TORO

Service Manual

Greensmaster® 3000/3000-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 Greensmaster 3000/3000-D.

REFER TO THE GREENSMASTER 3000 OR 3000-D TRACTON UNIT AND CUTTING UNIT OPERATOR'S MANUALS FOR OPERATING, MAINTENANCE AND ADJUSTMENT INSTRUCTIONS. Space is provided in Chapter 2 of this publication 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 of traction unit and cutting unit to:

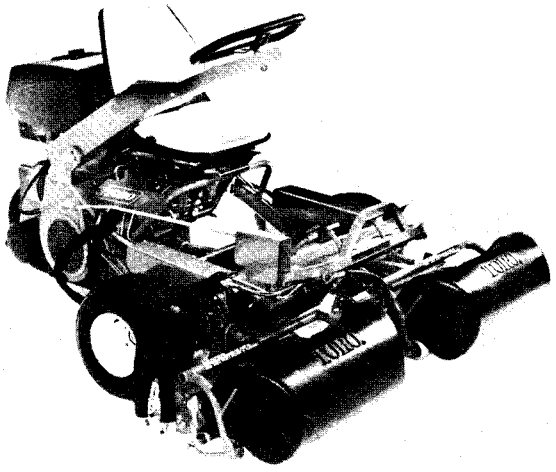
The Toro Company
8111 Lyndale Avenue South
Minneapolis, MN 55420

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

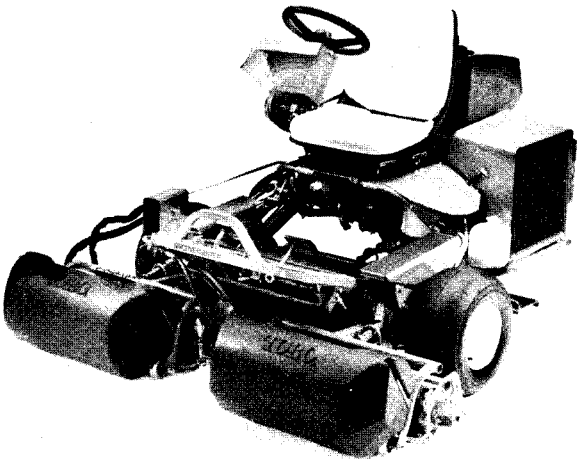
This safety symbol means DANGER, WARNING, or CAUTION, PERSONAL SAFETY INSTRUCTION. When you see this symbol, carefully read the instructions that follow. Failure to obey the instructions may result in personal injury.

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.



Greensmaster 3000, Model 04350



Greensmaster 3000-D, Model 04375

Table Of Contents

TORO

Chapter 1
Safety

Table of Contents

Safety Instructions

The Greensmaster 3000 and 3000-D have been tested and verified for compliance with the B71.4-1984 specifications of the American National Standards Institute (ANSI) for riding mowers. However, improper use or maintenance by the owner or operator of the machine can result in personal injury.

CAUTION

Obey the following safety instructions. Read and understand these instructions before operating the Greensmaster 3000/3000-D or doing maintenance, troubleshooting, testing, adjustments or repairs. Failure to comply with the safety instructions may result in personal injury.

Before Operating

1. Read and understand the Operator's Manual before starting, operating, maintaining or repairing the machine. Replacement Operator's Manuals are available by sending complete Model and Serial Number of traction unit and cutting units to:

The Toro Company
8111 Lyndale Avenue South
Minneapolis, MN 55420

Use the Model and Serial Number when referring to your machine. If you have questions about this Service Information, please contact:

The Toro Company
Commercial Service Department
8111 Lyndale Avenue South
Minneapolis, MN 55420

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 defective or damaged, repair or replace it before operating the machine.

5. Always wear substantial shoes. Do not operate machine 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 reels.

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

9. Since gasoline and 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.

While Operating

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

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

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

13. To start the engine:

A. Sit on the seat, depress lift pedal and release it to disengage cutting units.
B. Verify that traction system is in neutral.
C. Verify that parking brake is set.
D. Proceed to start the engine.

14. 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. Apply the service brakes when going down hill to keep forward speed slow and to maintain control of the machine.

15. Keep hands, feet and clothing away from moving parts and the reels. The grass baskets must be in place during operation of the reels or thatchers for maximum safety. Shut the engine off before emptying the baskets.

