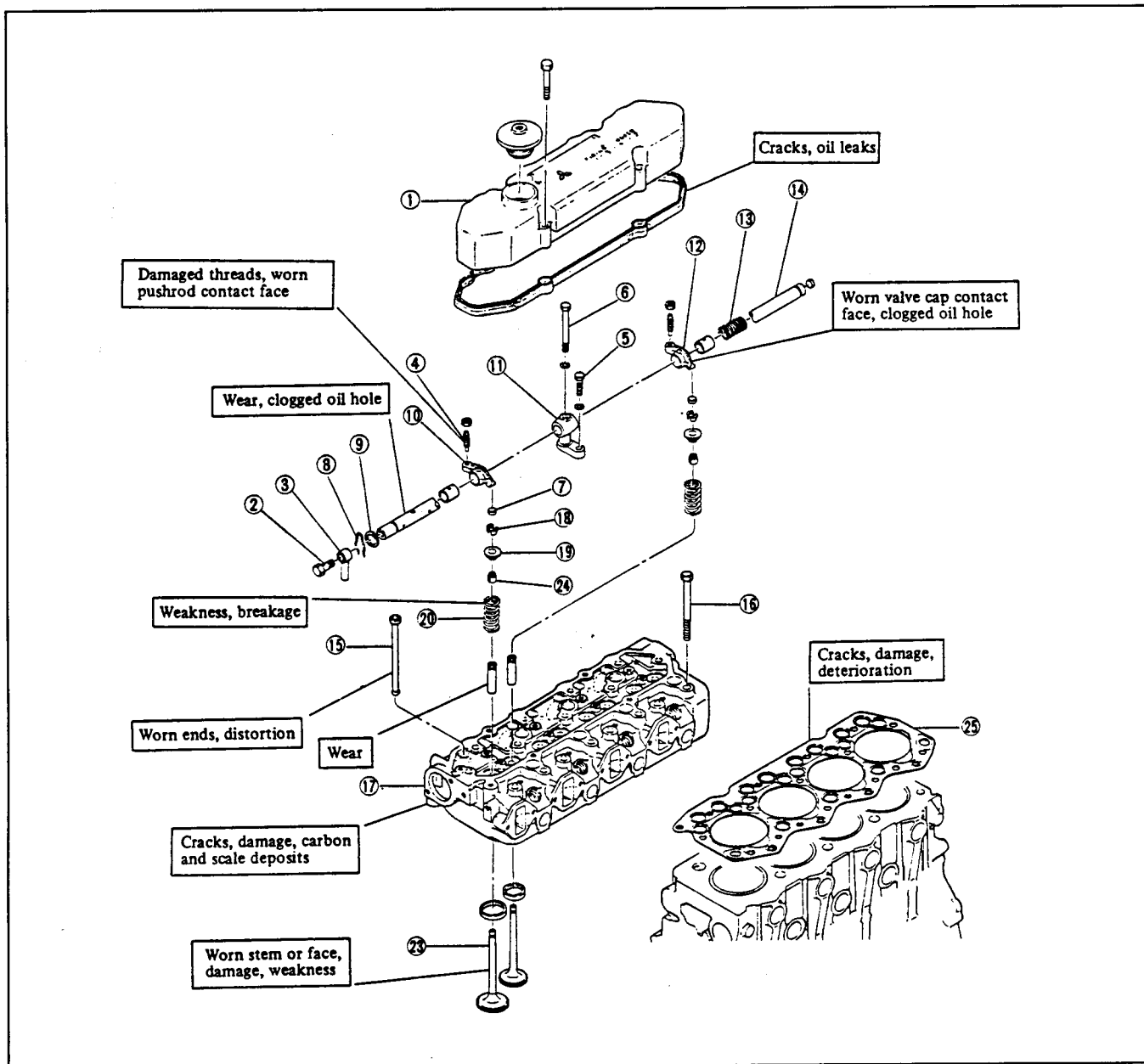


Figure 49

1. Rocker cover
2. Eye bolt
3. Oil pipe
4. Adjusting screw
5. Bolt (short)
6. Bolt (long)
7. Valve cap
8. Snap ring
9. Washer

10. Inlet rocker arm
11. Rocker shaft bracket
12. Exhaust rocker arm
13. Rocker shaft spring
14. Rocker shaft
15. Valve pushrod
16. Cylinder head bolt
17. Cylinder head
18. Valve cotter

19. Upper retainer
20. Outer valve spring
23. Valve
24. Valve stem seal
25. Cylinder head gasket

1. Removing rocker shaft assembly

A. Loosen the adjusting screw of each rocker about one rotation.

B. Loosen the rocker bracket short bolt and long bolt in that order, and remove the rocker shaft assembly from the cylinder head.

IMPORTANT: If these bolts are loosened in reverse order, the rocker shaft bracket may become damaged.

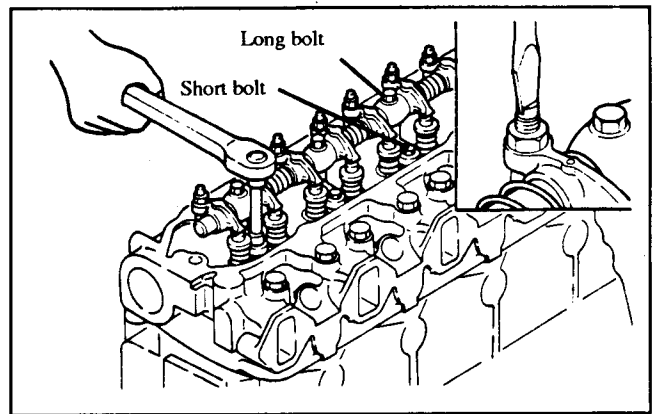


Figure 50

2. Disassembling rocker shaft assembly.

Position the disassembled rocker in the order removed, and install them in that order at the time of reassembly. This is for reproducing the same rocker shaft-to-rocker arm clearance as before.

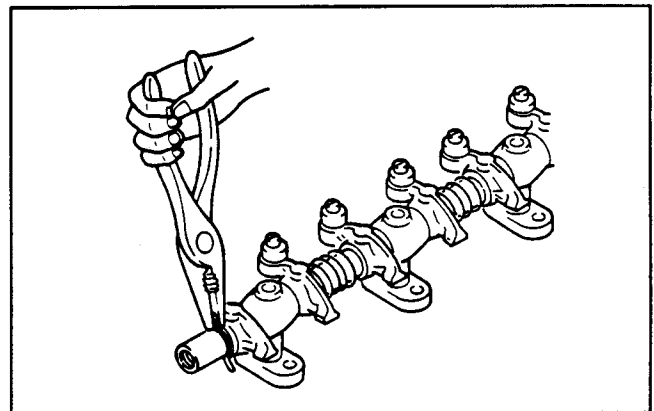


Figure 51

3. Removing cylinder head

Unscrew the cylinder head bolts and lift the head off the crankcase.

IMPORTANT: When removing the gasket from the crankcase, be careful not to damage the mounting surface of crankcase.

If any cylinder head parts are out of order, check the cylinder head bolts for tightening torque with a torque wrench before removing the head bolts.

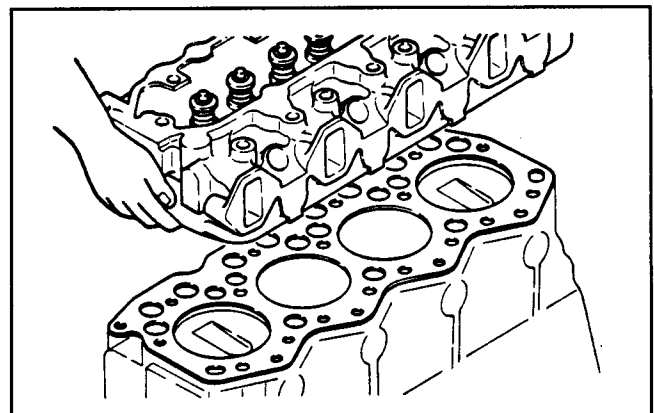


Figure 52

4. Removing valves and valve springs

Using a valve spring compressor, compress the valve spring squarely and remove the valve keepers.

NOTE: If the valves are to be reused, mark them for their locations to aid installation at the time of reassembly.

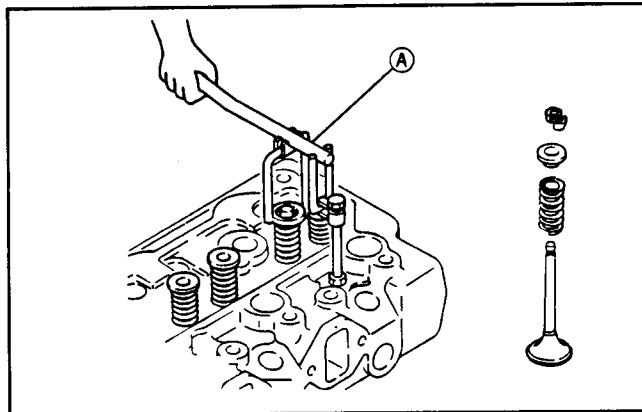


Figure 53

Inspection and Repair

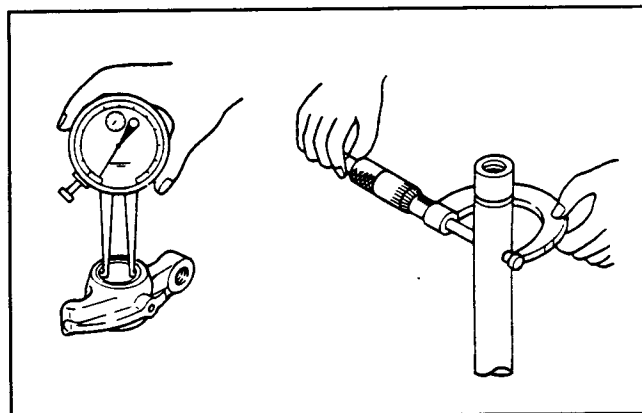
Rocker arms, rocker bushings and rocker shafts

1. Measuring rocker bushing inside diameter and rocker shaft diameter.

Determine the clearance between the bushing and shaft on the basis of the measurements. If the Repair limit is reached, replace the bushing. If it is exceeded, replace both bushing and shaft.

Unit: mm (in).

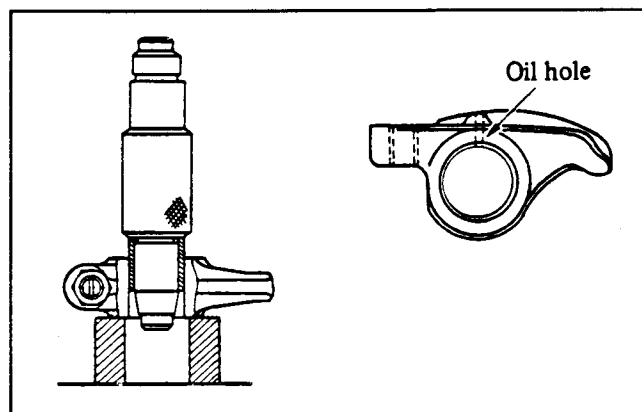
Item	Nominal Value	Assembly standard	Repair limit
Rocker bushing inside diameter		20.000 - 20.021 (0.78740 - 0.78823)	
Rocker shaft diameter		19.984 - 19.966 (0.78677 - 0.78606)	
Rocker shaft-to-bushing clearance	20 (0.79)	0.016 - 0.055 (0.00063 - 0.00217)	0.070 (0.00276)



Measuring rocker bushing and rocker shaft

2. Replacing rocker bushings

When installing a replacement bushing, align the oil holes in the bushing and rocker arm.



Replacing rocker bushing

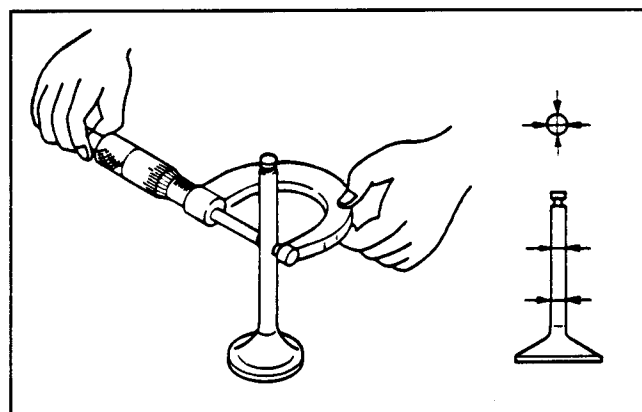
Valves, Valve Guides and Valve Seats

1. Measuring valve stem diameter

If the Service limit is exceeded, or if the stem is abnormally worn excessively, replace the valve.

Unit: mm (in.)

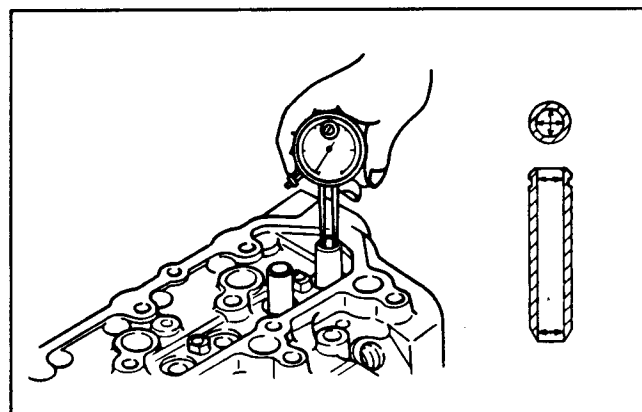
Item		Assembly standard	Service limit
Valve stem diameter	Inlet	7.955 - 7.940 (0.31319 - 0.31260)	7.900 (0.31102)
	Exhaust	7.940 - 7.920 (0.31260 - 0.31181)	7.850 (0.30905)



Measuring valve stem

2. Measuring valve stem-to-guide clearance

The valve guide wears more rapidly at the ends than through the center. Measure the guide at its ends and in two directions at right angles to each other. If the Service limit is exceeded, replace the guide.



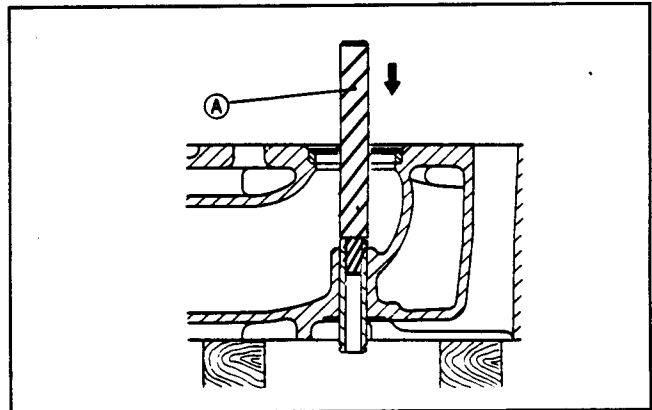
Measuring valve guide

Unit: mm (in.)

Item		Nominal value	Assembly standard	Service limit
Valve stem-to-guide clearance	Inlet	8 (0.31)	0.055 - 0.085 (0.00217 - 0.00335)	0.150 (0.00591)
	Exhaust		0.070 - 0.105 (0.00276 - 0.00413)	0.020 (0.00787)
As-installed depth of valve guide		17 (0.67)	± 0.3 (± 0.012)	

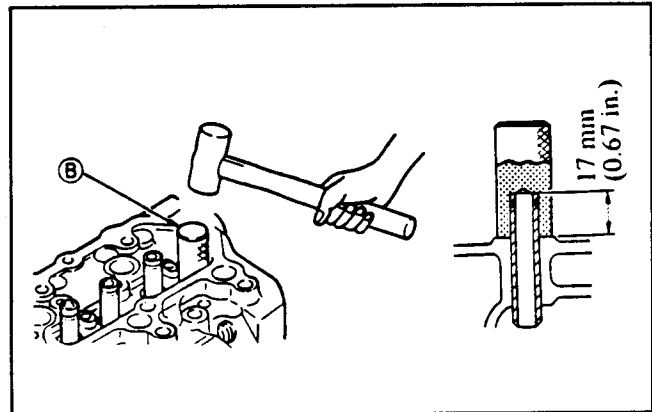
3. Replacing valve guides

A. Using a valve guide remover, remove the worn guide.



Removing valve guide

B. To install a replacement guide, use valve guide installer to position the new guide at the proper depth.



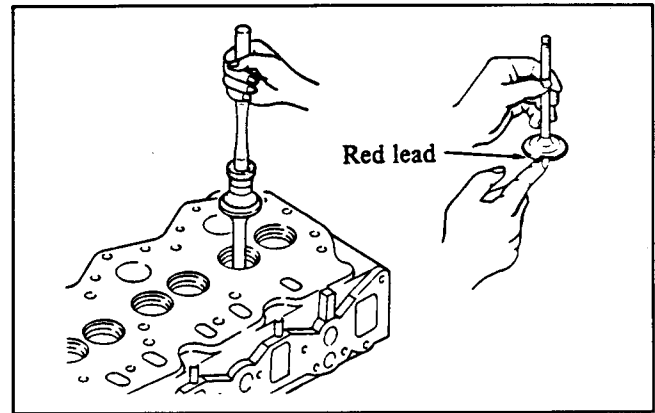
Installing valve guide

4. Inspecting valve face

Coat the valve face lightly with red lead and, using valve lapper, check the valve contact with its seat. If the contact is not uniform, or if the valve is defective or the Repair limit is exceeded, repair or replace the valve and valve seat.

IMPORTANT: Check the valve face after inspecting or replacing the valve guide.

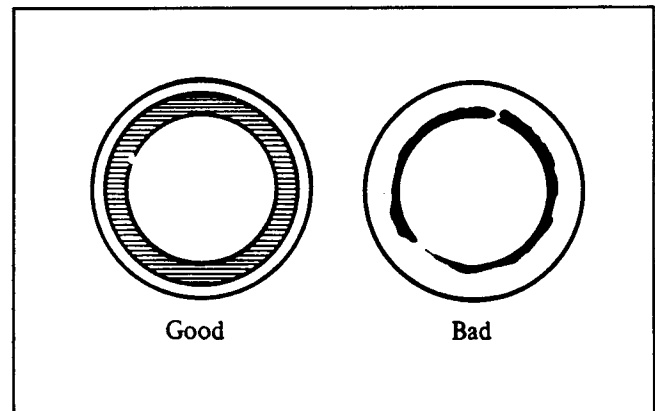
Press the valve into the seat without rotating it.



Inspecting valve guide

Unit: mm (in.)

Item		Assembly standard	Repair limit
Valve seat	Angle	30 degrees	
	Valve sinkage	0.4 ± 0.2 (0.016 ± 0.008) [IN] 0.5 ± 0.02 (0.020 ± 0.008) [EX]	1.1 (0.043)
	Width	1.2 ± 0.14 (0.047 ± 0.0055)	1.6 (0.063)
Valve margin		2.13 (0.0839)	Up to 1.2 (0.047) by refacing



Valve contact with its seat

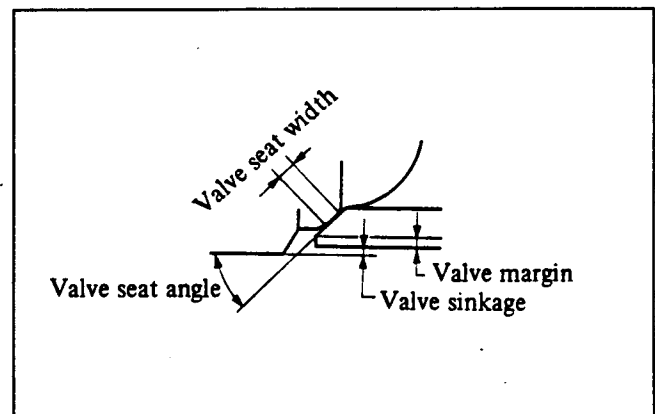


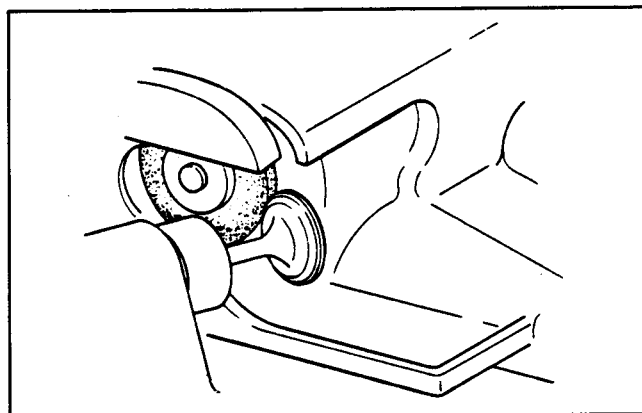
Figure 54

5. Refacing valves

If the valve face is worn, it may be refaced.

IMPORTANT: Regrind valve angle at 30 degrees.

If the valve margin is less than the Repair limit when ground, replace the valve.



Refacing valve

6. Refacing the valve seats

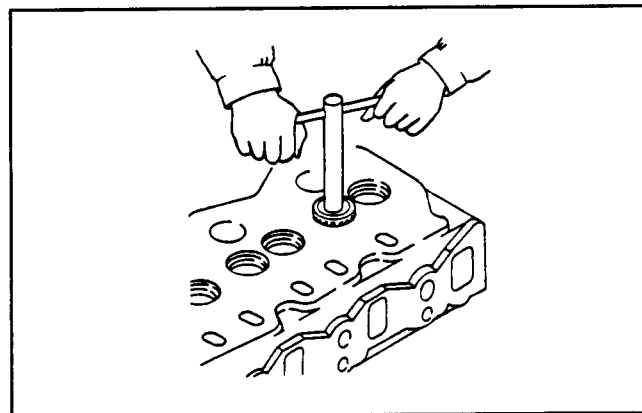
A. Using a valve seat cutter or valve seat grinder, cut the valve seat.

B. Lap the valve to the seat.

IMPORTANT: Cut or grind the valve seat only as necessary for refacing.

If the seat width is in excess of the Repair limit as a result of wear or cutting, replace the valve seat.

If the valve sinkage exceeds the Repair limit after refacing, replace the valve seat.



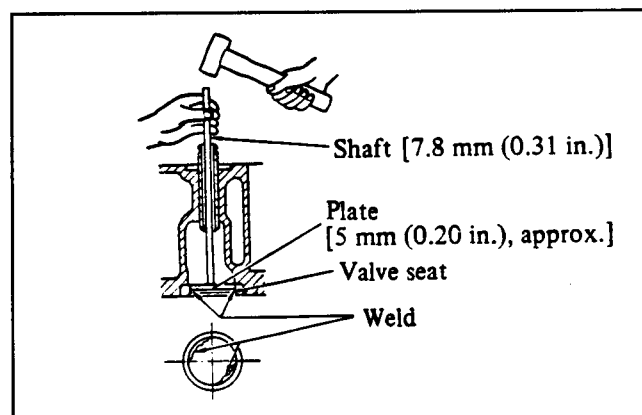
Refacing valve seat

7. Replacing valve seats

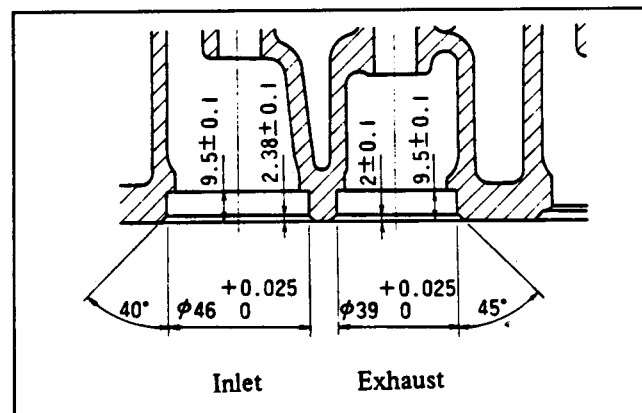
A. Weld a plate of about 5 mm 0.20 in. thickness to the valve seat. Insert a shaft into the valve guide hole from the upper side of cylinder head, and drive the seat off the head as shown.

IMPORTANT: When welding the plate, be careful not to permit spatters to come in contact with the machined surfaces of cylinder head.

B. Measure dimensions of valve seat holes in the cylinder head before installing valve seats and make sure that they are as specified.



Removing valve seat



Valve seat dimensions

C. Chill the valve seat in liquid nitrogen about -170 degrees C (-247 degrees F) for more than 4 minutes with the cylinder head kept at normal temperature, or heat the cylinder head to 80 degrees C to 100 degrees C (176 degrees F to 222 degrees F) with the valve seat chilled in ether or alcohol containing dry ice.

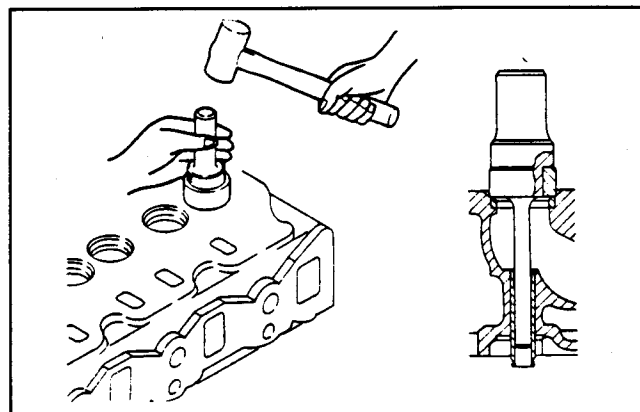
D. Use a valve seat installing tool to install the valve seat.

8. Lapping valves in valve seats.

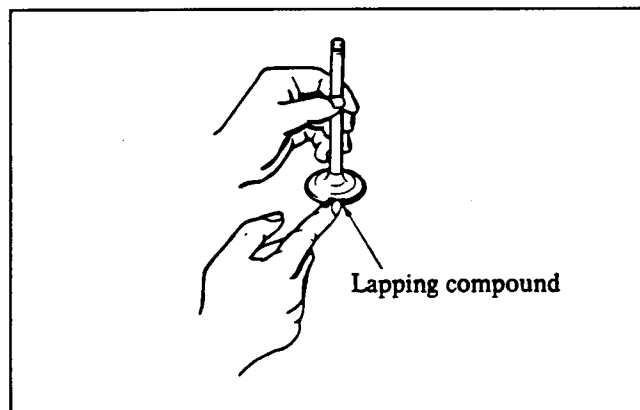
Be sure to lap the valves in the valve seats after the seats have been replaced.

IMPORTANT: Do not permit the compound to come in contact with the valve stem.

Use 120 to 150 grit for initial lapping and 200 grit for finish lapping.



Installing valve seat



Coating valve with lapping compound

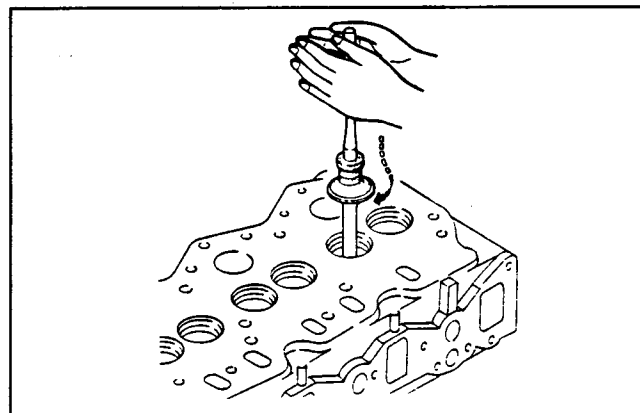
Valve Springs

Measuring squareness and free length

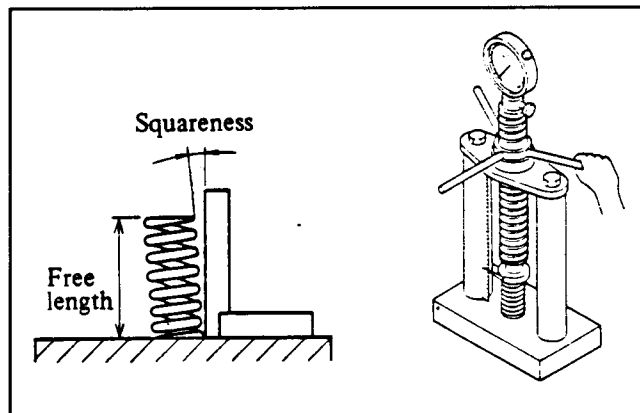
If the squareness or free length exceeds the Service limit, replace the spring.

Unit: mm (in.)

Item		Assembly standard	Service limit
Outer spring	Free length	56.40 (2.2205)	55.00 (2.1654)
	Squareness deg	2, maximum	
	Test force/length under test force kgf (lbf)	23.9 \pm 1.2 (52.7 \pm 2.6)	21.2 (46.7)
Inner spring	Free length	40.8 (1.606)	39.8 (1.567)
	Squareness deg	1.5, maximum	
	Test force/length under test force kgf (lbf)	6 \pm 0.3 (13 \pm (0.7)	4.6 (10)



Lapping valve in valve seat



Measuring valve spring

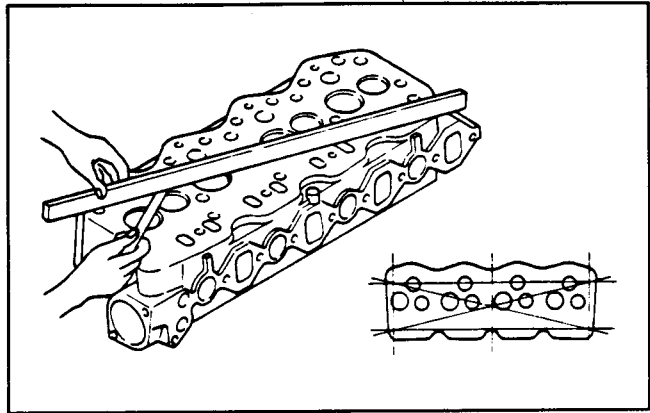
Cylinder Head

Measuring surface warpage

Measure warpage with a straightedge and a feeler gauge. If the warpage exceeds the Repair limit, reface the surface with a surface grinder.

Unit: mm (in.)

Item	Assembly standard	Repair limit
Cylinder head gasketed surface warpage	0.05 (0.0020), maximum	0.020 (.0079)



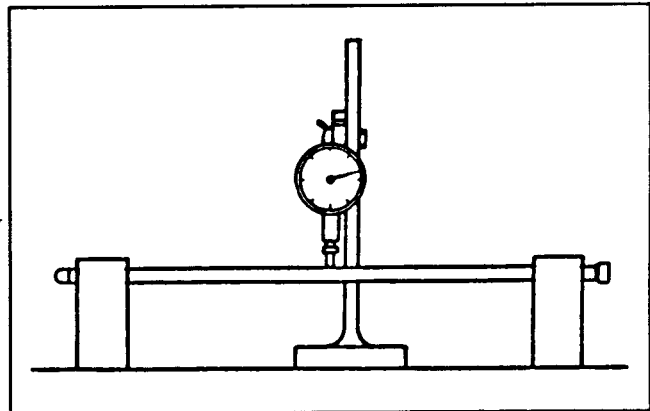
Measuring cylinder head gasketed surface warpage

Valve Pushrods

If the runout exceeds the Assembly standard, replace the pushrods.

Unit: mm (in.)

Item	Assembly standard
Valve pushrod runout	0.04 (0.016), maximum



Measuring pushrod runout

Reassembly

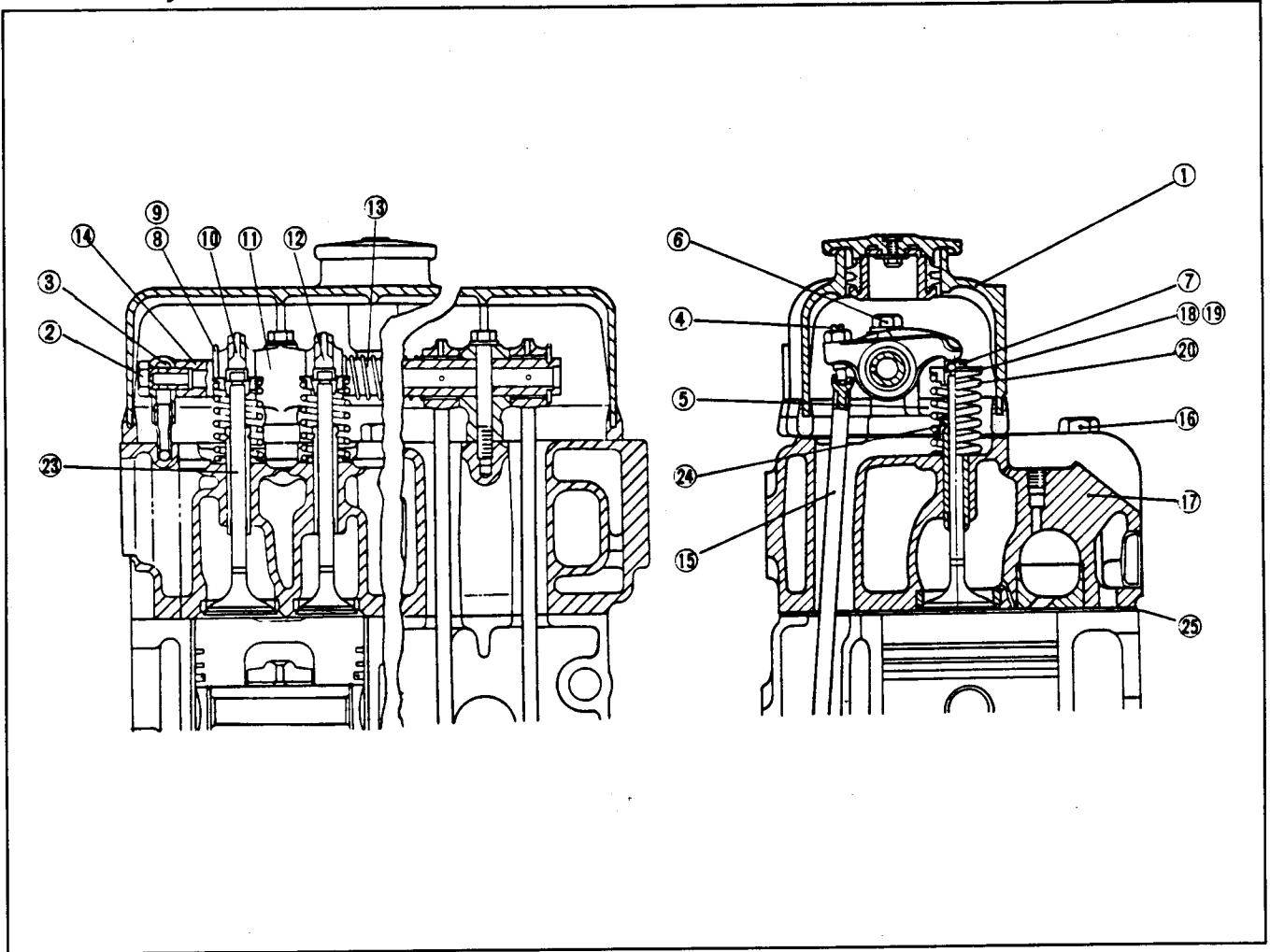


Figure 55

Reassembling sequence

17→24→23→22→21→20→19→18→25→16→15
 14→13→12→11→10→ 9→ 8]→7→6→5→3→2→4→1

1. Installing valve stem seal

After installing the stem seal to the valve guide, make sure that the seal is properly fitted in the groove of the guide.

IMPORTANT: Do not apply any oil or sealant to the mating face of stem seal that comes in contact with the valve guide. When installing the stem seal, coat the valve stem with engine oil to insure initial lubrication of the stem seal lip.

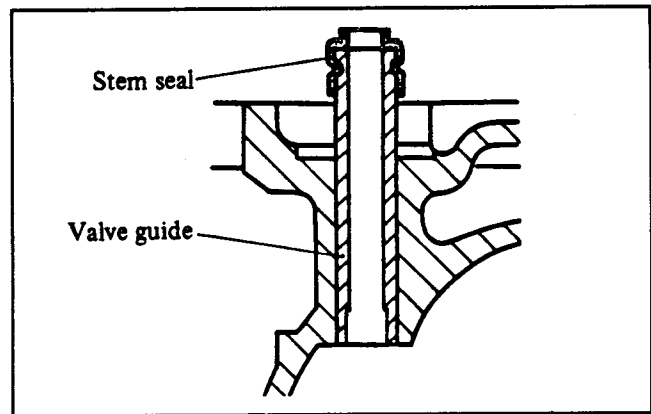


Figure 56

2. Installing valves and valve springs

A. Install the valve spring and retainer to the valve guide with spring compressor and install the retainers.

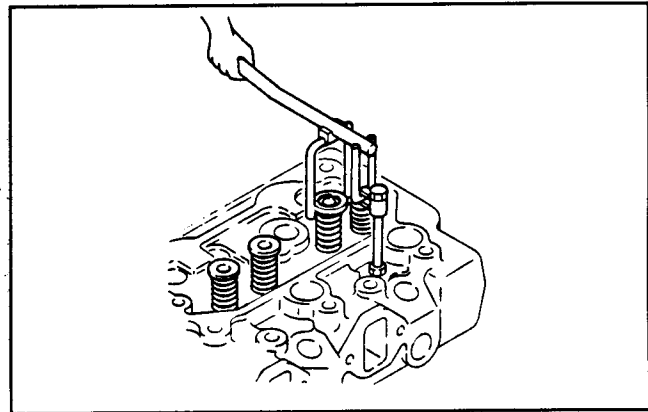


Figure 57

B. Using a soft hammer, give light blows to the valve stem top several times to make sure that the spring and retainer are properly installed.

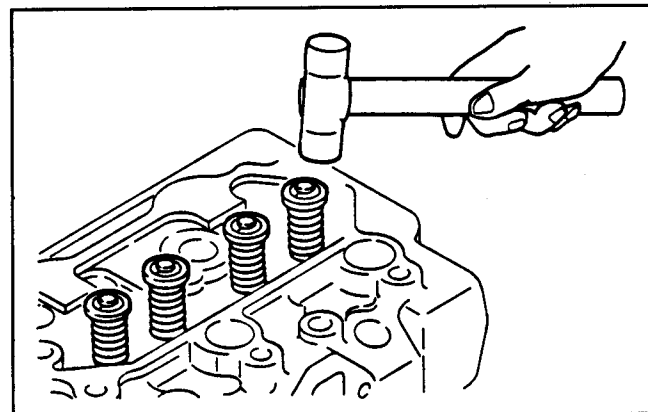


Figure 58

3. Installing cylinder head

A. Screw two guide bolts into the crankcase to hold the gasket in place.

B. Place the cylinder head on the crankcase as guided by the two guide bolts. Apply engine oil to the threads of cylinder head bolts and insert the bolts into the head.

IMPORTANT: Do not apply any sealant to the cylinder head bolts.

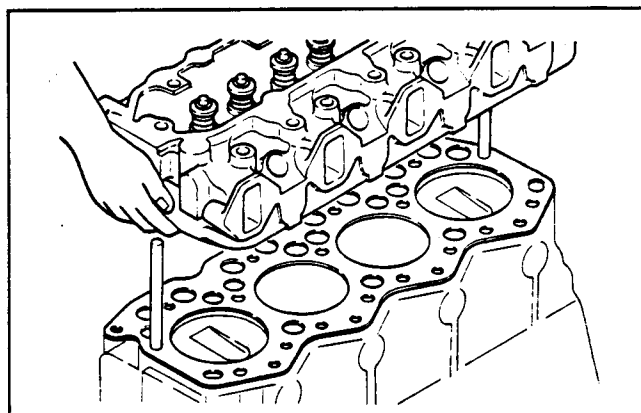
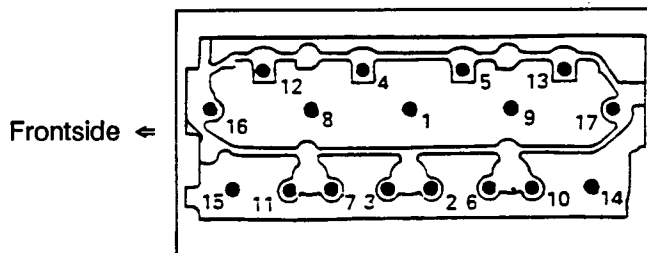


Figure 59

C. Tighten the cylinder head bolts to the specified torque in the sequence shown.

S4F : No. of bolts: 17



Unit: kgf .m (lbf-ft)

Tightening torque	12 ± 0.5 (87 \pm 4)
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4. Reassembling rocker shafts

The rocker arms for inlet valves are different in dimension from those for exhaust valves. After installing the arms, make sure that they move freely.

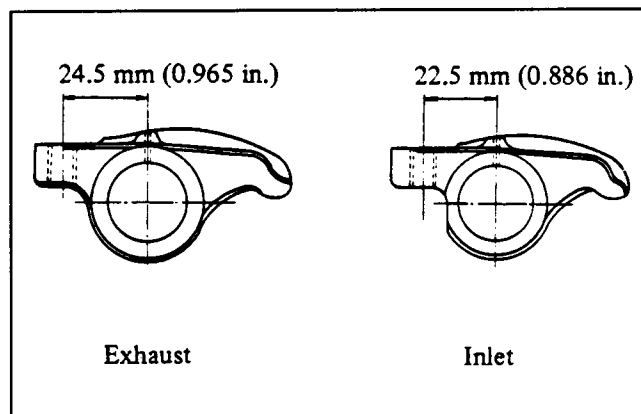


Figure 60

5. Installing rocker shaft assembly.

Tighten the long bolt (1) and short bolt (2) in that order (by following the reverse of loosening order).

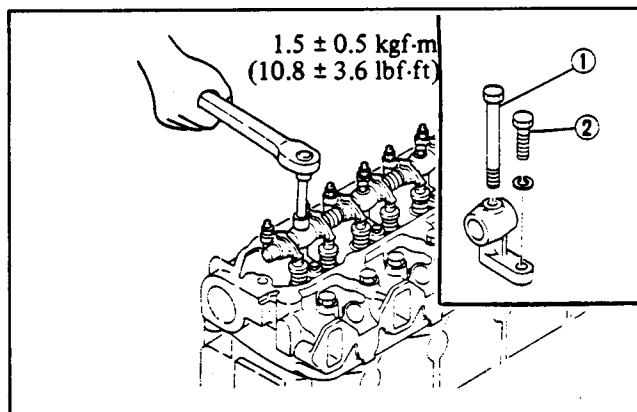


Figure 61

6. Adjusting valve clearance

(See Valve Clearance in the Adjustments section of this chapter.)

Flywheel, Timing Gears and Camshaft

Disassembly

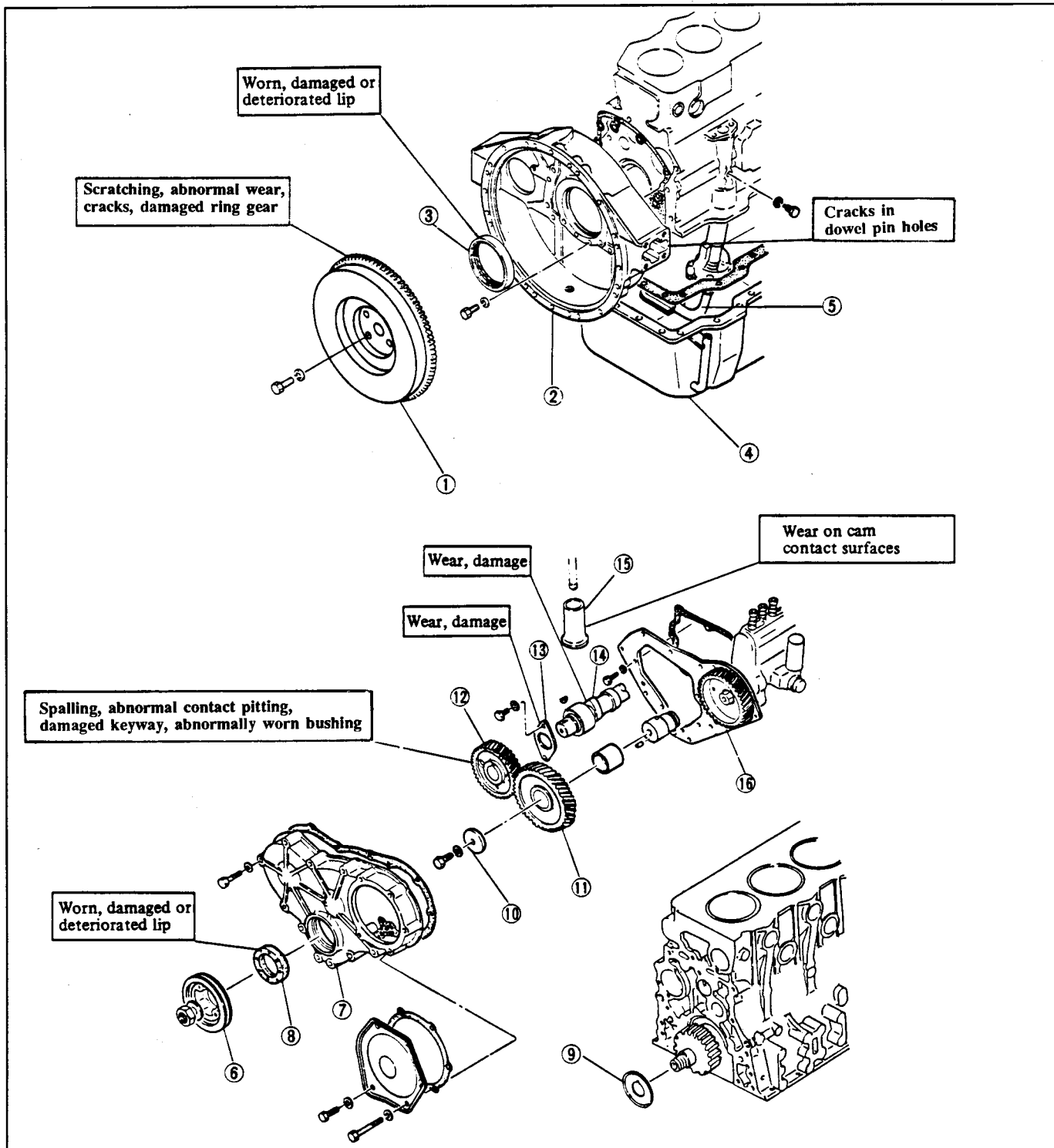


Figure 62

- 1. Flywheel
- 2. Flywheel housing
- 3. Oil seal
- 4. Oil pan
- 5. Oil pump
- 6. Cranshaft pulley

- 7. Timing gear case
- 8. Oil seal
- 9. Deflector plate
- 10. Thrust plate
- 11. Idler

- 12. Camshaft gear
- 13. Thrust plate
- 14. Camshaft
- 15. Tappet
- 16. Front plate

1. Removing flywheel

A. Unscrew the flywheel mounting bolts.

B. Install the jacking bolts into the holes provided in the flywheel uniformly and remove the flywheel.

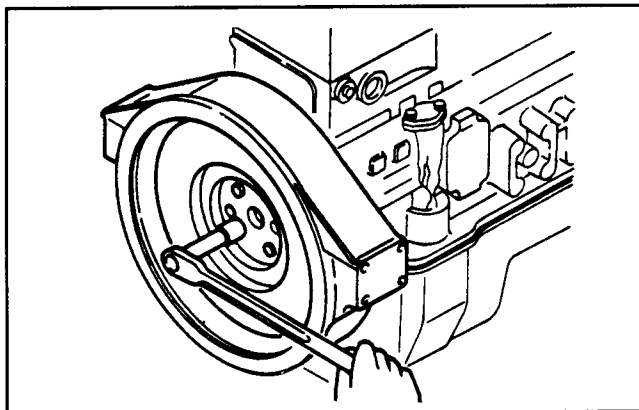


Figure 63

2. Removing flywheel housing

Unscrew the housing mounting bolts and remove the housing.

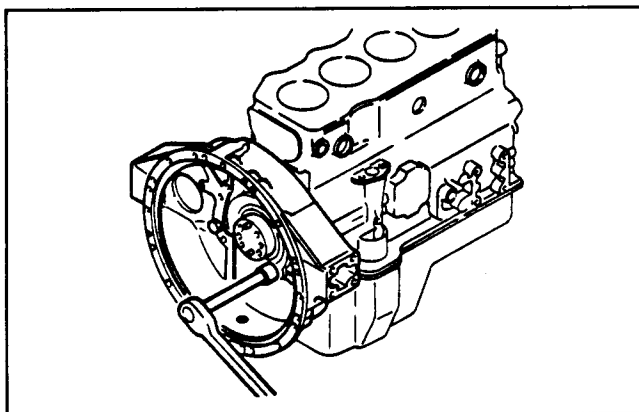


Figure 64

3. Removing oil pan and oil pump

Unscrew the oil pan mounting bolts and remove the oil pan. Then, remove the oil pump by unscrewing its bolt. (See Accessory Removal and Installation section of this chapter.)

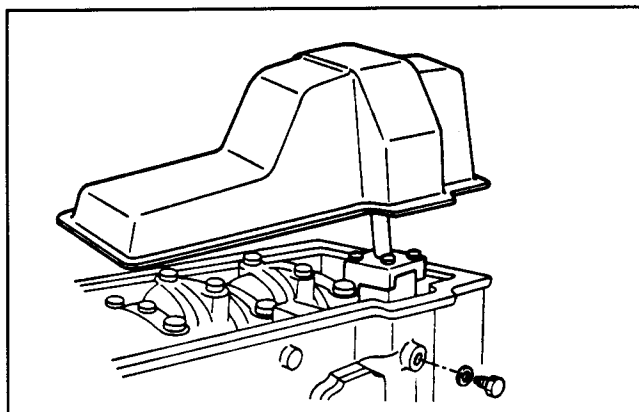


Figure 65

4. Removing timing gear case

Remove the crankshaft pulley and timing gear case.

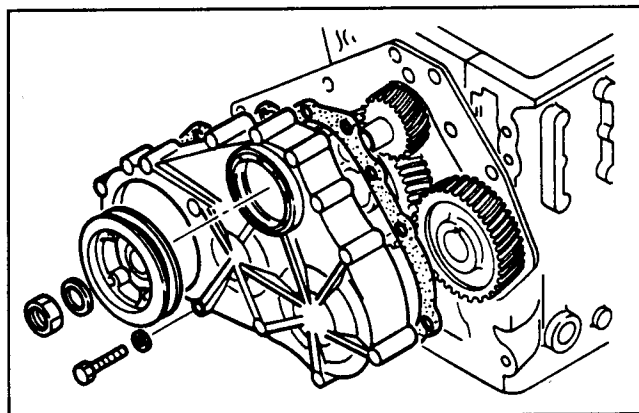


Figure 66

5. Measuring backlash and end play

Measure the backlash and end play on each gear to obtain the data for parts replacement. (See Inspection and Repair in this section of the book.)

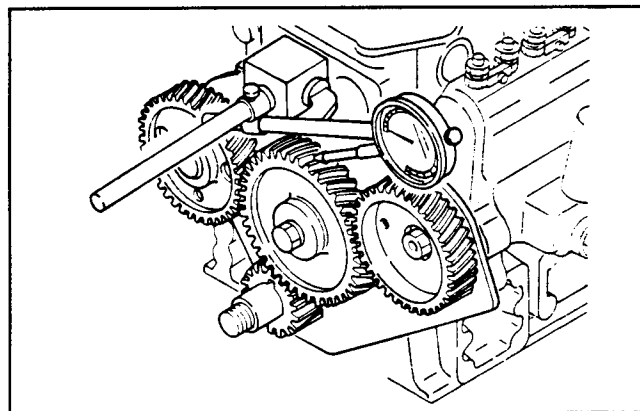


Figure 67

6. Removing timing gears

Be sure to align the timing marks for each pair of gears before removing or installing the gears.

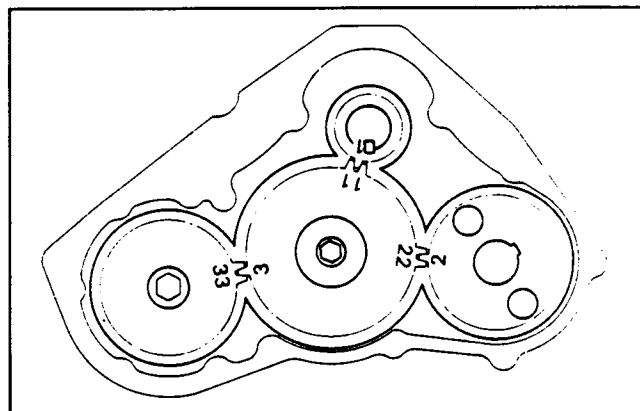


Figure 68

7. Removing idler

Remove the idler by turning it in the direction of helix of gear teeth.

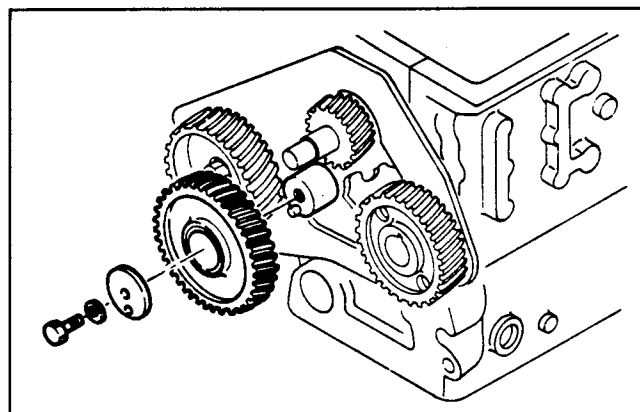


Figure 69

8. Removing crankshaft

Position the camshaft gear so that its two jacking bolt holes come to top and bottom. Unscrew the thrust plate bolts and remove the camshaft from the crankcase.

After removing the camshaft, remove the tappets.

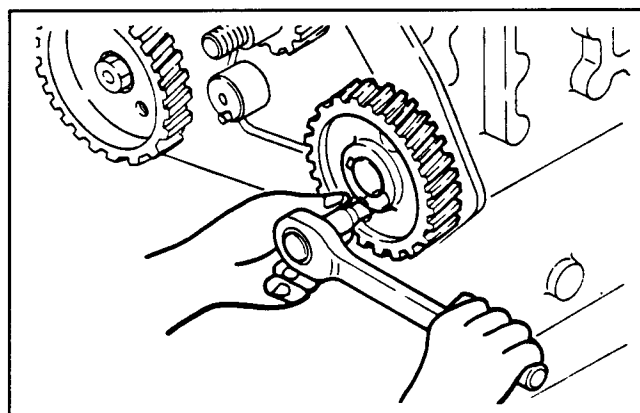


Figure 70

9. Removing the camshaft gear

Using a puller, remove the gear from the camshaft. Now, the thrust plate can be removed.

NOTE: It is not necessary to remove camshaft gear unless camshaft gear or thrust plate require replacement.

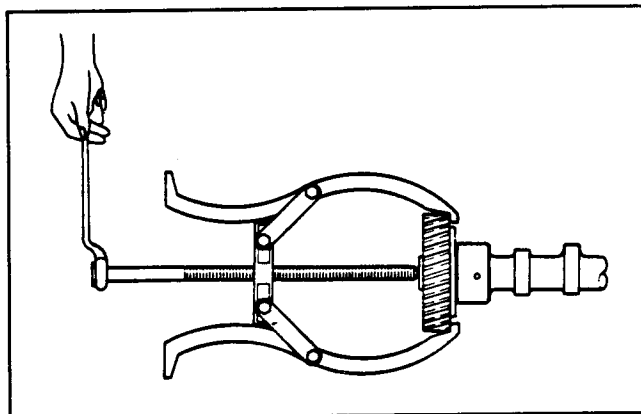


Figure 71

10. Removing front plate

Unscrew two front plate mounting bolts and remove the plate from the crankcase.

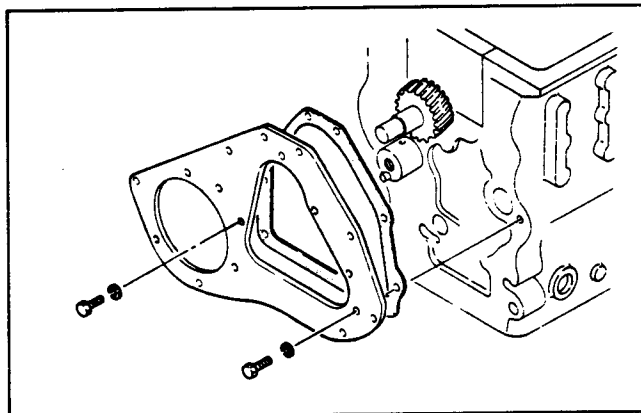


Figure 72

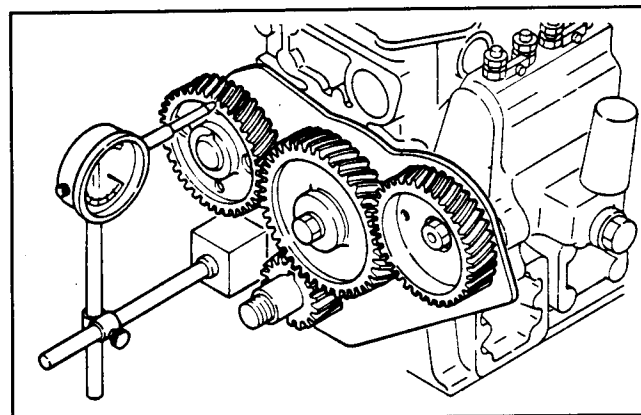
Inspection and Repair

1. Measuring camshaft end play

If the end play exceeds the Repair limit, replace the thrust plate.

Unit: mm (in.)

Item	Assembly standard	Repair limit
Camshaft end play	0.050 - 0.112 (0.00197 - 0.00441)	0.300 (0.01181)



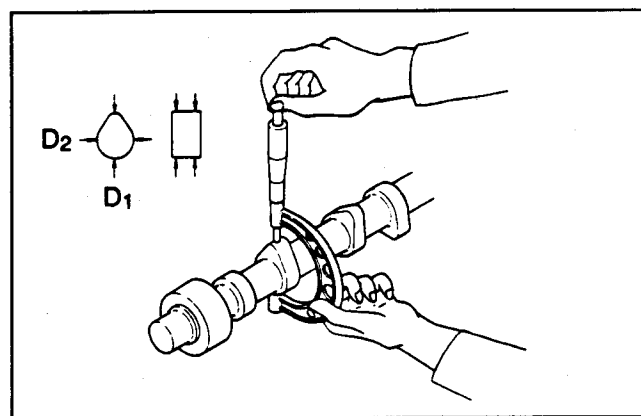
Measuring camshaft end play

2. Measuring cam lift

Using a micrometer, measure the cam lift. If it exceeds the Service limit, replace the camshaft.

Unit: mm (in.)

Item		Nominal Value	Assembly standard	Service limit
Cam lift	Inlet	D_1 $46.911^{+0.1}_{-0.3}$ $(1.84689^{+0.004}_{-0.012})$	$D_1 - D_2$ $= 6.689$ (0.26335)	$D_1 - D_2$ $= 6.189$ (0.24366)
	Exhaust	D_1 $46.256^{+0.1}_{-0.3}$ $(1.82110^{+0.004}_{-0.012})$	$D_1 - D_2$ $= 7.344$ (0.28913)	$D_1 - D_2$ $= 6.844$ (0.26945)



Measuring cam lift

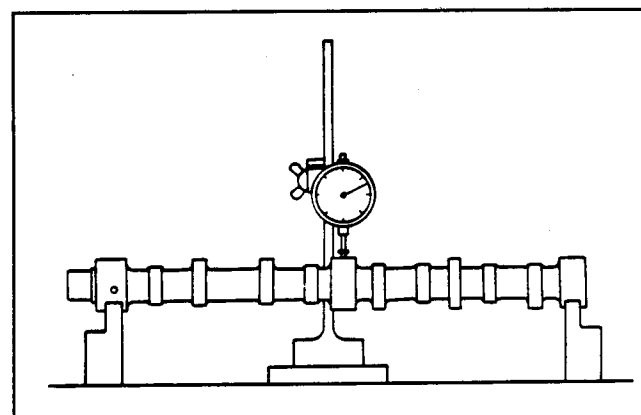
3. Measuring camshaft runout

If the runout exceeds the Repair limit, straighten the camshaft by means of a press, or replace it with a new one.

IMPORTANT: Set up a dial gauge on the camshaft and turn the camshaft. One half (1/2) of the gauge indication is the runout.

Unit: mm (in.)

Item	Assembly standard	Repair limit
Camshaft runout	0.02 (0.0008), maximum	0.05 (0.0020)



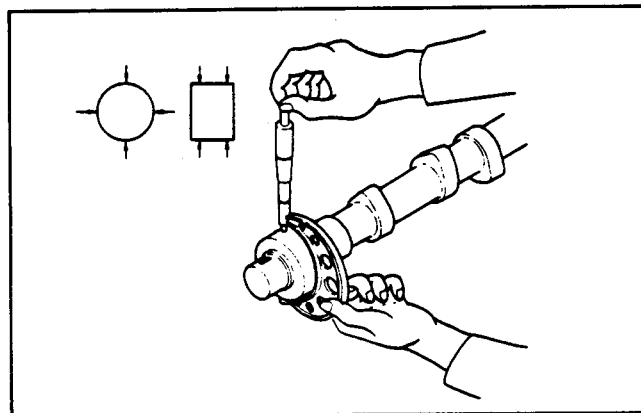
Measuring camshaft runout

4. Measuring camshaft journal diameter

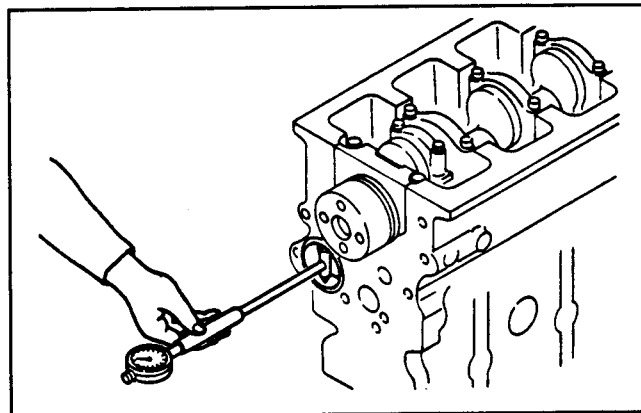
If the journals exceed the Service limit, replace the camshaft bearings.

Unit: mm (in.)

Item		Assembly standard	Service limit
Camshaft journal diameter	No. 1, 2	53.96 - 53.94 (2.1244 - 2.1236)	53.90 (2.1220)
	No.3	52.96 - 52.94 (2.0850 - 2.0842)	52.90 (2.0827)
Camshaft journal-to-bushing clearance		0.04 - 0.09 (0.0016 - 0.0035)	0.15 (0.0059) (Repair limit)



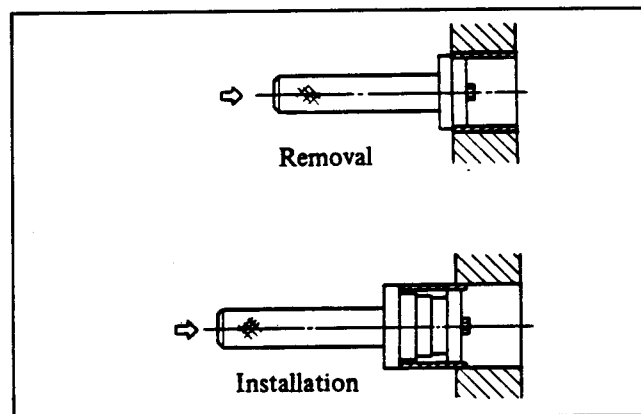
Measuring camshaft journal diameter



Measuring camshaft bushing inside diameter

5. Replacing camshaft bushings

To install bushings, align the bushing oil holes with those from oil gallery and drive the bushings in.

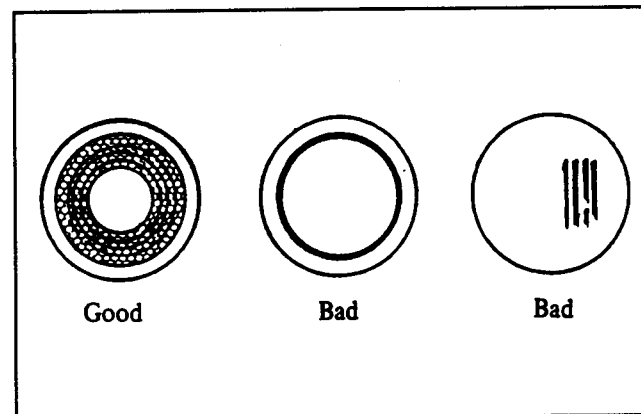


Replacing camshaft bushing

Tappets

1. Inspection

Check the cam contact face of each tappet for abnormal wear and replace if necessary.



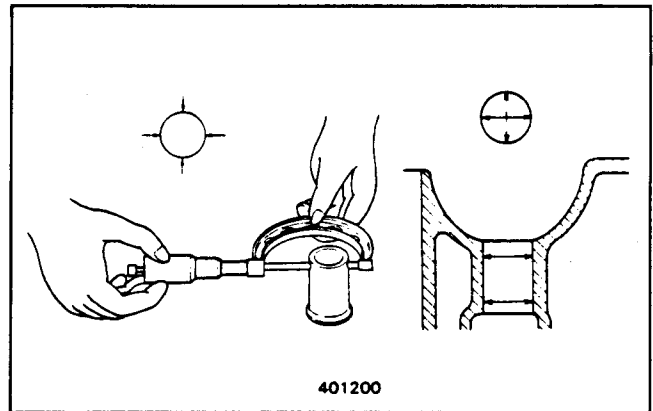
Cam contact face of tappet

2. Measuring tappet-to-guide clearance

If the clearance exceeds the Assembly standard, replace the tappet.

Unit: mm (in.)

Item	Assembly standard	Repair limit	Service limit
Tappet hole diameter	22.000 - 22.021 (0.86614 - 0.86697)		22.100 (0.87008)
Tappet-to-guide clearance	0.035 - 0.086 (0.00138 - 0.00339)	0.12 (0.0047)	



Measuring tappet and guide

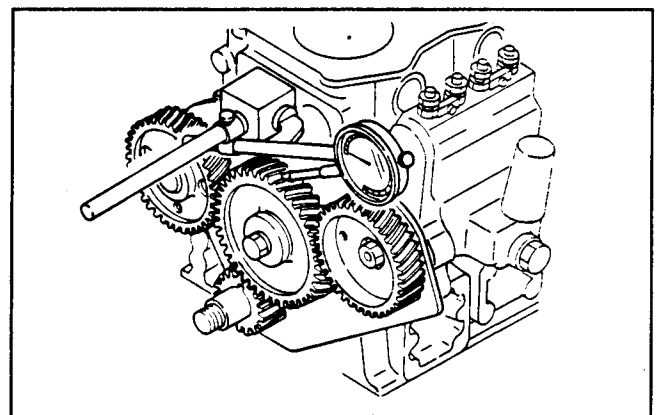
Timing Gears

Measuring backlash

Set up a dial gauge so that it contacts the pitch circle of the gear and move one gear back and forth to measure the backlash between the gears. If the backlash exceeds the Repair limit, replace the gears.

Unit: mm (in.)

Item	Assembly standard	Repair limit
Timing gear backlash	0.03 - 0.17 (0.012 - 0.0067)	0.25 (0.0098)



Measuring timing gear backlash

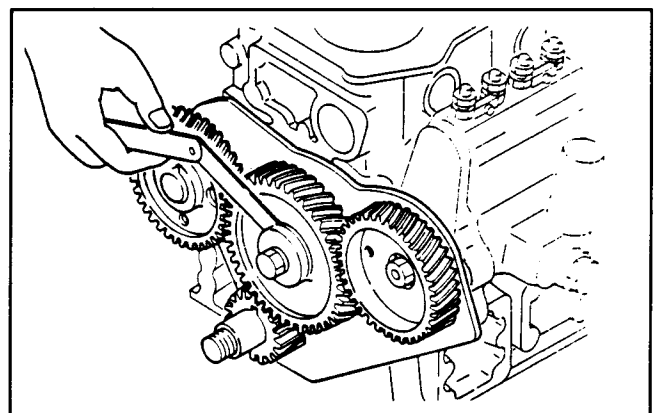
Idler, Idler Bushing and Idler Shaft

1. Measuring idler end play

Measure the end play with a feeler gauge or dial gauge. If the end play exceeds the Repair limit, replace the thrust plate.

Unit: mm (in.)

Item	Assembly standard	Repair limit
Idler end play	0 - 0.10 (0 - 0.0039)	0.35 (0.0138)



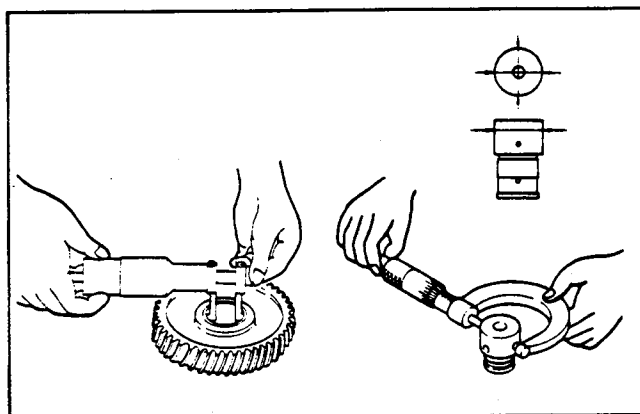
Measuring idler end play

2. Measuring idler bushing inside diameter and idler shaft diameter

If the idler shaft-to-bushing clearance exceeds the Standard clearance, replace the bushing.

Unit: mm (in.)

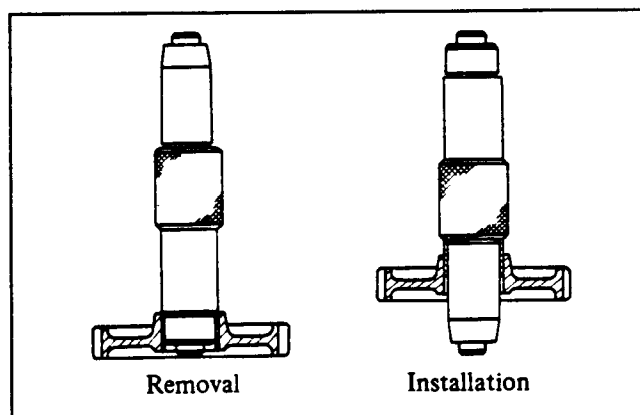
Item	Nominal value	Standard clearance	Repair limit
Idler shaft-to-bushing clearance	36 (1.42)	0.025 - 0.075 (0.00098 - 0.00295)	0.100 (0.00394)



Measuring idler shaft and bushing

3. Replacing idler bushing

When installing the bushing, press it in until its end face is flush with that of gear boss.



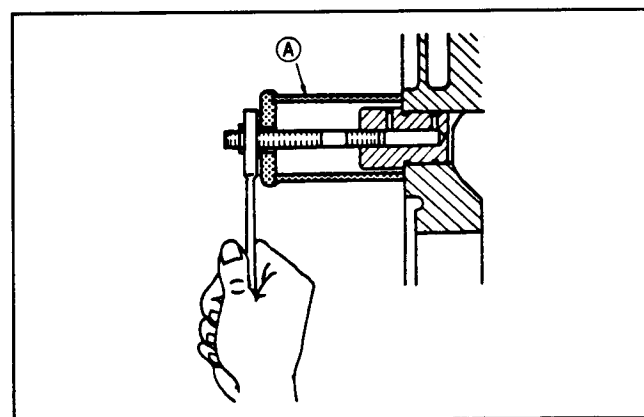
Removal

Installation

Replacing idler bushing

4. Replacing idler shaft

Use a puller to remove the idler shaft.



Removing idler shaft

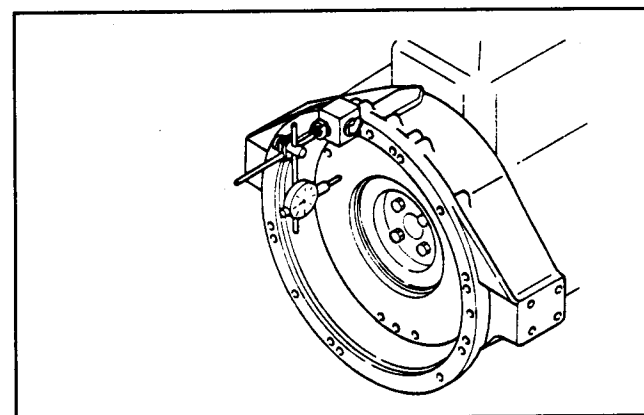
Flywheel and Ring Gear

1. Measuring flywheel runout

With the flywheel installed on the engine, measure its runout. If the runout exceeds the Assembly standard, check for improper installation or foreign matter lodged in the mounting face.

Unit: mm (in.)

Item	Assembly standard	Repair limit
Runout	0.15 (0.0059), maximum	0.50 (0.020)



Measuring flywheel runout

2. Replacing ring gear

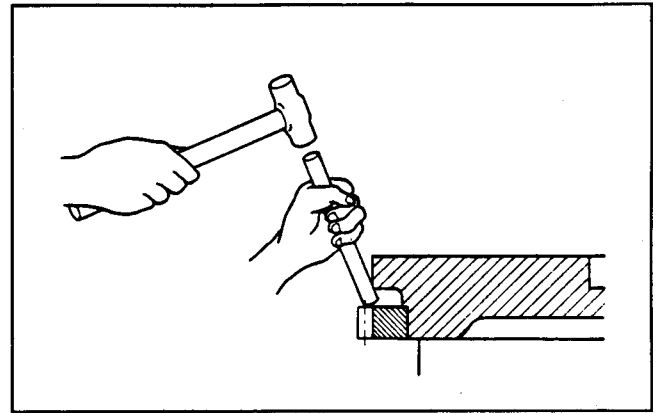
Check the ring gear for broken teeth, corrosive wear, or other defects, and replace the gear if defective. To remove, proceed as follows:

A. Removal

- 1) Heat the ring gear uniformly with an acetylene torch.
- 2) Using a bar, give light hammer blows to the outer segment of ring gear.

B. Installation

Heat a replacement ring gear up to about 100 degrees C (212 degrees F) in a piston heater and press the gear onto the flywheel so that the starter pinion would engage chamfered teeth.



Replacing ring gear

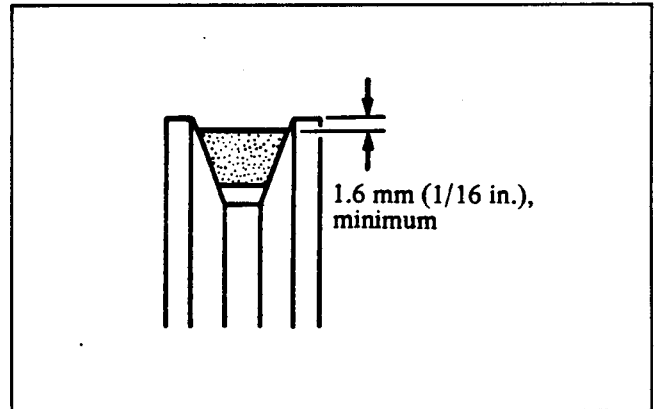
Crankshaft Pulley

Inspecting V-belt groove

Inspect the groove for wear. Wrap a new belt around the pulley, pressing it in the groove as far as it goes, and see if the top surface of the belt is above the top of the pulley.

If the top surface of the belt is uniformly above the top of the pulley all the way around, it is not necessary to replace the pulley.

If the top surface of the belt sinks into the groove more than 1.6 mm 1/16 in., replace the pulley.



Inspecting V-belt groove in crankshaft pulley

Reassembly

Reassembling Sequence

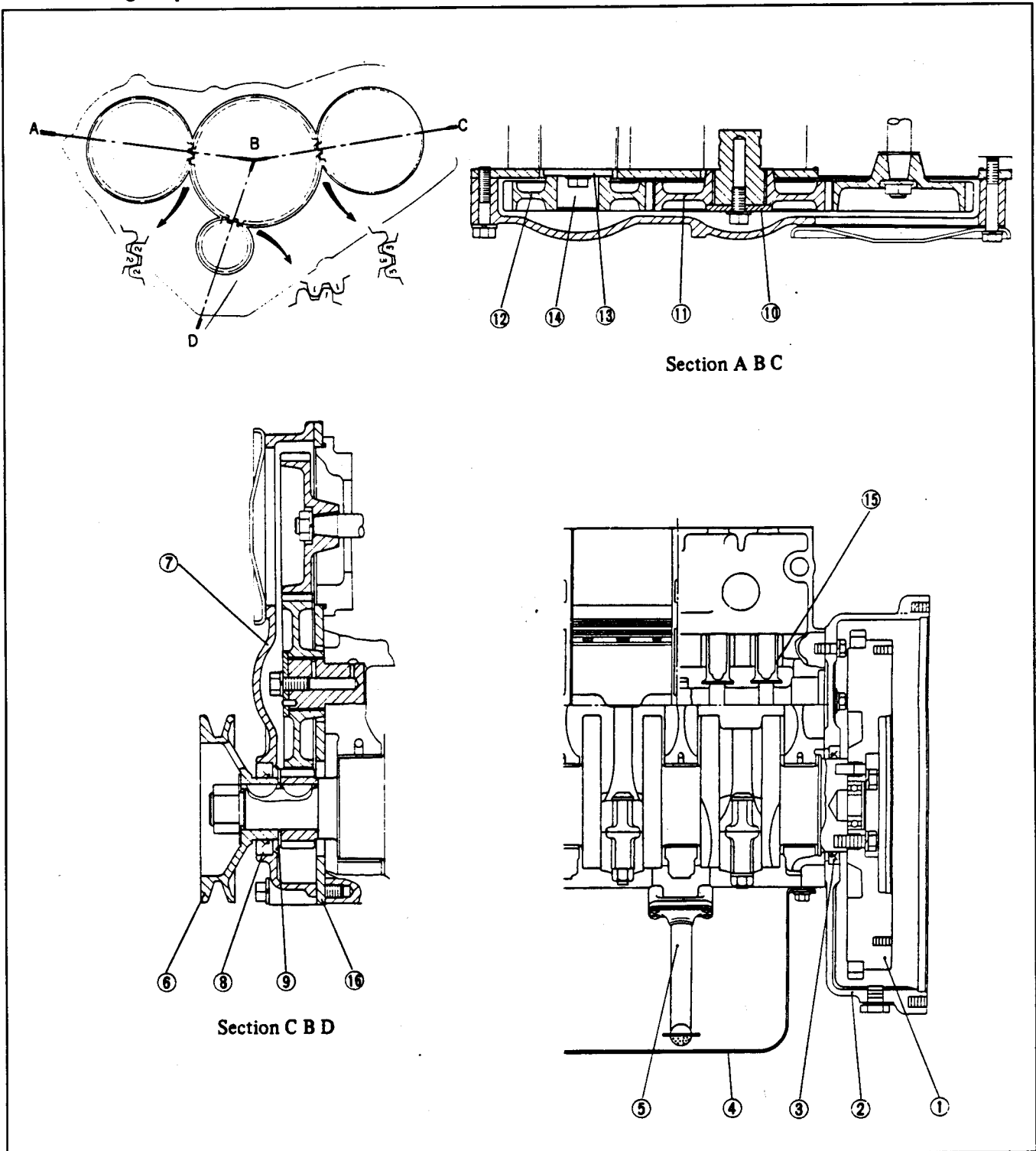


Figure 73

Reassembling sequence

16→15→14→11→10→9→7→6→5→4→2→1
 13→12 ↑ 8 ↑ 3 ↑

1. Installing camshaft gear and thrust plate

Install thrust plate onto camshaft. Heat the gear for installation.

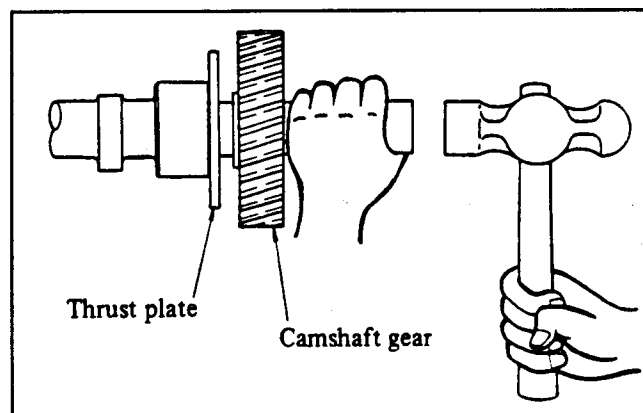


Figure 74

2. Installing camshaft

Carefully insert the camshaft into the crankcase. Install and tighten the thrust plate bolts.

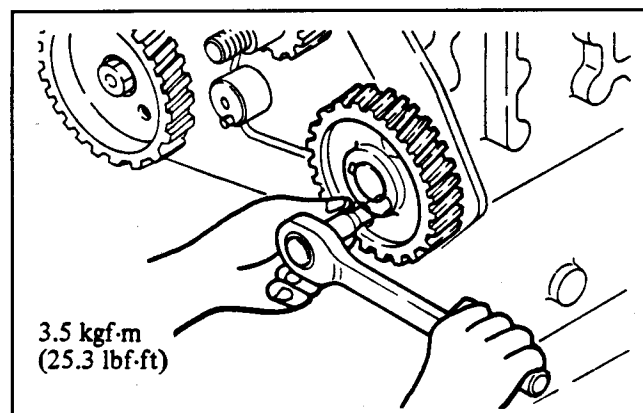


Figure 75

3. Installing idler

Install the idler while aligning the timing marks on each pair of gears, and install thrust plate with bolt.

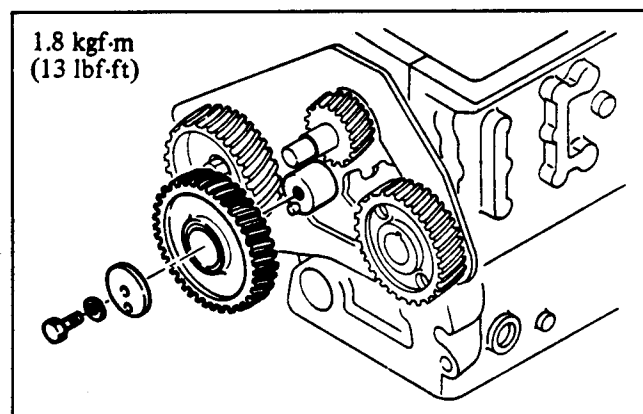


Figure 76

4. Installing oil seal

To install the oil seal, use an installer.

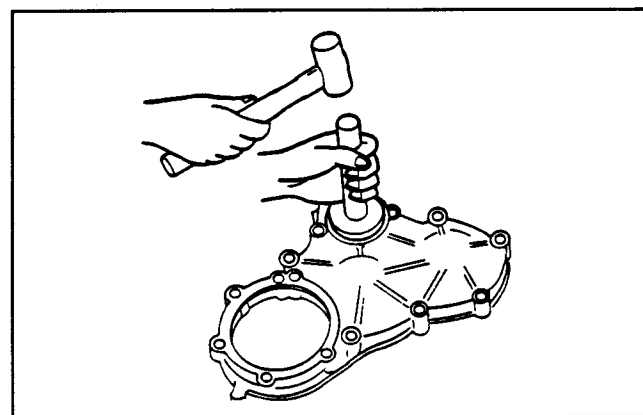


Figure 77

5. Inspecting and adjusting timing gears after installation.

After installing the timing gears, be sure to inspect and adjust them as follows:

Inspecting Timing Gear Backlash and End Play

After installing the timing gears, inspect the backlash between the gears in mesh and the end play of each gear (Page 3 - 67).

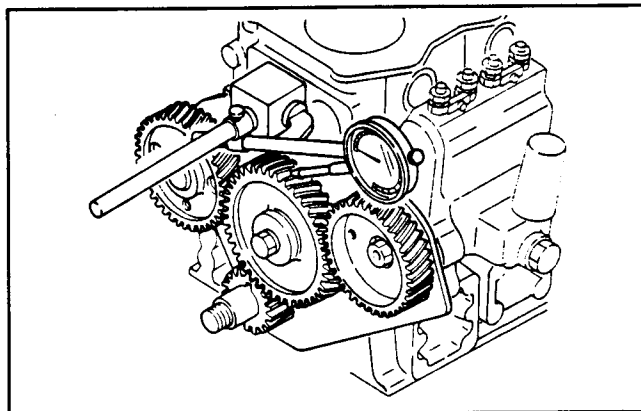
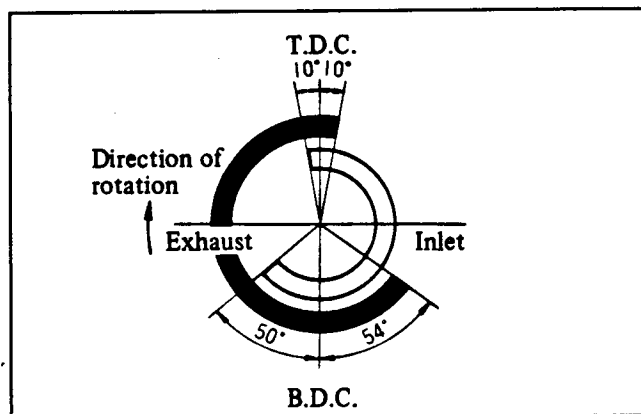


Figure 78

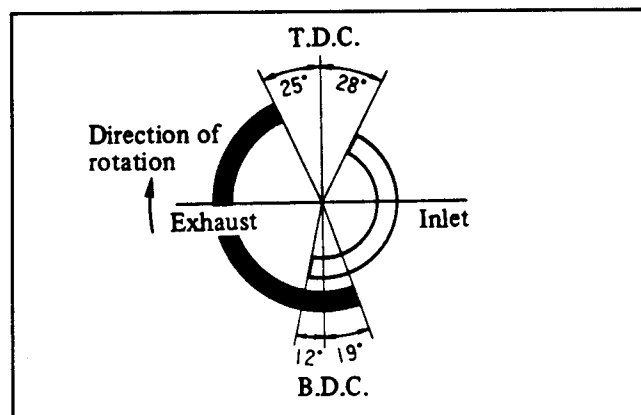
Inspecting Valve Timing

It is not necessary to inspect the valve timing, provided that all matching marks on the timing gears are aligned. However, the timing may be verified as follows:

Using a 3 mm (0.12 in.) thick smooth steel plate, add 3 mm (0.12 in.) clearance to the inlet and exhaust valves of No. 1 cylinder. Then insert a 0.05 mm (0.0020 in.) feeler gauge between the top of valve cap and rocker and slowly turn the crankshaft, trying to find a position where the feeler gauge is firmly gripped (the valve starts opening) and a position where the gauge is just un-gripped (the valve starts closing.) Check to make sure that these positions coincide with the angular positions shown in the valve timing diagram with 3 mm (0.12 in.) clearance added to valves.



SF-series valve timing diagram



SF-series valve timing diagram with
3mm (0.12 in.) clearance added to valves

Pistons, Connecting Rods, Crankshaft & Block

Disassembly

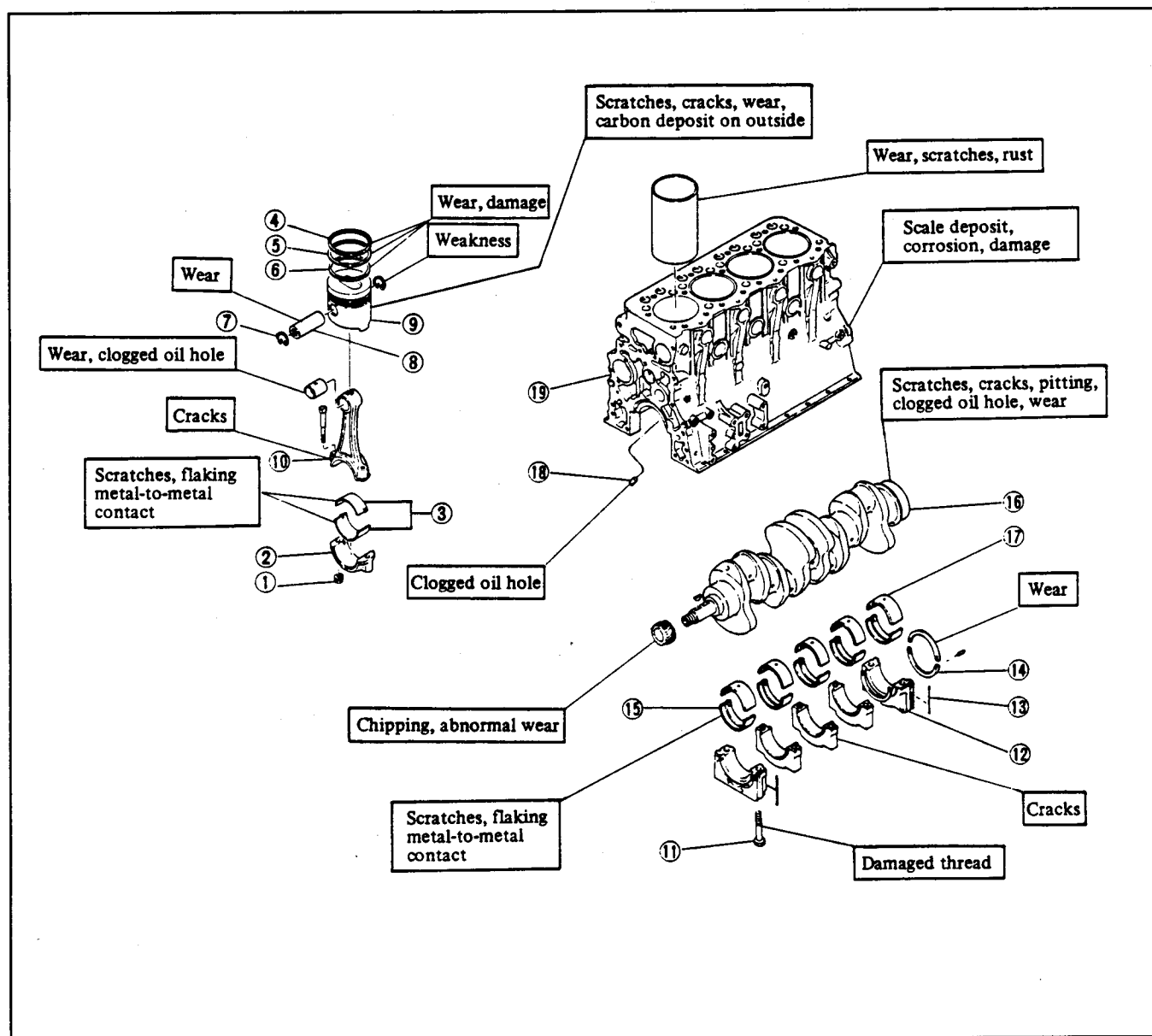


Figure 79

1. Nut
2. Connecting rod cap
3. Connecting rod bearing
4. Top compression ring
5. Second compression ring
6. Oil ring
7. Snap ring

8. Piston pin
9. Piston
10. Connecting rod
11. Bearing cap bolt
12. Main bearing cap
13. Side seal
14. Thrust plate

15. Main bearing (lower shell)
16. Crankshaft
17. Main bearing (upper shell)
18. Check valve (w/turbocharger)
19. Crankcase

1. Removing connecting rod caps

A. Unscrew the nuts securing the cap and remove cap.

B. Mark the removed connecting rod bearings for identification of cylinder numbers and whether upper or lower shells.

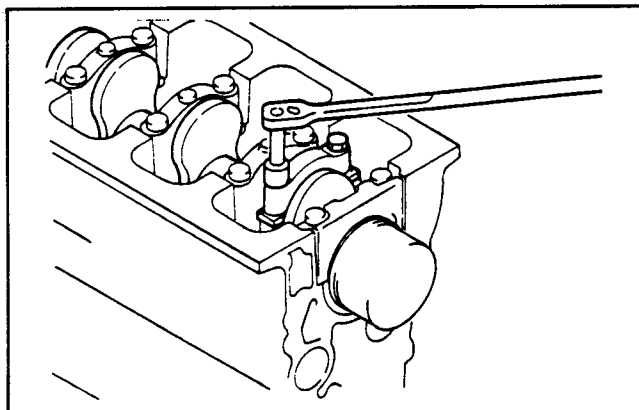


Figure 80

2. Preparing to remove pistons

A. Lay the crankcase on its side.

B. Remove all carbon deposits from the upper areas of cylinder sleeves. Carbon deposits, if any, will make it difficult to pull the pistons out. Use a ridge reamer if necessary.

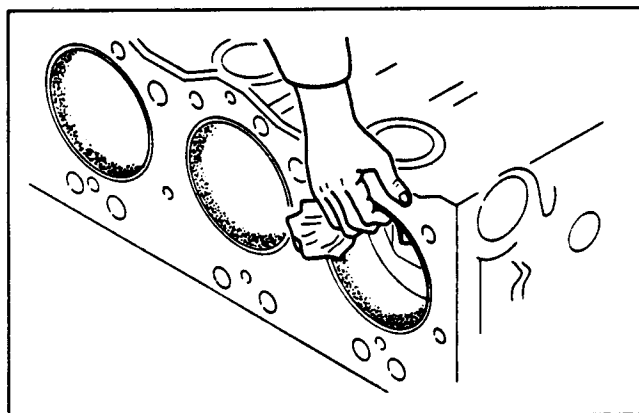


Figure 81

3. Removing pistons

Bring the piston assembly to top dead center position. Use a hammer handle and push the assembly out of the crankcase.

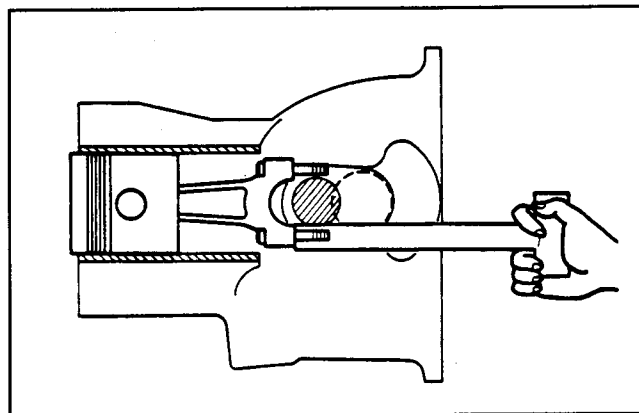


Figure 82

4. Removing piston rings

Use a piston ring pliers to remove the rings.

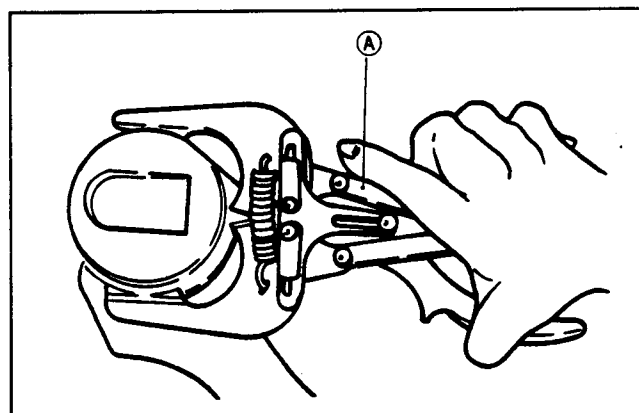


Figure 83

5. Removing piston pin

- A. Using snap ring pliers, remove the snap rings.
- B. Remove the piston pin and separate the piston from the connecting rod.
- C. If it is difficult to pull out the pin, heat the piston to expand the pin bore.

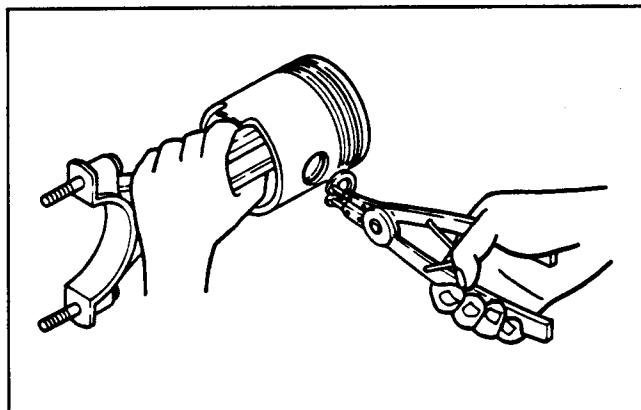


Figure 84

6. Removing main bearing caps

Unscrew the bolts securing the cap and remove the cap complete with main bearing. To remove the front and rear main bearing, caps may require a puller.

IMPORTANT: When removing the caps, be careful not to damage the bearings. After removing the caps and bearings, mark each combination for its location so that it is installed to the same crankshaft journal.

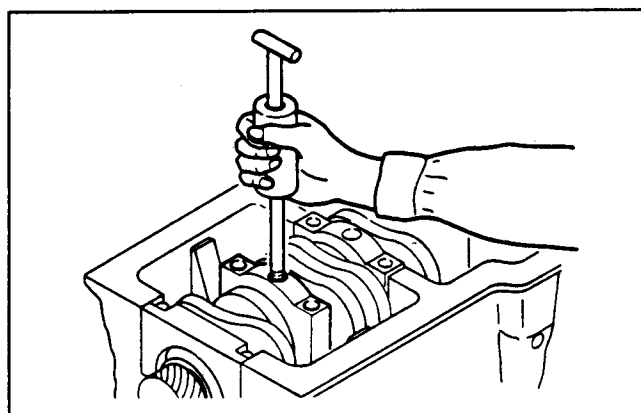


Figure 85

7. Removing crankshaft

Slowly lift the crankshaft out of the crankcase.