16. Raise cutting units when driving from one work area to another.

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

18. If cutting unit 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. If reel or bedknife is damaged, repair or replace it before operating.

19. Before getting off the seat:

A. Move shift selector to N - neutral.
B. Set parking brake.
C. Depress the lift pedal to raise the cutting units, wait for the reels to stop spinning and release lift pedal.
D. Set the parking brake.
E. Stop engine and remove key from switch.

While Doing Maintenance, Troubleshooting, Testing, Adjustments or Repairs

20. Stop the engine and remove the key from the ignition switch before servicing or making adjustments. Also disconnect the negative (–) cable from the battery. Secure the cable off to the side. This will prevent sparks, electrical shocks, or accidental starting of the engine when servicing, cleaning, adjusting, or storing the machine. If battery voltage is required for troubleshooting or test procedures, temporarily connect the battery.

21. If the engine must be running to perform an inspection or procedure, use extreme caution. Always use two people, with the operator at the controls able to see the person doing the inspection or procedure. Keep hands, feet, clothing, and body away from cutting units and other moving parts.

22. Be sure you understand a service procedure before working on the machine. Unauthorized modifications to the machine may impair the function, safety and life of the machine. If major repairs are ever needed, or assistance is desired, contact your TORO Distributor.

23. Make sure the entire machine is properly maintained and in good operating condition. Frequently tighten all nuts bolts. and screws.

24. Frequently tighten all hydraulic line connectors and fittings. Make sure all hydraulic hoses and lines are in good condition before applying pressure to the system.

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 the 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 the engine and lower the cutting units to the ground so all pressure is relieved.

27. To reduce potential fire hazard, keep engine area free of excessive grease, grass, leaves and dirt. Do not use flammable solvents for cleaning parts. Do not use diesel fuel, kerosene or gasoline.

28. Wear safety glasses, goggles or a face shield to prevent possible eye injury when using compressed air for cleaning or drying components.

29. Do not overspeed the engine by changing governor setting. Maximum governed engine speed should be 2850 rpm.

30. Shut engine off before checking or adding oil to the engine crankcase.

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

32. 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.

33. When changing attachments or performing other service, use the correct blocks and hoists. Always use jackstands to safely support the machine when it is raised by a jack or hoist.

34. Do not use your hand to prevent cutting unit reel from turning while servicing; this can result in personal injury. Use a 1/2 in. thick x 3 in. wide x 8 in. long piece of hardwood inserted into front of cutting unit between reel blades.

35. The asbestos brake linings contain asbestos fibers. Breathing dust containing asbestos fibers may be hazardous to your health and may cause serious respiratory or other bodily harm. When servicing wheel brake parts, do not create dust by grinding, sanding or filing brake linings or by cleaning wheel brake parts with a dry brush or compressed air. (Use a water dampened cloth.) Follow O.S.H.A. standards for proper protective devices to be used when working with asbestos materials.

36. For optimum performance and safety, use genuine Toro replacement parts and accessories. Replacement parts and accessories made by other manufacturers could be dangerous and my void the product warranty of The Toro Company.

Chapter 2

Product Records and Manuals

Table of Contents

Product Records

Record information about your Greensmaster 3000 or 3000-D on the OPERATION AND SERVICE HISTORY REPORT form. Use this information when referring to your machine.

Insert Operator's Manuals and Parts Manuals for your Greensmaster 3000 or 3000-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	0.9375	— 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. Subract 32° 2. Multiply by 5/9

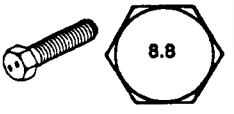
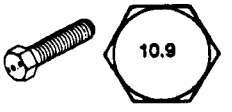
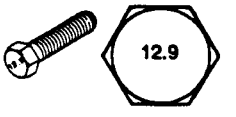
Torque Specifications

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

EQUIPMENT OPERATION AND SERVICE HISTORY REPORT
for
GREENSMASTER® 3000-D

TORO Model and Serial Number: _____-_____

Engine Numbers: _____

Date Purchased: _____ Warranty Expires_____

Purchased From: _____

_____

_____

_____

Contacts: Parts _____ Phone_____

Service _____ Phone_____

Sales _____ Phone_____

See your TORO *Distributor/Dealer for other Publications, Manuals, and Videos from* The TORO Company.