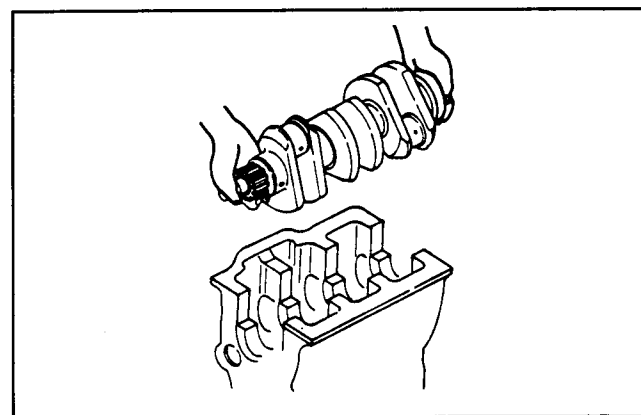


Figure 86

Inspection and Repair

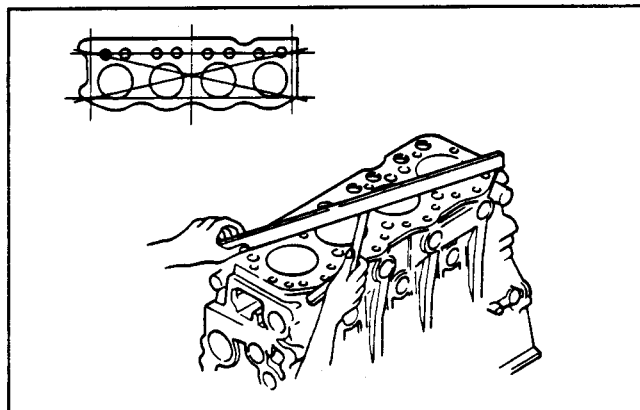
Crankcase and cylinder sleeves.

1. Measuring warpage of crankcase gasketed surface

Measure the warpage with a straightedge and feeler gauge. If the warpage exceeds the Assembly standard, grind the surface with a surface grinder. Grind the crankcase only enough to remove the warpage.

Unit: mm (in.)

Item	Assembly standard	Repair limit
Warpage of crankcase gasketed surface	0.05 (0.0020), maximum	0.20 (0.0079)



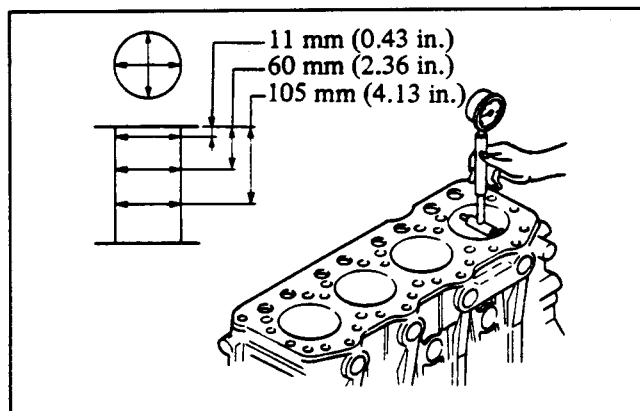
Measuring crankcase gasketed surface

2. Measuring cylinder sleeve inside diameter

A. Measure the sleeve in two directions inline and perpendicular to the crankshaft and at three positions, top, middle, and bottom, as shown.

Unit: mm (in.)

Item	Assembly standard	Repair limit	Service limit
Cylinder sleeve inside diameter	98.00 – 98.035 (3.85826 – 3.85964)	98.200 (3.86613)	99.200 (3.90550)
Out of round	0.015, maximum		
Taper	0.05, maximum		



Measuring cylinder sleeve diameter

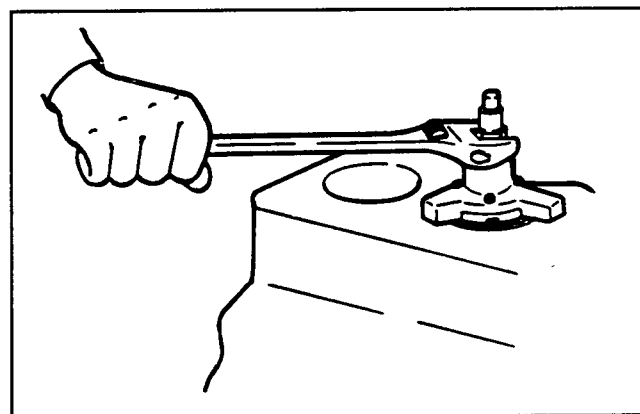
B. If the inside diameter reaches the Repair limit, bore the sleeve to the specified oversize.

C. Hone the sleeve to +0.25 mm (+0.0098 in.) or +0.5 mm (+0.0197 in.) oversize accurate within 0 to 0.035 mm (0.00138 in.). Use pistons and piston rings of the same oversize.

D. If any sleeve is unevenly worn, determine the oversize on the basis of the maximum wear noted to ensure perfect roundness in the oversized bore.

NOTE: Refinish all sleeves to the same oversize.

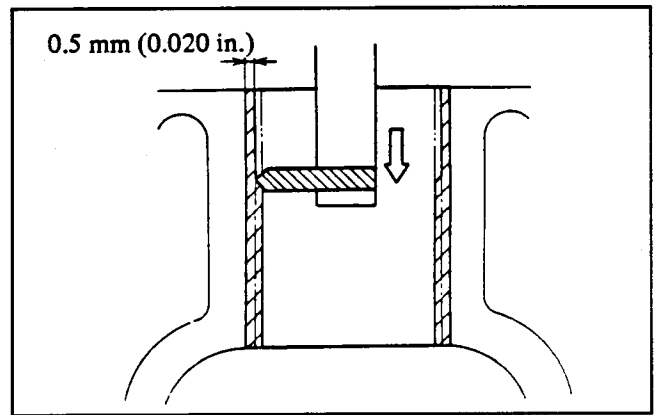
If the sleeve is found in good condition, with the wear far less than the Repair limit, replace the piston rings, and ream off "ridge" at the top of the sleeve. Hone the bore if necessary.



Ridge-reaming cylinder sleeve

3. Replacing cylinder sleeve

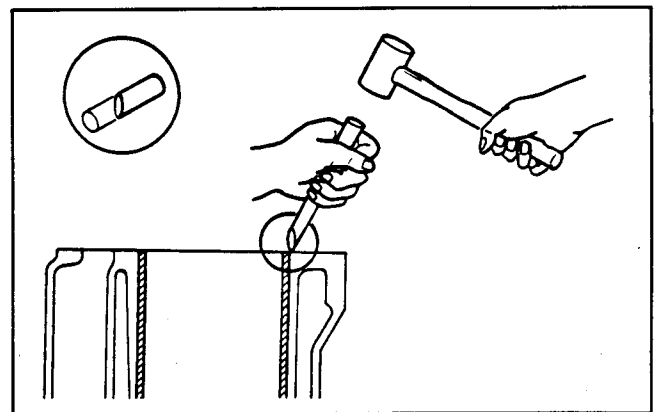
If one sleeve exceeds the Service limit in inside diameter or it is defective, with the other sleeves in good condition, replace that sleeve only.



Removing cylinder sleeve (1)

Removing Cylinder Sleeve

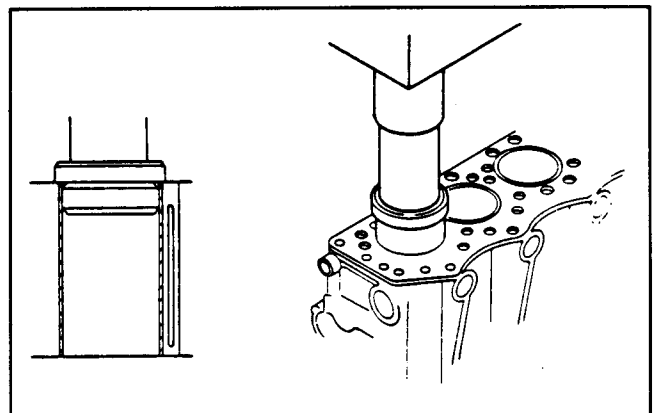
- A. Set up a boring machine on the crankcase by aligning it with the center of the less-worn area of the sleeve at the bottom.
- B. Bore the sleeve until its stock thickness is about 0.5 mm (0.02 in.).
- C. Break and remove the sleeve, being careful not to damage the inside surface of the crankcase.



Removing cylinder sleeve (2)

Installing a New Cylinder Sleeve

- A. Press the sleeve into the crankcase, leaving a protrusion of 0.3 to 0.5 mm (0.012 to 0.020 in.) at the top. Machine sleeve flush with the crankcase top.
- B. Bore and hone the sleeve to $98 \begin{smallmatrix} +0.035 \\ 0 \end{smallmatrix} \text{ mm}$ ($3.86 \begin{smallmatrix} +0.00138 \\ 0 \end{smallmatrix} \text{ in.}$).



Installing cylinder sleeve

Pistons and Piston Rings

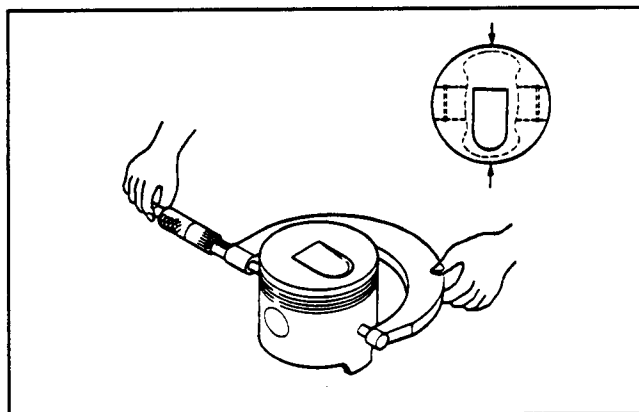
1. Measuring piston diameter

A. Using a micrometer, measure each piston perpendicular to the piston pin. If the diameter exceeds the Service limit, replace the piston.

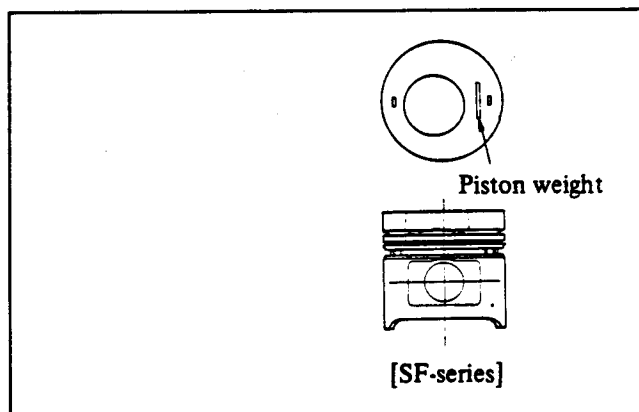
Unit: mm (in.)

Item		Assembly standard	Service limit
Piston diameter	Standard	97.975 – 97.945 (3.85728 – 3.85609)	97.760 (3.84881)
	0.25 (0.0098) oversize	98.225 – 98.195 (3.86712 – 3.86594)	98.010 (3.85865)
	0.50 (0.0197) oversize	98.475 – 98.445 (3.87696 – 3.87578)	98.260 (3.86850)
Variance in weight per engine gram (oz)		± 3 (± 0.1)	

B. Piston weight is stamped on the top of each piston. If any pistons have to be replaced, select new pistons so that the variance in weight among pistons per engine is within the Assembly standard.



Measuring piston diameter



Piston weight marking

2. Measuring piston ring end gap

Place the ring in a new or master sleeve, and measure the gap. If the gap exceeds the Service limit, replace all rings as a set.

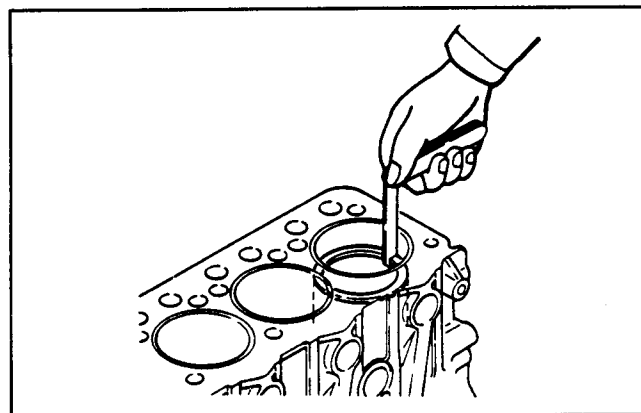
Inside diameter of a master cylinder sleeve:

$$98 \begin{smallmatrix} +0.035 \\ 0 \end{smallmatrix} \text{ mm } (3.86 \begin{smallmatrix} +0.00138 \\ 0 \end{smallmatrix} \text{ in.})$$

NOTE: Place the piston ring in the master sleeve by pushing it squarely with the use of piston.

Unit: mm (in.)

Item	Assembly standard	Service limit
Piston ring end gap	0.30 – 0.50 (0.0118 – 0.0197)	1.50 (0.0591)



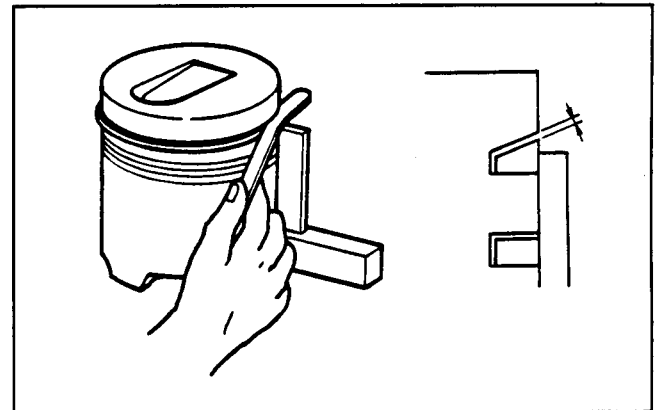
Measuring piston ring end gap

3. Measuring piston ring side clearance

Insert new piston rings into the ring grooves in the piston and measure the clearance of each ring with a feeler gauge and straightedge as shown.

Unit: mm (in.)

Item		Nominal value	Assembly standard	Service limit
Piston ring side clearance	No. 1 ring	2.5 (0.098)	0.030 - 0.070 (0.00118 - 0.00276)	0.200 (0.00787)
	No. 2 ring	2.0 (0.079)	0.025 - 0.060 (0.00098 - 0.00236)	0.150 (0.00591)
	Oil ring	4.5 (0.177)		



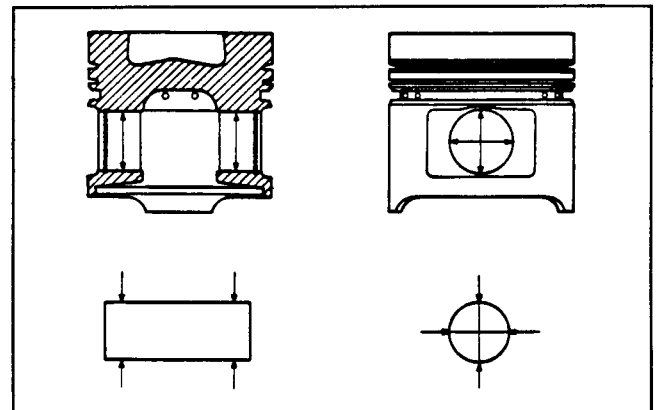
Measuring piston ring side clearance

4. Measuring piston pin and hole diameters

If the Repair limit is reached, replace the piston pin. If it is exceeded, replace the piston.

Unit: mm (in.)

Item	Assembly standard	Repair limit
Piston pin diameter	32.000 - 31.984 (1.25984 - 1.25921)	1.25921
Piston pin-to-hole clearance	0 - 0.016 (0 - 0.00063)	0.050 (0.00197)



Measuring piston pin and hole

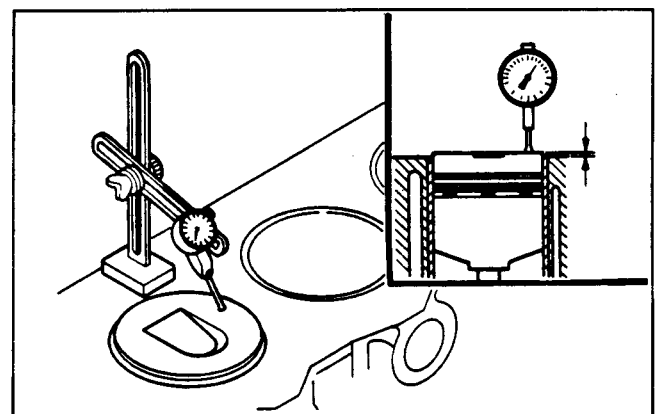
5. Measuring piston protrusion

Measure protrusion of each piston and, if it is not within the Assembly standard, inspect the various parts for clearance.

A. Determine the top dead center of piston with a dial gauge.

B. Set up the dial gauge at the top of crankcase, and set the gauge pointer to zero (0.)

C. Measure the protrusion at three places on the piston head, and average the three measurements to determine the protrusion. Subtract the protrusion from the "as-installed" thickness of cylinder head gasket to determine the clearance between the piston top and cylinder head.



Measuring piston protrusion

Unit: mm (in.)

Item	Assembly standard
Piston protrusion	0.65 – 1.05 (0.0256 – 0.0413)
"As-installed" thickness of cylinder head gasket	1.6 ± 0.15 (0.063 ± 0.0059)

IMPORTANT: Keeping the piston protrusion within the Assembly standard is important not only for engine performance but also for prevention of interference of the valve with the piston.

Connecting Rods, Connecting Rod Bearings and Small-end Bushings

1. Measuring connecting rod bearing-to-crankpin clearance

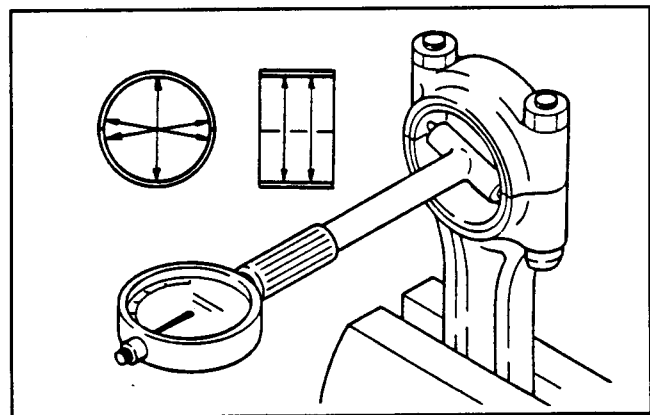
Measure the crankpin diameter and bearing inside diameter to determine the clearance between the two. If the clearance exceeds the Repair limit, replace the bearing. If the crankpin is worn excessively or unevenly, grind the crankpin, and use undersize bearing.

The two bearing undersizes are -0.25 mm -0.0098 in. and -0.50 mm -0.0197 in..

NOTE: To measure the bearing inside diameter, install upper and lower shells to the connecting rod and tighten the cap bolts to the specified torque.

Unit: mm (in.)

Item	Assembly standard	Repair limit
Crankpin diameter	58 ^{-0.035} -0.055 (2.28 ^{-0.0014}) -0.002	- 0.20 (- 0.0079)
Connecting rod bearing-to-crankpin clearance	0.035 – 0.10 (0.0014 – 0.0039)	0.20 (0.0079)



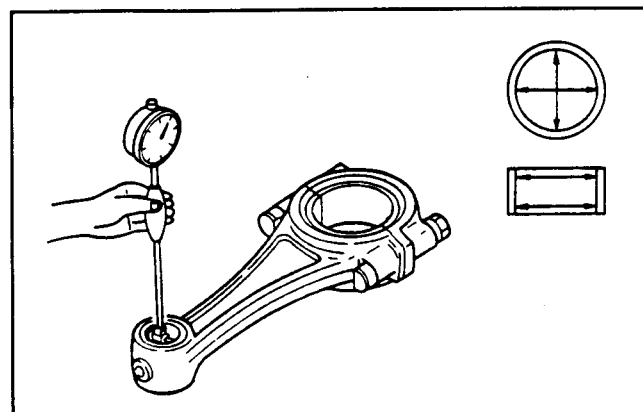
Measuring connecting rod bearing inside diameter

2. Measuring connecting rod bushing-to-piston pin clearance

Measure the piston pin diameter and bushing inside diameter to determine the clearance between the two. If the clearance exceeds the Repair limit, replace the pin or bushing whichever is badly worn.

Unit: mm (in.)

Item	Assembly standard	Repair limit
Piston pin bushing inside diameter	32.048 – 32.020 (1.2617 – 1.2606)	
Connecting rod bushing-to-piston pin clearance	0.020 – 0.051 (0.0008 – 0.0020)	0.080 (0.0032)



Measuring connecting rod bushing inside diameter

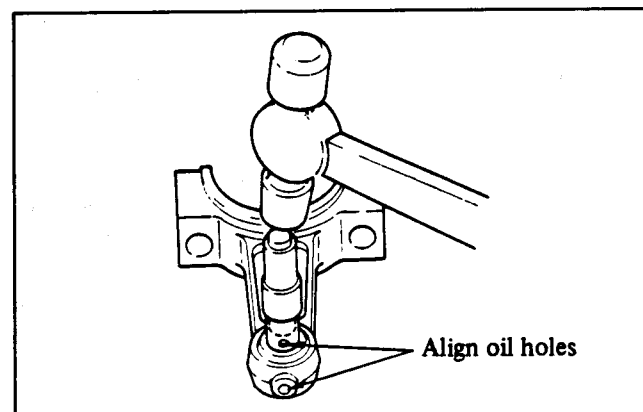
3. Replacing connecting rod bushing

A. To remove the bushing for replacement, use a connecting rod bushing puller.

B. Align the oil holes in the replacement bushing and connecting rod.

C. Press the bushing into position from the chamfered side of connecting rod.

D. After installing the bushing, insert the piston pin to make sure that the pin rotates freely.



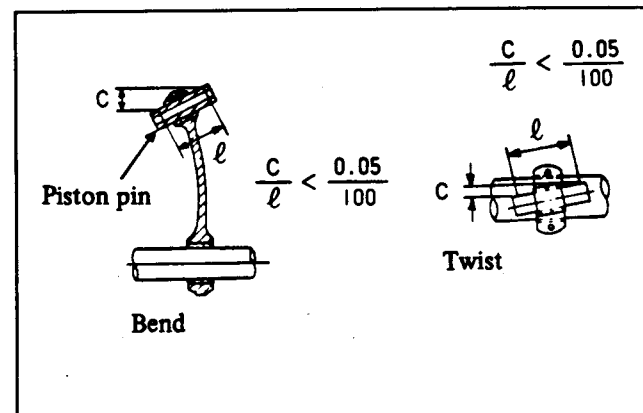
Installing connecting rod bushing

4. Inspecting connecting rods for bend and twist

A. Measure "C" and "l". If the measurement at "C" is larger than 0.05 mm (0.0020 in.) per 100 mm (3.9 in.) of "l", straighten the rod with a press, or replace.

Unit: mm (in.)

Item	Assembly standard	Repair limit
Connecting rod bend and twist	0.05/100 (0.0020/3.9), maximum	0.15 (0.0059)



Inspecting connecting rod

5. Inspecting connecting rod bearings

Inspect each bearing shell for wiped overlay, scratching, burning, pitting and other damage. If any of these are present, replace the shell.

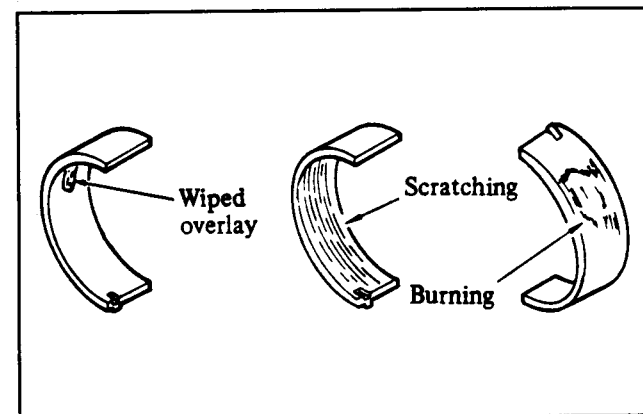


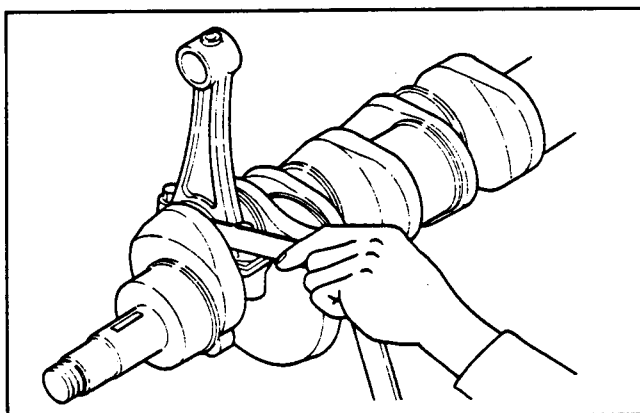
Figure 87

6. Measuring connecting rod end play

Install the connecting rod to the mating crankpin and tighten the cap to the specified torque. Using a feeler gauge, measure the end play. If the end play exceeds the Service limit, replace the connecting rod.

Unit: mm (in.)

Item	Nominal value	Standard clearance	Service limit
Connecting rod end play	40 (1.57)	0.15 - 0.35 (0.0059 - 0.0138)	0.50 (0.0197)



Measuring connecting rod end play

7. Variance in weight among connecting rods per engine

When replacing connecting rods, make sure that the variance in weight among connecting rods per engine is within the Assembly standard shown below.

Unit: mm (in.)

Item	Assembly standard
Variance in weight per engine	± 5g (± 0.2 oz), maximum

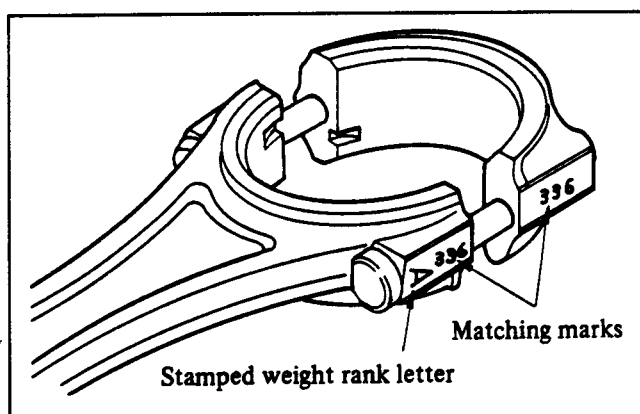


Figure 88

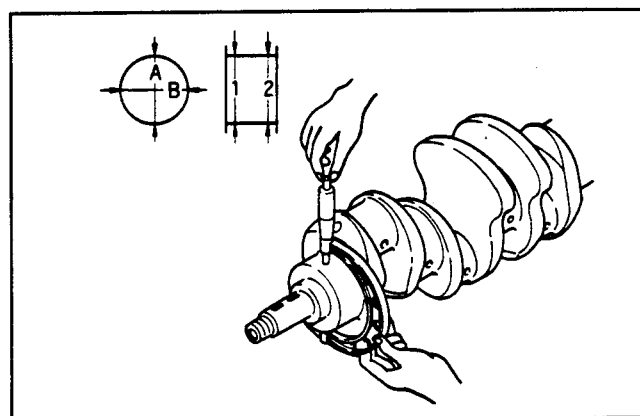
Crankshaft

1. Measuring journal diameter

Using a micrometer, measure the journal in two positions, 1 and 2, and in two directions, A and B, to determine the wear, out of round and taper. If any of the Repair limits is exceeded, regrind the journal to the undersize or replace the crankshaft.

Unit: mm (in.)

Item		Assembly standards	Repair limit	Service limit
Crankshaft journals	Diameter	75 ^{-0.03} _{-0.05} (2.95 ^{-0.0012} _{-0.0020})	- 0.15 (-0.0059)	-0.90 (-0.0354)
	Out of round	0.01 (0.0004), maximum	0.03 (0.0012)	
	Taper			



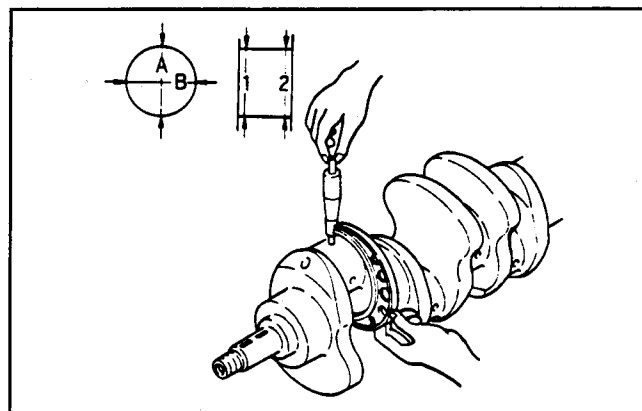
Measuring crankshaft journals

2. Measuring crankpin diameter

Using a micrometer, measure the crankpin in two positions, 1 and 2, and in two directions, A and B, to determine the wear, out of round and taper. If any of the Repair limits is exceeded, regrind the crankpin to the undersize or replace the crankshaft.

Unit: mm (in.)

Item		Assembly standard	Repair limit
Crankpins	Diameter	58 - 0.035 - 0.055 (2.95 - 0.00138) - 0.00217	- 0.20 (-0.0079)
	Out of round	0.01 (0.0004), maximum	0.03 (0.0012)
	Taper		



Measuring crankpins

3. Grinding crankshaft

If the crankshaft is ground to any of the undersizes and refinished to a dimension which is 0.100 to 0.120 mm 0.00394 to 0.00472 in. smaller than the undersize, it is not necessary to check the bearing contact pattern.

Crankshaft grinding dimensions

Unit: mm (in.)

	Undersize	Refinishing dimension
Crankshaft journal	0.25 (0.0098)	74.65 - 74.63 (2.939 - 2.938)
	0.50 (0.0197)	74.40 - 74.38 (2.929 - 2.928)
Crankpin	0.25 (0.0098)	57.65 - 57.63 (2.2697 - 2.2689)
	0.50 (0.0197)	57.40 - 57.38 (2.2598 - 2.2591)

When grinding the journals and crankpins, be sure to produce the same fillet radius as the original one. They should have a hardness of 620 or more in terms of Vickers Hardness Number. If necessary, reharden the journals and crankpins, and inspect them for cracks by conducting a magnaflux magnetic particle test.

4. Measuring crankshaft end play

Install the thrust plates in position and secure the main bearing caps. Under this condition, measure the end play the end clearance of thrust plates in the journal. If the end play exceeds the Assembly standard, replace the thrust plates.

Unit: mm (in.)

Item	Nominal value	Assembly standard	Repair limit
Crankshaft end play	37 (1.46)	0.100 - 0.264 (0.0039 - 0.010)	0.300 (0.0118)

5. Measuring crankshaft runout

Support the crankshaft on its front and rear journal in V-blocks and measure the runout at the center journal, using a dial gauge. Depending on the amount of runout, repair the crankshaft by grinding or straightening with a press. If the runout exceeds the Repair limit, replace the crankshaft.

Unit: mm (in.)

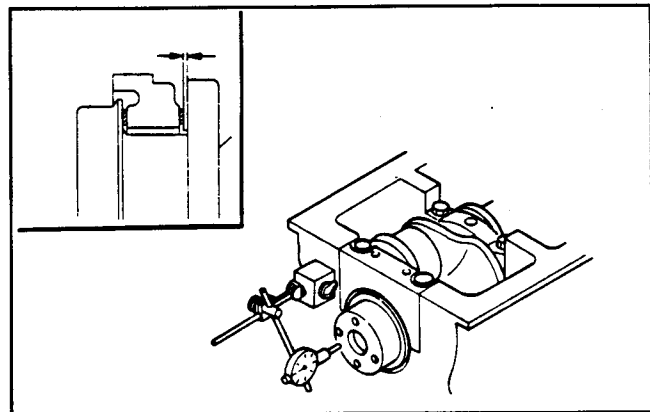
Item	Assembly standard	Repair limit
Crankshaft runout	0.02 (0.0008), maximum	0.05 (0.0020)

6. Replacing crankshaft gear

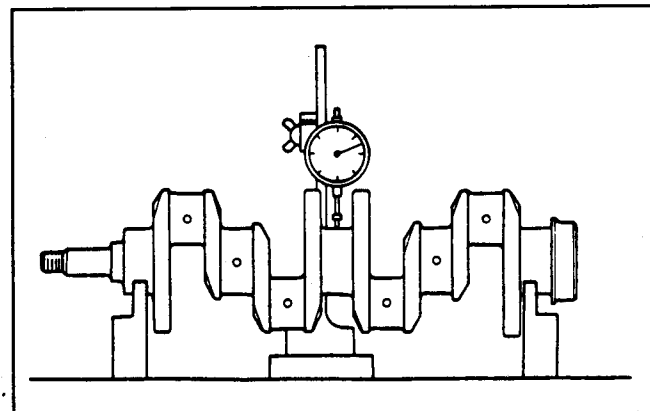
A. Using gear puller, remove the gear from the crankshaft.

NOTE: Do not remove the gear by driving with a hammer.

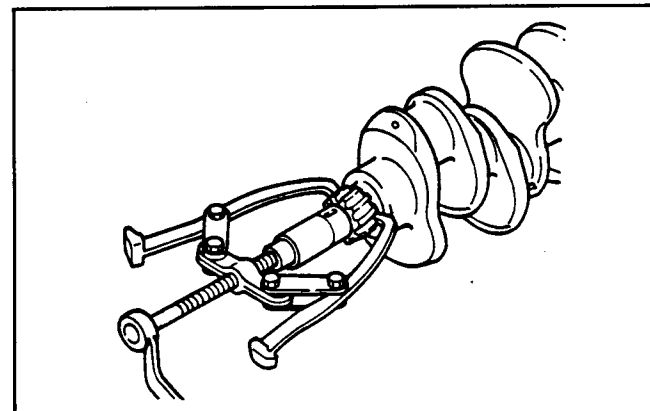
B. To install, heat the gear to about 100 degrees C 212 degrees F. Place the new gear on the crankshaft by aligning the key with the notch of the gear and lightly tap into position with a soft-faced hammer.



Measuring crankshaft end play



Measuring crankshaft runout



Replacing crankshaft gear

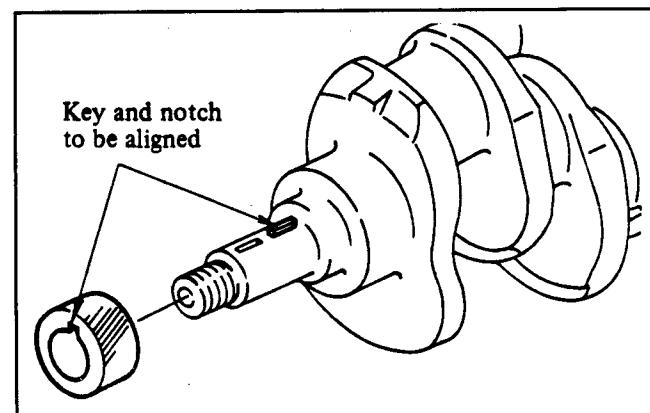
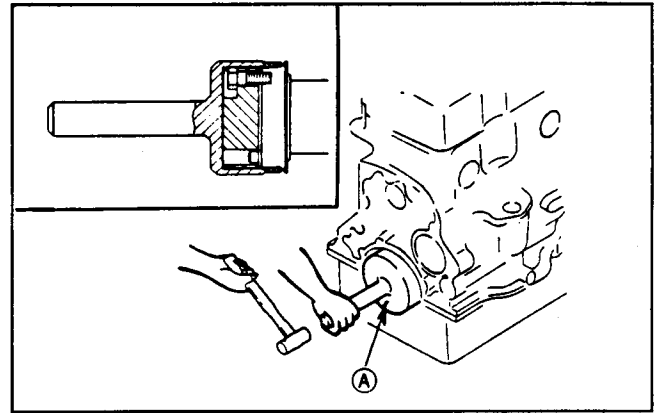


Figure 74

7. Replacing rear oil seal

If the seal shows a sign of oil leaks, replace it with a replacement oil seal with sleeve.

To install the sleeve, apply oil to the inside surface of the sleeve and drive it onto the crankshaft using a sleeve installer.



Replacing rear oil seal

Main bearings

1. Inspection

Inspect each bearing shell for abnormal contact, scratching, corrosion, wiped overlay, and other defects. Also check for a sign of poor seating in the bore of the crankcase or bearing cap.

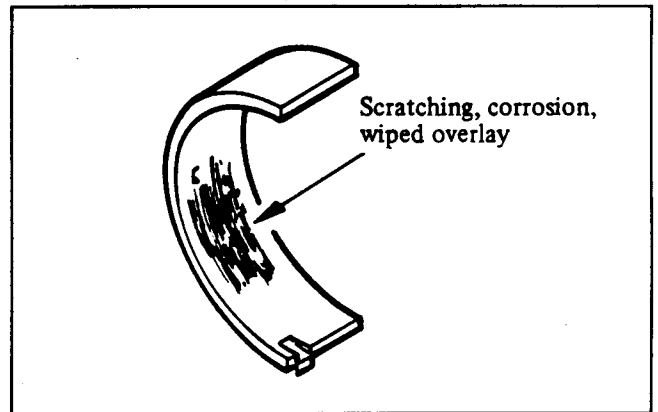


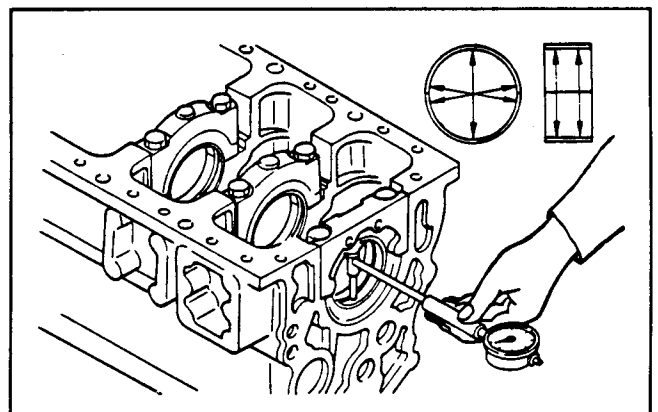
Figure 89

2. Measuring main bearing clearance

Fit the bearing shells to the crankcase and bearing cap and tighten the cap bolts to the specified torque. Measure the inside diameter of the bearing in two positions, front and back, along the longitudinal axis of crankshaft, in the criss-cross directions to take an average. Obtain the difference between the journal diameter and this inside diameter to determine the clearance.

Unit: mm (in.)

Item	Assembly standard	Repair limit
Main bearing-to-journal clearance	0.050 – 0.015 (0.002 – 0.0045)	0.200 (0.007)



Measuring main bearing inside diameter

3. Replacing main bearings

If the clearance exceeds the Repair limit, replace the bearings or refinish the crankshaft and use undersize bearings. If the crankshaft is refinished in compliance with any of the undersizes, it is not necessary to inspect the bearing contact pattern.

Reassembly

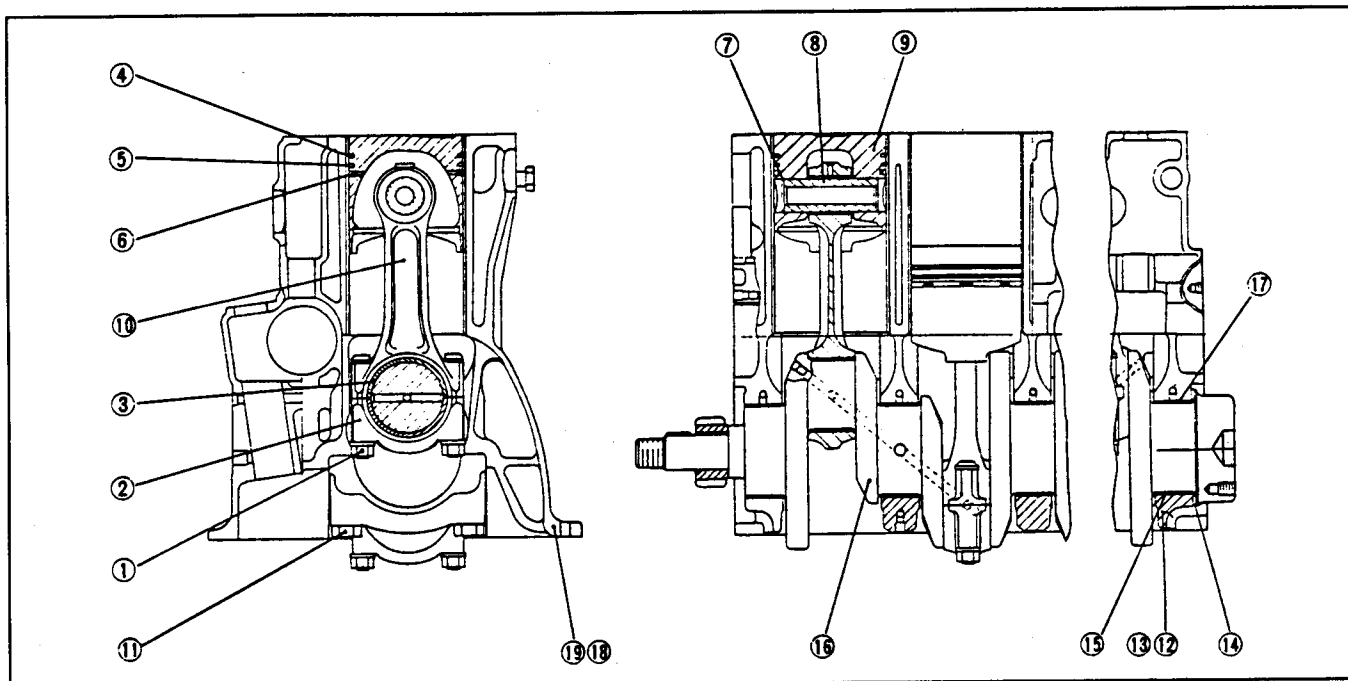


Figure 90

Reassembling sequence

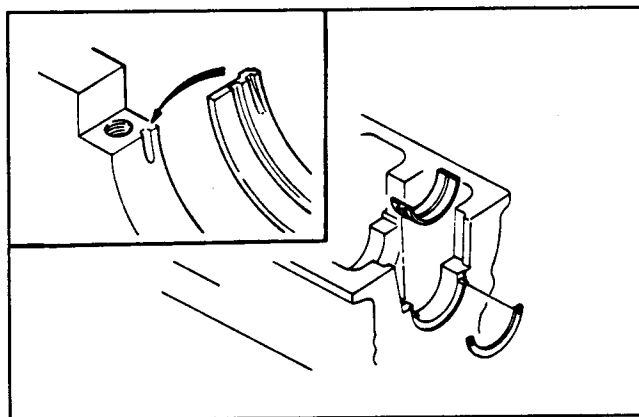
19→18→17→14→16→15→12→11→13 □ → 3→2→1
 9→ 8 →10→ 7→ 6→ 5→ 4

1. Install main bearings

A. Install each upper shell in the crankcase by fitting its locking lip in the recess. The oil holes in the shell and crankcase will be aligned when the shell is so installed.

B. Apply a thin coat of engine oil to the inside surface of each shell.

C. Install the thrust plate in position.



Installing main bearing upper shell

2. Installing crankshaft

- A. Wash the crankshaft with cleaning solvent and dry.
- B. Hold the crankshaft in horizontal position and carefully place it on the crankcase.
- C. Apply a thin coat of engine oil to the journals of the crankshaft.

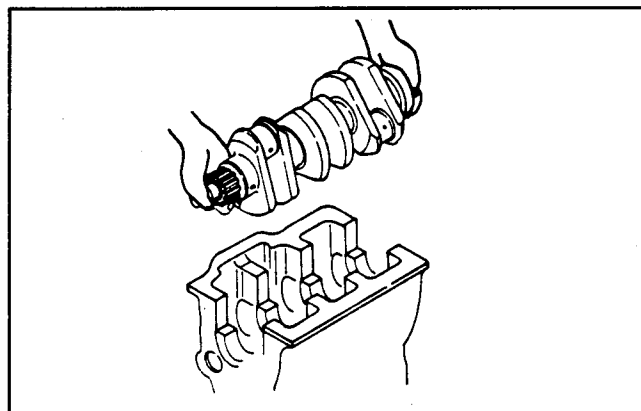


Figure 91

3. Installing main bearing caps

- A. Apply engine oil to each lower shell and fit it to the bearing cap.
- B. Apply sealant to the mating face of the front and rear caps.

NOTE: Apply sealant to the sides of the bearing caps where seals are to be installed only.

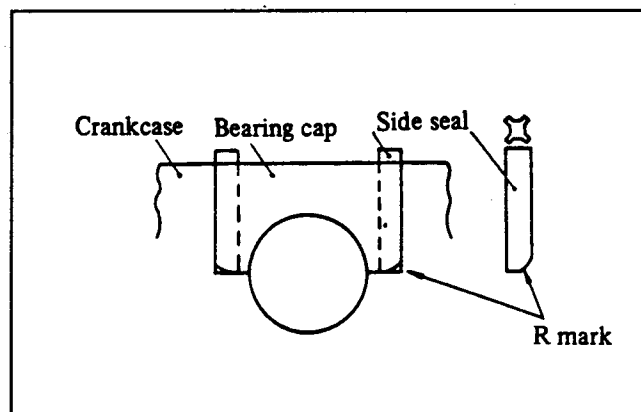


Figure 92

- C. Install the bearing caps to the crankcase, making sure that they are flush with the crankcase walls on the front and rear sides.

- D. Coat the side seals with soapy water and insert them into the grooves in each bearing cap. Using the face of a screwdriver, push in the seals, bringing their rounded corners on the outer side and taking care not to twist the seals.

- E. Apply sealant to the side seal joint.

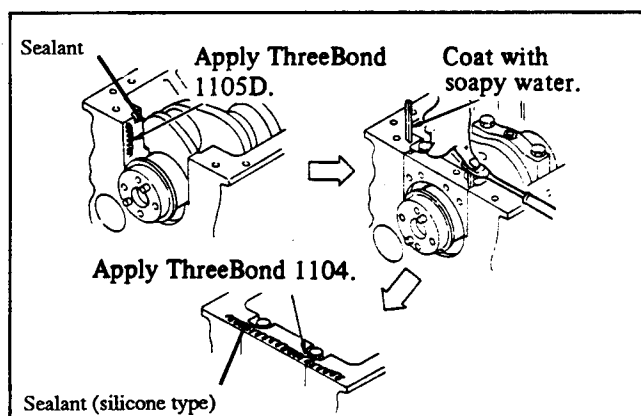


Figure 93

4. Installing bearing cap bolts

- Apply engine oil to the bolts and tighten them to the specified torque.

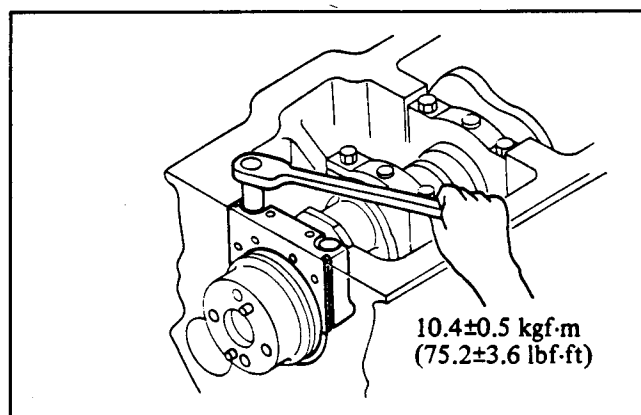


Figure 94

5. Measuring crankshaft end play

Install the thrust plates in position and secure the main bearing caps. Under this condition, measure the end play (the end clearance of thrust plates in the journal). If the end play exceeds the Assembly standard, replace the thrust plates.

Unit: mm (in.)

Item	Assembly standard	Repair limit
Crankshaft end play	0.100 - 0.264 (0.0039 - 0.010)	0.300 (0.0118)

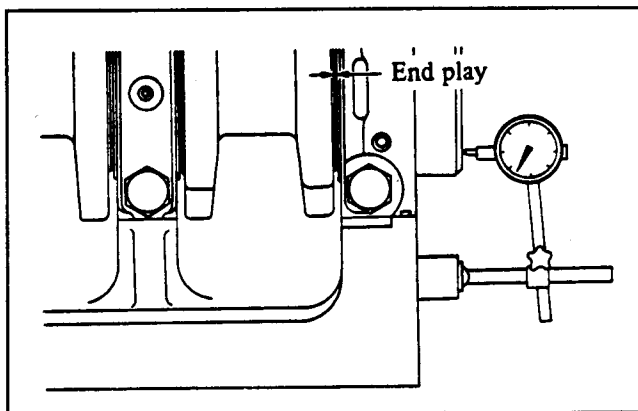


Figure 95

6. Lay the crankcase on its side

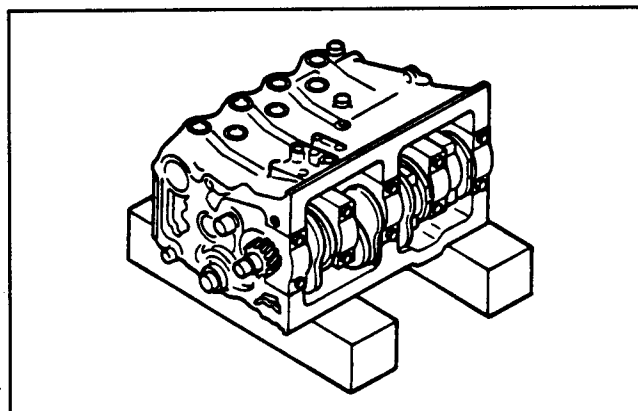
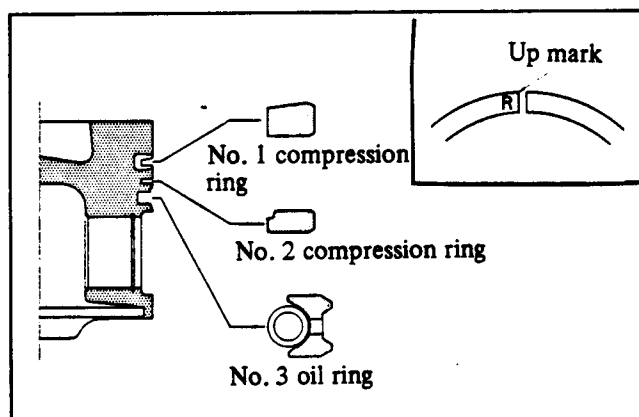


Figure 96

7. Installing piston rings

A. Using a piston ring pliers, install the piston rings on the piston.

NOTE: Each piston ring is marked "R" on the side to be UP when installed on the piston.



B. Install the oil ring with its end gap positioned at 180 degrees to that of spring expander. Attach teflon tube to the expander close to the oil ring end gap.

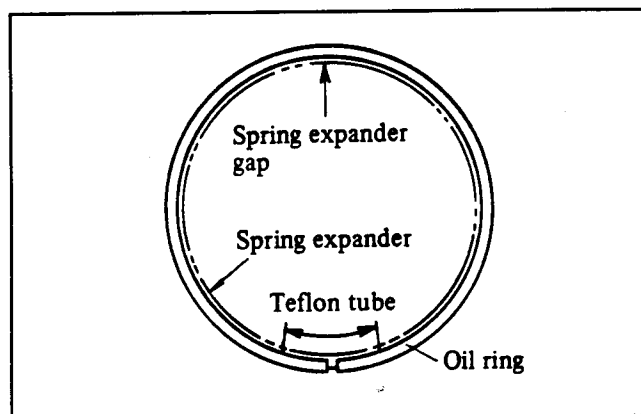


Figure 97

8. Prepare to install pistons

Clean the cylinder sleeve bore surface with a clean cloth and apply engine oil to the surface.

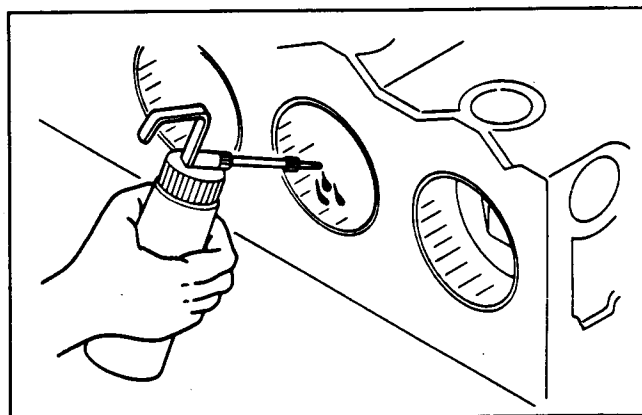


Figure 98

9. Installing connecting rod bearings and caps

A. Insert the bolts into the cap by settling the flat of bolt head in place on the cap.

B. Install the upper shell of the bearing in the rod by fitting its locking lip in the groove and apply engine oil to the inside surface of the shell.

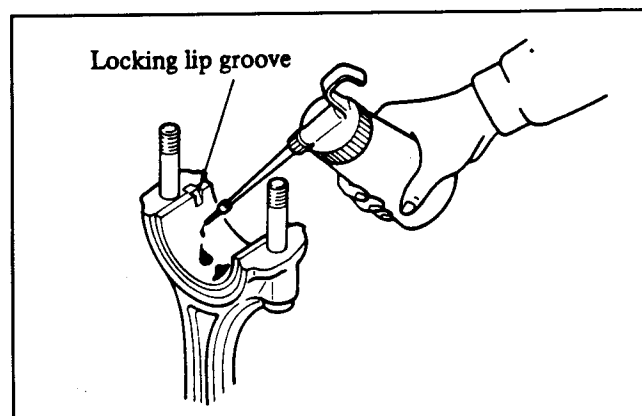


Figure 99

10. Installing pistons

A. Apply engine oil to the piston rings and reposition the rings by keeping their end gaps away from the direction of piston pin and thrust side.

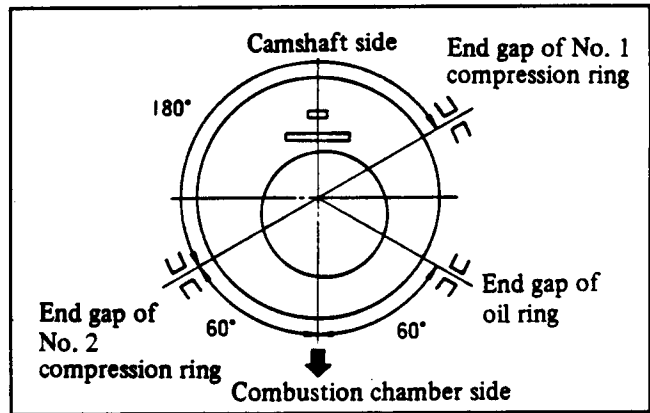


Figure 100

B. Bring the crankpin to which the piston is to be installed to top dead center position. Using a piston installer insert the piston assembly into the crankcase, with the matching mark of the connecting rod on the camshaft side.

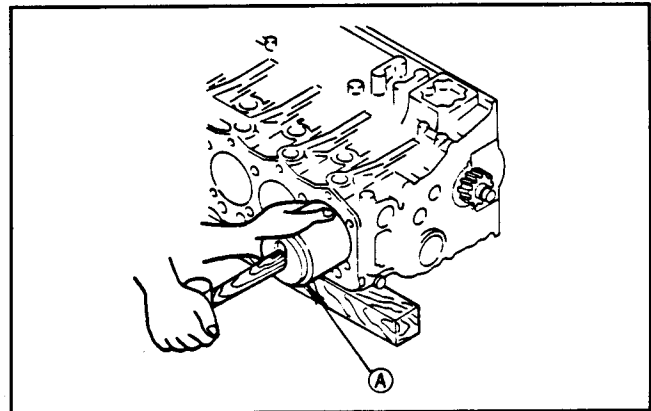


Figure 101

C. After resting the big end of connecting rod on the crankpin, turn crankshaft 180 degrees (bottom dead center) and install the cap.

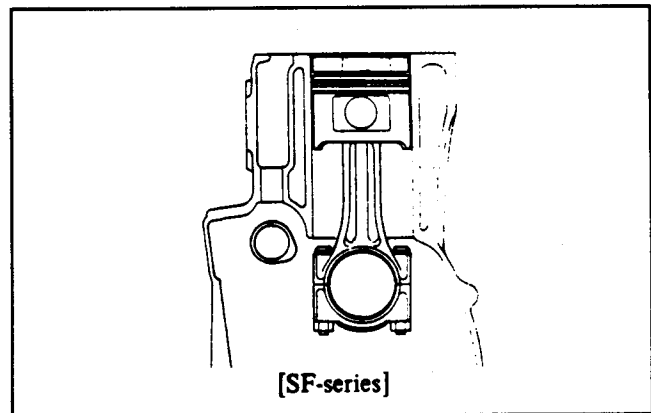


Figure 102

11. Installing connecting rod caps

A. Install the lower shell of the bearing in the cap. Apply engine oil to the inside surface of the shell.

B. Install the cap by tightening the nuts to the specified torque.

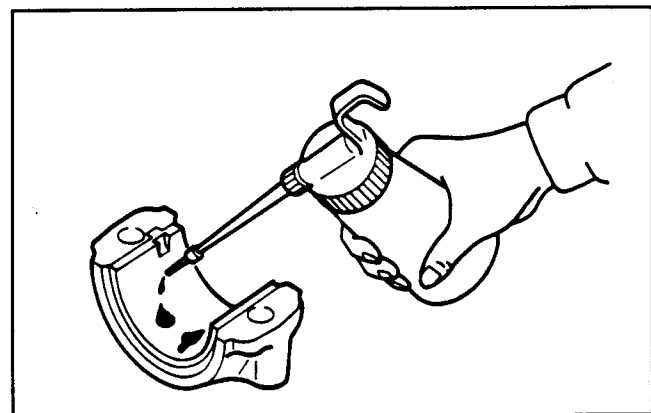


Figure 103

Inlet and Exhaust Systems

Description

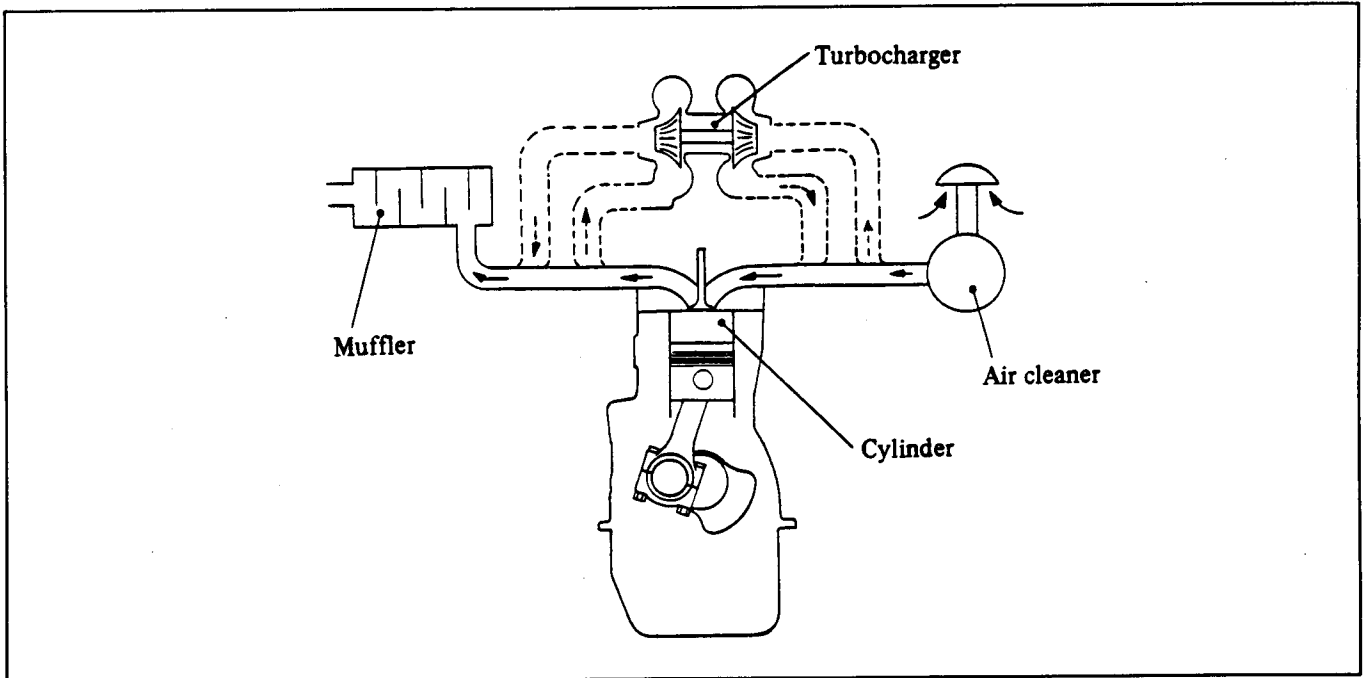


Figure 104

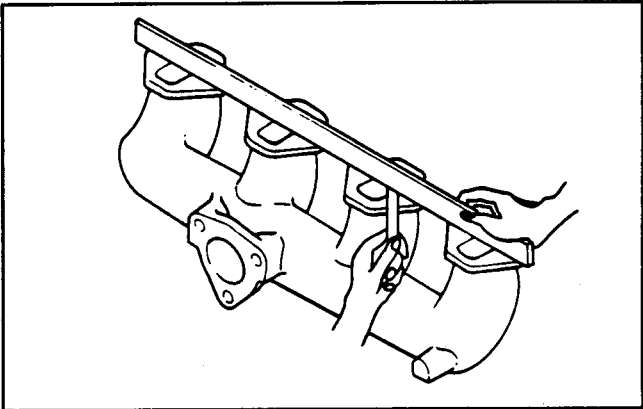
Exhaust Manifold

Inspection

- A. Inspect flanges for cracks.
- B. Inspect flanges for warpage. If the warpage exceeds the Assembly standard, repair the flanges or replace the manifold.

Unit: mm (in.)

Item	Assembly standard
Warpage of exhaust manifold flanges	0.2 (0.008), maximum



Inspecting exhaust manifold flanges for warpage

Turbocharger

Disassembly

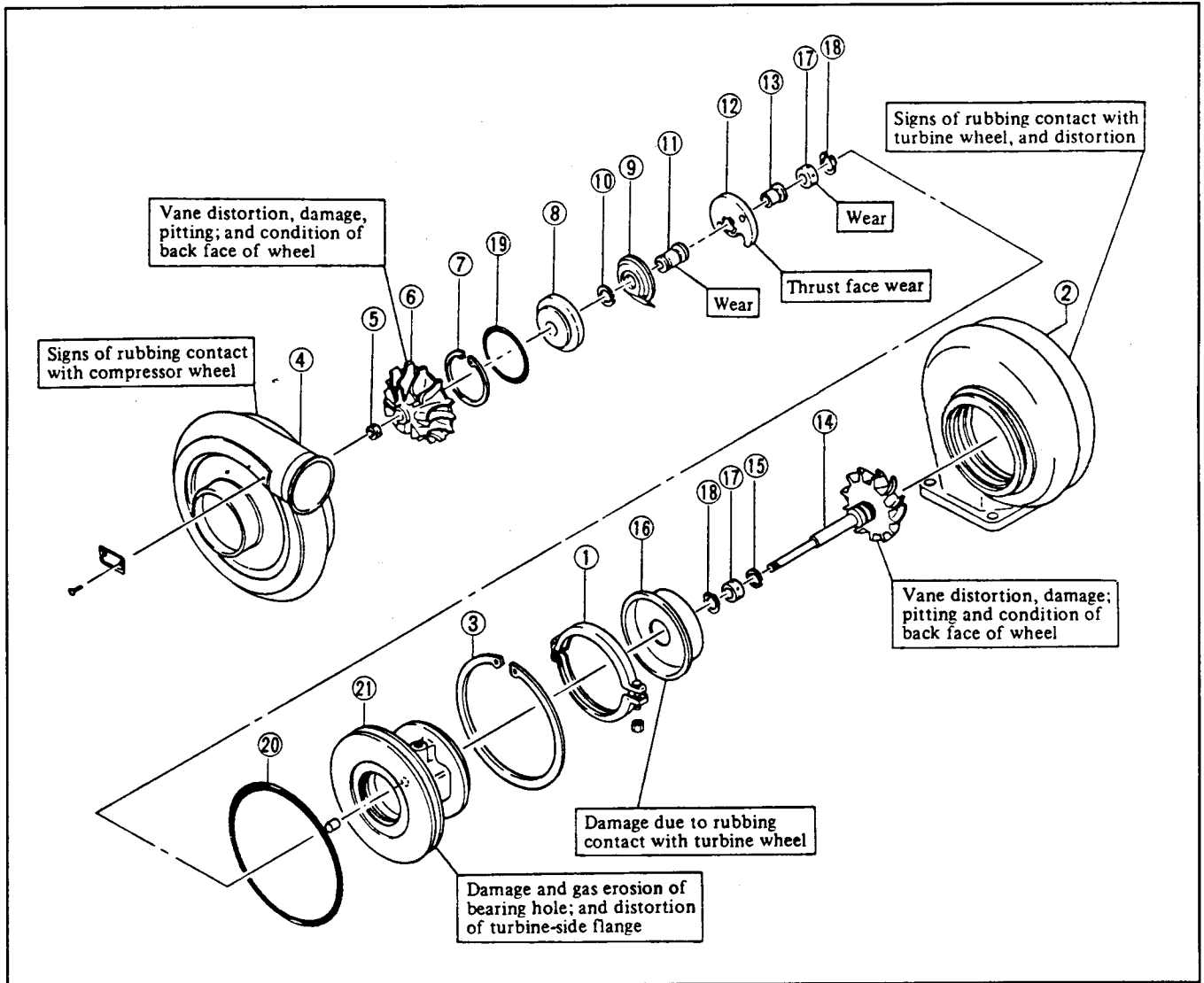


Figure 105

1. Coupling assembly
2. Turbine housing
3. Snap ring
4. Compressor cover
5. Lock nut
6. Compressor wheel
7. Snap ring
8. Insert

9. Oil deflector
10. Piston ring
11. Thrust sleeve
12. Thrust bearing
13. Thrust ring
14. Shaft & turbine wheel
15. Piston ring

16. Turbine back plate
17. Bearing
18. Snap ring
19. O-ring
20. O-ring
21. Bearing housing

IMPORTANT: The compressor wheel vanes and turbine wheel vanes can be easily distorted. Be careful to prevent damage when handling compressor wheel and turbine wheel.

1. Removing turbine housing

Loosen coupling assembly (Item 1), as shown, and separate turbine housing (Item 2) from bearing housing (Item 21).

NOTE: Mark the compressor cover (Item 4), bearing housing (Item 21) and turbine housing (Item 2) before disassembling. When reassembling, make sure the marks are aligned.

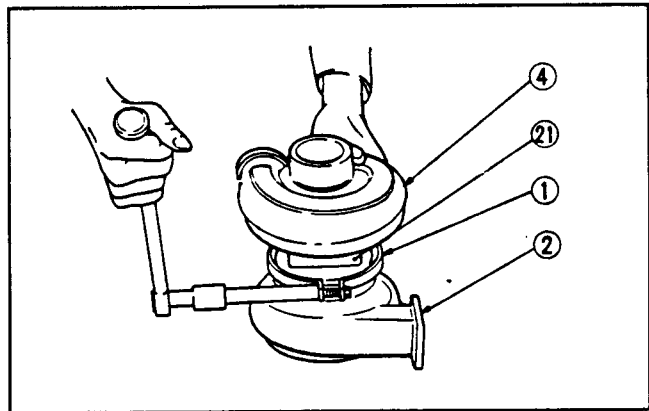


Figure 106

2. Removing compressor cover

A. Lay compressor cover (Item 4) on a flat surface. Use a snap ring pliers (Item A) to remove snap ring.

Hold down snap ring while compressing ring ends with snap rings, so ring does not fly off if ring ends slip off pliers.

B. Use a plastic hammer to lightly tap around compressor cover (Item 4) to remove bearing housing (Item 21).

IMPORTANT: When removing compressor cover (Item 4), be careful not to hit compressor wheel against cover.

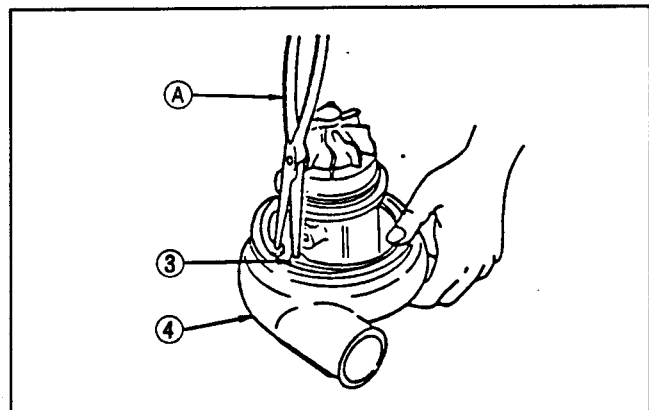


Figure 107

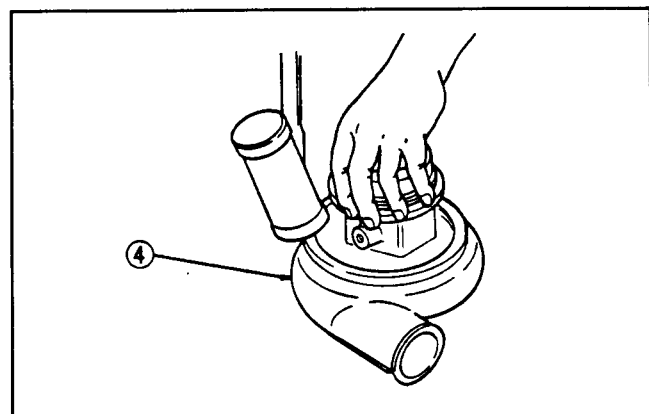


Figure 108

3. Removing compressor wheel

A. Hold turbine housing (Item 2) in a vise. Fit removed bearing housing (Item 21) to housing so shaft and turbine wheel is in turbine housing and compressor wheel (Item 6) is on top.

While holding turbine wheel boss, loosen locknut from shaft.

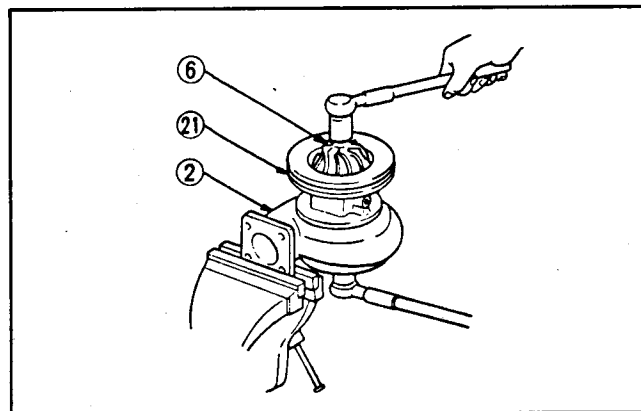


Figure 109

B. Hold turbine wheel stationary and turn compressor wheel (Item 6) back and forth to lift it off the shaft.

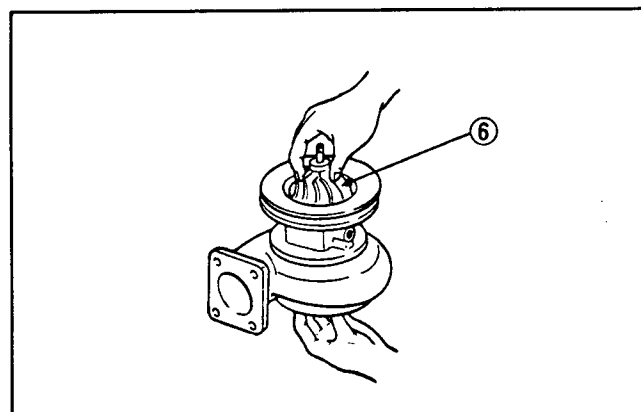


Figure 110

4. Removing inner snap ring

Use a snap ring pliers (Item A) to remove the snap ring (Item 7).



CAUTION

Hold down snap ring while compressing ring ends, so snap ring does not fly off, if ring ends slip off pliers.

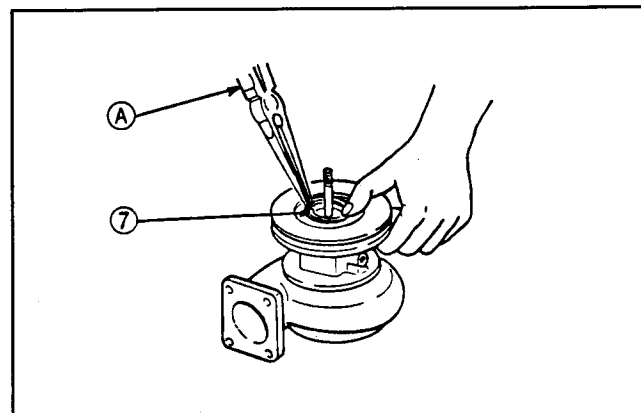


Figure 111

5. Removing insert, oil deflector and other parts

Use two screwdrivers to gently lift insert (Item 8) off bearing housing (Item 21). Remove the piston ring (Item 10), oil deflector (Item 9), thrust sleeve (Item 11), thrust bearing (Item 12), and thrust ring (Item 13).

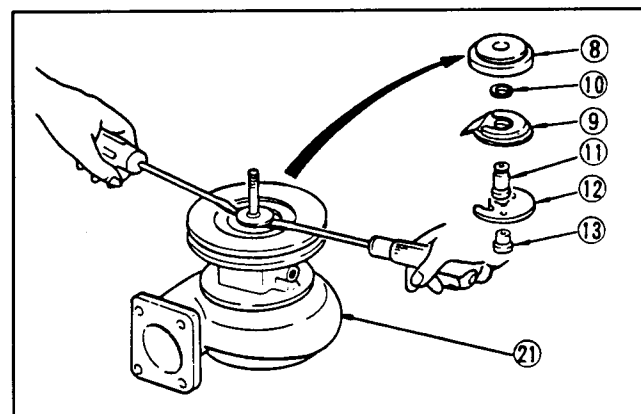


Figure 112

6. Removing shaft and turbine wheel, and bearings

A. Hold turbine housing in a vise. With one hand holding shaft and the other hand holding bearing housing (Item 21), carefully lift bearing housing (Item 21), complete with shaft and turbine wheel (Item 14), off turbine housing. Be careful not to damage the turbine wheel vanes (Item 2).

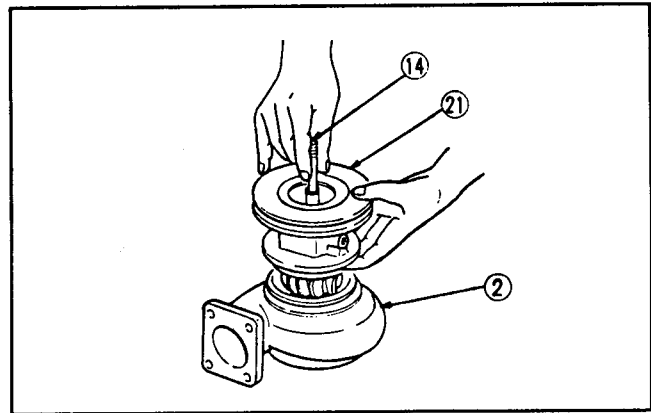


Figure 113

B. Disassemble the shaft and turbine wheel (Item 14), piston ring (Item 15), turbine back plate (Item 16), bearing (Item 17), snap ring (Item 18), o-ring (Item 19) and o-ring (Item 20) from the bearing housing (Item 21).

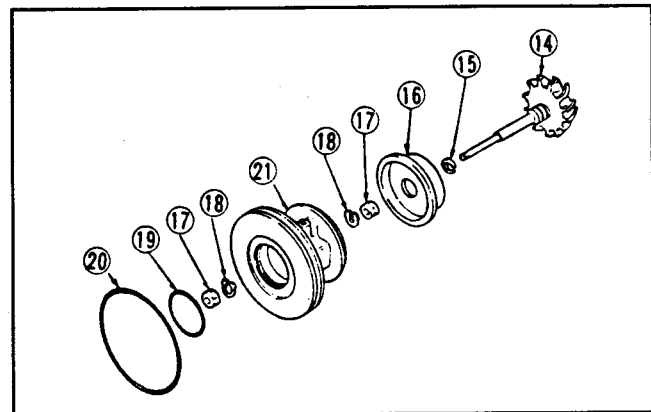


Figure 114

Cleaning and Inspection

1. Cleaning

A. Inspect the parts for signs of burning or other damage.

B. Wash parts in cleaning solvent. Make sure all parts are clean of oily material.

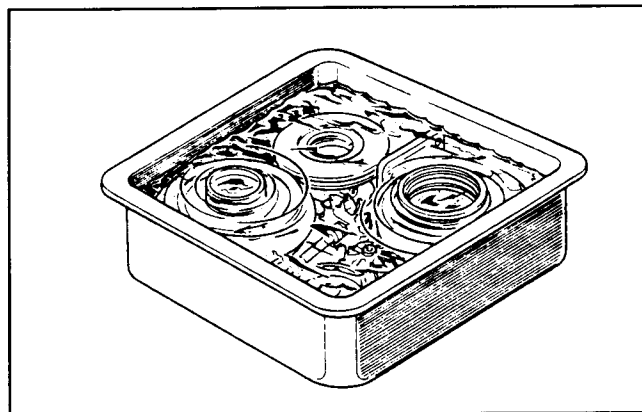


Figure 115

C. Dry the clean parts thoroughly with compressed air.

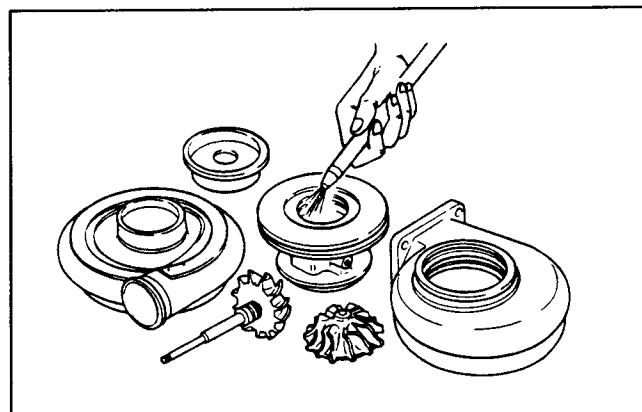


Figure 116

D. Remove scale-like deposits with a bristle brush. After removing deposits with brush, wash parts in solvent again and dry.

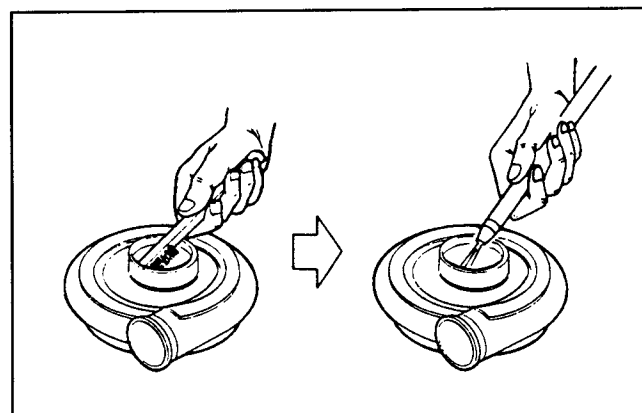


Figure 117

E. Apply clean engine oil to surfaces of moving parts to prevent corrosion.

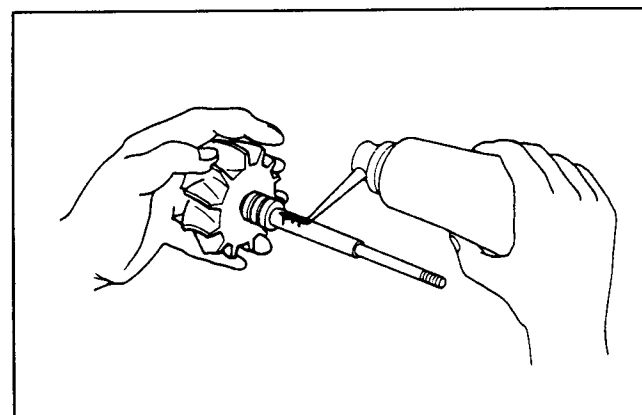


Figure 118

2. Inspection

A. Bearing housing

Measure inside diameter of bearing bores in housing. If measurement exceeds service limit, replace housing.

Unit: mm (in.)

Item	Service limit
Inside diameter of bearing bores in housing	15.686 (0.61756)

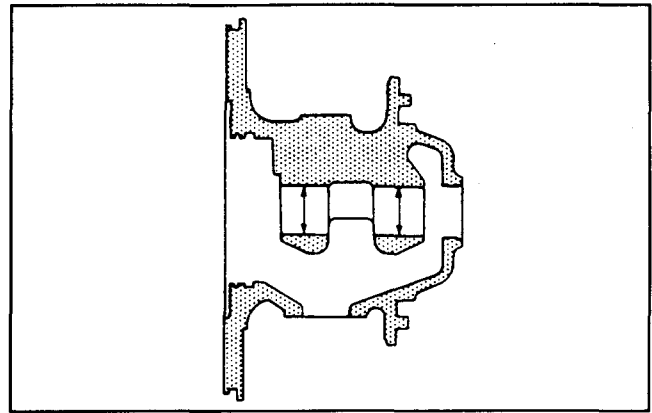


Figure 119

B. Bearing

1) Measure outside diameter of bearing. If measurement exceeds service limit, replace bearing.

Unit: mm (in.)

Item	Service limit
Outside diameter of bearing	15.574 (0.61315)

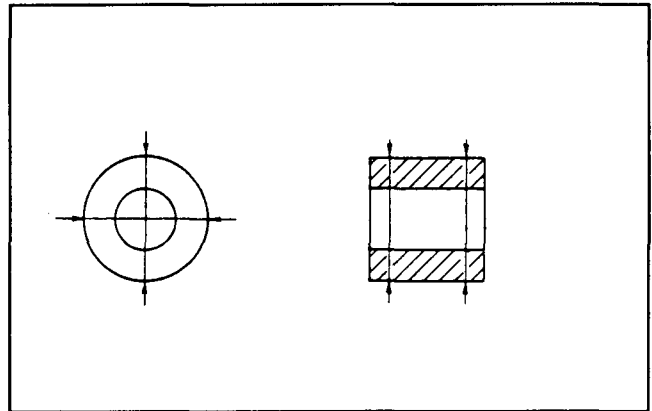


Figure 120

2) Measure inside diameter of bearing. If measurement exceeds service limit, replace bearing.

Unit: mm (in.)

Item	Service limit
Inside diameter of bearing	9.04 (0.3559)

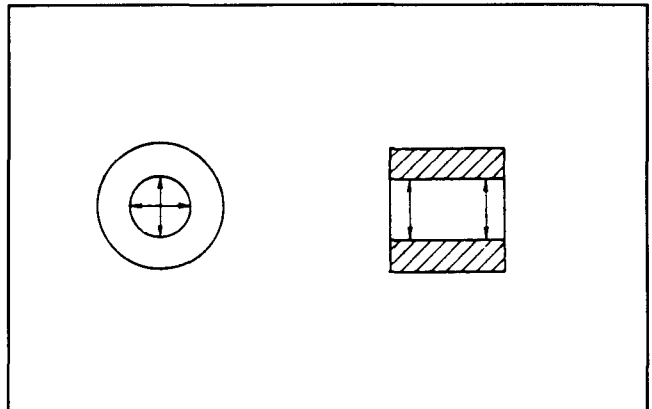


Figure 121

3) Measure length of bearing. If measurement is less than service limit, replace bearing.

Unit: mm (in.)

Item	Service limit
Length of bearing (Model TC)	9.34 (0.3677)

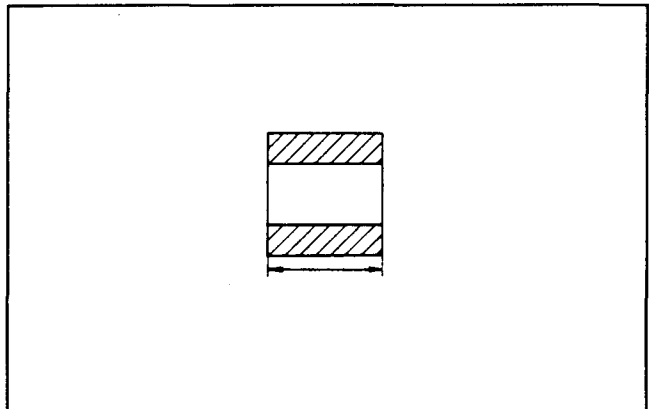


Figure 122

C. Shaft and turbine wheel

- 1) Measure inside diameter of shaft journals. If measurement is less than service limit, replace shaft & turbine wheel and piston ring.

Unit: mm (in.)

Item	Service limit
Diameter of shaft journals	8.994 (0.35409)

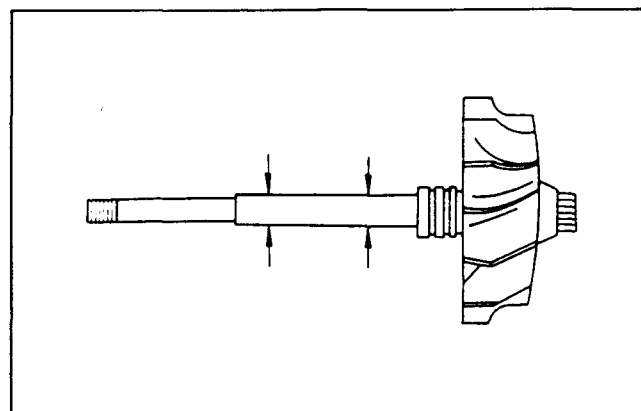


Figure 123

- 2) Use a dial indicator and V-block to measure runout of shaft. If measurement exceeds service limit, replace shaft & turbine wheel.

Unit: mm (in.)

Item	Service limit
Runout of turbine wheel & shaft	0.015 (0.00059)

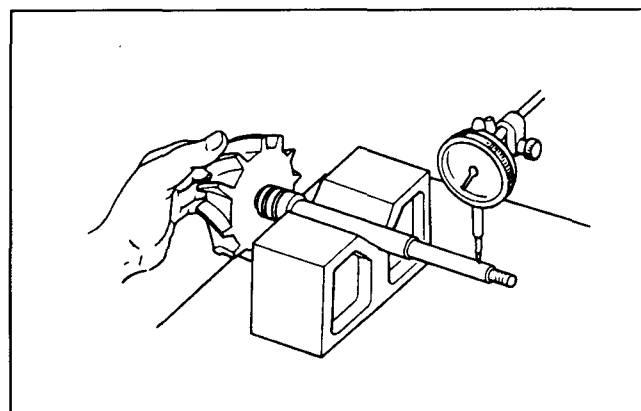


Figure 124

IMPORTANT: Do not attempt to straighten a distorted shaft. Replace shaft & turbine wheel if shaft is distorted.

- 3) Check surfaces of shaft journals. If surfaces are rough, install in a lathe and lightly polish journals with #400 sandpaper and engine oil at 300 to 600 rpm. Install in lath by tightening shaft in chucks at its center.

D. Insert

Put a new piston ring in groove of insert, and measure end gap of ring. If gap measurement exceeds standard clearance, replace insert.

Unit: mm (in.)

Item	Standard clearance
End gap of piston ring	0.05 - 0.15 (0.0020 - 0.00059)

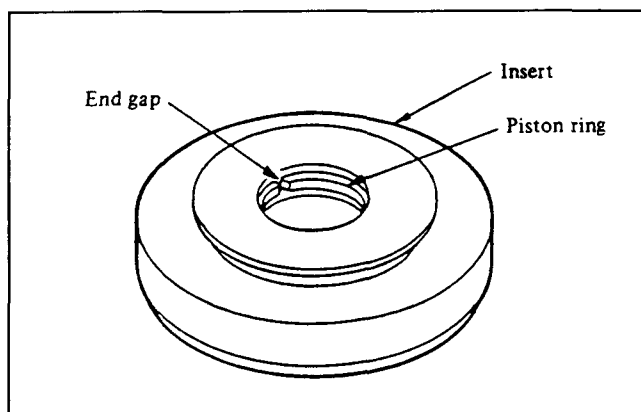


Figure 125

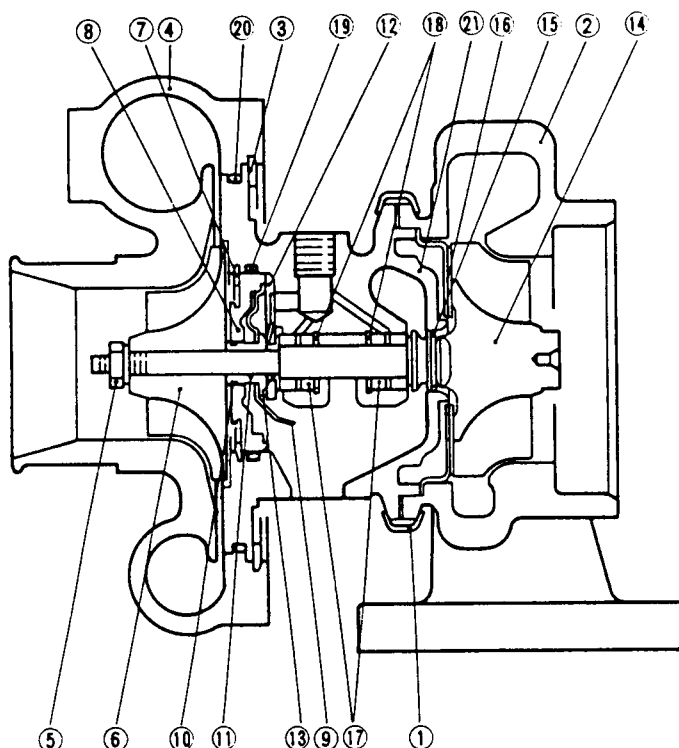


Figure 126

Reassembling sequence

21 → 18 → 17 → 16 → 13 → 12 → 19 → 7 → 6 → 5 → 20 → 4 → 3 → 2 → 1
 15 → 14 → 9 → 11 → 10 → 8

NOTE: When reassembling the turbocharger, replace the piston ring (Item 10), piston ring (Item 15), O-ring (Item 19), and O-ring (Item 20).

IMPORTANT: After installing an overhauled turbocharger on the engine, disconnect the run solenoid electrical connector (so the engine will not start) and crank the engine with the starter to permit engine oil to flow to the turbocharger.

IMPORTANT: Replace the compressor wheel or shaft & turbine wheel assembly if the blades are badly distorted or damaged. It is not necessary to make a replacement if a single blade has minor distortion or scratches. Never attempt to re-shape the distorted blade.

1. Installing shaft & turbine wheel, and bearings

A. Reassemble the bearing housing (Item 21), snap ring (Item 18), bearing (Item 17), turbine back plate (Item 16), piston ring (Item 15), and shaft & turbine wheel (Item 14).

IMPORTANT:

Apply engine oil to the inside and outside surfaces of bearing when installing bearing to shaft.

Apply engine oil to piston ring when installing to shaft & turbine wheel. Be careful not to twist or expand ring more than is necessary for installation.

Make sure to insert shaft & turbine wheel straight into turbine back plate and bearing housing.

When installing bearing, make sure that the end with six (6) holes is on the compressor wheel side.

B. Temporarily install reassembled bearing housing (Item 21) to turbine housing (Item 2), and install coupling assembly (Item 1) by tightening its nut temporarily.

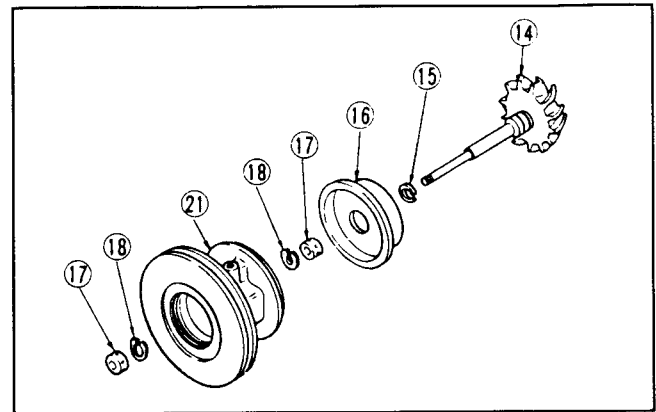


Figure 127

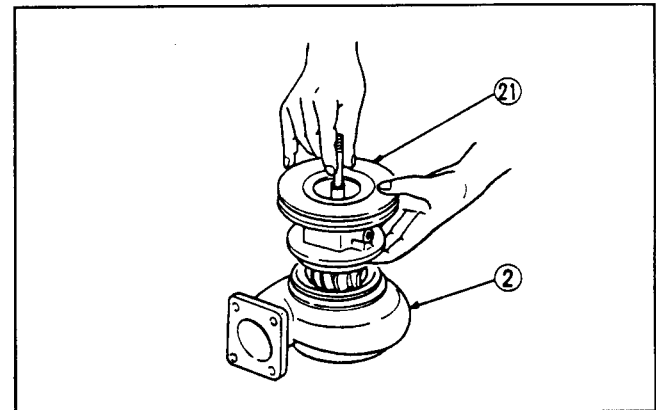


Figure 128

2. Installing thrust bearing

Apply engine oil to inside and outside surfaces of thrust ring (Item 13) and thrust bearing (Item 12), and install the ring and bearing in place.

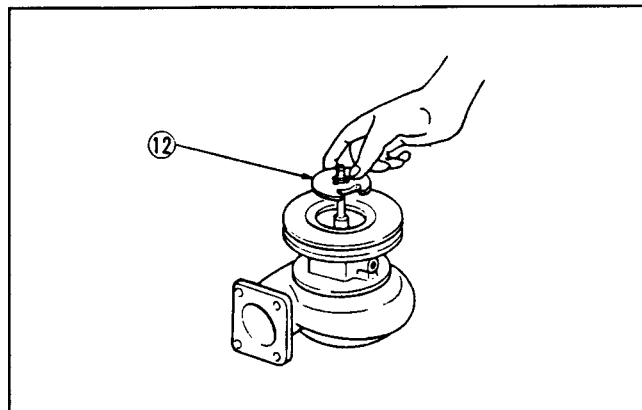


Figure 129

3. Installing o-ring

Apply engine oil to o-ring (Item 19) and install it in place.

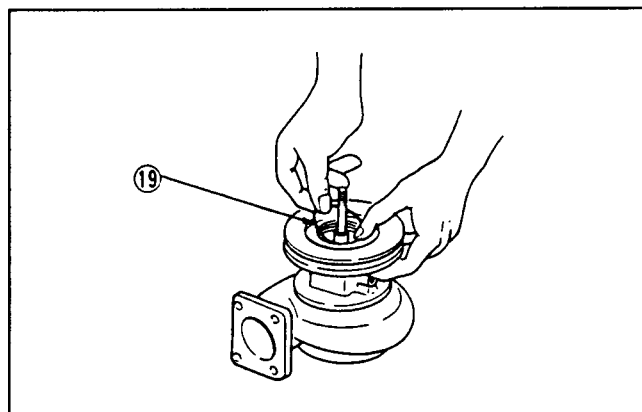


Figure 130

4. Reassembling insert subassembly

A. Assemble the oil deflector (Item 9) to the thrust sleeve (Item 11). Install the piston ring (Item 10) to the thrust sleeve. Install the insert.

IMPORTANT:

When installing piston ring to thrust sleeve, be careful not to expand the ring more than necessary or to twist the end gap.

Apply Molykote to the piston ring fitted on thrust sleeve, and install sleeve to insert, taking care not to damage ring.

B. Install insert subassembly to bearing housing (Item 21).

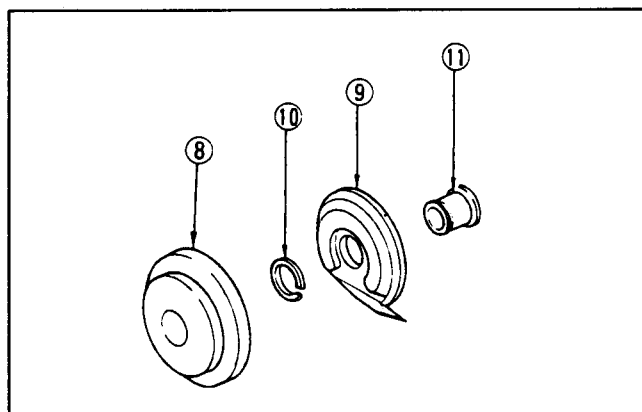


Figure 131

5. Installing snap ring

A. Use a snap ring pliers to install snap ring (Item 7) to bearing housing (Item 21), with tapered side of snap ring facing up.

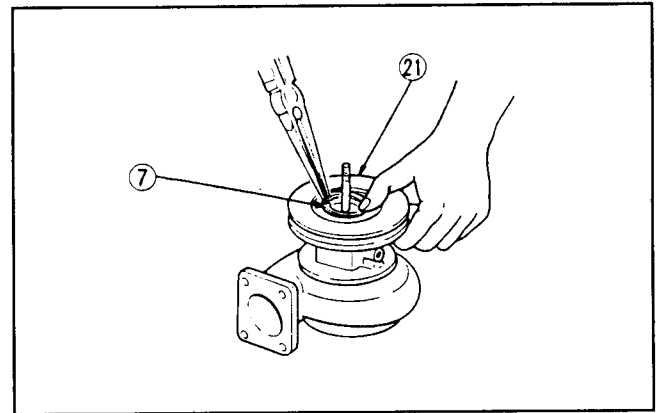


Figure 132

B. Use light blows from a hammer and screwdriver to fit the ring in the groove of the bearing housing.

IMPORTANT: Be careful not to damage bearing housing when fitting snap ring to groove in bearing housing with hammer and screwdriver.

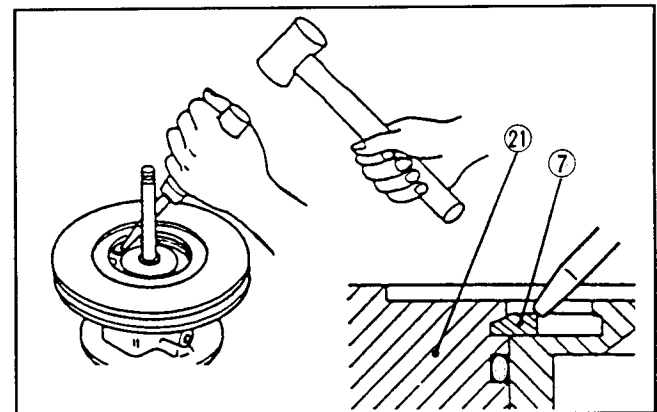


Figure 133

6. Measuring clearance between turbine wheel and turbine housing

Set up a dial indicator on shaft & turbine wheel as shown (Fig. 134). Move shaft in axial direction to measure clearance. If clearance measurement is not within standard clearance, disassemble the parts and find the cause.

Unit: mm (in.)

Item	Standard clearance
Clearance between shaft & turbine wheel and turbine housing	0.42 - 1.10 (0.0165 - 0.0433)

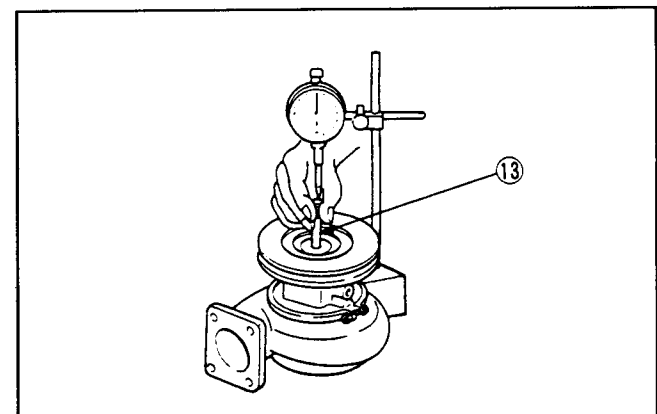


Figure 134

7. Installing compressor wheel

Install compressor wheel (Item 6). Apply Molykote to locknut and tighten it to the specified torque.

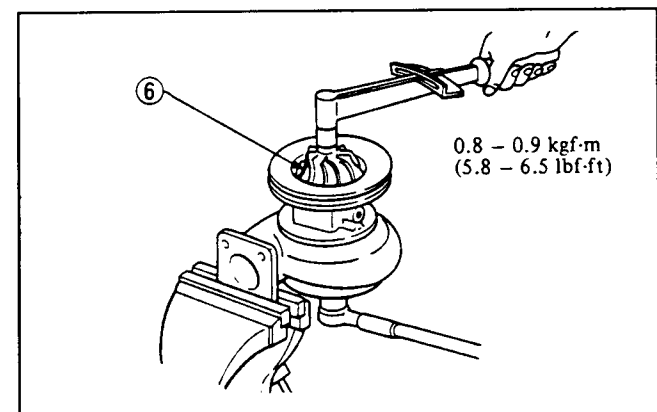


Figure 135

8. Measuring axial play of shaft & turbine wheel

Set up a dial indicator on shaft & turbine wheel (Item 14) as shown (Fig. 136). Move compressor wheel (Item 6) in axial direction to measure end play. If measurement is not within standard clearance, disassemble parts and find cause.

Unit: mm (in.)

Item	Standard clearance
Axial play of shaft & turbine wheel	0.057 - 0.103 (0.00224 - 0.00406)

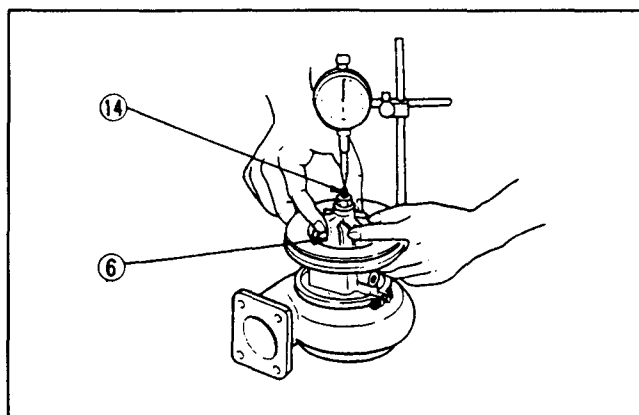


Figure 136

9. Measuring clearance between turbine back plate and turbine wheel

Remove turbine housing from bearing housing (Item 21), and install compressor cover (Item 4). Use feeler gauges to measure clearance between turbine back plate (Item 16) and turbine wheel. If measurement is not within standard clearance, disassemble parts and find cause.

NOTE: Measure clearance at tips of vanes with two (2) feeler gauges.

Unit: mm (in.)

Item	Standard clearance
Clearance between turbine back plate and turbine wheel	0.37 - 0.85 (0.0146 - 0.0335)

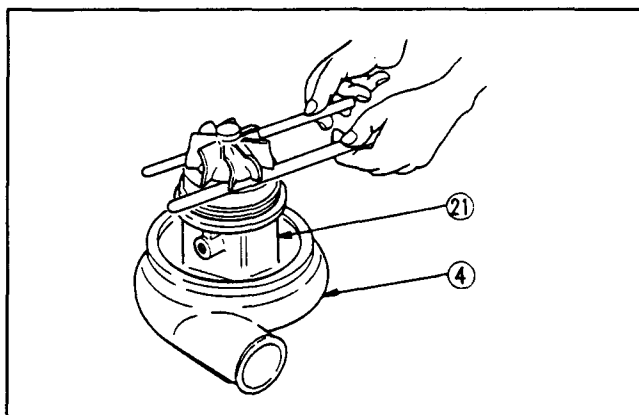


Figure 137

10. Installing compressor cover

Install compressor cover (Item 4), making sure that it is in correct position with respect to turbine housing. Apply grease to o-ring (Item 20) when installing it.

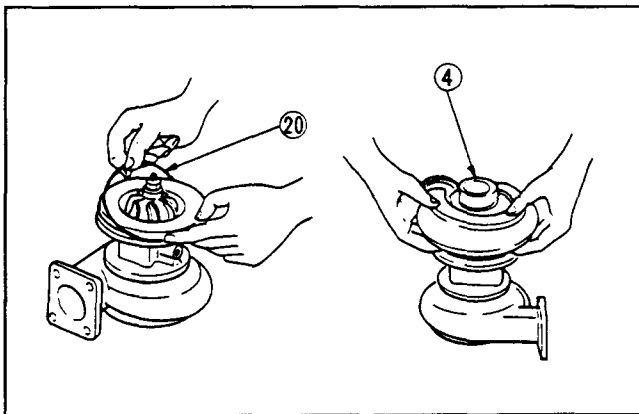


Figure 138

11. Installing snap ring

Use a snap ring pliers to install snap ring (Item 3) to compressor cover (Item 4), with its tapered side facing up.

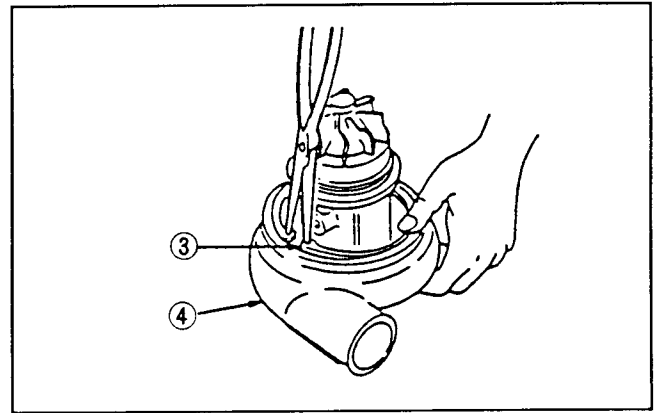


Figure 139

12. Installing turbine housing

Install turbine housing (Item 2) to bearing housing (Item 21), making sure it is in correct position with respect to the housing.

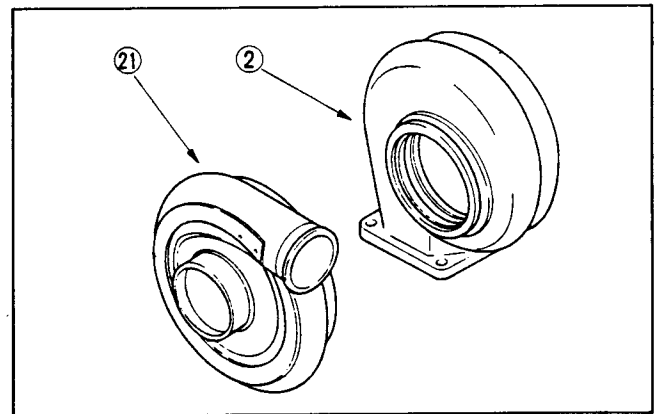


Figure 140

13. Installing coupling assembly

Apply Molykote to threads of nut in coupling assembly (Item 1), and tighten nut to specified torque.

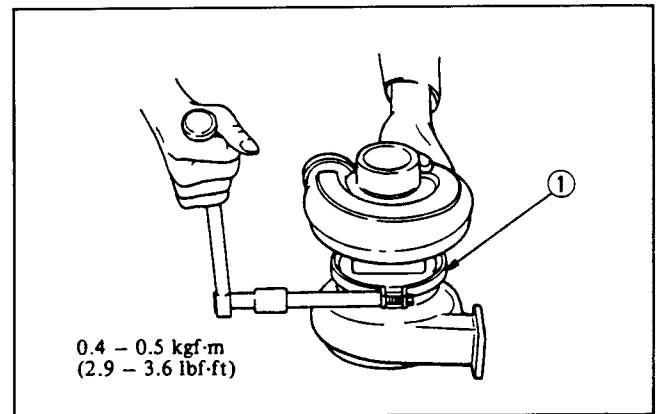


Figure 141

Lubrication System

Description

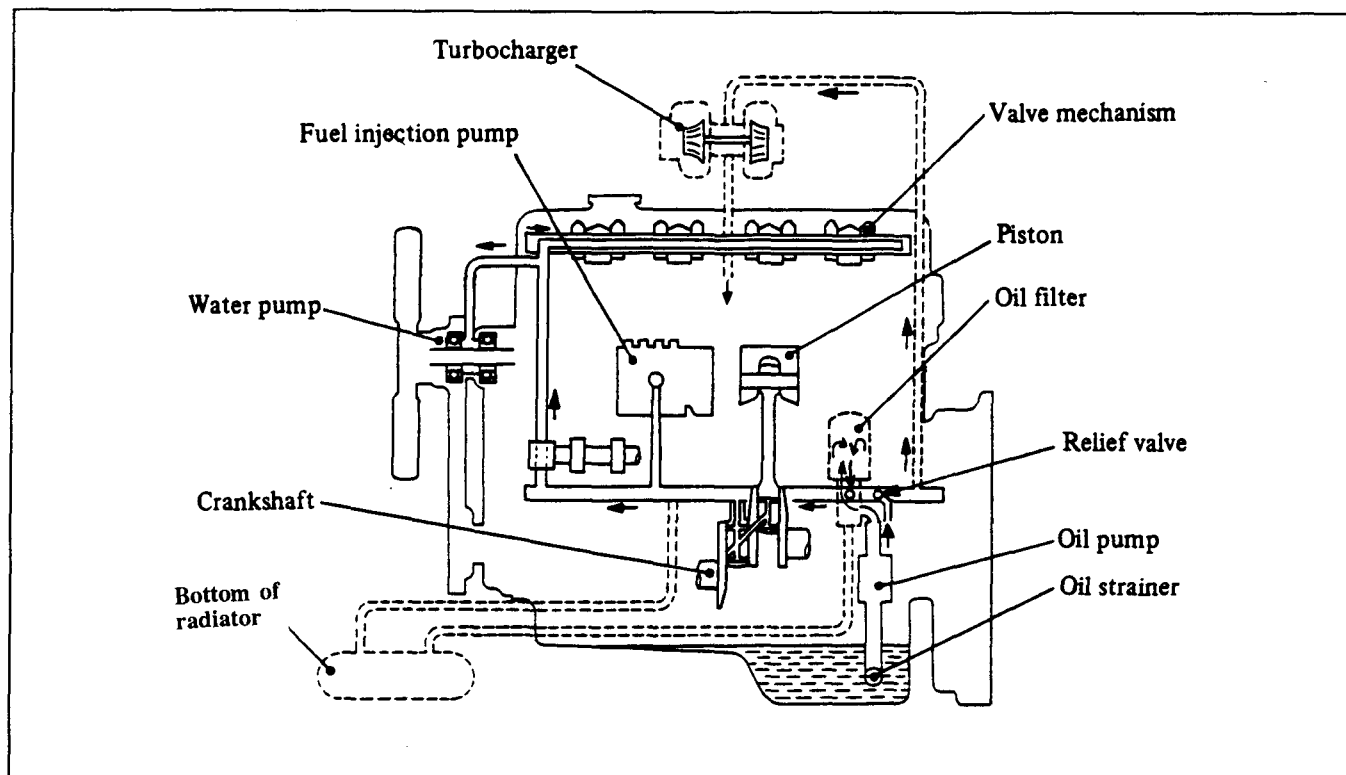


Figure 142

Oil Pump

Disassembly

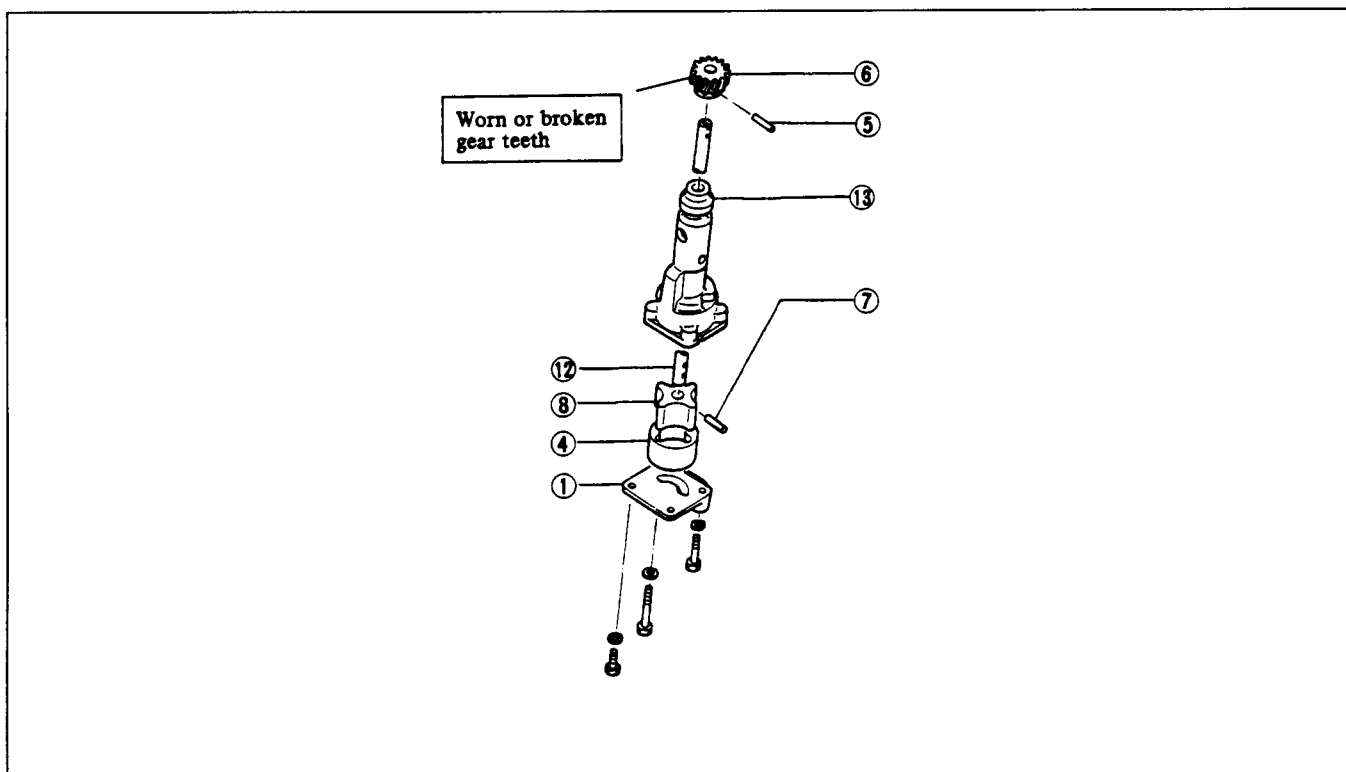


Figure 143

- 1. Oil pump case cover
- 2. Spacer
- 3. Pin
- 4. Outer rotor
- 5. Taper pin

- 6. Pump drive gear
- 7. Pin
- 8. Inner rotor
- 9. Outer rotor
- 10. Pin

- 11. Inner rotor
- 12. Main shaft
- 13. Oil pump case

1. Removing main shaft

Take off the taper pin and remove the drive gear from the main shaft. Pull the main shaft complete with the inner rotors from the pump case.

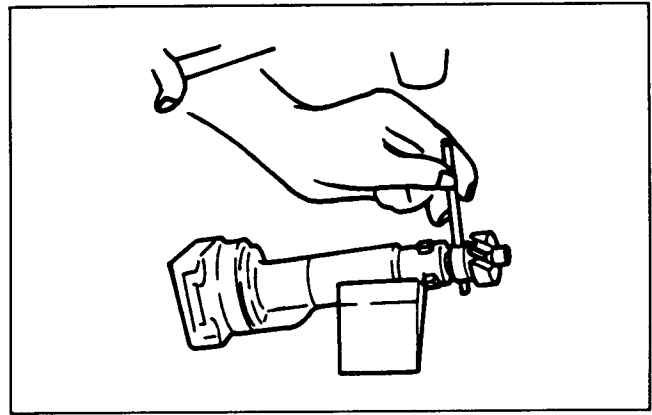


Figure 144

2. Removing inner rotors

Remove the pin and separate the inner rotors from the main shaft.

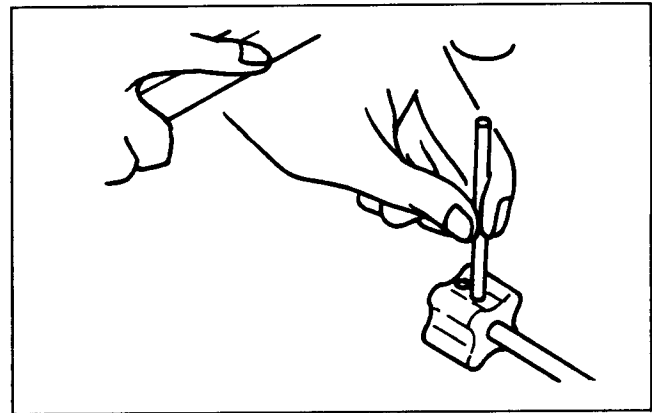


Figure 145

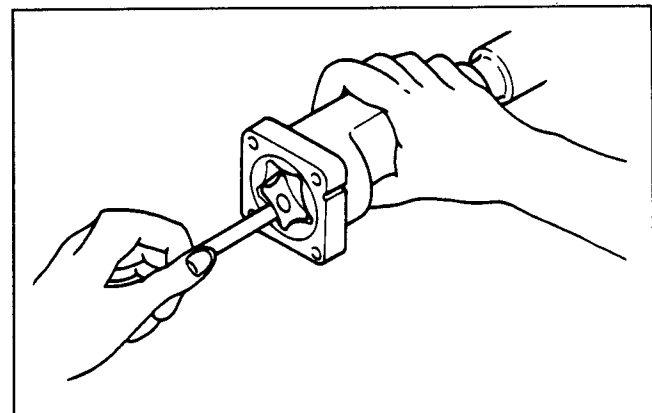
Inspection and Repair

1. Measuring outer rotor-to-inner rotor clearance

If the clearance exceeds the Service limit, replace the outer and inner rotors as an assembly.

Unit: mm (in.)

Item	Assembly standard	Service limit
Outer rotor-to-inner rotor clearance	0.013 – 0.150 (0.0005 – 0.0059)	0.250 (0.0098)



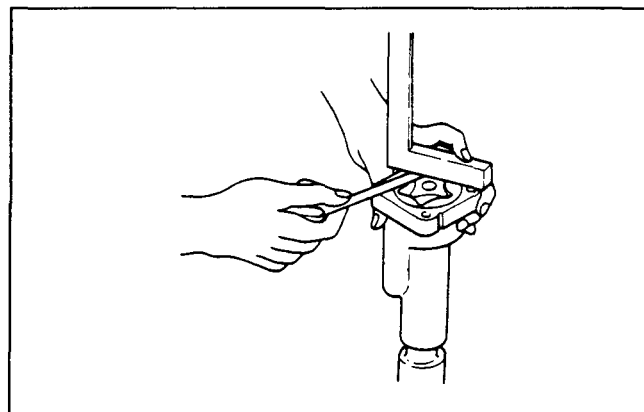
Measuring outer rotor-to-inner rotor clearance

2. Measuring rotor-to-cover clearance (end play of rotors)

If the clearance exceeds the Repair limit, replace the rotors or grind the mating faces of the case and cover.

Unit: mm (in.)

Item	Assembly standard	Repair limit
Rotor-to-cover clearance (end play of rotors)	0.04 – 0.09 (0.0016 – 0.0035)	0.15 (0.0059)



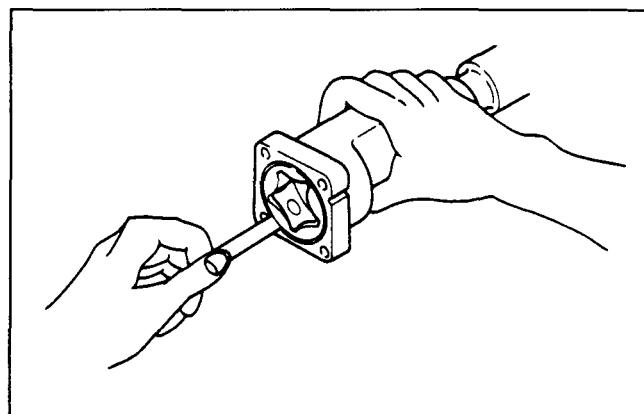
Measuring rotor-to-cover clearance

3. Measuring outer rotor-to-pump case clearance

If the clearance exceeds the Service limit, replace the rotor or case whichever is badly worn.

Unit: mm (in.)

Item	Assembly standard	Service limit
Outer rotor-to-pump case clearance	0.20 – 0.28 (0.0079 – 0.0110)	0.50 (0.0197)



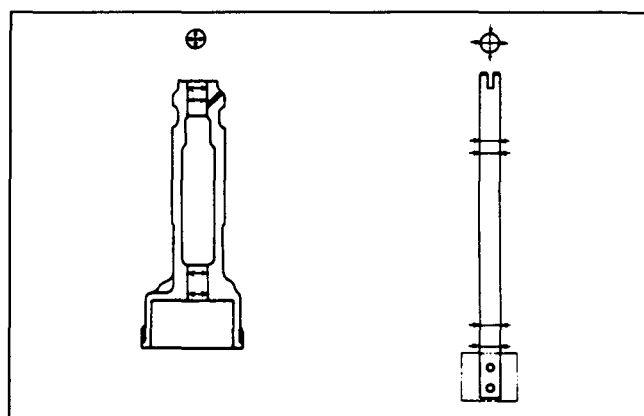
Measuring outer rotor-to-pump case clearance

4. Measuring main shaft-to-pump case clearance

Measure the diameter of main shaft and the inside diameter of pump case to determine the clearance between the two. If the clearance exceeds the Service limit, replace the main shaft or the pump assembly.

Unit: mm (in.)

Item	Assembly standard	Service limit
Diameter of main shaft	13.000 – 12.985 (0.5118 – 0.5112)	
Main shaft-to-pump case clearance	0.032 – 0.074 (0.0013 – 0.0029)	0.150 (0.0059)



Measuring main shaft-to-pump case clearance

Reassembly

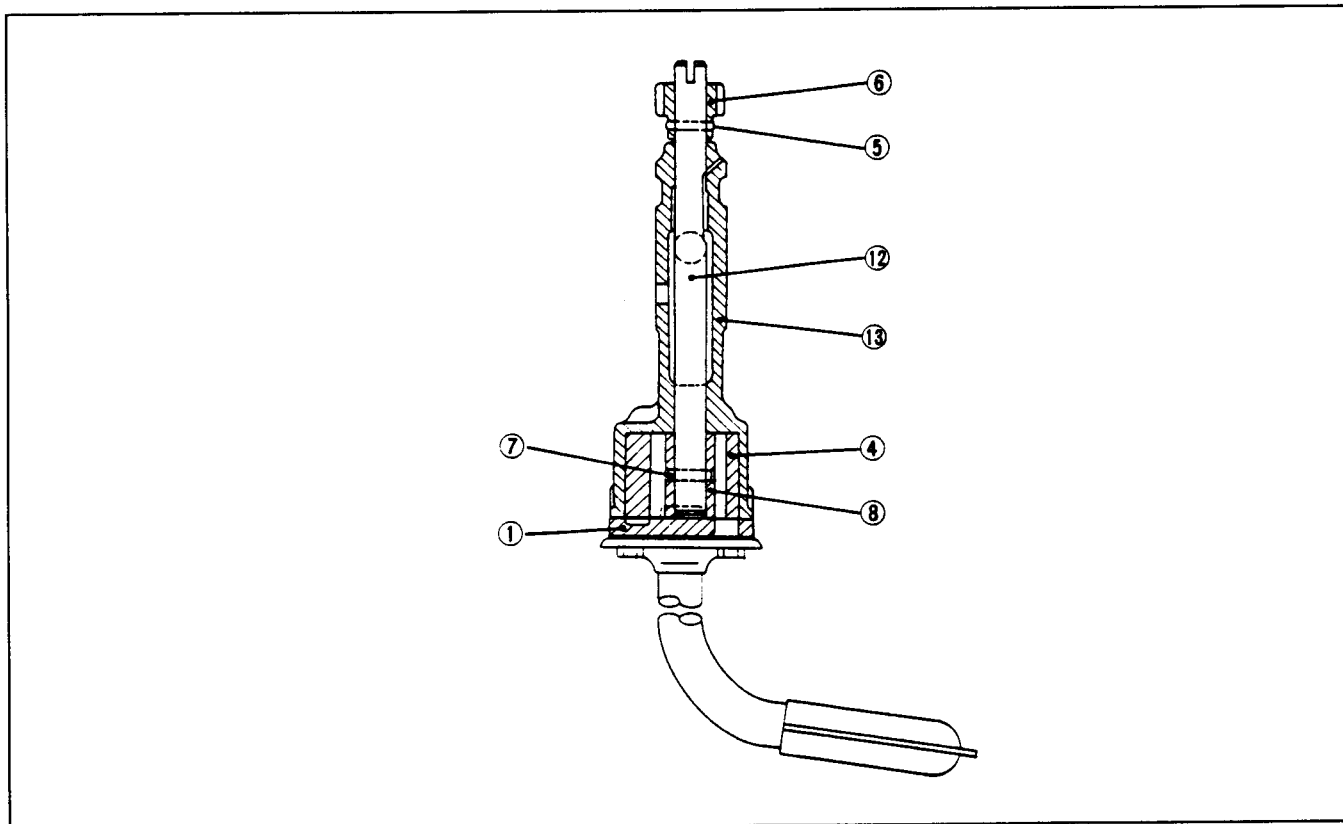


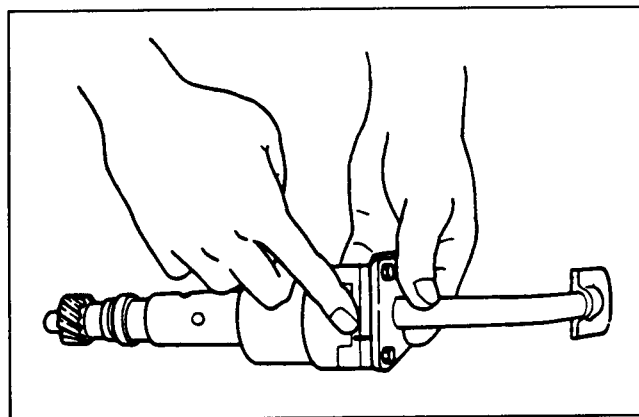
Figure 146

Reassembling sequence

12→ 11→ 10→8→7→13→9→6→5→4→3→2→13

NOTE: When using replacement (new) main shaft and drive gear at the time of reassembling the pump, drill dowel pin hole in and through the shaft and gear.

When tightening the cover bolts, be sure that the matching marks on the cover and case are aligned. Failure to match the marks will result in misalignment and internal damage during operation.



Measuring marks on pump case and cover

Oil Filter

Disassembly and Inspection

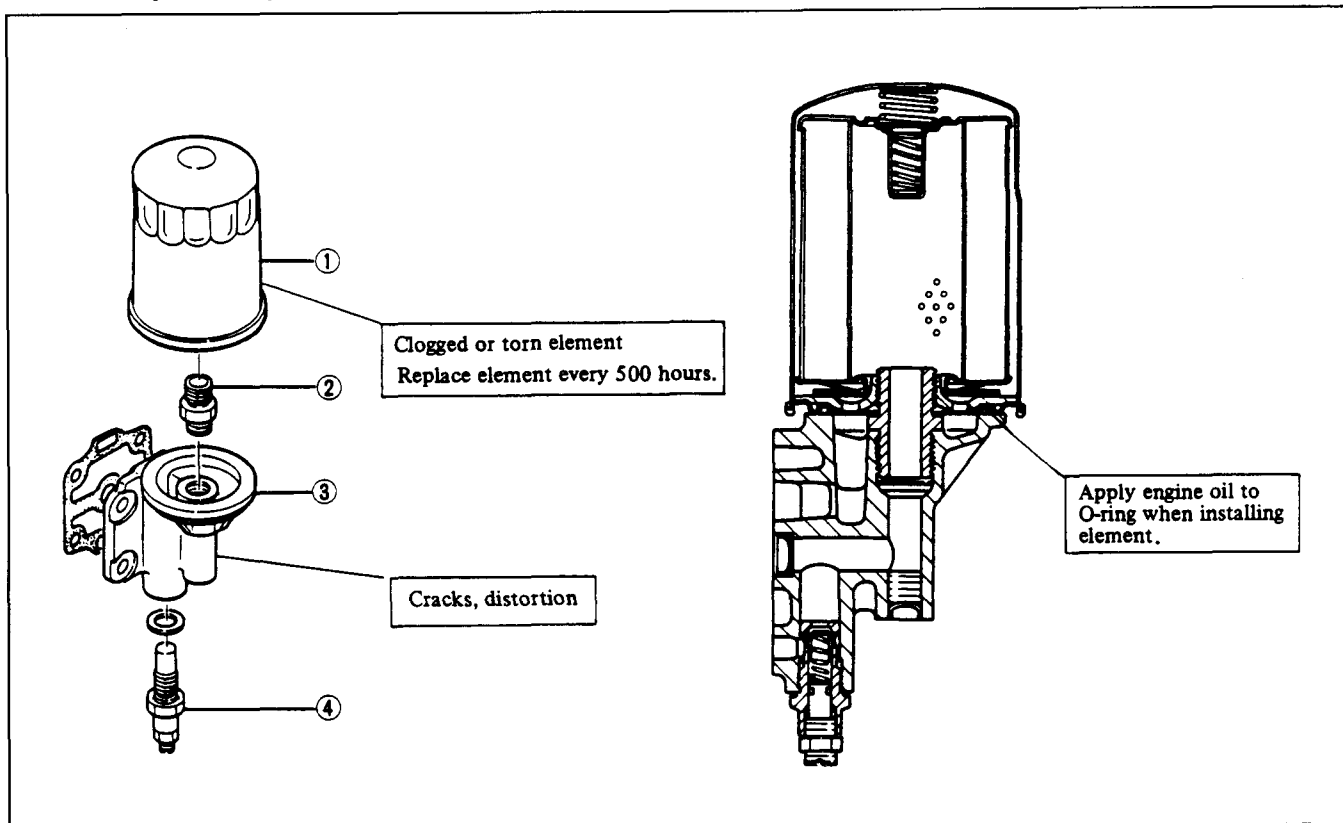


Figure 147

1. Filter element
2. Center screw

3. Filter case
4. Relief valve

Relief Valve

Inspection

1. Check the valve seat for abnormal contact. Also check the spring for weakness or damage.
2. Measure the relief valve opening pressure. If it exceeds the Assembly standard, make an adjustment by tightening or loosening the adjusting screw.

Unit: kgf/cm² (psi)

Item	Assembly standard
Relief valve opening pressure	3 ± 0.2 (42.7 ± 2.8)

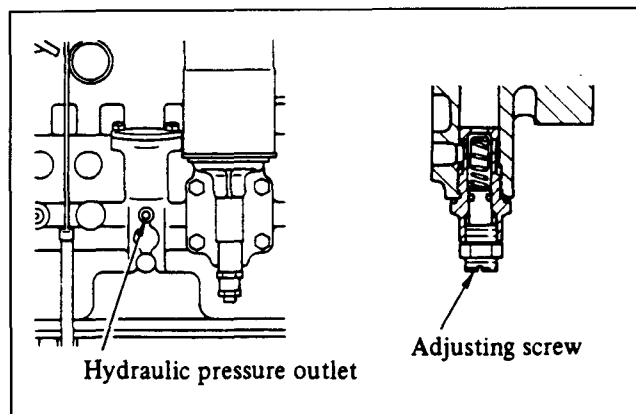


Figure 148

Cooling System

Water Pump

Disassembly

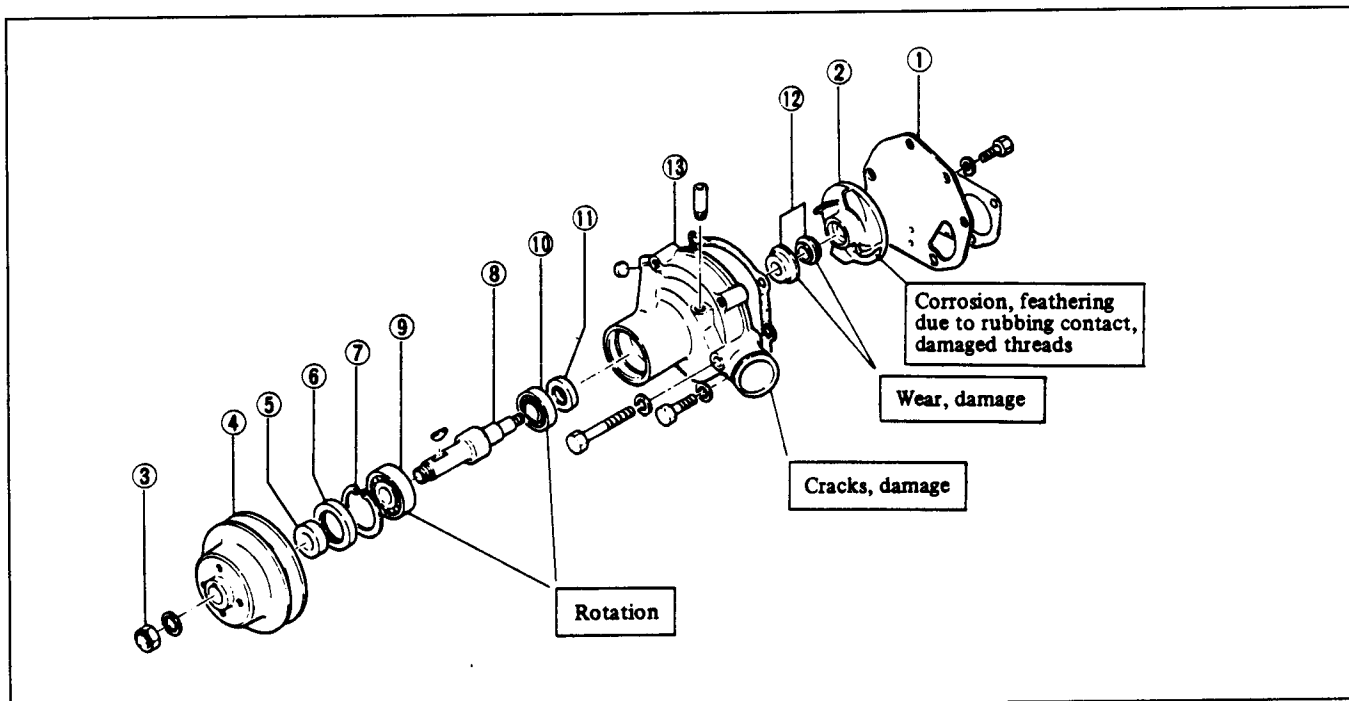


Figure 148

- 1. Cover
- 2. Impeller
- 3. Nut
- 4. Pump pulley
- 5. Spacer

- 6. Oil seal
- 7. Snap ring
- 8. Shaft
- 9. Bearing
- 10. Bearing

- 11. Oil seal
- 12. Unit seal
- 13. Case

1. Removing impeller

The impeller is right-hand-threaded. To remove the impeller, turn it counterclockwise (in the direction of the arrow).

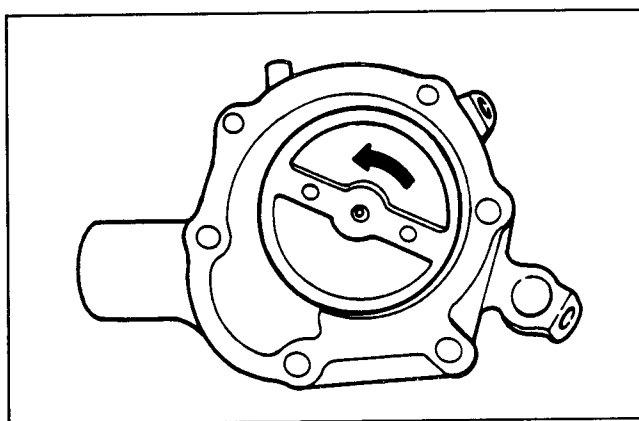


Figure 149

2. Removing shaft

Remove the oil seal and snap ring and pull out the shaft complete with bearings from the pulley side.

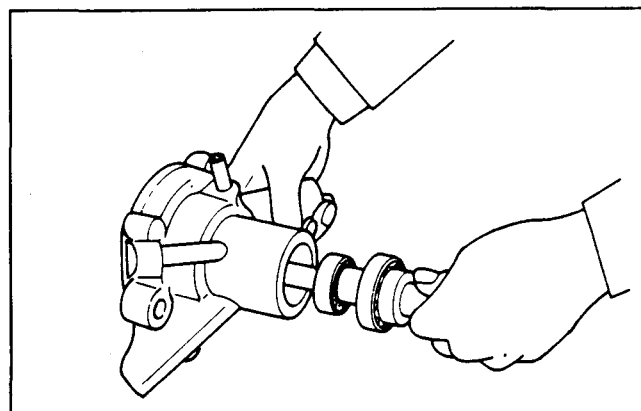


Figure 150

Inspection

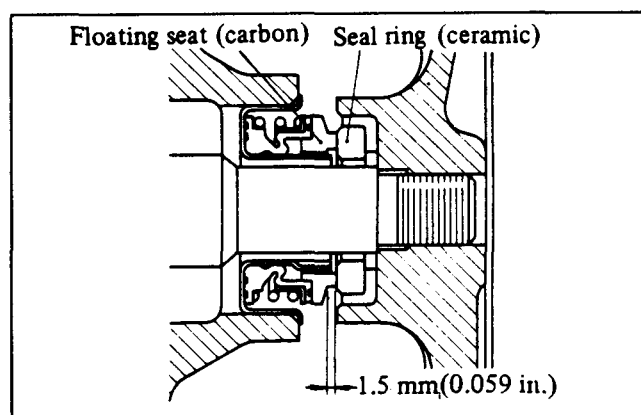
A. Inspect the pump operation by slowly rotating it. If it is erratic in rotation, replace the bearings.

B. Visually inspect the impeller for corrosion or broken blade. Replace the impeller if defective. Also check the impeller for signs of rubbing contact with the pump case and rear cover. If such a contact is evident, replace the impeller and bearings.

C. Inspect the seal condition. Replace the seal if any sign of leakage is noted during operation.

Unit: mm (in.)

Item	Assembly standard	Service limit
Carbon protrusion	1.5 (0.059)	0
Free-state height	21.8 ± 1 (0.858 ± 0.04)	



Unit seal

Reassembly

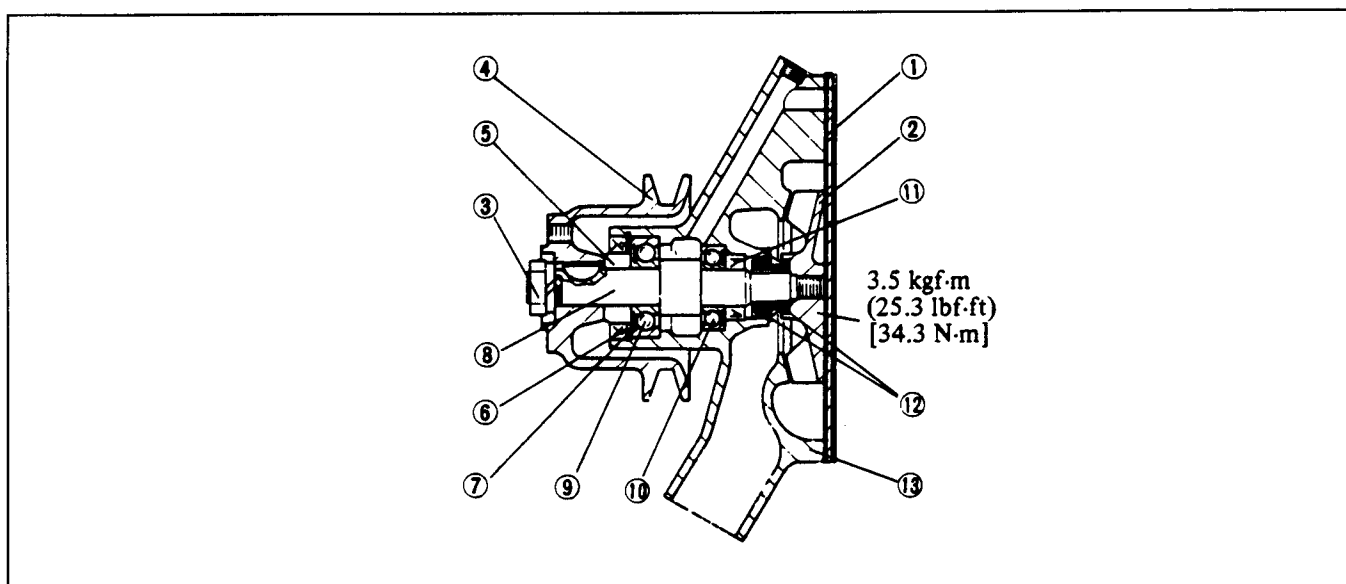


Figure 151

Reassembling sequence

13→12→11→10→9→8→7→6→5→4→3→2→1

NOTE: After reassembling the pump, operate it by means of the pulley and belt, making sure that it runs smoothly without any sign of rubbing contact with the pump case or cover.

1. Installing unit seal

To install the seal, use a seal installer.

Do not reuse a seal which has been removed from the pump case.

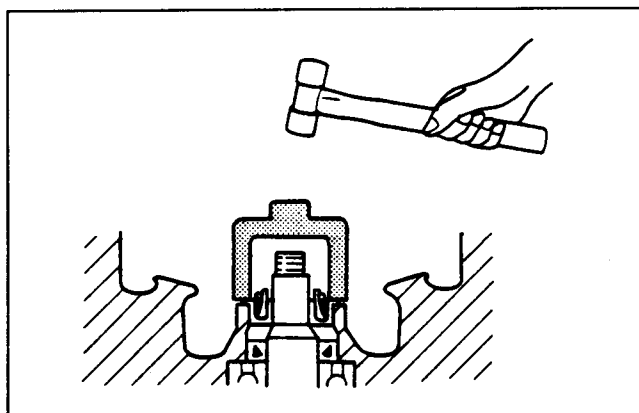


Figure 152

2. Installing oil seal

To install the seal, use seal installer.

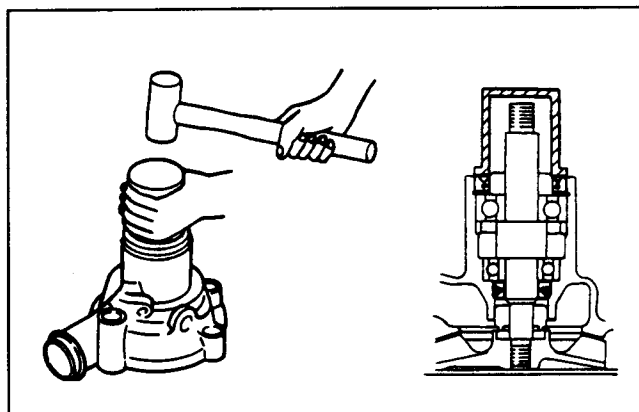


Figure 153

Thermostat

Inspection

Immerse the thermostat in heated water to test it for thermostatic action. If the valve fails to operate properly, replace the thermostat.

Unit: mm (in.)

Item	Assembly standard
Temperature at which valve starts opening	76.5 C 170°F
Temperature at which valve opens fully	90 C 195°F
Valve stroke	9(0.35)

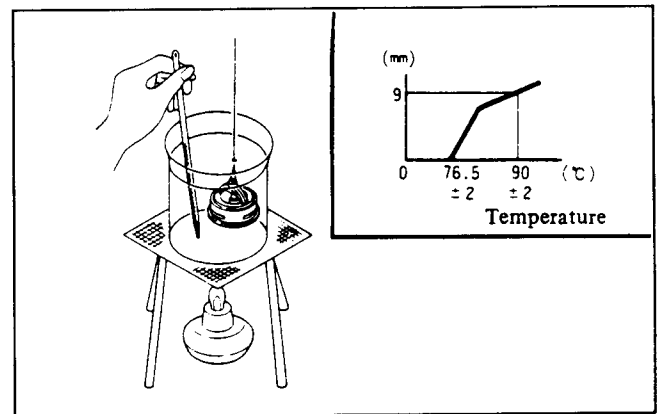


Figure 154

NOTE: Stir the water in the bath with a stick to maintain uniform temperature during test.

Radiator, Fan, and Fan Belt

Inspection

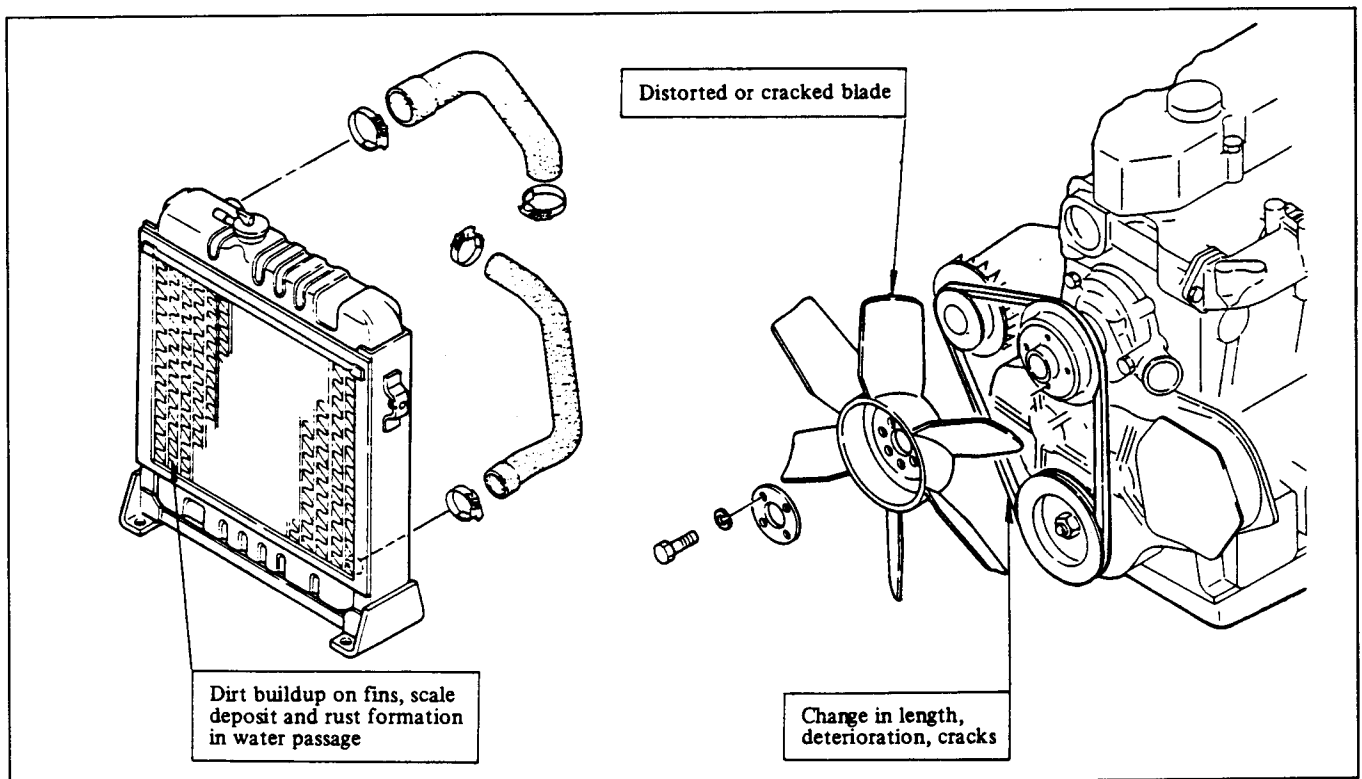


Figure 155

Fuel System

Description

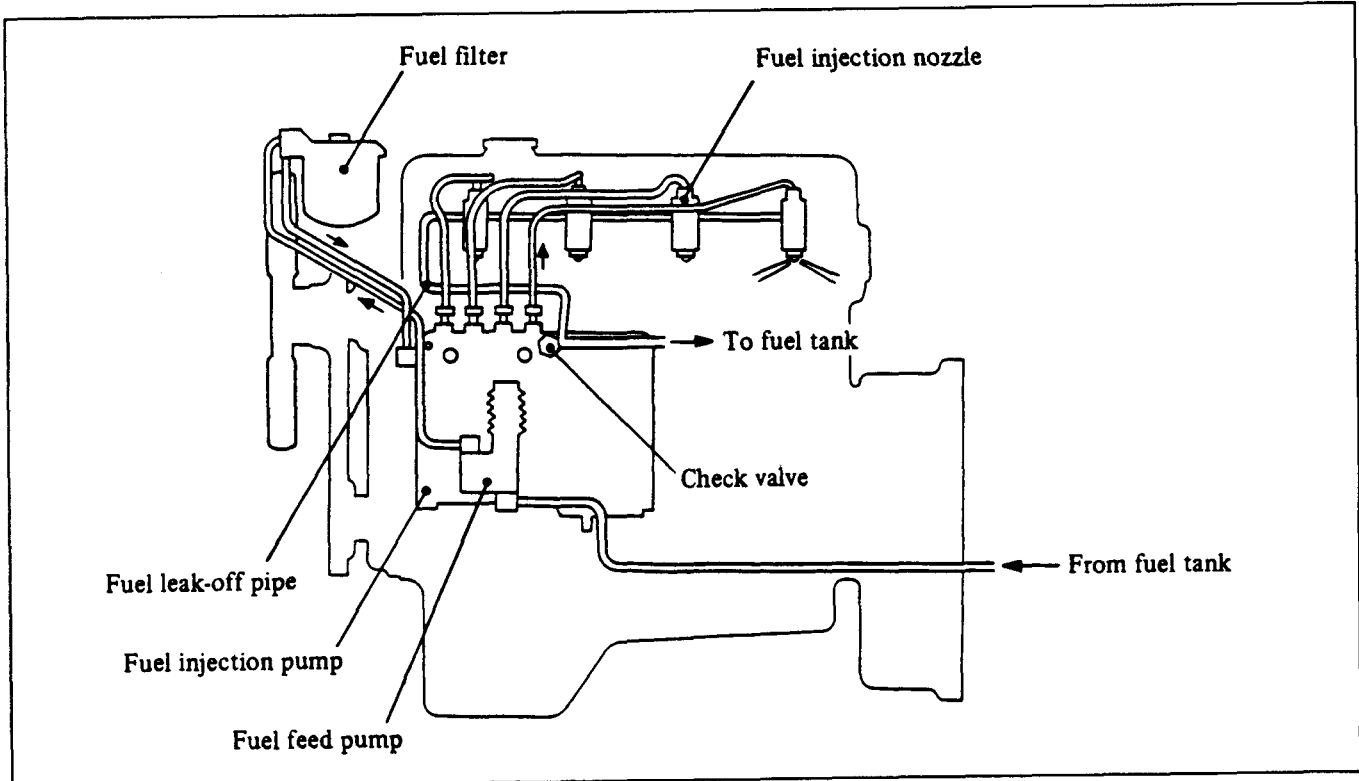


Figure 156

Fuel Injection Nozzles

Disassembly

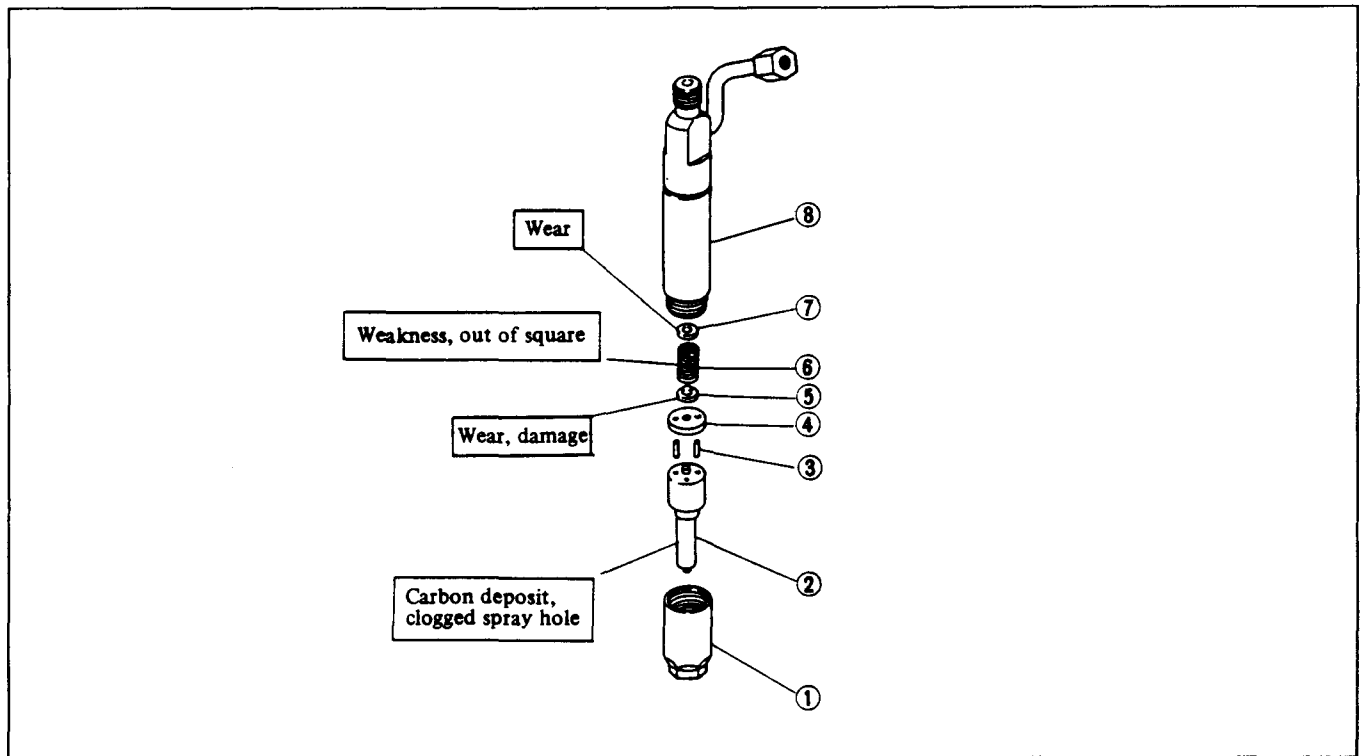


Figure 157

- 1. Retaining nut
- 2. Nozzle tip
- 3. Straight pin

- 4. Tip packing
- 5. Pressure pin
- 6. Pressure spring

- 7. Washer
- 8. Nozzle body

Inspection and Repair

1. Injection pressure

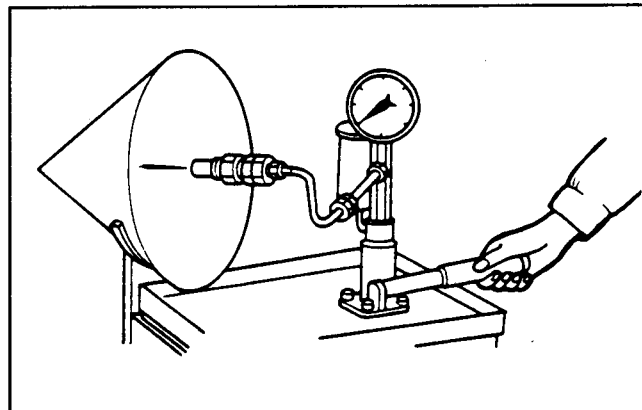
A. Set up the nozzle on the tester. Operate the tester handle several times to prime the pipe and nozzle.

B. Slowly operate the handle all the way up and down, completing each cycle in about a second, while observing the pressure gauge indication.

C. As the nozzle begins to spray fuel the needle of the gauge will register the injection pressure.

Unit: kg/cm^2 (psi)

Item	Assembly standard
Injection pressure (valve opening pressure)	180 - 220 (2500 - 3100 psi)



Testing injection nozzle



WARNING

Never expose your hand or other part of the body to fuel spray or the spray hole during the test.

D. If the pressure is out of specification, the nozzle may be shim adjusted.

NOTE: Increasing or decreasing shim thickness by 0.1 mm (0.004 in.) raises or drops injection pressure by about 10 kg/cm^2 (142 psi). Shims for this adjustment are available in 20 sizes, from 1.0 mm (0.039 in.) up to 1.95 mm (0.0768 in.) in an increment of 0.05 mm (0.0020 in.)

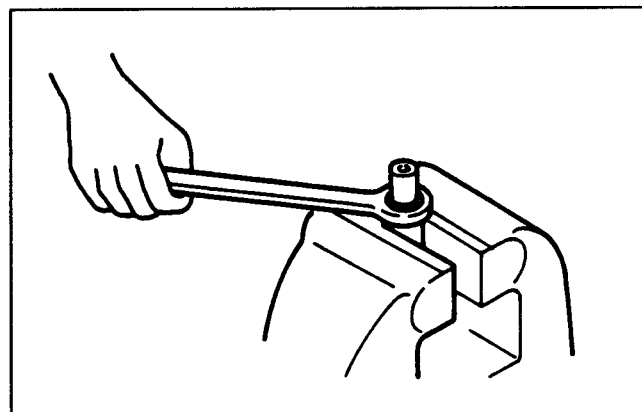


Figure 158

2. Spray pattern

A. At the time of testing the injection pressure, inspect each nozzle for clogged spray holes, fuel leaks from the holes, and incorrect spray pattern.

B. The nozzle should spray fuel from its four orifices at the same time in a good straight cone of 155 degrees, consisting of finely atomized fuel particles.

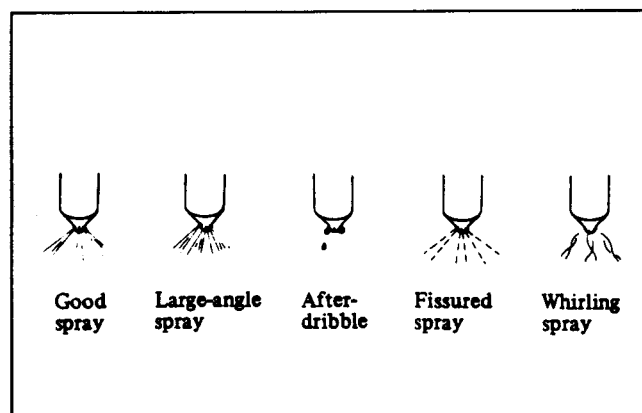


Figure 159

3. Washing or replacing nozzle tip.

A. Loosen the retaining nut and remove the nozzle tip. Wash the needle valve and body.

IMPORTANT: Use care to prevent damage to nozzle tip during disassembly.

B. Wash the nozzle tip in clean solvent. After washing, assemble the needle valve and body with clean diesel fuel.

IMPORTANT: The needle valve and body are finely finished. Do not interchange the combination or set of the valve and body.

C. Tighten the retaining nut to the specified torque.

D. If the spray pattern is still bad after the nozzle has been adjusted and cleaned, replace the nozzle tip.

IMPORTANT: Do not touch the sliding surface of the needle valve.

NOTE: New nozzle tips are coated with Vaseline for preservation. Be sure to wash thoroughly first in solvent and then in diesel fuel before assembly.

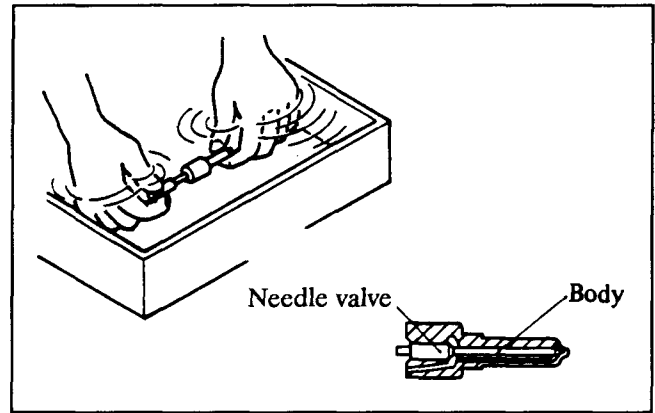


Figure 160

Reassembly

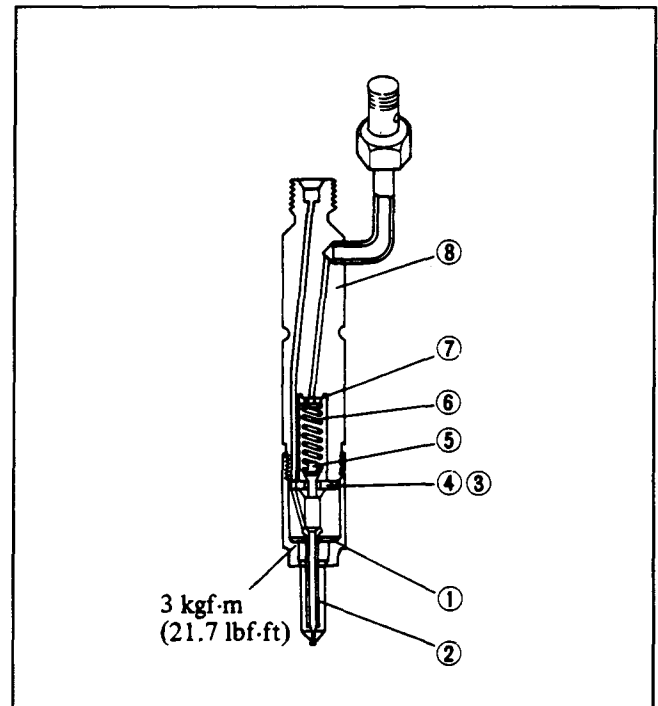


Figure 161

Reassembling sequence

8 → 7 → 6 → 5 → 4 → 3 → 2 → 1

Fuel Feed Pump

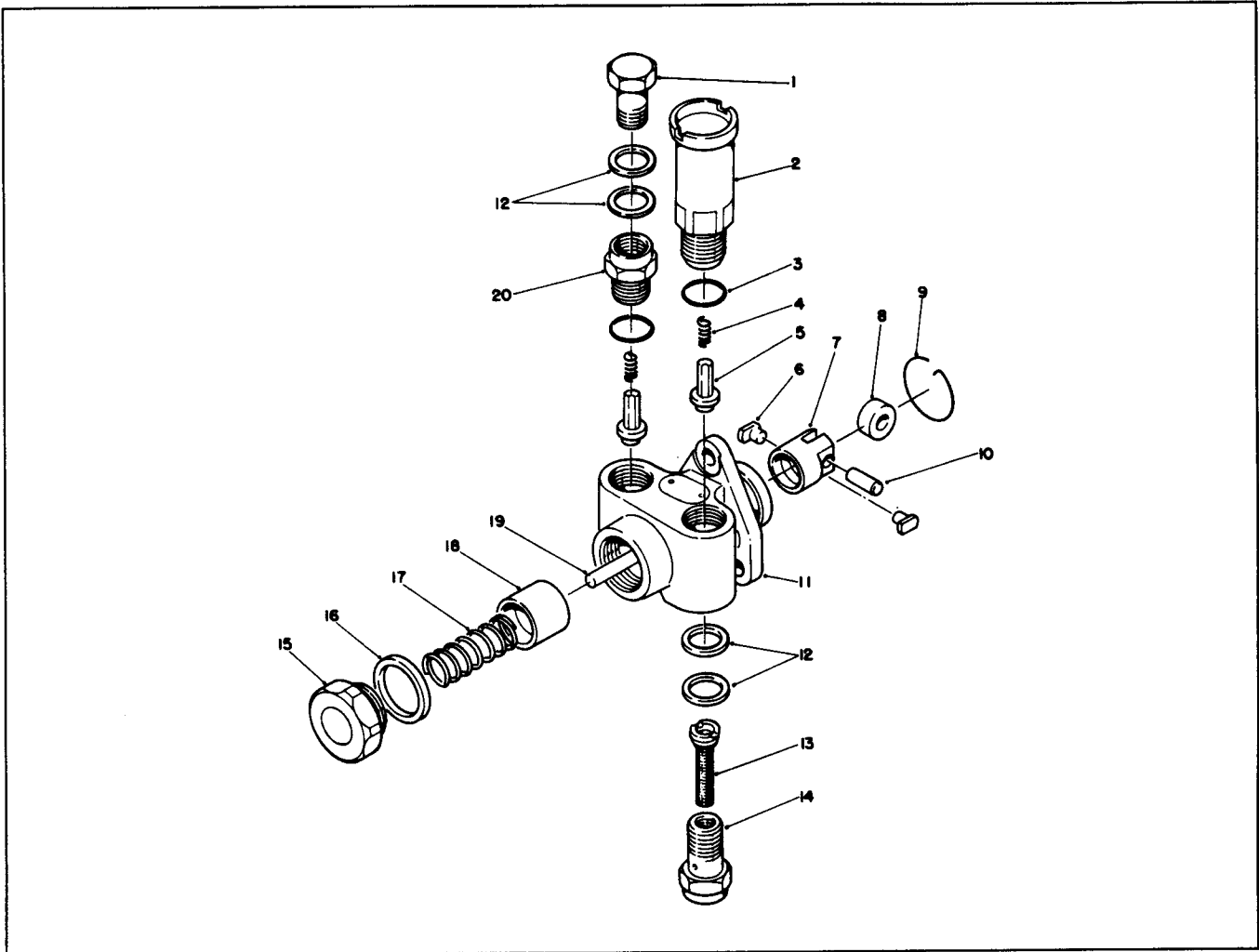


Figure 162

- 1. Screw
- 2. Pump assembly
- 3. Gasket
- 4. Spring
- 5. Valve
- 6. Block
- 7. Tappet

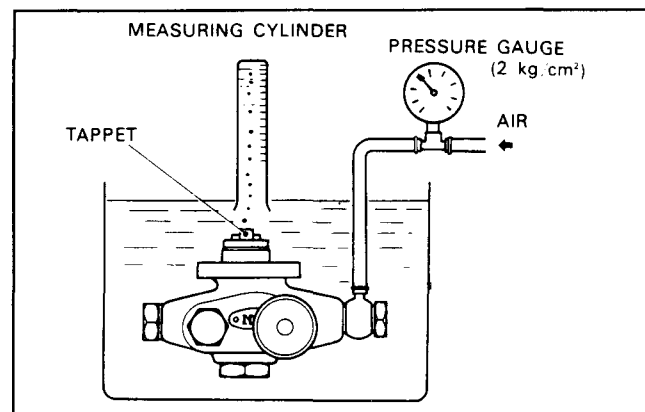
- 8. Roller
- 9. Ring
- 10. Pin
- 11. Housing assembly
- 12. Washer
- 13. Filter
- 14. Screw

- 15. Plug
- 16. Washer
- 17. Spring
- 18. Piston
- 19. Rod
- 20. Support

Testing

1. Leakage

Plug or cap outlet of feed pump and connect hose from air compressor to inlet of feed pump. Submerge feed pump in a container of diesel fuel and apply air pressure of 2 kg/cm^2 (28 psi) to the feed pump inlet for one minute. Air leakage from tappet bore should not exceed 50 cc/min.



Leakage test

2. Suction performance

A. Pump should be capable of delivering fuel within 30 seconds when operating priming pump up and down at 60 to 100 strokes per minute.

B. Pump should be capable of delivering fuel within 40 seconds when cranking engine (150 injection pump rpm).

3. Pressure and fuel delivery

A. Drive pump at 1000 injection pump rpm. Feed pressure of fuel and fuel delivery quantity should be approximately 1.5 kg/cm^2 (21 psi) and more than 600 cc/minute (36 oz/min).

B. With outlet of feed pump closed, drive pump at 600 injection pump rpm. Feed pump pressure should be more than 2 kg/cm^2 (28 psi).

Repair

1. Disassemble and inspect parts for wear. Replace parts if worn or damaged. Priming pump cannot be disassembled and must be replaced as a unit.

2. Install new gaskets when reassembling.

Fuel Injection Pump

NOTE: Special equipment is required for testing and adjustment of injection pump. It is recommended that you see an authorized Nippondenso service dealer for repair work on the fuel injection pump - especially during the warranty period. Repairs made by non-authorized dealers **COULD** void the pump warranty. Also, contact the Nippondenso service dealer **BEFORE** removing the pump from the engine.

IMPORTANT: Clean the injection pump and the area around the injection pump before removing or servicing it. **DO NOT** spray water onto a hot injection pump. (See the Accessory Removal and Installation section of this chapter for pump removal and installation instructions.)

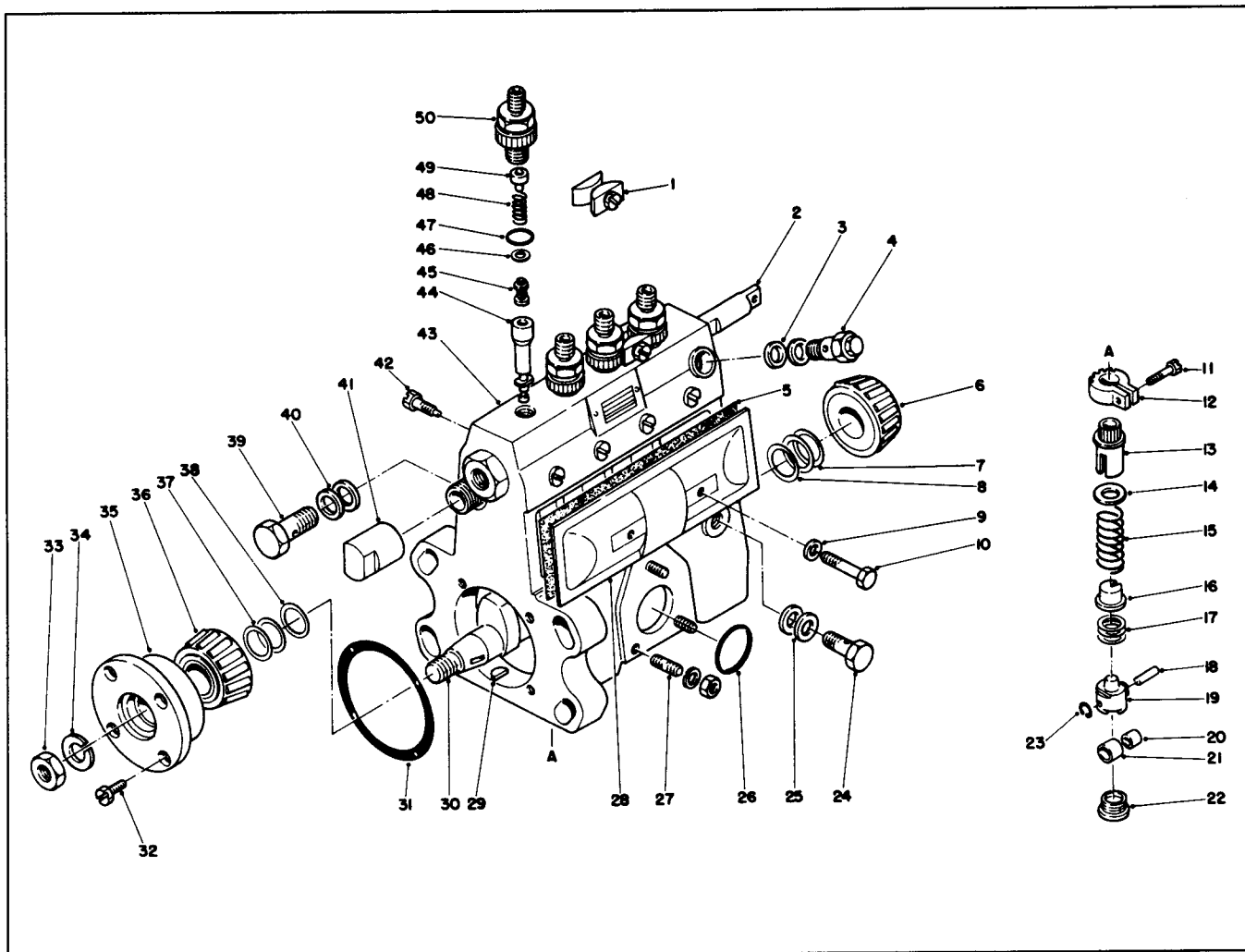


Figure 163

- 1. Plate
- 2. Rack
- 3. Washer
- 4. Valve
- 5. Gasket
- 6. Bearing
- 7. Plate
- 8. Ring

- 9. Packing
- 10. Screw
- 11. Screw
- 12. Pinion
- 13. Sleeve
- 14. Seat
- 15. Spring
- 16. Seat

- 17. Plate
- 18. Pin
- 19. Body
- 20. Bushing
- 21. Roller
- 22. Plug
- 23. E-ring
- 24. Screw

Disassembly and Assembly Precautions

1. Cleanliness is very important when servicing fuel injection equipment. Clean the exterior of the injection pump and visually inspect it for damage.

2. When removing plunger from barrel, smoothly pull it out. Always service the pump element and delivery valve assembly as complete units. These parts should not be mixed as they are "matched sets".

3. Overtightening the delivery valve holder will cause damage to the pump housing and malfunctions of moving parts (i.e. control rack). Tighten delivery valve holder to correct torque with a torque wrench.

Item	Specification
Delivery valve holder tightening torque	3.5 - 40.0 kg-m (25 - 29 ft-lb)

4. When assembling pump housing, put each plunger in correct location. At that time, marking on plunger vane must face outward toward cover plate opening in pump housing. Control helix of plunger has to align with barrel port as shown. Improper installation can cause excessive fuel injection or uncontrolled fuel injection quantity.

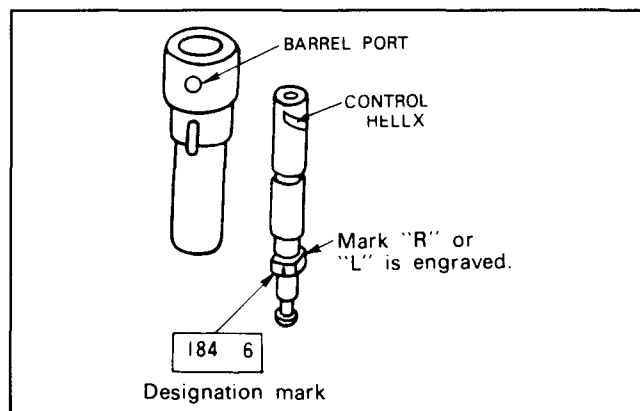


Figure 164

5. Control rack should slide smoothly back and forth. Sliding resistance should be less than 50 grams at 1000 pump rpm and less than 120 grams at 0 pump rpm. Sticking of control rack can be caused by scratches on rack and control pinion, friction between control pinion and pump housing and overtightening of delivery valve holder.

6. Camshaft endplay should be within specified value. If endplay is out of specification, adjust with shims.

Item	Specification
Injection pump camshaft endplay	0.003 - 0.05 mm (0.0012 - 0.0020 in.)

Injection Pump Testing

1. Delivery valve tightness

- A. Use a new pump element.
- B. Install a 0-300 kg/cm² (5000 psi) pressure gauge to delivery valve holder. Hold control rack in idling position. Drive pump at 200 rpm. Delivery pressure should be more than 150 kg/cm² (2133 psi).

2. Delivery valve retraction

- A. Wash delivery valve thoroughly in diesel fuel.
- B. Pull up on delivery valve and close the bore at valve housing bottom with thumb. When valve is released, it should drop quickly and stop where relief plunger of delivery valve closes the valve housing bore. If defective, replace delivery valve assembly as a set.

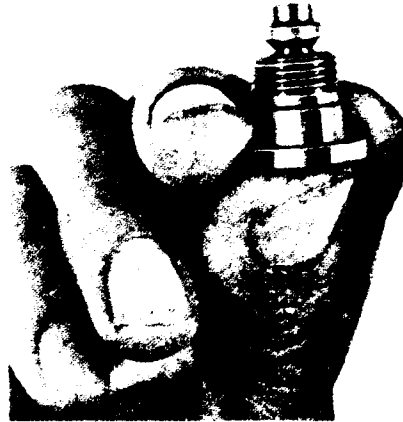


Figure 165

Governor

NOTE: Special tools and equipment are required for repair, testing and adjustment of governor. It is recommended that you see an authorized Nippondenso service dealer for repair work on the governor - especially during the warranty period. Repairs made by non-authorized dealers could void the governor warranty. Also, contact the Nippondenso service dealer **BEFORE** removing the governor from the engine.

(See No-Load Minimum and Maximum Speed in the Adjustments section of this chapter for additional information.)

General Overhaul Information

Oil seals

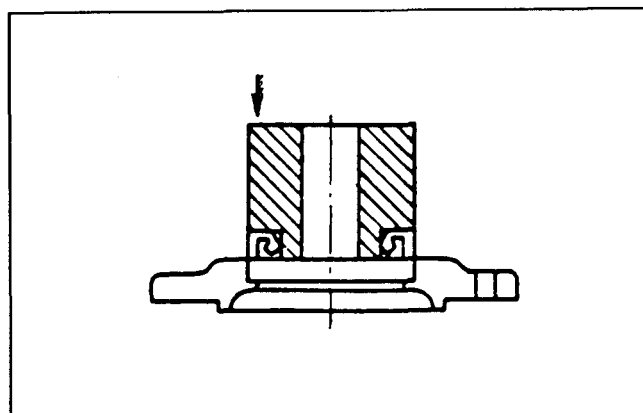
When installing oil seals, carefully observe the following points:

1. Driving oil seals into housing

A. Make sure that seal lip is not damaged and position it correctly with respect to oil compartment.

B. Apply a small amount of grease to the surface of oil seal to be fitted into housing bore.

C. Using a tool of the type shown to guide seal lip, drive oil seal squarely. Never give any hammer blows directly to oil seal since this will damage the seal, resulting in oil leakage.

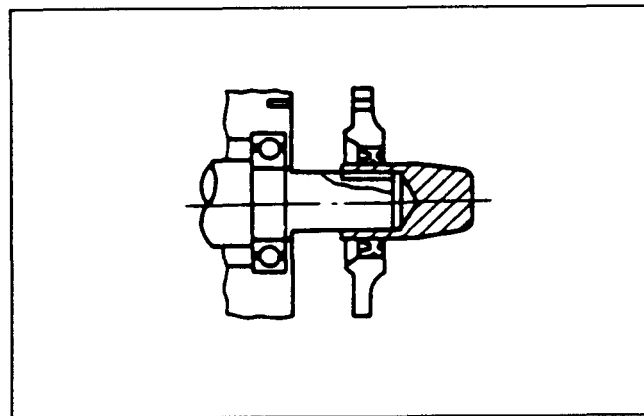


Oil seal driver

2. Driving oil seals onto shafts

A. Apply a thin coat of grease to oil seal lip.

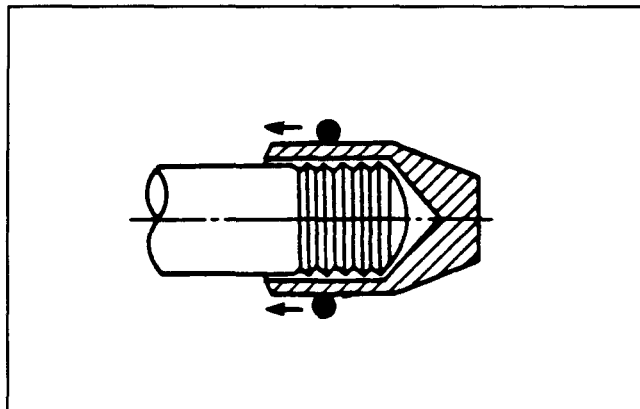
B. Use an oil seal guide of the type shown when driving oil seal over stepped portion, splines, threads or keyway to prevent damage to seal lip.



Oil seal guide

O-rings

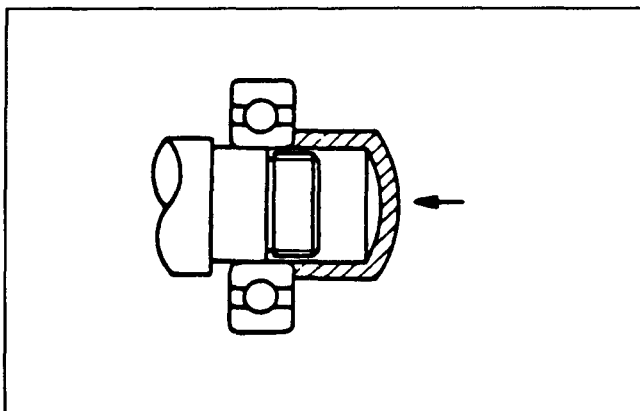
Use an O-ring guide of the type shown when installing O-ring over stepped portion, splines, threads or keyway to prevent damage to the ring. Apply a thin coat of grease to O-ring.



O-ring guide

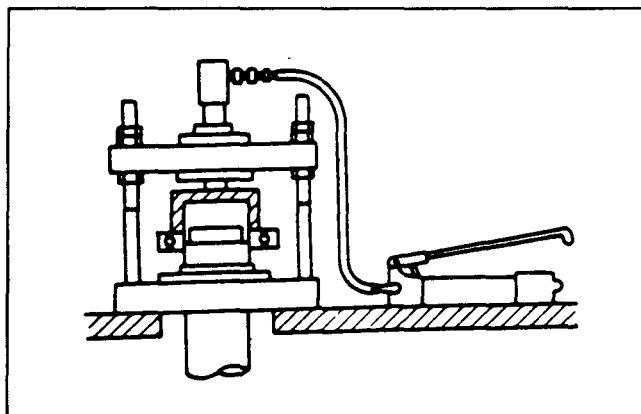
Bearings

When installing a rolling bearing, be sure to give a push to the race, inner or outer, by which the bearing is fitted. Be sure to use a bearing driver of the type shown.



Bearing driver

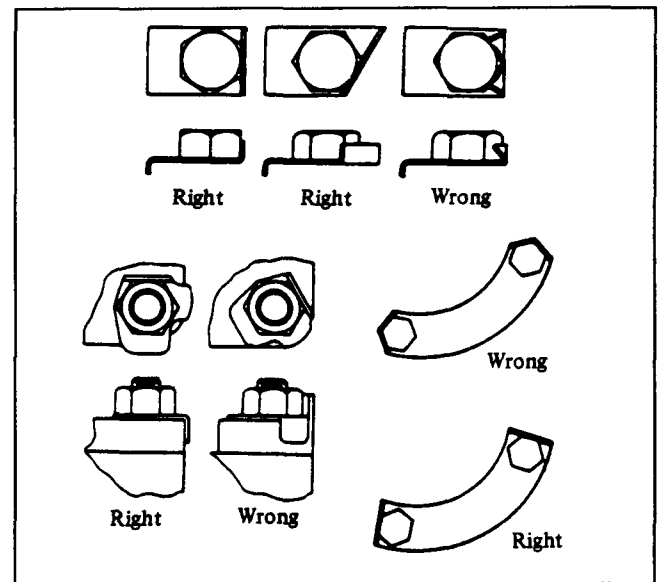
2. Use a press whenever possible to minimize shock to bearing and to assure proper installation.



Bearing installation by a press

Lock Plates

Bend lock plate against one of the flats of nut or bolt heads as shown.



Bearing lock plates

Split Pins and Spring Pins

Generally, spring pins are to be replaced at the time of disassembly. Drive each spring into position so that it does not get out of place after subsequent installation of parts has been completed.



Table of Contents

General Information	1
Specifications	2
MITSUBISHI S4S-DT SERVICE MANUAL	

General Information

The engine used in the Groundsmaster 580-D mower is manufactured by Mitsubishi Heavy Industries Limited. Service and repair parts for Mitsubishi engines are supplied through TORO Distributors. Repair parts may be ordered by TORO part number. If no parts list is available be sure to provide your Distributor with the TORO model number and serial number.

Specifications

Item	Description
Make / Designation	Mitsubishi Model S4S-DT 4 cycle, 4 cylinder Diesel Engine
Number of Cylinders	4
Total Displacement	3331 cc (203.3 cu. in.)
Fuel	Diesel Fuel No. 2-D
Fuel Capacity	28 U.S. gallon (106 liter)
Idle Speed (no load)	1150 +/- 50 RPM
High Idle (no load)	2750 +/- 50 RPM
Engine Oil (do not use multi-viscosity oils)	API Service Classification CD or better -20 to 20° F (-29 to -7° C) SAE 10 20 to 105° F (-7 to 41° C) SAE 30 105° F (41° C) and above SAE 40
Oil Capacity	10.6 U.S. quart (10 liter) with filter



Hydraulic System

Table of Contents

SPECIFICATIONS	2	TEST NO. 3: Steering Circuit	
GENERAL INFORMATION	3	Working Pressure and Relief Pressure	26
Hydraulic Hoses	3	TEST NO. 4: Lift Circuit	
Hydraulic Fitting Installation	3	Working Pressure and Relief Pressure	27
Pushing or Towing	5	TEST NO. 5: Counterbalance Pressure	28
Draining and Refilling System	5	Diagnosing Cutting Performance Problems ...	28.1
HYDRAULIC FLOW DIAGRAMS	6	Deck Motor Internal Leakage Test	28.2
Typical Circuits – Engine Running	6	TEST NO. 6: Deck Drive Circuit	
Typical Circuits – Mowing	10	Working Pressure	29
HYDRAULIC SCHEMATIC	See Foldout 9	ADJUSTMENTS	30
SPECIAL TOOLS	13	Traction Control Neutral Adjustment	30
TROUBLESHOOTING	14	Traction Control Rod Adjustment	31
System Operates Hot	15	Cruise Control Adjustment	31
Transmission Neutral		TRACTION DRIVE SYSTEM REPAIRS	32
Difficult or Impossible to Find	15	Mow/Transport Solenoid Service	32
Transmission Operates in One Direction Only ..	15	Variable Displacement Pump	
Transmission Response is Sluggish	16	Removal and Installation	33
Machine Will Not Travel in Either Direction ...	15	Wheel Motor Removal and Installation	35
Machine Will Not Go Into High Range	16	PTO SYSTEM REPAIRS	36
Machine Goes Into High Range,		PTO Valve Block Service	36
But Top Speed is Too Slow	16	PTO Pump Removal and Installation	38
Machine Does Not Go Into Low Range	16	Deck Motor Removal and Installation	39
Engine Shuts Off		Deck Motor Repair	40
When On Side Hill or Down Hill	17	Deck Motor Hydraulic Hose Replacement ...	41
No Decks Operate	17	AUX. HYDRAULIC (LIFT) SYSTEM REPAIRS ...	42
All Decks Operate Slowly	17	Lift/Traction Assist Manifold Block Service ...	42
One Deck Does Not Operate	18	Steering/Auxiliary Pump	
One Deck Operates Slowly and/or		Removal and Installation	44
Loses Power in Heavy Cutting	19	Steering/Auxiliary Pump Repair	45
Right Wing Deck Blades “Creep”		Front Lift Cylinder Removal and Installation ...	46
When System is Cold, or Right Deck Runs		Front Lift Cylinder Repair	46
Briefly When Raised or Off, If Left Wing is On	19	Wing Lift Cylinder Removal and Installation ...	48
Steering Problems	19	Wing Lift Cylinder Repair	48
One Deck Will Not Stop Operating	20	Lift Control Valve Removal and Installation ...	50
One Deck Stops Too Slowly	20	Lift Control Valve Repair	50
Deck(s) Do Not Lift or Lift Too Slow	21	STEERING SYSTEM REPAIRS	52
Decks Chatter While Lowering	21	Steering Cylinder Removal and Installation ...	52
Wing Decks Raise By		Steering Cylinder Repair	52
Themselves When Climbing a Hill	22	Steering Control Unit Removal and Installation.	54
Deck Weight is Not Transferred to		HYDRAULIC RESERVOIR AND FILTER	55
Traction Unit When Climbing a Hill	22	Flushing The Hydraulic System	55
Wing Decks Cut at Uneven		Inspecting Reservoir Parts	56
Height on Level Ground	22	SUNDSTRAND SAUER M46-AXIAL PISTON	
Front Deck Drops		PUMPS AND MOTORS SERVICE MANUAL	
With Lift Valve in Centered Position	22	SUNDSTRAND SAUER M46-AXIAL PISTON	
TESTING	23	PUMPS AND MOTORS REPAIR MANUAL	
TEST NO. 1: Traction Circuit Working Pressure		VICKERS GEAR PUMP OVERHAUL MANUAL	
and Relief Pressure	24	EATON CHAR-LYNN STEERING CONTROL	
TEST NO. 2: Traction Circuit Charge Pressure .	25	UNITS REPAIR INFORMATION	

Specifications

Item	Description
Traction Drive Pump Main relief pressure Charge relief pressure (Pump S/N below A-96-01-XXXXX) Charge relief pressure (Pump S/N A-96-01-XXXXX & Up)	Variable displacement axial piston pump with servo assisted manual displacement control (MDC) 5000 ± 250 psi 230 ± 10 psi 285 ± 10 psi
Wheel Motor (2)	Variable displacement axial piston motor Mow/Transport speed, elec./hyd. solenoid actuated
PTO (Deck Drive) Pump	Two section, external gear type
PTO (Deck Drive) Valve Block Relief pressure (3 relief valves: front deck, right deck, left deck)	Toro, cartridge logic, elec./hyd. solenoid actuated 3000 +200 -0 psi
Deck Drive Motor (3)	External gear type
Lift Control Valve Lift valve relief pressure NOTE: Lift pressure when measured at the LIFT test port is Lift Valve Relief Pressure + Counterbalance Pressure	3 spool 1500 ± 50 psi
Lift/Traction Assist Manifold Block Counterbalance pressure "Traction Plus" counterbalance pressure "Traction Plus" shift pressure	Toro, cartridge logic 400 ± 25 psi 600 ± 25 psi 2000 ± 50 psi
Lift/Steering Pump Steering relief pressure	External gear type w/priority flow divider 1500 ± 50 psi
Steering Control	Hydraulic power steering control unit
Hydraulic Oil	* Mobil DTE 26 or equivalent
Reservoir	32 U.S. gal. capacity (40 U.S. gal. system capacity)
Oil filter	Screw-on cartridge type, 5 micron, 50 psi bypass

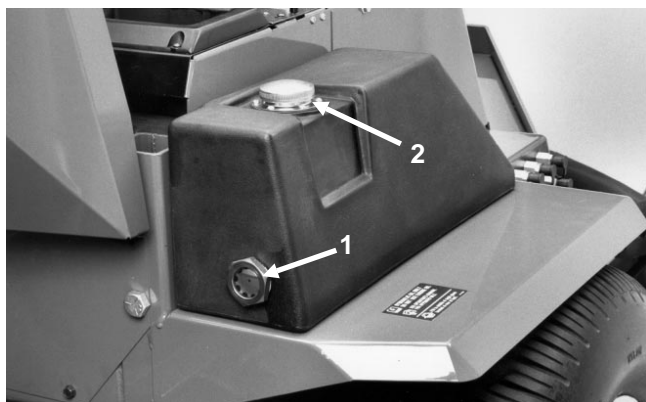


Figure 1

1. Hydraulic oil level sight glass
2. Reservoir fill cap

* Equivalent Hydraulic Oils (interchangeable):

Shell Tellus 68
 Amoco Rykon Oil #68
 Conoco Super Hydraulic Oil 68
 Exxon Nuto H 68
 Kendall Kenoil R & O AW 68
 Pennzoil Penreco 68
 Phillips Magnus A 68
 Standard Energol HLP 68
 Sun Sunvis 831 WR
 Union Unax AW 68

General Information

Hydraulic Hoses

Hydraulic hoses are subject to extreme conditions such as, pressure differentials during operation and exposure to weather, sun, chemicals, very warm storage conditions or mishandling during operation or maintenance. These conditions can cause damage or premature deterioration. Some hoses, such as deck motor hoses, are more susceptible to these conditions than others. Inspect the hoses frequently for signs of deterioration or damage.

When replacing a hydraulic hose, be sure that the hose is straight (not twisted) before tightening the fittings. This can be done by observing the imprint on the hose. Use two wrenches; one to hold the hose straight and one to tighten the hose swivel nut onto the fitting.



WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved by lowering the front deck to the ground, raising or lowering the wing decks completely, and stopping the engine.

Keep body and hands away from pin hole leaks or nozzles that eject hydraulic fluid under high pressure. Use paper or cardboard, not hands, to search for leaks. Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and do serious damage. If fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury or gangrene may result.

Hydraulic Fitting Installation

O-Ring Face Seal

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches, or any foreign material (Fig. 2).
2. Make sure the O-ring is installed and properly seated in the groove. It is recommended that the O-ring be replaced any time the connection is opened.
3. Lubricate the O-ring with a light coating of oil.
4. Put the tube and nut squarely into position on the face seal end of the fitting and tighten the nut until finger tight.
5. Mark the nut and fitting body. Hold the body with a wrench. Use another wrench to tighten the nut to the correct flats from finger tight (F.F.F.T.). The markings on the nut and fitting body will verify that the connection has been tightened.

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	.75 ± .25
6 (3/8 in.)	.75 ± .25
8 (1/2 in.)	.75 ± .25
10 (5/8 in.)	1.00 ± .25
12 (3/4 in.)	.75 ± .25
16 (1 in.)	.75 ± .25

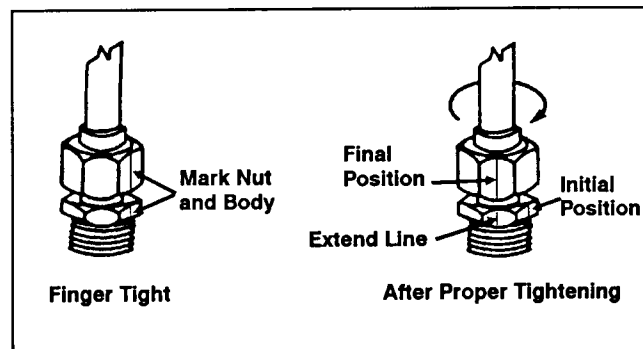
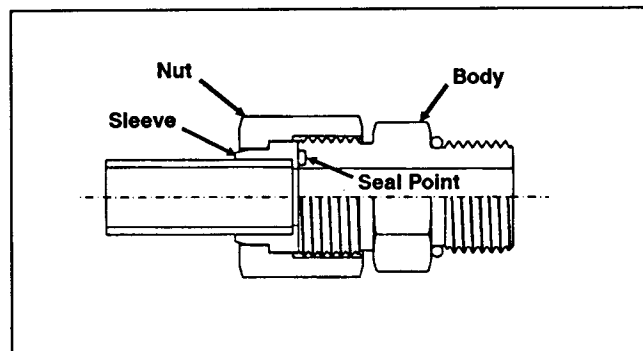


Figure 2

SAE Straight Thread O-Ring Port (Non-adjustable)

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches, or any foreign material.
2. Always replace the O-ring seal when this type of fitting shows signs of leakage.
3. Lubricate the O-ring with a light coating of oil.
4. Install the fitting into the port and tighten it down full length until finger tight (Fig. 3).
5. Tighten the fitting to the correct flats from finger tight (F.F.F.T.).

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	1.00 ± .25
6 (3/8 in.)	1.50 ± .25
8 (1/2 in.)	1.50 ± .25
10 (5/8 in.)	1.50 ± .25
12 (3/4 in.)	1.50 ± .25
16 (1 in.)	1.50 ± .25

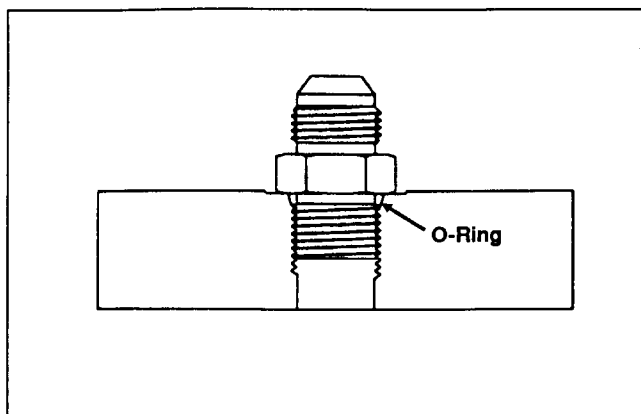


Figure 3

SAE Straight Thread O-Ring Port (Adjustable)

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches, or any foreign material (Fig. 4).
2. Always replace the O-ring seal when this type of fitting shows signs of leakage.
3. Lubricate the O-ring with a light coating of oil.
4. Turn back the jam nut as far as possible. Make sure the back up washer is not loose and is pushed up as far as possible (Step 1).
5. Install the fitting into the port and tighten finger tight until the washer contacts the face of the port (Step 2).
6. To put the fitting in the desired position, unscrew it by the required amount, but no more than one full turn (Step 3).
7. Hold the fitting in the desired position with a wrench and turn the jam nut with another wrench to the correct flats from finger tight (F.F.F.T.) (Step 4)

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	1.00 ± .25
6 (3/8 in.)	1.50 ± .25
8 (1/2 in.)	1.50 ± .25
10 (5/8 in.)	1.50 ± .25
12 (3/4 in.)	1.50 ± .25
16 (1 in.)	1.50 ± .25

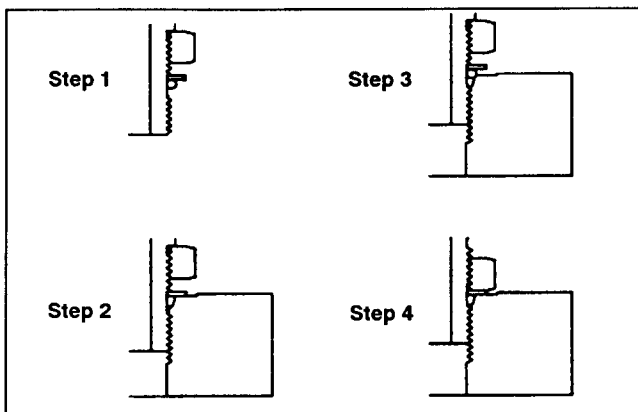
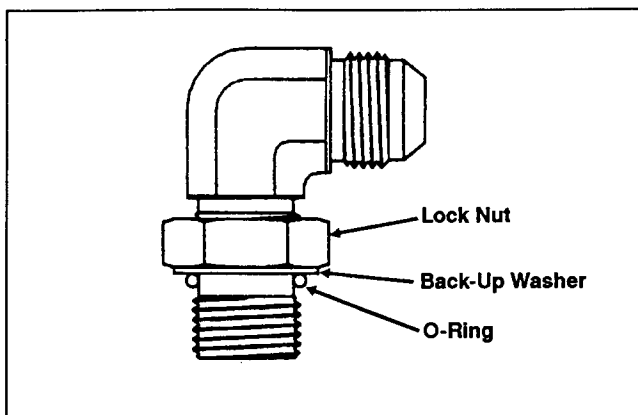


Figure 4

Pushing or Towing (Pump By-Pass Method)

In an emergency, the machine can be moved a short distance by opening the by-pass valve on the variable displacement hydraulic pump and pushing or towing the machine.