GREENSMASTER® 3000-D Maintenance Schedule

Minimum Recommended Maintenance Intervals:

Maintenance Procedure	Maintenance Interval & Service			
Check Battery Fluid Level Check Battery Cable Connections Inspect Air Filter, Dust Cup, and Baffle Lubricate Grease Fittings Change Engine Oil	Every 50hrs *A Level Service*			
Inspect Cooling System Hoses ‡ Replace Engine Oil Filter † Check Alternator Belt Tension		Every 100hrs *B Level Service*		
Check Reel Bearing Preload Adjustment Service Air Filter Element † Torque Wheel Lug Nuts			Every 200hrs *C Level Service*	
Replace Electric Fuel Pump Filter Replace Fuel/Water Separator Filter ‡ Torque Head and Adjust Valves ‡ Check Engine RPM (idle and full throttle)				Every 400hrs *D Level Service*

† Initial break in at 10 hours

‡ Initial break in at 50 hours

Replace Moving Hoses
Replace Safety Switches
Fuel Tank - Drain/Flush
Coolant System - Flush/Replace Fluid
Hydraulic Tank - Drain/Flush
Replace Hydraulic Filter

Bi-annual Recommendations:
Items listed are recommended every 2000 hours or 2 years whichever occurs first.

(See Operator's and Service Manual for specifications and procedures)

GREENSMASTER® 3000-D Daily Maintenance Check List

Unit Designation:_____

Daily Maintenance:(duplicate this page for routine use) TORO ID#:_____-_____

Maintenance Check Item	Daily Maintenance Check For Week Of _____						
	MON _____HR S	TUES _____HR S	WED _____HR S	THURS _____HR S	FRI _____HR S	SAT _____HR S	SUN _____HR S
✓ Safety Interlock Operation							
✓ Instrument Operation							
✓ Leak Detector Alarm							
✓ Brake Operation							
✓ Fuel Level							
✓ Engine Oil Level							
✓ Cooling System Fluid Level							
Drain Water/Fuel Separator							
✓ Air Filter Pre-Cleaner Condition							
✓ Radiator & Screen for Debris							
✓ Unusual Engine Noises[1]							
✓ Unusual Operating Noises							
✓ Hydraulic System Oil Level							
✓ Hydraulic Hoses for Damage							
✓ Fluid Leaks							
✓ Tire Pressure							
✓ Reel-to-Bedknife Adjustment							
✓ Height-of-Cut Adjustment							
Lubricate All Grease Fittings[2]							
Lube Mow, Lift, & Brake Linkage							
Touch-up damaged paint							

[1] = Check Glow Plugs and Injector Nozzles, if hard starting, excessive smoke, or rough running is noted.

[2] = Immediately after every high pressure washing, regardless of the interval listed.

Notation for areas of concern: Inspection performed by:_____

Item	Date	Information
1		
2		
3		
4		
5		
6		
7		

(See Operator's and Service Manual for specifications and procedures)

GREENSMASTER® 3000-D Supervisor Maintenance Work Order

Date:_____

(duplicate this page for routine use)

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

Remarks:

A -Service (every 50 hours)

- ☐ Check Battery Fluid Level
- ☐ Check Battery Cable Connections
- ☐ Inspect Air Filter, Dust Cup, and Baffle
- ☐ Lubricate Grease Fittings
- ☐ Change Engine Oil
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

B -Service (every 100 hours)

- ☐ Inspect Cooling System Hoses
- ☐ Replace Engine Oil Filter
- ☐ Check Alternator Belt Tension
- ☐ **A-Service** required
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

C -Service (every 200 hours)

- ☐ Check Reel Bearing Preload
- ☐ Service Air Filter Element
- ☐ Torque Wheel Lug Nuts
- ☐ **A** and **B Service** required
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

D -Service (every 400 hours)

- ☐ Replace Electric Fuel Pump Filter
- ☐ Replace Fuel/Water Separator Filter
- ☐ Torque Head and Adjust Valves
- ☐ Check Engine RPM (idle & full throttle)
- ☐ **A**, **B**, and **C Service** required
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

Annual Service Recommendations

- ☐ Replace Moving Hoses
- ☐ Replace Safety Switches
- ☐ Fuel Tank - Drain/Flush
- ☐ Coolant System - Flush/Replace Fluid
- ☐ Hydraulic Tank - Drain/Flush
- ☐ Replace Hydraulic Filter
- ☐ _____
- ☐ _____
- ☐ _____