NOTE: The machine can be moved longer distances by disengaging the planetary wheel drives. (See Disengage Planetary Wheel Drive For Towing in the General Information section of Chapter 6 - Wheels, Brakes and Steering.)

IMPORTANT: Do not push or tow the machine faster than 2 - 3 mph because internal transmission damage may occur. The by-pass valve must be open whenever the machine is pushed or towed by this method. TORO does not recommend this process be used as standard procedure.

1. The by-pass valve is located on the left side of the variable displacement pump (Fig. 5). With the engine off, rotate the valve 1/2 to 1 turn counterclockwise to open and allow oil to by-pass internally. Because fluid is by-passed, the machine can be moved - slowly - without damaging the transmission.

2. Rotate the valve clockwise until it is securely seated before starting the engine. Do not exceed 8 ft-lb torque to close the valve.

IMPORTANT: Running the engine with the by-pass valve open will cause the transmission to overheat.

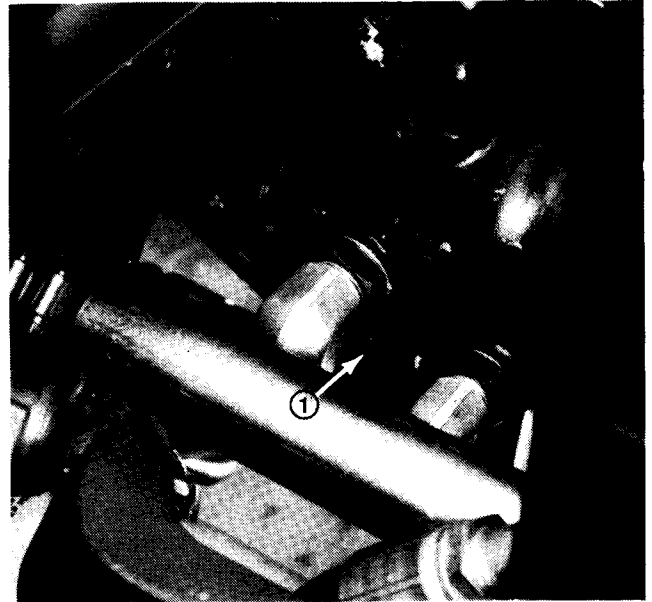


Figure 5

1. By-pass valve

Draining and Refilling System

IMPORTANT: Drain and refill the reservoir (Fig. 1) and change oil filter (Fig. 6) if component failure was severe or system is contaminated. (See Hydraulic Reservoir and Filter section of this chapter.)

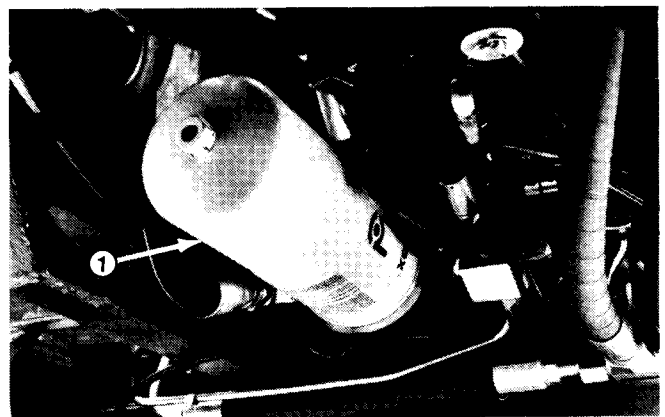


Figure 6

Hydraulic Flow Diagrams

Typical Circuits – Engine Running

Traction Circuit – NEUTRAL

The traction pump is a variable-displacement piston pump driven by a drive shaft off the front of the engine crankshaft. The operator sets the displacement of the pump with the foot pedal. The pump swash plate returns to neutral when the foot pedal is released.

An integral charge pump provides a constant supply of charge oil to the pump and closed loop circuit for lubrication and to make up for oil that is lost due to internal leakage in the pump and motors. Oil from internal leakage returns to the reservoir through case drain lines. This constant replacement of oil provides cooling for the closed loop system. Charge pressure is limited by a relief valve in the traction pump. Charge pressure may be monitored at the CHARGE PUMP test port.

The wheel motors have two displacement positions: low speed and high speed. The motor swash plates are held in the low speed position by springs. When the two-speed solenoid is energized the spool is shifted to direct charge pressure to the wheel motors. This shifts the motor swash plates to the high speed range.

Hydraulic pressure to the wheel motors may be monitored at the TRACTION FORWARD and TRACTION REVERSE test ports.

Steering / Lift Circuit – Steering NEUTRAL

The single section gear pump is mounted on the variable displacement traction pump and is driven by the traction pump shaft. A priority flow divider in the pump directs priority oil flow to the steering orbitrol control valve.

When the steering wheel is not being turned, oil flows through the control spool in the steering valve and returns to reservoir. Oil is blocked in both steering cylinders, keeping the wheels in their straight or turned condition.

A relief valve in the pump limits pressure in the steering circuit. Hydraulic pressure to the steering valve may be monitored at the POWER STEERING test port.

Steering / Lift Circuit – LIFT All Decks

Oil flow from the pump that is not required for steering is directed through the float/traction assist manifold block to the lift valve.

The flow control cartridge in the float/traction assist manifold block provides a constant flow of oil to the lift

valve. Excess oil exits the float/traction assist manifold block, and is directed through the case drain ports of the wheel motors to the reservoir.

The lift valve is an open-center valve which has three sets of spools. The operator sets the position of the spools with three levers on the control panel. Holding a lever in the UP position directs oil through the float/traction assist manifold block to the lift cylinder(s). The cylinder(s) raise the deck. Oil displaced from the other port of the cylinder(s) returns to reservoir. Displaced oil from the front deck cylinders returns directly to reservoir. Displaced oil from each wing deck cylinder flows through the lift valve to the float/traction manifold block and is directed through the wheel motor case drain ports to reservoir. A cold oil by-pass valve allows oil exiting the float/traction assist manifold block to return directly to reservoir instead of through the wheel motor case drain ports if pressure exceeds 15 psi.

Oil pressure is limited by a relief valve in the lift valve. Lift circuit hydraulic pressure may be monitored at the DECK LIFT test port.

PTO Circuit – All Decks OFF

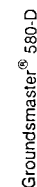
The PTO circuit is powered by a two-section gear pump, which is driven directly off the engine flywheel. Oil from the rear section of the pump is directed to port P1 of the PTO valve block. Oil from the front section of the pump is directed to port P2 of the PTO valve block.

A solenoid valve and two logic cartridges control each deck motor. In the OFF condition the solenoid valve is de-energized, which blocks return oil flow from the deck motor through the brake logic cartridge and allows oil to flow through the bypass (main) logic cartridge to port T of the valve block. Return oil from port T is directed through the oil cooler and return filter to the hydraulic reservoir. The return filter is equipped with a bypass valve. If the filter becomes clogged, the bypass valve opens, allowing unfiltered oil to enter the reservoir.

NOTE: If the deck was operating and the solenoid valve goes to the OFF condition, the brake relief valve provides braking action for the deck motor after return oil flow from the deck motor is blocked by the brake logic cartridge.

Hydraulic pressure to the drive motors may be monitored at the LEFT, FRONT, and RIGHT DECK DRIVE test ports.

Traction Circuit – NEUTRAL
Steering / Lift Circuit – Steering NEUTRAL / LIFT All Decks
PTO Circuit – All Decks OFF



Typical Circuits – Mowing

Traction Circuit – FORWARD

Pushing the top of the traction pedal shifts the pump swash plate to create a flow of high pressure oil. This oil is directed to the forward inlets of the left and right wheel motors, driving the machine forward. Return oil from the motors flows back to the traction pump and is re-used in the closed-loop traction circuit.

An integral charge pump provides a constant supply of charge oil to the pump and closed loop circuit for lubrication and to make up for oil that is lost due to internal leakage in the pump and motors. Oil from internal leakage returns to the reservoir through case drain lines. This constant replacement of oil provides cooling for the closed loop system. Charge pressure is limited by a relief valve in the traction pump. Charge pressure may be monitored at the CHARGE PUMP test port.

If the 2 speed solenoid valve is energized, charge pressure is directed to the shift valve in each wheel motor which shifts the motor swash plate to transport speed. A spring in each wheel motor shift valve keeps the swash plate in the low speed position when the 2 speed solenoid valve is de-energized.

Oil pressure to the wheel motors is limited by two relief valves in the traction pump (one for forward traction, and one for reverse). If oil pressure exceeds the relief setting, oil flows through the relief valve to the low pressure side of the pump. Hydraulic pressure to the wheel motors may be monitored at the TRACTION FORWARD and TRACTION REVERSE test ports.

Steering / Lift Circuit – RIGHT Turn

A priority flow divider in the pump directs priority oil flow to the steering orbitrol control valve.

Turning the steering wheel to the right meters oil to both steering cylinders. The cylinder rod for the right wheel retracts, and the cylinder rod for the left wheel extends. Cylinder rod movement sends return oil back through the steering valve to the reservoir.

A relief valve in the pump limits pressure in the steering circuit. Hydraulic pressure to the steering valve may be monitored at the POWER STEERING test port.

Steering / Lift Circuit – Decks FLOATING

Oil flow from the pump that is not required for steering is directed through the float/traction assist manifold block to the lift valve.

The flow control cartridge in the float/traction assist manifold block provides a constant flow of oil to the lift valve. Excess oil exits the float/traction assist manifold block, and is directed through the case drain ports of the wheel motors to the reservoir.

A detent plunger holds the lift valve spools in a free-float position after the levers are released to neutral from the lower position, allowing the decks to follow ground contours.

After oil leaves the lift valve, it is directed through the counterbalance relief cartridge in the traction assist manifold block then through the case drain ports of the wheel motors to reservoir. The counterbalance relief cartridge creates back-pressure through the lift valve to the lift port of the lift cylinders, causing a counterbalance effect. If forward traction pressure exceeds 2,000 psi (such as when climbing a hill) the traction plus shift cartridge directs oil from the return side of the lift valve to the "traction plus" relief cartridge. The "traction plus" relief cartridge creates a higher back pressure through the lift valve resulting in more deck weight being transferred to the traction unit.

Hydraulic counterbalance pressure may be monitored at the DECK LIFT test port.

PTO Circuit – ALL Decks ON

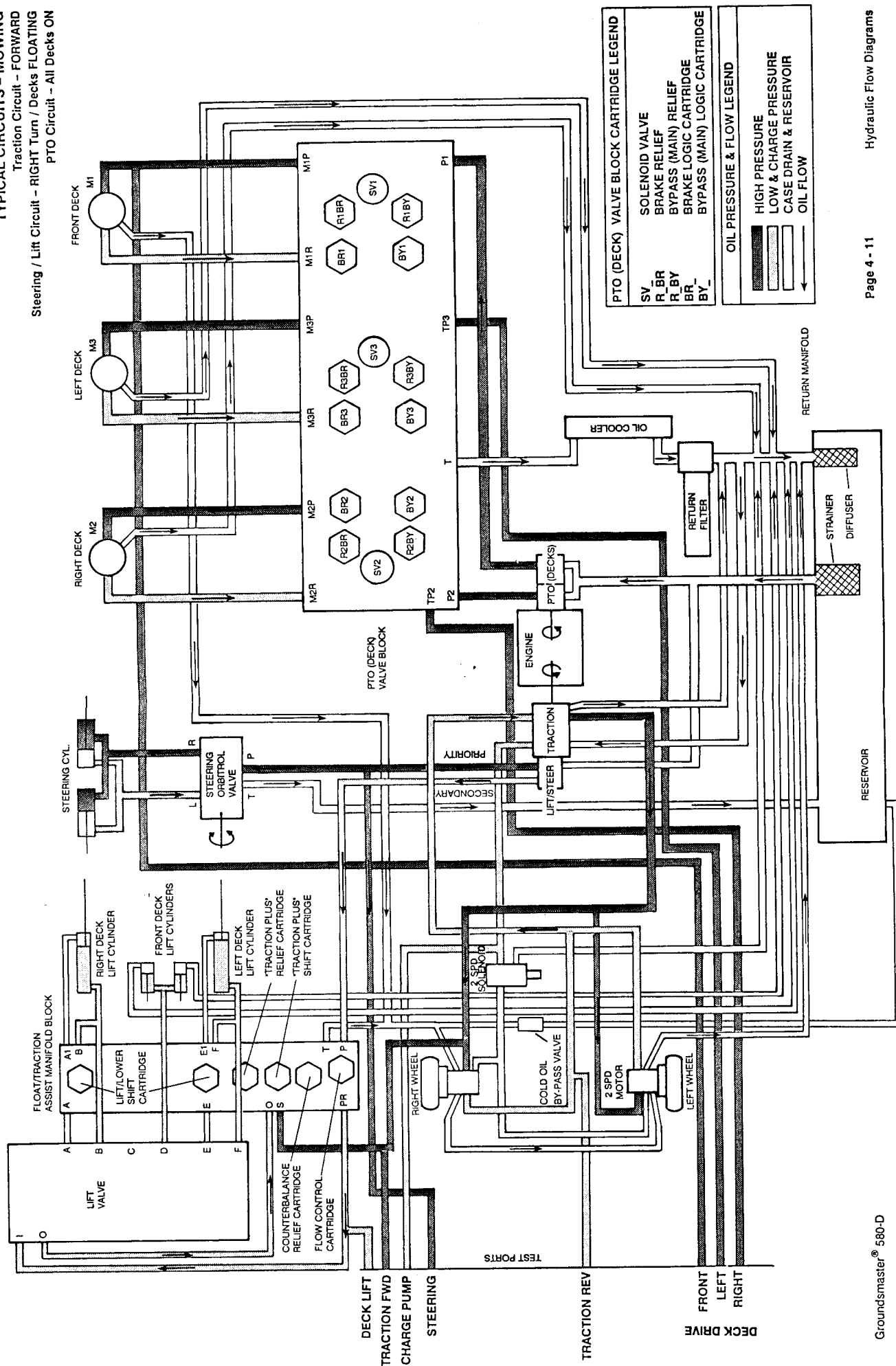
The PTO circuit is powered by a two-section gear pump, which is driven directly off the engine flywheel. The rear section of the pump provides oil for the front deck, and the front section of the pump provides oil for the left and right wing decks.

A solenoid valve and two logic cartridges control each deck motor. When the solenoid is energized, the solenoid valve spool shifts, blocking oil flow through the bypass (main) logic cartridge. Oil flow is directed out of the valve block to the deck motor.

Return oil from the motor is directed back to the valve block, through the brake logic cartridge, out port T and through the oil cooler and return filter to the hydraulic reservoir. The return filter is equipped with a bypass valve. If the filter becomes clogged, the bypass valve opens, allowing unfiltered oil to enter the reservoir.

Hydraulic pressure is limited by relief valves in the PTO valve block. Hydraulic pressure to each drive motor may be monitored at the LEFT, FRONT, and RIGHT DECK DRIVE test ports.

TYPICAL CIRCUITS - MOWING
 Traction Circuit - FORWARD
 Steering / Lift Circuit - RIGHT Turn / Decks FLOATING
 PTO Circuit - All Decks ON



Special Tools

NOTE: Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*. Some tools may be listed in the Groundsmaster 580-D Parts Catalog. Some tools may also be available from a local supplier.

Hydraulic Pressure Test Kit

Used to take various hydraulic pressure readings for diagnostic tests. Quick disconnect fittings provided attach directly to mating fittings on machine test ports without tools. A high pressure hose is provided for remote readings. Contains one each, 1,000, 5,000 and 10,000 PSI gauges. Use gauges as recommended in Testing section of this chapter.

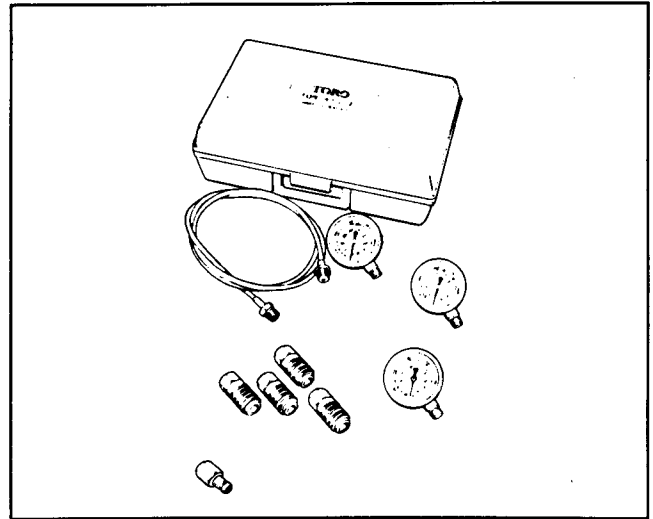


Figure 7

Seal Installation Tools

Information about seal installation tools for traction pump, traction motor and PTO pump are provided in component manuals at the end of this chapter.

Troubleshooting

The cause of an improperly functioning hydraulic system is best diagnosed with the use of proper testing equipment and a thorough understanding of the complete hydraulic system.

A hydraulic system with an excessive increase in heat or noise is a potential failure. Should either of these conditions be noticed, immediately stop the machine, turn off the engine, locate the cause of the trouble, and correct it before allowing the machine to be used again. Continued use of an improperly functioning hydraulic sys-

tem could lead to extensive internal component damage.

The charts that follow contain detailed information to assist in troubleshooting. There may possibly be more than one cause for a machine malfunction. All causes should be checked in the order in which they are listed on the charts.

Refer to the Testing section of this Chapter for precautions and specific test procedures.

System Operates Hot

Cause	Correction
Excessive uphill operation in high range.	Operate in low range.
Low engine RPM.	Adjust - use tachometer.
Hydraulic oil level too low.	Fill to proper level.
Cooling system not operating properly.	Clean screen, oil cooler & radiator. Repair fan or belt.
Traction pump bypass (tow) valve open or damaged.	Close or repair.
Kinked or severely bend hose or tubing.	Replace kinked or bent hose or tubing.
Traction circuit charge pressure to low - TEST NO. 2.	Inspect charge relief valve and repair or adjust if necessary. Inspect charge pump and repair or replace if necessary.
Traction pressure too low - TEST NO. 1.	Inspect check / high pressure relief valve(s) and replace if necessary. Check traction pump and motor(s) for damage or excessive wear and repair or replace if necessary.
Traction working pressure too high - TEST NO. 1.	Inspect brakes for binding and adjust or repair if necessary. Check for other cause of excessive machine load and correct.

Neutral Difficult or Impossible to Find

See Troubleshooting section of SUNDSTRAND
SAUER M46-AXIAL PISTON PUMPS AND MOTORS
SERVICE MANUAL

Machine Travels In One Direction Only

See Troubleshooting section of SUNDSTRAND
SAUER M46-AXIAL PISTON PUMPS AND MOTORS
SERVICE MANUAL

Traction Response Is Sluggish

Cause	Correction
Brakes dragging.	Inspect brakes and adjust or repair if necessary.
Also see Troubleshooting section of SUNDSTRAND SAUER M46-AXIAL PISTON PUMPS AND MOTORS SERVICE MANUAL.	

Machine Will Not Travel In Either Direction

Cause	Correction
Planetary wheel drive hubs disengaged.	Install disengage covers so dimple on cover is facing out.
Drive shaft between engine and transmission disconnected or failed.	Connect or replace drive shaft.
Coupling(s) between wheel motor and planetary wheel drive failed.	Inspect coupling and repair if necessary.
Brakes engaged.	Inspect brakes and adjust or repair if necessary. NOTE: Electrical interlock system should shut engine down if parking brake is engaged when traction pedal is pushed down.
Also see Troubleshooting section of SUNDSTRAND SAUER M46-AXIAL PISTON PUMPS AND MOTORS SERVICE MANUAL.	

Machine Will Not Go Into High Range

Cause	Correction
Deck(s) down.	Raise deck(s).
Traction circuit charge pressure too low - TEST NO. 2.	Inspect charge relief valve and repair or adjust if necessary. Inspect charge pump and repair or replace if necessary. NOTE: If the charge pump is in good condition, the general condition of the traction pump and wheel motors might be suspected of wear and inefficiency, i.e. charge pump cannot keep up with internal leakage.
Two-speed shift valve not shifting.	Check for electrical problems. (See Troubleshooting section of Chapter 5 - Electrical System). Check solenoid shift spool for damage or binding and replace solenoid valve if necessary.
Hydraulic wheel motors not shifting to high range.	If correct charge pressure is available to wheel motor from two-speed shift valve, repair or replace wheel motor.

Machine Goes Into High Range But Top Speed Is Too Slow

Cause	Correction
Traction control rod out of adjustment.	Adjust so when traction control rod is all the way back, front of traction pedal hits floor.
One wheel motor not shifting.	Repair or replace damaged wheel motor.

Machine Does Not Go Into Low Range

Cause	Correction
Electrical problems.	See Troubleshooting section of Chapter 5 - Electrical System.
Two-speed shift valve spool damaged or binding.	Replace two-speed shift solenoid valve.

Engine Shuts Off When On Side Hill Or Down Hill

Cause	Correction
Hydraulic oil level too low.	Fill to proper level.
Seat lifting off seat switch.	Instruct operator to sit back in seat during operation Check seat plate hinges and seat support pin and repair if faulty.
Electrical problems.	See Troubleshooting section of Chapter 5 - Electrical System.

No Decks Operate

Cause	Correction
Hydraulic oil level too low.	Fill to proper level.
Low engine RPM.	Adjust engine rpm - use tachometer.
Electrical problem.	See Troubleshooting section of Chapter 5 - Electrical System.
Low or no PTO (deck) drive pressure for all decks - TEST NO. 6.	Check for restriction in pump intake line or strainer and repair if necessary. Check for damaged PTO pump shaft. Repair or replace pump if necessary.

All Decks Operate Slowly

Cause	Correction
Low engine RPM.	Adjust engine rpm - use tachometer.
Hydraulic oil level too low.	Fill to proper level.
Low PTO (deck) drive pressure for all decks - TEST NO. 6.	Check for restriction in pump intake line or strainer and repair if necessary. Repair or replace PTO pump.

One Deck Does Not Operate

Cause	Correction
Deck drive belt slipping or drive motor pulley is damaged/disconnected.	Inspect and adjust or replace belt or pulley.
Electrical problem.	See Troubleshooting section of Chapter 5 - Electrical System.
Low or no PTO (deck) drive pressure for affected deck - TEST NO. 6.	<p>Inspect solenoid valve (SV_) for damage or sticking in off position and clean or replace if necessary. (Interchange solenoid valves with another deck. If problem follows suspected bad valve, replace valve.)</p> <p>Inspect bypass logic cartridge (BY_) for plugged orifice, damage, or sticking, and clean or replace if necessary. (Interchange cartridge with another deck circuit. If problem follows suspected bad cartridge, replace cartridge.) NOTE: If affected deck is a wing deck, interchange cartridges with the front deck circuit for proper diagnosis.</p> <p>Inspect bypass relief cartridge (R_BY) for damage or sticking in open position and clean or replace if necessary. (Interchange relief cartridges with another deck circuit. If problem follows suspected bad cartridge, attempt to adjust, then replace cartridge if necessary.) NOTE: If affected deck is a wing deck, interchange cartridges with the front deck circuit for proper diagnosis.</p> <p>Repair or replace PTO pump. NOTE: Rear section of pump drives front deck. Front section of pump drives both wing decks. Pump is not the problem if only one wing deck is affected.</p>
Damaged deck drive motor.	Interchange deck drive motors with another deck. If problem follows suspected bad motor, repair or replace motor. NOTE: If affected deck is a wing deck, interchange motor with the front deck for proper diagnosis.

One Deck Operates Slowly and/or Loses Power in Heavy Cutting

Cause	Correction
Deck drive belt slipping or drive pulley damaged.	Inspect belt and adjust or replace belt or drive pulley.
Low PTO (deck) drive pressure for affected deck - TEST NO. 6.	<p>Remove cap from affected bypass relief cartridge (R_BY) and adjust screw to get correct pressure.</p> <p>Inspect bypass relief cartridge (R_BY) for damage or sticking and clean or replace if necessary. (Interchange cartridge with another deck circuit. If problem follows suspected bad cartridge, replace cartridge). NOTE: If affected deck is a wing deck, interchange cartridges with the front deck circuit for proper diagnosis.</p> <p>Repair or replace PTO pump. NOTE: Rear section of pump drives front deck. Front section of pump drives both wing decks. Pump is not the problem if only one wing deck is affected.</p>
Inefficient or damaged deck drive motor.	Interchange deck drive motors with another deck. If problem follows suspected bad motor, repair or replace motor. NOTE: If affected deck is a wing deck, interchange motor with the front deck for proper diagnosis.

Right Wing Deck Blades "Creep" When System is Cold, or Right Deck Runs Briefly When Raised or Off If Left Wing is On

Cause	Correction
Orifice in PTO valve block plugged or restricted.	Remove orifice and clean or replace if necessary.

Steering Problems

See Troubleshooting section of REPAIR INFORMATION, STEERING CONTROL UNITS, CHAR-LYNN.

One Deck Will Not Stop Operating

Cause	Correction
Electrical problem.	See Troubleshooting section of Chapter 5 - Electrical System.
Solenoid valve (SV_) sticking.	Inspect solenoid valve (SV_) for damage or sticking in off position and clean or replace valve if necessary. (Interchange solenoid valves with another deck. If problem follows suspected bad valve, replace valve.)
Faulty brake logic cartridge (BR_).	Inspect brake logic cartridge (BR_) for plugged orifice, damage, or sticking, and clean or replace if necessary. (Interchange cartridge with another deck circuit. If problem follows suspected bad cartridge, replace cartridge.)
Faulty brake relief cartridge (R_BR).	Inspect brake relief cartridge (R_BR) for damage, or sticking, and clean or replace if necessary. (Interchange cartridge with another deck circuit. If problem follows suspected cartridge, replace cartridge.)

One Deck Stops Too Slowly

Cause	Correction
Brake relief cartridge (R_BR) out of adjustment.	Remove cap from affected brake relief cartridge (R_BR) and adjust screw to get correct pressure.
Faulty brake logic cartridge (BR_).	Inspect brake logic cartridge (BR_) for plugged orifice, damage, or sticking, and clean or replace if necessary. (Interchange cartridge with another deck circuit. If problem follows suspected bad cartridge, replace cartridge.)
Faulty or sticking brake relief cartridge (R_BR).	Inspect brake relief cartridge (R_BR) for damage, or sticking, and clean or replace if necessary. (Interchange cartridge with another deck circuit. If problem follows suspected cartridge, replace cartridge.)

Deck(s) Do Not Lift or Lift Too Slowly

Cause	Correction
Hydraulic oil level too low.	Fill to proper level.
Low engine RPM.	Adjust engine rpm - use tachometer.
Lift arm or cylinder pivots binding.	Lubricate bushings. Inspect for damage. Repair or replace damaged parts.
Internal leakage of lift cylinder(s)	Check lift cylinder(s) and repair or replace if necessary.
Low lift pressure - TEST NO. 4.	<p>Check for restriction in pump intake line or strainer and repair if necessary.</p> <p>Check lift cylinder(s) for internal leakage and repair or replace if necessary.</p> <p>Clean relief valve in lift control valve and adjust if necessary by adding required shims.</p> <p>Inspect lift valve for internal leakage or improper operation and repair or replace if necessary.</p> <p>Inspect steering/lift pump for wear or damage and repair or replace if necessary.</p>
Faulty flow control cartridge in float/traction assist manifold block.	Remove flow control cartridge and check for spool being stuck open. Make sure spool moves freely. Replace if necessary.
Plugged orifice in float/traction assist manifold block.	Remove and check each orifice (2) for being plugged.

Decks "Chatter" While Lowering

Cause	Correction
Counterbalance pressure too high - TEST NO. 5.	Remove cap and adjust the counterbalance relief valve screw until correct pressure is attained.
Faulty shift cartridge in float/traction assist manifold block.	Remove shift cartridge for affected deck (right or left) and check spool for sticking. Make sure spool moves freely. Replace shift valve cartridge if necessary.

Wing Decks Raise By Themselves When Climbing a Hill

Cause	Correction
"Traction Plus" pressure too high - TEST NO. 5.	Remove cap and adjust the "traction plus" relief valve screw until correct pressure is attained.

Deck Weight is Not Transferred to Traction Unit When Climbing a Hill

Cause	Correction
"Traction Plus" pressure too low - TEST NO. 5.	Remove "traction plus" relief cartridge and check for spool sticking open or plugged orifice. Make sure spool moves freely. Replace cartridge if necessary. Remove cap and adjust "traction plus" relief valve screw until correct pressure is attained.
"Traction Plus" shift pressure too high - TEST NO. 5.	Remove cap and adjust the shift cartridge screw until correct shift pressure is attained.

Wing Decks Cut at Uneven Height on Level Ground

Cause	Correction
Counterbalance pressure not correct - TEST NO. 5.	Remove cap and adjust the counterbalance relief valve screw until correct pressure is attained.

Front Deck Drops With Lift Valve in Centered Position

Cause	Correction
Internal leakage of lift cylinder(s)	Check lift cylinder(s) and repair or replace if necessary.
Lift cylinder hydraulic lines or fittings leaking.	Check for leaks. Correct any leaks by replacing o-rings and tightening connection properly. Replace lines or fittings if necessary.
Faulty lift valve lockout assembly.	Check for damaged o-rings on lockout plugs or seats and repair if necessary. Check for damaged or worn lockout poppet assembly and replace if necessary. Check for broken lockout spring and replace if necessary.

Testing

The most effective method for isolating problems in the hydraulic system is by using hydraulic test equipment such as pressure gauges and flow meters in the circuits during various operational checks. (See the Special Tools section in this Chapter.)



WARNING

Failure to use gauges with the recommended pressure (psi) rating as listed in the test procedures could result in damage to the gauge and possible personal injury from leaking hot oil.

Before Performing Hydraulic Tests

All obvious areas such as oil supply, filter, binding linkage, loose fasteners, or improper adjustments must be checked before assuming that a hydraulic component is the source of the problem being experienced.



WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved by lowering the front deck to the ground, completely raising or lowering the wing decks and shutting the engine OFF.

Keep body and hands away from pin hole leaks or nozzles that eject hydraulic fluid under high pressure. Use paper or cardboard, not hands, to search for leaks. Hydraulic fluid escaping under pressure can have sufficient force to penetrate skin and do serious damage. If fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury or gangrene may result.

1. Thoroughly clean the machine before disconnecting or disassembling any hydraulic components. Always keep in mind the need for cleanliness when working on hydraulic equipment.

2. Put caps or plugs on any hydraulic lines left open or exposed during testing or removal of components.

3. The engine must be in good operating condition. ALWAYS use a tachometer when making a hydraulic test. Engine speed will affect the accuracy of the tester readings.

4. To prevent damage to tester or components, the inlet and the outlet hoses must be properly connected, and not reversed (tester with pressure and flow capabilities).

5. To minimize the possibility of damaging components, completely open the load valve by turning it counterclockwise (tester with pressure and flow capabilities).

6. Install fittings finger tight, far enough to insure that they are not cross-threaded, before tightening with a wrench.

7. Position the tester hoses so that rotating machine parts will not make contact with them and result in hose or tester damage.

8. Check the oil level in the reservoir.

9. Check the control linkage for improper adjustment, binding or broken parts.

10. All hydraulic tests should be made with the hydraulic oil at normal operating temperature (hoses warm to the touch).

TEST NO. 1: Traction Circuit Working Pressure and Relief Pressure

WORKING Pressure Test:

1. Connect a 10,000 psi gauge to traction circuit test port for function to be checked (TRACTION FORWARD shown) (Fig. 9).

2. Operate machine while monitoring gauge.

RANGE OF TESTER READINGS: 220 - 5,250 PSI

3. If working pressure is too low, do traction circuit relief pressure test.

RELIEF Pressure Test:

1. Hydraulic oil must be at operating temperature.

2. Connect a 10,000 psi gauge to traction circuit test port for function to be checked (TRACTION FORWARD shown) (Fig. 9).

3. Start the engine and move throttle to full speed (2,500 rpm).

4. Release parking brake.

5. Engage traction pedal to set machine in motion.

6. Maintain traction pedal engagement while momentarily engaging service brake to bring machine to a stop and read gauge.

TESTER READING TO BE $5,000 \pm 250$ PSI.

7. If traction pressure is too low, inspect traction pump check/high pressure relief valves. If problem occurs in one direction only, interchange the check/relief valves to see if the problem changes to other the direction. If so, one check/relief valve cartridge is either malfunctioning or does not have the proper setting. Clean or replace valves as necessary. These cartridge type valves are factory set, and are not adjustable. If check valves and relief valves are in good condition, replace or overhaul traction pump. (See the SUNDSTRAND SAUER M46 AXIAL PISTON PUMPS AND MOTORS SERVICE MANUAL.)

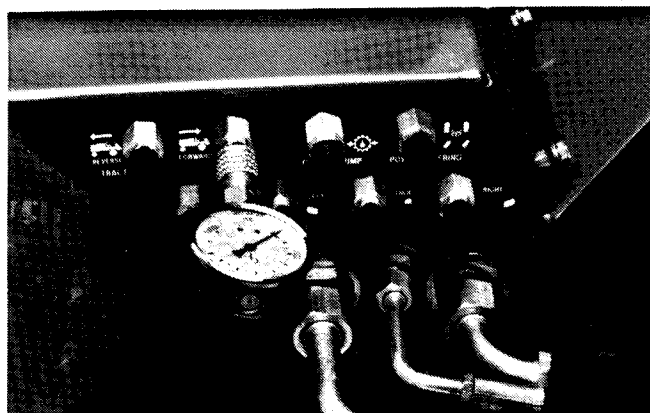


Figure 9

TEST NO. 2: Traction Circuit Charge Pressure

1. Hydraulic oil must be at operating temperature.
2. Connect a 1,000 psi gauge onto charge pressure test port (Fig. 10).
3. Start the engine and put throttle at idle position (approx. 1,200 rpm) with no load on the system.

TESTER READING TO BE:

230 ± 10 PSI (Pump S/N Below A-96-01-XXXXX)

285 ± 10 PSI (Pump S/N A-96-01-XXXXX & Up)

4. If there is no pressure or pressure is too low, check for restriction in pump intake line. Inspect charge relief valve and valve seat. Charge pressure can be adjusted by changing shim thickness behind the spring. Check for sheared charge pump key. Disassemble charge pump and check for internal damage or worn parts. If charge pump is in good condition (no scoring, scratches, or excessive wear), general condition of piston pump might be suspected of wear and inefficiency, thus charge pump is unable to keep up with internal leakage). (See the SUNDSTRAND SAUER M46 AXIAL PISTON PUMPS AND MOTORS SERVICE MANUAL.)



Figure 10

TEST NO. 3: Steering Circuit Working Pressure and Relief Pressure

WORKING Pressure Test:

1. Connect a 5,000 psi gauge onto POWER STEERING test port (Fig. 11).

2. Operate the machine while monitoring gauge.

RANGE OF TESTER READINGS 0 - 1,550 psi.

3. If working pressure is too high or too low, perform relief pressure test.

RELIEF Pressure Test:

1. Hydraulic oil must be at operating temperature.

2. Connect a 5,000 psi gauge onto POWER STEERING test port (Fig. 11).

3. Start the engine and move throttle to full speed (2,500 rpm).

4. Turn steering wheel until heavy resistance is felt indicating that cylinders have reached maximum stroke.

5. Momentarily hold steering wheel against resistance and read gauge.

TESTER READING TO BE $1,500 \pm 50$ PSI.

6. If pressure is too high, remove cap and adjust relief valve screw. If pressure is too low, check for restriction in pump intake line. Check steering cylinder(s) for internal leakage. If cylinder is not leaking, inspect relief valve. Adjust relief valve if necessary by removing cap and adjusting relief valve screw. If pressure is still too low, repair or replace steering pump.

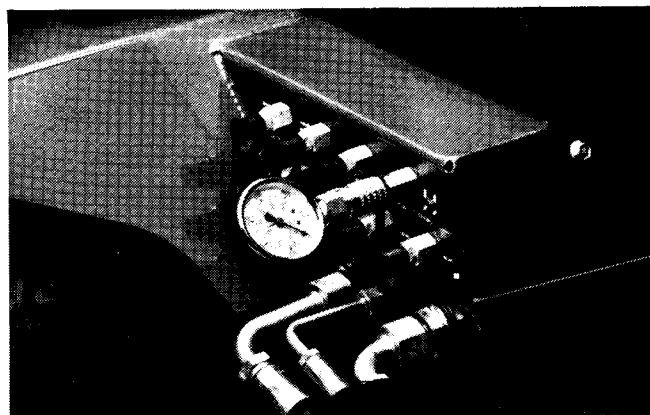


Figure 11

TEST NO. 4: Lift Circuit Working Pressure and Relief Pressure

WORKING Pressure Test:

1. Connect a 5,000 psi gauge onto the LIFT test port (Fig. 12).
2. Operate the machine while monitoring gauge.

RANGE OF TESTER READINGS 375 - 1950 psi.

3. If working pressure is too high or too low, perform relief pressure test.

RELIEF Pressure Test:

1. Hydraulic oil must be at operating temperature.
2. Connect a 5,000 psi gauge onto the LIFT test port (Fig. 12).
3. Start the engine and move throttle to full speed (2,500 rpm).
4. Engage the control lever into the LIFT position. Momentarily hold lever in engaged position after full cylinder extension and read gauge.

TESTER READING TO BE $1,900 \pm 50$ PSI.

NOTE: Always set counterbalance pressure to correct amount before attempting to adjust lift pressure.

5. If pressure is too high, inspect relief valve in lift control valve. If necessary, adjust relief valve by removing the required shims. If pressure is too low, check for restriction in pump intake line. Check lift cylinder(s) for internal leakage. If cylinder is not leaking, clean relief valve, and adjust if necessary by adding required shims. If pressure is still too low, repair or replace steering/lift pump.

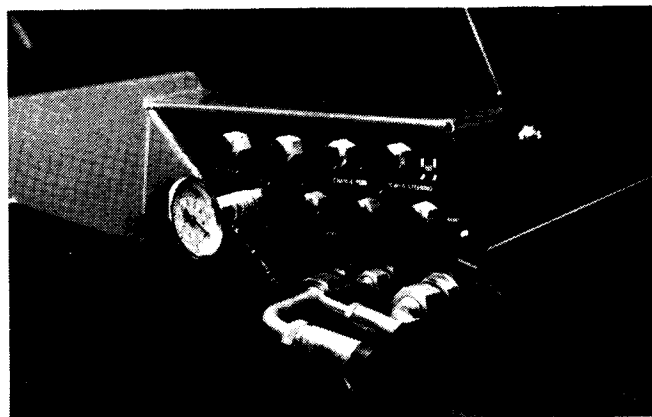


Figure 12

TEST NO. 5: Counterbalance Pressure

IMPORTANT: To prevent damage to gauge, raise all decks before connecting 1,000 psi gauge to LIFT test port.

NOTE: Hydraulic oil must be at operating temperature for these tests or pressure reading will be too high.

COUNTERBALANCE Pressure Test:

1. Connect a 1,000 psi gauge to LIFT test port (Fig. 13).
2. Start the engine and move throttle to full speed (2,500 rpm)

TESTER READING TO BE $400 + 25 - 0$ PSI:

3. If pressure is too high or too low, remove cap and adjust the counterbalance relief valve screw until correct pressure is attained (Fig. 15).

"TRACTION PLUS" Pressure Test:

1. Connect a 1,000 psi gauge to LIFT test port (Fig. 13).
2. Start the engine and move throttle to full speed (2,500 rpm). Move GROUND SPEED switch to HIGH RANGE.
3. Engage service brake, momentarily push traction pedal forward and read the gauges.

TESTER READING TO BE $600 + 50 - 0$ PSI:

4. If pressure is too high or too low, remove cap and adjust the "traction plus" relief valve screw until correct pressure is attained (Fig. 15).

SHIFT Pressure Test:

1. Connect a 1,000 psi gauge to LIFT test port (Fig. 13). Connect a 5,000 psi gauge to TRACTION FORWARD test port (Fig. 14).

2. Start the engine and move throttle to full speed (2,500 rpm). Move GROUND SPEED switch to HIGH RANGE.

3. While watching gauges, engage service brake, and slowly push traction pedal forward. Note pressure at TRACTION PORT when pressure at LIFT port shifts from 400 to 600 psi.

TESTER READING TO BE $2,000 + 50 - 0$ PSI:

4. If shift pressure is too high or too low, remove cap and adjust the shift cartridge screw until correct shift pressure is attained (Fig. 15).

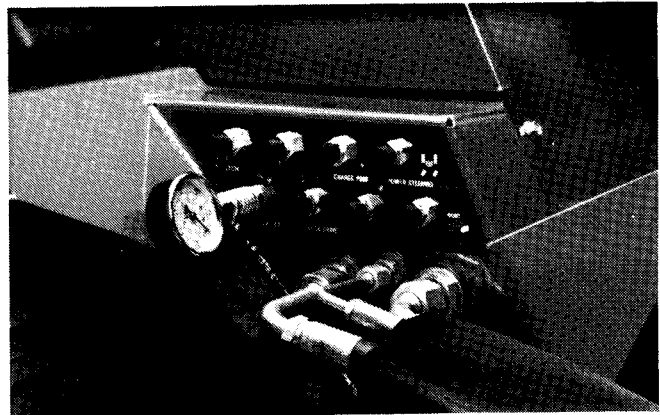


Figure 13

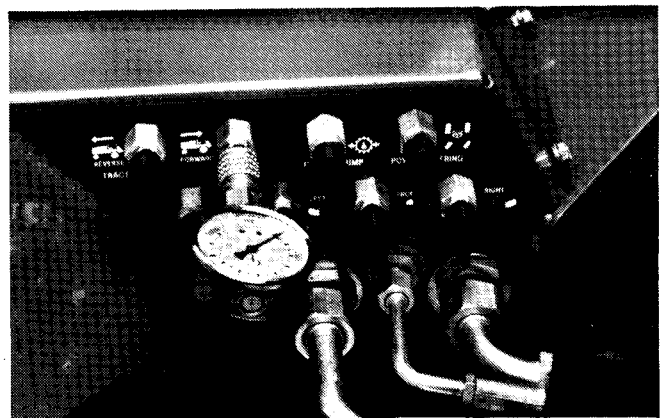


Figure 14

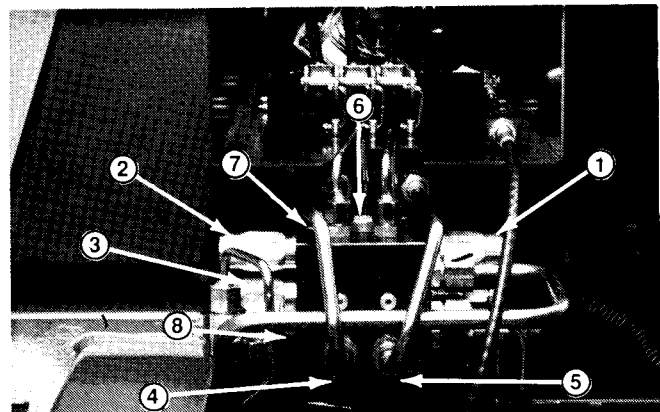


Figure 15
(Control housing removed)

1. Counterbalance relief cartridge
2. "Traction Plus" relief cartridge
3. "Traction Plus" shift cartridge
4. Lift/lower shift cartridge (right deck)
5. Lift/lower shift cartridge (left deck)
6. Flow control cartridge
7. Orifice (0.047)
8. Orifice (0.120)

Diagnosing Cutting Performance Problems

Over a period of time, the seals in the deck motors can deteriorate and wear from heat and contamination. A leaking motor seal will by-pass oil to the case drain line and make the motor less efficient. Eventually enough oil loss will occur and cause the deck motor to stall in heavy cutting conditions. Continued operation with a motor in an inefficient condition can generate so much heat that the cartridge seals in the hydraulic manifold block can be affected, compounding the problem.

If the deck motors slow during operation, use the following procedure to analyze the problem:

1. Make sure deck drive area is clean, drive belt is at proper tension and belts are free of grease.
2. Check the hydraulic oil for water contamination and replace as necessary (appears cloudy or milky).
3. Make sure deck drive hydraulic circuit working and relief pressures are within specification.
4. Check PTO manifold block logic cartridges and relief valves for burnt or hardened o-rings. Replace o-rings as necessary.
5. Test deck motor for internal leakage (see Deck Motor Internal Leakage Test on the next page).

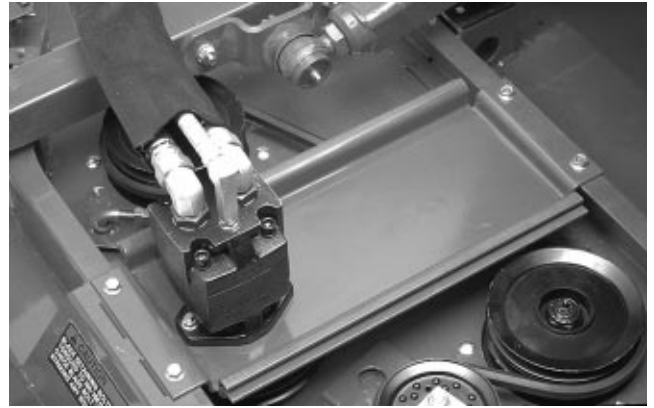


Figure 17A

Deck Motor Internal Leakage Test

NOTE: Test only one deck at a time. Decks not being tested should be in the raised position so the deck will not operate when the PTO is engaged.

1. Determine which deck motor is turning slow. The left and right decks are powered in series by the same circuit, therefore one deck could affect the other.
2. To prevent deck blades from rotating, remove one outer blade from the deck to be tested and install a longer blade (P/N 29-5530) from a Groundsmaster 72 inch deck. Put the front cutting edge of the longer blade against the deck housing.



DANGER

Make sure other two decks not being tested are in the raised position. Blades on the other decks will rotate if in the lowered position when PTO switch is engaged. To prevent serious personal injury or death, keep clear of rotating blades. Other blades on deck being tested will rotate if belt on spindle with longer blade breaks or slips.

3. Remove the case drain line (smallest of the three lines) from the deck motor.
4. Connect a flow meter in line with the case drain (oil flow will be away from the motor).
5. With the other decks in the raised position, start the engine and engage the PTO. Move the throttle to full speed position and note the oil flow exiting the motor through the case drain line. If the flow exceeds 1.5 GPM, the deck motor should be repaired or replaced.

NOTE: If one motor shows excessive case drain flow, other motors may also be in a similar condition. Failure to test all three motors may lead to repeat failures.

Alternate Deck Motor Test

(If you do not have a flow meter.)

1. Do steps 1 – 3 as described above, except disconnect the case drain line from the bulkhead instead of the motor. Put a cap on the bulkhead fitting.
2. Put the case drain line from the motor into a 5 gallon container and secure the line in place.
3. Start the engine and engage the PTO for exactly 15 seconds at full throttle, then disengage the PTO and stop the engine.
4. Measure the amount of oil in the container. Multiply the amount collected by 4 to get the gallons per minute flow discharged from the case drain line. If the flow exceeds 1.5 GPM, the deck motor should be repaired or replaced.

NOTE: If one motor shows excessive case drain flow, other motors may also be in a similar condition. Failure to test all three motors may lead to repeat failures.

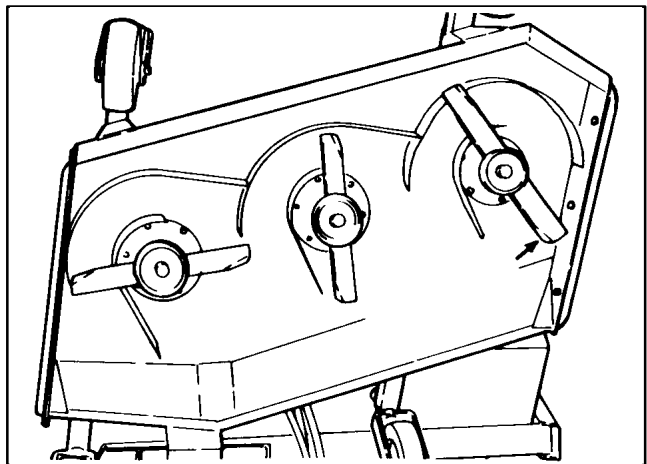


Figure 17B

TEST NO. 6: Deck Drive Circuit Working Pressure and Relief Pressure

WORKING Pressure Test:

1. Connect a 5,000 psi gauge onto DECK DRIVE test port for circuit to be checked (Fig. 16).

2. Do mowing operation while monitoring gauge.

RANGE OF TESTER READINGS 0 - 3,200 psi.

3. If working pressure is too high or too low, perform relief pressure test. Normal pressure during operation is 1,500 - 2,000 psi. However gauge may show a pressure spike during initial engagement.

RELIEF Pressure Test:

NOTE: Hydraulic oil must be at operating temperature to get a correct pressure reading.

1. Start engine and raise all decks.

2. Turn engine OFF.

3. To prevent deck blades from rotating on deck to be tested: Remove one outer blade from deck to be tested and install a longer blade (P/N 29-5530) from Groundsmaster 72 in. deck (Fig. 16a). Loosen belt and turn spindle to put front (cutting) edge of blade against deck housing. Make sure deck drive belts are properly adjusted and in good condition before performing test.

4. Start engine and move throttle to approximately 3/4 speed (2,000 rpm). Lower only deck to be tested.



DANGER

Deck blades of other decks will rotate if lowered while DECK DRIVE / PTO switch is ENGAGED. Other blades on deck being tested will rotate if belt on spindle with longer blade breaks or slips. Keep clear of rotating blades to prevent personal injury.

5. Engage DECK DRIVE / PTO switch and read gauge.

TESTER READING TO BE 3,000 + 200 - 0 PSI.

6. If pressure is too high, remove cap for affected bypass (main) relief valve and adjust screw to get correct pressure (Fig. 17). If pressure is too low, check for restriction in pump intake line. Remove cap from affected bypass (main) relief valve and adjust screw to get correct pressure. Inspect bypass (main) logic cartridge and clean or replace if necessary. If pressure is still too low, pump or motor should be suspected of inefficiency, wear or damage. Remove pump or motor and repair or replace.

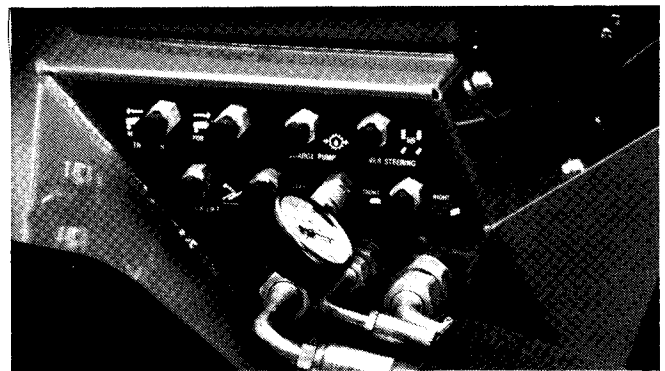


Figure 16
(Gauge shown on DECK DRIVE FRONT port)

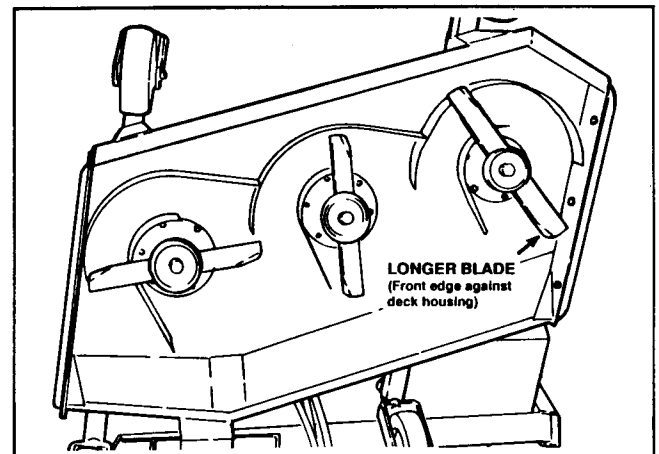


Figure 16a
(L.H. outboard wing deck shown)

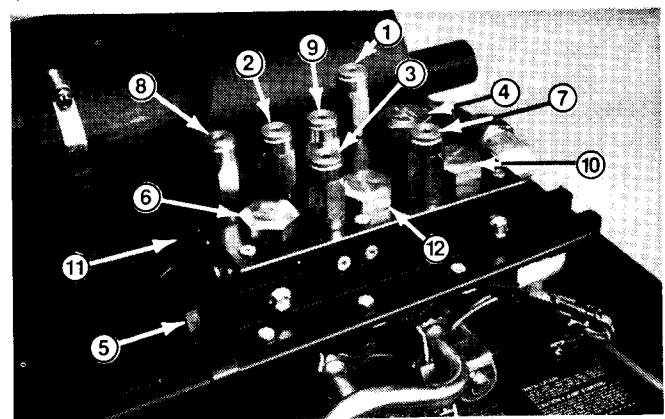


Figure 17

1. Front deck relief valve (port R1BY)
2. Right wing deck relief valve (port R2BY)
3. Left wing deck relief valve (port R3BY)
4. Front deck bypass (main) logic cartridge (port BY1)
5. Right deck bypass (main) logic cartridge (port BY2)
6. Left deck bypass (main) logic cartridge (port BY3)
7. Front deck brake relief valve (port R1BR)
8. Right wing deck brake relief valve (port R2BR)
9. Left wing deck brake relief valve (port R3BR)
10. Front deck brake logic cartridge (port BR1)
11. Right wing deck brake logic cartridge (port BR2)
12. Left wing deck brake logic cartridge (port BR3)

Adjustments

Traction Control Neutral Adjustment

If machine moves when traction pedal and pump lever are in neutral position, adjustment is required.

1. Park machine on a level surface, engage parking brake, raise wing decks completely, lower front deck to ground and turn engine OFF.

2. Actuate pump lever (with foot pedal) to make sure that foot pedal and linkage operate freely. Correct if necessary.

3. Put blocks at front and rear of all four wheels. Disengage the two (2) planetary wheel drives. (See Disengage Planetary Wheel Drive in the General Information section of Chapter 6 - Wheels, Brakes and Steering.)



WARNING

Failure to put machine on a level surface, block wheels, and disengage planetary wheel drives before doing neutral adjustment procedure could result in personal injury from machine movement.

4. Do procedures in the SUNDSTRAND SAUER M46-AXIAL PISTON PUMPS AND MOTORS SERVICE MANUAL under **Swashplate Neutral Adjustment** and **Manual Displacement Control (MDC) Neutral Bracket Adjustment**.

5. With engine OFF, loosen nut on carriage bolt and allow bearing to locate cam (Fig. 18). Carefully tighten nut on carriage bolt.

6. Loosen screws to allow neutral device bracket to move; but not freely (Fig. 18). Adjust neutral device bracket so that 40 ± 5 in-lb of torque on control lever just starts to rotate cam. Tighten screws.

7. Adjust neutral switch. (see Neutral Switch Adjustment in the Adjustments section of Chapter 5 - Electrical System.)

8. Adjust traction control rod. (See Traction Control Rod Adjustment in this section.)

9. Make sure planetary wheel drives are engaged after doing these procedures.

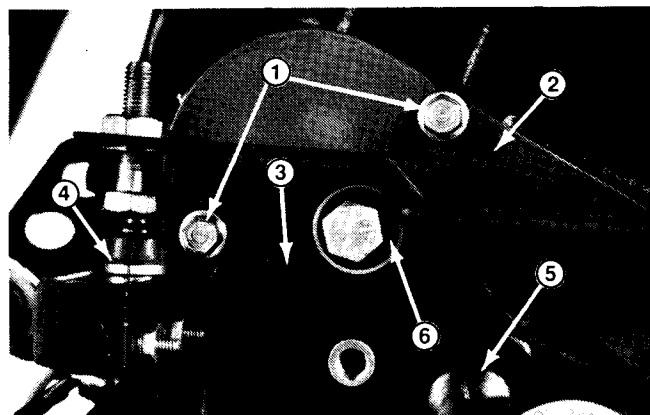


Figure 18

- | | |
|---------------------------|-------------------|
| 1. Screws | 4. Neutral switch |
| 2. Neutral device bracket | 5. Carriage bolt |
| 3. Cam | 6. Bearing |

Traction Control Rod Adjustment

1. Park machine on a level surface, engage parking brake, raise wing decks completely, lower front deck to ground and turn engine OFF.

2. Remove cotter key and slotted nut from ball joint at traction pedal (Fig. 19). Disconnect ball joint from traction pedal.

3. Loosen jam nut and adjust ball joint so that when control rod is all the way back, front of traction pedal hits the floor. Tighten jam nut.

4. Connect ball joint to traction pedal. Tighten slotted nut until ball joint is tight against traction pedal then loosen nut until next slot aligns with hole in ball joint and install cotter pin.

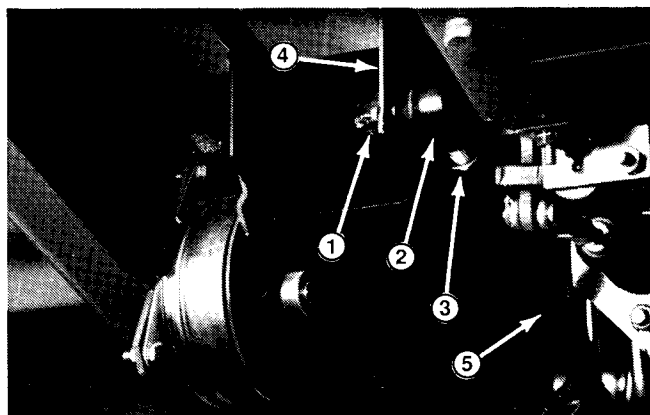


Figure 19

- 1. Cotter key and slotted nut
- 2. Ball joint
- 3. Jam nut
- 4. Traction pedal
- 5. Control rod

Cruise Control Adjustment

1. Park machine on a level surface, engage parking brake, raise wing decks completely, lower front deck to ground and turn engine OFF.

2. With engine off, turn ignition key switch to ON position. Push traction pedal part way down and engage cruise control.

3. With cruise control engaged, traction pedal should move with approximately 40 lb. of force at front tip of traction pedal.

4. If force required is less than 35 lb. or more than 45 lb., loosen jam nut and turn setscrew one turn and check force again – turn counterclockwise for less force and clockwise for more force (Fig. 20). After correct force is achieved, hold setscrew in position and tighten jam nut.

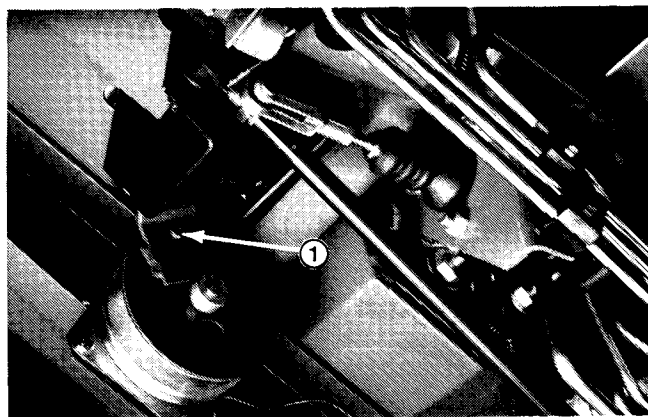


Figure 20

- 1. Setscrew and jam nut

Traction Drive System Repairs

Mow/Transport Solenoid Service

1. Park machine on a level surface, engage parking brake, raise wing decks completely, lower front deck to ground and turn engine OFF.
2. Disconnect solenoid electrical connector.
3. Remove nut from solenoid.
4. Remove cover and solenoid coil.
5. Remove solenoid spool.
6. Inspect valve for sticking, damage or wear and replace if necessary.
7. Reverse steps 2 - 5 to install solenoid valve.

NOTE: See Testing section of Chapter 5 - Electrical System for information on testing solenoid coil.

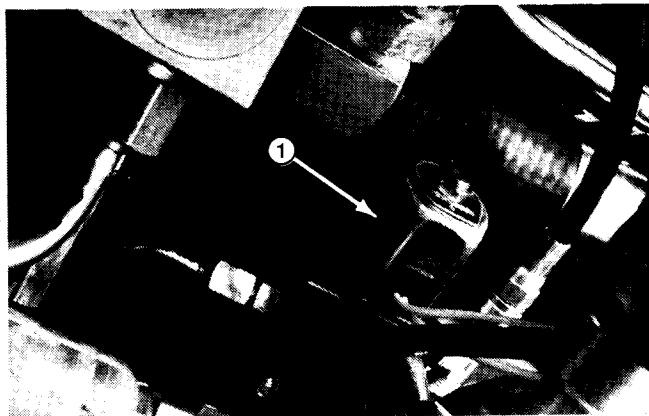


Figure 21

1. Mow/transport solenoid

Variable Displacement Pump Removal and Installation

1. Park machine on a level surface, engage parking brake, raise wing decks completely, lower front deck to ground and turn engine OFF.

2. Move seat forward. Remove upper and lower grill from in front of radiator. Disconnect four (6) latches and remove radiator cowl. Disconnect four (4) latches and remove lower grill support.

3. Remove cotter pin and disconnect control rod from pump (Fig. 22).

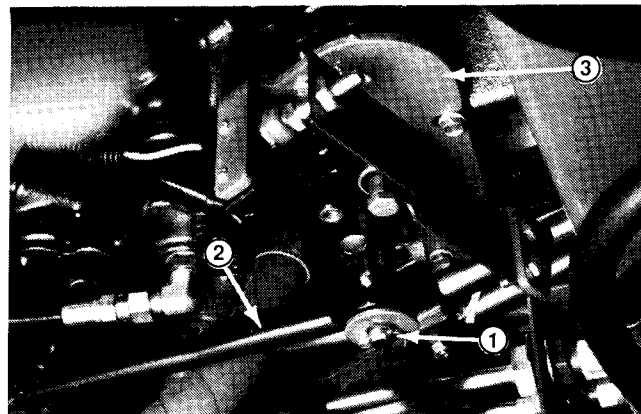


Figure 22

- 1. Cotter pin
- 2. Control rod
- 3. Neutral device bracket

4. Remove two (2) capscrews securing steering/auxiliary pump to variable displacement pump (Fig. 23). Pull steering auxiliary pump away from variable displacement pump. Do not disconnect hydraulic lines from steering/auxiliary pump.

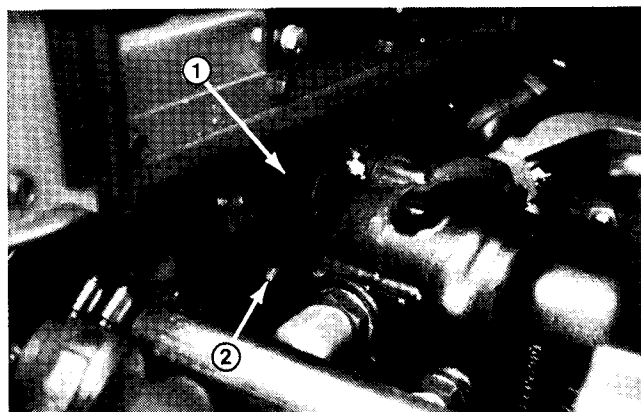


Figure 23

- 1. Steering auxiliary pump
- 2. Capscrews (2)

5. Loosen two capscrews on pump yoke end of drive shaft. Pull pump yoke end of drive shaft off pump input shaft (Fig. 24).

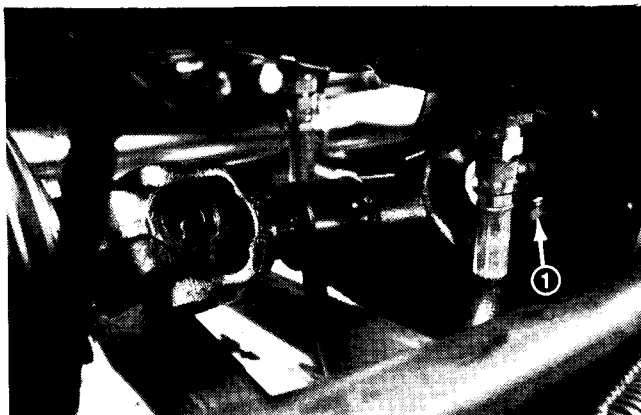


Figure 24

- 1. Drive shaft (pump yoke end)

6. Disconnect all hydraulic lines from the variable displacement pump. Put caps or plugs on all open hydraulic lines to prevent contamination.

7. Remove two (2) capscrews and nuts securing variable displacement pump to frame and lift pump out of machine (Fig. 25).

8. Put caps or plugs on all open ports of the pump to prevent contamination.

9. Reverse steps 2 - 8 to install the pump.

NOTE: Install drive shaft to pump so center line of clamping bolts on drive shaft yoke is over center line of splines on transmission input shaft (Fig. 24).

10. Prime pump after installing. (See Priming After Pump Overhaul or Replacement in this section of the book.). Do traction control neutral adjustment. (See Traction Control Neutral Adjustment in the Adjustments section of this chapter.)

After Repair or Replacement

1. Check oil level in hydraulic reservoir and add correct oil if necessary.

2. Disconnect fuel stop solenoid electrical connector to prevent fuel delivery to engine cylinders (Fig. 26).

3. Turn ignition key switch to engage starter for 10 seconds to prime pumps. Repeat this procedure five (5) times for a total cranking time of 60 seconds.

4. Connect injection pump fuel stop solenoid electrical connector.

5. Engage parking brake. Start engine and let idle at low speed for minimum of 30 seconds.

6. Check for hydraulic oil leaks. Shut off engine and correct leaks if necessary. Check oil level in hydraulic reservoir and add correct oil if necessary.

7. Disengage parking brake and operate machine slowly in forward and reverse.

8. With machine in neutral there should be no movement of wheels or "whining noise" from pump. Do traction control neutral adjustment if necessary. (See Traction Control Neutral Adjustment in the Adjustments section of this chapter.)

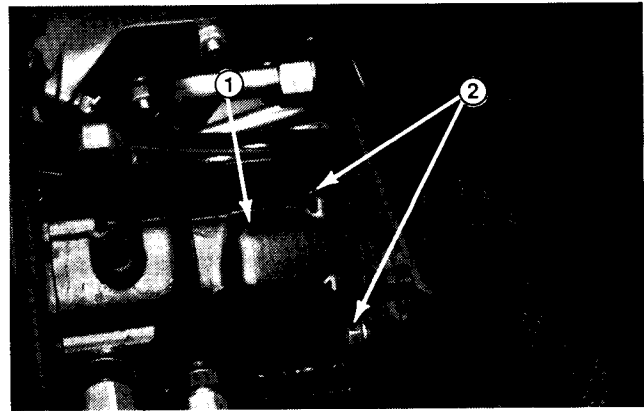


Figure 25

- 1. Variable displacement pump
- 2. Capscrews and nuts (2)

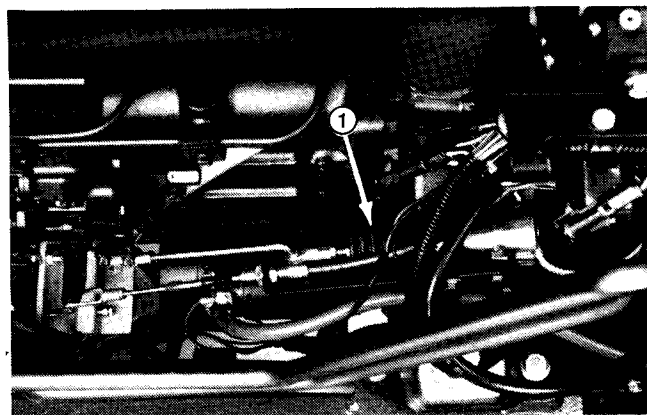


Figure 26

- 1. Fuel stop solenoid

Wheel Motor Removal and Installation

1. Park machine on a level surface, engage parking brake, raise wing decks completely, lower front deck to ground and turn engine OFF.

2. Remove planetary wheel drive. (See Planetary Wheel Drive Removal and Installation in Chapter 6 - Wheels, Brakes and Steering.)

3. Disassemble wheel brakes, remove wheel brake housing and remove wheel motor shaft cup rings. (See Wheel Brake Service, Brake Housing Removal, and Wheel Motor Shaft Cup Ring Service in the Repairs section of Chapter 6 - Wheels, Brakes and Steering.)

4. Disconnect all hydraulic lines from the wheel motor and lower wheel motor out of machine. Put caps or plugs on all open hydraulic lines and wheel motor ports to prevent contamination.

5. Reverse steps 2 - 4 to install the wheel motor.

6. After installing motor and brakes, adjust service brakes. (See Service Brake Adjustment in the Adjustments section of Chapter 6 - Wheels, Brakes and Steering).

After Repair or Replacement

1. Start engine and operate machine slowly in forward and reverse.

2. Check for hydraulic oil leaks. Shut off engine and correct leaks if necessary. Check oil level in hydraulic reservoir and add correct oil if necessary.

PTO System Repairs

PTO Valve Block Service

1. Park machine on a level surface, engage parking brake, raise or lower wing decks completely, lower front deck to ground and turn engine OFF.

2. Open hood latches, raise hood and secure it in raised position with prop rod. Open left side panel latch and remove side panel.

3. Ports on valve block are marked for easy identification of components. Example: SV1 is front deck solenoid valve and R1BY is front deck bypass (main) relief cartridge. (See Hydraulic Flow Diagrams to identify function of hydraulic lines and cartridges at each port location.)

NOTE: For troubleshooting purposes, relief valve cartridges, logic cartridges and solenoid valves can be interchanged with those of different circuits. For ex-

ample, interchange BY1 with BY2 to determine faulty bypass (main) logic cartridge.

4. If necessary PTO valve block can be removed:

A. Disconnect battery cables. Remove battery tray and batteries.

B. Disconnect and cap or plug hydraulic lines.

C. Disconnect solenoid electrical connectors.

D. Remove two capscrews and remove hood prop rod bracket from block.

E. Remove four capscrews from bottom of block and lift block out of machine.

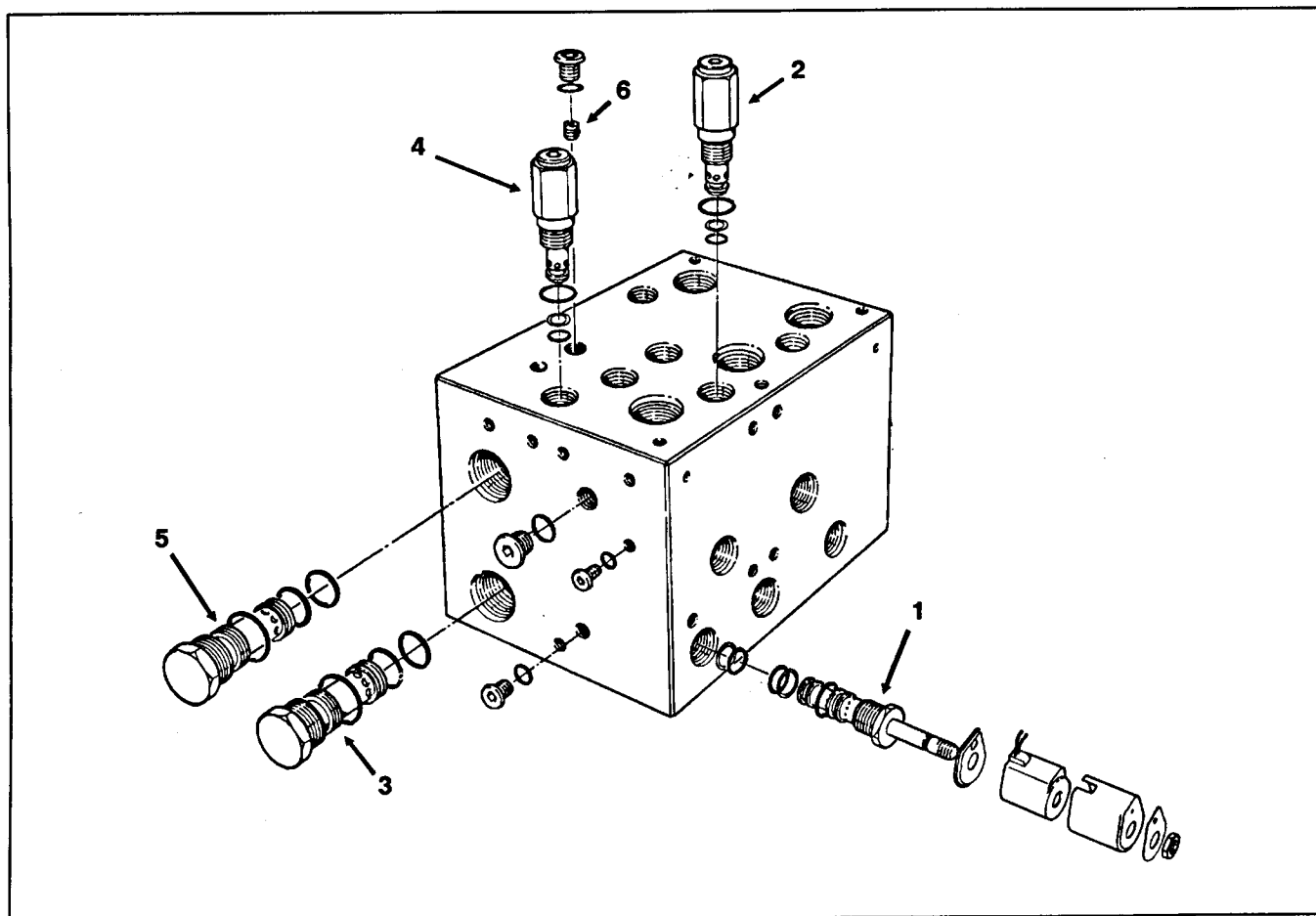


Figure 27

- 1. Solenoid valve (SV2 shown)
- 2. Bypass (main) relief cartridge (R3BY shown)
- 3. Bypass (main logic cartridge (BY2 shown)

- 4. Brake relief cartridge (R2BR shown)
- 5. Brake logic cartridge (BR2 shown)
- 6. Orifice

PTO Valve Block Service (S/N 50001 & UP)

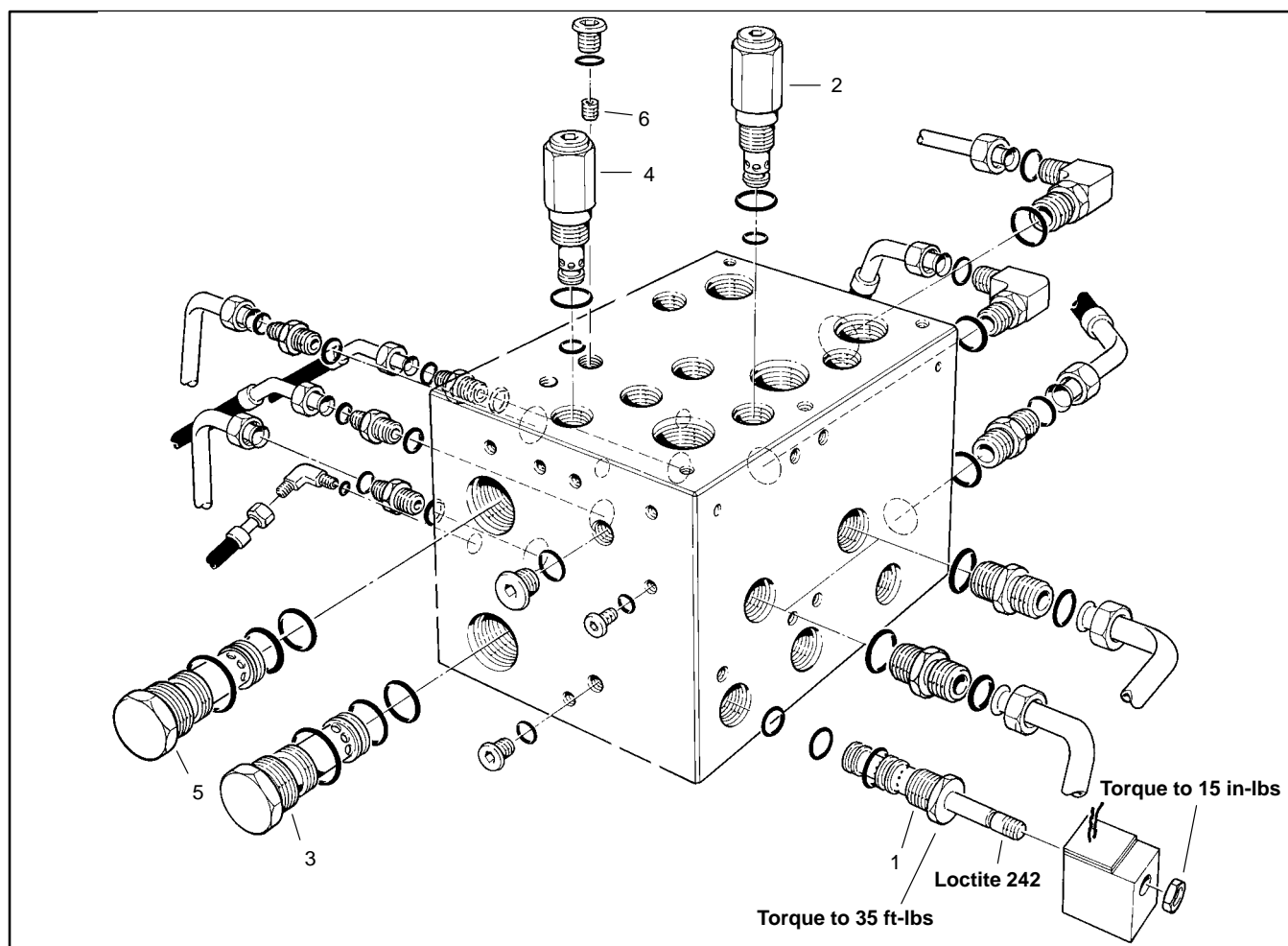


Figure 27A

- 1. Solenoid valve (SV2 shown)
- 2. Bypass (main) relief cartridge (R3BY shown)
- 3. Bypass (main) logic cartridge (BY2 shown)

- 4. Brake relief cartridge (R2BR shown)
- 5. Brake logic cartridge (BR2 shown)
- 6. Orifice



Figure 28A

1. Clean valve block to prevent contamination when valve cartridge is removed.
2. Remove cartridge valve:
 - A. Remove nut from solenoid.
 - B. Remove solenoid coil and o-ring at each end of solenoid coil.
 - C. Use a deep socket to remove cartridge valve.
NOTE: Use care when handling valve cartridges, because slight bending or distortion of stem tube can cause binding and malfunction.
3. Visually inspect port in block for damage to sealing areas, damaged threads or contamination.
4. Visually inspect cartridge for damaged seals and contamination.
 - A. O-rings and backup rings must be arranged properly on the valve for proper operation and sealing. Replace any damaged seals.

B. Contamination may cause valves to stick or hang up. Contamination can become lodged in small valve orifices or seal areas on poppet type valves causing malfunction.

C. If cartridge valve seals appear pitted or damaged, the hydraulic system may be overheating or there may be water in the system.

5. Clean and check for proper valve operation:

A. Use clean mineral spirits to clean cartridge valve. Submerge the valve in clean mineral spirits and use a probe to push the internal spool in and out 20 to 30 times to flush out contamination. Mineral spirits does not affect the o-ring material. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves.

Cartridge Installation

1. Lubricate all o-rings with clean hydraulic oil.
2. Carefully thread cartridge into the port by hand. Valve cartridge should go in easily without binding.
3. Use a torque wrench and deep socket to tighten cartridge valves to a torque of 35 ft-lb. Excessive torque may cause the spool to bind and malfunction.

NOTE: Use care when handling solenoid valve cartridges because slight bending or distortion of stem tube can cause binding and malfunction.
4. Install solenoid coil. Make sure there is an o-ring at each end of the coil. Apply "Loctite 242" or equivalent to threads of stem tube before installing nut. Tighten nut to a torque of 15 in-lb.
5. If problem still exists, remove valve and clean again or replace valve.

PTO Solenoid Valve Replacement

1. Disconnect electrical connector from affected solenoid valve (Fig. 28).
2. Remove nut from solenoid (Fig. 27).
3. Remove cover.
4. Remove solenoid coil.
5. Remove solenoid spool.
6. Inspect valve for sticking, damage or wear and replace if necessary.

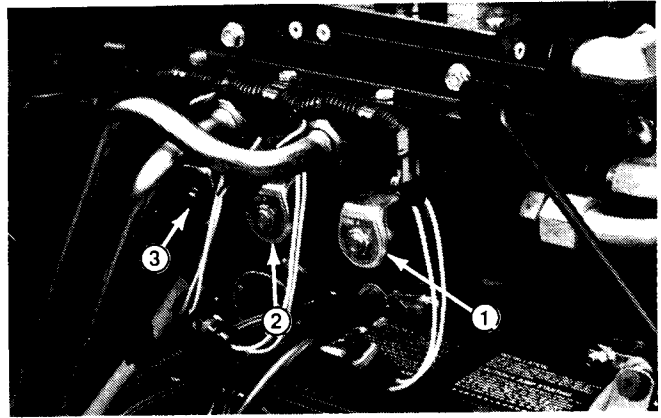


Figure 28

1. Front deck solenoid valve (port SV1)
2. Left wing deck solenoid valve (port SV3)
3. Right wing deck solenoid valve (port SV2)

7. Reverse steps 1 - 5 to install solenoid valve. It is recommended to replace seals when reinstalling a used solenoid valve. Install seals as shown (Fig. 29).

NOTE: See Testing section of Chapter 5 - Electrical System for information on testing solenoid coil.

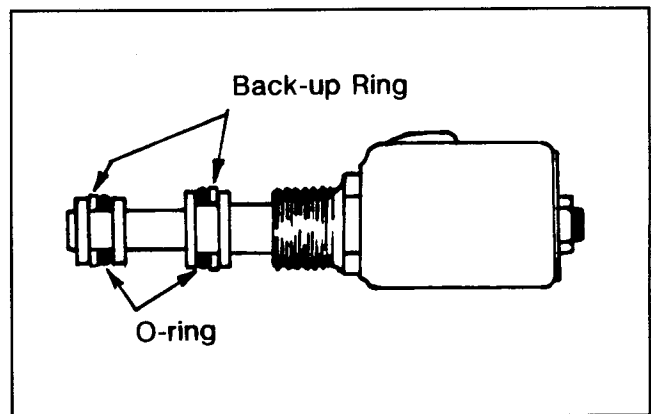


Figure 29

Cartridge Replacement

1. Remove affected cartridge (Fig. 30). Inspect cartridge for sticking, plugged orifice, damage or wear and replace if necessary. It is recommended to replace seals when reinstalling a used cartridge.
2. Check relief pressure after installing new bypass (main) relief cartridges (port R_BY). (See TEST NO. 6 - Deck Drive Circuit Working Pressure and Relief Pressure in Testing section of this chapter.).

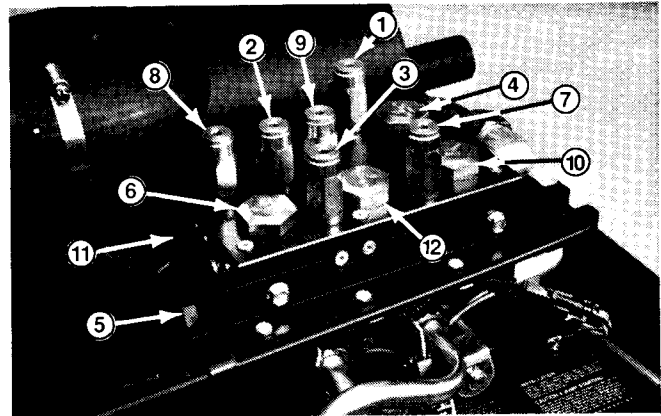


Figure 30

1. Front deck relief valve (port R1BY)
2. Right wing deck relief valve (port R2BY)
3. Left wing deck relief valve (port R3BY)
4. Front deck bypass (main) logic cartridge (port BY1)
5. Right deck bypass (main) logic cartridge (port BY2)
6. Left deck bypass (main) logic cartridge (port BY3)
7. Front deck brake relief valve (port R1BR)
8. Right wing deck brake relief valve (port R2BR)
9. Left wing deck brake relief valve (port R3BR)
10. Front deck brake logic cartridge (port BR1)
11. Right wing deck brake logic cartridge (port BR2)
12. Left wing deck brake logic cartridge (port BR3)

PTO Pump Removal and Installation

1. Park machine on a level surface, engage parking brake, raise or lower wing decks completely, lower front deck to ground and turn engine OFF.

2. Open hood latches, raise hood and secure it in raised position with prop rod. Open side panel latches and remove side panels.

3. Remove two (2) capscrews and pull battery tray out (Fig. 31). Disconnect cables from batteries.

4. Remove six (6) capscrews and remove rear panel.

5. Push battery tray in approximately half way and align tangs on battery tray with notches on rail, then lift up rear of battery tray and pull completely out of machine.

6. Drain hydraulic oil from reservoir. Disconnect hydraulic lines from pump. Put caps or plugs on disconnected lines and fittings to prevent contamination.

NOTE: If hydraulic reservoir is not drained, a large amount of hydraulic oil will drain from reservoir when pump suction line is removed.

7. Remove four (4) capscrews from pump and pull pump shaft out of drive coupling to remove pump.

8. Reverse steps 2 - 7 to install PTO hydraulic pump.

IMPORTANT: Be careful when connecting high pressure hoses to special fittings on pump to prevent excessive stress on fittings and possible hydraulic oil leakage. Hold fitting with a wrench while tightening hose with another wrench .

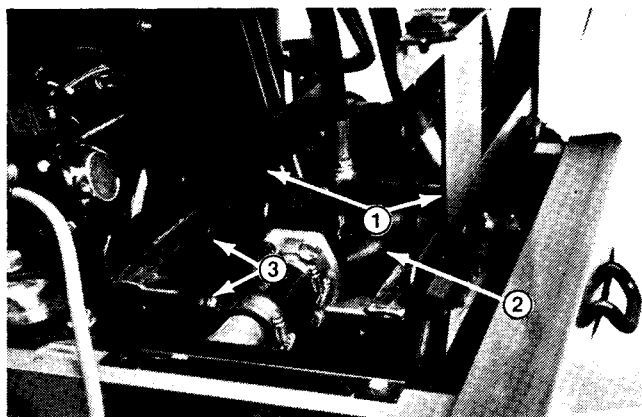


Figure 31

1. Notch on battery tray rail (2)

2. PTO hydraulic pump

3. Capscrew (4)

After Pump Repair or Replacement

1. Check oil level in hydraulic reservoir and add correct oil if necessary.

2. Disconnect fuel stop solenoid electrical connector (Fig. 26) to prevent fuel delivery to engine cylinders.

3. Turn ignition key switch to engage starter for 10 seconds to prime pump. Repeat this procedure five (5) times for a total cranking time of 60 seconds.

4. Connect injection pump fuel stop solenoid electrical connector.

5. Engage parking brake. Start engine and let idle at low speed for minimum of 30 seconds.

6. Check for hydraulic oil leaks. Shut off engine and correct leaks if necessary. Check oil level in hydraulic reservoir and add correct oil if necessary.

Deck Motor Removal and Installation

Removing Deck Motor

1. Park machine on a level surface, engage parking brake, lower wing decks and front deck to ground, then turn engine OFF.

2. Remove deck covers and loosen belt tension. (See Belt Tension Adjustment in Chapter 7 - Cutting Units).

3. Disconnect hydraulic lines from motor. Put caps or plugs on hydraulic lines and motor ports.

4. Remove flange head screws separate plate and motor assembly from deck. To separate from wing deck, rotate plate end toward traction unit (Fig.). Tip plate, motor and pulley assembly on its side and remove from deck.

5. Remove set screws from taper lock bushing (Fig.). Install one (1) setscrew into hole that is threaded on side of taper lock. Tighten setscrew until taper lock is loose from inside of pulley hub.

6. Slide pulley and taper lock off motor output shaft. Remove key that positions pulley on shaft. Remove setscrew from side of taper lock.

7. Remove two flange lock nuts and carriage bolts to remove motor from plate.

Installing Deck Motor

1. Install motor by securing to plate with carriage bolts and flange lock nuts.

2. Put pulley on work bench, hub side up. Slide taper lock, small end first, into pulley hub.

3. Insert key into keyway of motor shaft. Slide pulley, with taper lock, onto motor shaft while aligning key and keyway. Large hub on pulley must face away from motor.

4. Rotate pulley to get non-threaded holes in taper lock to line up with two threaded holes on hub of pulley. Start threading setscrews into two holes and tighten them alternately and evenly until both setscrews are tight.

5. Using a brass drift pin or sleeve and hammer, hit taper lock firmly. Tighten setscrews to 55 in-lb. Continue to hit taper lock and tighten setscrews until the 55 in-lb of torque will not turn the setscrews.

6. Fill recessed socket head in each setscrew, and other taper lock holes with grease to prevent dirt from packing into holes.

7. Reverse steps 2 - 4 under Removing Deck Motor to install motor plate and pulley assembly.

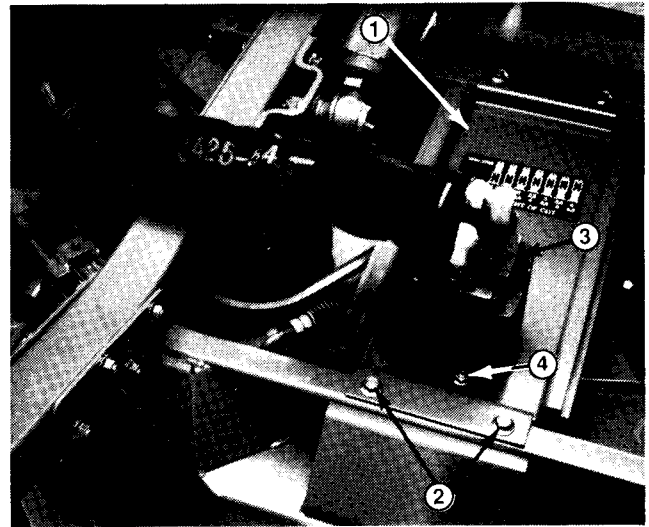


Figure 32
(Front Deck)

- | | |
|-------------------------------|--|
| 1. Plate | 3. Motor |
| 2. Flange head cap screws (4) | 4. Flange head locknut & carriage bolt (2) |

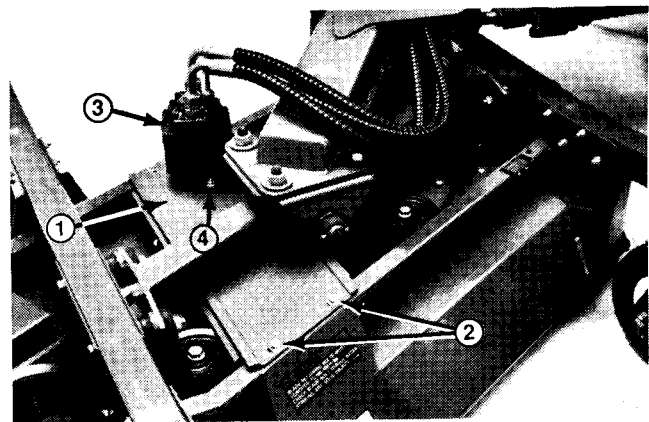


Figure 33
(Wing Deck)

- | | |
|-------------------------------|--|
| 1. Plate | 3. Motor |
| 2. Flange head cap screws (4) | 4. Flange head locknut & carriage bolt (2) |

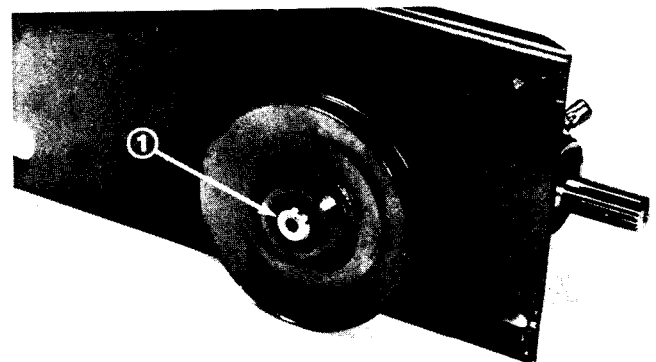


Figure 34

1. Taper lock bushing

Deck Motor Repair

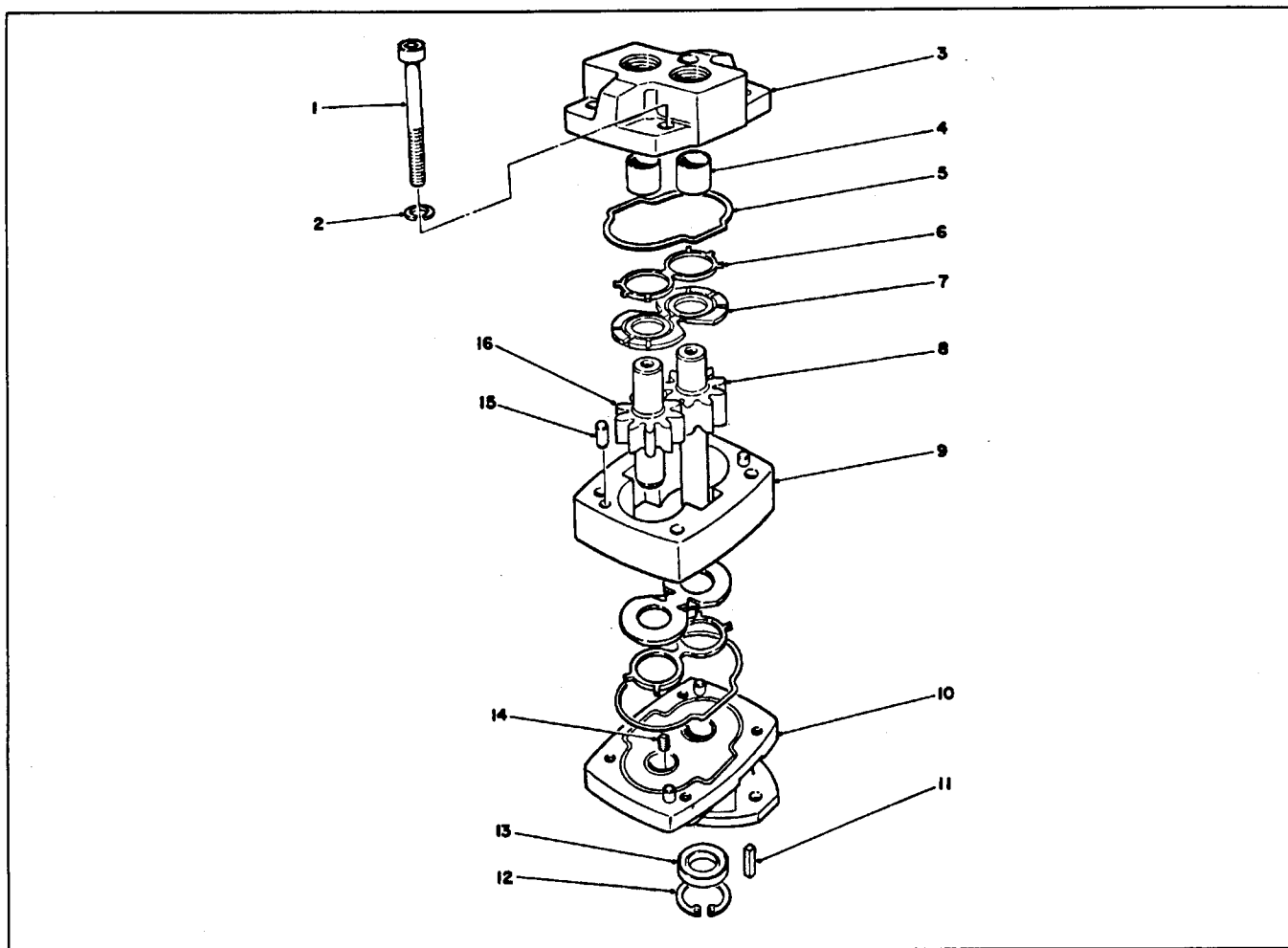


Figure 35

- 1. Capscrew
- 2. Washer
- 3. Cover
- 4. Bushing
- 5. Square seal
- 6. Load seal

- 7. Wear plate
- 8. Drive shaft/gear
- 9. Gear plate
- 10. Body
- 11. Key
- 12. Retaining ring

- 13. Shaft seal
- 14. Plug
- 15. Dowel pin
- 16. Idler gear

1. Plug ports and wash exterior with mineral spirits or solvent. Clean parts and work area.

2. Use caution when using a vise to prevent distorting or damaging parts.

3. Never pry components apart. Light tapping with a plastic hammer on mounting ears will separate body from cover (Fig. 35).