Additional Service Items

- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

(See Operator's and Service Manual for specifications and procedures)

EQUIPMENT OPERATION AND SERVICE HISTORY REPORT
for
GREENSMASTER® 3, 300, & 3000

TORO Model and Serial Number: _____-_____

Engine Numbers: _____

Date Purchased: _____ Warranty Expires_____

Purchased From: _____

_____

_____

_____

Contacts: Parts _____ Phone_____

Service _____ Phone_____

Sales _____ Phone_____

See your TORO *Distributor/Dealer for other Publications, Manuals, and Videos from* The TORO Company.

GREENSMASTER® 3, 300, and 3000 Daily Maintenance Check List

Unit Designation:_____

Daily Maintenance:(duplicate this page for routine use) TORO ID#:_____-_____

Maintenance Check Item	Daily Maintenance Check For Week Of _____						
	MON _____HR S	TUES _____HR S	WED _____HR S	THURS _____HR S	FRI _____HR S	SAT _____HR S	SUN _____HR S
✓ Safety Interlock Operation							
✓ Instrument Operation							
✓ Steering Cable Operation							
✓ Brake Operation							
✓ Fuel Level							
✓ Engine Oil Level							
Clean Engine Air Cooling Fins							
Inspect Air Filter Pre-Cleaner							
✓ Unusual Operating Noises							
✓ Hydraulic System Oil Level							
✓ Hydraulic Hoses for Damage							
✓ Fluid Leaks							
✓ Tire Pressure							
✓ Reel-to-Bedknife Adjustment							
✓ Height-of-Cut Adjustment							
Lubricate All Grease Fittings[1]							
Lube Mow, Lift, & Brake Linkage							
Touch-up damaged paint							

[1] = Immediately after every high pressure washing, regardless of the interval listed.

Notation for areas of concern: Inspection performed by:_____

Item	Date	Information
1		
2		
3		
4		
5		
6		
7		

(See Operator's and Service Manual for specifications and procedures)

GREENSMASTER® 3, 300, and 3000 Maintenance Schedule

Minimum Recommended Maintenance Intervals:

Maintenance Procedure	Maintenance Interval & Service Type:		
Check Battery Fluid Level Check Battery Cable Connections Service Air Filter Pre-Cleaner Lubricate Grease Fittings † Change Engine Oil	Every 25hrs *A Level Service*	Every 100hrs	Every 400hrs
Service Air Filter Paper Element Service Spark Plug † Torque Wheel Lug Nuts Check Reel Bearing Preload Adjustment		*B Level Service*	
Decarbon Combustion Chamber Adjust Valves and Torque Head Bolts ‡ Check Engine RPM (idle and full throttle)			*C Level Service*
† Initial break in at 5 hours ‡ Initial break in at 50 hours			
Replace Moving Hoses Replace Safety Switches Fuel Tank - Drain/Flush Replace Fuel Filter Hydraulic Tank - Drain/Flush Replace Hydraulic Filter	**Annual Recommendations:** *Items listed are recommended every 2000 hours or 2 years whichever occurs first.*		

(See Operator's and Service Manual for specifications and procedures)

GREENSMASTER® 3, 300, and 3000 Supervisor Maintenance Work Order

Date:_____

(duplicate this page for routine use)

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

Remarks:

A -Service (every 25 hours)

- ☐ Check Battery Fluid Level
- ☐ Check Battery Cable Connections
- ☐ Service Air Filter Pre-Cleaner
- ☐ Lubricate Grease Fittings
- ☐ Change Engine Oil
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

B -Service (every 100 hours)

- ☐ Service Air Filter Paper Element
- ☐ Service Spark Plug
- ☐ Torque Wheel Lug Nuts
- ☐ Check Reel Bearing Preload Adjustment
- ☐ **A Service** required
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

C -Service (every 400 hours)

- ☐ Decarbon Combustion Chamber
- ☐ Adjust Valves and Torque Head Bolts
- ☐ Check Engine RPM (idle and full
- ☐ **A** and **B Service** required
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

Annual Service

- ☐ Replace Moving Hoses
- ☐ Replace Safety Switches
- ☐ Fuel Tank - Drain/Flush
- ☐ Replace Fuel Filter
- ☐ Hydraulic Tank - Drain/Flush
- ☐ Replace Hydraulic Filter
- ☐ _____
- ☐ _____
- ☐ _____

Additional Service Items

- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

Additional Service Items

- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

(See Operator's and Service Manual for specifications and procedures)

Chapter 3

Kohler Engine

Table of Contents

Specifications

Item	Specification
Make/Designation	Kohler M16S Air cooled, single cylinder, gasoline, horizontal shaft
Bore x Stroke	3.75 x 3.25 in.
Displacement	35.90 $in.^3$
Compression Ratio	7.3:1
Weight (approximate)	129 lb.
Crankcase Oil Capacity	5.25 pints)
Oil	SAE 30W, API Classification SF
Fuel	Unleaded Regular Gasoline
High Idle Speed (no load)	2800 $^{+50}/_{-0}$ rpm
Low Idle Speed (no load)	1700 ± 75 rpm

Adjustments

Governor and Throttle Adjustment

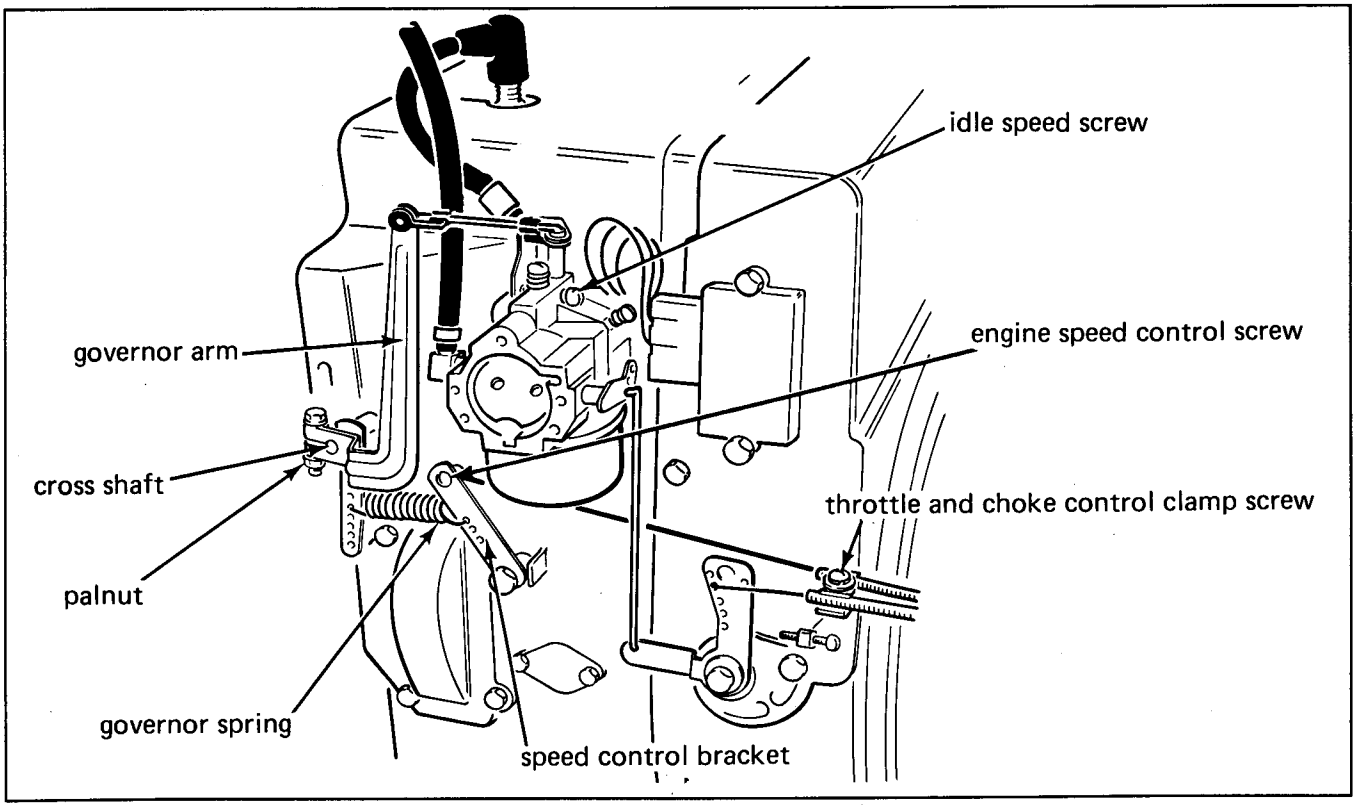


Figure 1

Governor Adjustment

The governor cross shaft - governor arm must be adjusted whenever the governor arm is removed from the cross shaft.