4. Inspect parts and replace all worn or damaged parts.

5. All parts must be free from burrs, scoring, nicks, etc. Lap body on a flat plate if necessary. Rub wear plates on 220/320 grit wet/dry paper if necessary. Excess scoring of plate requires installation of new plates.

6. Gears should always be replaced in sets if necessary.

7. Extreme care must be used when replacing shaft seal. It must be installed square with seal bore and with metal case to outside of motor. Be careful to prevent drive shaft keyway from cutting the new seal. Use a "bullet" type seal protector or put tape over the keyway. Apply grease to lips of seal before installing over shaft.

8. Apply grease to o-rings to retain in body and cover groove during assembly.

9. Rotate drive shaft before and after tightening bolts. Torque all bolts and capscrews evenly to avoid distortion.

10. Fill motor with hydraulic oil before connecting hydraulic fittings and lines. Break in motor slowly.

Deck Motor Repair (P/N 94-4907)

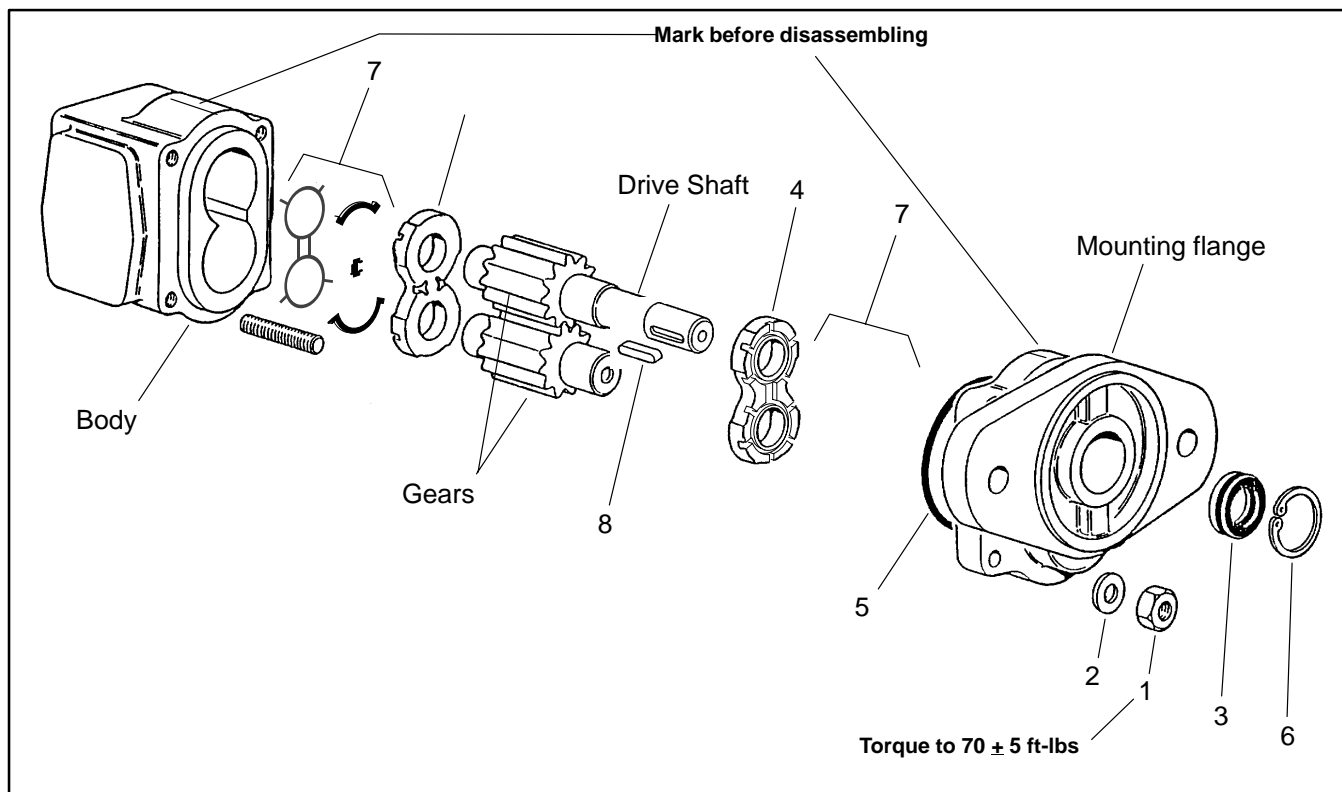


Figure 35A

- 1. Hex nut
- 2. Flat washer
- 3. Shaft seal

- 4. Load plate
- 5. O-ring seal
- 6. Retaining ring

- 7. Load seal
- 8. Square key
- * Seal Kit (Items 3, 5-8)

Disassembly

1. Use a marker or scribe to make a line across the body and mounting flange for proper reassembly (put mark along drive shaft side of body and flange as shown).
2. Remove key (8) from shaft.
3. Remove nuts (1) and washers (2).
4. Use a soft face hammer to lightly tap the mounting flange to disengage it from the body. Slide the flange off of the shaft.
5. Remove O-ring seal (5).
5. Remove retaining ring (6) and push the shaft seal (3) squarely out of the mounting flange, taking care not to damage any sealing surfaces.

NOTE: Before disassembling internal components, mark the load plates for proper reassembly. Mark on an area away from the seal location. Mark "F" for flange end and "B" for body end.

6. With the motor lying on its side, hold the driveshaft and pull it squarely out of the body bringing the load plates (4) with it.
7. Remove the load plates (4) from the gears. Remove the load seals (7) from the load plates.

Inspection and Repair

1. Wash each of the components with cleaning solvent or mineral spirits and dry with a lint free cloth or compressed air.
2. Body: Inspect the body bore cut-in where gears wipe into the body. The cut-in should be bright and polished in appearance with a depth of less than .08 mm. Replace the motor if the surface is scored, has a matt appearance or shows signs that the tip of the gears have dug in and torn away the surface material. Inspect for damage to port threads and body O-ring recesses.

Check the shaft seal recess for scoring or damage that could result in oil leakage around the outside diameter of the shaft seal.

NOTE: Replacement shaft seals can be refitted with Loctite hydraulic sealant to overcome slight damage to this area.

3. Load Plates: The side faces which are against the gears should be perfectly flat showing no signs of scoring. Typically there are bright polished areas on this surface caused by loading against the gear side faces. This is often more noticeable on the low pressure side. The load plates should be replaced if there is any general scoring, fine scoring with a dull appearance, or tearing of the surface material. Often there is an area where the tips of the opposing gears have wiped an overlap with a half moon shape. There must be no noticeable wear step; it is critical that the load plate side face is completely flat to the gear side face. The load plate bearing liners should not show any scoring or other damage. The general outside area of the load plate should not show any significant wear.

4. Gears: The gear faces should be examined for bruising or scoring. Operation with contaminated hydraulic fluid will often show scoring between the root of the gear and the journal that leaves a wear step. If a wear step can be felt, along the root diameter, by drawing a sharp pointed tool across the surface from the journal outwards toward the tip of the gear, then the gear is unserviceable and the motor should be replaced.

The gear teeth should be carefully examined for bruising or pitting.

The journal bearing surfaces should be completely free from scoring or bruising. The surface should appear highly polished and smooth to the touch.

Examine the area where the shaft seal lips run on the driveshaft, this shows up as a polished ring or rings. If a noticeable groove can be felt or there is scoring, the shaft is unserviceable and the motor should be replaced.

Reassembly

NOTE: Install new seals when reassembling the motor. Use petroleum jelly to hold seals and O-rings in place during assembly.

1. Install new load seals (7) on the load plate (4) you marked "B". Install load plate (4) into body.

2. Put body on work bench so gear openings face up.

3. Install gears into their original positions in the body. NOTE: Install gear with driveshaft into the side of the body you marked in step 1 under Disassembly.

4. Install new load seals (7) on the load plate (4) you marked "F". Install load plate into mounting flange.

5. Install new O-ring seal (6) in mounting flange.

6. Install mounting flange over drive shaft and onto the body.

7. Install washers (2) and nuts (1). Tighten nuts evenly in a crossing pattern to a torque of $70 \pm$ ft-lb.

8. Install shaft seal.

Shaft Seal Installation

1. Apply grease to seal bore in mounting flange. NOTE: If using Loctite hydraulic sealant to overcome slight damage to the seal bore area, do not apply grease.

2. Pack lips of new shaft seal (3) with high melting point grease.

3. Install Mylar sleeve from seal kit onto drive shaft, checking to make sure that the sleeve covers all sharp edges of the shaft.

4. Slide new shaft seal onto shaft down to flange housing with the exposed spring side of the seal facing the motor.

5. Press the shaft seal in until it bottoms squarely in the bore.

6. Put on protective eyewear, such as safety glasses or a face shield, then install the retaining ring (6).

Running-in

A motor which has been rebuilt with new load plates, must be run-in before it is subjected to full load conditions. Ideally this should be done on a test stand where pressure can be gradually applied. If a test stand is not available, install the motor on the machine and operate the cutting deck at low speed with no load for at least one minute. Gradually increase speed, running for one minute at a time at each speed until you reach full engine RPM. Stop the machine and check to make sure the motor is not running hotter than the others.

Wing Deck Hose Replacement (S/N 50001 & Up)

Routing of wing deck hoses through the wing arms requires accurate hose positioning or the hoses can be damaged as the wing decks are raised and lowered.

In order to reduce hose damage due to incorrect routing, a Hose Routing Kit (P/N **93-9956**) is available for previously manufactured products (S/N 80101 – 49999). The kit contains all the parts, hoses and instructions necessary to re-route the wing deck hoses external to the arms. The external routing reduces the possibility of damage due to incorrect routing. Current production will include the external hose routing.

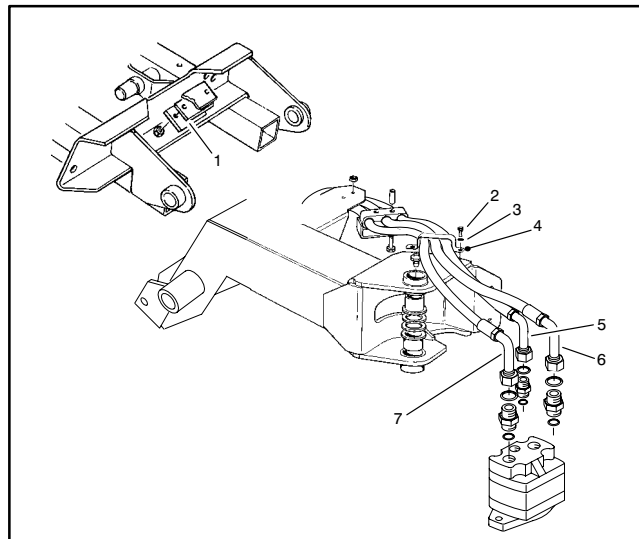


Figure 36A

Wing Deck Motor Hydraulic Hose Replacement

IMPORTANT: If deck motor hydraulic hoses are installed incorrectly the hose may rub against the lift arm and in extreme cases could be stretched tight between the traction unit and cutting unit. These conditions could cause the hose to fail.

To Get Correct Hose Position

1. Lower cutting unit to the ground. Loosen cap screws that secure hoses to hose clamps.
2. Loosen hose connections at motor until ends are free to rotate.
3. Extend protective hose covers (between hose clamp and motor) to full length. Pull hoses through until protective covers touch clamp. Tighten clamp screws to retain hoses.
4. Inspect routing of hoses through "window" in outer lift arm. If hoses make contact with lift arm in this area, pivot 90° formed end of hoses (motor end) until clearance is obtained between hoses and "window" (Fig. 36). Hoses should be approximately parallel to motor centerline.
5. Make sure that clearance remains between "window" and hoses when cutting unit is raised to transport position. If a hose tightens when deck is raised, pivot hose end toward traction unit.
6. Extend protective covers at traction unit end of hoses to protect them from wear and damage.

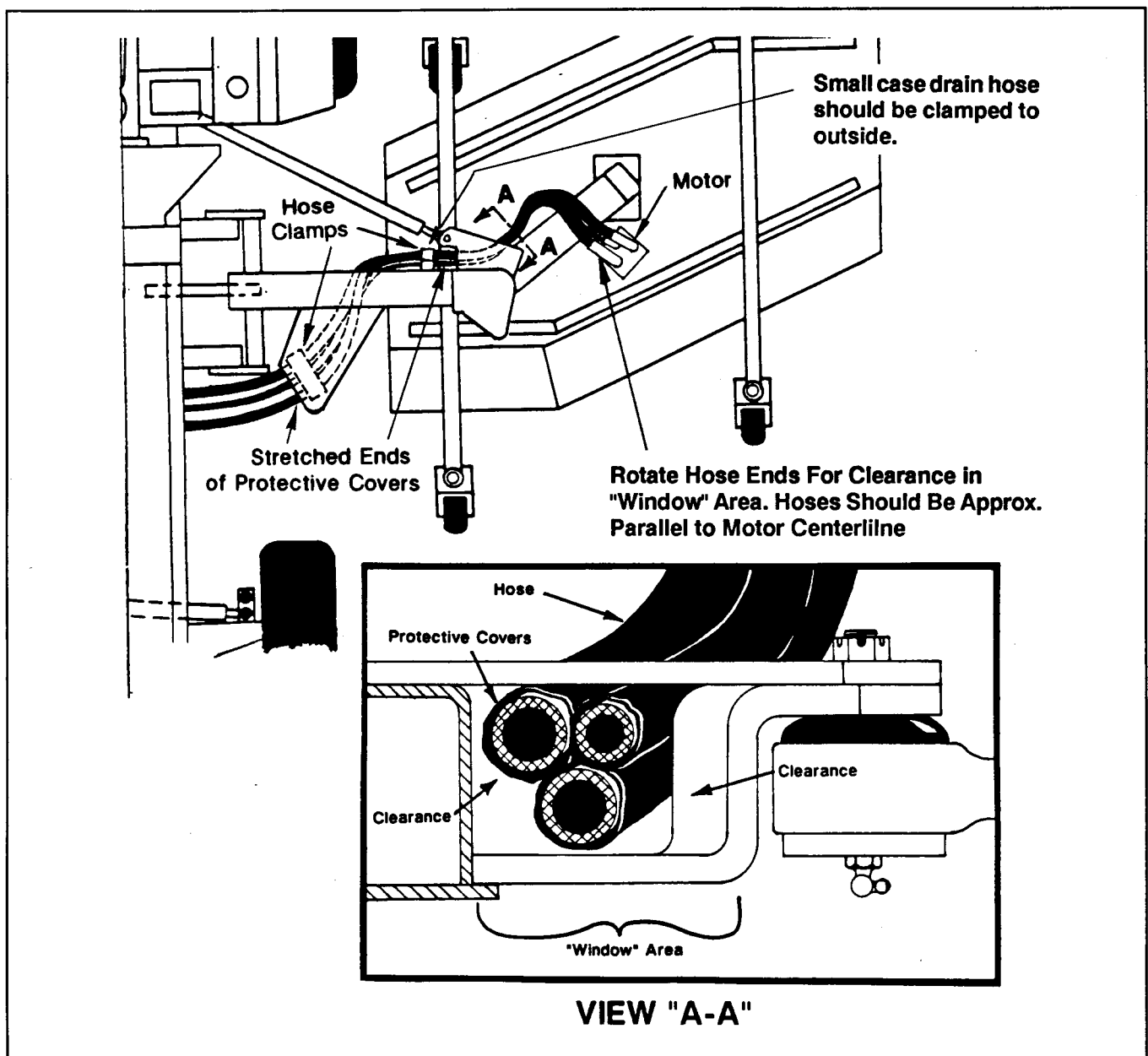


Figure 36

Auxiliary (Lift/Counterbalance) System Repairs

Float/Traction Assist Manifold Block Service

1. Park machine on a level surface, engage parking brake, raise or lower wing decks completely, lower front deck to ground and turn engine OFF.

3. Ports on valve block are marked for easy identification of components. (See Hydraulic Flow Diagrams to identify function of hydraulic lines and cartridges at each port location.)

2. Remove control housing.

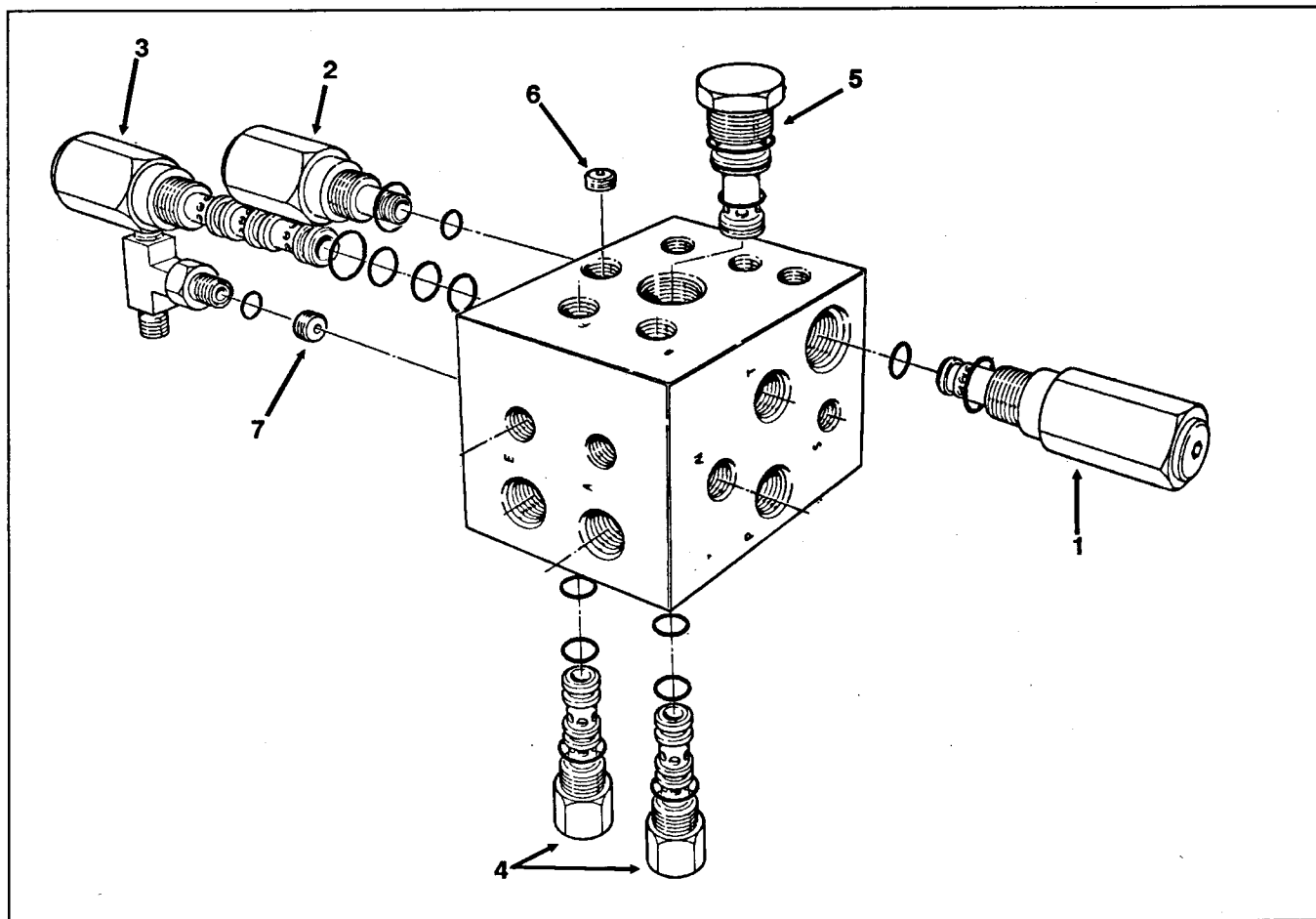


Figure 37

1. Counterbalance relief cartridge
2. "Traction Plus" relief cartridge
3. "Traction Plus" shift cartridge

4. Lift/lower shift cartridge
5. Flow control cartridge

6. Orifice (0.047)
7. Orifice (0.120)

Cartridge Replacement

1. Remove affected cartridge (Fig. 37, 38). Inspect cartridge for sticking, plugged orifice, damage or wear and replace if necessary. It is recommended to replace seals when reinstalling a used cartridge.

2. Check pressure after installing new counterbalance relief cartridge, "traction plus" relief cartridge, or "traction plus" shift cartridge. (See TEST NO. 5 - Counterbalance Pressure In Testing section of this chapter.).

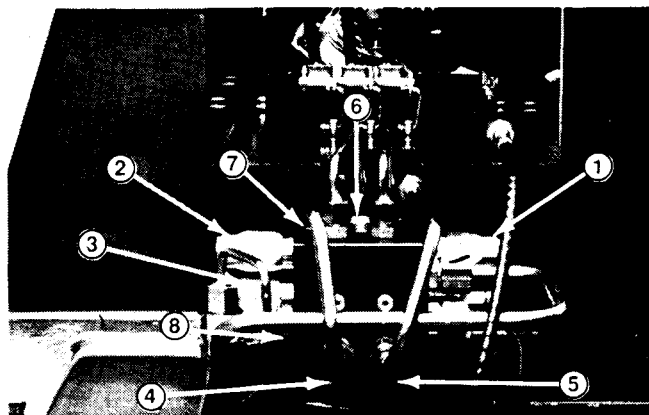


Figure 38
(Control housing removed)

1. Counterbalance relief cartridge
2. "Traction Plus" relief cartridge
3. "Traction Plus" shift cartridge
4. Lift/lower shift cartridge (right deck)
5. Lift/lower shift cartridge (left deck)
6. Flow control cartridge
7. Orifice (0.047)
8. Orifice (0.120)

Steering/Auxiliary Pump Removal and Installation

1. Park machine on a level surface, engage parking brake, raise or lower wing decks completely, lower front deck to ground and turn engine OFF.

2. Move seat forward. Remove upper and lower grill from in front of radiator. Disconnect six (6) latches and remove radiator cowl. Disconnect four (4) latches and remove lower grill support.

3. Disconnect all hydraulic lines from the steering/auxiliary pump (Fig. 39). Put caps or plugs on all open hydraulic lines to prevent contamination.

4. Remove two (2) capscrews securing steering/auxiliary pump to variable displacement pump. Pull steering auxiliary pump away from variable displacement pump and lift pump out of machine.

5. Put caps or plugs on all open ports of the pump to prevent contamination.

6. Reverse steps 2 - 5 to install the pump.

After Repair or Replacement

1. Check oil level in hydraulic reservoir and add correct oil if necessary.

2. Disconnect fuel stop solenoid electrical connector (Fig. 26) to prevent fuel delivery to engine cylinders.

3. Turn ignition key switch to engage starter for 10 seconds to prime pump. Repeat this procedure five (5) times for a total cranking time of 60 seconds.

4. Connect injection pump fuel stop solenoid electrical connector.

5. Engage parking brake. Start engine a let idle at low speed for minimum of 30 seconds. Increase engine speed and turn steering wheel fully left and right several times. Raise and lower cutting units several times.

6. Check for hydraulic oil leaks. Shut off engine and correct leaks if necessary. Check oil level in hydraulic reservoir and add correct oil if necessary.

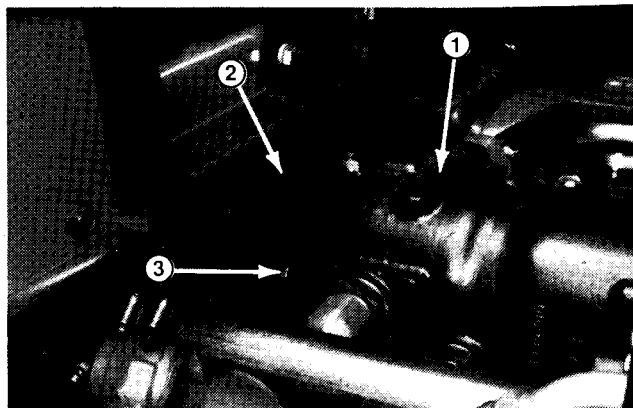


Figure 39

- 1. Variable displacement pump
- 2. Steering/auxiliary pump
- 3. Capscrews and nuts (2)

Steering /Auxiliary Pump Repair

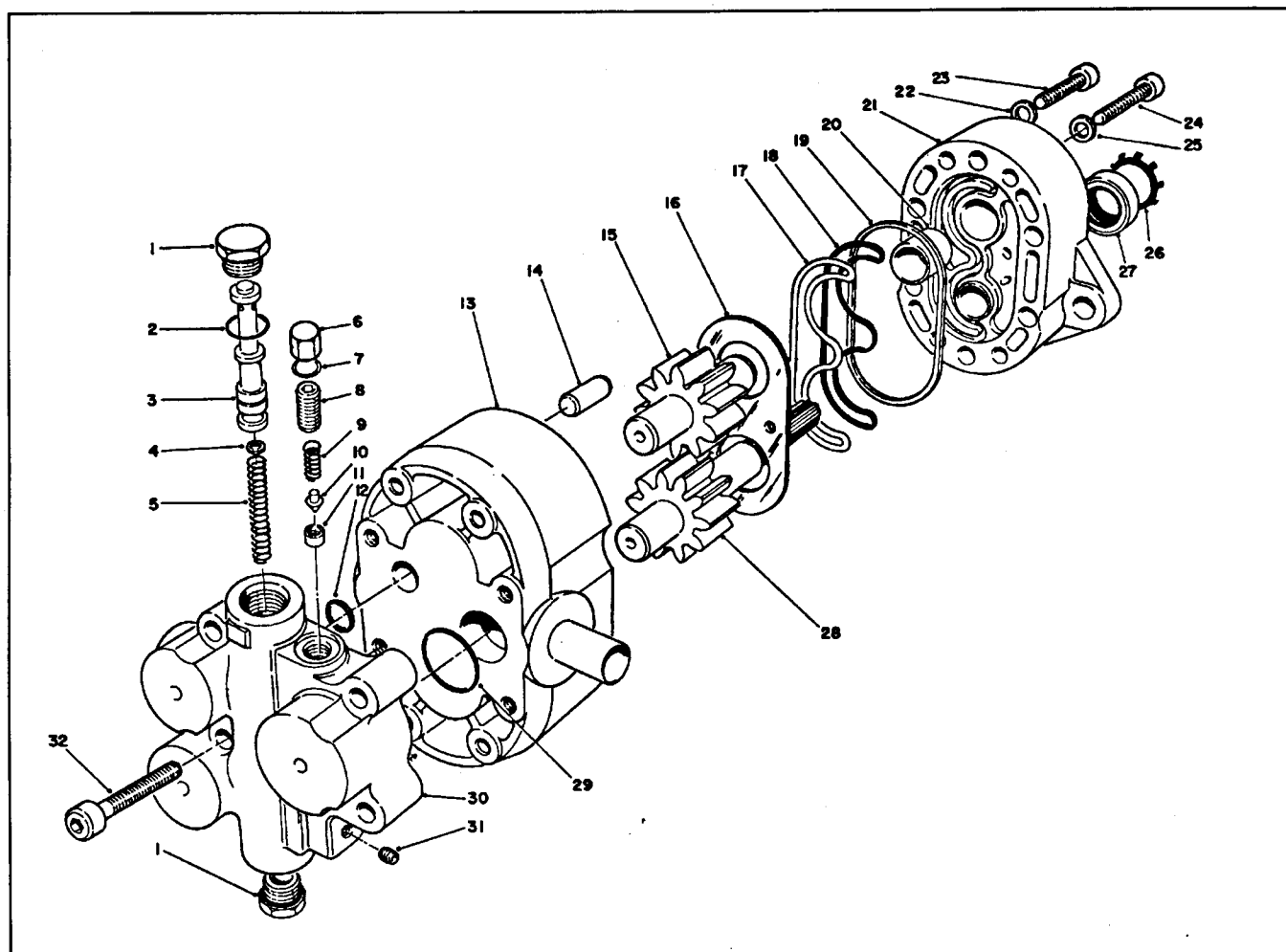


Figure 40

- 1. Plug
- 2. O-ring seal
- 3. Piston
- 4. Orifice
- 5. Spring
- 6. Cap
- 7. Gasket
- 8. Set screw
- 9. Spring
- 10. Poppet
- 11. Seat

- 12. O-ring seal
- 13. Cover assembly
- 14. Dowel pin
- 15. Idler gear / shaft
- 16. Wear plate
- 17. Load seal
- 18. Pre-load seal
- 19. Sealing ring
- 20. Sleeve bearing
- 21. Body assembly
- 22. Washer

- 23. Screw
- 24. Screw
- 25. Washer
- 26. Retaining ring
- 27. Shaft seal
- 28. Drive gear / shaft
- 29. O-ring seal
- 30. Flow divider assembly
- 31. Plug
- 32. Screw

1. Plug ports and wash exterior with mineral spirits or solvent. Clean parts and work area.

2. Use caution when using a vise to prevent distorting or damaging parts.

3. Never pry components apart. Light tapping with a plastic hammer on drive shaft will separate body from cover without burring. **IMPORTANT:** Put hand over cover assembly while tapping drive shaft to prevent dropping parts or disengaging gear mesh when separation of parts occurs.

4. All parts must be free from burrs, scores, nicks, etc.

5. Before removing gear set, apply marking dye to mating teeth to retain "timing" when reassembling.

6. Use complete pump repair kit when rebuilding pump.

7. Extreme care must be used when replacing shaft seal. It must be installed square with seal bore and with metal case to outside of pump. Great care must be taken to prevent the drive shaft spline from cutting the new seal. Use a "bullet" type sleeve or tape over the keyway and grease lips of seal before installing.

8. Lap gears. Replace as set if necessary. Put oil on the inside cover and insert the gear set, maintaining the original timing and locations.

9. Apply grease to wearplate and slip over shafts with bronze side facing gears.

10. Mating surfaces of body and cover must be clean, free of oil and dry.

11. Assemble body to cover making certain that none of the parts become displaced. Insert and hand tighten all capscrews.

12. Rotate drive shaft before tightening capscrews. Tighten capscrews to a torque of 360 to 380 in-lb.

13. Generously lubricate pump and break in slowly.

Flow Divider Cover

1. Refer to illustration to disassemble, inspect, and assemble the flow divider cover (Fig. 40).

2. Inspect parts for wear or damage. Repair as necessary.

3. Use complete repair kit when rebuilding pump and flow divider.

4. When installing flow divider cover to pump, tighten capscrews evenly to a torque of 190 to 210 in-lb.

Front Lift Cylinder Removal and Installation

1. Park machine on a level surface, engage parking brake, raise or lower wing decks completely, lower front deck to ground and turn engine OFF.

2. Clean cylinder and surrounding area thoroughly. Disconnect hydraulic lines and plug to prevent contamination from entering hydraulic system.

3. Remove nut and bolt securing front of cylinder (Fig. 41). Remove cotter pins and cylinder pin securing rear of cylinder.

4. Remove cylinder.

5. Check condition of bushings and replace if worn or damaged before installing cylinder. Reverse steps 2 - 4 to install cylinder.

6. After installation of cylinder, start engine, and raise and lower cutting unit several times. Check cylinder for leaks. Check oil level in hydraulic reservoir and add correct oil if necessary.

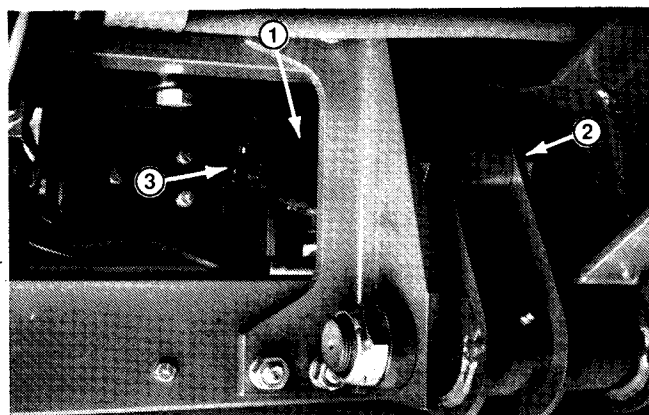


Figure 41

- 1. Front lift cylinder
- 2. Bolt and nut
- 3. Cotter pin and cylinder pin

Front Lift Cylinder Repair

IMPORTANT: To prevent damage when clamping cylinder barrel or rod in a vise, clamp only on pivot ends.

1. After removing cylinder, pump oil out of cylinder into a drain pan by SLOWLY moving rod and piston in and out of cylinder bore.

2. Plug ports and clean outside of cylinder.

3. Mount cylinder in a vise so shaft end of cylinder is tilted up slightly. Do not close vise so firmly that cylinder tube could become distorted.

4. Use a snap ring pliers to remove retaining ring (Fig. 42).

5. Grasp clevis end of shaft and use a twisting and pulling motion to carefully extract piston, shaft, and head from cylinder barrel.

6. Securely mount piston, shaft, and head into vise and remove nut.

IMPORTANT: Do not clamp vise jaws against smooth shaft surface; the shaft will become damaged.

7. Remove piston. Slide head off of shaft.

8. Remove all seals and O-rings.

9. Wash parts in a safe solvent. Dry parts with compressed air. DO NOT wipe them dry with a cloth or paper as lint and dirt may remain.

10. Carefully inspect internal surface of barrel for damage (deep scratches, out-of-round, etc.). Replace entire cylinder if barrel is damaged. Inspect head, shaft, and piston for evidence of excessive scoring, pitting, or wear. Replace any damaged parts.

11. Use a complete seal repair kit when rebuilding the cylinder. Put a coating of oil on all new seals, and O-rings. Install the new seals and O-rings.

12. Install head onto shaft.

13. Install piston onto shaft and tighten hex nut.

14. Put a coating of oil on all cylinder parts to ease assembly.

15. Slide shaft assembly into cylinder tube.

16. Install head into tube and install retaining ring

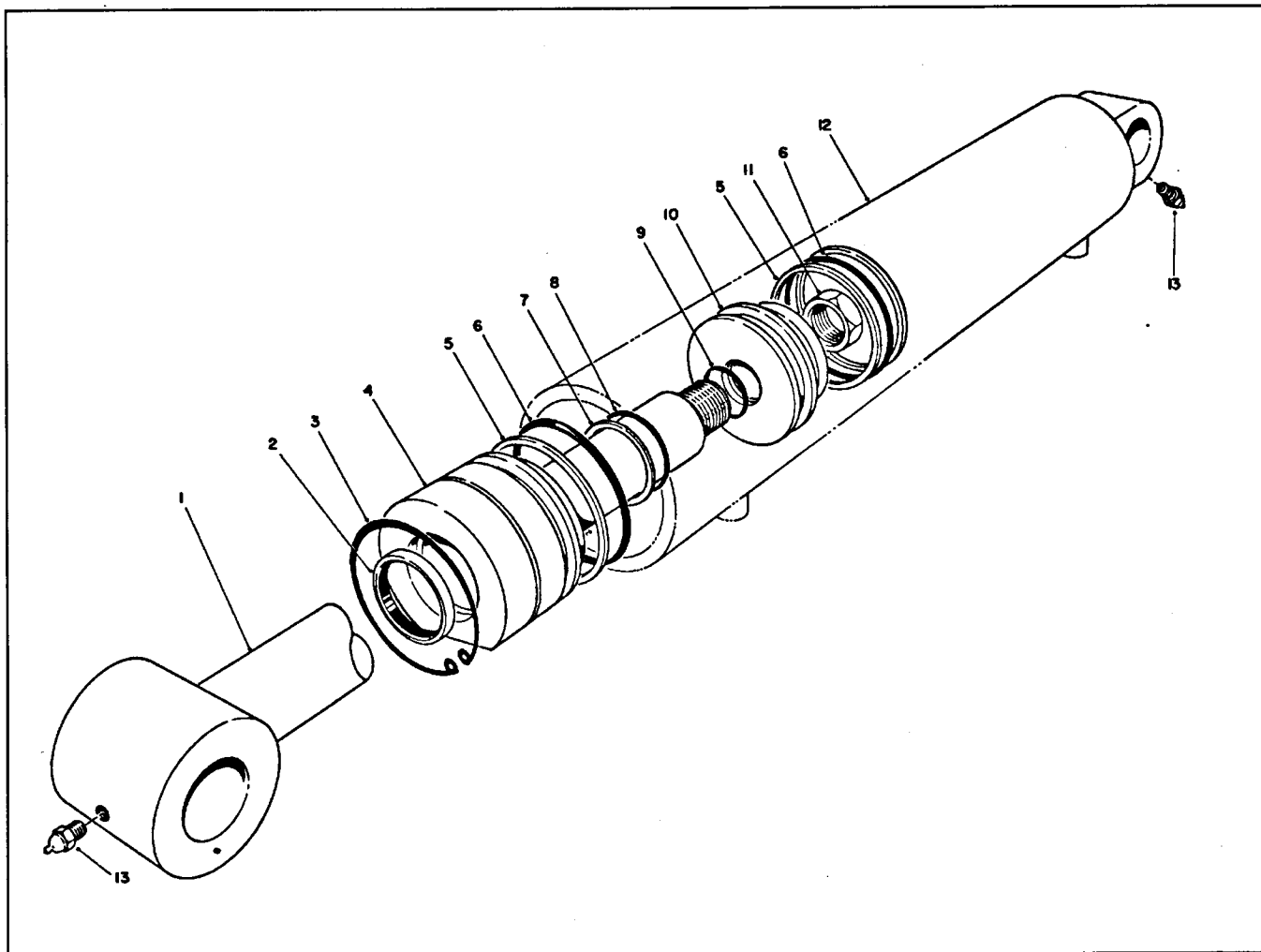


Figure 42

1. Shaft w/clevis
2. Dust seal
3. Retaining ring
4. Head

5. Back-up ring
6. O-ring seal
7. Back-up ring
8. O-ring seal

9. O-ring seal
10. Piston
11. Lock nut
12. Barrel

Wing Lift Cylinder Removal and Installation

1. Park machine on a level surface, engage parking brake, raise or lower wing decks completely, lower front deck to ground and turn engine OFF.

2. Clean cylinder and surrounding area thoroughly. Disconnect hydraulic lines and plug to prevent contamination from entering hydraulic system.

3. Remove nut and bolt securing rod end of cylinder to lift arm (Fig. 43). Remove cotter pin securing barrel end of cylinder to frame.

4. Remove cylinder.

5. Check condition of bushing in rod end of cylinder and replace if worn or damaged before installing cylinder. Reverse steps 2 - 4 to install cylinder.

6. After installation of cylinder, start engine, and raise and lower cutting unit several times. Check cylinder for leaks. Check oil level in hydraulic reservoir and add correct oil if necessary.

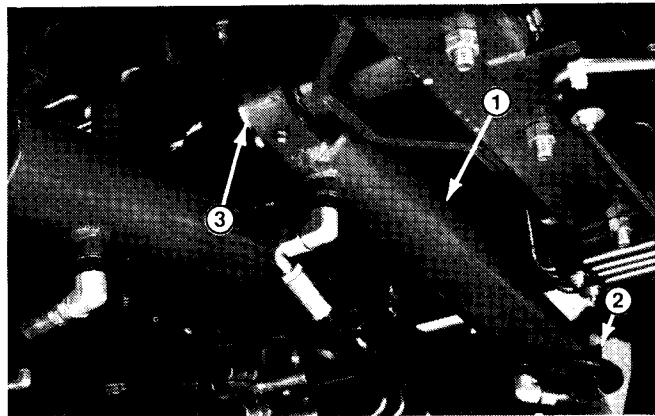


Figure 43

- 1. Wing lift cylinder
- 2. Bolt and nut
- 3. Cotter pin

Wing Lift Cylinder Repair

IMPORTANT: To prevent damage when clamping cylinder barrel or rod in a vise, clamp only on pivot ends.

1. After removing cylinder, pump oil out of cylinder into a drain pan by SLOWLY moving rod and piston in and out of cylinder bore.

2. Plug ports and clean outside of cylinder.

3. Mount cylinder in a vise so shaft end of cylinder is tilted up slightly. Do not close vise so firmly that cylinder tube could become distorted.

4. Unscrew collar (Fig. 44).

NOTE: Some cylinders may be of a different design and have a large retaining ring securing the head instead of a threaded collar. Use a snap ring pliers to remove retaining ring. See the parts catalog for identification of parts. The two different cylinders are interchangeable but internal parts are different. Both cylinders use the same seal repair kit.

5. Grasp clevis end of shaft and use a twisting and pulling motion to carefully extract piston, shaft, and head from cylinder barrel.

6. Securely mount piston, shaft, and head into vise and remove nut.

IMPORTANT: Do not clamp vise jaws against smooth shaft surface; the shaft will become damaged.

7. Remove piston. Slide cushion and head off of shaft.

8. Remove all seals and O-rings.

9. Wash metal parts in a safe solvent. Dry parts with compressed air. DO NOT wipe them dry with a cloth or paper as lint and dirt may remain.

10. Carefully inspect internal surface of barrel for damage (deep scratches, out-of-round, etc.). Replace entire cylinder if barrel is damaged. Inspect head, shaft, and piston for evidence of excessive scoring, pitting, or wear. Replace any damaged parts.

11. Use a complete seal repair kit when rebuilding the cylinder. Put a coating of oil on all new seals, and O-rings. Install the new seals and O-rings.

12. Install head and cushion onto shaft.

13. Install piston with o-ring onto shaft and tighten hex nut.

14. Put a coating of oil on all cylinder parts to ease assembly.

15. Slide shaft assembly into cylinder tube.

16. Install head into tube and install collar (or retaining ring).

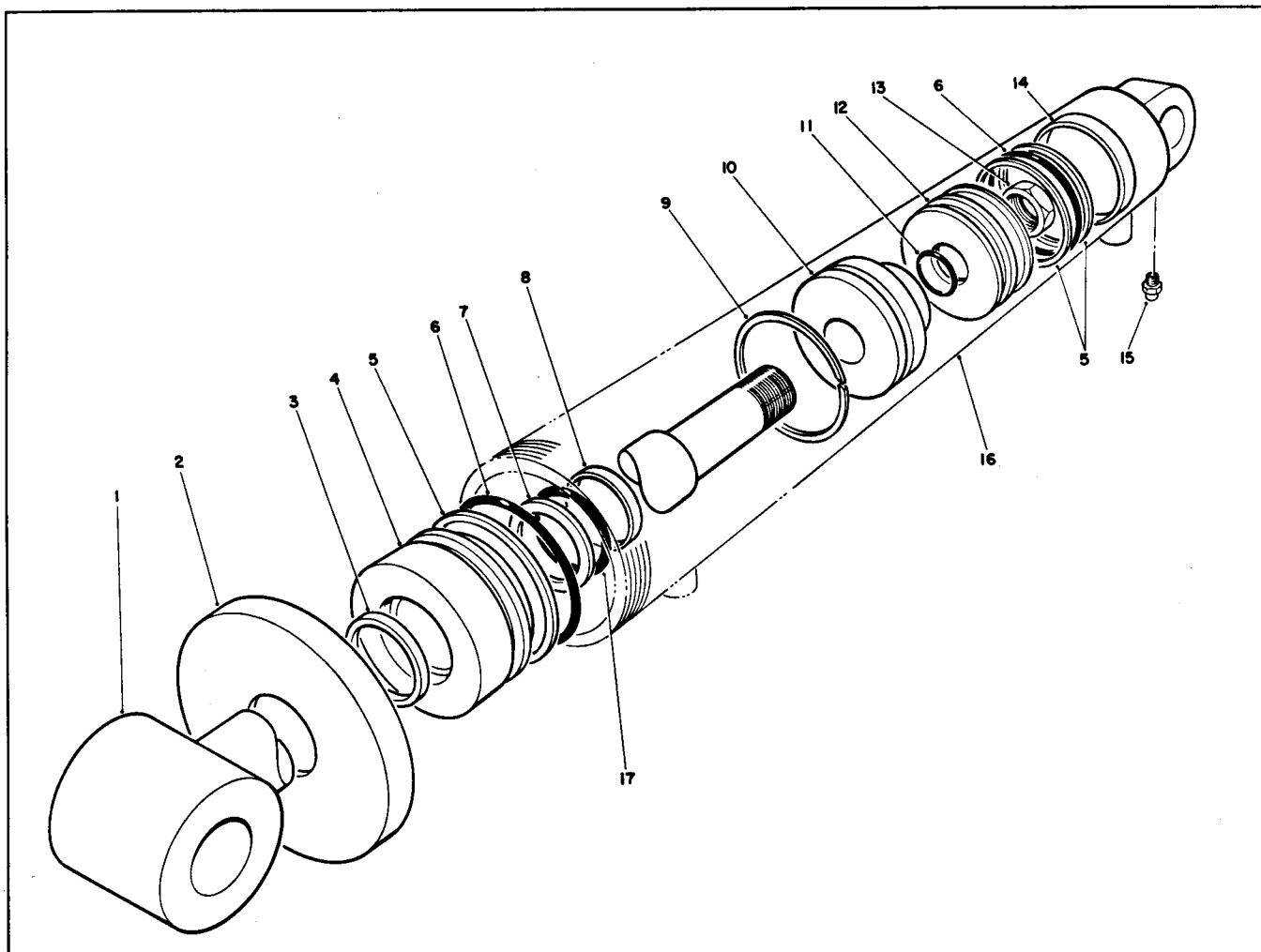


Figure 44

- 1. Shaft w/clevis
- 2. Collar
- 3. Dust seal
- 4. Head
- 5. Back-up ring
- 6. O-ring seal

- 7. Back-up ring
- 8. Wear ring
- 9. Steel ring
- 10. Cushion
- 11. O-ring seal
- 12. Piston

- 13. Locknut
- 14. Wear ring
- 15. Grease fitting
- 16. Barrel w/clevis
- 17. O-ring seal

Lift Control Valve Removal and Installation

1. Park machine on a level surface, engage parking brake, raise or lower wing decks completely, lower front deck to ground and turn engine OFF.
2. Remove control housing.
3. Thoroughly clean valve and surrounding area.
3. Mark hydraulic lines for ease in identification during reassembly.
4. Remove hydraulic lines. Cap open ends of lines or fittings to prevent contamination of hydraulic system.
5. Remove cotter pins and disconnect control lever linkage from valve.
6. Remove two (2) capscrews and nuts securing valve to bracket and remove valve.
7. Reverse steps 2 - 6 to install valve.

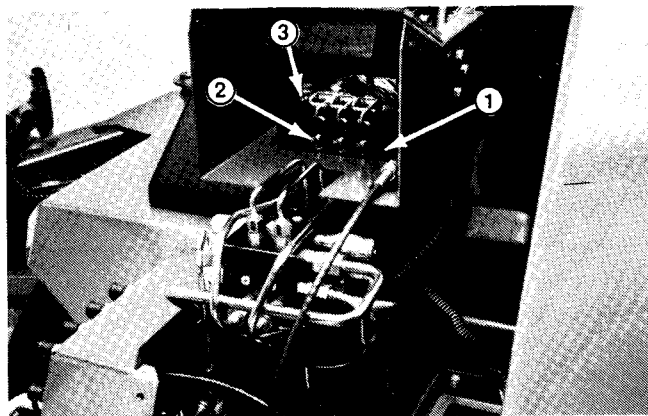


Figure 45
(Control housing removed)

- 1. Lift control valve
- 2. Cotter pin and control linkage (3)
- 3. Valve bracket

Lift Control Valve Repair

1. Plug all ports and clean outside of valve.
2. Remove spool caps (Fig. 46, Item 30). Do not remove retaining rings from spools.
3. Remove spools (Item 13) from valve body (Item 8).
NOTE: Spools and spool bores are a matched set. Be sure each spool is identified with the correct spool bore in body.
4. Remove bushings (Item 25) and o-rings (Item 12) from spools.
5. Remove lockout plugs (Item 11) and port adapter plugs (Item 32) from valve body.
6. Remove plungers (Item 31, 37). IMPORTANT: Check location and position of plungers when removing from body to assure proper assembly.
7. Remove relief valve plug (Item 16), shims (Items 18, 19, 20), spring (Item 21) and poppet (Item 22) from body.
NOTE: Do not remove poppet seat (Item 23). Seat has been set to a predetermined depth and locked in place.
8. Remove wiper seals (Item 24) and o-rings (Item 12) from body spool bores.
9. Remove plug (Item 6).
10. Remove detent plunger plug (Item 1), detent spring (Item 3) and detent plunger (Item 4). Remove discs (Item 2) from plug.
11. Remove all o-rings and back-up washers from all plugs and seats.
12. Inspect all parts for nicks, burrs, roughness or excessive wear or breakage. If spools have excessive wear, the valve is non-serviceable as the spools and spool bores are matched and damaged spools cannot be replaced.
13. Thoroughly clean and dry all parts. Metal parts should be lightly oiled before assembly. NOTE: All o-rings, back-up washers and nylon poppets should be replaced as new items.
14. Put new o-rings in proper grooves in spool bores.
15. Install relief valve components and new o-ring on plug.
16. Install plungers (Items 31 and 37). NOTE: Check location and positioning of plungers during installation.
17. Install seats (Item 35), poppets (Item 34), springs (Item 33) and port adapter plugs (Item 32) into valve body.

18. Install plugs (Item 6) with new o-rings.

19. Install detent plunger (Item 4), detent spring (Item 3), disc, and detent plunger plug (Item 1) with new o-ring and tighten to a torque of 20 - 30 in-lb.

20. Slide bushings (tem 25) over spools, slide new o-ring (Item 12) over spool and position next to bushing. Dip

spools in oil and install spool assemblies in proper location.

21. Install spool caps (Item 30) into proper location in valve body and tighten to a torque of 20 - 25 ft-lb.

22. Install lockout plugs (Item 11) with new backup washers and o-rings.

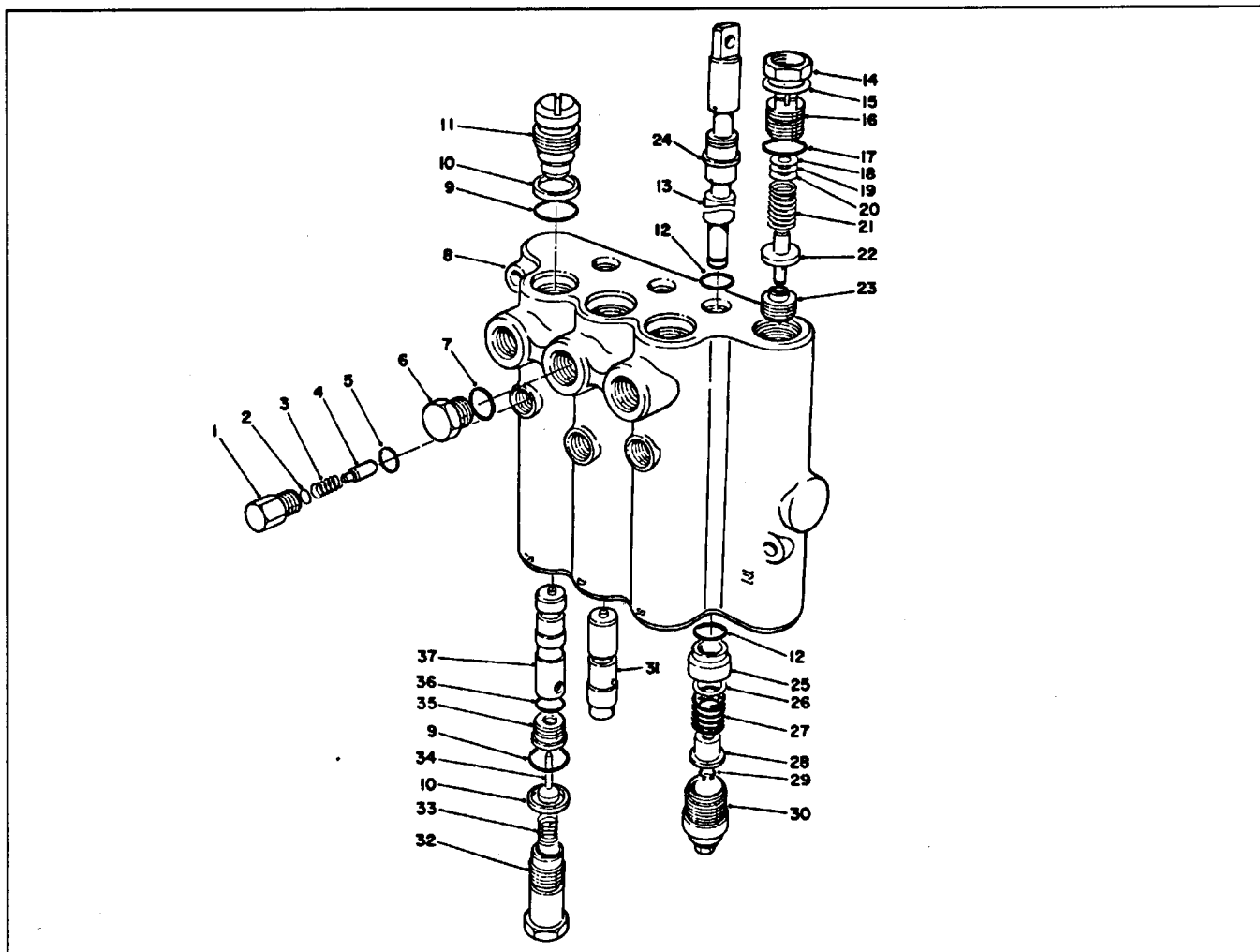


Figure 46

- 1. Detent plug
- 2. Disc
- 3. Detent spring
- 4. Detent plunger
- 5. O-ring
- 6. Plug
- 7. O-ring
- 8. Body
- 9. O-ring
- 10. Back-up washer
- 11. Lockout plug
- 12. O-ring
- 13. Spool

- 14. Locknut
- 15. Washer
- 16. Relief plug
- 17. O-ring
- 18. Washer
- 19. Washer
- 20. Washer
- 21. Spring
- 22. Poppet
- 23. Seat
- 24. Wiper seal
- 25. Bushing
- 16. Washer

- 27. Spring
- 28. Spacer
- 29. Retaining ring
- 30. Spool cap
- 31. Plunger
- 32. Port adapter plug
- 33. Spring
- 34. Poppet
- 35. Seat
- 36. O-ring
- 37. Plunger

Steering System Repairs

Steering Cylinder Removal and Installation

1. Park machine on a level surface, engage parking brake, raise or lower wing decks completely, lower front deck to ground and turn engine OFF.
2. Clean cylinder and surrounding area thoroughly. Disconnect hydraulic lines and plug to prevent contamination from entering hydraulic system.
3. Remove cotter keys from castle nut on each end of cylinder (Fig. 47).
4. Remove castle nuts and remove cylinder.
5. Reverse steps 2 - 4 to install cylinder.
6. After installation of cylinder, start engine and turn steering wheel fully left and right several times. Check cylinder for leaks. Check oil level in hydraulic reservoir and add correct oil if necessary.

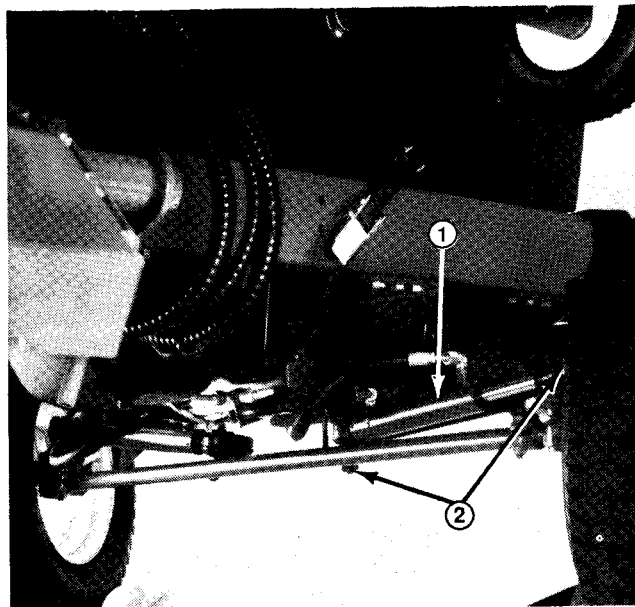


Figure 47

1. Steering cylinder
2. Cotter pin and castle nut

Ball Joint Adjustment

Ball joint (Fig. 48, Item 2) must be adjusted on cylinder shaft so steering arms hit stops on rear axle in either direction. Toe-in must be adjusted first. (See Steering Cylinder Adjustment in the Adjustments section of Chapter 6 - Wheels, Brakes and Steering.)

Steering Cylinder Repair

IMPORTANT: To prevent damage when clamping cylinder barrel or rod in a vise, clamp only on pivot ends.

1. After removing cylinder, pump oil out of cylinder into a drain pan by SLOWLY moving rod and piston in and out of cylinder bore.
2. Plug ports and clean outside of cylinder.
3. Mount cylinder in a vise so piston rod end of cylinder is tilted up slightly. Do not close vise so firmly that cylinder tube could become distorted.
4. Use a snap ring pliers to remove retaining ring (Fig. 48).
5. Grasp clevis end of piston rod and use a twisting and pulling motion to carefully extract piston, piston rod, and head from cylinder barrel.
6. Securely mount piston, piston rod, and head into vise and remove nut.

IMPORTANT: Do not clamp vise jaws against smooth piston rod surface; the piston rod will become damaged.

7. Remove piston. Slide head off of piston rod.
8. Remove all seals and O-rings.
9. Wash parts in a safe solvent. Dry parts with compressed air. DO NOT wipe them dry with a cloth or paper as lint and dirt may remain.
10. Carefully inspect internal surface of barrel for damage (deep scratches, out-of-round, etc.). Replace entire cylinder if barrel is damaged. Inspect head, piston rod, and piston for evidence of excessive scoring, pitting, or wear. Replace any damaged parts.
11. Use a complete repair kit when rebuilding the cylinder. Put a coating of oil on all new seals, and O-rings. Install the new seals and O-rings.

12. Install head onto piston rod.
13. Install piston onto piston rod with o-ring seal (Item 10) and tighten hex nut.
14. Put a coating of oil on all cylinder parts to ease assembly.
15. Slide piston rod assembly into cylinder tube.
16. Install head into tube and install retaining ring.

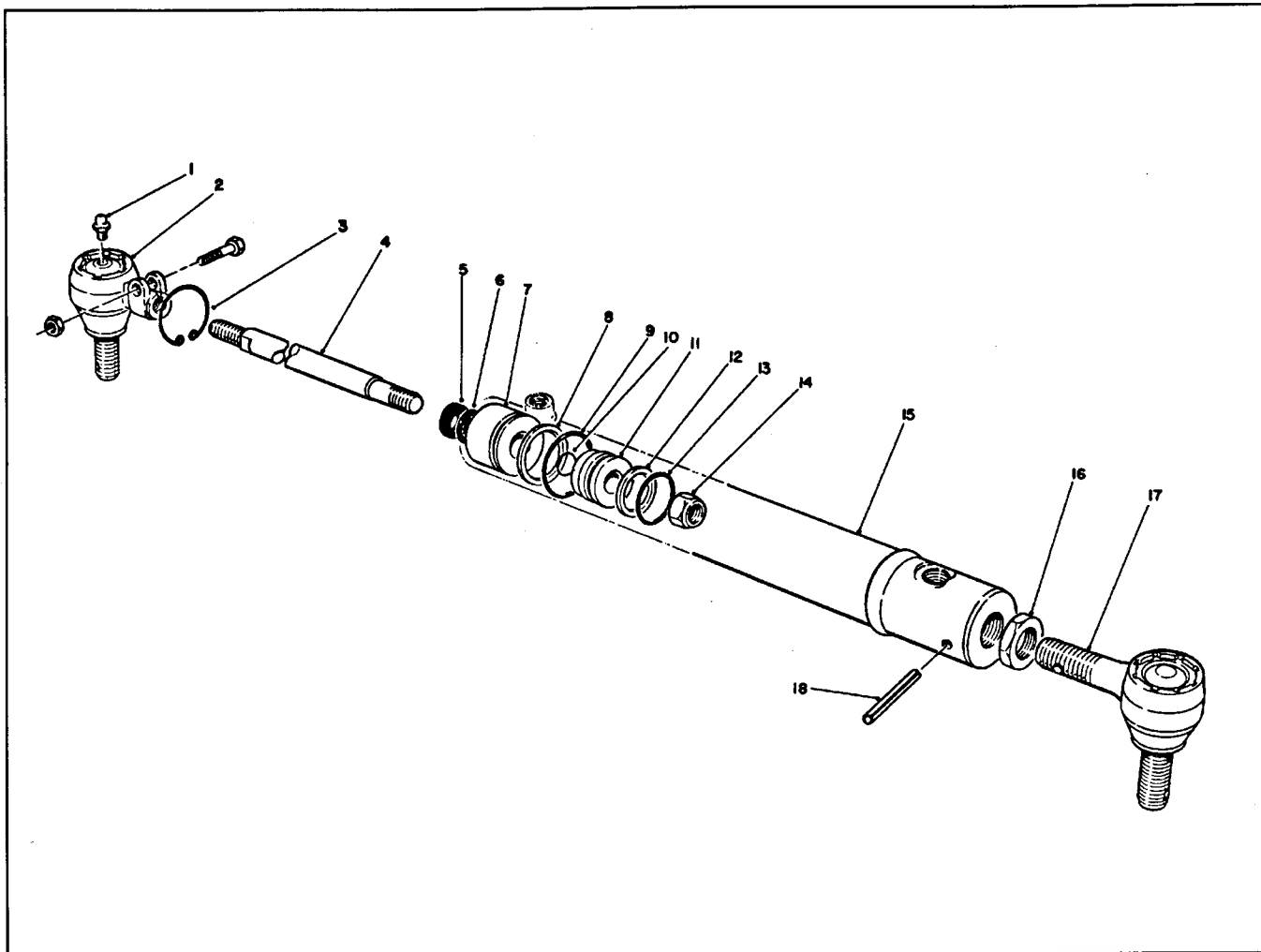


Figure 48

- 1. Grease fitting
- 2. Ball joint
- 3. Retaining ring
- 4. Piston rod
- 5. Rod wiper
- 6. U-cup seal

- 7. Head
- 8. Back-up ring
- 9. O-ring seal
- 10. O-ring seal
- 11. Piston
- 12. Piston ring

- 13. O-ring seal
- 14. Locknut
- 15. Barrel
- 16. Jam nut
- 17. Ball joint
- 18. Roll pin

Steering Control Unit Removal and Installation

1. Park machine on a level surface, engage parking brake, raise or lower wing decks completely, lower front deck to ground and turn engine OFF.

2. Remove steering tower cover.

3. Thoroughly clean steering control unit and surrounding area.

3. Mark hydraulic lines for ease in identification during reassembly.

4. Remove hydraulic lines. Cap open ends of lines or fittings to prevent contamination of hydraulic system.

5. Remove four (4) capscrews and remove steering control unit from bracket.

6. Reverse steps 2 - 5 to install steering control unit.

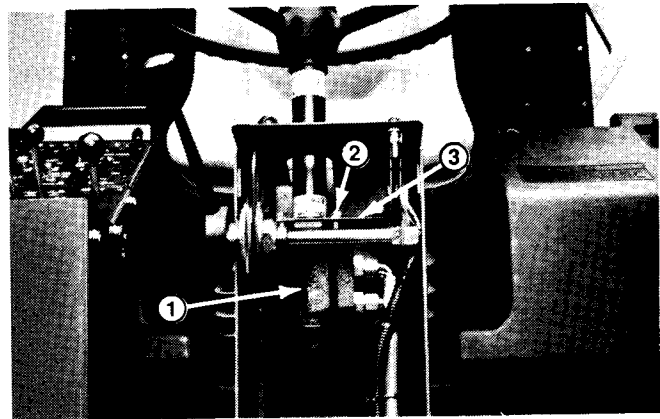


Figure 49
(Steering tower cover removed)

- 1. Steering control unit
- 2. Capscrew and lock washer (4)
- 3. Steering gear bracket

Hydraulic Reservoir and Filter

Flushing The Hydraulic System

IMPORTANT: Drain and refill reservoir, change oil filter and flush hydraulic system if component failure was severe or system is contaminated (oil appears milky or black or contains metal particles).

1. Put drain pan under reservoir. Remove drain plug and drain cap, one at a time, and let oil drain into pan (Fig. 52). Inspect o-rings on plug and cap, and replace, if damaged. Install drain plug and cap.

2. Inspect and clean reservoir. (See Inspecting Reservoir Parts in this section of the book.)

3. Put drain pan under filter and remove filter (Fig. 51). Coat o-ring of replacement filter with clean hydraulic oil. Install filter and tighten by hand until filter element is firmly seated against filter head.

4. With machine on a level surface, fill reservoir with hydraulic oil until oil level is midway up in sight glass (Fig. 50). Install fill cap.

5. Disconnect fuel stop solenoid electrical connector to prevent fuel delivery to engine cylinders (Fig. 26).

6. Turn ignition key switch to engage starter for 10 seconds. Repeat this procedure five (5) times for a total cranking time of 60 seconds.

7. Connect injection pump fuel stop solenoid electrical connector.

8. Engage parking brake. Start engine and let idle at low speed for minimum of two (2) minutes.

9. Increase engine speed to high idle for minimum of one (1) minute under no load.

10. Raise and lower cutting units several times.

11. Turn steering wheel fully left and right several times.

12. Engage cutting units and run under no load for five (5) minutes.

13. Disengage parking brake and operate machine in forward and reverse.

14. Shut off engine and check for hydraulic oil leaks. Check oil level in hydraulic reservoir and add correct oil if necessary.

15. Replace hydraulic filter again after first 10 - 15 hours of operation, or sooner if hydraulic filter warning light comes on.

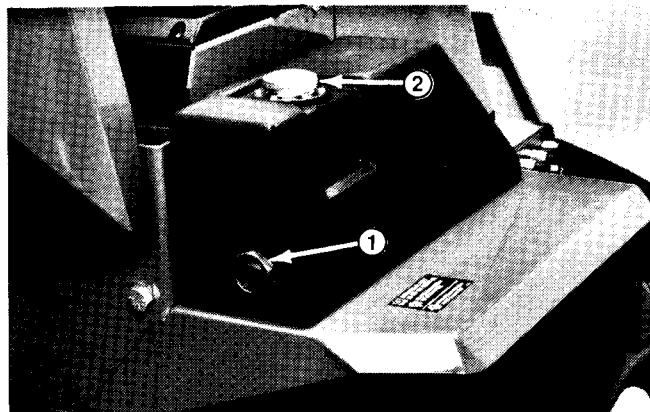


Figure 50

- 1. Hydraulic oil level sight glass
- 2. Reservoir fill cap

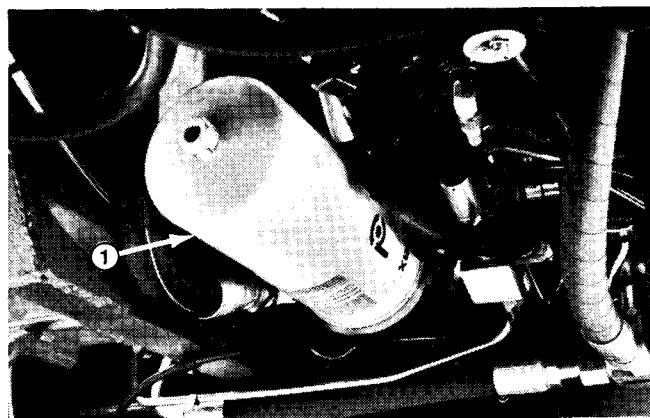


Figure 51

- 1. Hydraulic oil filter

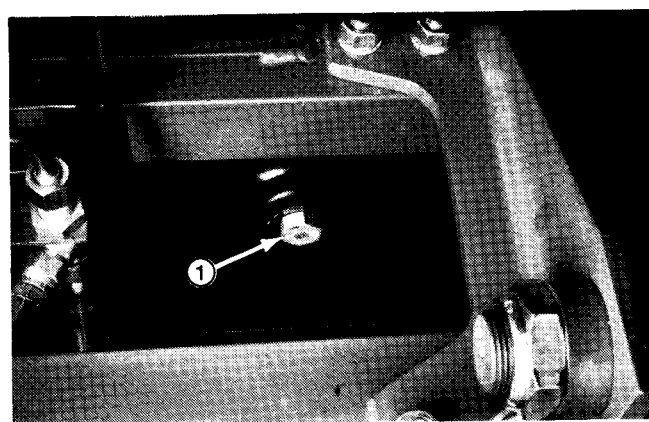


Figure 52

- 1. Drain plug

Inspecting Reservoir Parts

1. Clean filler screen, suction screen and reservoir with clean solvent (Fig. 54).
2. Inspect reservoir for leaks, cracks or other damage.
3. Replace hoses and fittings if worn or leaking.
4. Replace breather with new part (Fig. 53).

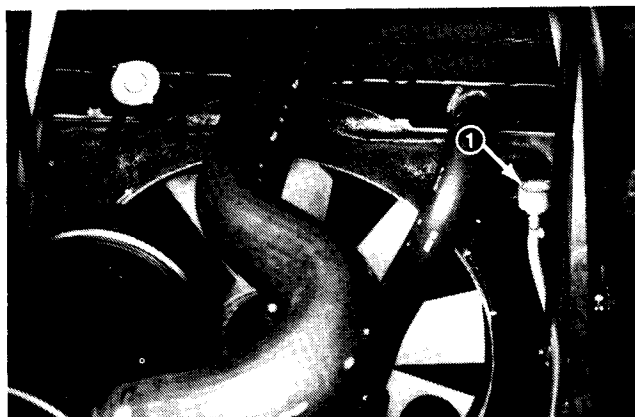


Figure 53

1. Hydraulic system breather

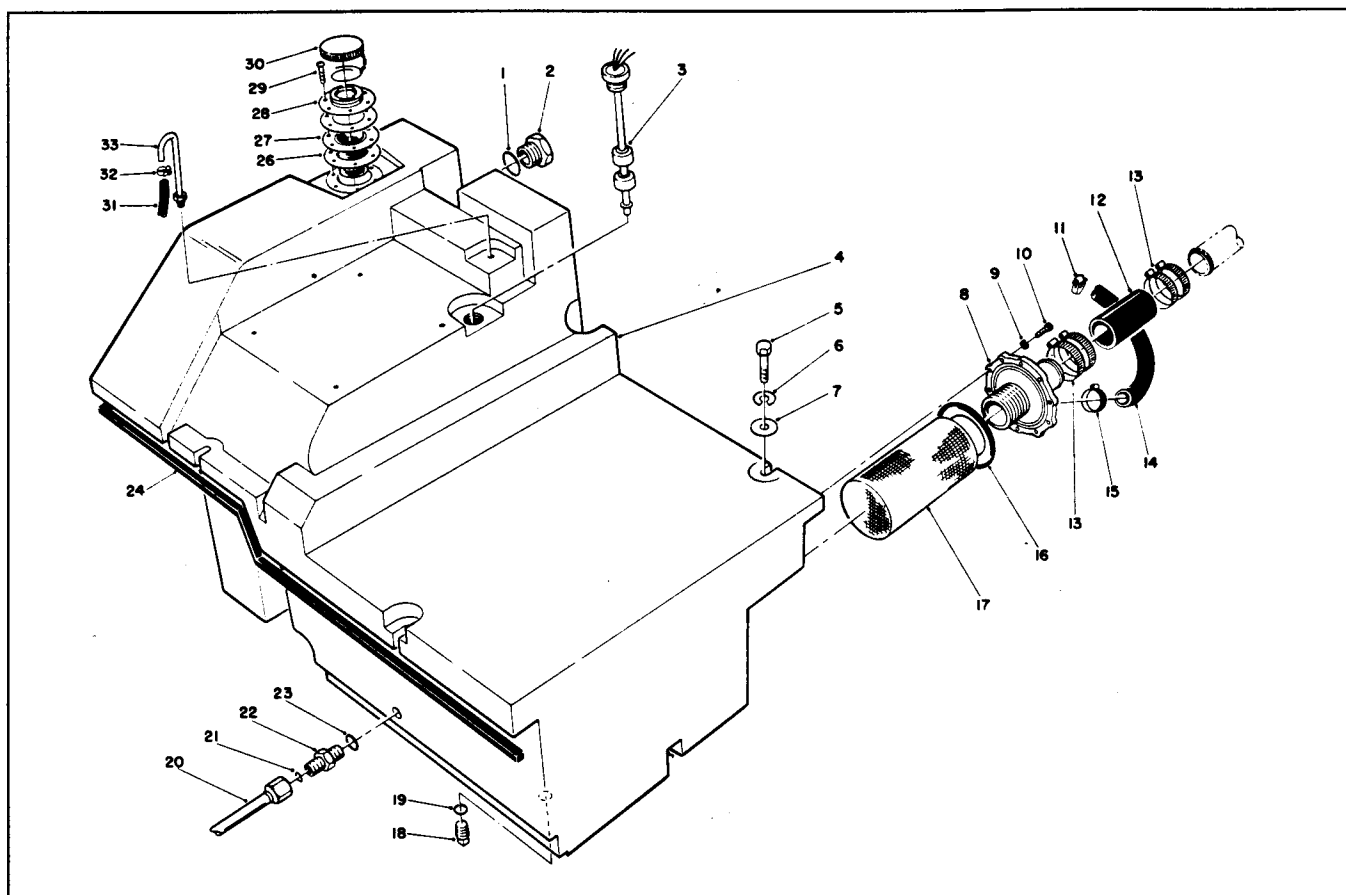


Figure 54

1. O-ring
2. Sight gauge
3. Level sensing unit
4. Hydraulic tank
5. Capscrew
6. Lockwasher
7. Flat washer
8. Suction hose adapter
9. Lockwasher
10. Capscrew
11. Hose clamp

12. Suction hose
13. Hose clamp
14. Auxiliary suction hose
15. Hose clamp
16. O-ring
17. Suction screen
18. Drain plug
19. O-ring
20. Hydraulic tube
21. O-ring
22. Hydraulic fitting

23. O-ring
24. Sealing strip
26. Filler gasket
27. Filler screen
28. Filler cap flange
29. Self-tapping screw
30. Filler cap ass'y.
31. Hose vent
32. Hose clamp
33. Hydraulic vent tube



Electrical System (Model 30580, S/N Below 30101)

Table of Contents

WIRING SCHEMATICS AND DIAGRAMS	2	Hourmeter	28
Controller Logic Chart	2	Temperature and Fuel Level Gauges	28
Controller Schematic – Simplified	3	Engine Temperature	
Wiring Diagram – Traction Unit	See Foldout 1	Switches and Gauge Sender	29
Wiring Diagram – Gauge Package	7	Hydraulic Temperature Warning Switch	30
SPECIAL TOOLS	9	Engine Oil Pressure Switch	30
TROUBLESHOOTING	11	2-Speed (Mow/Transport Switch	31
Starting Problems	11	PTO (Deck) Solenoids	31
General Run and Transport Problems	14	Cruise Control	31
Deck Operation Problems	18	Hydraulic Oil Level Sensing Unit	32
Verify Interlock Operation	21	Fuel Gauge Sender	32
TESTING	22	Hydraulic Oil Filter Warning Switch	33
Ignition Key Switch	22	Air Cleaner Warning Switch	33
Controller	23	REPAIRS	34
Seat Switch	23	Battery Service	34
Traction (Neutral) Switch	24	Fuses and Circuit Breakers	35
Deck Down Switches	24	Traction (Neutral) Switch	
Service Brake Switch	25	Replacement and Adjustment	36
Parking Brake Switch	25	Controller Replacement	37
Start Relay	26	Solenoid Valve Coil Replacement	38
Fuel Stop Solenoid	27	Starter	39
Battery	28	Alternator	46
Warning Indicator Lights	28		

NOTE: Additional troubleshooting information for older machines equipped with the Controller Update Kit is available in **Chapter 8 - Electrical System (S/N 30101 & Up)**.

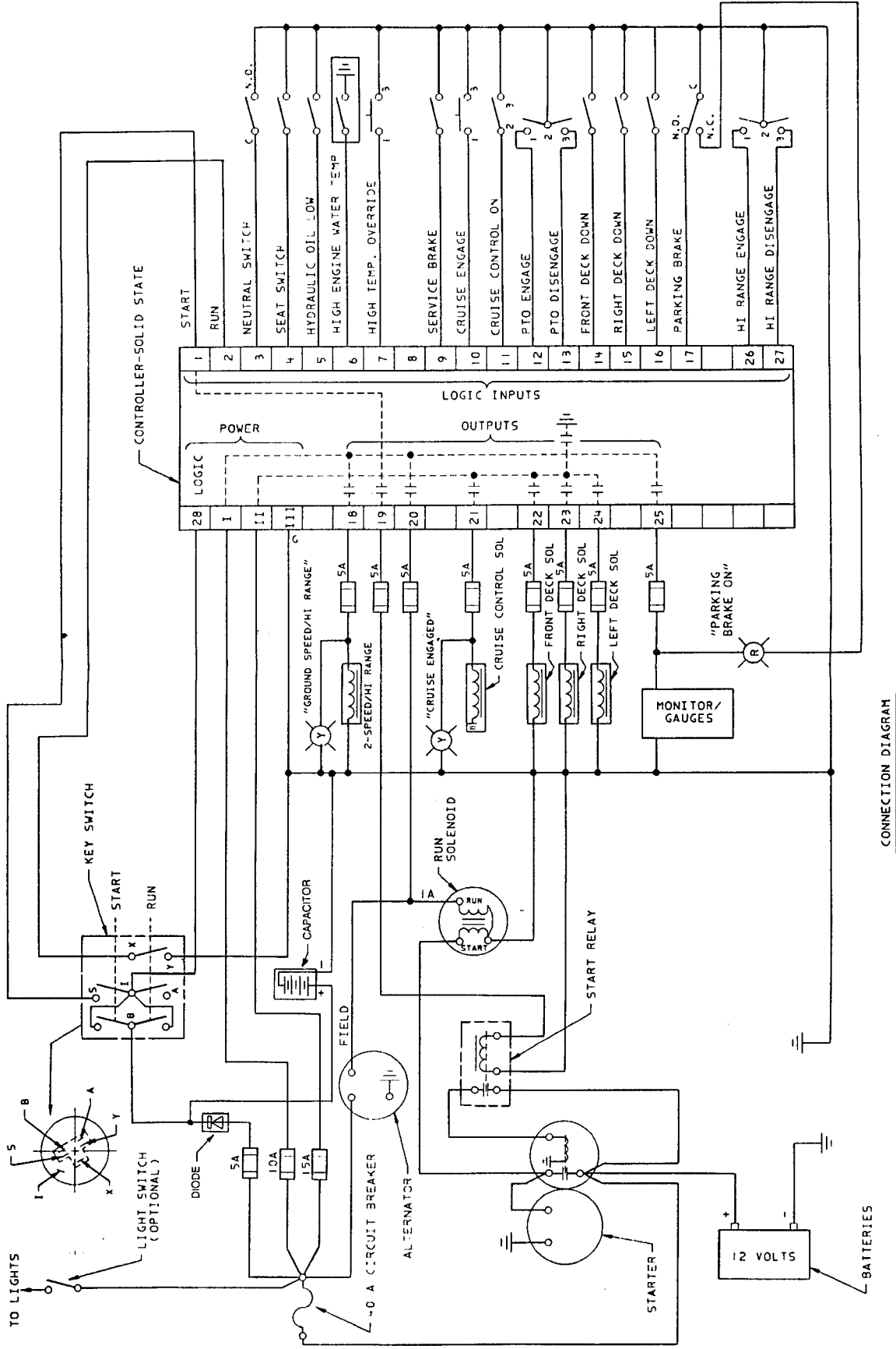
**X=CLOSED, O=OPEN, P=OUTPUT ON,
KEY: M=MOMENTARILY CLOSED,
B= MUST BE CLOSED ONLY IF HI TEMP**

X=CLOSED, O=OPEN, P=OUTPUT ON,

KEY: M=MOMENTARILY CLOSED,

B= MUST BE CLOSED ONLY IF HI TEMP SWITCH IS CLOSED.

[illegible]

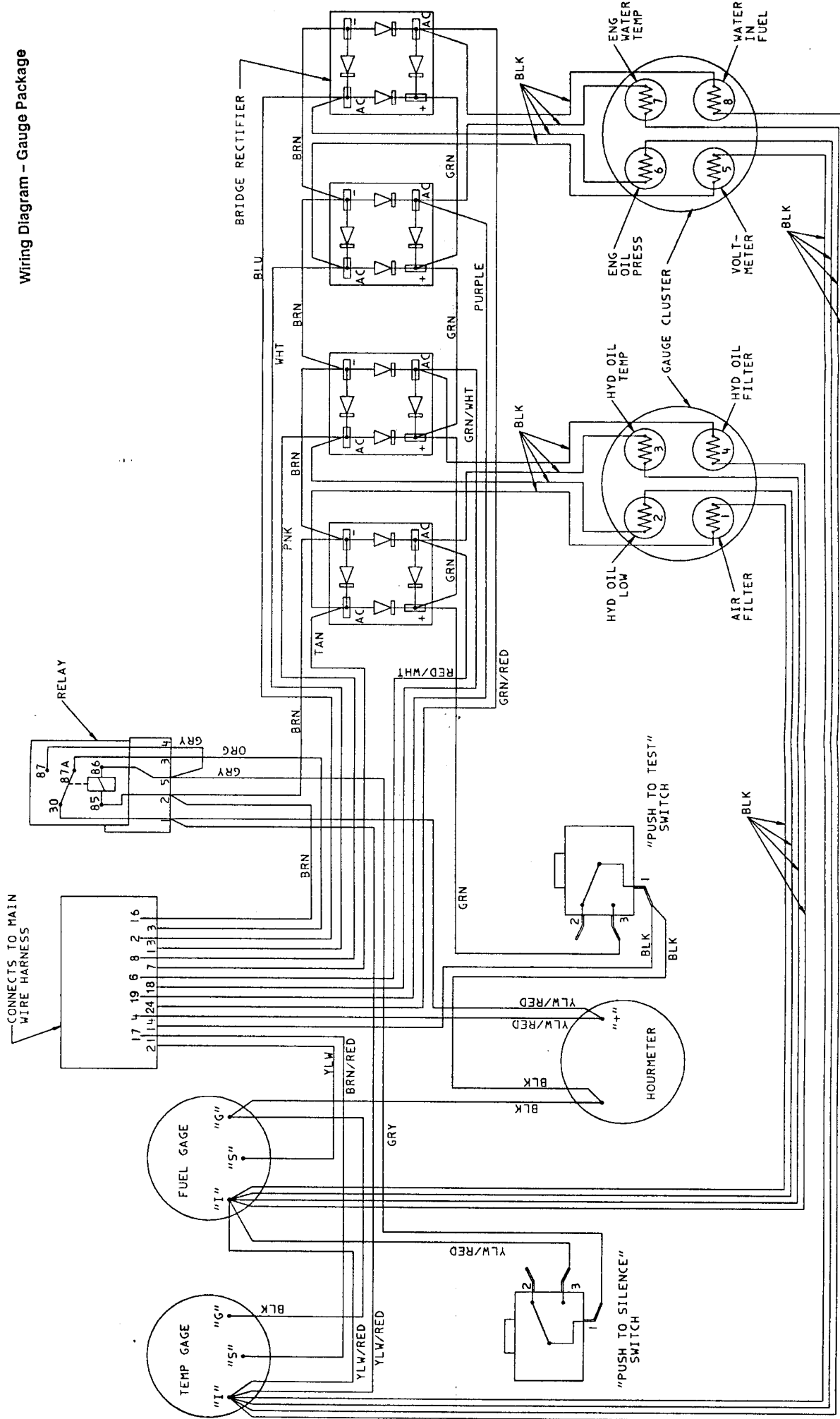


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Wiring Diagram - Gauge Package



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Special Tools

NOTE: Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*. Some tools may be available from a local supplier.

Continuity Tester

Battery powered test lamp which is helpful in testing for continuity of circuits and electrical components when the current is off (Fig. 1).

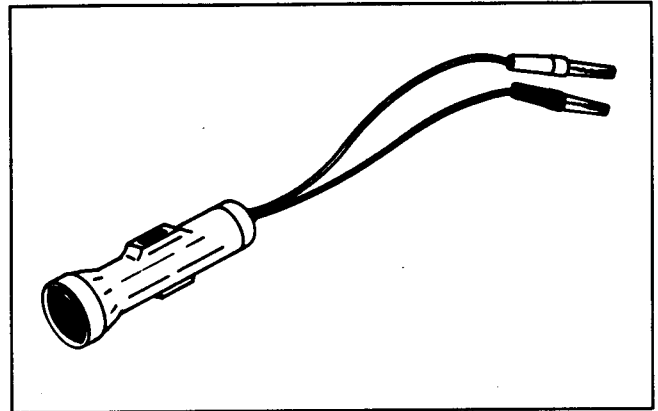


Figure 1

Volt - Ohm - Amp Meter

The meter (Fig. 2) can test electrical components and circuits for current, resistance, or voltage draw.

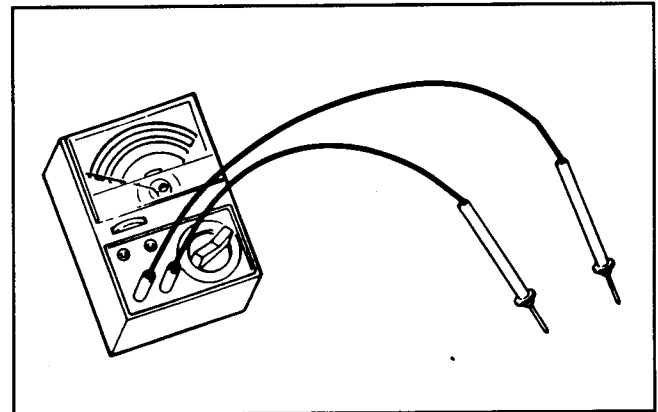


Figure 2

Skin-Over Grease

Special non-conductive grease which forms a light protective skin to help waterproof electrical switches and contacts. Recommended for all interlock system connections (Fig. 3).

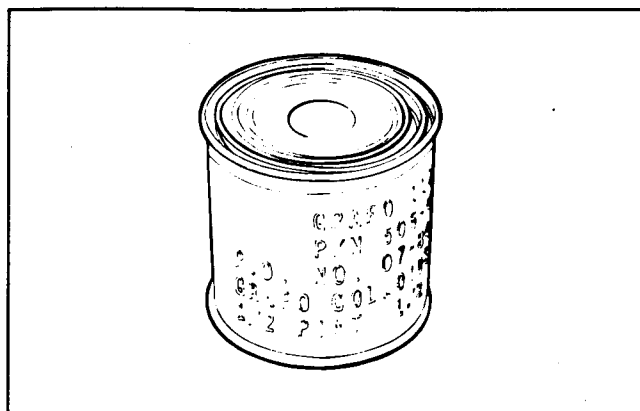


Figure 3

Troubleshooting



CAUTION

Remove all jewelry, especially rings and watches, before doing any electrical troubleshooting or testing. Disconnect the battery cables unless the test requires battery voltage.

For effective troubleshooting and repairs, you **MUST** have a good understanding of the electrical circuits and components used on this machine. (See Electrical Schematics and Diagrams section of this chapter.)

Study the operating characteristics preceding the electrical failure to help identify the area of difficulty. Try to isolate the failure to a specific functional system; then check that area, repairing one component at a time. Attempting to repair more than one system at one time will lead to confusion.

Possible Causes and Corrections in the troubleshooting charts should be checked in the order in which they are listed.

If the machine being repaired has any interlock switches by-passed, they must be reconnected for proper troubleshooting and safety.

Starting Problems

Condition	Possible Cause	Correction
All electrical is dead, including gauges.	Low battery charge.	Charge batteries. Replace batteries if they will not hold a charge.
	Circuit breaker open.	Find cause for open circuit breaker and correct. Push circuit breaker button to reset.
	5A Control Power (key switch) fuse open.	Check fuse and replace if fuse is open. If fuses burn out often, find and correct cause.
	Faulty diode.	Replace diode.
	Faulty key switch wiring.	Repair wiring.
	Faulty key switch.	Check key switch and replace if necessary.
Starter solenoid clicks, but starter will not crank. (If solenoid clicks, problem is not in interlock system or controller.)	Low battery charge.	Charge batteries. Replace batteries if they will not hold a charge.
	Loose or corroded battery cables. Loose or corroded ground.	Clean and tighten or repair as necessary.
	Faulty wiring at starter.	Repair wiring.
	Loose starter mounting bolts.	Clean mounting surface and tighten bolts.
	Faulty starter.	Repair or replace starter.
	Faulty starter solenoid.	Replace starter solenoid.

Condition	Possible Cause	Correction
Nothing happens when start attempt is made (control panel lights and gauges DO operate with ignition key switch in ON position).	Low battery charge.	Charge batteries. Replace batteries if they will not hold a charge.
	Faulty ignition (key) switch.	Replace switch.
	Faulty wiring between ignition (key) switch and controller.	Repair wiring.
	With foot off traction pedal, Traction Neutral LED on controller OFF (must be ON to start).	Adjust or repair traction control linkage if necessary. Check traction neutral switch and adjust or replace if necessary. Check neutral switch wiring and repair if necessary. Replace controller.
	5A Start Relay fuse open.	Check fuse and replace if fuse is open. If fuses burn out often, find and correct cause.
	Faulty wiring between controller and start relay.	Repair wiring.
	Faulty ground on start relay.	Repair wiring.
	Start relay faulty.	Replace start relay.
	Faulty wiring between start relay and starter solenoid.	Repair wiring.
	Starter solenoid faulty.	Replace starter solenoid.
	Faulty controller.	Replace controller.
Starter and/or run solenoid shifts in and out when start attempt is made. (If solenoid clicks, problem is not in interlock system or controller.)	Low battery charge.	Charge batteries. Replace batteries if they will not hold a charge.
	Diode faulty	Replace diode.
	Capacitor faulty.	Replace capacitor.

Condition	Possible Cause	Correction
Engine starts, but dies when ignition key switch is released from start position.	Run solenoid out of adjustment.	Adjust run solenoid.
	5A Run Solenoid/Alternator fuse open.	Check fuse and replace if open. If fuses burn out often, find and correct cause.
	Run solenoid faulty.	Replace run solenoid.
	Run solenoid wiring faulty.	Repair wiring.
	Faulty hydraulic oil level switch (oil level is correct).	Replace low hydraulic oil level switch.
	Faulty hydraulic oil level circuit wiring.	Repair wiring.
	Faulty high engine water temperature shut-down switch (engine not overheated).	Replace high engine water temperature shut-down switch.
	Faulty high engine water temperature shut-down circuit wiring.	Repair wiring.
Starter cranks but engine will not start.	Engine not cranking fast enough.	Check batteries and cable connections. Charge batteries. Replace batteries if they won't accept a charge. Repair wiring if necessary.
	Run solenoid out of adjustment	Adjust run solenoid.
	Faulty run solenoid.	Replace run solenoid.
	Problem is not electrical.	See Troubleshooting section of Chapter 3 - Engine.
Starter cranks, but should not when traction pedal is depressed.	With traction pedal depressed, Traction Neutral LED on controller is ON (should be OFF).	Check traction neutral switch adjustment and adjust if faulty. Check traction neutral switch and replace if faulty. Check traction neutral switch wiring and repair if faulty. Replace controller.
	Faulty controller.	Replace controller.

General Run and Transport Problems

Condition	Possible Cause	Correction
Engine continues to run, but should not, when ignition key is turned off.	Engine fuel lever stuck in "on" position.	Check operation of run solenoid and adjust or replace if necessary. Make sure fuel stop lever moves without sticking and repair if necessary.
	Ignition switch faulty.	Replace ignition switch.
	Controller faulty.	Replace controller.
Engine continues to run, but should not, when traction pedal is engaged with no operator on seat.	With operator off seat, Seat Occupied LED on controller ON (should be OFF).	Check seat plate hinges and seat support pin and repair if faulty. Check for waterlogged seat. Check seat switch and replace if faulty. Check seat switch wiring and repair if faulty. Replace controller.
	With traction pedal depressed, Traction Neutral LED on controller is ON (should be OFF).	Check traction neutral switch adjustment and adjust if faulty. Check traction neutral switch and replace if faulty. Check traction neutral switch wiring and repair if faulty. Replace controller.
	Faulty controller.	Replace controller.

Condition	Possible Cause	Correction
Cruise control will not engage.	Cruise control out of adjustment (cruise engaged light comes on).	Adjust cruise control.
	5A Cruise fuse open.	Check fuse and replace if open. If fuses burn out often, find and correct cause.
	Service brake pedal or switch out of adjustment.	Adjust brake pedal and/or switch.
	Faulty service brake switch.	Replace switch.
	Cruise control coil faulty.	Test coil. Replace coil if faulty.
	Faulty ground from cruise control coil housing to frame.	Remove coil housing and clean it and frame. Tighten fasteners.
	Cruise control switch faulty.	Replace switch.
	Cruise control actuating button faulty.	Replace actuating button.
	15A Deck Supply fuse open.	Check fuse and replace if open. If fuses burn out often, find and correct cause (sign of faulty controller).
	Faulty wiring.	Check wiring to cruise control coil, cruise control switch, actuating button, and service brake switch. Repair faulty wiring.
	Faulty controller.	Replace controller.
With cruise control engaged, traction pedal does not return to neutral when service brake pedal is depressed.	Service brake pedal or switch out of adjustment.	Adjust brake pedal and/or switch.
	Service brake switch faulty.	Replace switch.
	Problem is not electrical (traction control linkage binding).	Repair linkage.
	Faulty controller.	Replace controller.

Condition	Possible Cause	Correction
High range ground speed will not engage, or disengages while transporting.	Deck(s) lowered.	Raise deck(s) all the way up.
	5A 2-Speed Solenoid fuse open.	Check fuse and replace if open. If fuses burn out often, find and correct cause.
	With all decks up, Deck Down LED on controller is ON (all should be OFF).	Check deck interlock switch and replace if faulty. Check deck interlock switch wiring and repair if faulty. Replace controller.
	Faulty two speed solenoid coil.	Replace solenoid coil.
	Faulty ground speed switch.	Replace switch.
	Faulty wiring.	Check wiring to ground speed switch and two-speed solenoid. Repair faulty wiring.
	Problem not electrical.	See Troubleshooting section of Chapter 4 - Hydraulic System.
	Faulty controller.	Replace controller.
High range ground speed remains engaged, but should not, when deck(s) lowered.	With deck(s) down, Deck Down LED(s) on controller OFF (should be ON).	Check deck interlock switch and replace if faulty. Check deck interlock switch wiring and repair if faulty. Replace controller.
	Problem is not electrical.	Check for two-speed shift valve spool binding or damage.
	Faulty controller.	Replace controller.

Condition	Possible Cause	Correction
Engine kills during operation, but restarts.	Seat lifting off seat switch.	Instruct operator to sit back in seat during operation. Check seat plate hinges and seat support pin and repair if faulty.
	With operator on seat, Seat Occupied LED on controller is OFF (should be ON).	Check seat switch and replace if faulty. Check seat switch wiring and repair if faulty. Replace controller.
	Faulty ignition switch.	Replace switch.
	Faulty ignition switch wiring.	Repair wiring.
	Faulty low hydraulic oil level switch (oil level not too low).	Replace switch.
	Faulty low hydraulic oil level wiring. (oil level not too low).	Repair wiring.
	Faulty controller.	Replace controller.
Engine kills when traction pedal is depressed.	Parking brake on.	Disengage parking brake.
	Seat lifting off seat switch.	Instruct operator to sit back in seat during operation. Check seat plate hinges and seat support pin and repair if faulty.
	With operator on seat, Seat Occupied LED on controller is OFF (should be ON).	Check seat switch and replace if faulty. Check seat switch wiring and repair if faulty. Replace controller.
	Faulty parking brake switch.	Replace parking brake switch.
	Faulty parking brake switch wiring.	Repair wiring.
Batteries do not charge.	Alternator belt slipping.	Adjust belt tension.
	Faulty wiring.	Check and repair wiring.
	Malfunctioning alternator.	Repair or replace alternator.
	Faulty battery(s).	Replace battery(s).

Deck Operation Problems

Condition	Possible Cause	Correction
Deck(s) remain engaged, but should not, with no operator on seat.	With operator off seat, Seat Occupied LED on controller ON (should be OFF).	<p>Check seat plate hinges and seat support pin and repair if faulty. Check for waterlogged seat.</p> <p>Check seat switch and replace if faulty.</p> <p>Check seat switch circuit wiring and repair if faulty.</p> <p>Replace controller.</p>
	Controller faulty.	Replace controller.
Deck(s) run, but should not, when raised (but shut off with PTO switch).	With deck(s) raised, Deck Down LED(s) on controller ON (should be OFF).	<p>Check deck interlock switch(s) and replace if faulty.</p> <p>Check deck interlock switch wiring and repair if faulty.</p> <p>Make sure switch(s) screwed in all the way.</p> <p>Check for damaged pivot shaft or bushings and repair if damaged.</p> <p>Replace controller.</p>
	Faulty controller.	Replace controller.
Deck(s) run, but should not, when raised (does not shut off with PTO switch).	Hydraulic problem.	See Troubleshooting section of Chapter 4 - Hydraulic System.
Deck engages, but should not when lowered (all decks were raised and off).	Faulty deck drive/PTO switch	Replace switch.
	Faulty deck drive/PTO switch wiring.	Repair wiring.
	Faulty controller.	Replace controller.

Condition	Possible Cause	Correction
No decks operate.	Deck solenoid coil wiring connectors disconnected.	Connect wiring connectors.
	Seat lifting off seat switch.	Instruct operator to sit back in seat during operation. Check seat plate hinges and seat support pin and repair if faulty.
	With operator on seat, Seat Occupied LED on controller OFF (should be ON).	Check seat switch and replace if faulty. Check seat switch wiring and repair if faulty. Replace controller.
	15A Deck Supply fuse open.	Check fuse and replace if open. If fuses burn out often, find and correct cause (sign of faulty controller).
	Faulty wiring between 15A deck supply fuse and controller.	Repair wiring.
	Faulty deck drive/PTO switch or wiring.	Check deck drive/PTO switch and wiring. Replace switch or repair wiring if faulty.
	Hydraulic problem.	See Troubleshooting section of Chapter 4 - Hydraulic System.
	Faulty controller.	Replace controller.