1. Pull governor arm away from carburetor as far as it will go (Fig. 1).

2. Grasp end of cross shaft with pliers and turn counterclockwise as far as it will go.

3. Tighten palnut on governor arm to 15 in-lb.

NOTE: To prevent interference, make sure there is at least 1/16 in. clearance between governor arm and upper-left cam gear cover fastener.

Throttle Adjustment

1. Loosen throttle and choke control clamp screw on engine.

2. Loosen engine speed control screw (behind air cleaner).

3. Put throttle control lever (on steering arm/instrument panel) in full forward (FAST) position.

NOTE: Governor spring goes in top hole of speed control bracket and middle hole of governor arm.

4. Adjust speed control bracket so it is in full throttle position at 2850 rpm maximum.

5. Tighten speed control screw and control clamp screw.

6. Check full throttle (FAST) engine speed. Check engine idle (SLOW) speed. Readjust as necessary.

Engine Speed (with hydraulic pump mounted and no load):

Full Throttle RPM	2800 $^{+50}/_{-150}$ rpm
Idle RPM	1700 $^{+50}/_{-100}$ rpm

NOTE: Choke control plate may require adjustment after this procedure.

Engine Removal and Installation

Removing the Engine

1. Disconnect the negative (–) and positive (+) battery cables from the battery.

2. Close the fuel shut-off valve and disconnect the fuel line.

DANGER

Gasoline is highly flammable. Use caution while handling it. Do not smoke cigarettes, cigars or pipes. Dispose of the gasoline in a safe place immediately after draining.

3. Remove the starter cable, throttle and choke cable and ground wire from engine.

4. Disconnect the wiring harness connector.

5. Loosen the two set screws securing the pump hub onto the engine shaft with an allen wrench. Remove the two capscrews mounting the pump to the pump mount.

6. Remove the engine mount bolts, nuts and washers. Carefully slide the engine off the pump shaft and mounting base.

Installing the Engine

1. Carefully slide the engine over the engine mounts and the pump hub over the pump shaft and key. Be sure that the key is properly positioned and aligned with the keyway.

2. Install the engine mount bolts, washers and nuts. Be sure to install the ground cable to the left rear mounting bolt and the muffler support bracket to the right rear mounting bolt.

3. Mount the pump to the pump housing and tighten the set screws to secure the hub to the shaft.

4. Re-connect the fuel line, wire connectors and the cables to the engine and battery.

5. Make sure the crankcase is filled the correct oil. Open the fuel shut-off valve. Fill the fuel tank. Start the engine and check for proper operation.

TORO

Chapter 4

Mitsubishi Diesel Engine

Table of Contents

Introduction

This chapter gives information about specifications, maintenance, troubleshooting, testing and repair of the diesel engine used in the Greensmaster® 3000-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 Greensmaster® 3000-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.

The engine model number is cast onto the injection pump side of the cylinder block (Fig. 1a). The serial number is stamped on the injection pump mounting surface of the crankcase (Fig. 1b). There is also a model and serial number decal on the valve cover.

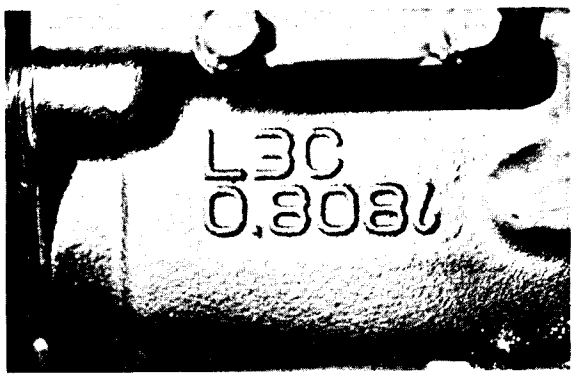


Figure 1a

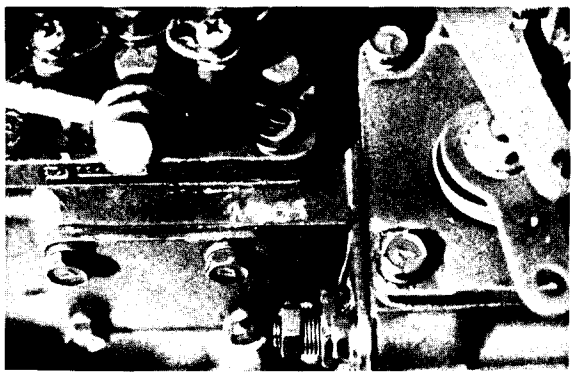


Figure 1b

Specifications

The illustrations (Figs. 2a and 2b) will give information about the general construction of the engine.