Condition	Possible Cause	Correction
One or two decks do not operate.	With deck(s) down, Deck Down LED(s) on controller OFF (should be ON).	<p>Check deck interlock switch and replace if faulty.</p> <p>Check deck interlock switch wiring and repair if faulty.</p> <p>Make sure switch(s) screwed in all the way.</p> <p>Check for damaged pivot shaft or bushings and repair if damaged.</p> <p>Replace controller.</p>
	5A Deck solenoid fuse open.	Check fuse and replace if open. If fuses burn out often, find and correct cause.
	Faulty deck solenoid coil.	Replace solenoid coil(s).
	Faulty wiring between controller and deck solenoid coil.	Make sure wiring connector at solenoid is connected. Repair faulty wiring.
	Hydraulic problem.	See Troubleshooting section of Chapter 4 - Hydraulic System.
	Faulty controller.	Replace controller.

Verify Interlock System Operation



CAUTION

Do not disconnect or bypass interlock switches. Check switch operation daily to assure interlock system is functioning correctly. If a switch is malfunctioning, replace it before operating the machine. To ensure maximum safety, replace all switches after every two years or 1000 hours of operation, whichever comes first.

The interlock switches in conjunction with the controller, prevent the engine from starting if the traction pedal is not in neutral. The interlock system will also stop the engine if the operator leaves the seat or parking brake is on with the traction pedal out of neutral. The PTO will not engage if the seat is unoccupied, the engine is shut-off or all three (3) cutting units are raised.

To check interlock system operation:

1. Drive the machine slowly to a large, relatively level open area. Lower cutting units and stop engine.
2. Sit on seat. Depress traction pedal in both forward and reverse positions and try to start engine. If engine cranks, there is a malfunction that must be repaired immediately. If engine does not crank, proceed to step 3.
3. Sit on seat, engage parking brake and turn ignition switch to ON. Hold traction pedal about halfway down, switch cruise control to ON and push SET button. Cruise Engaged light should come on and traction pedal should hold position indicating cruise control is functioning correctly. Depress the service brake pedal. The traction pedal should return to neutral position and the Cruise Engaged light should shut off, indicating the interlock is working correctly; proceed to step 4. If the pedal did not return to neutral and the light did not turn off, there is a malfunction in the safety interlock system that should be corrected before operating the machine.
4. Sit on seat. Engage parking brake and start engine. Raise off seat and attempt to move PTO switch to ENGAGE position. The PTO should not engage, indicating the interlock is working correctly; proceed to step 5. If the PTO did engage, there is a malfunction in the safety interlock system that should be corrected before operating the machine.
5. Set on the seat and depress the service brake pedal. With the engine running, raise off the seat and slowly depress traction pedal. The engine should stop, indicating the interlock system is working correctly; proceed to step 6. If the engine did not stop, there is a malfunction in the safety interlock system that should be corrected before operating the machine.
6. Sit on the seat and engage the parking brake. With the engine running, slowly depress the traction pedal. The engine should stop, indicating the interlock is working correctly; proceed to step 7. If the engine did not stop, there is a malfunction in the safety interlock system that should be corrected before operating the machine.
7. Sit on seat. With the engine running, parking brake set and all three (3) cutting units fully lowered, place the PTO switch in ENGAGE position. Raise the right hand cutting unit. The cutting blades of the right hand unit should stop, indicating the interlock is working correctly; proceed to step 8. If the blades did not stop, there is a malfunction in the safety interlock system that should be corrected before operating the machine.
8. Raise the left hand cutting unit. The cutting blades of the left hand unit should stop, indicating the interlock is working correctly; proceed to step 9. If the blades did not stop, there is a malfunction in the safety interlock system that should be corrected before operating the machine.
9. Raise the front cutting unit. The cutting blades of the front unit should stop, indicating the interlock is working correctly; proceed to step 10. If the blades did not stop, there is a malfunction in the safety interlock system that should be corrected before operating the machine.
10. Lower the front cutting unit. The cutting blades should not engage, indicating the interlock is working correctly; proceed to step 11. If the blades did engage, there is a malfunction in the safety interlock system that should be corrected before operating the machine.
11. Sit on the seat, engage parking brake and start engine. Raise all three (3) cutting units. Position High/Low Range ground speed selector in High Range. The High Range indicator light should come on. Lower one of the cutting units. The High Range indicator light should go off, indicating the interlock is working correctly. If the light did not go out, there is a malfunction in the safety interlock system that should be corrected before operating the machine.

Testing

It is often to the technician's advantage to leave the components intact in the electrical system, and by studying the electrical troubleshooting charts and schematics, determine which component is at fault. However, this section will define given components, and the tests that can be performed on those components, when those parts are disconnected from the electrical system.

For accurate resistance and/or continuity checks, electrically disconnect the component being tested from the circuit (e.g. unplug the seat switch connector before doing a continuity check).



CAUTION

When testing electrical components with a volt-ohm meter or continuity tester, make sure that power to the circuit has been disconnected.

Ignition Key Switch

The Ignition (key) switch has three positions (OFF, START and RUN). The terminals are marked as shown in Figure 4.

The circuitry of the ignition switch is shown in the chart (Fig. 5). With the use of a continuity tester, the switch functions may be tested to determine whether all circuits are being completed while the key is moved to each position.

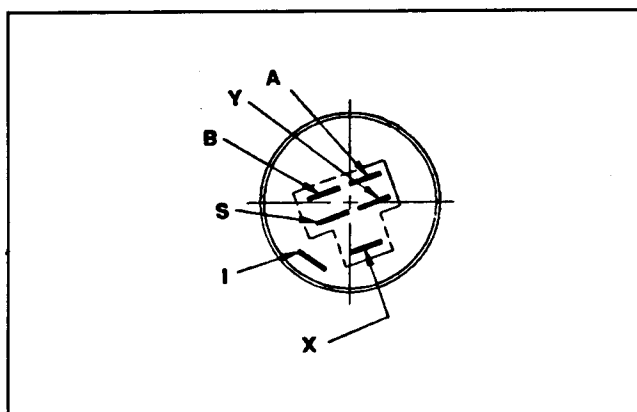


Figure 4




POSITION	CONTINUITY AMONG TERMINALS	OTHER CIRCUITS MADE
1. OFF	NONE	NONE
2. RUN	 B + I + A	 X + Y
3. START	 B + I + S	NONE

Figure 5

Controller

The controller senses the condition of various switches, such as the seat switch, deck down switches, neutral switch, etc., and directs power output to allow certain machine functions, such as engine run, front deck engage, etc. (See Controller Logic Chart in the Wiring Schematics and Diagrams section of this chapter for possible combinations of inputs to satisfy controller logic for output.)

Because of the solid state circuitry built into the controller, there is no method to test it directly. The controller may be damaged if an attempt is made to test it with an electrical test device, such as a volt-ohm meter.

Lights (LED's) on the controller indicate the condition of the interlock switches. The LED's, in conjunction with the following tests for interlock switches, should be used to help isolate a problem in a switch, wiring or the controller. (See Troubleshooting section of this chapter.)

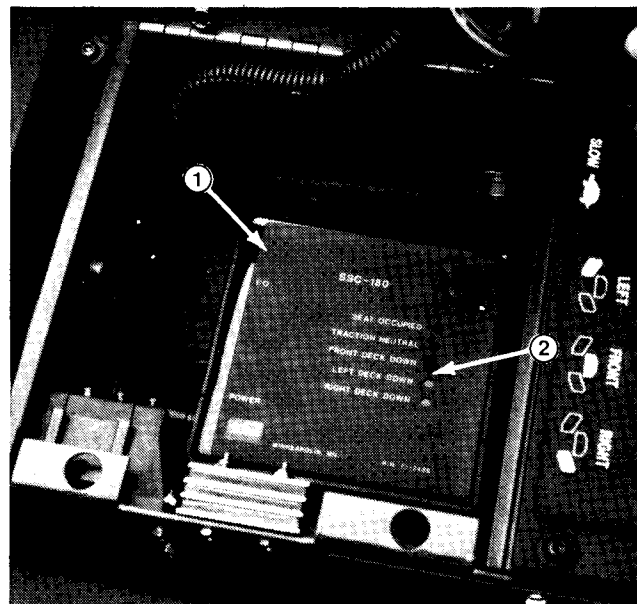


Figure 6

1. Controller

2. LED's

Seat Switch

The seat switch is normally open (NO) and closes with the operator on the seat.

1. Raise the seat to get access to the seat switch.
2. Disconnect the seat switch wire connector and install a continuity tester or ohm meter between the two leads of the seat switch.
3. Lower the seat. The continuity tester should show no continuity.
3. Have the operator sit on the seat, slowly depressing the seat switch. The continuity tester should show continuity as the seat approaches the bottom of its travel.

NOTE: Make sure the compression spring and pin hold the seat up off the seat switch when there is no operator on the seat.

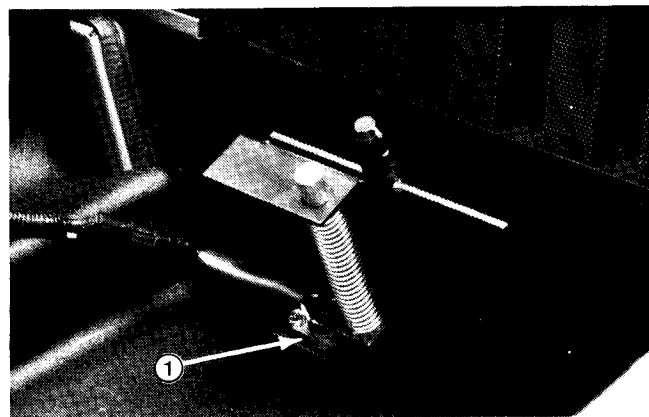


Figure 7

1. Seat switch

Traction (Neutral) Switch

The traction switch is a normally closed (NC) switch and opens when traction pedal is depressed in either direction. The switch is located on the bottom of the variable displacement pump.

IMPORTANT: The traction switch has three (3) terminals. Make sure the wires are connected to the "COMMON" and "NO" terminals.

Test the switch by connecting a continuity tester across the two terminals that have wires connected. With the engine turned off, slowly push the traction pedal in a forward and reverse direction while watching the continuity tester. There should be indications that the traction switch is making and breaking contact. Allow the traction pedal to return to neutral. There should be continuity across the terminals. (See Replacing the Traction Switch in the Repairs section of this chapter for replacement and adjustment procedures.)

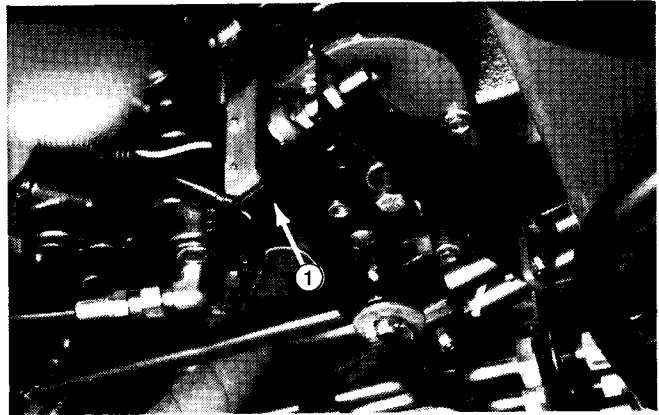


Figure 8

1. Traction (neutral) switch

Deck Down Switches

Each deck down switch is normally closed (NC) and open when the deck is raised.

1. Disconnect the deck switch wire connector and install a continuity tester or ohm meter between the two leads of the deck switch.

2. With the deck in the lowered position the tester should show continuity. With the deck in the raised position, the tester should show no continuity.

NOTE: For proper operation the switch must be screwed all the way in. A damaged pivot shaft or bushings could cause the switch to not open and close properly.

NOTE: Debris in the switch could cause the switch to not open and close properly.

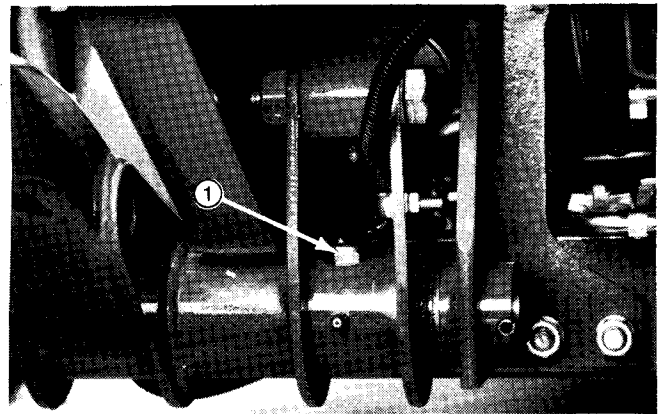


Figure 9
(Front deck switch shown)

1. Deck down switch

Service Brake Switch

The service brake switch is normally open (NO) and is closed when pedal is NOT depressed.

1. Disconnect the service brake switch wire connector and install a continuity tester or ohm meter between the two leads of the switch.

2. With the pedal in the completely raised position the tester should show continuity. When the pedal is depressed, the tester should show no continuity.

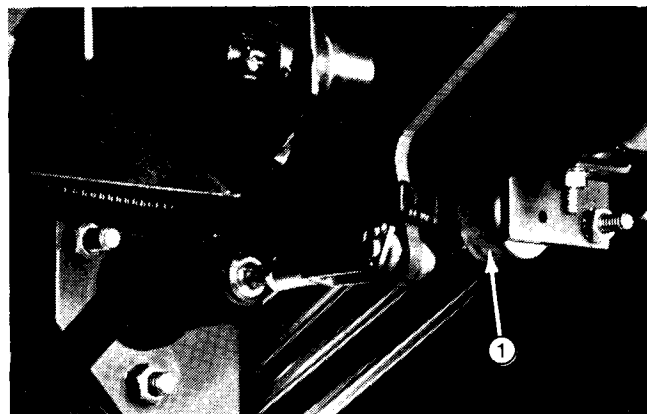


Figure 10

1. Service brake switch

Parking Brake Switch

The common and normally closed (NC) terminals are closed when the parking brake knob is pulled up (parking brake engaged).

The common and normally open (NO) terminals are closed when the parking brake knob is down (parking brake released).

1. Sit on the seat and apply parking brake. With ignition key switch ON parking brake light should be on.

2. If the light does not come on, replace the bulb and test again.

3. If the light still does not come on there is a problem in the switch or wiring.

4. Release the parking brake. The parking brake light should go off.

5. If the light does not go off when the parking brake is released there is a problem in the switch or wiring.

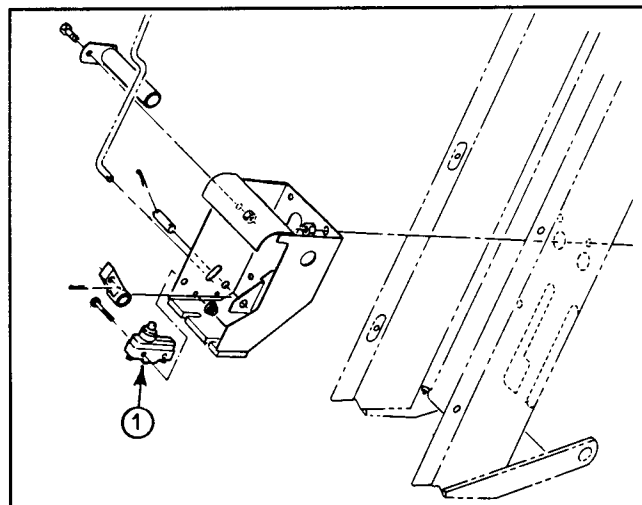


Figure 11

1. Parking brake switch

Start Relay

To test the start relay (Fig. 12), disconnect the relay wire connector and install a continuity tester between the relay terminals (terminals 30 and 87) (Fig. 13). The relay should make and break continuity as 12 V.D.C. is connected and disconnected between the winding terminals (terminals 85 and 86).

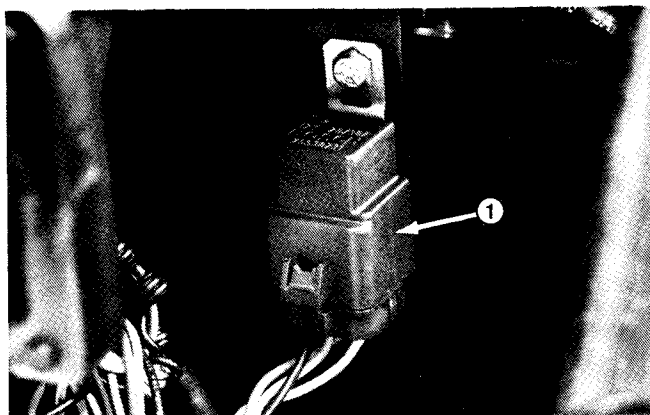


Figure 12

1. Start relay

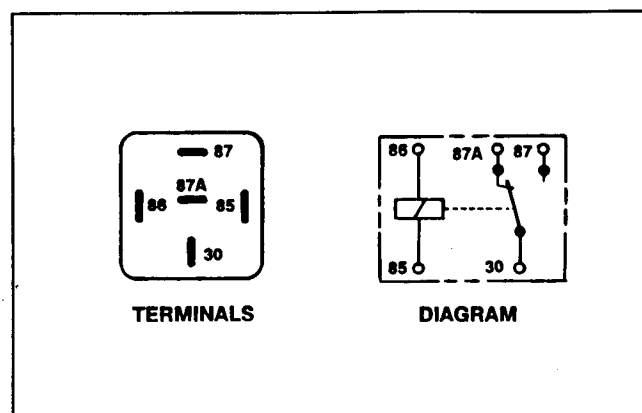


Figure 13

Fuel Stop Solenoid

The Groundsmaster 580-D has an energize to run fuel stop solenoid. The solenoid will move the fuel stop lever to stop injector pump fuel delivery if the RUN circuit is open.

1. Open hood latches, raise hood and secure it in raised position with prop rod. Open left side panel latch and remove side panel.

2. Disconnect the wire connector.

3. Connect a 12 volt battery so the positive (+) battery terminal is connected to red lead (terminal A -hold) and white lead (terminal B-pull). Connect the negative (-) battery terminal to black lead (terminal C-common). The plunger should retract to move the fuel stop lever all the way to the fuel delivery position.

IMPORTANT: Do not connect terminal B (pull) for more than 30 seconds or damage to the solenoid coil could result.

4. With the battery connected the same as step 2, disconnect the battery from solenoid terminal B (pull). The plunger should remain pulled in.

5. Disconnect the battery from terminal A (hold). The plunger should return to the extended position and move the fuel lever to the stop position.

6. Check the solenoid spring tension. The spring must have enough force to quickly move the fuel stop lever to the off position when solenoid is de-energized.

NOTE: If solenoid retracts when terminal B (pull) is energized but will not stay retracted when only terminal A (hold) terminal is energized, rod may require adjustment. Rod length must be adjusted so solenoid is fully bottomed out when energized to remain in ON position with only HOLD coil energized.

To Test While Connected to Wire Harness

1. Open hood latches, raise hood and secure it in raised position with prop rod. Open left side panel latch and remove side panel.

2. Remove cotter pin and washer to disconnect fuel stop solenoid from rod.

3. Hold fuel stop lever to prevent fuel delivery. Have operator sit in seat and turn the key switch to the START position and quickly release it to the ON position. The solenoid plunger should retract when ignition key switch is turn to START and stay retracted as the key is released to the ON position.

4. Turn the key switch to the OFF position. The solenoid plunger should extend.

NOTE: If solenoid works properly when disconnected from fuel stop lever, but will not stay retracted with only HOLD coil energized when connected, rod may require adjustment. Rod length must be adjusted so solenoid is fully bottomed out when energized to remain in ON position with HOLD coil energized.

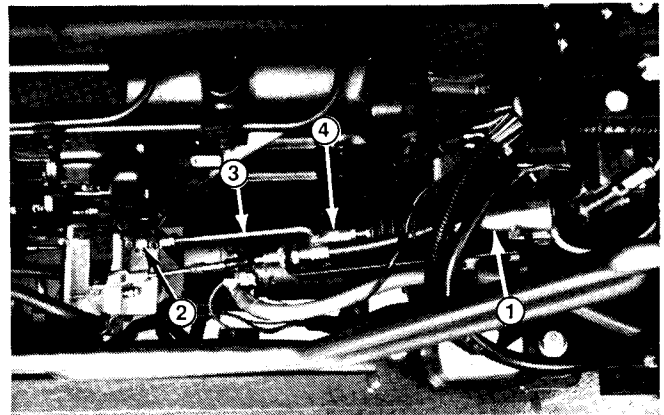


Figure 14

- | | |
|-----------------------|---------------|
| 1. Fuel stop solenoid | 3. Rod |
| 2. Engine stop lever | 4. Ball joint |

Battery

1. Use a volt-ohm meter to measure the voltage between the battery terminals.
2. If the voltage is less than 12.3 Volts D.C. , the battery should be charged.

Warning Indicator Lights

1. Sit on the seat and apply parking brake. Turn ignition key switch ON and push TEST button (Fig. 15). All lights should come on.
2. If a light does not come on, replace the bulb and test again.
3. If a light still does not come on there is a problem in the wiring or a bridge rectifier is faulty.



Figure 15

1. Test switch

Hourmeter

Test the hourmeter by disconnecting the wires and applying 12 V.D.C. between the terminals.

Temperature and Fuel Level Gauges

To test a gauge, use a commercial gauge tester. If a commercial gauge tester is not available, substitute a new gauge or test the sending unit.

Engine Temperature Switches and Gauge Sender

High Temperature Warning Switch

NOTE: Confirm bulb function by doing warning indicator lights test.

1. Lower the coolant level in the engine and remove the high temperature shut-down switch (Fig. 16).
2. Put the switch in a container of oil with a thermometer and heat the oil (Fig. 17).
3. The switch is normally open (NO) and should close at approximately 215° F.



CAUTION

Handle hot oil with care to prevent personal injury or fire.

High Temperature Shut-Down Switch

1. Lower the coolant level in the engine and remove the high temperature shut-down switch (Fig. 16).
2. Put the switch in a container of oil with a thermometer and heat the oil (Fig. 17).
3. The switch is normally open (NO) and should close at approximately 230° F.

Temperature Gauge Sender

1. Lower the coolant level in the engine and remove the temperature gauge sender (Fig. 16).
2. Put the switch in a container of oil with a thermometer and heat the oil (Fig. 17a).

90.5 - 117.5 ohm at 160° F)
21.3 - 26.3 ohm at 207° F)

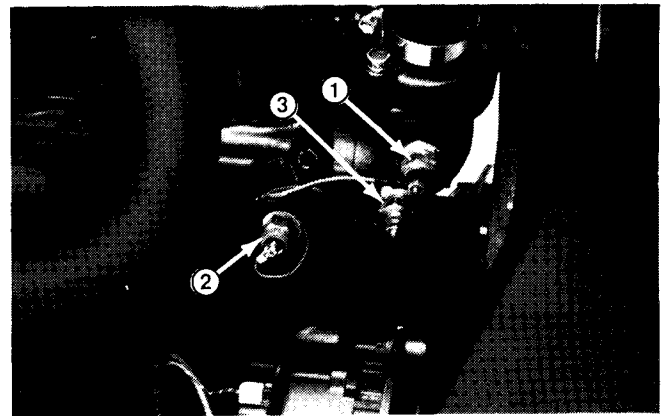


Figure 16

1. High temperature warning switch
2. Temperature gauge sender
3. High temperature shut-down switch

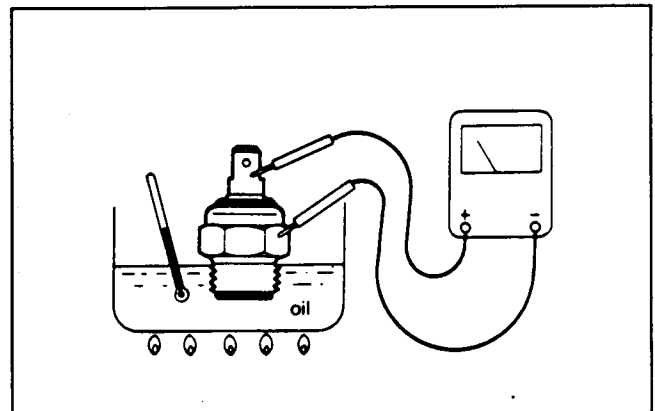


Figure 17

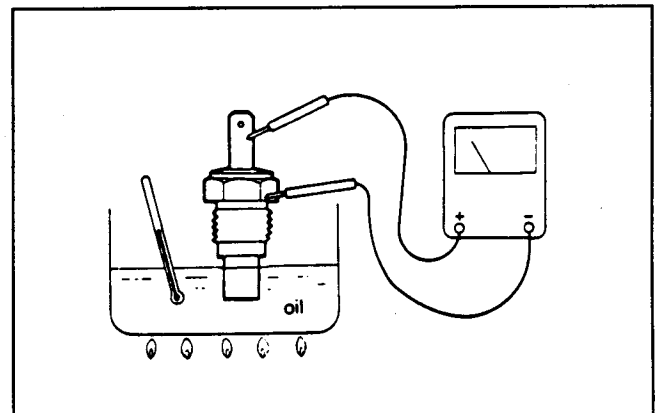


Figure 17a

Hydraulic Oil Temperature Warning Switch

NOTE: Confirm bulb function by doing warning indicator lights test.

1. Remove the hydraulic oil temperature warning switch (Fig. 18).
2. Put the switch in a container of oil with a thermometer and heat the oil (Fig. 17).
3. The switch is normally open (NO) and should close at approximately 215° F.

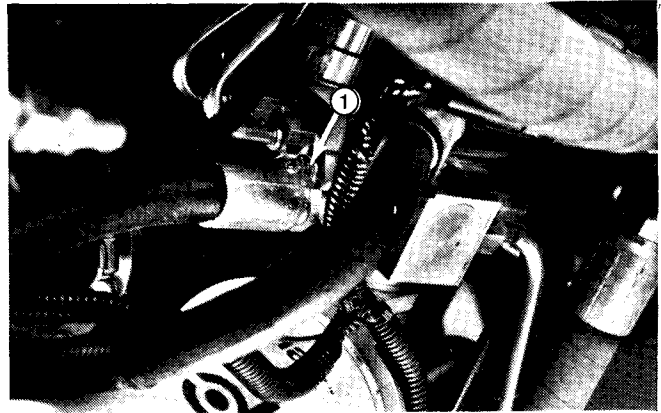


Figure 18

1. Hydraulic oil temperature warning switch

Engine Oil Pressure Switch

The switch is normally closed (NC) and opens with pressure.

The switch opens at approximately 8 psi.

NOTE: Confirm bulb function by doing warning indicator lights test.

1. Turn ignition key switch ON. Oil pressure lamp should be on.

If bulb is not on:

1. Disconnect wire from switch and touch wire to a good ground.
2. If lamp comes on, replace switch.
3. If lamp does not come on check wiring between lamp and switch for continuity.

If lamp is on with engine running:

1. Shut off engine immediately.
2. Check switch by disconnecting wire. Light should go out.
3. If light is still on, check for short circuit in wiring.
4. If lamp is still on, check for problem at test switch or bridge rectifier.
5. Install test gauge in engine oil pressure switch port. Start engine and check for 30 psi minimum at 1500 rpm. If engine pressure is good, replace switch. If engine pressure is low, DO NOT operate.

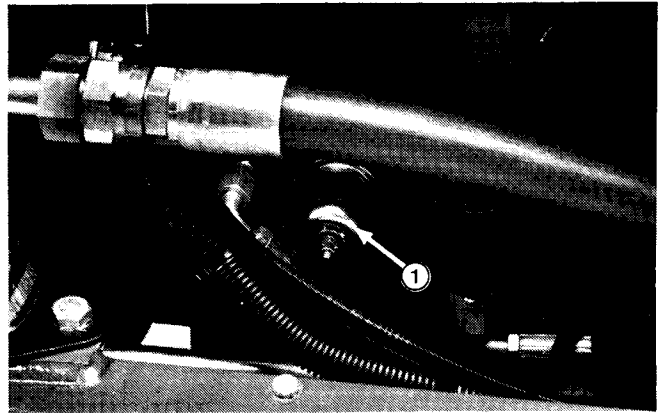


Figure 19

1. Engine oil pressure switch

2-Speed (Mow/Transport) Solenoid

1. Disconnect the wire connector.
2. Connect a 12 volt battery so the positive (+) battery terminal is connected to blue/white lead . Connect the negative (-) battery terminal to black lead. The valve spool should retract completely as 12 V.D.C. is applied between leads.
3. If valve spool does not retract check for binding or damage in valve.
4. If valve operates smoothly replace solenoid coil.

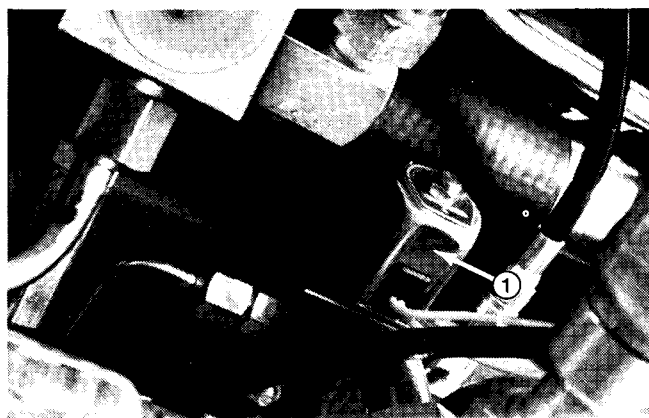


Figure 20

1. 2-speed (mow/transport) solenoid

PTO (Deck) Solenoids

1. Disconnect the wire connector.
2. Connect a 12 volt battery so the positive (+) battery terminal is connected to red solenoid lead. Connect the negative (-) battery terminal to black lead. The valve spool should retract completely as 12 V.D.C is applied between leads.
3. If valve spool does not retract check for binding or damage in valve.
4. If valve operates smoothly, but does not retract when 12 V.D.C is applied to solenoid leads, replace solenoid.

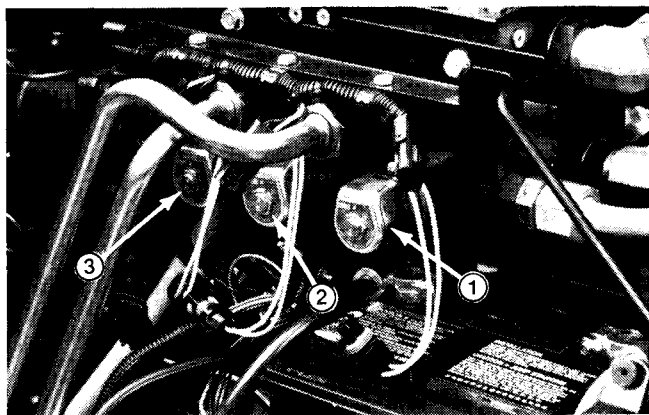


Figure 21

1. Front deck solenoid (port SV1)
2. Left wing deck solenoid (port SV3)
3. Right wing deck solenoid (port SV2)

Cruise Control

1. Disconnect the wire connector.
2. Connect a 12 volt battery so positive (+) battery terminal is connected to lead coming out of cruise control coil. Connect negative (-) battery terminal to mounting flange on coil assembly. The clutch plate should pull into contact with the coil assembly.

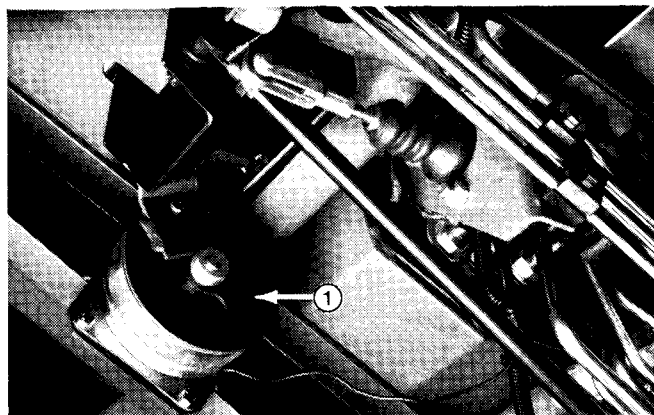


Figure 22

1. Cruise control

Hydraulic Oil Level Sensing Unit

NOTE: Confirm bulb function by warning indicator lights test.

The low oil level **WARNING** circuit is normally open (NO) and closes in a low oil condition.

The low oil level **SHUT DOWN** circuit is normally closed (NC) and opens with low oil condition to shut down engine.

1. Disconnect wiring connector and remove low hydraulic oil level switch from reservoir (Fig. 23).
2. Install a continuity tester or ohm meter between yellow leads of sensing unit (warning switch).
3. With upper float raised, the tester should show no continuity. With the upper float lowered, the tester should show continuity. Snap rings on tube may be repositioned if float under or overtravels the desired position.
4. Install a continuity tester or ohm meter between red leads of sensing unit (shut-down switch).
5. With lower float raised, the tester should show continuity. With lower float lowered, the tester should show no continuity. Snap rings on tube may be repositioned if float under or overtravels the desired position.

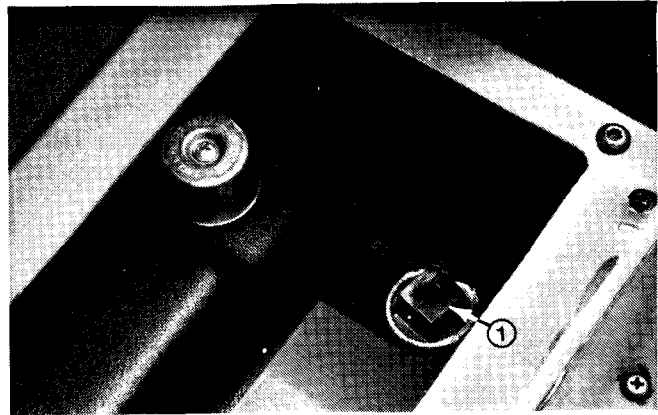


Figure 23
(Cup holder removed from control housing)

1. Hydraulic oil level sensing unit

Fuel Gauge Sender

1. Disconnect wire and remove the fuel gauge sender from the fuel tank (Fig. 24).
2. Install an ohm meter between the terminal and base.
3. With arm completely down (empty), resistance should be 240-260 ohms.
4. With arm completely up (full), resistance should be 29-34 ohms.

NOTE: Bend float arm, if necessary, to get proper gauge reading for 1/2 full tank.

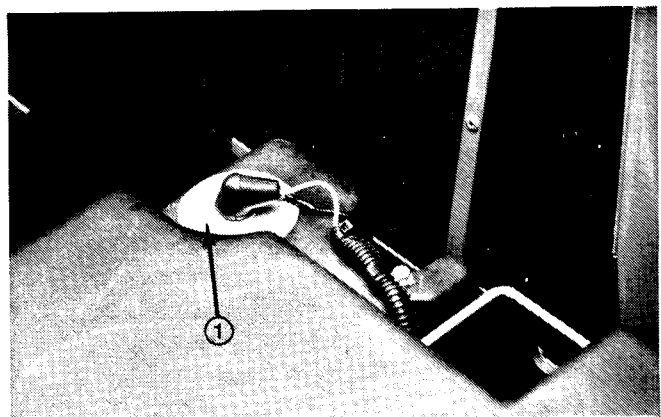


Figure 24

1. Fuel gauge sender



CAUTION

Make sure the sending unit is completely dry (no fuel on it) before testing. Perform test away from fuel tank to prevent an explosion or fire from sparks.

Hydraulic Oil Filter Warning Switch

The oil filter warning switch is normally open (NO) and closes if the bypass valve in the oil filter housing opens.

NOTE: Confirm bulb function by doing warning indicator lights test.

If light is on with engine running:

NOTE: Oil may bypass filter when cold (light should go out as oil temperature increases).

1. Stop engine.
2. Replace hydraulic filter element.

If light is still on with engine running, or is on with engine off and ignition key switch ON:

1. Check switch by disconnecting wire. Light should go out.
2. If light goes out, switch or by-pass valve is faulty.
3. If light is still on, check for short circuit in wiring.
4. If light is still on, check for problem with test switch or bridge rectifier.

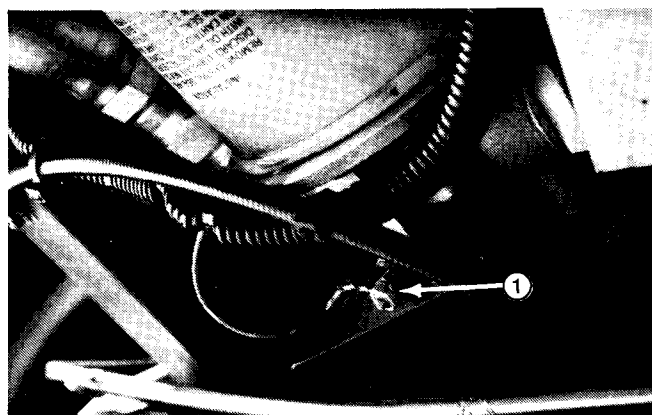


Figure 25

1. Hydraulic oil filter warning switch

Air Cleaner Warning Switch

The air cleaner warning switch is normally open (NO) and closes when the air cleaner is restricted (high vacuum).

NOTE: Confirm bulb function by doing warning indicator lights test.

If light is on with engine running:

1. Stop engine.
2. Replace or clean air filter element.

If light is still on with engine running or is on with engine off and ignition key switch ON::

1. Check switch by disconnecting wires. Light should go out.
2. If light goes out, switch is faulty.
3. If light is still on, check for short circuit in wiring.
4. If light is still on, check for problem with test switch or bridge rectifier.

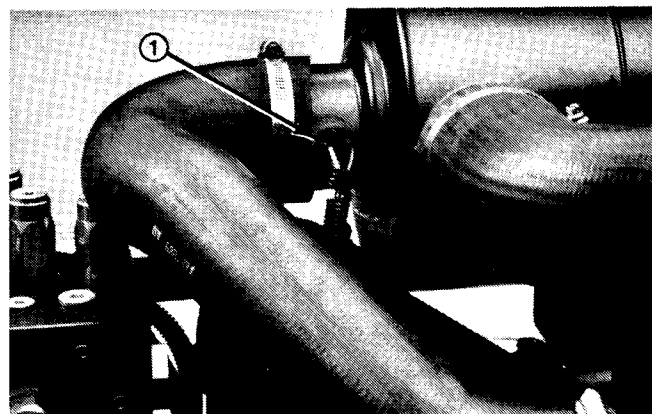


Figure 26

1. Air cleaner warning switch

Repairs

IMPORTANT: Before welding on the machine, disconnect the negative (-) battery cables from the battery and **DISCONNECT THE ELECTRICAL CONNECTORS FROM THE CONTROLLER** to prevent damage to the electrical system.

Battery Service

1. Unlatch hood and left hand engine side panel. Raise and prop hood open and remove left side panel.

2. Remove capscrews securing battery tray and slide tray out (Fig. 27).

IMPORTANT: To prevent damage to the electrical components, do not operate the engine with the battery cables disconnected.

Keep the terminals and entire battery case clean. To clean the battery, wash the entire case with a solution of baking soda and water. Rinse with clear water. Do not get the soda solution into the battery because damage to the battery will result. Coat the battery posts and cable connectors with skin-over grease, or petroleum jelly to prevent corrosion.

Check for loose battery hold-downs. A loose battery may crack or cause the container to wear and leak acid.

Check the electrolyte solution to make sure the level is above the plates (Fig. 28). If the level is low (but above the plates inside the battery), add water so the level is to the bottom of the cap tubes. If the level is below the plates, add water only until the plates are covered and then charge the battery. After charging, fill the battery to the proper level.



WARNING

Do not charge a frozen battery because it can explode and cause injury. Let the battery warm to 60° F (15.5° C) before connecting to a charger.

Charge the battery in a well-ventilated place so that gases produced while charging can dissipate. Since the gases are explosive, keep open flame and electrical spark away from the battery; do not smoke. Nausea may result if the gases are inhaled. Unplug the charger from the electrical outlet before connecting or disconnecting the charger leads from the battery posts.

Electrolyte Specific Gravity

Fully charged: 1.250 - 1.280

Discharged: less than 1.240

Battery Specifications

Two (2) BCI Group 26 SMF-5 Batteries

Each battery:

530 Amp Cranking Performance at 0° F (-17° C)

85 min. Reserve Capacity at 80° F (27° C)

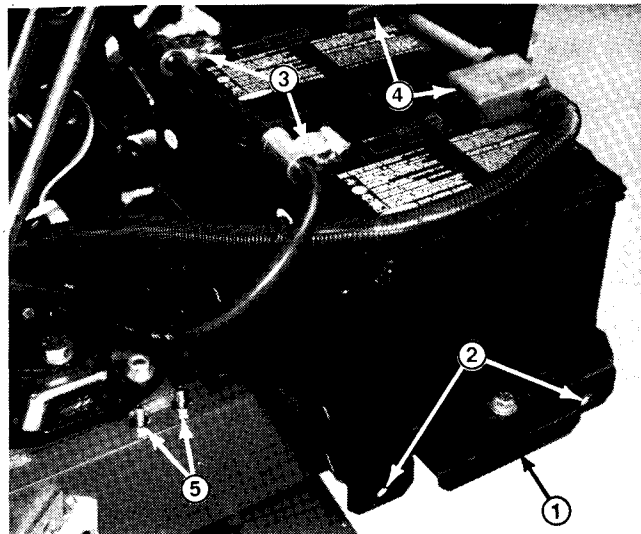


Figure 27

- 1. Battery tray
- 2. Tray mounting holes
- 3. Negative (-) connections
- 4. Positive (+) connections
- 5. Tray mounting screws

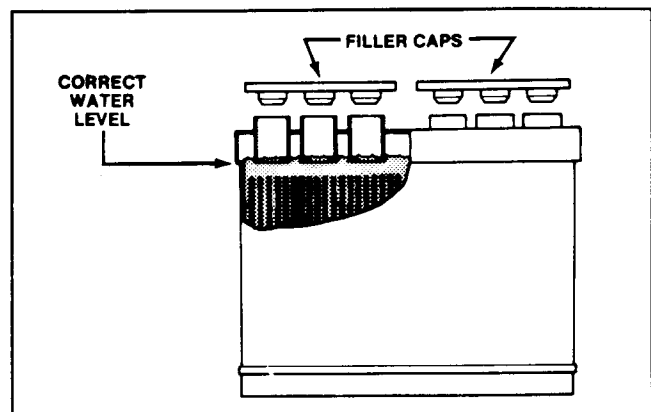


Figure 28

Fuses and Circuit Breakers

The electrical system is protected by nine 5 Amp and single 10 and 15 amp fuses located under the control panel to the operator's right.

NOTE: It is not always possible to see if a fuse is faulty. It is recommended that you check for faulty fuses with a continuity tester, not visually.

A 40 Amp circuit breaker with reset button is also under the control panel for protection of the entire wiring circuit. The button can be pressed to reset the circuit breaker, if total loss of electrical functions occurs. However, the reason for the malfunction should first be found and corrected.

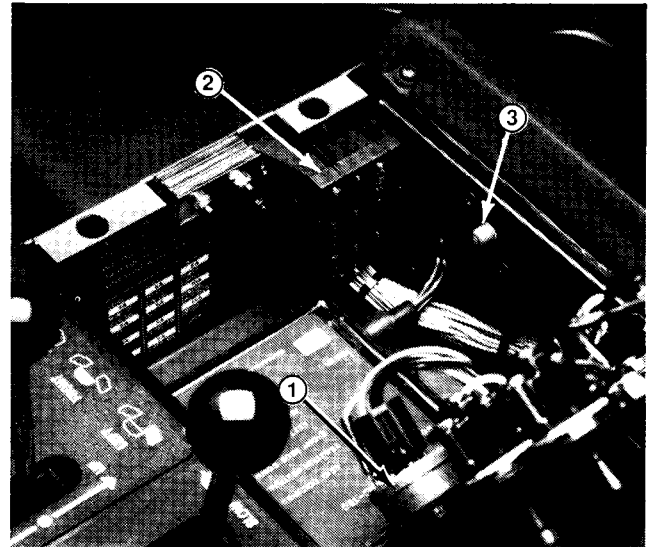


Figure 29

- 1. Control panel
- 2. Fuse block
- 3. Circuit breaker reset button

IMPORTANT

Use correct fuses.

Wrong fuses can cause damage to controller and void warranty.

71-4270

GAUGES	START	CONTROL
5A	5A	5A
MONITOR	RELAY	POWER
DECK SOL	RUN SOL	SUPPLY
5A	5A	10A
LEFT	ALT	GENERAL
5A	5A	SPLY DECKS
RIGHT	CRUISE SOL	15A
5A	5A	CRUISE
FRONT	2-SPD SOL	OPEN

Traction (Neutral) Switch Replacement and Adjustment

1. Remove the two wires that are connected to the traction switch (bottom of transmission) (Fig. 30).

2. Have a helper push the traction pedal down into either the FORWARD or REVERSE position; this will take the switch adjusting screw tension off of the switch. Loosen two (2) screws and remove the switch.

3. Install new switch. DO NOT over-tighten screws as the switch case could break.

NOTE: Have a helper hold the traction pedal down while installing the switch.

4. Reconnect the two wires to the new switch. Make sure that one wire is connected to the "COMMON" terminal, and one wire is connected to the "NORMALLY OPEN" terminal.

IMPORTANT: The traction switch has three (3) terminals. If the two (2) wires are not connected to the "COMMON" and "NORMALLY OPEN" (NO) terminals, the engine will be unable to start and the safety interlock circuit will not function properly.



CAUTION

If the wires are not correctly installed to the switch, the engine could start with the traction pedal in forward or reverse.

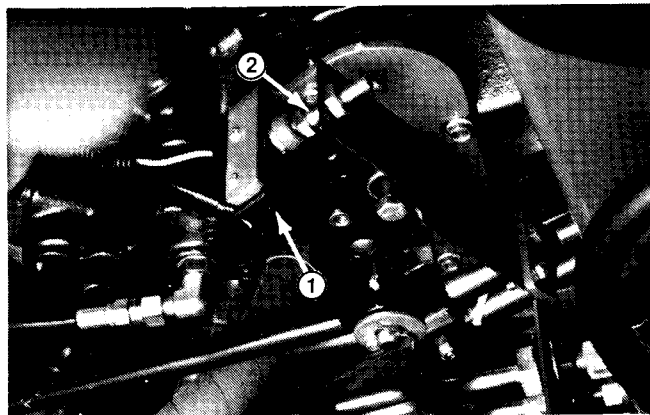


Figure 30

- 1. Traction (neutral) switch
- 2. Adjusting screw

5. Coat the switch connectors with skin-over grease.

6. Check traction control neutral adjustment. (See Traction Control Neutral Adjustment in the Adjustments section of Chapter 4 - HYDRAULIC SYSTEM.

7. Make sure traction pedal is neutral position. Loosen jam nut and rotate switch adjusting screw until there is a gap between head of screw and switch button.

8. Rotate adjusting screw until it contacts the switch button. Continue to rotate screw until circuit is completed (switch "clicks"). After switch clicks, rotate adjusting screw an additional 1 turn. Tighten jam nut.

9. Actuate traction pedal in both FORWARD and REVERSE to assure that switch "clicks" in both directions.

Controller Replacement

IMPORTANT: Before doing any welding on the machine, disconnect the negative (-) battery cables from the battery and **DISCONNECT THE ELECTRICAL CONNECTORS FROM THE CONTROLLER** to prevent damage to the electrical system.

1. Stop the engine and disconnect the negative (-) battery cables from the battery.
2. Disconnect the POWER and I/O connectors from the controller.
3. Remove nuts securing controller to frame and remove controller.
4. Install controller and secure to frame with nuts removed in step 3.



WARNING

To prevent possible personal injury, or damage to electrical system when installing controller, make sure POWER connector is installed correctly. If you attempt to install it upside down, the engine will immediately begin to crank, or will crank as soon as the battery cables are connected.

5. Connect I/O and POWER connectors to controller.
6. Connect battery cables.

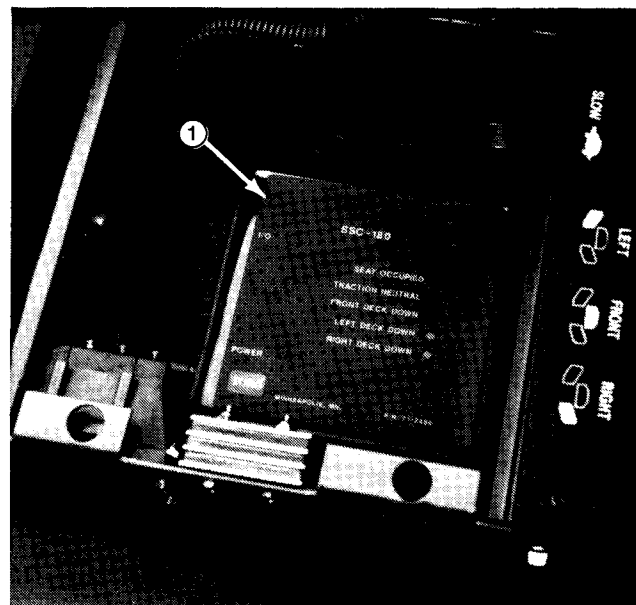


Figure 31

1. Controller

Solenoid Valve Coil Replacement

1. Park machine on a level surface, engage parking brake, raise wing decks completely, lower front deck to ground and turn engine OFF.
2. Disconnect solenoid electrical connector.
3. Remove nut from solenoid.
4. Remove cover and solenoid coil.
5. Install new solenoid coil and secure with nut.
6. Connect electrical connector.

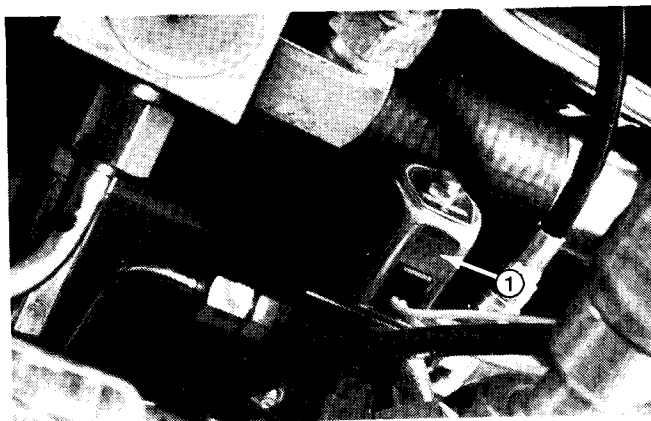


Figure 32

1. 2-speed (mow/transport solenoid)

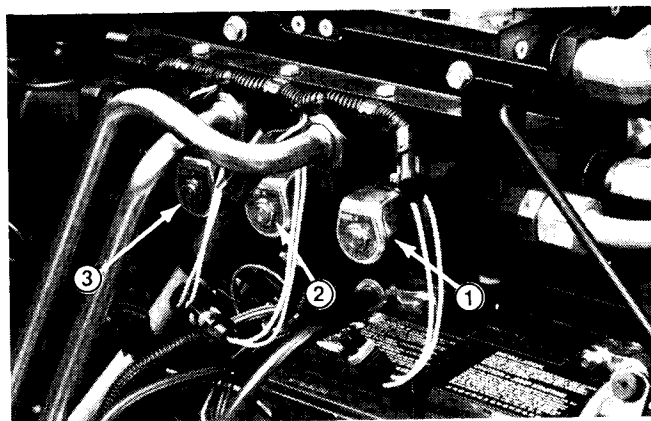


Figure 33

1. Front deck solenoid valve (port SV1)
2. Left wing deck solenoid valve (port SV3)
3. Right wing deck solenoid valve (port SV2)

Starter

Disassembly

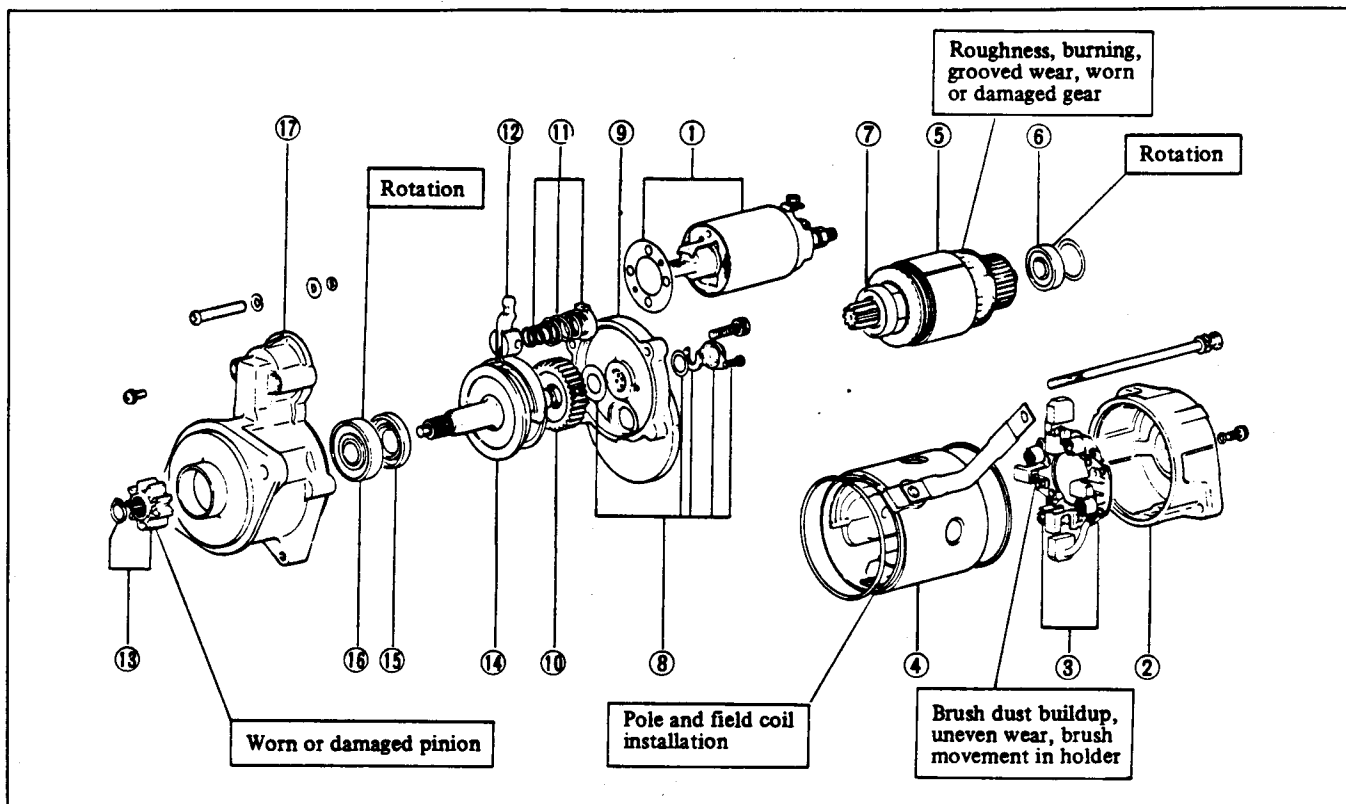


Figure 34

- 1. Switch
- 2. Rear bracket
- 3. Brush holder
- 4. Yoke
- 5. Armature
- 6. Ball bearing

- 7. Ball bearing
- 8. Cover set
- 9. Center bracket
- 10. Gear
- 11. Spring set
- 12. Lever

- 13. Pinion set
- 14. Pinion shaft
- 15. Oil seat
- 16. Ball bearing
- 17. Front bracket

Inspection and Repair

1. Armature

A. Testing armature for short circuits

Place the armature on a growler and slowly revolve it with a hacksaw blade held above the armature core. The hacksaw blade vibrates against the core when it is above a slot containing a shorted winding. Replace the armature if shorted.

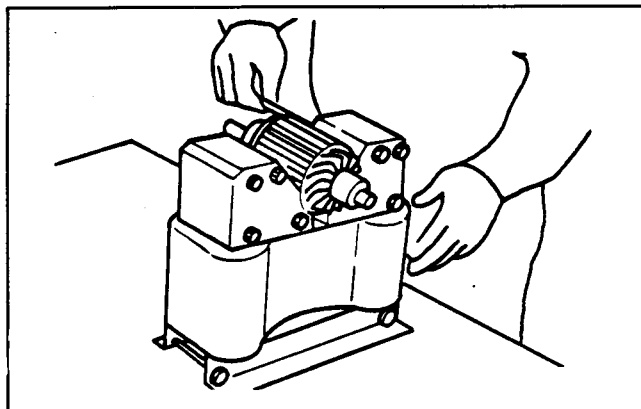


Figure 35

B. Testing armature for grounded circuits

If there is continuity between the commutator and shaft (or core), the armature is grounded and should be replaced.

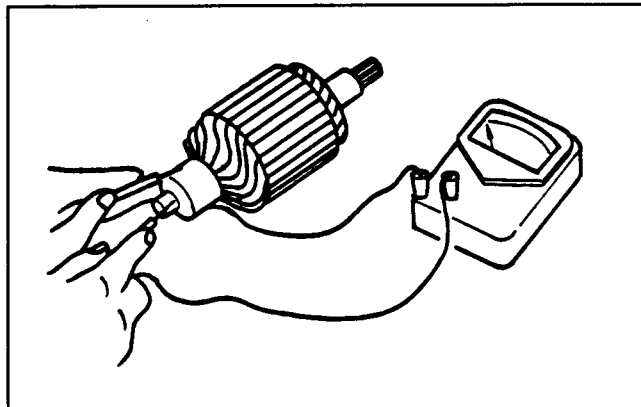


Figure 36

C. Inspecting commutator

a. Support the armature in V-blocks and measure the runout of commutator with a dial gauge. If the runout exceeds the Repair limit, repair the commutator by turning it in a lathe within the Service limit for the outside diameter. If the commutator surface is rough, smooth it with a sandpaper of 300 to 500 grit.

Unit: mm (in.)

Item	Assembly standard	Repair limit	Service limit
Commutator runout	0.03 (0.0012)	0.05 (0.0020)	0.05 (0.0020)

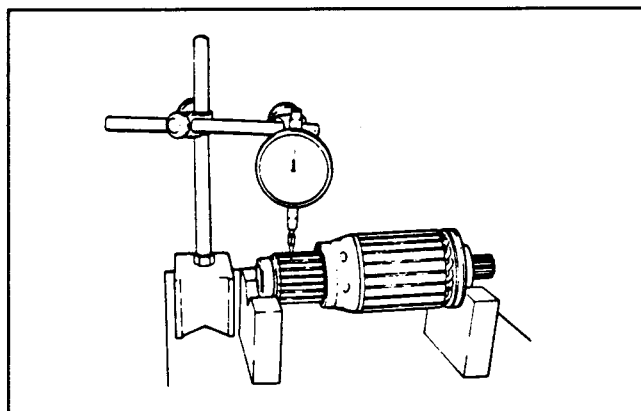


Figure 37

b. Measure the outside diameter of commutator. If it is smaller than the Service limit, replace the armature.

Unit: mm (in.)

Item	Assembly standard	Service limit
Outside diameter of commutator	32 (1.26)	31 (1.22)

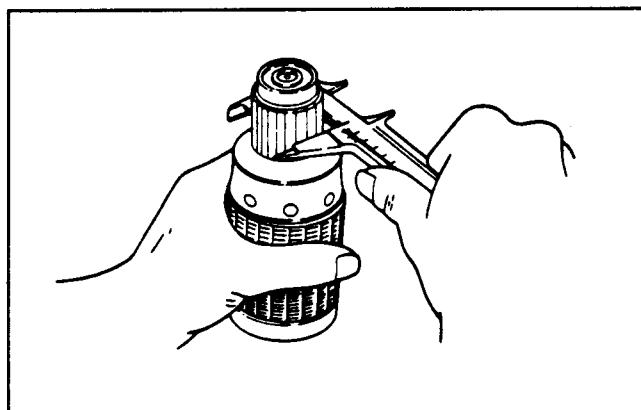


Figure 38

c. Measure the depth of each mica between segments with a depth gauge. If the depth exceeds the Repair limit, recondition the mica.

Unit: mm (in.)

Item	Repair limit
Commutator mica depth	0.2 (0.008), maximum

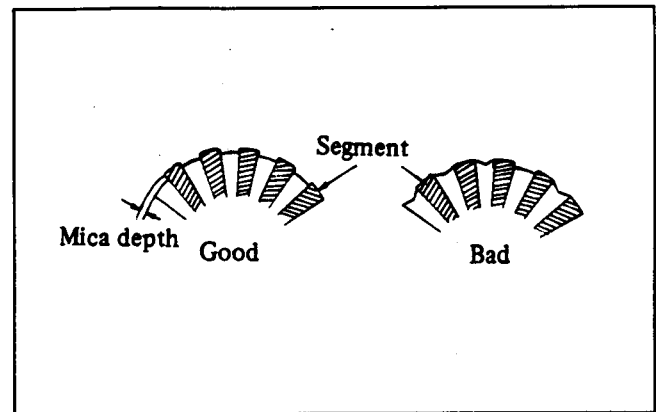


Figure 39

2. Field coil

A. Testing for open circuits

If there is not continuity between the lead wire and positive (+) brush, the field coil is open and the yoke assembly should be replaced.

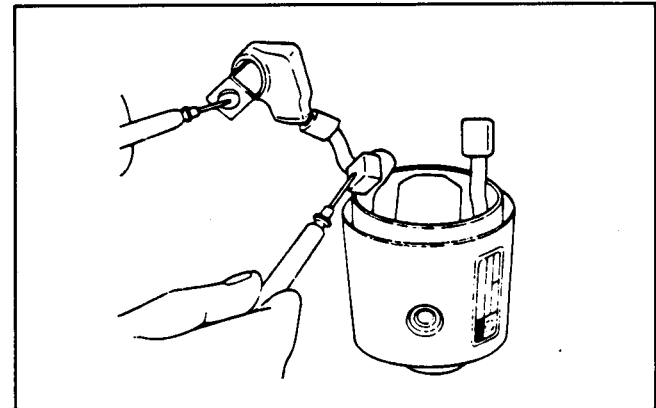


Figure 40

B. Testing for grounded circuits

If there is continuity between the yoke and positive (+) brush, check the insulation and repair or replace the yoke assembly.

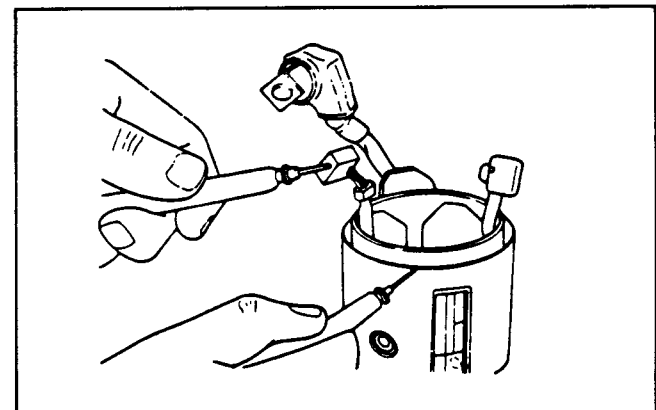


Figure 41

3. Brushes and holders

A. Wear of brushes

Measure the brush length and, if it is less than the Service limit, replace the brushes. If the brushes are unevenly worn or rough, recondition them with a sandpaper of 300 to 500 grit.

Unit: mm (in.)

Item	Assembly standard	Service limit
Brush length	18 (0.71)	11 (0.43)

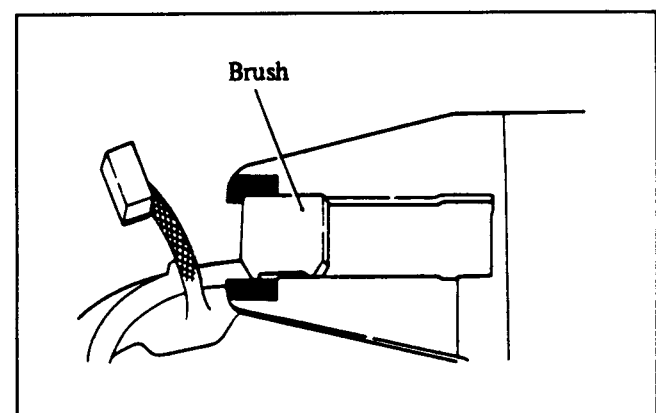


Figure 42

B. Brush spring tension

Test the spring tension (test force) using a new brush. In this test, read the load at the moment that the spring moves off the brush. If the tension is below the Service limit, replace the spring.

Unit: mm (in.)

Item	Assembly standard	Service limit
Brush spring tension	3.5 (0.138)	2.3 (0.091)

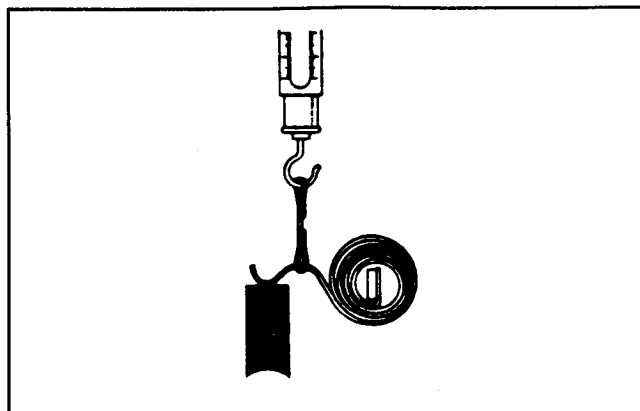


Figure 43

C. Testing brush holders for insulation

If there is continuity between the positive (+) brush holder and negative (-) holder plate, replace the brush holder assembly.

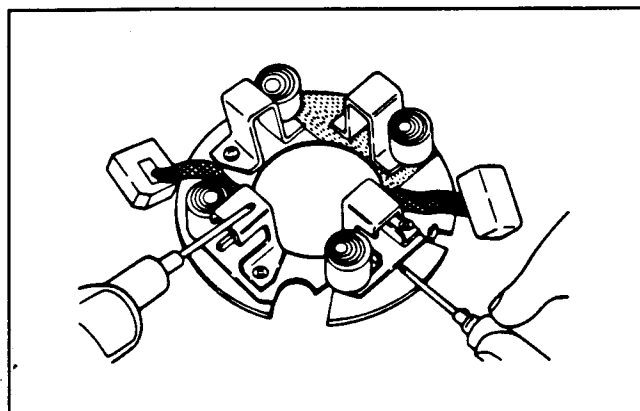


Figure 44

4. Overrunning Clutch

Make sure that the pinion shaft turns smoothly when turned in the direction of driving (clockwise) and that it locks when turned in the opposite direction. If not, replace the overrunning clutch.

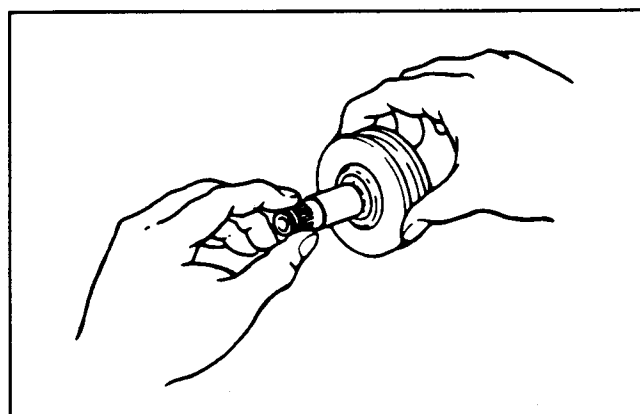


Figure 45

5. Pinion thrust gap

The pinion thrust gap is the play exhibited by the pinion shaft when it is moved in the thrust direction. Measure the thrust gap in the following manner. If it is out of specification, select the adjusting washer and adjust the gap.

A. When the pinion is removed:

Install the gear on the pinion shaft. Insert the shaft into the center bracket and lock the shaft with the washer and ring. Under this condition, move the shaft in the axial direction and measure the thrust gap.

B. When the pinion is installed:

Install the pinion shaft and gear between the front and center brackets and temporarily tighten the bolt. Under this condition, move the shaft in the axial direction and measure the thrust gap.

Unit: mm (in.)

Item	Assembly standard
Pinion thrust gap	0.5 (0.020), maximum [Below 0 not permissible]

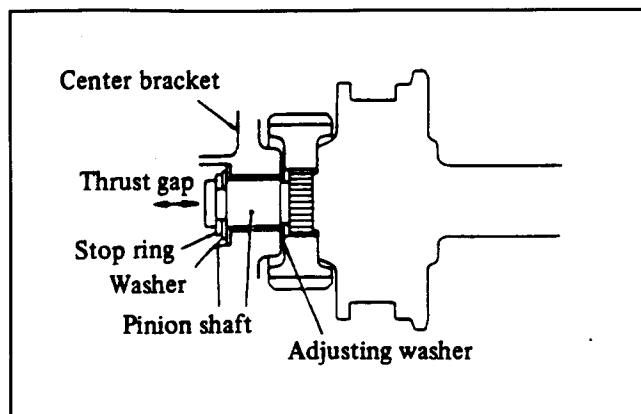


Figure 46

Reassembly

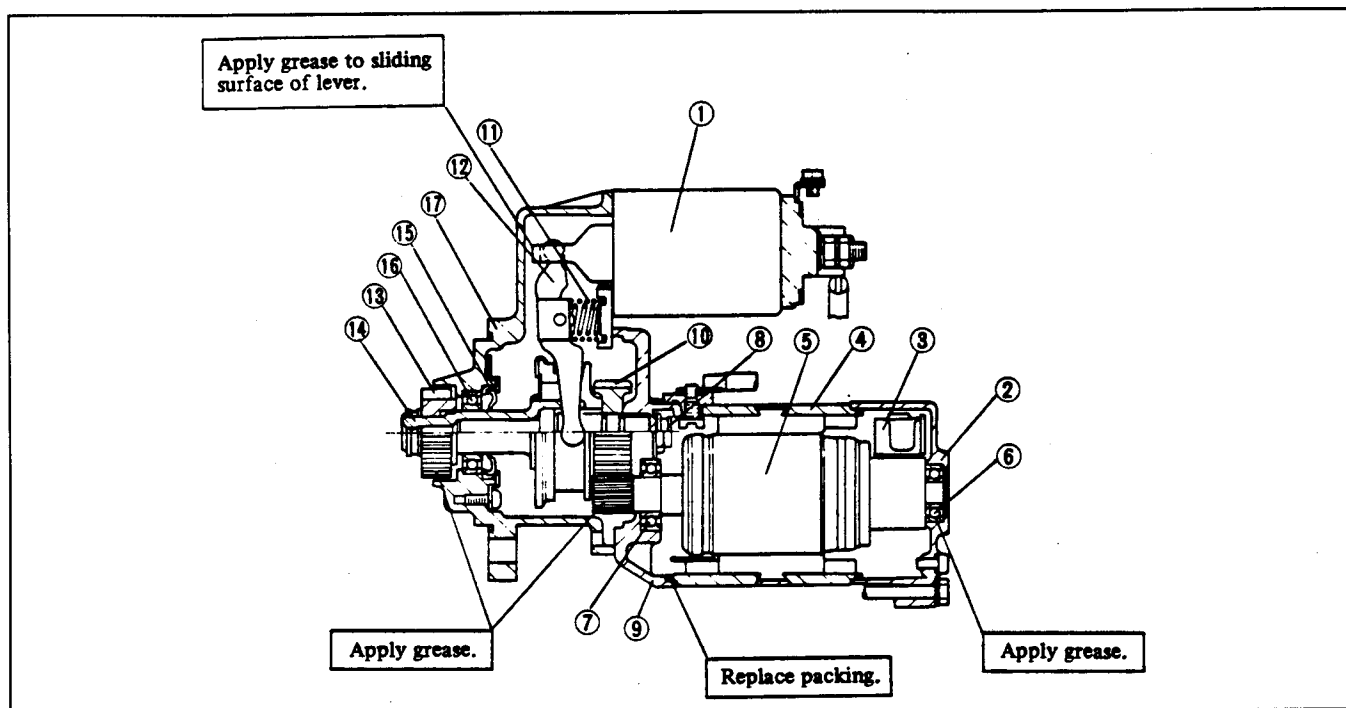


Figure 47

Reassembling sequence

17→ 16→ 15→ 11→ 12→ 14→ 10→ 13→ 9→ 8→ 7→ 6→ 5→ 4→ 3→ 2→ 1

Inspection and testing after reassembly

1. Pinion gap adjustment

A. If the assembled starter is wired as shown, the pinion will shift and turn slowly. Remove the connector from the M terminal to stop the pinion.

B. Under this condition, lightly push in the pinion toward the armature and measure the movement (gap) of the pinion.

C. To adjust the gap, increase or decrease the packing fitted to the magnetic switch. Increasing the packing decreases the pinion gap.

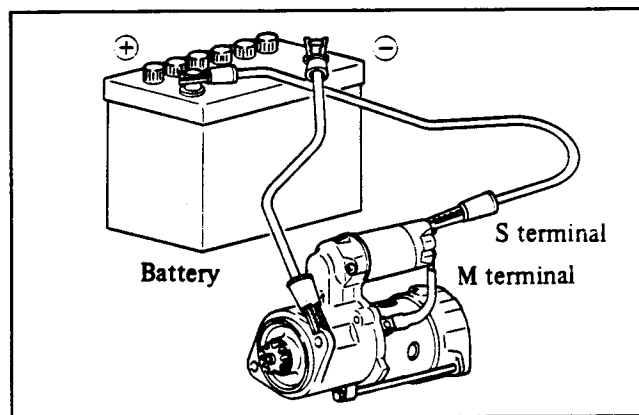


Figure 48

Unit: mm (in.)

Item	Assembly standard
Pinion gap	0.5 - 2.0 (0.025 - 0.079)

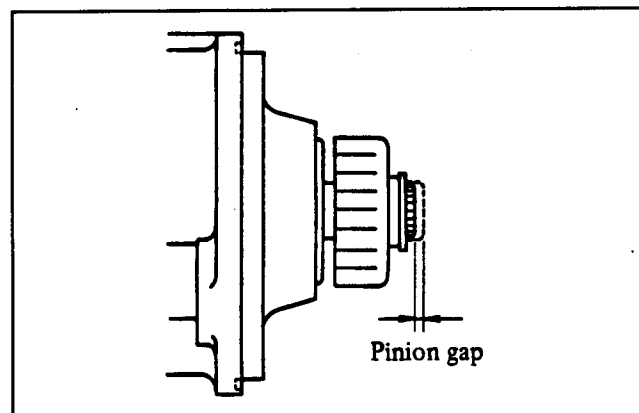


Figure 49

IMPORTANT: Do not test the starter continuously for more than 20 seconds or the switch coil will over-heat.

2. No-load test

After adjusting the pinion gap, hook up the starter as shown and test it for no-load characteristics.

NOTE: Use wires as thick as possible and tighten each terminal securely.

Voltage (V)	Current (A)	Speed (rpm)
11	130, maximum	4000

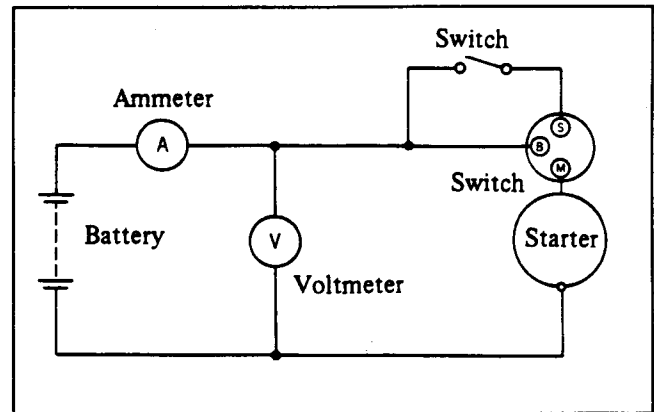


Figure 50

3. Magnetic switch

A. Testing coil for open circuits

If there is no continuity between S and M terminals and between S terminal and body (ground), replace the switch.

B. Inspecting contacts for continuity.

If there is continuity between M and B terminals, replace the switch.

C. Inspecting contacts for poor contact action

Inspect for voltage drop. If voltage drop is excessive, the contacts are damaged.

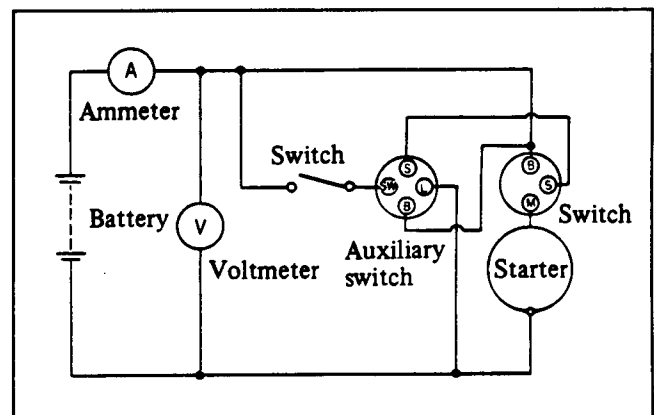


Figure 51

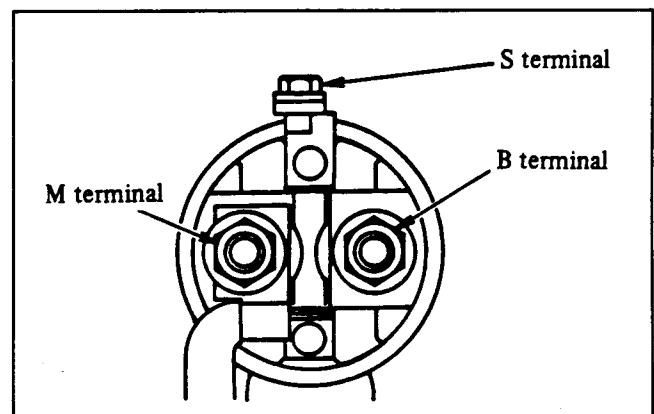


Figure 52

Alternator

Disassembly

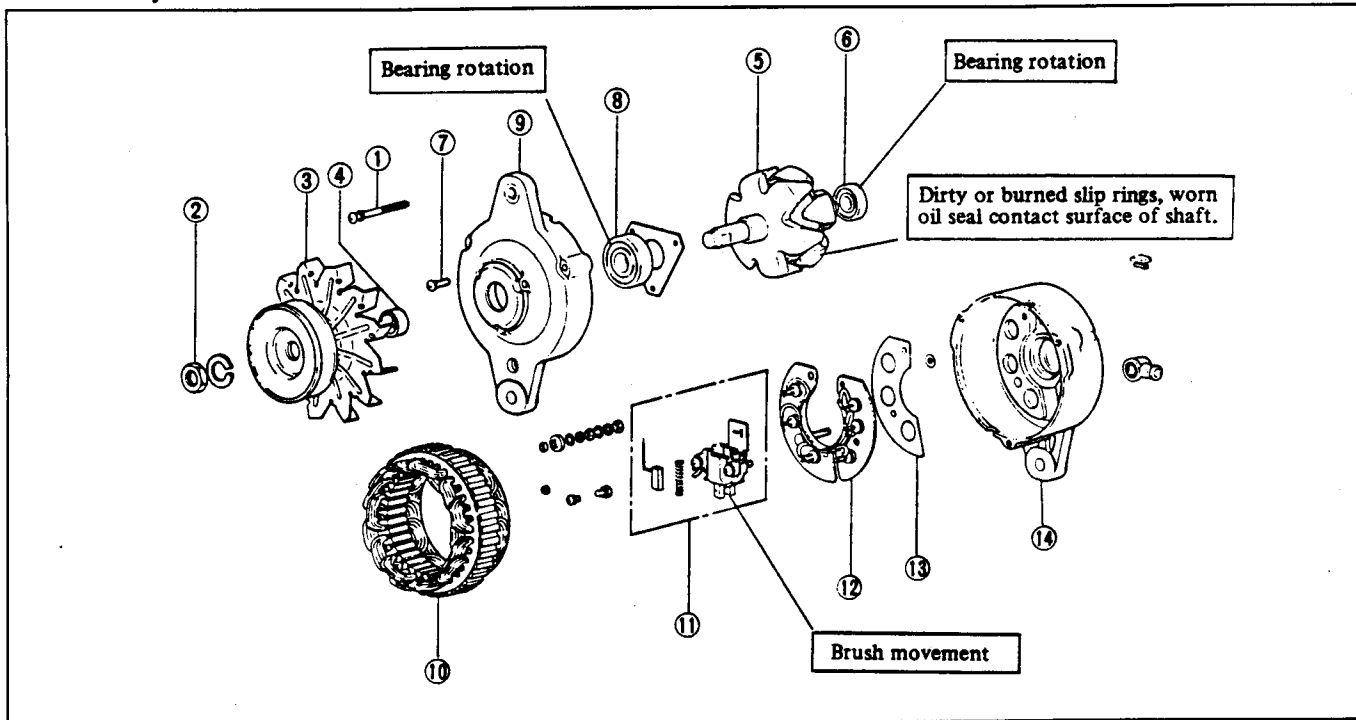


Figure 53

1. Screw

2. Nut

3. Pulley (with fan)

4. Spacer

5. Rotor

6. Bearing

7. Screw

8. Bearing

9. Front bracket

10. Stator

11. Brush holder set

12. Rectifier assembly

13. Plate

14. Rear bracket

Inspection and Repair

1. Brushes

Replace the brushes if they are worn down to the wear limit line.

Unit: mm (in.)

Item	Assembly standard	Service limit
Brush length	18 (0.71)	8 (0.31)

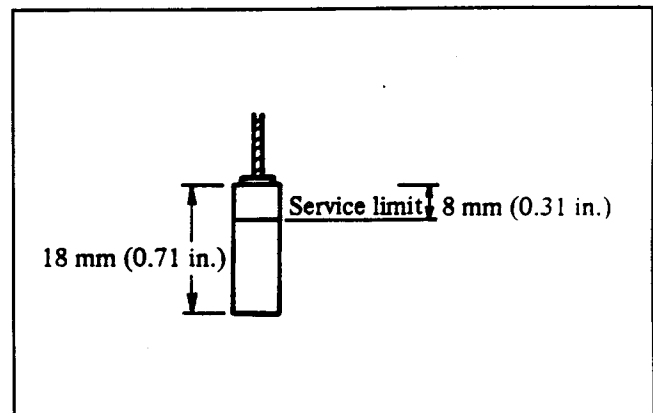


Figure 54

2. Field coil

Measure the resistance between the slip rings. If the resistance is out of specification, replace the rotor.

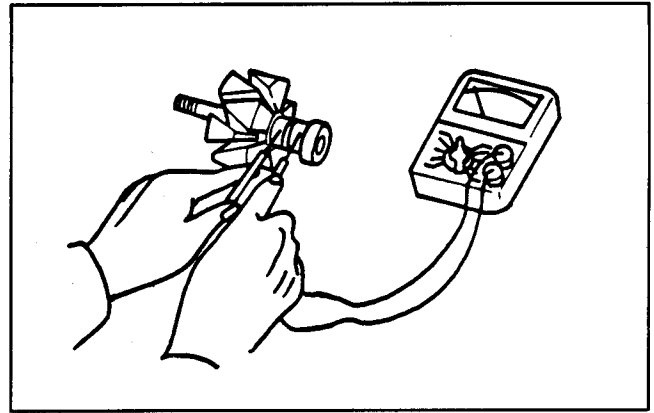


Figure 55

3. Stator coil

Inspect for continuity between the lead wires. If no continuity is noted, the coil is open-circuited. Also check for continuity between the lead wire and coil. If any continuity is noted, the coil is grounded.

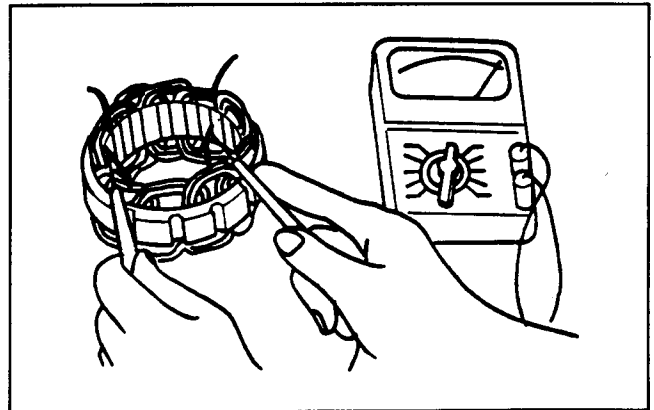


Figure 56

4. Rectifier

Inspect the resistance between the lead wire and heat sink on each diode by connecting the positive (+) side lead wire and negative (-) side lead wire of the tester to the diode. If the resistance is infinite in both cases, the diode is open-circuited. If it is nearly zero in both cases, the diode is short-circuited. If the diode is open- or short-circuited, replace the rectifier.

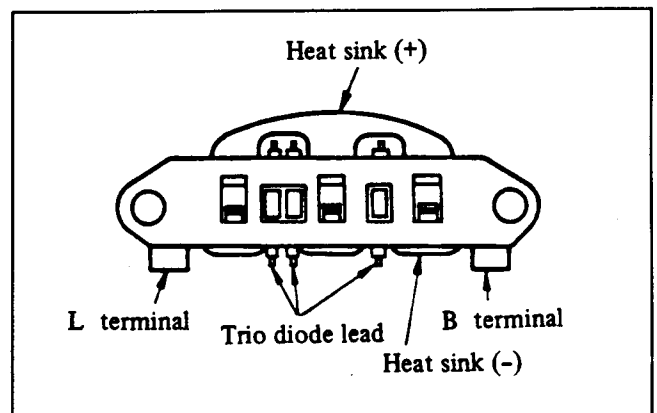


Figure 57

Reassembly

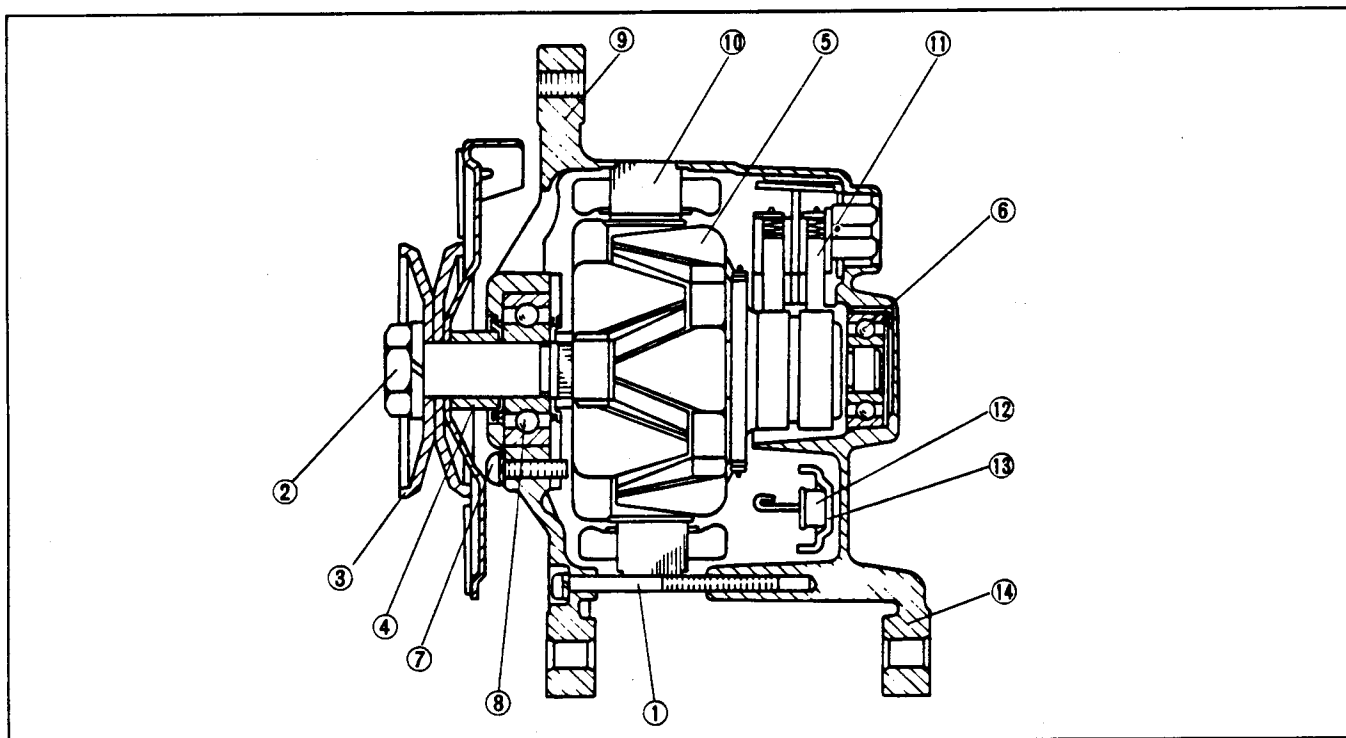


Figure 58

Reassembling sequence

14→13→12→11→10→9→8→7→6→5→4→3→2→1

Push the brush into the holder, and hold it there by inserting a 2 mm (0.08 in.) diameter wire into the hole in the brush. Then install the rotor. Remove the wire after installing the rotor.

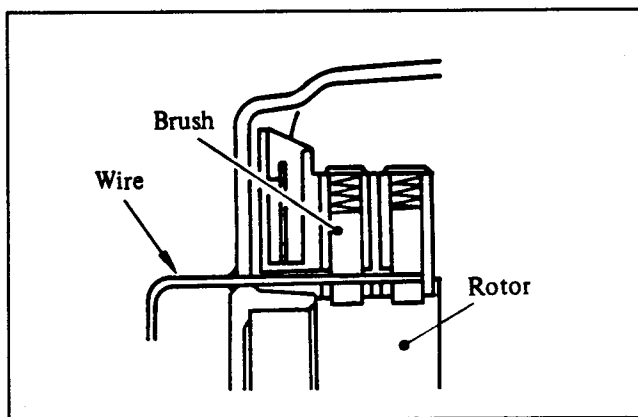


Figure 59



Wheels, Brakes and Steering

Table of Contents

SPECIFICATIONS	2	REPAIRS	10
GENERAL INFORMATION	3	Rear Wheel Bearing Service	10
Disengage Planetary Wheel Drives For Towing ..	3	Planetary Wheel Drive Removal and Installation ..	11
Bleeding Service Brakes	4	Planetary Wheel Drive Disassembly	12
ADJUSTMENTS	5	Planetary Wheel Drive Assembly	13
Service Brake Adjustment	5	Wheel Brake Service	14
Steering/Parking Brake Adjustment	6	Brake Housing Removal	16
Rear Wheel Toe-in Adjustment	7	Wheel Motor Shaft Cup Ring Service	16
Steering Cylinder Adjustment	8	Brake Actuator Seal Replacement	17
Rear Wheel Bearing Adjustment	9	Master Cylinder Service	18
Rear Axle Pivot Adjustment	9		

See Chapter 4 - Hydraulic System for information about the steering hydraulic pump, steering control unit and hydraulic steering cylinders.

Specifications

Planetary Wheel Drive Weight: Approx. 95 lb.

Planetary Wheel Drive Oil Capacity: Fill to bottom of check/drain plug hole when check/drain plug is at either 3 or 9 o'clock position (Fig. 1).

Planetary Wheel Drive Lubricant: API GL-5, SAE 80W or 90W Gear Lubricant.

Brake System: Enclosed, multiple hydraulic disc service brakes operated by right foot pedal. Mechanical steering brakes with two pedals which lock together for parking brake function. Dynamic braking through closed-loop hydrostatic drive system.

Brake Fluid: DOT 3 hydraulic brake fluid. Check and add fluid at master cylinder reservoir (Fig. 2).

Rear Wheel Toe-in: 0.00 to 0.12 in. toe-in (wheels in straight ahead position).

Front Wheel Lug Nut Torque: 60 - 70 ft-lb.

Rear Wheel Lug Nut Torque: 30 - 35 ft-lb.

Tire Pressure:

Normal mowing conditions – 15 psi front; 13 psi rear.

Wet and/or soft conditions – 12 psi front; 9 psi rear.

Dry and/or hard conditions – 18 psi front and rear.

IMPORTANT: Do not operate in HIGH RANGE for extended periods when tire pressure is less than 20 psi because tires may be damaged.

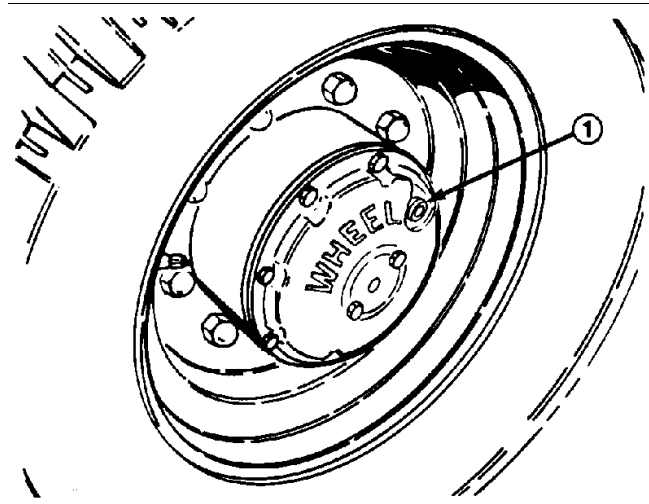


Figure 1

1. Check/drain plug (3 or 9 o'clock position)



Figure 2

1. Master cylinder reservoir (cover removed)

General Information

Disengage Planetary Wheel Drive For Towing

In an emergency, the Groundsmaster 580-D can be moved by unlocking the front wheel hubs and towing the machine.



DANGER

There is no effective braking of the machine with the wheel hubs disengaged. Machine will roll with front wheel hubs disengaged unless machine is on a level surface or wheels are blocked. Do not unlock the wheel hubs without either blocking the wheels or connecting the machine to a towing vehicle with a rigid towing device.

NOTE: The machine can also be moved slowly a short distance by opening the by-pass valve on the variable displacement hydraulic pump and pushing or towing the machine (See Pushing or Towing in the General Information section of Chapter 4 - Hydraulic System).

1. Block the wheels or connect the machine to a towing vehicle with a rigid towing device.
2. Remove bolts securing disengage covers to both front wheel hubs (Fig. 3).
3. Install disengage covers so dimple on cover is facing in towards hub. Wheel hubs are now unlocked.
4. Lock the wheel hubs immediately after towing is completed. Remove disengage covers and reinstall so dimple on cover is facing away from hub.



CAUTION

Do not remove wheel blocks or towing devices until wheel hubs are securely locked.

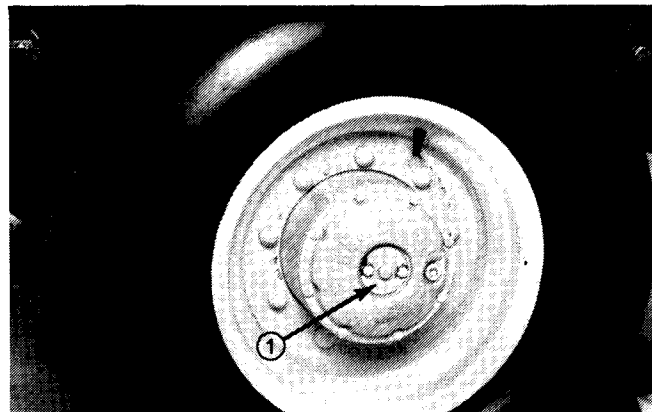


Figure 3

1. Disengage cover - engaged (dimple facing out)

Bleeding Service Brakes

If service brake pedal bottoms out or loses solid feel, bleed brakes.

1. Fill master cylinder with fluid (Fig. 2). Push brake pedal with short strokes until bubbling stops inside master cylinder reservoir (Fig. 4).

2. Install a hose on right hand bleed screw (Fig. 5). Bleed screw is on wheel brake actuator. Have open end of hose submerged in a glass container of clean brake fluid.

3. Loosen bleed screw. Depress brake pedal so brake fluid flows out of bleed screw, through hose and into container. Continue pushing brake pedal and adding brake fluid to master cylinder reservoir until bubbling stops in container at bleed screw. Tighten bleed screw as pedal is depressed.

4. Repeat steps 2 and 3 for left hand bleed screw. Pedal should then have a solid feel, and pedal travel should not exceed 3 inches.

NOTE: To flush the system, continue bleeding at each actuator and adding fluid to master cylinder reservoir until old fluid is replaced by new fluid.

5. After bleeding is completed, make sure master cylinder reservoir is filled and cover is secured in place.

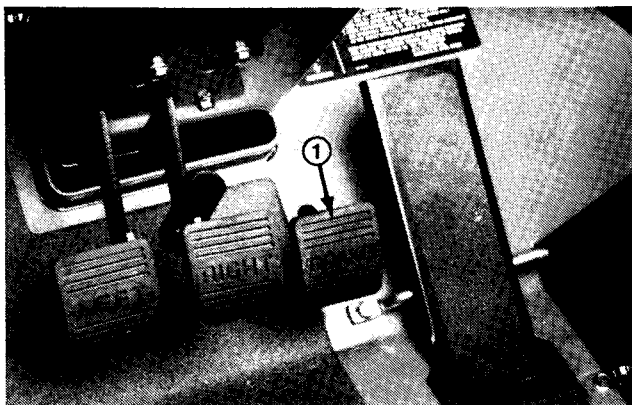


Figure 4

1. Brake pedal

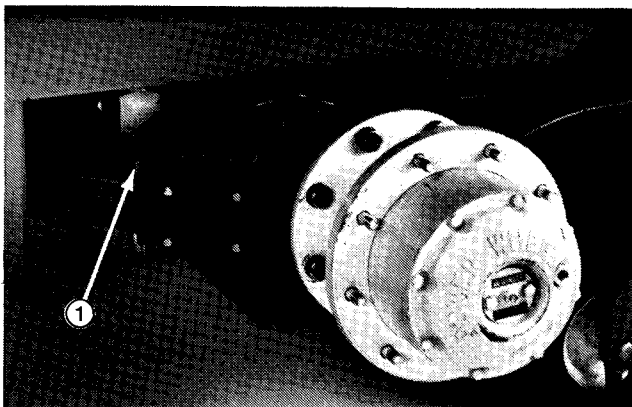


Figure 5

1. Bleed screw (shown with wheel removed)

Adjustments

Service Brake Adjustment

Adjust the service brakes when there is excessive "free travel" that is not caused by air in the system (Fig. 6). Free travel is the distance the brake pedal moves before braking resistance is felt.

Excessive free travel could also indicate that brake disks require replacement. Service brake actuators must be adjusted again after brake disks are replaced.

1. To reduce free travel of service brake pedal, adjust service brake actuators:

A. Use a $\frac{3}{8}$ in. drive $\frac{9}{16}$ in. deep well socket wrench to tighten adjusting nut on end of actuator until brakes are tight (Fig. 7).

B. Put a mark on the socket so you can count the number of rotations. Loosen the adjusting nut three (3) complete turns.

C. Repeat steps A and B for the actuator at the other wheel brake.

D. Check steering/parking brake pedal free play and adjust if there is more than one (1) in. of "free travel". Free travel is the distance the brake pedal moves before braking resistance is felt. (See Steering/Parking Brake Adjustment in this section of the book.)

2. Adjust service brake pedal (Fig. 8).

A. Remove cotter pin and clevis pin to disengage clevis from brake pedal.

B. Loosen jam nut on clevis. With brake pedal completely raised, turn brake rod until clevis pin just slips through hole in brake pedal, then turn clevis one turn clockwise on brake rod.

C. Connect clevis to brake pedal with clevis pin and cotter pin. Tighten jam nut.

D. Adjust switch, so that switch opens when pedal is pushed down 0.50 ± 0.25 in.

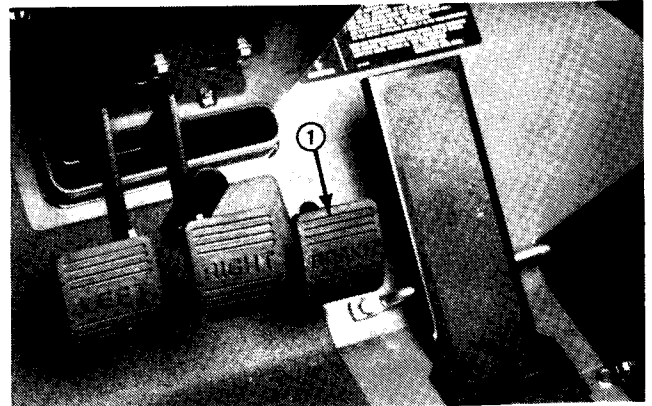


Figure 6

1. Service brake pedal

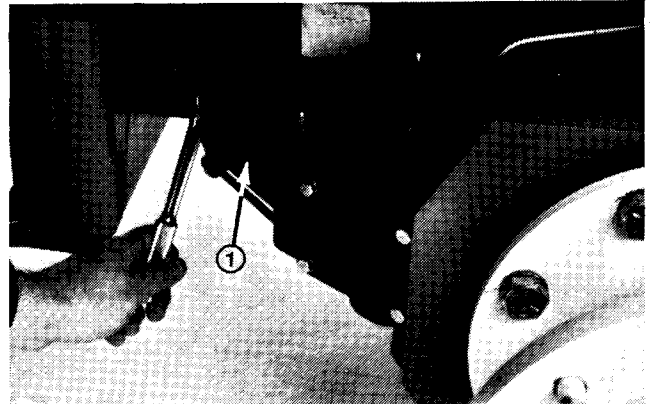


Figure 7
(Shown with wheel removed)

1. Service brake actuator

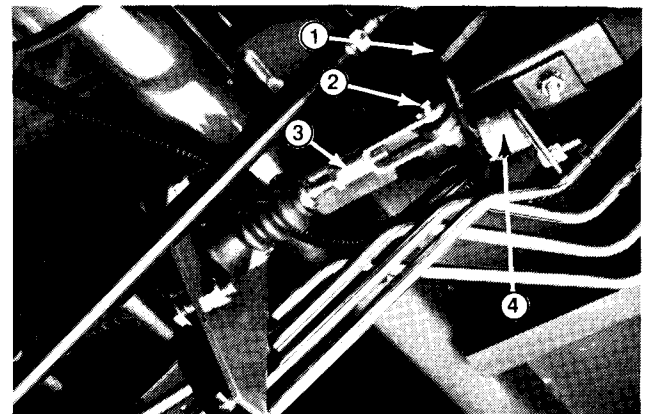


Figure 8

1. Brake pedal 3. Clevis
2. Clevis pin and cotter pin 4. Brake switch

Steering/Parking Brake Adjustment

Adjust the brakes when there is more than one (1) in. of "free travel". Free travel is the distance the brake pedal moves before braking resistance is felt (Fig. 9).

If the cable reaches the end of its adjustment range, or the brakes become ineffective, the brake disks require replacement. Brake pedals must be adjusted again after brake disks are replaced.

1. Disengage the lock arm from the left brake pedal so both pedals operate independently.

2. To reduce free travel of brake pedals, tighten the brakes:

A. Remove cover from front of steering tower.

B. Loosen top jam nut on threaded end of brake cable (Fig. 9).

C. Tighten bottom jam nut to move cable down until brake pedals have 1/2 to 1 in. of free travel.

D. Tighten top jam nut after brakes are adjusted correctly.

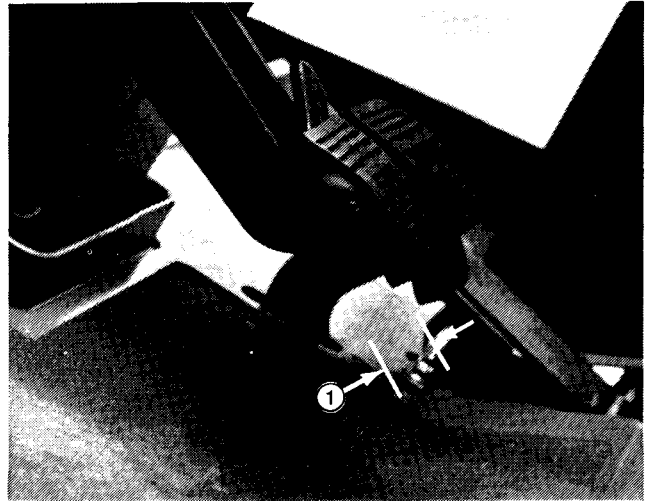


Figure 9

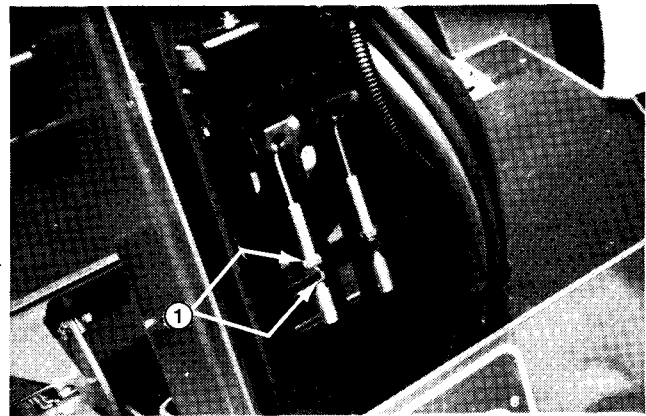


Figure 10

1. Jam nuts

Rear Wheel Toe-in Adjustment

1. Put rear wheels in straight ahead position.

2. Measure center-to-center distance (at axle height) at front and rear of steering tires (Fig. 11). Front measurement should be 0 to 0.12 in. less than rear measurement.

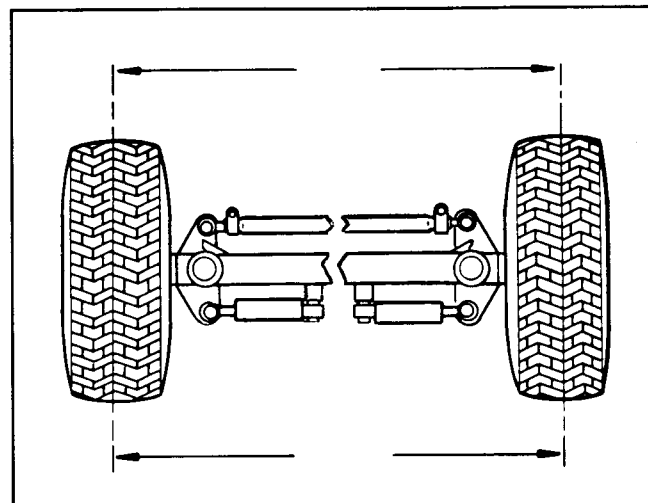


Figure 11

3. If adjustment is required, loosen tie rod clamps (Fig. 12).

4. Turn tie rod to get 0.00 to 0.12 in. toe-in (measured at front of tires). Measurement must be taken at the same height from the ground both front and rear.

5. After adjusting, slots in tie rod and clamps should face down.

6. Tighten clamps.

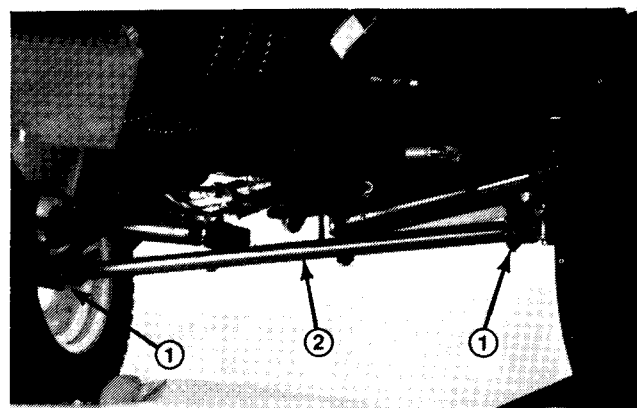


Figure 12

1. Clamp

2. Tie rod

Steering Cylinder Adjustment

NOTE: Adjust toe-in before adjusting steering cylinder ball joints (See Rear Wheel Toe-in Adjustment).

Ball joint must be located on cylinder shaft so that steering arms hit stops in either direction (Fig. 13).

1. If adjustment is required, loosen clamp (Fig. 14).
2. Turn cylinder shaft so steering arm hits stop on rear axle before cylinder shaft is fully retracted.
3. Tighten clamp.

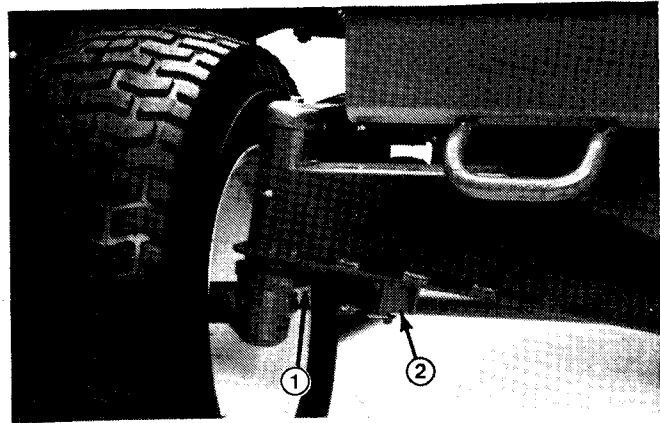


Figure 13

1. Steering arm

2. Steering stop

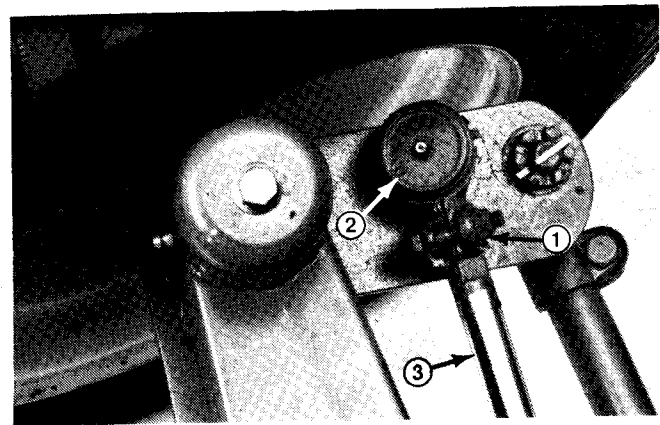


Figure 14

1. Clamp

2. Ball joint

3. Cylinder shaft

Rear Wheel Bearing Adjustment

1. Jack up rear of machine until wheel is off floor. Support machine with jack stands or blocks to prevent it from falling.

2. Remove dust cap from end of wheel spindle. Remove cotter pin retaining slotted nut in place (Fig. 15).

3. Rotate wheel by hand and tighten slotted nut until bearing binds SLIGHTLY. Then, loosen nut until nearest slot and hole in spindle are aligned. Reinstall cotter pin to retain slotted nut in place.

4. Remove jack stands or blocks and lower machine to floor. Put a coating of grease on inside of dust cap. Install dust cap on end of wheel spindle.

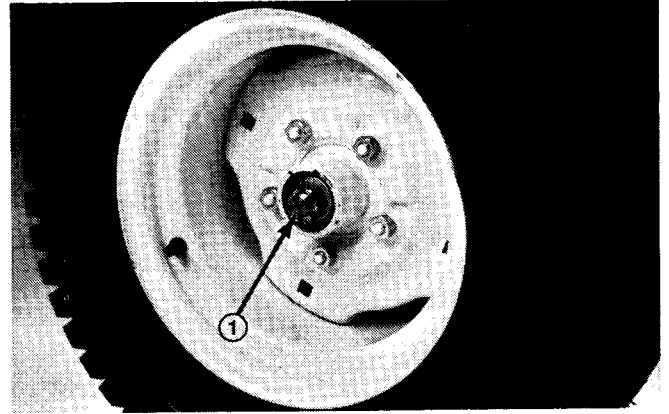


Figure 15

1. Cotter pin and slotted nut

Rear Axle Pivot Adjustment

Tighten nut to eliminate any axial movement of rear axle while still allowing free rotation (Fig. 16).

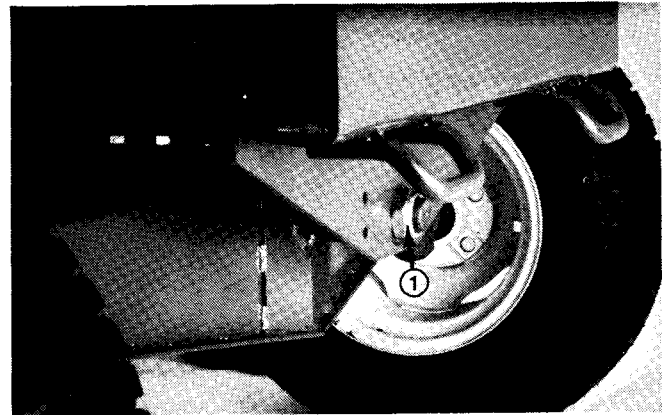


Figure 16

1. Rear axle pivot shaft nut

Repairs

Rear Wheel Bearing Service

1. Jack up rear of machine until tire is off floor. Support machine with jack stands or blocks to prevent it from falling.

2. Remove dust cap from end of wheel spindle (Fig. 17).

3. Remove cotter pin, slotted nut, and washer. Slide wheel off spindle shaft.

4. Pull seal out of wheel hub.

5. Remove bearing cones from both sides of wheel hub. Clean bearings in solvent. Make sure bearings are in good operating condition. Clean inside of wheel hub. Check bearing cups for wear, pitting or other noticeable damage. Replace worn or damaged parts.

6. If bearing cups were removed from wheel hub, press them into the hub until they seat against the shoulder.

7. Pack both bearings with grease. Use No. 2 general purpose lithium base grease containing E.P. additive. Install one bearing into cup on inboard side of wheel hub. Lubricate inside of new lip seal and press it into wheel hub.

IMPORTANT: Lip seal must be pressed in so it is flush with end of hub. Lip of seal must be toward bearing.

8. Pack inside of wheel hub with some grease (not full). Install remaining bearing into bearing cup.

9. Slide wheel onto spindle shaft and secure it in place with flatwasher and slotted nut. DO NOT tighten nut or install cotter pin.

10. Adjust preload on wheel bearings. (See Rear Wheel Bearing Adjustment in the Adjustments section of this chapter.)

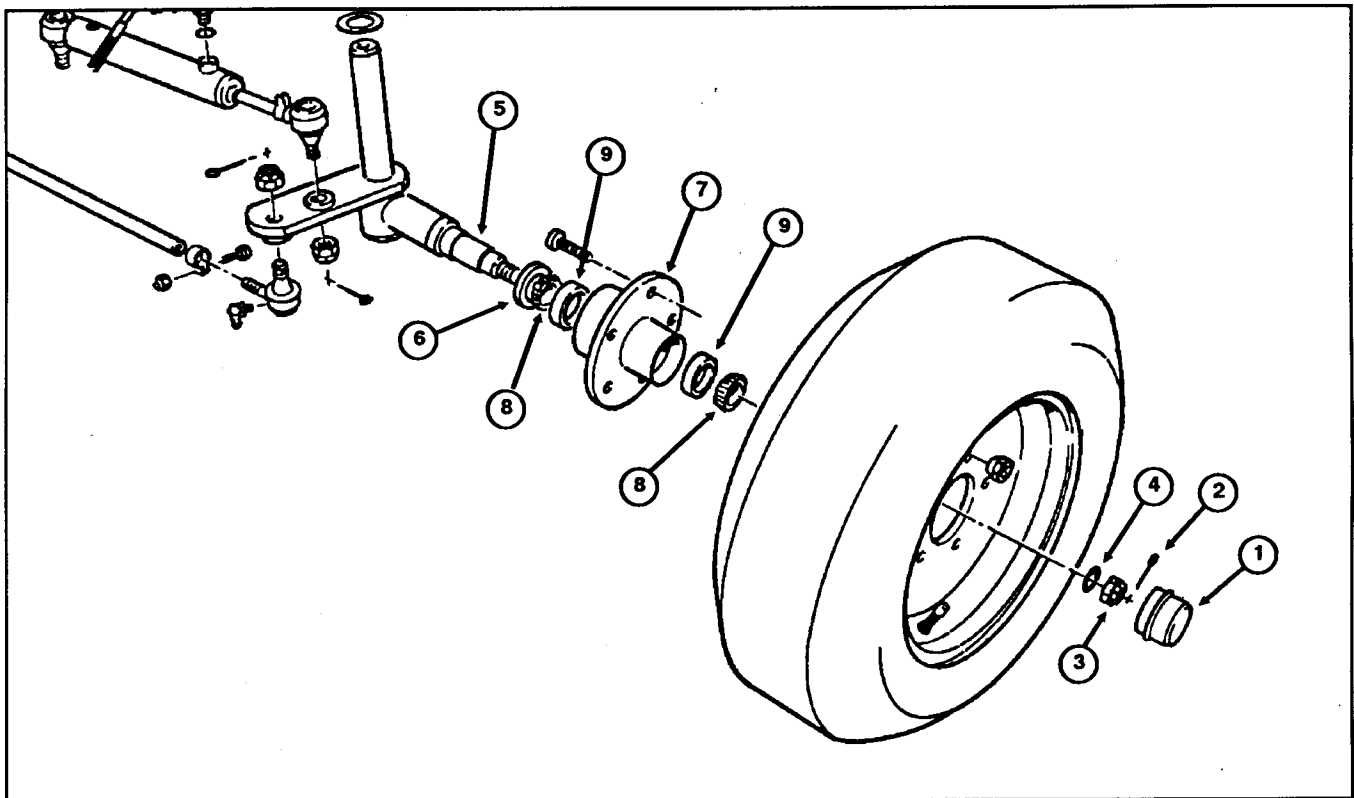


Figure 17

1. Dust cap
2. Cotter pin
3. Slotted nut

4. Washer
5. Spindle shaft
6. Seal

7. Wheel hub
8. Bearing cone
9. Bearing cup

Planetary Wheel Drive Removal and Installation

1. Loosen wheel lug nuts (Fig. 18).
2. Jack up machine and support with jack stands of proper capacity.
3. Remove wheel lug nuts and remove wheel.

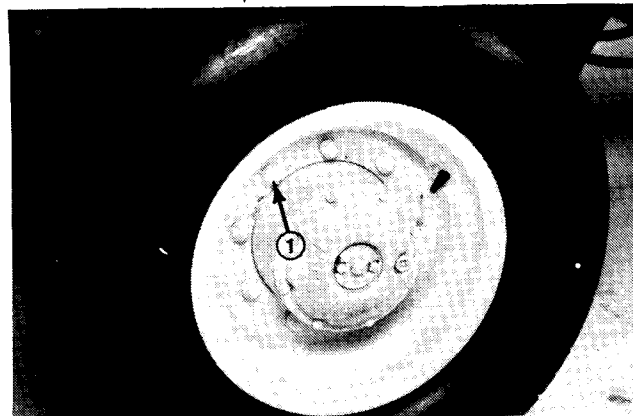


Figure 18

1. Wheel lug nuts

NOTE: Put a drain pan below planetary wheel drive to catch oil. If oil has not been drained, approximately 8 oz. of oil will drain out as wheel drive is pulled away from hydraulic motor coupling.

4. Remove eight (8) capscrews and lockwashers securing planetary wheel drive to brake housing (Fig. 19). Pull wheel drive out approximately 1/2 in. and allow oil to drain out.

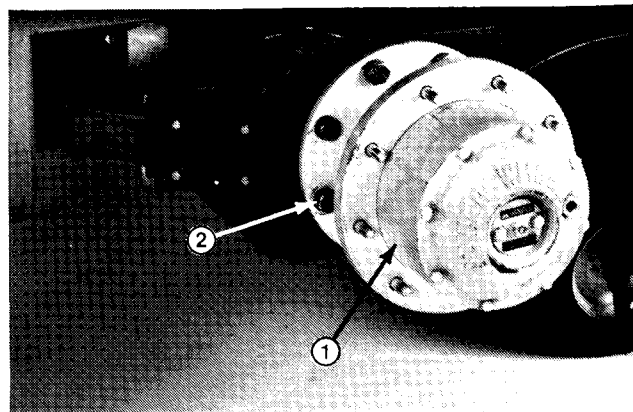


Figure 19

1. Planetary wheel drive 2. Mounting capscrews

5. Remove planetary wheel drive (Fig. 20).
6. Before installing planetary wheel drive make sure o-ring is installed on brake housing cap. Replace o-ring if damaged.
7. Reverse steps 1 - 4 to install planetary wheel drive. Install so breather is up. It will be necessary to rotate wheel drive when installing to align splines on input shaft with hydraulic motor coupling.
8. Tighten wheel lug nuts in a crossing pattern to a torque of 60 - 70 ft-lb.
9. Check planetary wheel drive oil level and add correct oil as necessary.

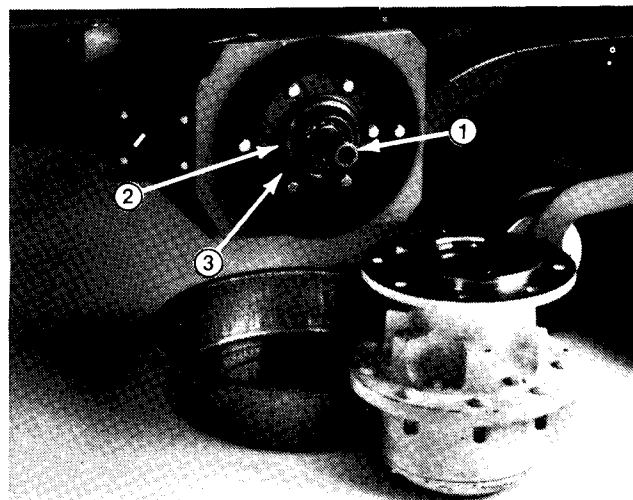


Figure 20

1. Hydraulic motor coupling 3. Brake housing cap
2. O-ring

Planetary Wheel Drive Disassembly

1. Put assembly upright on face of spindle (Fig. 21, Item 3).

2. Remove two (2) bolts (Item 14) and remove disengage cover (Item 18).

3. Remove eight (8) bolts (Item 17) and remove large cover (Item 19). Plunger (Item 22) usually remains with cover. Remove plunger and o-ring (Item 21) from cover on end of input shaft (Item 2).

4. A thrust washer (Item 23) will usually remain in position on thrust face of cover.

5. Remove sun gear (Item 13) and thrust washer (Item 12) from end of input shaft.

6. Remove primary carrier (Item 15).

NOTE: Primary and secondary carrier assemblies must be replaced as complete assemblies. Individual parts are not serviceable.

7. Remove secondary carrier assembly (Item 20). It may be necessary to remove the ring gear (Item 24) first, if difficulty is encountered in removing the carrier.

8. Remove input shaft (Item 2) from spindle (Item 3). Remove the retaining rings, washers and spring from input shaft only if replacement is required.

9. Remove six (6) bolts (Item 10) from hub and ring gear and remove ring gear (Item 24). It may be necessary to strike ring gear with a rubber mallet to loosen from hub.

10. Use a snap ring expander to remove large retaining ring (Item 28) from in front of tapered bearing. Lift hub (Item 8) from spindle. If bearings are not a loose fit, it may be necessary to press spindle from hub.

11. Remove oil seal (Item 4) and bearing cones (Items 5 and 9) from hub. Inspect bearing cups (Item 6) in position and remove only if replacement is required.

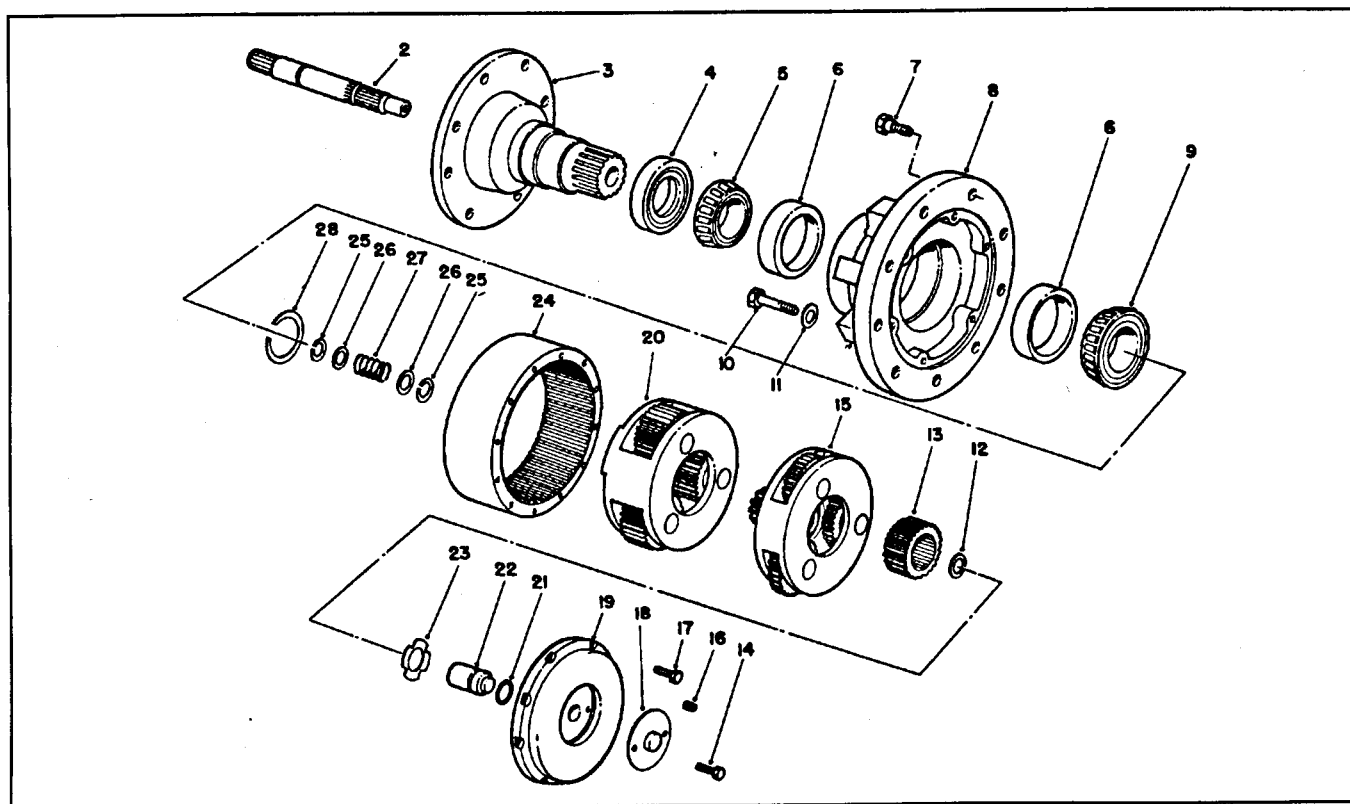


Figure 21

2. Input shaft

3. Spindle

4. Oil seal

5. Bearing cone

6. Bearing cup

7. Wheel bolt

8. Hub

9. Bearing cone

10. Bolt

11. Flat washer

12. Thrust washer

13. Primary sun gear

14. Bolt

15. Primary carrier assembly

16. Plug

17. Bolt

18. Disengage cover

19. Large cover

20. Secondary carrier assembly

21. O-ring seal

22. Disengage plunger

23. Thrust washer

24. Ring gear

25. Retaining ring

26. Washer

27. Disengage spring

Planetary Wheel Drive Assembly

1. Press a new bearing cup (Item 6) in each side of hub (Item 8).

2. Assemble a bearing cone (Item 5) into cup (Item 6) at seal end of hub and press a new seal (Item 4) into hub.

3. Put spindle (Item 3) upright on bench. Lubricate lips of seal (Item 4) and lower hub onto spindle. Hub (Item 8) should be centered as it is lowered over spindle to prevent seal damage.

4. Assemble bearing cone (Item 9) over spindle and into bearing cup (Item 6). Select the thickest retaining ring (Item 28) that can be assembled into ring groove of spindle shaft above bearing cone. Bearing should have from 0.000 - 0.006 in. end play when proper retaining ring is installed.

5. Assemble a retaining ring (Item 25) in groove opposite pilot end of input shaft (Item 2). Assemble a washer (Item 26), spring (Item 27), a second washer (Item 26) and a second retaining ring (Item 25) in the middle groove of input shaft.

6. Assemble the splined end of the input shaft down into spindle.

7. Assemble secondary carrier splines over splined end of spindle.

8. Apply a bead of RTV compound to hub face that mates with ring gear (Item 24). Apply RTV compound in a continuous bead, which is centered on mating surface and goes around inside of each bolt hole. Assemble the end of ring gear having six (6) bolt holes against hub with

bolt holes of hub and ring gear aligned. Install six (6) bolts and tighten to a torque of 39 - 49 ft-lb. If grade 8 bolts are used, the bolts should be tightened to a torque of 52 - 60 ft-lb.

9. Assemble the primary carrier and sun gear into ring gear. It will be necessary to rotate carrier and pinion to align sun gear teeth with secondary pinion and primary pinions with ring gear teeth. Assemble the small sun gear (Item 13) over input shaft. Rotate sun gear to align shaft to gear splines and gear teeth.

10. Assemble the small thrust washer (Item 12) over input shaft and against shoulder of shaft.

11. Install an o-ring (Item 21) in groove of the disengage plunger (Item 22). Assemble plunger over end of input shaft and against thrust washer.

12. Lubricate the o-ring in groove of engage plunger. Assemble the thrust washer (Item 23) with tangs engaged with cover (Item 19). Apply a bead of RTV compound to end face of ring gear. Apply RTV compound in a continuous bead, which is centered on mating surface and goes around inside of each bolt hole. Assemble cover over plunger as holes of cover and ring gear are aligned. Install the eight (8) bolts (Item 17) and tighten to a torque of 20 - 25 ft-lb.

13. Assemble the disengage cover (Item 18) with dimpled center facing out. Install the two (2) bolts (Item 14) and tighten to a torque 10 - 20 ft-lb.

Wheel Brake Service

1. Remove planetary wheel drive. (See Planetary Wheel Drive Removal and Installation in this Chapter.)

2. Remove four (4) capscrews and lock washers from brake housing cap (Fig. 22).

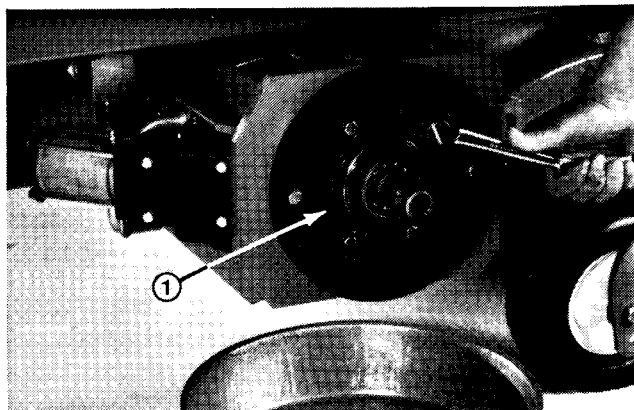


Figure 22

1. Brake housing cap

3. Remove brake housing cap and outer brake disc (Fig. 23).

4. Remove four (4) capscrews and remove cover from brake actuator housing (Fig 23).

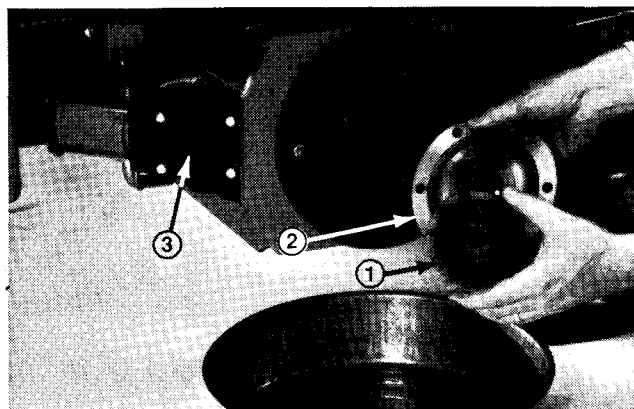


Figure 23

1. Outer brake disc
2. Brake housing cap

3. Actuator housing cover

5. Remove cotter key and clevis pin to disconnect brake cable clevis (Fig 24).

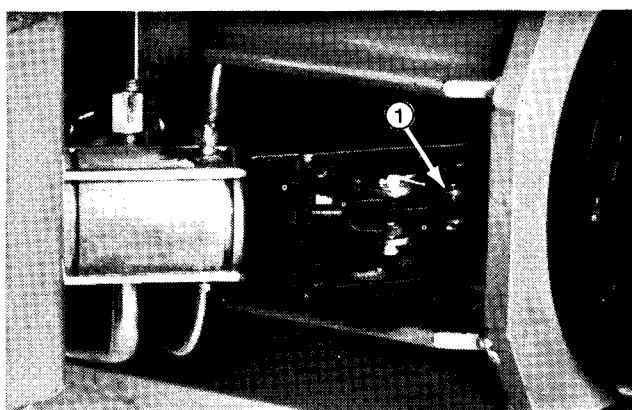


Figure 24

1. Brake cable clevis

6. Remove brake actuating disc assembly and inner brake disc (Fig. 25).

7. Inspect brake actuating disc assembly for proper operation and repair as necessary (Fig. 26).

8. Inspect braking surface of brake housing (Fig. 25) and brake housing cap (Fig. 23). Replace parts as necessary.

9. Oil leakage from planetary wheel drive in area of inner brake disc, may indicate that oil seal in brake housing cap requires replacement or wheel motor shaft cup rings require replacement. Inspect oil seal in brake housing cap and replace if necessary (Fig. 26). Inspect cup rings on hydraulic wheel motor shaft and replace if necessary. (See Wheel Motor Shaft Cup Ring Service in this section of the book.)

10. Reverse steps 1 - 6 to install new brake discs and assemble wheel brakes.

11. Adjust the brakes. (See Service Brake Adjustment and Steering/Parking Brake Adjustment in the Adjustments section of this chapter.)

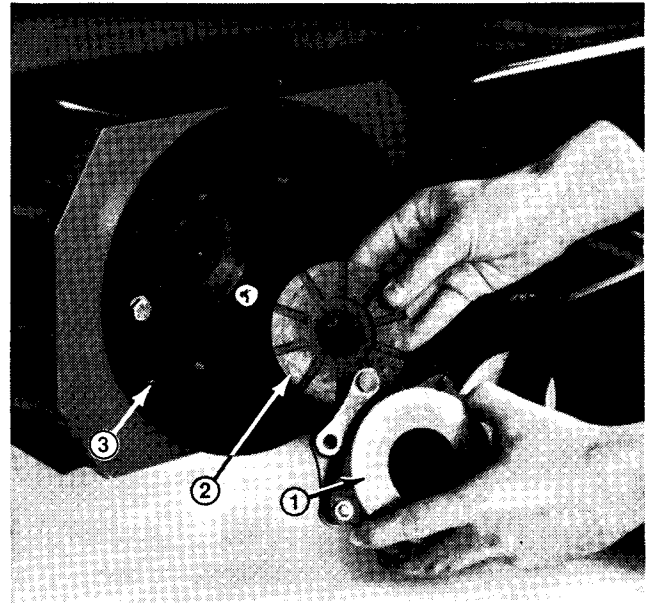


Figure 25

1. Actuating disc assembly 3. Brake housing
2. Inner brake disc

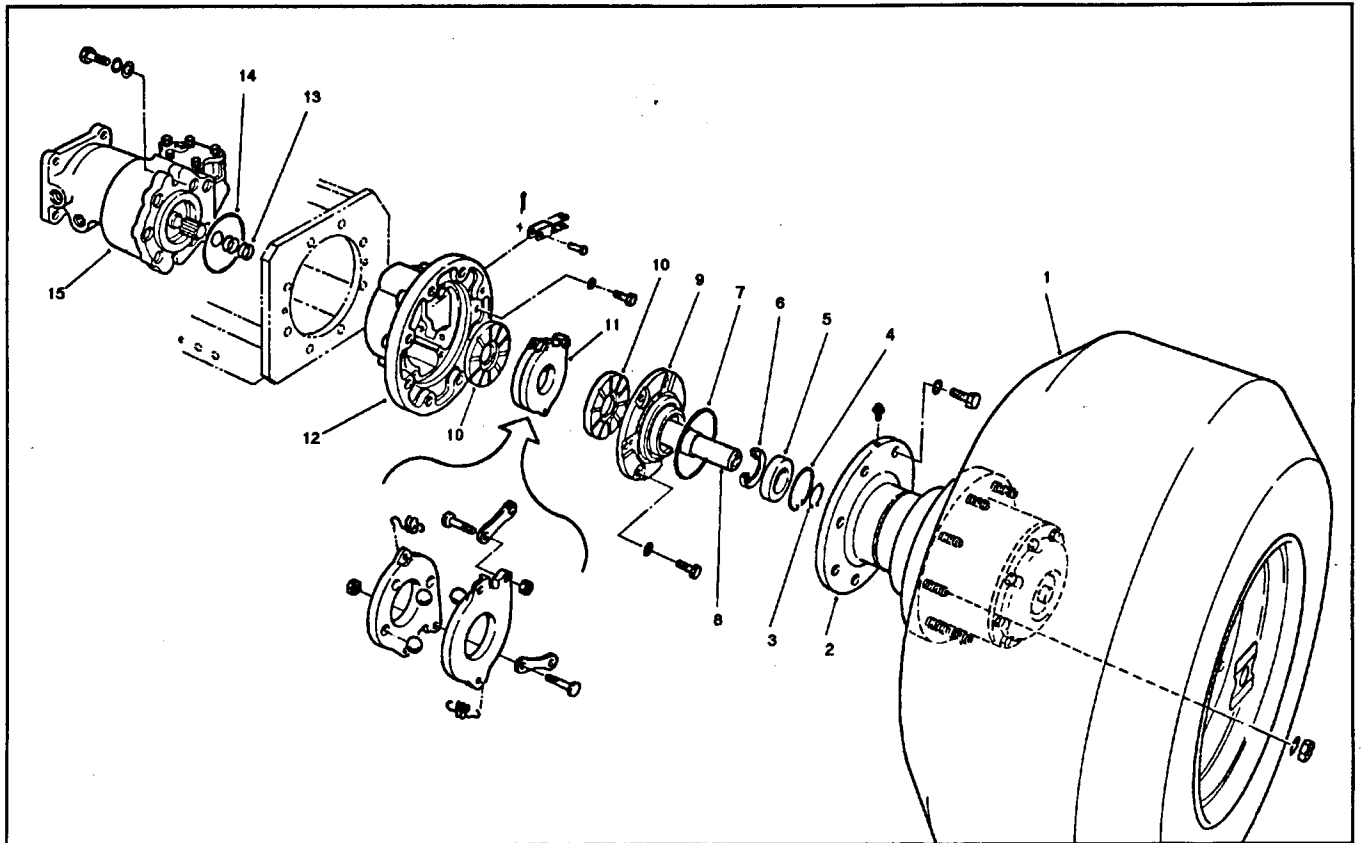


Figure 26

1. Wheel & tire
2. Planetary wheel drive
3. Retaining ring (external)
4. Retaining ring (internal)
5. Bearing

6. Oil seal
7. O-ring
8. Coupling
9. Brake housing cap
10. Disc (2)

11. Actuating disk assembly
12. Brake housing
13. Cup ring (8)
14. O-ring
15. Hydraulic wheel motor

Brake Housing Removal

1. Do steps 1 - 6 under Wheel Brake Service.
2. Remove four allen head capscrews to disconnect brake actuator housing from brake housing (Fig. 27). Be careful not to damage the brake tube line when moving the brake actuator housing away from the brake housing.

NOTE: Removing one of the allen head capscrews will require the use of a special tool. This tool can be made by cutting off a short section of allen wrench. Insert the short piece of allen wrench into the capscrew head and remove the capscrew by turning the short section of allen wrench with a combination wrench.

3. Remove two (2) capscrews, lockwashers and flat washers securing hydraulic wheel motor to brake housing (Fig. 26).
4. Remove two (2) capscrews and lockwashers securing brake housing to frame. Remove brake housing (Fig. 28).
5. Reverse steps 1 - 4 to install brake housing.

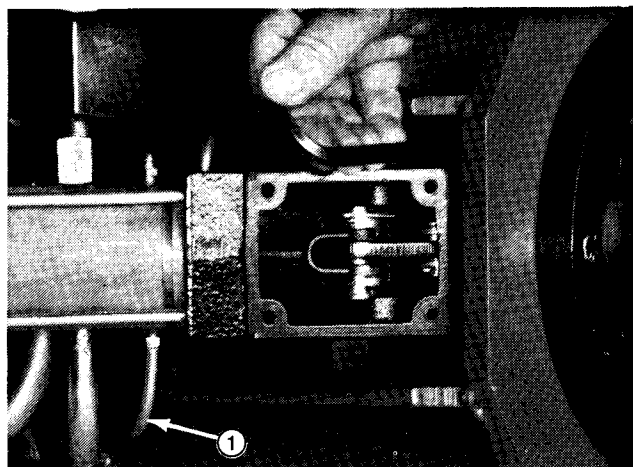


Figure 27

1. Brake tube line

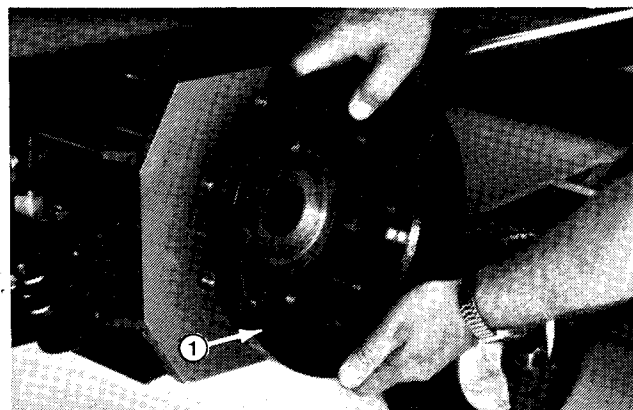


Figure 28

1. Brake housing

Wheel Motor Shaft Cup Ring Service

If there is oil leakage from planetary wheel drive in area of inner brake disc, wheel motor shaft cup rings may require replacement.

1. Do steps 1 - 8 under Wheel Brake Service.
2. Remove cup rings from motor shaft (Fig. 29).
3. Apply a coating of hydraulic oil to new cup rings before installing. Install new cup rings on motor shaft with lips facing the motor.

IMPORTANT: Put a seal protector on motor shaft or apply tape on the shaft before installing cup rings. Be careful to prevent shaft spline from damaging the new cup rings.

4. Reverse steps 1 - 8 to install new brake discs and assemble wheel brakes.

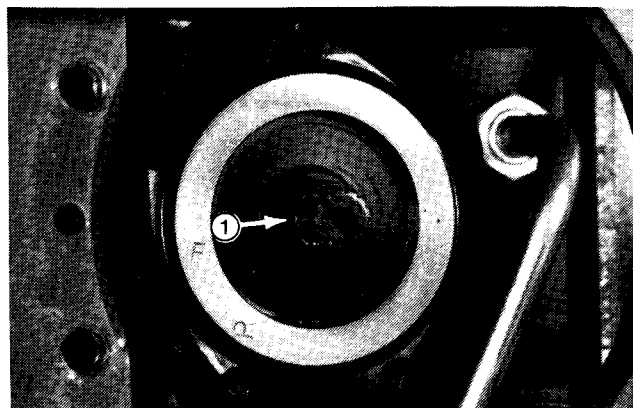


Figure 29

1. Cup ring (8)
(Shown with brake housing removed)

Brake Actuator Seal Replacement

1. Loosen wheel lug nuts (Fig. 18). Jack up machine and support with jack stands of proper capacity. Remove wheel lug nuts and remove wheel.
2. Remove service brake adjusting nut (Fig. 7).
3. Disconnect brake tube line from fitting on actuator (Fig. 27).
4. Remove cotter key and clevis pin to disconnect brake actuator end yoke (Fig. 24).
5. Loosen four (4) long capscrews securing actuator to actuator housing. Remove actuator and end yoke from brake actuator housing.
6. Remove end yoke and collar from actuator.
7. There is spring pressure against the retaining ring (Fig. 30). Use a socket tool to push in flat washer and remove retaining ring.
8. Remove flat washer and spring. Pull piston out.
9. Remove packing and back-up rings from piston and housing.
10. Install new packing and back-up rings on piston and in housing as shown in Figure 30. Be careful to prevent damage to packing and back-up rings during installation.
11. Reverse steps 1 - 9 to reassemble and install brake actuator. Replace gaskets if necessary. Make sure collar is installed before installing locknut (adjusting nut) on end yoke.
12. Bleed the system and adjust the service brakes. (See Bleeding Service Brakes in the General Information section of this chapter and Service Brake Adjustment in the Adjustments section.)

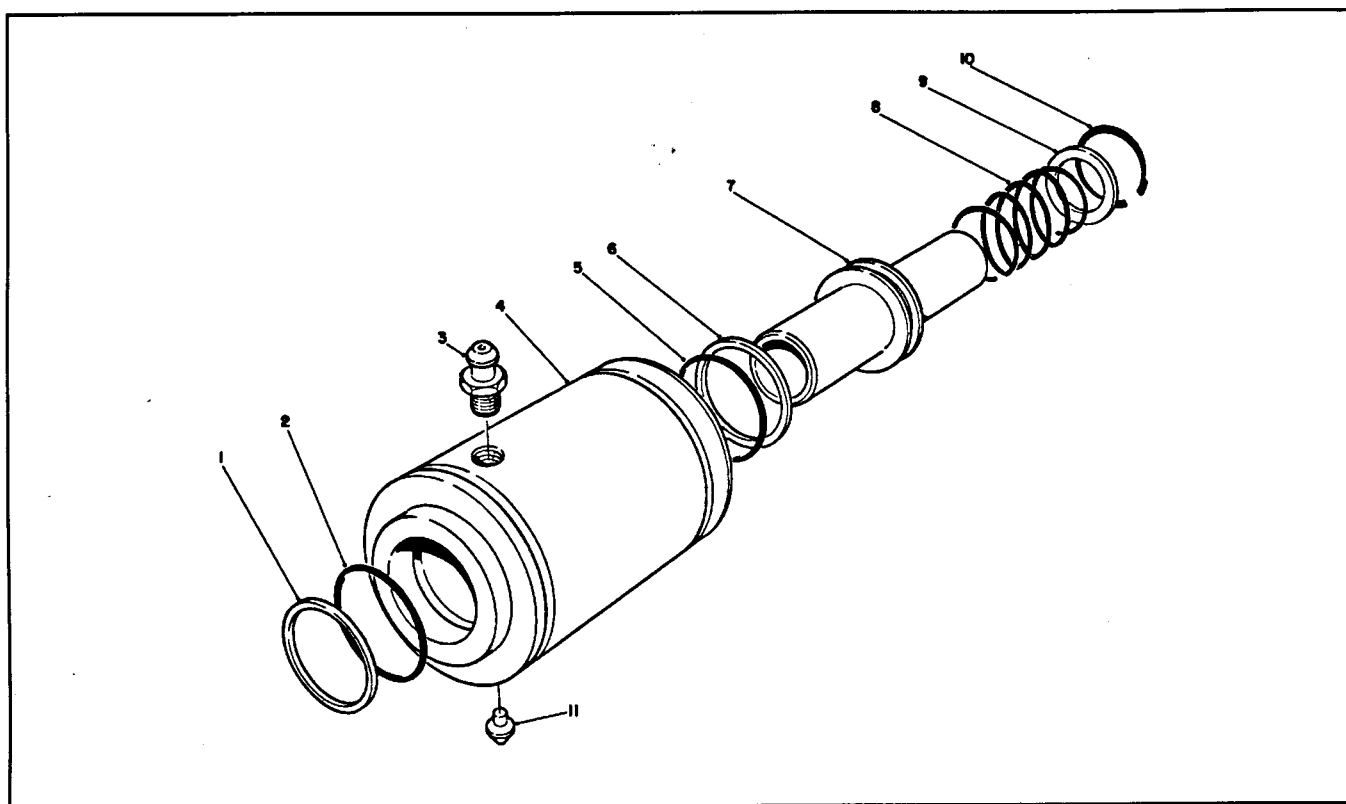


Figure 30

- 1. Back-up ring
- 2. Packing
- 3. Bleeder screw
- 4. Housing

- 5. Packing
- 6. Back-up ring
- 7. Piston
- 8. Spring

- 9. Flat washer
- 10. Retaining ring
- 11. Seat insert

Master Cylinder Service

1. Disconnect brake line from rear of master cylinder.
2. Remove three (3) capscrews and locknuts securing master cylinder to frame. Remove master cylinder.
3. Remove rod boot (Fig. 31, Item 1).
4. The piston is held against the retaining ring by spring pressure. Use a rod to push the piston in and then remove the retaining ring.

5. Remove the piston assembly (Items 3 - 8).

NOTE: Piston assembly parts (Items 3 - 8) are not serviced separately and must be replaced as a complete assembly.

6. Reverse Steps 1 - 5 to reassemble the master cylinder.

7. Fill the master cylinder with DOT 3 brake fluid and bleed the system. (See Bleeding Service Brakes in the General Information section of this chapter.)

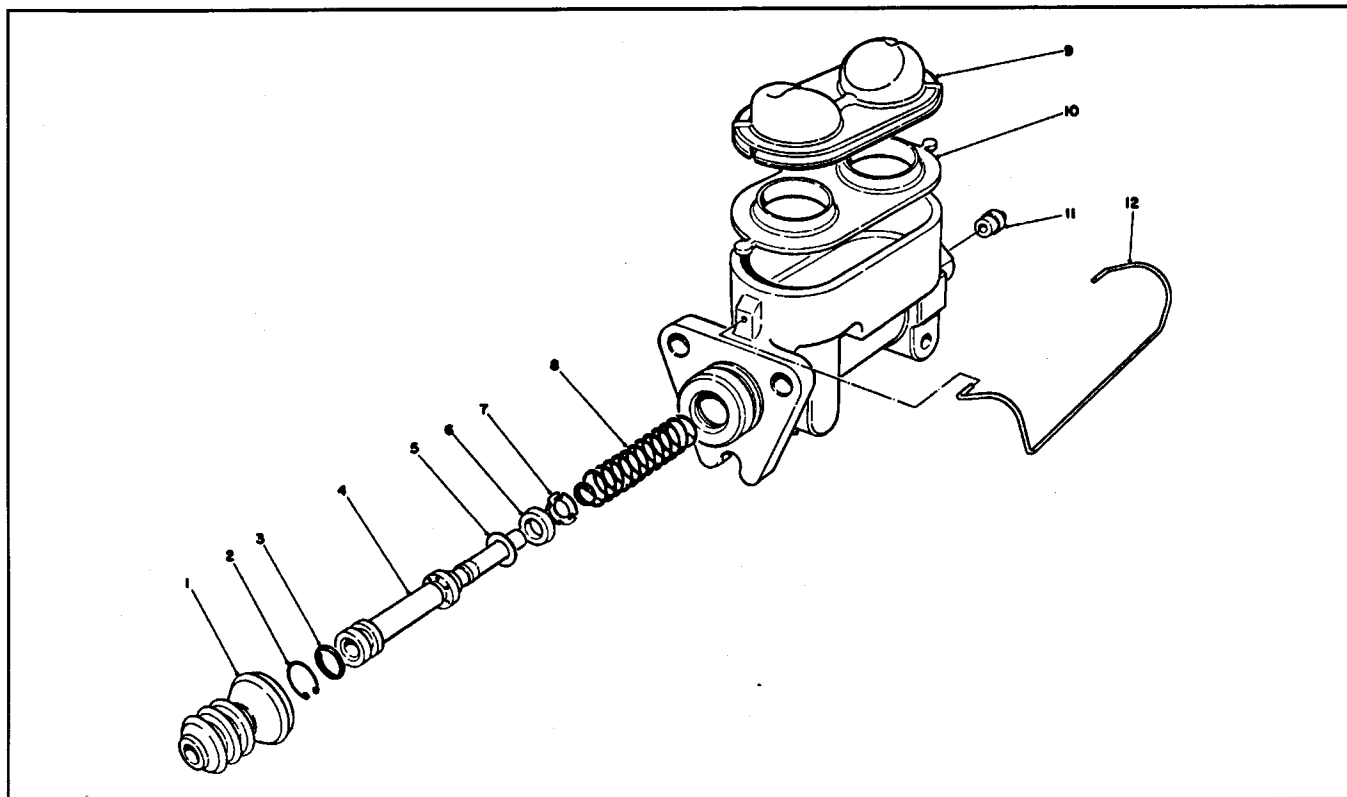


Figure 31

1. Rod boot
2. Retaining ring
3. Lip seal
4. Piston

5. Cup protector
6. Pumping cup
7. Cup retainer
8. Piston return spring

9. Reservoir cover
10. Diaphragm gasket
11. Tube seat
12. Cover bail



Chapter 7

Cutting Units

Table of Contents

SPECIFICATIONS	1	Outboard Cutting Unit	
ADJUSTMENTS	2	Spring (Break-away) Adjustment	8
Height-of-Cut Adjustment	2	REPAIRS	9
Skid Adjustment	3	Blade Service	9
Mismatch Adjustments	4	Belt Replacement	12
Belt Tension Adjustment	6	Separating Cutting Unit From Traction Unit	14
Front Cutting Unit Lift Arm Ball Joint Adjustment ..	7	Spindle Service	15
Tie Rod Adjustment	8		

Specifications

ITEM	SPECIFICATION
Total cutting width Outboard unit cutting width (2) Front unit cutting width	192 in. 57 in. 92 in.
Height of cut range	Low range: 1 to 4 in. High range: 2-1/2 to 5-1/2 in.
Height of cut adjustment	1/2 in. increments
Blade bolt torque	140 - 165 ft-lb
Spindle bolt torque	140 - 160 ft-lb
Spindle end play	.006 max.
Spindle rolling torque	10 in-lb max.
Blade plane (with cutting unit leveled above measuring plane) Lowest tips (tip to tip) of adjacent blades All tips of any two adjacent blades - rotated to any position All blade tips of same cutting unit- rotated to any position	0.125 in. max. in same plane within 0.250 in. in same plane within 0.375 in..
Tie rod spring length (outboard cutting unit break-away adjustment)	8.38 ± 0.12 in.

Adjustments

Height-of-Cut Adjustment

The height-of-cut is adjustable from 1 to 5-1/2 in., in 1/2 in. increments. Positioning the castor wheel axles in the top holes of the castor forks (Fig. 1) allows High range height-of-cut settings from 2-1/2 to 5-1/2 in.

1. Start engine, position the machine on a level surface, lower cutting units to a point where castor wheels can be removed from arms, set lift levers in neutral, set parking brake and shut engine off. Remove ignition key to prevent accidental start up.

2. Position castor wheel axles on all cutting units in the same hole in the castor forks (high range or low range).

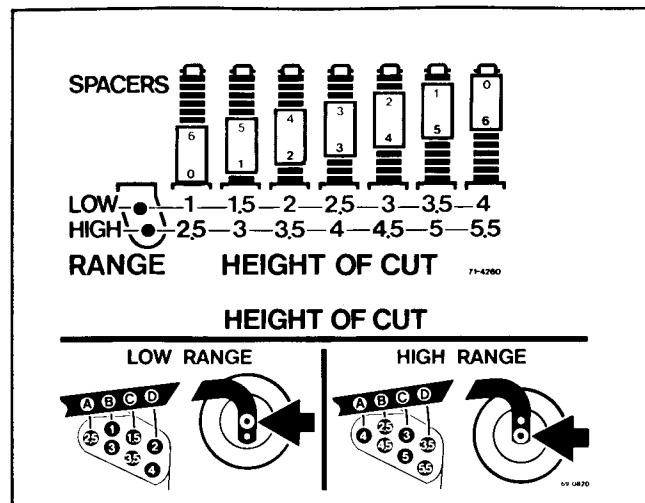


Figure 1

3. On the front cutting unit, remove the hairpin cotter and clevis pins from the rear castor pivot arms (Fig. 2). Align the pivot arm holes with selected height-of-cut bracket holes in the cutting unit frames, insert clevis pins and install the hairpin cottes (Fig. 2).

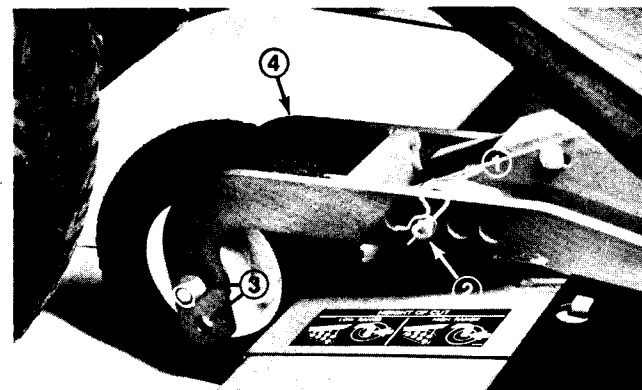


Figure 2

1. Hairpin cotter
2. Clevis pin

3. Castor axle mount holes
4. Pivot arm

4. On all remaining castor wheel assemblies, remove lynch pin from castor fork shafts (Fig. 3). Remove castor fork shaft and spacer assembly from the castor arm (Fig. 3). Place spacers onto castor spindle to desired height-of-cut setting and install castor fork shaft in arm (Fig.). Install remaining spacers onto shaft and secure assemblies with the lynch pin (Fig. 3). Washers must remain on same side of castor arm before and after height-of cut change.

NOTE: Install lynch pins with wire loop facing to the rear. This will help prevent the lynch pin from catching on branches or brush and coming off (Fig. 3).

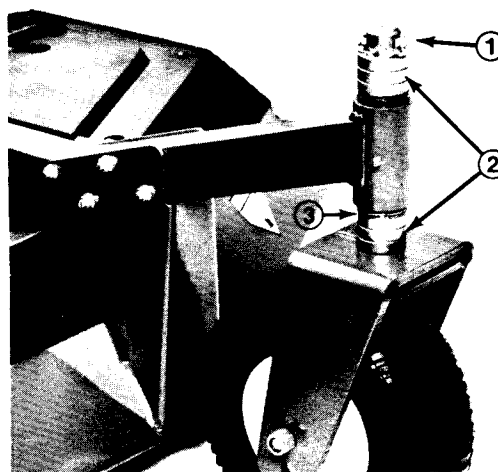


Figure 3

1. Lynch pin
2. Spacers

3. Washers

Skid Adjustment

After initial set up or if height-of-cut is changed, cutting unit skids should be adjusted. Adjust skids by loosening flange lock nuts (Fig. 4), positioning skid at specified height (see chart below) and retightening flange lock nuts.

Front Cutting Unit

All H.O.C. – Skid $\frac{3}{8}$ in. to $\frac{1}{2}$ in. above level surface

Outboard Cutting Units

1 in. H.O.C. – Skid all the way up

1- $\frac{1}{2}$ to 3 in. H.O.C. – Skid $\frac{1}{2}$ to 1 in. above level surface.

1- $\frac{1}{2}$ " to 3" H.O.C. – Skid all the way down.

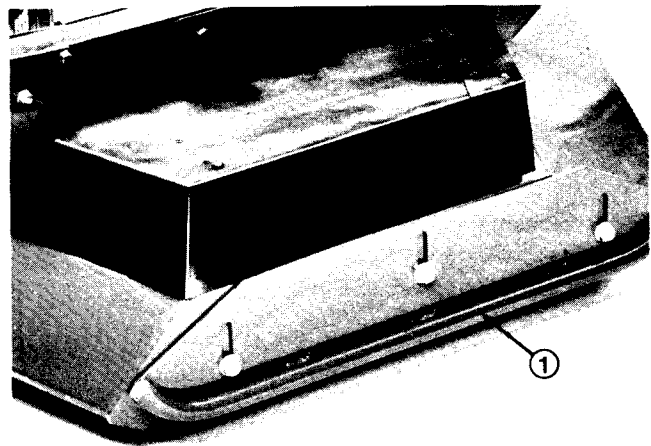


Figure 4

1. Skid

Mismatch Adjustments

If there is a mismatch between the blades or cutting units, the grass will appear streaked or uneven when it is cut. Perform steps 1 - 5 in order as listed. DETAILED INSTRUCTIONS FOR STEPS 2, 3 AND 4 ARE LISTED ON THE NEXT PAGE.

NOTE: All measurements are from floor surface to blade tip. USE A FLAT 4 X 8 FT. SHEET OF 3/4 IN. PLYWOOD TO GET A FLAT FLOOR SURFACE.

1. Adjust all cutting units to highest height-of-cut. Position castor wheel axles in lower castor fork holes (Fig. 5, 6). On front cutting unit, reposition two rear castor's clevis pins to highest height-of-cut setting (Fig. 5). Move all castor spacers to the underside of the castor arms (Fig. 6). Do not move washers. Leave them in their original position.

2. Check each outboard cutting unit and center section of front cutting unit for cutting BLADE mismatch (page 7-5). Adjust by adding or removing washers between spindle housing and bottom of cutting unit.

3. Check each outboard cutting unit and center section of front cutting unit for CUTTING UNIT mismatch (page 7-5). To match cutting blade height, transfer washers from one side of a castor wheel arm to the other.

4. Check for front cutting unit WING and WING BLADE mismatch (page 7-5). Adjust wings by adding or removing shims between rubber pad and bracket (Fig. 7). Adjust blades by adding or removing washers between spindle housing and bottom of cutting unit.

5. Compare BLADE HEIGHT DIMENSIONS OF ALL CUTTING UNITS. Blade heights must be within 3/8 in. of one another. If they are not, determine which cutting unit height can be changed to compensate for difference and either transfer washers from bottom to top to lower unit, or from top to bottom to raise. Transfer an equal number of washers at all castor wheel locations to keep cutting unit level - two on front unit, four on outboard units.

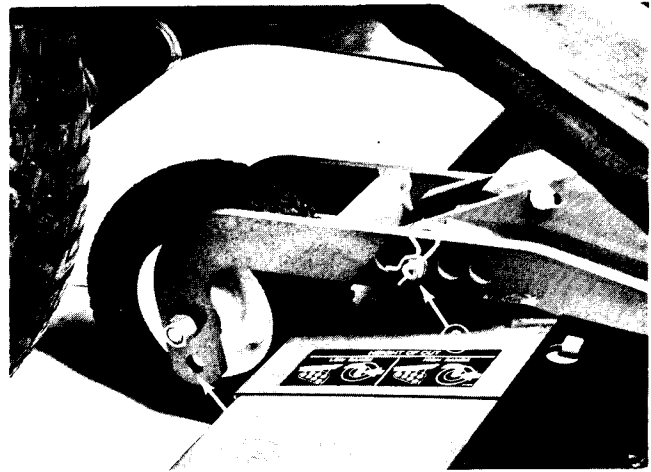


Figure 5

1. High range height-of-cut
2. Move to highest height-of-cut setting

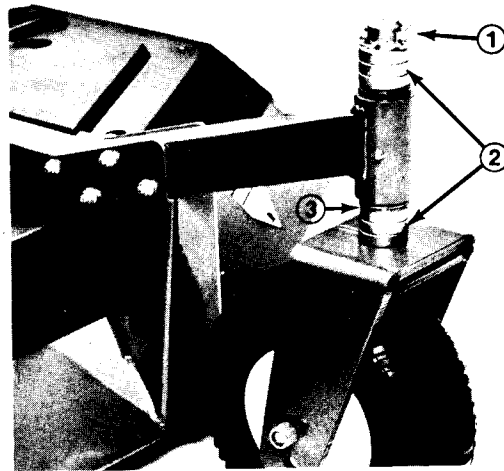


Figure 6

1. Lynch pin
2. Spacers - move to underside of castor arm (highest height of cut)
3. Washers

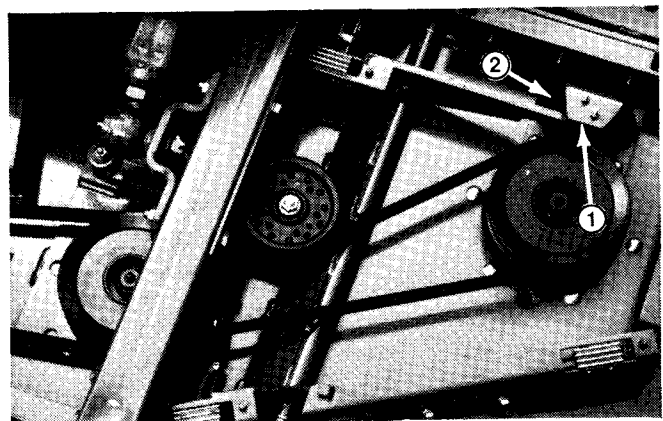


Figure 7

1. Rubber pad
2. Bracket

Cutting BLADE Mismatch

1. Lower cutting unit onto flat surface.
2. Rotate blade so ends face forward and backward. Measure from flat surface to front tip of cutting blade and record dimension. Rotate same blade so opposite end faces forward and repeat measurement. Difference between the two measurements must not exceed 1/8 in. If difference exceeds 1/8 in, the blade is bent. Replace it. Use same procedures to measure all blades.
3. Rotate blade so ends face forward and backward. Measure from flat surface to front of cutting blade and record dimension. Repeat process for all blades and compare measurements. Maximum difference allowed between any two adjacent blades is 1/4 in. Maximum difference allowed between the highest and lowest blade measurement is 3/8 in. If measurements are not within specification, add shims between the and spindle housing; proceed to step 5. If measurements meet specification, proceed to step 4.
4. Rotate blades so ends line up with one another. Ends of adjacent blades must be within 1/8 in of each other. If ends are not within 1/8 in. of one another, add shims between spindle housing and bottom of deck; proceed to step 5.
5. Remove locknuts securing spindle housing to deck in area where shims are to be added. To lower a blade, add a shim (Part No. 3256-24), to each mounting bolt, between spindle housing and deck. Repeat step 4. Continue process until blade ends are within the required dimensions. **IMPORTANT: Do not exceed three (3) shims at any hole location. If more than one (1) shim is added to any hole location, install decreased amounts of shims in adjacent holes.**

CUTTING UNIT Mismatch

1. Lower cutting unit onto flat surface.
2. Rotate blade so ends face forward and backward. Measure from plywood to front end of blade and record dimension. Repeat procedure for all blades and compare measurements. All blade heights on same cutting unit should be within 1/4 in. of one another. If blade heights are within 1/4 in., proceed to step 4. If blade heights are not within 1/4 in., proceed to step 3.
3. To match blade height, transfer washers from one side of a castor wheel arm to the other. If end is to be lowered, transfer one or both washers from the underside to the top. If end is to be raised, transfer washer(s) from the top to the underside. Each washer is 1/8 in. thick. Repeat measurement of blade tip height and record new dimensions.
4. Repeat steps 1 - 2 on remaining cutting units, and step 3, if necessary. If washers are transferred on a

outboard cutting unit castor arm, be sure to transfer the same number on both ends of the castor arm.

Front Cutting Unit WING and WING BLADE Mismatch

1. Lower front cutting unit onto the flat surface.
2. Rotate blades so ends face forward and backward. Measure from plywood to front end of blade and record dimension. Repeat procedure for all blades and compare measurements. Blade heights between each wing and center section should be within 1/4 in. of one another. If blade heights are within 1/4 in., proceed to step 4. If blade heights are not within 1/4 in., proceed to step 3.
3. To match blade height, between each wing and center section add or remove shim (Part No. 42-6200) between rubber pad and bracket (Fig. 9). To lower wing, remove shim. To raise wing, add shim. Each shim is 1/8 in. thick. Repeat measurement of blade tip height and record new dimensions.
4. Rotate wing blade so ends face forward and backward. Measure from flat surface to front tip of cutting blade and record dimension. Rotate same blade so opposite end faces forward and repeat measurement. Difference between the two measurements must not exceed 1/8 in. If difference exceeds 1/8 in, the blade is bent. Replace it. Use same procedures to measure other wing blade.
5. Rotate blade so ends face forward and backward. Measure from flat surface to front of cutting blade and record dimension. Repeat procedure for all blades of front cutting unit and compare measurements. Maximum difference allowed between any two adjacent blades is 1/4 in. Maximum difference allowed between the highest and lowest blade measurement is 3/8 in. If measurements are not within specification, add shims between the deck and spindle housing; proceed to step 7. If measurements meet specification, proceed to step 6.
6. Rotate blades so ends line up with one another. Ends of adjacent blades must be within 1/8 in of each other. If ends are not within 1/8 in. of one another, add shims between spindle housing and bottom of deck; proceed to step 7.
7. Remove locknuts securing spindle housing to deck in area where shims are to be added. To lower a blade, add a shim (Part No. 3256-24), to each mounting bolt, between spindle housing and deck. Repeat step 6. Continue process until blade tips are within the required dimensions. **IMPORTANT: Do not exceed three (3) shims at any hole location. If more than one (1) shim is added to any hole location, install decreased amounts of shims in adjacent holes.**

Inspecting and Adjusting Cutting Unit Belt Tension

IMPORTANT: After first ten hours of operation, check new belts for proper tension; thereafter, check tension every 50 hours.

Front Cutting Unit –

Note: Belts for wing unit spindles are tensioned by spring loaded idlers and normally do not require tensioning.

1. Position machine on level surface, lower cutting unit to shop floor, engage parking brake, shut engine off and remove key from ignition switch.
2. Remove deck covers.

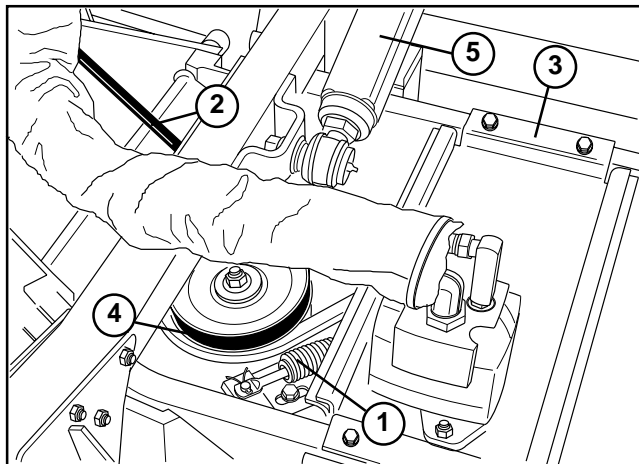


Figure 8

1. Compression Spring and Tension Plate
2. Wing Unit Drive Belt
3. Gear Box Plate
4. Center Drive Belt
5. Lift Arm

3. Note position of shoulder bolts in slots in tension plate. Optimum belt tension will be maintained when the flanges on the shoulder bolts are 1/8 in. (3 mm) from the pulley ends of the slots (Fig. 9A). If the shoulder bolt flanges are more than 3/8 in. (9 mm) from the pulley end of the slots, an adjustment should be made.

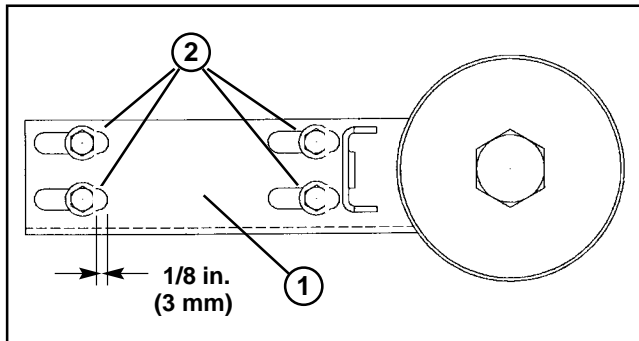


Figure 9A

1. Tension Plate
2. Shoulder Bolts

4. To adjust, loosen jam nuts (Fig. 9B) and extend tension arm until the shoulder bolt flanges are within 1/8 in. (3 mm) of the pulley end of the slots (Fig. 9A).

Note: When the shoulder bolt flanges are positioned 1/8 in. (3 mm) from the pulley end of the slots, the length of the compression spring (Fig. 8) will be approximately 5 in. (127 mm).

5. Tighten jam nuts to secure adjustment. Replace covers.

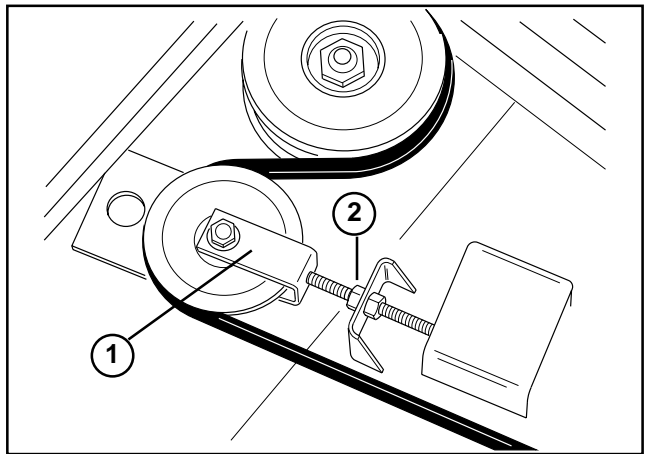


Figure 9B

1. Tension Arm
2. Jam Nuts

Outboard Cutting Units –

1. Remove deck covers. To check belt tension, apply 8 lb. (35.5 N) force at mid-span of belt and check deflection. There should be approximately 5/16 in. (7.9 mm) deflection. If deflection is incorrect, proceed to step 2. If deflection is correct, proceed to step 3.

2. To tension belts, loosen flange locknut at top of idler pulley (Fig. 10). Slide pulley against belt until proper tension is reached. Hold pulley in position and tighten locknut.

3. Replace deck covers.

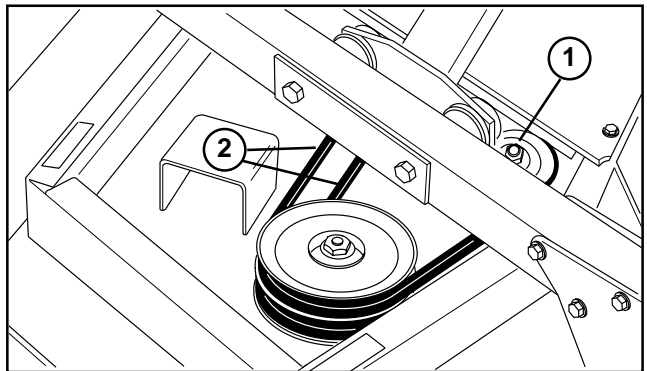


Figure 10

1. Idler Pulley Flange Locknut
2. Drive Belts

Front Cutting Unit Lift Arm Ball Joint Adjustment

Ball joint must be threaded into each lift arm so there is a distance of 2 in. from end of lift arm to center line of ball joint (Fig. 11). Tighten jam nut on ball joint against end of lift arm.

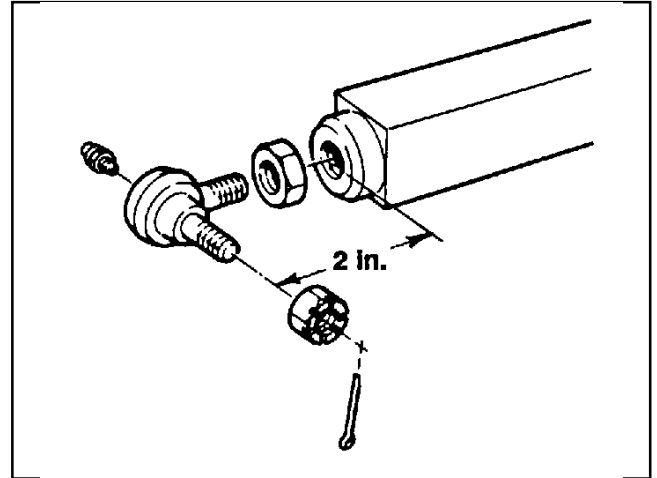


Figure 11

Outboard Cutting Unit Tie Rod Adjustment

Outer lift arm of outboard cutting unit must rest on rubber pad when in raised position.

1. Raise outboard cutting unit so inner lift arm rests on rubber pad (Fig. 12).

2. Loosen jam nuts and adjust tie rod (Fig. 12a) until outer lift arm, contacts rubber pad (Fig. 12). Tie rod assembly must be rotated so that rollers face hydraulic hoses when lift arms are raised. Tighten jam nuts.

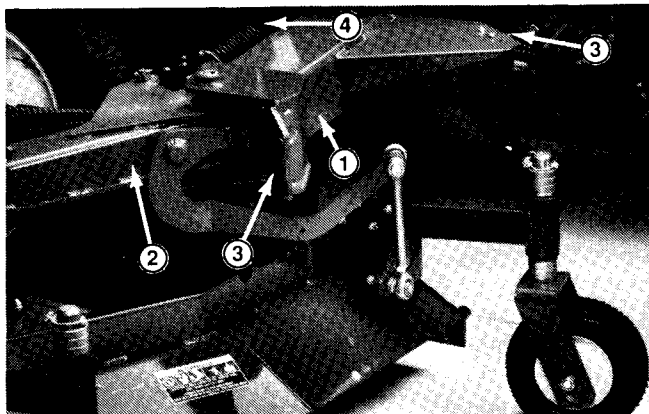


Figure 12

1. Inner lift arm
2. Outer lift arm

3. Rubber pad
4. Tie rod

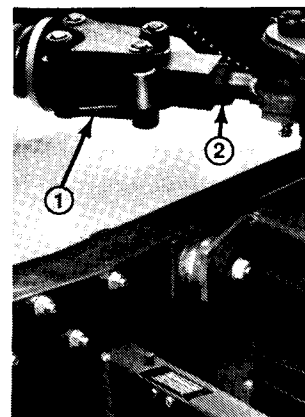
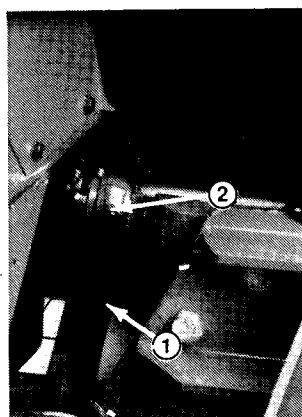


Figure 12a

1. Tie rod

2. Jam nut

Outboard Cutting Unit Spring (Break-away) Adjustment

Loosen jam nut and tighten adjusting nut so spring is 8.38 ± 0.12 in. long (Fig. 13). Hold adjusting nut and tighten jam nut.

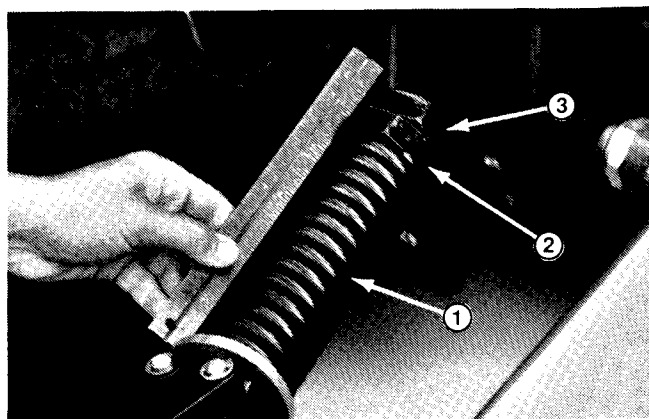


Figure 13

1. Spring
2. Adjusting nut

3. Jam nut

Repairs

Blade Service

Note: Although not needed for normal maintenance procedures, the front cutting unit can be pivoted (tilted) to a fully upright position (Fig. 14).

To Pivot (Tilt) Cutting Unit Upright:

1. Position front cutting unit so rear castor wheels just clear the floor, set parking brake and shut engine off.
2. Remove cutting unit tilt link from tool box under traction unit floor. Remove klik pins from weldments on traction unit frame and cutting unit lift arm.
3. Remove hairpin cotter and clevis pins from the two (2) rear castor assemblies (Fig. 15). Set the left hand clevis pin aside and insert the right hand clevis pin into the most forward holes in the castor wheel arm on the right side of the unit (Fig. 16). The castor arm and pin should be resting on top of the unit.
4. Sit on seat, start the engine and raise the cutting unit to the full up position so the spring latch on the left lift arm disengages from the cutting unit. Stop the engine and remove the key from the ignition switch.
5. Fit cutting unit tilt link over weldment on the right side of traction unit and secure with klik pin. Position link so it clears when cutting unit is raised. Keep remaining klik pin handy to secure opposite end of link to cutting unit arm weldment (Fig 16).
6. Use at least one other person to tilt the cutting unit. Grasp the front of the unit and lift it to an upright position (Fig 14).
7. Hold the unit upright, fit link end over pin on cutting unit lift arm weldment and secure with klik pin.



CAUTION

The cutting unit is too heavy for one person to pivot up or down. Use at least one other person to assist in lifting or lowering the unit. Always use proper lifting techniques and hold unit securely when pivoting it up or down.

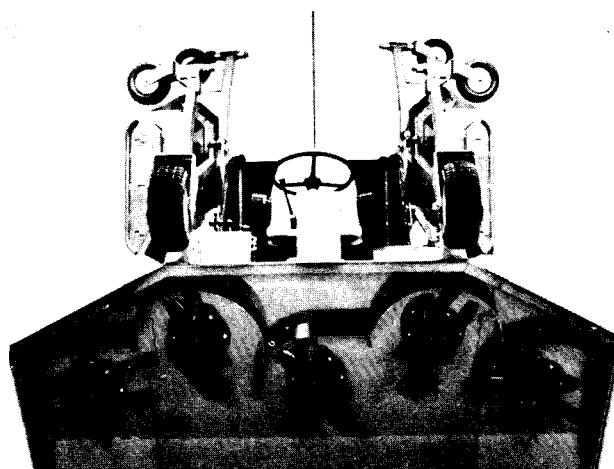


Figure 14

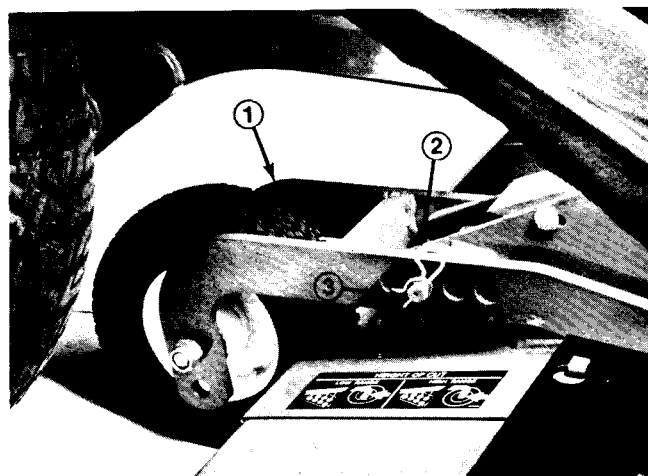


Figure 15

1. Rear castor wheel assembly
2. Hair pin cotter

3. Clevis pin

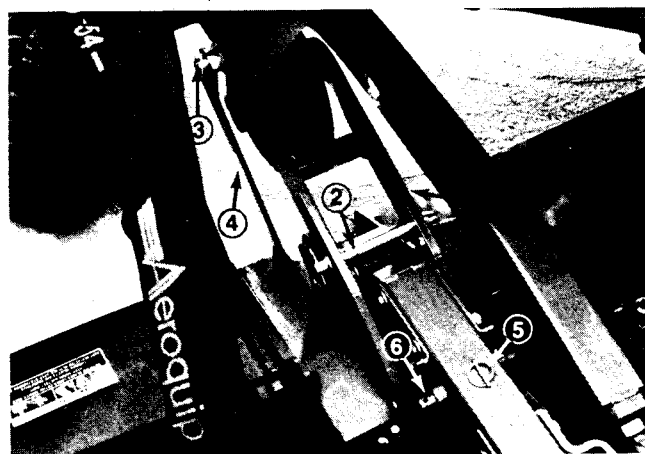


Figure 16

1. Right rear caster
2. Clevis pin
3. Weldment

4. Cutting unit tilt klik pin(2)
6. Cutting unit arm weldment

To Pivot Cutting Unit down into Operating Position:

1. With the help of an assistant, hold the unit upright, remove the klik pin securing the link end and remove link end from the weldment.
2. Pivot (tilt) the cutting unit downward.
3. Sit on seat, start engine and lower the cutting unit so castor wheels just clear the floor.
4. Remove the height-of-cut pin from the right castor wheel arm. Insert it and the left height-of-cut pin in the proper height-of-cut holes in the castor arms and cutting unit.

Blade Bolt Torque

Check blade bolt torque daily or after blade strikes a solid object. However, if solid object causes blade to be damaged or bent, replace it; refer to Removing Cutting Unit Blade, below.

1. Raise cutting units to transport position, engage parking brake, shut engine off and remove key from ignition switch.
2. Hold blade with a thickly padded glove or rag. Use a torque wrench to tighten blade bolts on all cutting units to a torque of 140 - 165 ft-lb.

Removing Cutting Unit Blade

Replace the blade if a solid object is hit, the blade is out of balance or bent. Always use genuine TORO replacement blades to ensure safety and optimum performance. Never use blades made by other manufacturers because they could be dangerous.



CAUTION

Do not try to straighten a bent blade. Never weld a broken or cracked blade. Always use a new TORO blade to assure continued safety certification of the product.

1. Raise cutting unit to transport position, engage parking brake, shut the engine off and remove key from ignition.
2. Using a rag or thickly padded glove, grasp end of blade. Remove blade bolt, lockwasher, anti-scalp cup and blade from spindle assembly (Fig. 17).
3. When re-assembling, make sure blade sail is facing up. Torque the blade bolt to 140-165 ft-lb.

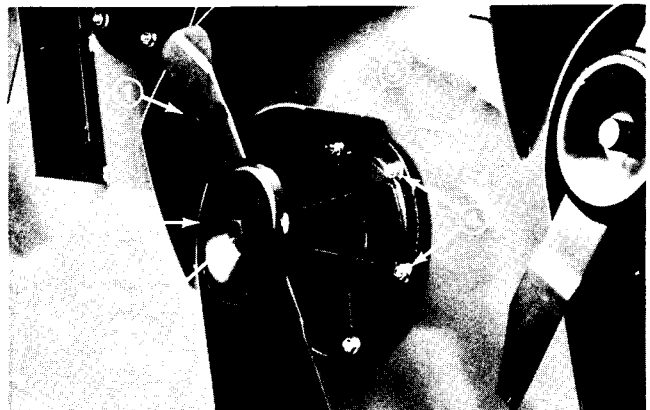


Figure 17

1. Cutting blade
2. Blade bolt and lockwasher
3. Anti - scalp cup
4. Carriage bolt and flange locknut (6)

Inspecting and Sharpening Blade

1. Raise cutting units to transport position, engage parking brake, shut engine off and remove key from ignition switch.

2. Carefully examine cutting ends of the blade, especially where the flat and sail (curved part) meet (Fig. 18). Since sand and abrasive material can wear the metal connecting the flat and sail portions, check the blade before using the machine. If wear is noticed (Fig. 18), replace the blade.



CAUTION

If the blade is allowed to wear, a slot will form between the sail and flat part of the blade (Fig. 18). Part of the blade may eventually break off and be thrown from under the housing, possibly resulting in serious injury to yourself or bystanders.

3. Examine cutting edges of all blades. Sharpen cutting edges that are dull or nicked. To assure sharpness, sharpen only the top side of the cutting edge while maintaining the original cutting angle (Fig. 19). If the same amount of metal is removed from both cutting edges, the blade will remain balanced.

4. To check blade for being straight and parallel, remove from cutting unit. Lay blade on level surface and check its ends. Blade ends must be slightly lower than blade center and cutting edge lower than heel to the blade. If so, it will produce good quality-of-cut and require minimal engine power to turn. By contrast, a blade with ends higher than blade center, or with cutting edge higher than the blade heel, is warped or bent and must be replaced.

5. When re-assembling, make sure blade sail is facing up. Torque the blade to 140-165 ft-lb.

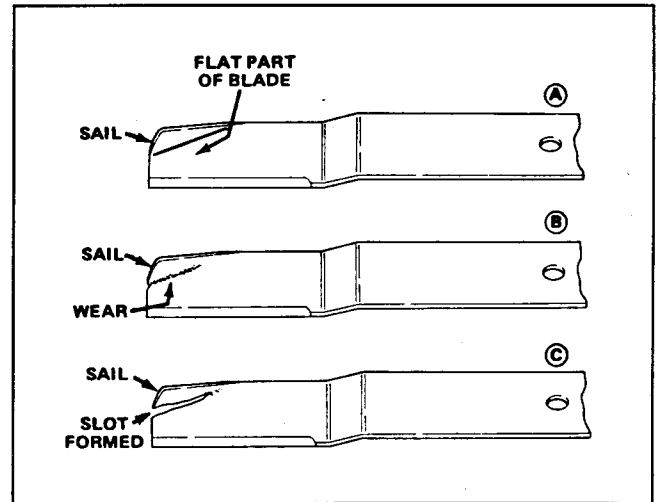


Figure 18

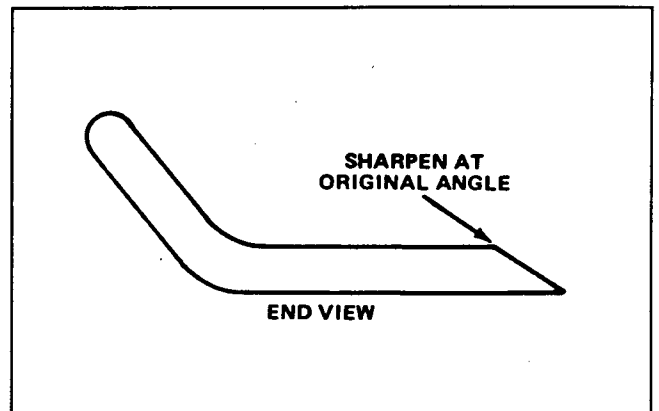


Figure 19

Belt Replacement

Position machine on level surface, lower cutting unit to shop floor, engage parking brake, shut engine off and remove key from ignition switch.

Front Cutting Unit

NOTE: To remove center section belt, wing spindle drive belts must first be removed.

1. Remove belt covers. Lift each wing to release idler pulley tension and slip belt off pulleys (Fig 20).
2. Loosen jam nuts securing tension arm until compression spring on idler assembly is relaxed (Fig. 21).
3. Remove flange head screws securing gearbox plate and separate plate and drive motor assembly from the cutting unit (Fig. 20). Be careful not to bend, twist, kink or damage flexible hydraulic lines.
4. Remove old belt. Position new belt in pulleys and assemble gear box and plate assembly to cutting unit.
5. Adjust belt tension. (See Belt Tension Adjustment in the Adjustments section of this chapter.)
6. Install wing drive belts. Lift wings to allow belts to slip over outer drive spindle pulleys and install covers.

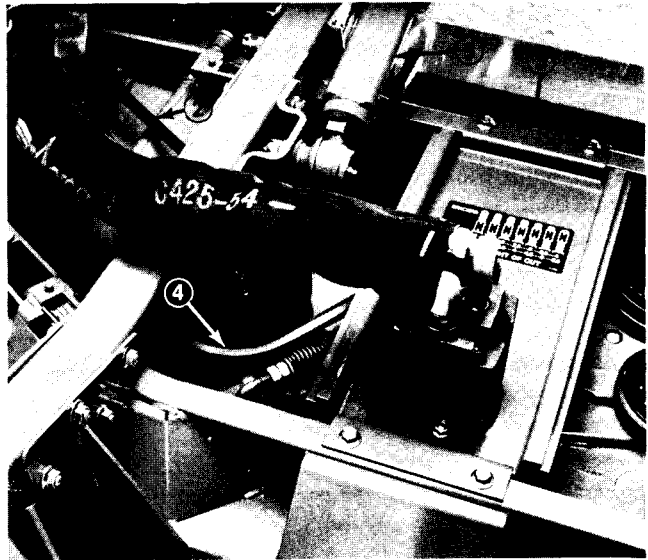


Figure 20

1. Compression spring and tension plate
2. Wing unit drive belt
3. Gear box plate
4. Center drive belt
5. Lift arm

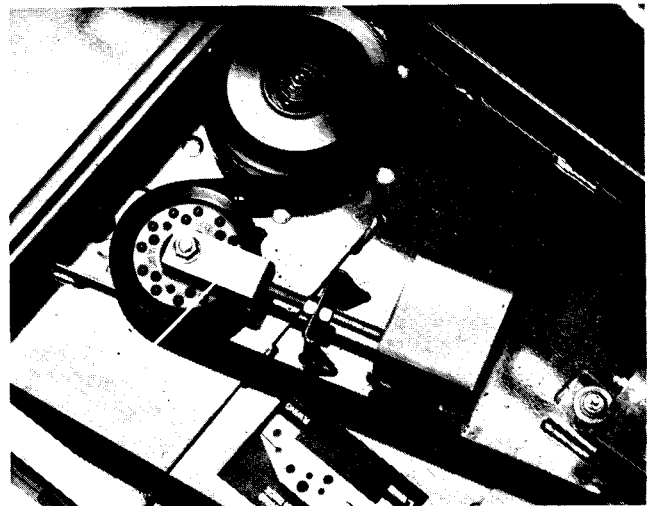


Figure 21

1. Tension arm
2. Jam nuts

Outboard Cutting Units

NOTE: To remove lower belt, the other two belts must first be removed.

1. Position machine on level surface, lower cutting unit to shop floor, engage parking brake, shut engine off and remove key from ignition switch.
2. Remove belt covers. Loosen flange locknuts on idler pulleys and slide pulleys away from belts.
3. Remove flange head screws securing gearbox plate to cutting unit. To separate plate and drive motor assembly from cutting unit, rotate front end of plate toward traction unit (Fig. 22). Tip plate, motor and pulley assembly on its side and remove from cutting unit. Be careful not to bend, twist, kink or damage flexible hydraulic lines.
4. Remove belt(s). Position new belt(s) in pulleys and assemble gear box and plate assembly to cutting unit.
5. Adjust belt tension. (See Belt Tension Adjustment in the Adjustments section of this chapter.)

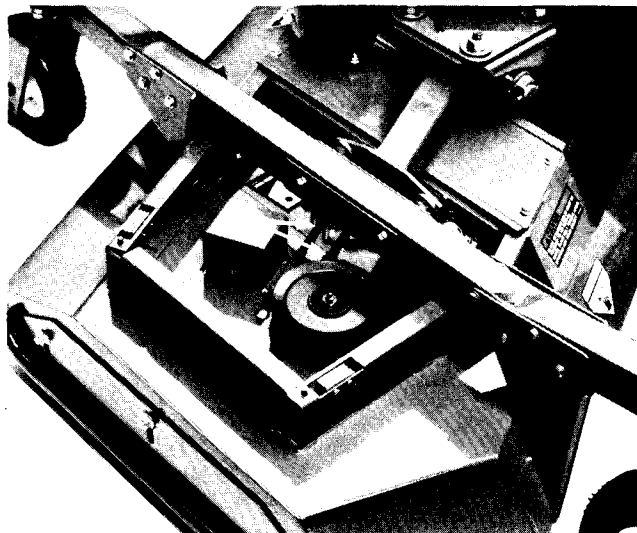


Figure 22

1. Idler pulley flange locknut
2. Drive belts

Separating Cutting Units From Traction Unit

Front Cutting Unit

1. Position machine on level surface, lower cutting unit to shop floor, engage parking brake, shut engine off and remove key from ignition switch.
2. Remove belt covers and relieve belt tension on all belts (Fig. 23).
3. Remove flange head screws securing gearbox plate and separate plate and drive motor assembly from the cutting unit (Fig. 23). Be careful not to bend, twist, kink or damage flexible hydraulic lines.
4. Remove hex head screws and flange locknuts securing each lift arm to the castor arm and separate from the arm (Fig. 23).
5. Roll the cutting unit away from the traction unit.
6. To re-install cutting unit, assemble in reverse order.



CAUTION

If the engine is started with the front cutting unit removed, hydraulic system counter-balance pressure will cause the lift arms to raise quickly. Warn personnel to keep away from the lift arms before starting the engine.

Outboard Cutting Units

1. Position machine on level surface, lower cutting unit to shop floor, engage parking brake, shut engine off and remove key from ignition switch.
2. Remove belt covers. Relieve tension for belt on hydraulic motor pulley (Fig. 24).
3. Remove flange head screws securing gearbox plate to cutting unit. To separate plate and drive motor assembly from cutting unit, rotate front end of plate toward traction unit (Fig. 26). Tip plate, motor and pulley assembly on its side and remove from cutting unit. Be careful not to bend, twist, kink or damage flexible hydraulic lines.
4. Remove locknut securing cutting unit pivot shaft into cutting unit clevis and lift bar (Fig. 24).
5. Move the cutting unit away from the machine.
6. To re-install cutting unit, assemble in reverse order.

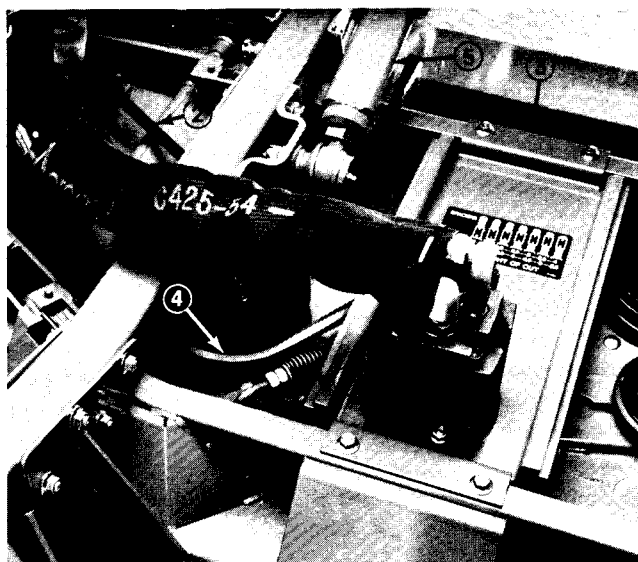


Figure 23

1. Compression spring and tension plate
2. Wing unit drive belt
3. Gear box plate
4. Center drive belt
5. Lift arm

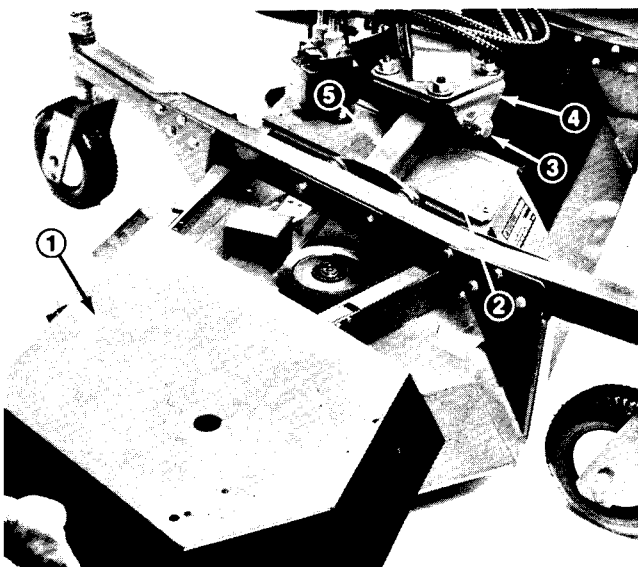


Figure 24

1. Cutting unit cover
2. Gearbox plate
3. Cutting unit pivot shaft
4. Cutting unit clevis
5. Lift bar

Spindle Service

Removing Spindle Housing Assembly

1. Lower cutting unit to ground and engage parking brake. Turn engine OFF and remove key from key switch.
2. Remove belt cover on top of spindle housing to be serviced. Loosen belt tension and remove belt from spindle to be serviced.
3. Raise cutting unit to transport position, engage parking brake, shut the engine off and remove key from ignition switch.
4. Using a rag or thickly padded glove, grasp end of blade. Remove blade bolt, lockwasher, anti-scalp cup and blade from spindle assembly (Fig. 25).
5. Remove six (6) carriage bolts and flange nuts holding spindle housing assembly to cutting unit housing. Lift spindle housing assembly out of cutting unit.

Disassembly

1. Remove nut and flat washer retaining spindle pulley on spindle shaft. Slide pulley off of shaft (Fig. 26).
2. Press spindle shaft out of spindle housing using an arbor press. Bearing spacer remains on spindle shaft as shaft is being removed.
3. Remove seals from spindle housing.
4. Allow bearings and small thick spacer to fall out of spindle housing.
5. Using a punch and hammer, drive both bearing cups out of spindle housing. Also drive large spacer out of housing.
6. A large snap ring is still inside the spindle housing and it should remain there because it cannot be easily removed.

IMPORTANT: If new bearings will be installed into a used spindle housing that has the original snap ring installed, discard the large snap ring that came with the bearings because it is not needed. However, new bearings with their matched spacer and snap ring must always be installed when spindle housing is being replaced. Replacement bearings are sold only with a matched snap ring and spacer set. These parts cannot be purchased separately.

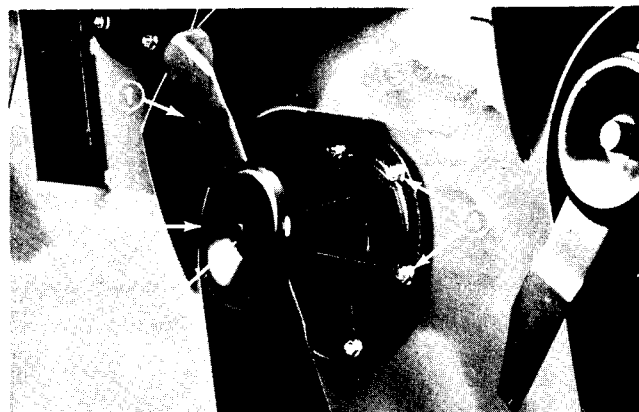


Figure 25

1. Cutting blade
2. Blade bolt and lockwasher
3. Anti - scalp cup
4. Carriage bolt and flange locknut (6)

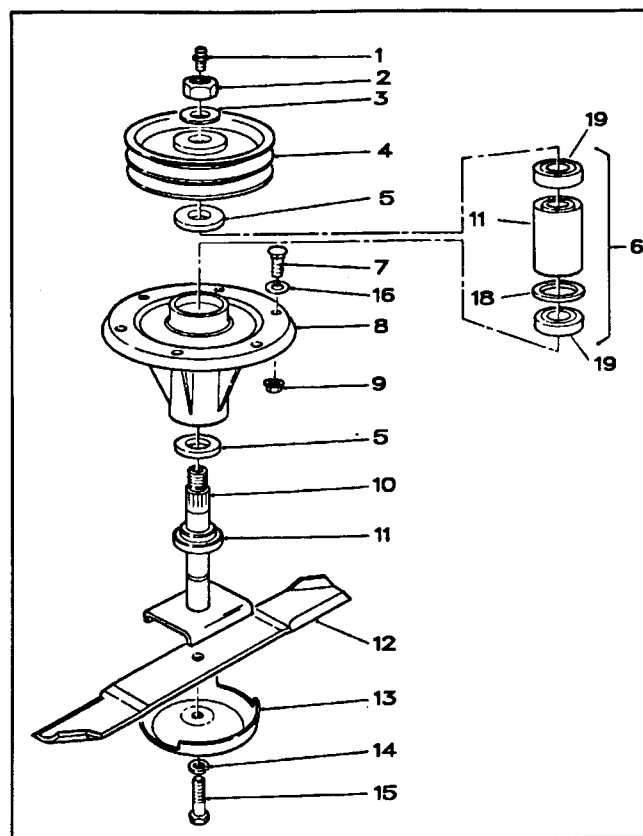


Figure 26

- | | |
|--------------------|--------------------|
| 1. Grease fitting | 11. Spacer |
| 2. Nut | 12. Blade |
| 3. Washer | 13. Anti-scalp cup |
| 4. Pulley | 14. Lockwasher |
| 5. Seal | 15. Blade bolt |
| 6. Bearing ass'y | 16. Flat washer |
| 7. Carriage bolt | 17. Spacer |
| 8. Spindle housing | 18. Snap ring |
| 9. Flange nut | 19. Bearing |
| 10. Spindle shaft | |

Assembly

IMPORTANT: If a new spindle housing is being used, new bearings and matched snap ring set must be installed; refer to step 1 below. Never use old bearings, spacer, and snap ring with a new spindle housing. If installing bearings into a used spindle housing that still has a snap ring installed, use only new bearings with cups and spacer - not the large snap ring because it is not required; refer to step 2 below.

1. Install large snap ring into groove in bore of spindle housing (Fig. 27). Make sure snap ring is seated in groove.

2. Use an arbor press to push large spacer into top of spindle housing tightly against snap ring. Spacer must contact snap ring to be sure of correct assembly of parts.

3. Thoroughly oil bearing cups. Use an arbor press to push bearing cups into top and bottom of spindle housing (Fig. 28). Top bearing cup must contact spacer that was installed in step 2, and bottom bearing cup must contact snap ring to be sure of correct assembly of parts. Make sure assembly is correct by supporting first cup and pressing the second cup against it (Fig. 28).

4. Apply a film of grease to lips of both seals, then install bearing and seal into bottom of spindle housing. **BOTTOM SEAL MUST HAVE LIP FACING OUT** so old grease can be purged during lubrication (Fig 27).

5. Check spindle shaft to make sure it is free of burrs and nicks that could possibly cut the seals and thoroughly lubricate both the shaft and seal lips.

6. Slide small, thick spacer into spindle housing. Then install bearing and seal into top of spindle housing. **LIP OF UPPER SEAL MUST FACE IN.**

7. Slide bearing spacer onto spindle shaft. Carefully slide spindle shaft through spindle housing. The bottom seal and bearing spacer fit together when the spindle is installed (Fig. 27).

8. Push pulley onto splines of spindle shaft and retain parts together with large flat washer and nut. Tighten nut to 140 - 160 ft-lb. Rotate spindle shaft to be sure that shaft rotates freely.

9. Mount spindle assembly on cutting unit with six (6) carriage bolts and flange nuts (Fig. 25).

10. Install and adjust belt. Install belt cover(s).

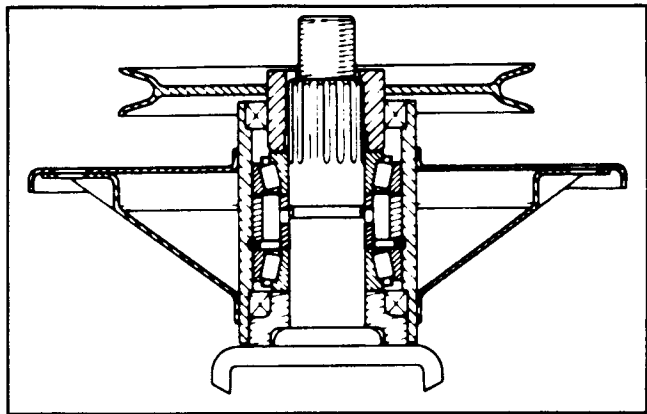


Figure 27

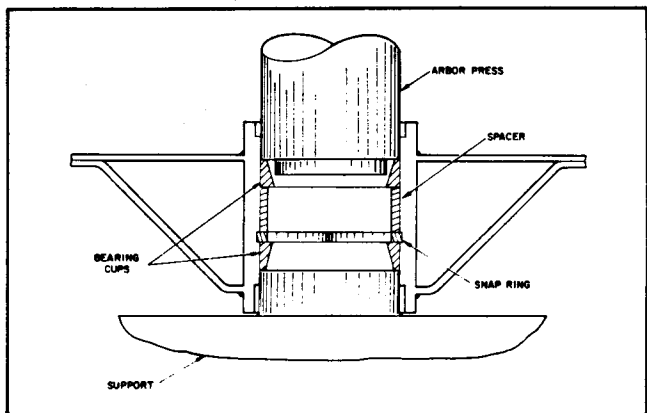


Figure 28



Chapter 8

(Model 30580 & 30581, S/N 30101 & UP)

Electrical System

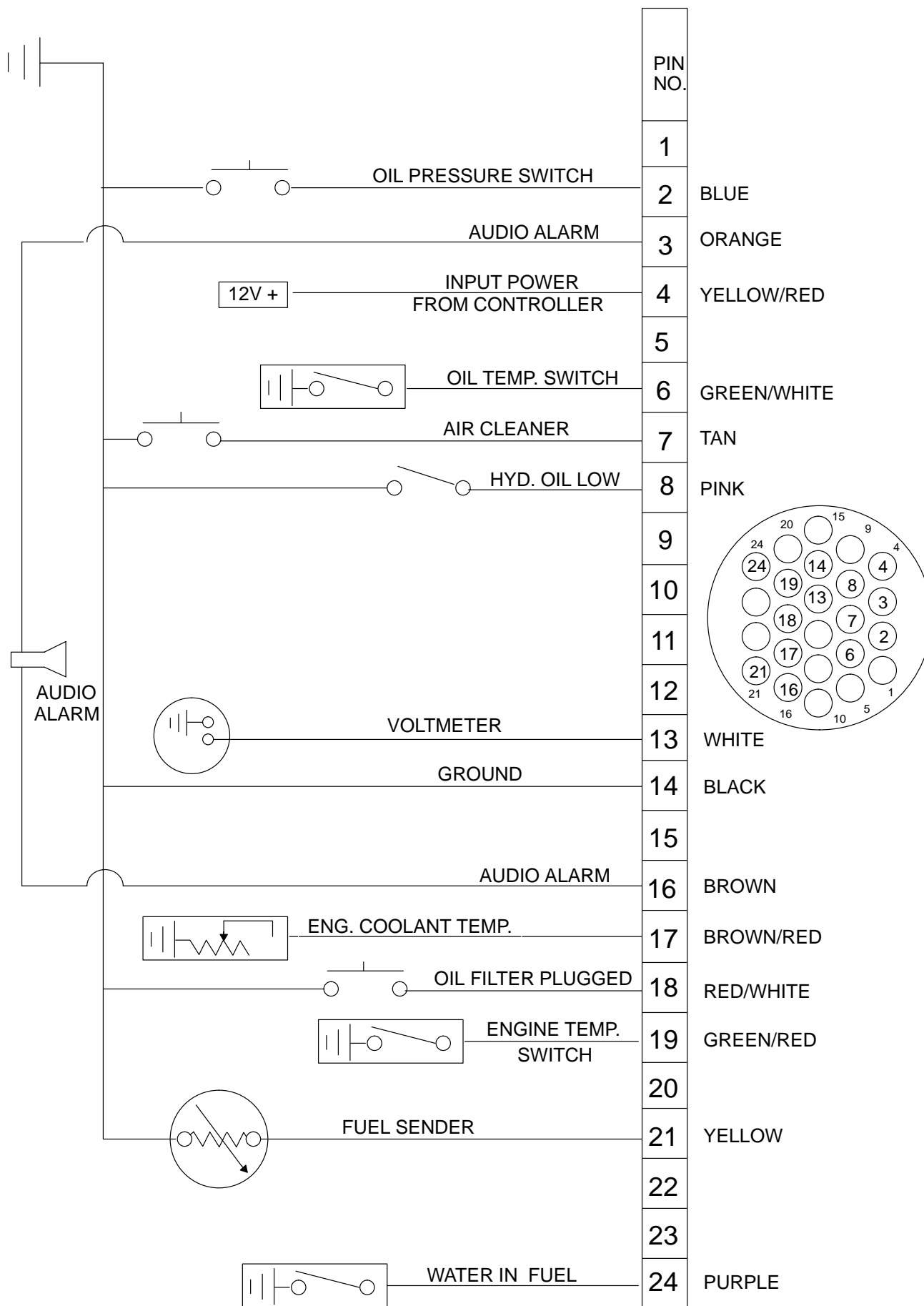
Table of Contents

WIRING SCHEMATICS	2	COMPONENT IDENTIFICATION AND TESTING ..	11
(See Chapter 9 – Foldout Diagrams for Wiring Diagrams)		Electronic Control Unit (ECU)	11
SPECIAL TOOLS	6	Seat Switch	11
TROUBLESHOOTING	8	SERVICE AND REPAIRS	12
Quick Reference Troubleshooting Guide	8	Fuses and Circuit Breaker	12
		Battery Service	13

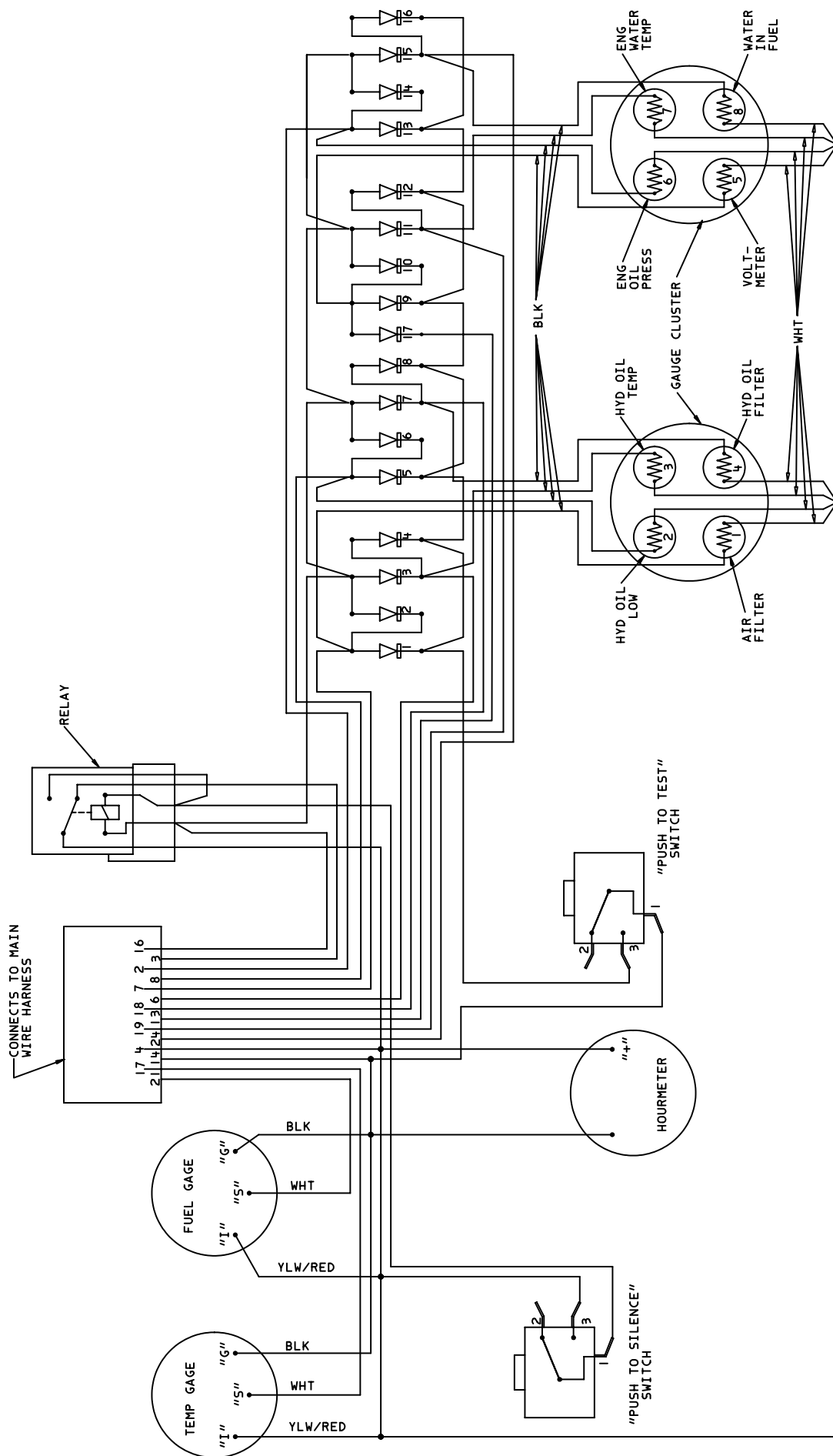
NOTE: Only new and changed information is provided in this Chapter. The Troubleshooting section of this chapter is also useful for older machines equipped with the Controller Update Kit. See **Chapter 5 – Electrical System (Model 30580, S/N Below 30101)** for additional information.

NOTE: Some wiring changes occurred from Model 30580 to 30581. The wiring diagrams for both models are provided in Chapter 9 – Foldout Diagrams.

LOGIC GRID		X=CLOSED, O=OPEN, P=OUTPUT ON, KEY: M=MOMENTARILY CLOSED, B= MUST BE CLOSED ONLY IF HI TEMP SWITCH IS CLOSED.	
ACTIONS		INPUTS	OUTPUTS
		0 Hi Range Disengage 1 Parking Brake (X=OFF) 2 Key Run 3 Traction Neutral 4 Seat Switch 5 High Coolant Temp 6 High Temp Override 7 Cruise Control Enable 8 PTO Engage 9 PTO Disengage 10 Front Deck Down 11 Right Deck Down 12 Left Deck Down 13 Hi Range Engage 14 Hyd. Oil Level (X=ok) 15 Cruise Control Engage 16 Service Brake (X=off) 17 A0 Start Key	0 1 2 Right Deck Engage 3 Left Deck Engage 4 Gauge Power ON 5 Front Deck Engage 6 Cruise Control Clutch 7 ETR Hold / Alt 8 9 Output Fail 10 Harness 11 12 Start 13 Hi Range Engage
1) Start		X	P
2) Hi Range Engage		X	P
3) Run (no operator)		X X O B	P
Run (with operator)		XX O X O B	P
4) Cruise Engage		X X X	P
5) Front Deck Engage		O X X O M O X	P
6) Right Deck Engage		O X X O M O X O	P
7) Left Deck Engage		O X X O M O X O	P
8) Gauges ON		X	P



T-1668



Special Tools

Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*.

Some tools may be listed in the Parts Catalog for the Groundsmaster 580–D. Some tools may also be available from a local supplier.

Digital Multimeter

The meter can test electrical components and circuits for current, resistance, or voltage drop.

NOTE: Toro recommends the use of a DIGITAL multi-meter when testing electrical circuits. The high impedance (internal resistance) of a digital meter will ensure that excess current is not allowed through the meter. Excess current can cause damage to a circuit that is not designed to carry it.

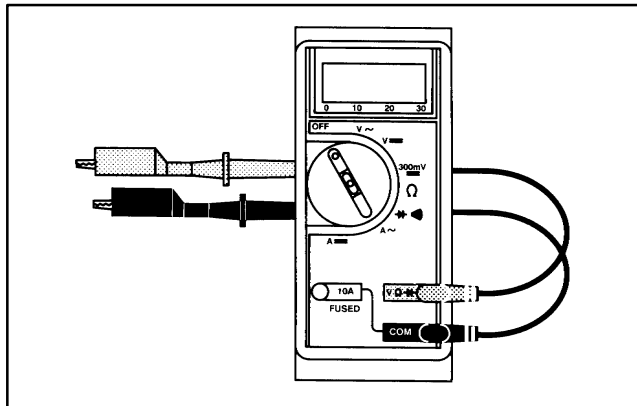


Figure 1

Inductive Ammeter (AC/DC Current Transducer – Hall Effect)

Use this tool, connected to a Digital multimeter for doing current draw tests. This tool can be useful when checking glow plug and starter circuits.

Skin–Over Grease

Special non–conductive grease which forms a light protective skin to help waterproof electrical switches and contacts.

Toro P/N **505–47** 8 oz. (.24 L) can

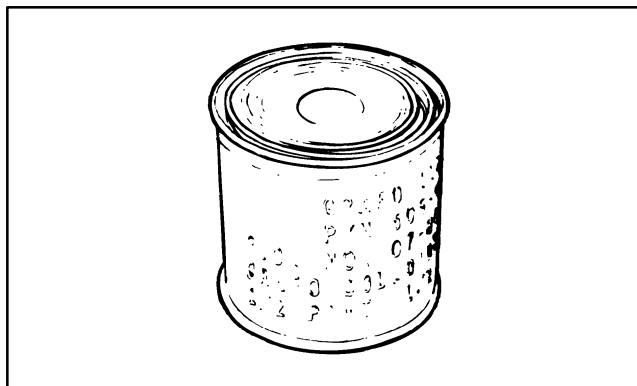


Figure 2

Diagnostic ACE Display

The diagnostic display is connected to the wiring harness connector located under the control panel to help the user verify correct electrical functions of the machine.

Diagnostic ACE Display, Toro P/N **85-4750**

Decal, V1.0, Toro P/N **88-1860**

(S/N Below 30101 with Controller Update Kit)

Decal, V2.0, Toro P/N **92-4087**

(S/N 30101 & Up)

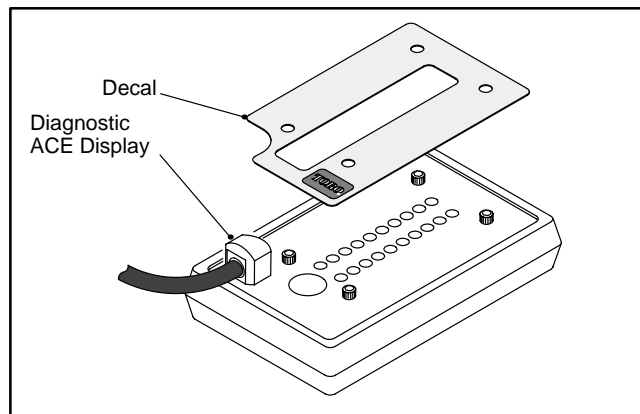


Figure 3



Figure 4

Troubleshooting

For all electrical problems, use of the **Quick Reference Troubleshooting Guide** is recommended. Using the **Diagnostic ACE Display** allows you to quickly find the source of the electrical problem.

If the machine has any interlock switches by-passed, they must be reconnected for proper troubleshooting and safety.

Quick Reference Troubleshooting Guide

Diagnostic Lamp

The Groundsmaster 580-D is equipped with a diagnostic lamp that indicates if the Electronic Controller Unit (ECU) is functioning correctly. The diagnostic light will be **on** when the ECU is functioning correctly and the ignition switch is to the ON position. The light will flash if the ECU detects any of the following malfunctions in the electrical system:

1. An electrically "open" condition.
2. An electrically "shorted" condition.
3. There is an over temperature condition in the ECU circuitry.

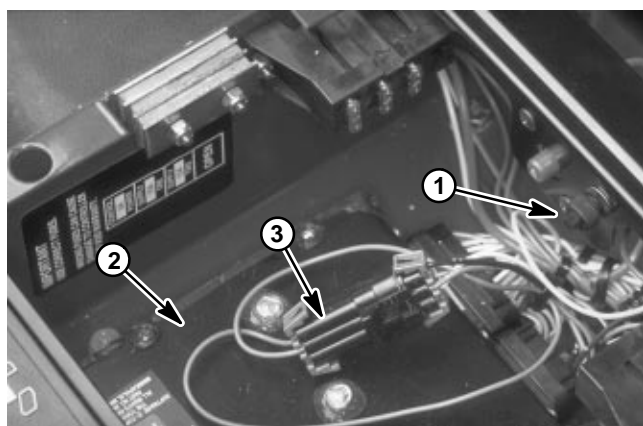


Figure 5

1. Diagnostic lamp 2. ECU 3. Loopback connector

Diagnostic ACE Display

The Groundsmaster 580-D is equipped with an ECU that controls most of the machine functions. The controller determines which function is required for various input switch conditions (i.e. seat switch, ignition switch, etc.) by producing various outputs to actuate solenoids or relays.

Each of the input switches, output solenoids, and relays must be connected and functioning properly for the ECU to properly control the machine.

The Diagnostic ACE display will help the user verify correct electrical functions of the machine.

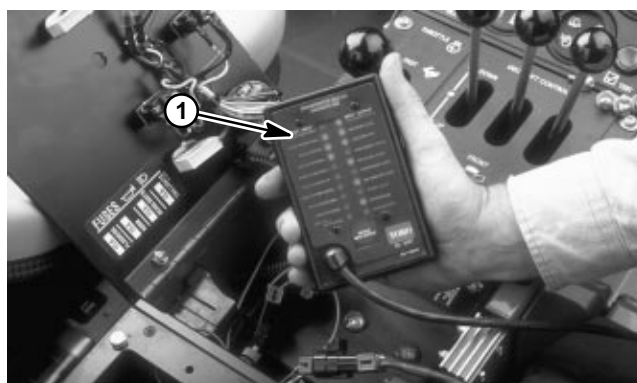


Figure 6

1. Diagnostic ACE display

Verify Input Functions

1. Park machine on a level surface, lower the cutting units, stop the engine and engage the parking brake.
2. Locate wire harness and loopback connector. Carefully unplug loopback connector from harness connector.
3. Connect Diagnostic ACE display connector to the harness connector. Make sure correct overlay decal is positioned on Diagnostic ACE display.
4. Turn Ignition switch to ON; **do not start machine.**

Note: The **red** text on the overlay decal refers to **input** switches and the **green** text refers to **output** switches.

5. The Inputs Displayed LED on lower right column of the Diagnostic ACE should be lighted. If the Outputs Displayed LED is lighted, press and release Toggle Input/Output button on Diagnostic ACE to change to the Inputs Displayed LED. **Do not hold button down.**

Note: The Diagnostic ACE will illuminate a LED associated with each input when its associated input switch is closed.

6. Change each switch individually from open to closed (i.e., sit on seat, engage traction pedal, etc.).

A. Observe that the appropriate LED on Diagnostic ACE blinks **on** and **off** when its corresponding switch is opened and closed. Check each switch that can be actuated by hand.

B. Now start engine and raise and lower each cutting unit. Note the appropriate LED on the Diagnostic ACE (i.e. LED is illuminated when cutting unit is lowered and LED is not illuminated when cutting unit is raised).

7. If switch is closed and appropriate LED does not turn on, check all wiring and connections to switch and/or check switch with an ohm meter. Replace any defective switches and repair any defective wiring.

Verify Output Function

The Diagnostic ACE also has the ability to detect which output solenoids or relays are turned on. This is a quick way to determine if a machine malfunction is electrical or hydraulic.

1. Park machine on a level surface, lower the cutting units, stop the engine and engage the parking brake.

2. Locate wire harness and connectors near controller. Carefully unplug loopback connector from harness connector.

3. Connect the Diagnostic ACE connector to the harness connector. Make sure correct overlay decal is positioned on Diagnostic ACE.

4. Turn Ignition switch to ON; **do not start machine.**

Note: The **red** text on the overlay decal refers to **input** switches and the **green** text refers to **output** switches.

5. The Outputs Displayed LED on the lower right column of the Diagnostic ACE should be lighted. If the Inputs Displayed LED is lighted, press Toggle Input/Output button on the Diagnostic ACE to change the LED to Outputs Displayed.

Note: It may be necessary to toggle between Inputs Displayed and Outputs Displayed several times to do the following step. To toggle back and forth, press Toggle Input/Output button once. This may be done as often as required. **Do not hold button.**

6. Operate desired function switch on the machine. The appropriate output LED's should illuminate to indicate that the ECU is turning on that function.

Note: If any output LED is blinking, this indicates an electrical problem with that OUTPUT. Repair or replace defective electrical parts immediately. To reset a blinking LED, turn Ignition switch to OFF and then back to ON.

If output LED's are not blinking and not lighted, verify that the required input switches are in their necessary positions to allow that function to occur. Verify correct switch position or output.

If the output LED's are **on** as specified with the machine not functioning properly, a non-electrical problem exists. Repair as necessary.

If each input switch is in the correct position and functioning correctly with the output LED's not correctly lighted, an ECU problem exists. If this condition occurs, contact your Toro Distributor for assistance.

Note: Due to electrical system constraints, the output LED's for "START", "MONITOR" and "ETR/ALT" may not blink even though an electrical problem may exist for those functions. If the machine problem appears to be with one of these functions, be certain to check the electrical circuit with a volt / ohm meter to verify that no electrical problem exists to these functions.

If electronic controller experiences an output failure for either the cruise control or one of the cutting units, the controller will disable the machine function.

Indications that this is the cause of the problem include:

- A. Flashing green diagnostic light.
- B. Diagnostic ACE will illuminate the "output fail" LED.
- C. Diagnostic ACE will flash which output failed.
- D. Machine will not respond to ignition key inputs.

The above indicates an ECU problem, contact your local Authorized TORO Distributor for assistance.

If each output switch is in the correct position and functioning correctly, but the output LED's are not correctly illuminated, this indicates an ECU problem. If this occurs, contact your Toro Distributor for assistance.

Retrieving Stored Faults

NOTE: The machine may require installation of updated software for this function to operate. This required software was installed on machines starting with S/N 70001. Older machines can have new software installed. Contact your Toro Distributor for assistance.

1. Turn ignition switch to OFF. Unplug loopback connector and connect Diagnostic ACE to the ECU harness connector.
2. Move PTO switch to the ENGAGED position and hold.
3. Turn Ignition switch to ON while continuing to hold the PTO switch in the ENGAGED position until the top left light on the Diagnostic ACE comes on (approximately 2 seconds).
4. Make sure Diagnostic ACE is set to OUTPUTS.
5. Release the PTO switch.

There will be 8 records displayed. The fault is displayed on the 8th record. Each record will be displayed for 10 seconds. Records will repeat until the Ignition switch is turned to OFF. The machine will not start in this mode.

6. Observe Diagnostic ACE for the playback of the retained fault in the ECU memory. The problem circuit will be flashing.

Clearing Fault Memory

Once a fault is repaired, it must be cleared from the ECU memory so any future fault can then be stored.

1. Turn Ignition switch to OFF.
2. Move the PTO switch to the ENGAGED position and hold.
3. Depress and hold Temp Override button OR the Cruise Set button.
4. Turn Ignition switch ON while holding the PTO switch in the ENGAGED position, and keeping the High Temp Override button or Cruise Set button depressed. Maintain this condition until the green lamp on the ECU starts to flash (approximately 2 seconds).
5. Release the PTO Switch and button. Turn Ignition switch to OFF. **Fault memory is now cleared.**

IMPORTANT: The Diagnostic ACE display must not be left connected to the machine. After using the Diagnostic ACE, disconnect it from the machine and reconnect loopback connector to the harness connector. The machine will not operate without the loopback connector installed to the harness. Store Diagnostic ACE in a dry, secure location.

Component Identification and Testing

See Chapter 5 – Electrical System (S/N Below 30101) for Component Identification and Testing information. Only components that are different or new information will be provided in this Chapter.

Electronic Control Unit (ECU)

The Toro electronic control unit (ECU) senses the condition of various switches, such as the seat switch, cutting unit down switches, traction neutral switch, etc., and directs power output to allow certain machine functions, such as engine run, cutting units engage, etc.

Because of the solid state circuitry built into the controller, there is no method to test it directly. The controller may be damaged if an attempt is made to test it with an electrical test device, such as a volt-ohm meter.

IMPORTANT: Before welding on the machine, disconnect both battery cables from the battery, disconnect both wire harness connectors from the electronic control unit and disconnect the terminal connector from the alternator to prevent damage to the electrical system.

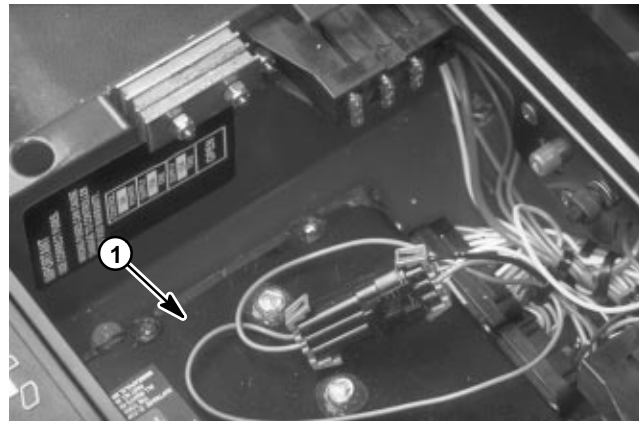


Figure 7

1. Electronic control unit (ECU)

Seat Switch

The seat switch is a proximity type, normally open (NO) reed switch that closes when the operator is on the seat. With the operator on the seat, the magnet on the bottom of the seat activates the reed switch causing it to close and complete the circuit.

1. Raise the seat to get access to the seat switch wiring connector.
2. Disconnect the seat switch wiring connector and install a continuity tester or ohm meter between the two leads of the seat switch.
3. Lower the seat. The continuity tester should show no continuity.

NOTE: Make sure the compression spring holds the seat up off the seat switch when there is no operator on the seat.

4. Have the operator sit on the seat, slowly depressing the seat switch magnet. The continuity tester should show continuity as the seat approaches the bottom of its travel.

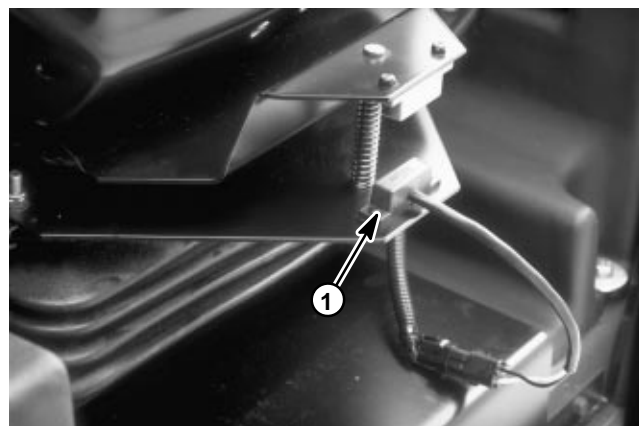


Figure 8

1. Seat switch

Service and Repairs

See Chapter 5 – Electrical System (S/N Below 30101) for Repair information. Only changed and new information will be provided in this Chapter.

Fuses and Circuit Breakers

One 5 Amp, two 15 Amp fuses, and a 40 Amp circuit breaker with reset button for protection of the entire wiring circuit are located under the control panel to the right of the seat. If total loss off electrical function occurs, find and correct the malfunction before pressing the reset button.

IMPORTANT: Do not install fuses in fuse block on left side of instrument panel. Fuses should be installed in this fuse block only if machine is equipped with a road light kit.

Fuses can be removed to check continuity, The test meter should read **less than 1 ohm**.

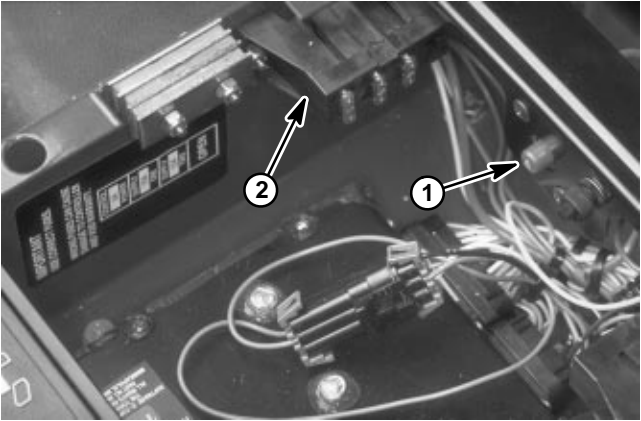


Figure 9

- 1. Circuit breaker reset button
- 2. Fuse block

IMPORTANT
USE CORRECT FUSES.

WRONG FUSES CAN CAUSE
DAMAGE TO CONTROLLER
AND VOID WARRANTY.

CONTROL
5A
POWER
SUPPLY
15A
ONE
SUPPLY
15A
TWO
OPEN

88-9490

Figure 10

Battery Service

The battery is the heart of the electrical system. With regular and proper service, battery life can be extended. Additionally, battery and electrical component failure can be prevented.

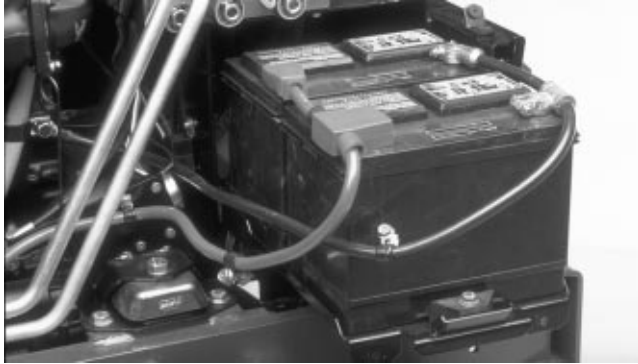


Figure 11

Electrolyte Specific Gravity

Fully charged: 1.265 corrected to 80°F (26.7°C)
Discharged: less than 1.240

Battery Specifications (S/N 10001 & UP)

BCI Group LTV24 Battery (2 batteries required)
650 Amp Cranking Performance at 0° F (-17.8° C)
125 Minute Reserve Capacity at 80° F (26.7° C)



CAUTION

Wear safety goggles and rubber gloves when working with electrolyte. Charge the battery in a well ventilated so gases produced while charging can dissipate. Since the gases are explosive, keep open flame and electrical spark away from the battery; do not smoke. Nausea may result if the gases are inhaled. Unplug charger from electrical outlet before connecting to, or disconnecting charger leads from battery posts.

Inspection, Maintenance , and Testing

1. Perform the following inspection and maintenance tasks:

A. Check for cracks caused by overly tight or loose hold-down clamp. Replace battery if cracked and leaking.

B. Check battery terminal posts for corrosion. Use a terminal brush or steel wool to clean corrosion from the battery terminal posts.

IMPORTANT: Before cleaning the battery, tape or block the vent holes to the filler caps and make sure the caps are on tightly.

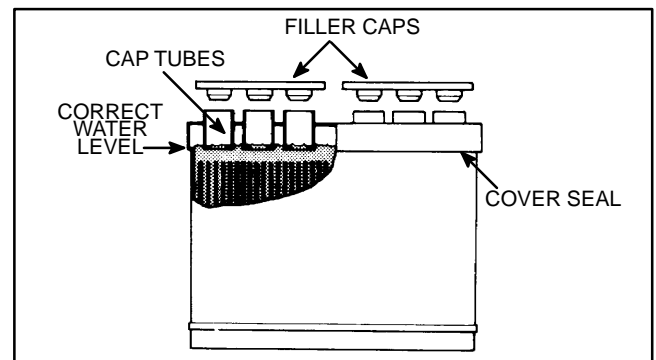


Figure 12

C. Check for signs of wetness or leakage on the top of the battery which might indicate a loose or missing filler cap, overcharging, loose terminal post, or overfilling. Also, check the battery case for dirt and oil. Clean the battery with a solution of baking soda and water, then rinse it with clean water.

D. Check that the cover seal is not broken away. Replace the battery if the seal is broken or leaking.

E. Check the electrolyte level in each cell. If the level is below the tops of the plates in any cell, fill all cells with **distilled** water to the bottom of the cap tubes. Charge at 15 to 25 amps for 15 minutes to allow sufficient mixing of the electrolyte.

2. Conduct a hydrometer test of the battery electrolyte.

IMPORTANT: Make sure the area around the cells is clean before opening the battery caps.

A. Measure the specific gravity of each cell with a hydrometer. Draw electrolyte in and out of the hydrometer barrel prior to taking a reading to warm-up the hydrometer. At the same time take the temperature of the cell.

B. Temperature correct each cell reading. For each 10°F (5.5°C) above 80°F (26.7°C) add 0.004 to the specific gravity reading. For each 10°F (5.5°C) below 80°F (26.7°C) subtract 0.004 from the specific gravity reading.

Example: Cell Temperature 100°F
Cell Gravity 1.245
ADD (20° above 80°F) 0.008
Correction to 80°F 1.253

C. If the difference between the highest and lowest cell specific gravity is 0.050 or greater or the lowest cell specific gravity is less than 1.225, charge the battery. Charge at the recommended rate and time given in **Charging** or until all cells specific gravity is 1.225 or greater with the difference in specific gravity between the highest and lowest cell less than 0.050. If these charging conditions can not be met, replace the battery.

3. Perform a high-discharge test with an adjustable load tester.

This is one of the most reliable means of testing a battery as it simulates the cold-cranking test. A commercial battery load tester is **required** to perform this test.



CAUTION

Follow the manufacturer's instructions when using a battery tester.

A. Check the voltage across the battery terminals prior to testing the battery. If the voltage is less than 12.0 VDC, recharge the battery.

B. If the battery has been charged, apply a 150 amp load for 15 seconds to remove the surface charge. Use a battery load tester following the manufacturer's instructions.

C. Make sure the battery terminals are free of corrosion.

D. Measure the temperature of the center cell.

E. Connect a battery load tester to the battery terminals **following the manufacturer's instructions**. Connect a digital multimeter to the battery terminals.

F. Apply a test load of one half the Cranking Performance rating (see Fig. 12) of the battery for 15 seconds.

G. Take a voltage reading at 15 seconds, then remove the load.

H. Using the table below, determine the minimum voltage for the cell temperature reading.

Minimum Voltage	Battery Electrolyte Temperature	
9.6	70°F (and up)	21.1°C (and up)
9.5	60°F	15.6°C
9.4	50°F	10.0°C
9.3	40°F	4.4°C
9.1	30°F	-1.1°C
8.9	20°F	-6.7°C
8.7	10°F	-12.2°C
8.5	0°F	-17.8°C

I. If the test voltage is below the minimum, replace the battery. If the test voltage is at or above the minimum, return the battery to service.

Charging

To minimize possible damage to the battery and allow the battery to be fully charged, the slow charging method is presented here. This charging method can be accomplished with a constant current battery charger which is available in most shops.



CAUTION

Follow the manufacturer's instructions when using a battery charger.

1. Determine the battery charge level from either its open circuit voltage or specific gravity.

Battery Charge Level	Open Circuit Voltage	Specific Gravity
100%	12.68	1.265
75%	12.45	1.225
50%	12.24	1.190
25%	12.06	1.155
0%	11.89	1.120

2. Determine the charging time and rate **using the manufacturer's battery charger instructions** or the following table.

Reserve Capacity (Minutes)	Battery Charge Level (Percent of Fully Charged)			
	75%	50%	25%	0%
80 or less	3.8 hrs at 3 amps	7.5 hrs at 3 amps	11.3 hrs at 3 amps	15 hrs at 3 amps
81 to 125	5.3 hrs at 4 amps	10.5 hrs at 4 amps	15.8 hrs at 4 amps	21 hrs at 4 amps
126 to 170	5.5 hrs at 5 amps	11 hrs at 5 amps	16.5 hrs at 5 amps	22 hrs at 5 amps
171 to 250	5.8 hrs at 6 amps	11.5 hrs at 6 amps	17.3 hrs at 6 amps	23 hrs at 6 amps
above 250	6 hrs at 10 amps	12 hrs at 10 amps	18 hrs at 10 amps	24 hrs at 10 amps



CAUTION

Do not charge a frozen battery because it can explode and cause injury. Let the battery warm to 60°F (15.5° C) before connecting to a charger.

Charge the battery in a well-ventilated place to dissipate gases produced from charging. These gases are explosive; keep open flame and electrical spark away from the battery. Do not smoke. Nausea may result if the gases are inhaled. Unplug the charger from the electrical outlet before connecting or disconnecting the charger leads from the battery posts.

3. **Following the manufacturer's instructions**, connect the charger cables to the battery. Make sure a good connection is made.
4. Charge the battery **following the manufacturer's instructions**.
5. Occasionally check the temperature of the battery electrolyte. If the temperature exceeds 125°F (51.6°C) or the electrolyte is violently gassing or spewing, the charging rate must be lowered or temporarily stopped.
6. Three hours prior to the end of the charging, measure the specific gravity of a battery cell once per hour. The battery is fully charged when the cells are gassing freely at a low charging rate and there is less than a 0.003 change in specific gravity for three consecutive readings.



Chapter 9

(Model 30580 & 30581, S/N 30101 & UP)

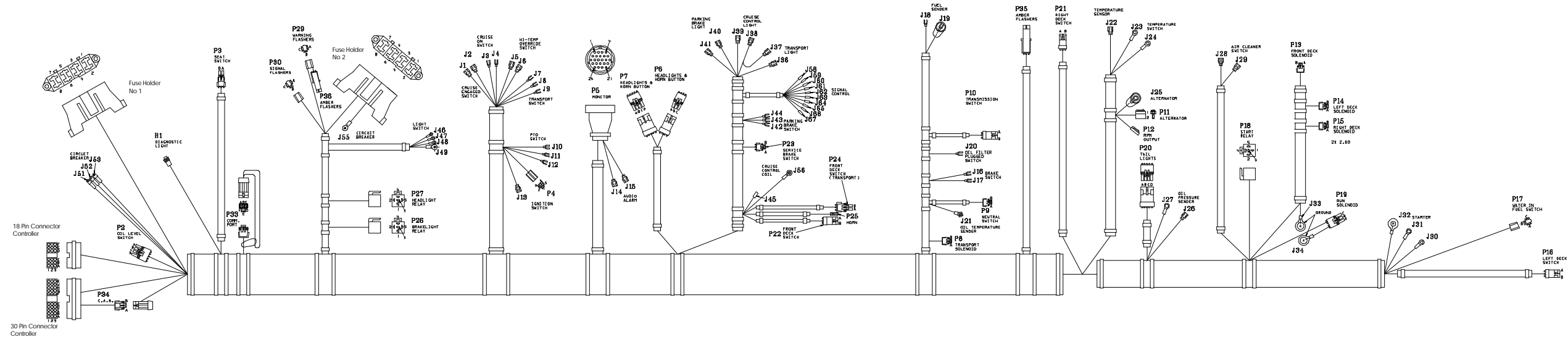
Foldout Diagrams

Table of Contents

Model 30580 Wiring Diagrams	1
Model 30581 Wiring Diagrams	5
Hydraulic Schematic	9

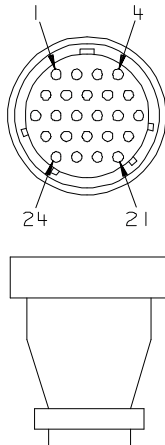
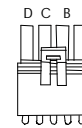
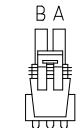




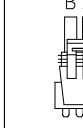
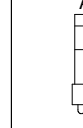

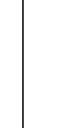

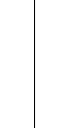
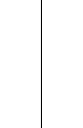
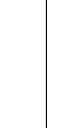

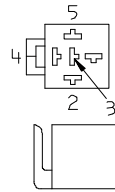
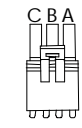
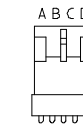
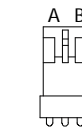
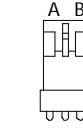
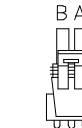





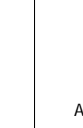
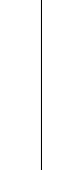

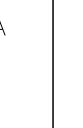
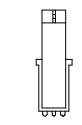

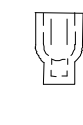




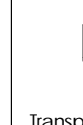

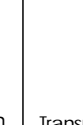

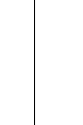
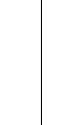
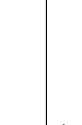

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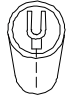







































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A 1	B 1	C 1		D 1	E 1	F 1	1																														
<div>Fuse Holder 1</div> <div><div><div><div>1 2</div><div>3 4</div><div>5 6</div><div>7 8</div></div><div><div>Fuse Size</div><div>10 Amp</div><div>10 Amp</div><div>10 Amp</div></div><div><div>Function</div><div>Controller Power</div><div>Controller Power</div><div>Head Lights</div></div></div><div>Located Under the Control Console</div><div><div>Cavity Wire</div><div><div>1 Red</div><div>2 Open</div><div>3 From No 1</div><div>4 Violet Blue</div><div>5 From No 1</div><div>6 Brown/White Green/White</div><div>7 From No 1</div><div>8 Yellow</div></div></div></div>	<div>Fuse Holder</div> <div><div><div><div>1 2</div><div>3 4</div><div>5 6</div><div>7 8</div></div><div><div>Fuse Size</div><div>10 Amp</div><div>10 Amp</div><div>10 Amp</div></div><div><div>Function</div><div>Lights</div><div>Headlights Horn</div><div>Headlights</div></div></div><div>Located Under the Operators Seat</div><div><div>Cavity Wire</div><div><div>1 Red</div><div>2 Violet</div><div>3 From No 1</div><div>4 Orange/White</div><div>5 From No 1</div><div>6 Blue</div><div>7 From No 1</div><div>8 Brown</div></div></div></div>																																				

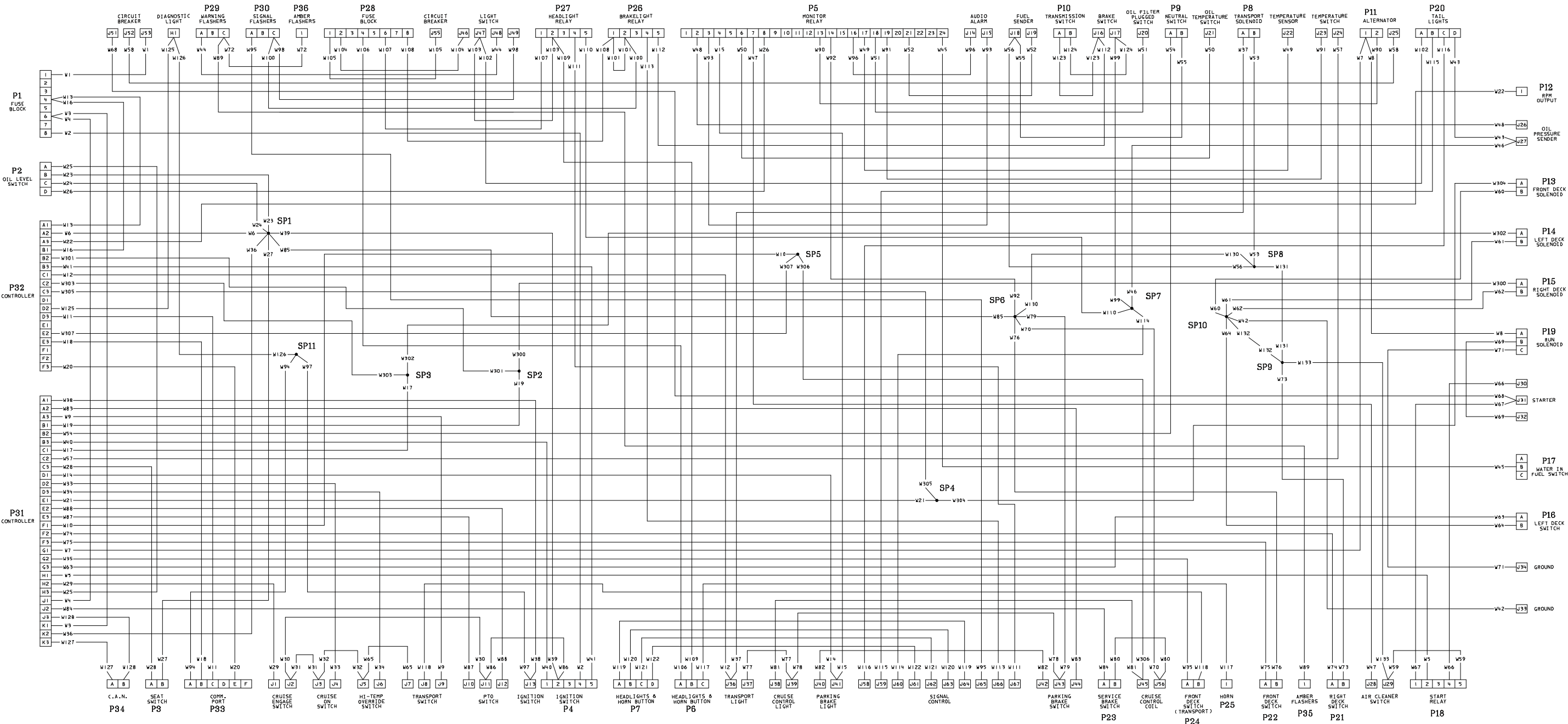
Model No 30580

<div><p>P5</p></div> <div><p>Monitor Connector</p><p>Located Under Control Console</p></div> <div><p>Cavity Wire</p><table><tr><td>1</td><td>Open</td></tr><tr><td>2</td><td>Blue</td></tr><tr><td>3</td><td>Orange</td></tr><tr><td>4</td><td>Yellow/Red</td></tr><tr><td>5</td><td>Open</td></tr><tr><td>6</td><td>Green/White</td></tr><tr><td>7</td><td>Tan</td></tr><tr><td>8</td><td>Pink</td></tr><tr><td>9</td><td>Open</td></tr><tr><td>10</td><td>Open</td></tr><tr><td>11</td><td>Open</td></tr><tr><td>12</td><td>Open</td></tr><tr><td>13</td><td>White</td></tr><tr><td>14</td><td>Black</td></tr><tr><td>15</td><td>Open</td></tr><tr><td>16</td><td>Brown</td></tr><tr><td>17</td><td>Brown/Red</td></tr><tr><td>18</td><td>Red/White</td></tr><tr><td>19</td><td>Green/Red</td></tr><tr><td>20</td><td>Open</td></tr><tr><td>21</td><td>Yellow</td></tr><tr><td>22</td><td>Open</td></tr><tr><td>23</td><td>Open</td></tr><tr><td>24</td><td>Violet</td></tr></table></div>	1	Open	2	Blue	3	Orange	4	Yellow/Red	5	Open	6	Green/White	7	Tan	8	Pink	9	Open	10	Open	11	Open	12	Open	13	White	14	Black	15	Open	16	Brown	17	Brown/Red	18	Red/White	19	Green/Red	20	Open	21	Yellow	22	Open	23	Open	24	Violet	<div><p>P2</p></div> <div><p>OIL Level Switch</p><p>Located Under Console</p><p>Cavity Wire</p><table><tr><td>A</td><td>Tan</td></tr><tr><td>B</td><td>Black</td></tr><tr><td>C</td><td>Black</td></tr><tr><td>D</td><td>Pink</td></tr></table></div>	A	Tan	B	Black	C	Black	D	Pink	<div><p>P3</p></div> <div><p>Seat Switch</p><p>Located Under Operators Seat</p><p>Cavity Wire</p><table><tr><td>A</td><td>Yellow/Blue</td></tr><tr><td>B</td><td>Black</td></tr></table></div>	A	Yellow/Blue	B	Black	<div><p>P4</p></div> <div><p>Key Switch</p><p>Located Under Operator Console</p><p>Cavity Wire</p><table><tr><td>1</td><td>Red</td></tr><tr><td>2</td><td>Black</td></tr><tr><td>3</td><td>Open</td></tr><tr><td>4</td><td>Yellow</td></tr><tr><td>5</td><td>Gray/White</td></tr></table></div>	1	Red	2	Black	3	Open	4	Yellow	5	Gray/White	<div><p>P6</p></div> <div><p>Horn Switch</p><p>Located Under Operator Console</p><p>Cavity Wire</p><table><tr><td>A</td><td>Orange/White</td></tr><tr><td>B</td><td>Brown</td></tr><tr><td>C</td><td>Orange/White</td></tr></table></div>	A	Orange/White	B	Brown	C	Orange/White	<div><p>P7</p></div> <div><p>Light Switch</p><p>Located Under Operator Console</p><p>Cavity Wire</p><table><tr><td>A</td><td>White/Green</td></tr><tr><td>B</td><td>Yellow/Black</td></tr><tr><td>C</td><td>Green</td></tr><tr><td>D</td><td>Red</td></tr></table></div>	A	White/Green	B	Yellow/Black	C	Green	D	Red	<div><p>P8</p></div> <div><p>Transport Solenoid</p><p>Located under machine, By main Axle</p><p>Cavity Wire</p><table><tr><td>A</td><td>Blue/White</td></tr><tr><td>B</td><td>Black</td></tr></table></div>	A	Blue/White	B	Black	<div><p>P9</p></div> <div><p>Neutral Switch</p><p>Located under Floor Plate, on Hydrostat Pump</p><p>Cavity Wire</p><table><tr><td>A</td><td>Orange</td></tr><tr><td>B</td><td>Black</td></tr></table></div>	A	Orange	B	Black	<div><p>P10</p></div> <div><p>Transmission Switch</p><p>Located under Floor Plate, on Hydrostat Pump</p><p>Cavity Wire</p><table><tr><td>A</td><td>Yellow/Red</td></tr><tr><td>B</td><td>Black/White</td></tr></table></div>	A	Yellow/Red	B	Black/White	<div><p>P11</p></div> <div><p>Alternator</p><p>Located on the Engine</p><p>Cavity Wire</p><table><tr><td>1</td><td>Orange</td></tr><tr><td>2</td><td>Orange White</td></tr></table></div>	1	Orange	2	Orange White	<div><p>P12</p></div> <div><p>RPM Output</p><p>Located on the Engine</p><p>Wire Color</p><p>Blue/Whitek</p></div>	<div><p>P13</p></div> <div><p>Front Deck Solenoid</p><p>Located on the Hydraulic Manifold</p><p>Cavity Wire</p><table><tr><td>A</td><td>Blue</td></tr><tr><td>B</td><td>Black</td></tr></table></div>	A	Blue	B	Black	<div><p>P14</p></div> <div><p>Left Deck Solenoid</p><p>Located on the Hydraulic Manifold</p><p>Cavity Wire</p><table><tr><td>A</td><td>Orange/White</td></tr><tr><td>B</td><td>Black</td></tr></table></div>	A	Orange/White	B	Black	<div><p>P15</p></div> <div><p>Right Deck Solenoid</p><p>Located on the Hydraulic Manifold</p><p>Cavity Wire</p><table><tr><td>A</td><td>Green</td></tr><tr><td>B</td><td>Black</td></tr></table></div>	A	Green	B	Black	<div><p>P16</p></div> <div><p>Left Deck Switch</p><p>Located on Left Deck Frame</p><p>Cavity Wire</p><table><tr><td>A</td><td>Green</td></tr><tr><td>B</td><td>Black</td></tr></table></div>	A	Green	B	Black	<div><p>P17</p></div> <div><p>Water in Fuel Switch</p><p>Located on Fuel Filter</p><p>Cavity Wire</p><table><tr><td>A</td><td>Open</td></tr><tr><td>B</td><td>Violet</td></tr><tr><td>C</td><td>Open</td></tr></table></div>	A	Open	B	Violet	C	Open
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	<div><p>P18</p></div> <div><p>Start Relay</p><p>Located Under Batteries</p><p>Cavity Wire</p><table><tr><td>1</td><td>Red</td></tr><tr><td>2</td><td>Yellow/Blue</td></tr><tr><td>3</td><td>Open</td></tr><tr><td>4</td><td>Blue</td></tr><tr><td>5</td><td>Black</td></tr></table></div>	1	Red	2	Yellow/Blue	3	Open	4	Blue	5	Black	<div><p>P19</p></div> <div><p>Run Solenoid</p><p>Located on Injection Pump</p><p>Cavity Wire</p><table><tr><td>A</td><td>Orange</td></tr><tr><td>B</td><td>White</td></tr><tr><td>C</td><td>Black</td></tr></table></div>	A	Orange	B	White	C	Black	<div><p>P20</p></div> <div><p>Tail Lights</p><p>Located at Back Of Units</p><p>Cavity Wire</p><table><tr><td>A</td><td>Brown</td></tr><tr><td>B</td><td>Black</td></tr><tr><td>C</td><td>Gray</td></tr><tr><td>D</td><td>Black</td></tr></table></div>	A	Brown	B	Black	C	Gray	D	Black	<div><p>P21</p></div> <div><p>Right Deck Switch</p><p>Located on Right Cutting Unit Frame</p><p>Cavity Wire</p><table><tr><td>A</td><td>Blue</td></tr><tr><td>B</td><td>Black</td></tr></table></div>	A	Blue	B	Black	<div><p>P22</p></div> <div><p>Front Deck Switch</p><p>Located on Front Cutting Unit Frame</p><p>Cavity Wire</p><table><tr><td>A</td><td>White</td></tr><tr><td>B</td><td>Black</td></tr></table></div>	A	White	B	Black	<div><p>P23</p></div> <div><p>Service Brake Switch</p><p>Located under Floor Plate,</p><p>Cavity Wire</p><table><tr><td>A</td><td>Brown/White</td></tr><tr><td>B</td><td>Black</td></tr></table></div>	A	Brown/White	B	Black	<div><p>P24</p></div> <div><p>Front Deck Switch (Transport)</p><p>Located under Floor Plate,</p><p>Cavity Wire</p><table><tr><td>A</td><td>Green/Yellow</td></tr><tr><td>B</td><td>Green/Yellow</td></tr></table></div>	A	Green/Yellow	B	Green/Yellow	<div><p>P25</p></div> <div><p>Horn</p><p>Located under Floor Plate,</p><p>Wire Color</p><p>Orange/White</p></div>	<div><p>P26</p></div> <div><p>Brakelight Relay</p><p>Located Under console</p><p>Cavity Wire</p><table><tr><td>1</td><td>Brown</td></tr><tr><td>2</td><td>Brown</td></tr><tr><td>3</td><td>Open</td></tr><tr><td>4</td><td>Gray/Black</td></tr><tr><td>5</td><td>Yellow/red</td></tr></table></div>	1	Brown	2	Brown	3	Open	4	Gray/Black	5	Yellow/red	<div><p>P27</p></div> <div><p>Headlight Relay</p><p>Located Under Console</p><p>Cavity Wire</p><table><tr><td>1</td><td>Blue</td></tr><tr><td>2</td><td>Brown</td></tr><tr><td>3</td><td>Open</td></tr><tr><td>4</td><td>Violet</td></tr><tr><td>5</td><td>Black/White</td></tr></table></div>	1	Blue	2	Brown	3	Open	4	Violet	5	Black/White	<div><p>P29</p></div> <div><p>Warning Flashers</p><p>Located Under Consoler</p><p>Cavity Wire</p><table><tr><td>A</td><td>Violet</td></tr><tr><td>B</td><td>Open</td></tr><tr><td>C</td><td>Brown Brown</td></tr></table></div>	A	Violet	B	Open	C	Brown Brown	<div><p>P30</p></div> <div><p>Warning Flashers</p><p>Located Under Console</p><p>Cavity Wire</p><table><tr><td>A</td><td>Yellow</td></tr><tr><td>B</td><td>Open</td></tr><tr><td>C</td><td>Brown Brown</td></tr></table></div>	A	Yellow	B	Open	C	Brown Brown	<div><p>P33</p></div> <div><p>Communications Port</p><p>Located By ACE Controller</p><p>Cavity Wire</p><table><tr><td>A</td><td>White</td></tr><tr><td>B</td><td>Grey</td></tr><tr><td>C</td><td>Black</td></tr><tr><td>D</td><td>Open</td></tr><tr><td>E</td><td>Green</td></tr><tr><td>F</td><td>Open</td></tr></table></div>	A	White	B	Grey	C	Black	D	Open	E	Green	F	Open	<div><p>P34</p></div> <div><p>C.A.N Buss</p><p>Located By ACE Controller</p><p>Cavity Wire</p><table><tr><td>A</td><td>Green/Red</td></tr><tr><td>B</td><td>Purple/White</td></tr></table></div>	A	Green/Red	B	Purple/White	<div><p>P35</p></div> <div><p>Amber Flasher</p><p>Located Under Hood, Middle of Machine</p><p>Wire Color</p><p>Orange</p></div>																																		
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	<div><p>P36</p></div> <div><p>Amber Flasher</p><p>Located Under Console</p><p>Wire Color</p><p>Orange</p></div>	<div><p>J1</p></div> <div><p>Cruse Engage Switch</p><p>Located Under Console</p><p>Wire Color</p><p>Yellow</p></div>	<div><p>J2</p></div> <div><p>Cruse Engage Switch</p><p>Located Under Console</p><p>Wire Color</p><p>Black Black</p></div>	<div><p>J3</p></div> <div><p>Cruse on Switch</p><p>Located Under Console</p><p>Wire Color</p><p>Black Black</p></div>	<div><p>J4</p></div> <div><p>Cruse On Switch</p><p>Located Under Console</p><p>Wire Color</p><p>Brown/Red</p></div>	<div><p>J5</p></div> <div><p>High Temp Override Switch</p><p>Located Under Console</p><p>Wire Color</p><p>Black Black</p></div>	<div><p>J6</p></div> <div><p>High Temp Override Switch</p><p>Located Under Console</p><p>Wire Color</p><p>White/Black</p></div>	<div><p>J7</p></div> <div><p>Transport Switch</p><p>Located Under Console</p><p>Wire Color</p><p>Black</p></div>	<div><p>J8</p></div> <div><p>Transport Switch</p><p>Located Under Console</p><p>Wire Color</p><p>Green/Yellow</p></div>	<div><p>J9</p></div> <div><p>Transport Switch</p><p>Located Under Console</p><p>Wire Color</p><p>Blue/White</p></div>	<div><p>J10</p></div> <div><p>PTO Switch</p><p>Located Under Console</p><p>Wire Color</p><p>White/Green</p></div>	<div><p>J11</p></div> <div><p>PTO Switch</p><p>Located Under Console</p><p>Wire Color</p><p>Black Black</p></div>	<div><p>J12</p></div> <div><p>PTO Switch</p><p>Located Under Console</p><p>Wire Color</p><p>Green/Black</p></div>	<div><p>J13</p></div> <div><p>Ignition Switch</p><p>Located Under Console</p><p>Wire Color</p><p>White Orange/White</p></div>	<div><p>J14</p></div> <div><p>Audio Alarm</p><p>Located Under Console</p><p>Wire Color</p><p>Brown</p></div>																																																																																																																										

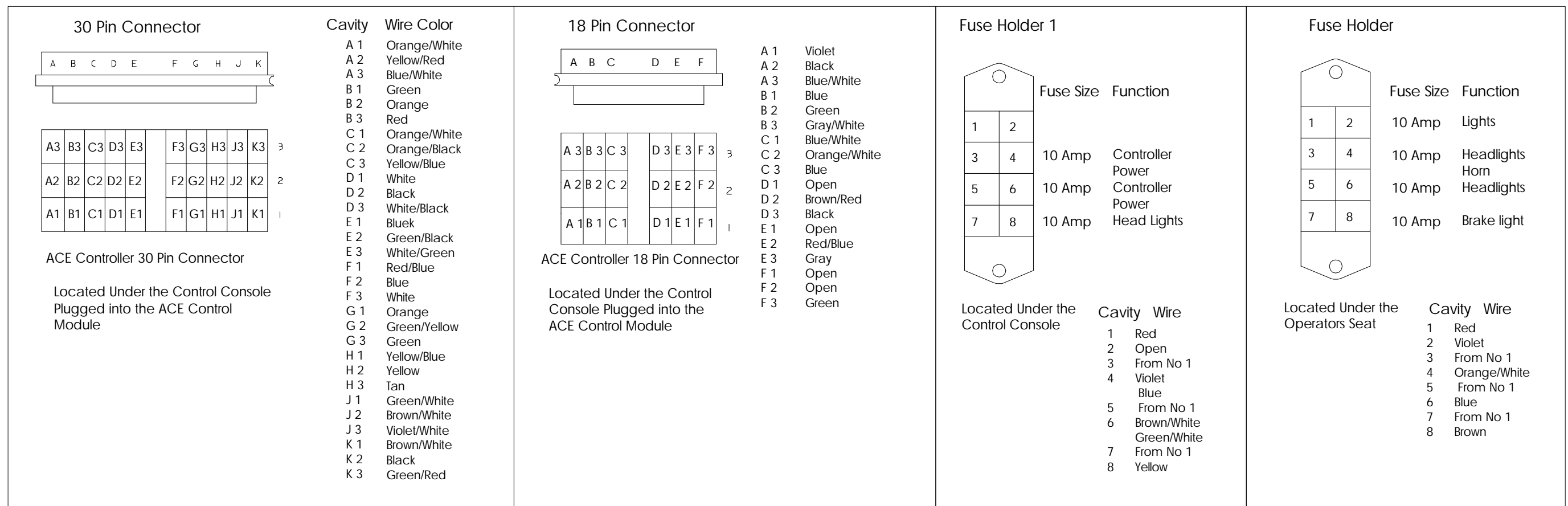
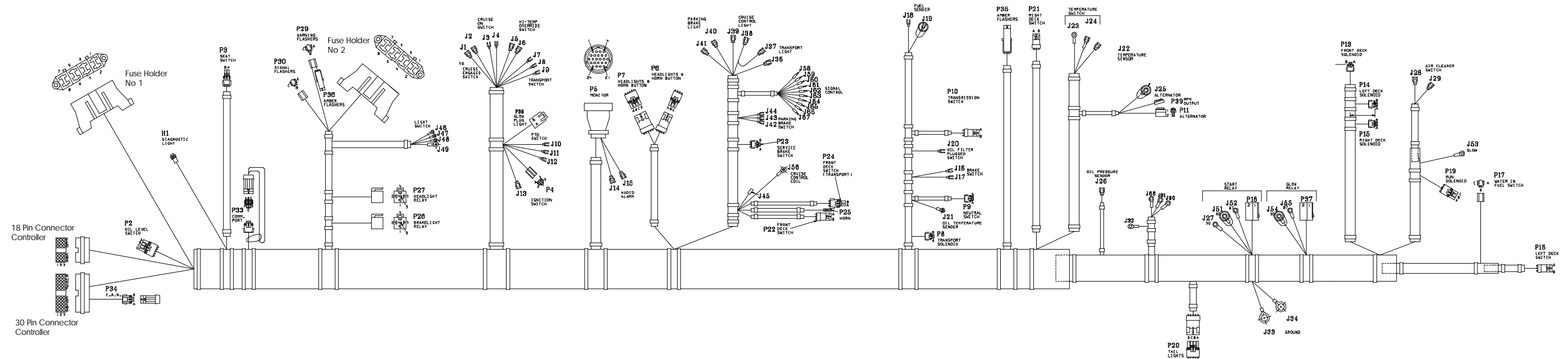
Model No 30580

<div>J15</div> <div></div> <div>Audio Alarm</div> <div>Located Under Console</div> <div>Wire Color Orange</div>	<div>J16</div> <div></div> <div>Brake Switch</div> <div>Located Under Floor Plate</div> <div>Wire Color Brown</div>	<div>J17</div> <div></div> <div>Brake Switch</div> <div>Located Under Floor Plate</div> <div>Wire Color Orange</div>	<div>J18</div> <div></div> <div>Fuel Sender</div> <div>Located On Fuel Tank</div> <div>Wire Color Black Black</div>	<div>J19</div> <div></div> <div>Fuel Sender</div> <div>Located on Fuel Tank</div> <div>Wire Color Yellow</div>	<div>J20</div> <div></div> <div>Oil Filter Plugged Switch</div> <div>Located On Oil Filter</div> <div>Wire Color Red/White</div>	<div>J21</div> <div></div> <div>Oil Temp Sender</div> <div>Located machine By Hydro Pump</div> <div>Wire Color Green/White</div>	<div>J22</div> <div></div> <div>Temperature Sender</div> <div>Located On Engine</div> <div>Wire Color Brown/Red</div>	<div>J23</div> <div></div> <div>Temperature Switch</div> <div>Located On Engine</div> <div>Wire Color Green/Yellow</div>	<div>J24</div> <div></div> <div>Temperature Switch</div> <div>Located on Engine</div> <div>Wire Color Blue/White</div>	<div>J25</div> <div></div> <div>Alternator</div> <div>Located on Alternator</div> <div>Wire Color Orange/Black</div>	<div>J26</div> <div></div> <div>Oil Pressure Sender</div> <div>Located on Engine</div> <div>Wire Color Blue</div>	<div>J27</div> <div></div> <div>Oil Pressure Sender</div> <div>Located on Engine</div> <div>Wire Color Black/White Black/White</div>	<div>J28</div> <div></div> <div>Air Cleaner Switch</div> <div>Located on Air Cleaner Housing</div> <div>Wire Color Tan</div>	<div>J29</div> <div></div> <div>Air Cleaner Switch</div> <div>Located on Air Cleaner Housing</div> <div>Wire Color Black Black</div>	<div>J30</div> <div></div> <div>Starter</div> <div>Located on side of Engine</div> <div>Wire Color Blue</div>	<div>J31</div> <div></div> <div>Starter</div> <div>Located on side of Engine</div> <div>Wire Color Red Red/White</div>
<div>J32</div> <div></div> <div>Starter</div> <div>Located on Side of Engine</div> <div>Wire Color White</div>	<div>J33</div> <div></div> <div>Ground</div> <div>Located On engine</div> <div>Wire Color Black</div>	<div>J34</div> <div></div> <div>Ground</div> <div>Located on Engine</div> <div>Wire Color Black</div>	<div>J36</div> <div></div> <div>Transport Light</div> <div>Located In Steering Column</div> <div>Wire Color Blue/White Blue/White</div>	<div>J37</div> <div></div> <div>Transport Light</div> <div>Located In Steering Column</div> <div>Wire Color Black</div>	<div>J38</div> <div></div> <div>Cruise Control Light</div> <div>Located In Steering Column</div> <div>Wire Color Red/Blue</div>	<div>J39</div> <div></div> <div>Cruise Control Light</div> <div>Located In Steering Column</div> <div>Wire Color Black Black</div>	<div>J40</div> <div></div> <div>Parking Brake Light</div> <div>Located In Steering Column</div> <div>Wire Color White</div>	<div>J41</div> <div></div> <div>Parking Brake Light</div> <div>Located In Steering Column</div> <div>Wire Color White Yellow/Red</div>	<div>J42</div> <div></div> <div>Parking Brake Switch</div> <div>Located In Steering Column</div> <div>Wire Color White</div>	<div>J43</div> <div></div> <div>Parking Brake Switch</div> <div>Located in Steering Column</div> <div>Wire Color Black Black</div>	<div>J44</div> <div></div> <div>Parking Brake Switch</div> <div>Located In Steering Column</div> <div>Wire Color Yellow/Red</div>	<div>J45</div> <div></div> <div>Cruise Control Solenoid</div> <div>Located Floor Plate</div> <div>Wire Color Red/Blue Red/Blue</div>	<div>J46</div> <div></div> <div>Light Switch</div> <div>Located Under Console</div> <div>Wire Color Violet</div>	<div>J47</div> <div></div> <div>Light Switch</div> <div>Located Under Console</div> <div>Wire Color Brown Brown</div>	<div>J48</div> <div></div> <div>Light Switch</div> <div>Located Under Console</div> <div>Wire Color Violet</div>	<div>J49</div> <div></div> <div>Light Switch</div> <div>Located Under Console</div> <div>Wire Color Brown</div>
<div>J51</div> <div></div> <div>Circuit Breaker</div> <div>Located Under Console</div> <div>Wire Color Red/White</div>	<div>J52</div> <div></div> <div>Circuit Breaker</div> <div>Located Under Console</div> <div>Wire Color Red</div>	<div>J53</div> <div></div> <div>Circuit Breaker</div> <div>Located Under Console</div> <div>Wire Color Red</div>	<div>J55</div> <div></div> <div>Circuit Breaker</div> <div>Located Under Console</div> <div>Wire Color Red</div>	<div>J56</div> <div></div> <div>Cruise Control Coil</div> <div>Located Under Floor Plate</div> <div>Wire Color Black Black</div>	<div>J58</div> <div></div> <div>Signal Control</div> <div>Located on Steering Column</div> <div>Wire Color Grey</div>	<div>J59</div> <div></div> <div>Signal Control</div> <div>Located on Steering Column</div> <div>Wire Color Black</div>	<div>J60</div> <div></div> <div>Signal Control</div> <div>Located on Steering Column</div> <div>Wire Color Black/White</div>	<div>J61</div> <div></div> <div>Signal Control</div> <div>Located on Steering Column</div> <div>Wire Color Red</div>	<div>J62</div> <div></div> <div>Signal Control</div> <div>Located on Steering Column</div> <div>Wire Color Green</div>	<div>J63</div> <div></div> <div>Signal Control</div> <div>Located on Steering Column</div> <div>Wire Color Yellow/Black</div>	<div>J64</div> <div></div> <div>Signal Control</div> <div>Located on Steering Column</div> <div>Wire Color White/Green</div>	<div>J65</div> <div></div> <div>Signal Control</div> <div>Located on Steering Column</div> <div>Wire Color Yellow</div>	<div>J66</div> <div></div> <div>Signal Control</div> <div>Located on Steering Column</div> <div>Wire Color Grey/Black</div>	<div>J67</div> <div></div> <div>Signal Control</div> <div>Located on Steering Column</div> <div>Wire Color Violet</div>	<div>H1</div> <div></div> <div>Diagnostic light</div> <div>Located under Console</div> <div>Wire Color Violet</div>	

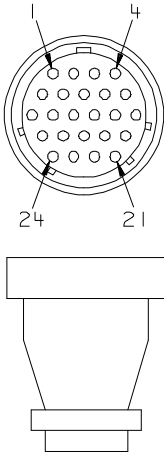
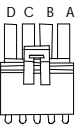
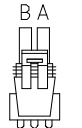
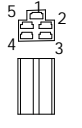
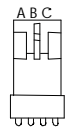
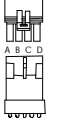
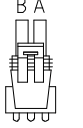
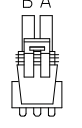
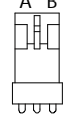
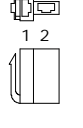
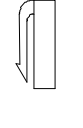
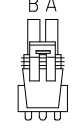
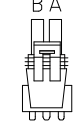
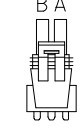
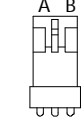
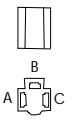
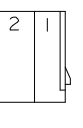
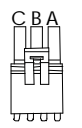
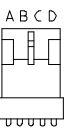
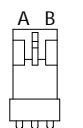
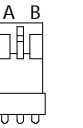
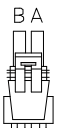
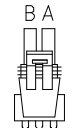
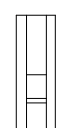
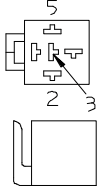
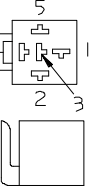
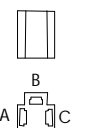
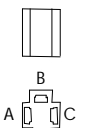
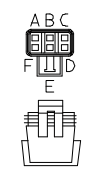

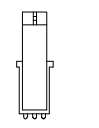
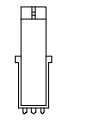
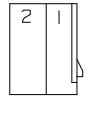
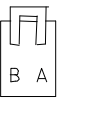
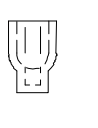

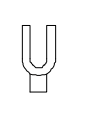
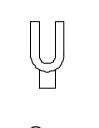
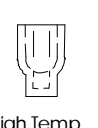

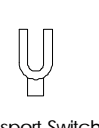
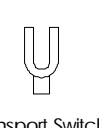

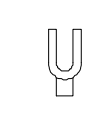
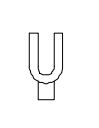

Model No 30580























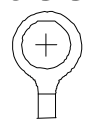















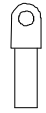
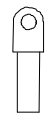















Model No 30581



Model No 30581

<div><div>P5</div><div></div><div>Monitor Connector</div><div>Located Under Control Console</div><div>Cavity Wire</div><div><div>1 Open</div><div>2 Blue</div><div>3 Orange</div><div>4 Yellow/Red</div><div>5 Open</div><div>6 Green/White</div><div>7 Tan</div><div>8 Pink</div><div>9 Open</div><div>10 Open</div><div>11 Open</div><div>12 Open</div><div>13 White</div><div>14 Black</div><div>15 Open</div><div>16 Brown</div><div>17 Brown/Red</div><div>18 Red/White</div><div>19 Green/Red</div><div>20 Open</div><div>21 Yellow</div><div>22 Open</div><div>23 Open</div><div>24 Violet</div></div></div>	<div><div>P2</div><div></div><div>OIL Level Switch</div><div>Located Under Rear of Console</div><div>Cavity Wire</div><div><div>A Tan</div><div>B Black</div><div>C Black</div><div>D Pink</div></div></div>	<div><div>P3</div><div></div><div>Seat Switch</div><div>Located Under Operators Seat</div><div>Cavity Wire</div><div><div>A Yellow/Blue</div><div>B Black</div></div></div>	<div><div>P4</div><div></div><div>Key Switch</div><div>Located In Steering Column</div><div>Cavity Wire</div><div><div>1 Red</div><div>2 Black</div><div>3 Open</div><div>4 Yellow</div><div>5 Gray/White</div></div></div>	<div><div>P6</div><div></div><div>Horn Switch</div><div>Located Under Operator Console</div><div>Cavity Wire</div><div><div>A Orange/White</div><div>B Brown</div><div>C Orange/White</div></div></div>	<div><div>P7</div><div></div><div>Light Switch</div><div>Located Under Operator Console</div><div>Cavity Wire</div><div><div>A White/Green</div><div>B Yellow/Black</div><div>C Green</div><div>D Red</div></div></div>	<div><div>P8</div><div></div><div>Transport Solenoid</div><div>Located under Machine, Behind Main Axle</div><div>Cavity Wire</div><div><div>A Blue/White</div><div>B Black</div></div></div>	<div><div>P9</div><div></div><div>Neutral Switch</div><div>Located under Machine, on Hydrostat Pump</div><div>Cavity Wire</div><div><div>A Orange</div><div>B Black</div></div></div>	<div><div>P10</div><div></div><div>Transmission Switch</div><div>Located under Machine on Hydrostat Pump</div><div>Cavity Wire</div><div><div>A Yellow/Red</div><div>B Black/White</div></div></div>	<div><div>P11</div><div></div><div>Alternator</div><div>Located on the Engine</div><div>Cavity Wire</div><div><div>1 Orange</div><div>2 Orange</div><div>White</div></div></div>	<div><div>P12</div><div></div><div>RPM Output</div><div>Located on the Engine</div><div>Wire Color</div><div>Blue/Whitek</div></div>	<div><div>P13</div><div></div><div>Front Deck Solenoid</div><div>Located on the Hydraulic Manifold</div><div>Cavity Wire</div><div><div>A Blue</div><div>B Black</div></div></div>	<div><div>P14</div><div></div><div>Left Deck Solenoid</div><div>Located on the Hydraulic Manifold</div><div>Cavity Wire</div><div><div>A Orange/White</div><div>B Black</div></div></div>	<div><div>P15</div><div></div><div>Right Deck Solenoid</div><div>Located on the Hydraulic Manifold</div><div>Cavity Wire</div><div><div>A Green</div><div>B Black</div></div></div>	<div><div>P16</div><div></div><div>Left Deck Switch</div><div>Located on Left Deck Frame</div><div>Cavity Wire</div><div><div>A Green</div><div>B Black</div></div></div>	<div><div>P17</div><div></div><div>Water in Fuel Switch</div><div>Located on Fuel Filter</div><div>Cavity Wire</div><div><div>A Open</div><div>B Violet</div><div>C Open</div></div></div>
	<div><div>P18</div><div></div><div>Start Relay</div><div>Located Under Batteries</div><div>Cavity Wire</div><div><div>1 Red</div><div>2 Yellow/Blue</div><div>3 Open</div><div>4 Blue</div><div>5 Black</div></div></div>	<div><div>P19</div><div></div><div>Run Solenoid</div><div>Located on Injection Pump</div><div>Cavity Wire</div><div><div>A Orange</div><div>B White</div><div>C Black</div></div></div>	<div><div>P20</div><div></div><div>Tail Lights</div><div>Located at Back Of Units</div><div>Cavity Wire</div><div><div>A Brown</div><div>B Black</div><div>C Gray</div><div>D Black</div></div></div>	<div><div>P21</div><div></div><div>Right Deck Switch</div><div>Located on Right Cutting Unit Frame</div><div>Cavity Wire</div><div><div>A Blue</div><div>B Black</div></div></div>	<div><div>P22</div><div></div><div>Front Deck Switch</div><div>Located on Front Cutting Unit Frame</div><div>Cavity Wire</div><div><div>A White</div><div>B Black</div></div></div>	<div><div>P23</div><div></div><div>Service Brake Switch</div><div>Located under Floor Plate,</div><div>Cavity Wire</div><div><div>A Brown/White</div><div>B Black</div></div></div>	<div><div>P24</div><div></div><div>Front Deck Switch (Transport)</div><div>Located under Floor Plate,</div><div>Cavity Wire</div><div><div>A Green/Yellow</div><div>B Green/Yellow</div></div></div>	<div><div>P25</div><div></div><div>Horn</div><div>Located under Floor Plate,</div><div>Wire Color</div><div>Orange/White</div></div>	<div><div>P26</div><div></div><div>Brakelight Relay</div><div>Located Under Console</div><div>Cavity Wire</div><div><div>1 Brown</div><div>2 Brown</div><div>3 Brown</div><div>4 Open</div><div>5 Gray/Black</div><div>Yellow/red</div></div></div>	<div><div>P27</div><div></div><div>Headlight Relay</div><div>Located Under Console</div><div>Cavity Wire</div><div><div>1 Blue</div><div>2 Brown</div><div>3 Brown</div><div>4 Violet</div><div>5 Black/White</div></div></div>	<div><div>P29</div><div></div><div>Warning Flashers</div><div>Located Under Console</div><div>Cavity Wire</div><div><div>A Violet</div><div>B Open</div><div>C Brown</div><div>Brown</div></div></div>	<div><div>P30</div><div></div><div>Warning Flashers</div><div>Located Under Console</div><div>Cavity Wire</div><div><div>A Yellow</div><div>B Open</div><div>C Brown</div><div>Brown</div></div></div>	<div><div>P33</div><div></div><div>Communications Port</div><div>Located By ACE Controller</div><div>Cavity Wire</div><div><div>A White</div><div>B Grey</div><div>C Black</div><div>D Open</div><div>E Green</div><div>F Open</div></div></div>	<div><div>P34</div><div></div><div>C.A.N Buss</div><div>Located By ACE Controller</div><div>Cavity Wire</div><div><div>A Green/Red</div><div>B Purple/White</div></div></div>	<div><div>P35</div><div></div><div>Amber Flasher</div><div>Located Under Console</div><div>Wire Color</div><div>Orange</div></div>
	<div><div>P36</div><div></div><div>Amber Flasher</div><div>Located Under hood, Middle of Machine</div><div>Wire Color</div><div>Orange</div></div>	<div><div>P37</div><div></div><div>Glow Plug Relay</div><div>Located Under Batteries</div><div>Wire Color</div><div>Black</div><div>Black</div></div>	<div><div>P38</div><div></div><div>Glow Plug Light</div><div>Located Under Console</div><div>Wire Color</div><div>Black</div><div>Black</div></div>	<div><div>J1</div><div></div><div>Cruse Engage Switch</div><div>Located Under Console</div><div>Wire Color</div><div>Yellow</div></div>	<div><div>J2</div><div></div><div>Cruse Engage Switch</div><div>Located Under Console</div><div>Wire Color</div><div>Black</div><div>Black</div></div>	<div><div>J3</div><div></div><div>Cruse on Switch</div><div>Located Under Console</div><div>Wire Color</div><div>Black</div><div>Black</div></div>	<div><div>J4</div><div></div><div>Cruse On Switch</div><div>Located Under Console</div><div>Wire Color</div><div>Brown/Red</div></div>	<div><div>J5</div><div></div><div>High Temp Override Switch</div><div>Located Under Console</div><div>Wire Color</div><div>Black</div><div>Black</div></div>	<div><div>J6</div><div></div><div>High Temp Override Switch</div><div>Located Under Console</div><div>Wire Color</div><div>White/Black</div></div>	<div><div>J7</div><div></div><div>Transport Switch</div><div>Located Under Console</div><div>Wire Color</div><div>Black</div></div>	<div><div>J8</div><div></div><div>Transport Switch</div><div>Located Under Console</div><div>Wire Color</div><div>Green/Yellow</div></div>	<div><div>J9</div><div></div><div>Transport Switch</div><div>Located Under Console</div><div>Wire Color</div><div>Blue/White</div></div>	<div><div>J10</div><div></div><div>PTO Switch</div><div>Located Under Console</div><div>Wire Color</div><div>White/Green</div></div>	<div><div>J11</div><div></div><div>PTO Switch</div><div>Located Under Console</div><div>Wire Color</div><div>Black</div><div>Black</div></div>	<div><div>J12</div><div></div><div>PTO Switch</div><div>Located Under Console</div><div>Wire Color</div><div>Green/Black</div></div>

Model No 30581

<div>J13</div> <div></div> <div>Ignition Switch</div> <div>Located Under Console</div> <div>Wire Color White Orange/White</div>	<div>J14</div> <div></div> <div>Audio Alarm</div> <div>Located Under Console</div> <div>Wire Color Brown</div>	<div>J15</div> <div></div> <div>Audio Alarm</div> <div>Located Under Console</div> <div>Wire Color Orange</div>	<div>J16</div> <div></div> <div>Brake Switch</div> <div>Located Under Floor Plate</div> <div>Wire Color Brown</div>	<div>J17</div> <div></div> <div>Brake Switch</div> <div>Located Under Floor Plate</div> <div>Wire Color Orange</div>	<div>J18</div> <div></div> <div>Fuel Sender</div> <div>Located On Fuel Tank</div> <div>Wire Color Black Black</div>	<div>J19</div> <div></div> <div>Fuel Sender</div> <div>Located on Fuel Tank</div> <div>Wire Color Yellow</div>	<div>J20</div> <div></div> <div>Oil Filter Plugged Switch</div> <div>Located On Oil Filter</div> <div>Wire Color Red/White</div>	<div>J21</div> <div></div> <div>Oil Temp Sender</div> <div>Located by Hydrostatic pump</div> <div>Wire Color Green/White</div>	<div>J22</div> <div></div> <div>Temperature Sender</div> <div>Located On Engine</div> <div>Wire Color Brown/Red</div>	<div>J23</div> <div></div> <div>Temperature Switch</div> <div>Located on Engine</div> <div>Wire Color Green/Yellow</div>	<div>J24</div> <div></div> <div>Temperature Switch</div> <div>Located on Engine</div> <div>Wire Color Blue/White</div>	<div>J25</div> <div></div> <div>Alternator</div> <div>Located on Alternator</div> <div>Wire Color Orange/Black</div>	<div>J26</div> <div></div> <div>Oil Pressure Sender</div> <div>Located on Engine</div> <div>Wire Color Blue</div>	<div>J27</div> <div></div> <div>Start Relay</div> <div>Located on Engine</div> <div>Wire Color Black/White Black/White</div>	<div>J28</div> <div></div> <div>Air Cleaner Switch</div> <div>Located on Air Cleaner Housing</div> <div>Wire Color Tan</div>	<div>J29</div> <div></div> <div>Air Cleaner Switch</div> <div>Located on Air Cleaner Housing</div> <div>Wire Color Black Black</div>	<div>J30</div> <div></div> <div>Starter</div> <div>Located on side of Engine</div> <div>Wire Color Blue</div>
<div>J31</div> <div></div> <div>Starter</div> <div>Located on side of Engine</div> <div>Wire Color Red Red/White</div>	<div>J32</div> <div></div> <div>Starter</div> <div>Located on Side of Engine</div> <div>Wire Color White</div>	<div>J33</div> <div></div> <div>Ground</div> <div>Located On engine</div> <div>Wire Color Black</div>	<div>J34</div> <div></div> <div>Ground</div> <div>Located on Engine</div> <div>Wire Color Black</div>	<div>J36</div> <div></div> <div>Transport Light</div> <div>Located in Steering Column</div> <div>Wire Color Blue/White Blue/White</div>	<div>J37</div> <div></div> <div>Transport Light</div> <div>Located in Steering Column</div> <div>Wire Color Black</div>	<div>J38</div> <div></div> <div>Cruse Control Light</div> <div>Located in Steering Column</div> <div>Wire Color Red/Blue</div>	<div>J39</div> <div></div> <div>Cruse Control Light</div> <div>Located in Steering Column</div> <div>Wire Color Black Black</div>	<div>J40</div> <div></div> <div>Parking Brake Light</div> <div>Located in Steering Column</div> <div>Wire Color White</div>	<div>J41</div> <div></div> <div>Parking Brake Light</div> <div>Located in Steering Column</div> <div>Wire Color White Yellow/Red</div>	<div>J42</div> <div></div> <div>Parking Brake Switch</div> <div>Located in Steering Column</div> <div>Wire Color White</div>	<div>J43</div> <div></div> <div>Parking Brake Switch</div> <div>Located in Steering Column</div> <div>Wire Color Black Black</div>	<div>J44</div> <div></div> <div>Parking Brake Switch</div> <div>Located in Steering Column</div> <div>Wire Color Yellow/Red</div>	<div>J45</div> <div></div> <div>Cruise Control Solenoid</div> <div>Located Floor Plate</div> <div>Wire Color Red/Blue Red/Blue</div>	<div>J46</div> <div></div> <div>Light Switch</div> <div>Located Under Console</div> <div>Wire Color Violet</div>	<div>J47</div> <div></div> <div>Light Switch</div> <div>Located Under Console</div> <div>Wire Color Brown Brown</div>	<div>J48</div> <div></div> <div>Light Switch</div> <div>Located Under Console</div> <div>Wire Color Violet</div>	<div>J49</div> <div></div> <div>Light Switch</div> <div>Located Under Console</div> <div>Wire Color Brown</div>
<div>J51</div> <div></div> <div>Circuit Breaker</div> <div>Located Under Console</div> <div>Wire Color Red/White</div>	<div>J52</div> <div></div> <div>Circuit Breaker</div> <div>Located Under Console</div> <div>Wire Color Red</div>	<div>J53</div> <div></div> <div>Circuit Breaker</div> <div>Located Under Console</div> <div>Wire Color Red</div>	<div>J55</div> <div></div> <div>Circuit Breaker</div> <div>Located Under Console</div> <div>Wire Color Red</div>	<div>J56</div> <div></div> <div>Cruise Control Coil</div> <div>Located Under Floor Plate</div> <div>Wire Color Black Black</div>	<div>J58</div> <div></div> <div>Signal Control</div> <div>Located on Steering Column</div> <div>Wire Color Grey</div>	<div>J59</div> <div></div> <div>Signal Control</div> <div>Located on Steering Column</div> <div>Wire Color Black</div>	<div>J60</div> <div></div> <div>Signal Control</div> <div>Located on Steering Column</div> <div>Wire Color Black/White</div>	<div>J61</div> <div></div> <div>Signal Control</div> <div>Located on Steering Column</div> <div>Wire Color Red</div>	<div>J62</div> <div></div> <div>Signal Control</div> <div>Located on Steering Column</div> <div>Wire Color Green</div>	<div>J63</div> <div></div> <div>Signal Control</div> <div>Located on Steering Column</div> <div>Wire Color Yellow/Black</div>	<div>J64</div> <div></div> <div>Signal Control</div> <div>Located on Steering Column</div> <div>Wire Color White/Green</div>	<div>J65</div> <div></div> <div>Signal Control</div> <div>Located on Steering Column</div> <div>Wire Color Yellow</div>	<div>J66</div> <div></div> <div>Signal Control</div> <div>Located on Steering Column</div> <div>Wire Color Grey/Black</div>	<div>J67</div> <div></div> <div>Signal Control</div> <div>Located on Steering Column</div> <div>Wire Color Violet</div>	<div>J68</div> <div></div> <div>Signal Control</div> <div>Located on Steering Column</div> <div>Wire Color Violet</div>	<div>H1</div> <div></div> <div>Diagnostic light</div> <div>Located under Console</div> <div>Wire Color Violet</div>	

Model No 30581