Refer to the specifications listed in this section when performing tests on the engine or examining parts for wear. Some specifications are included in the service procedures later in this chapter.

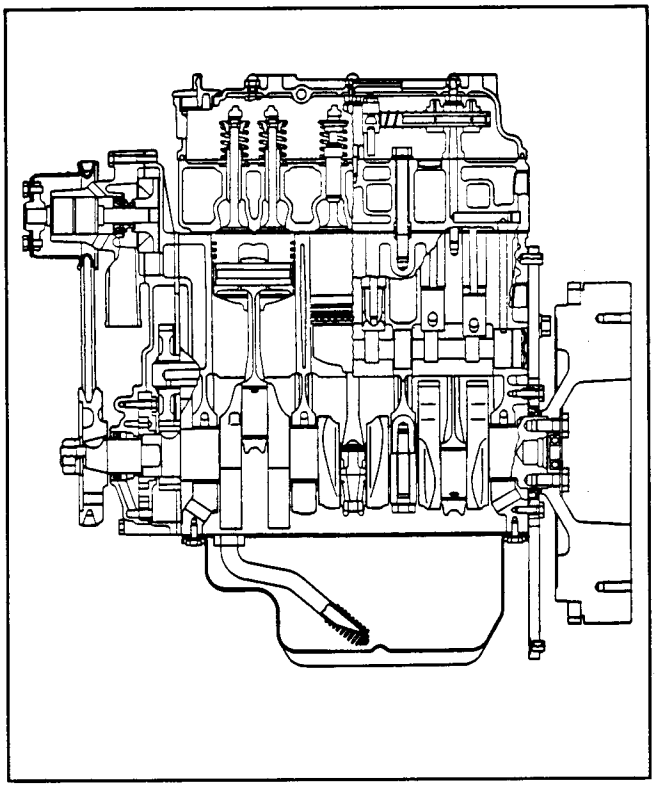


Figure 2a

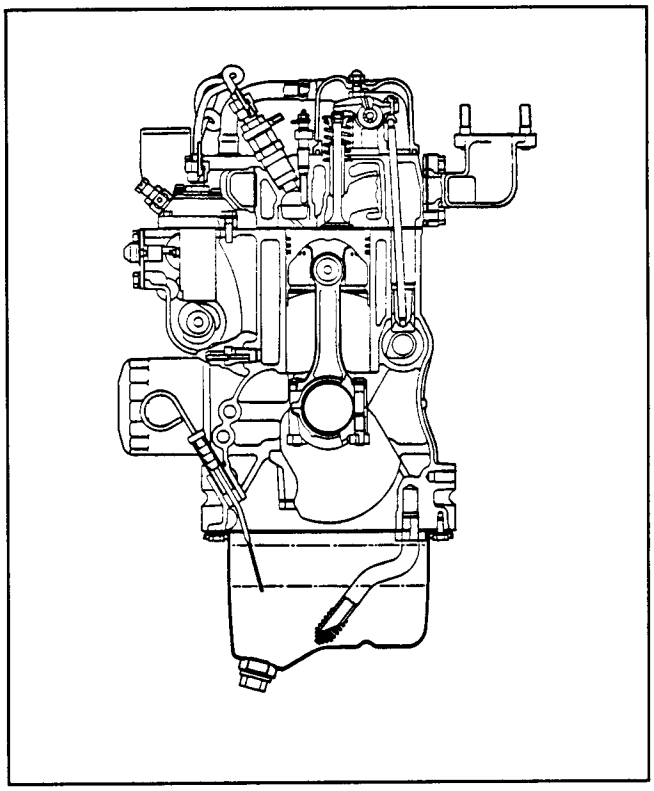


Figure 2b

General

Item	Specification
Make/Designation	Mitsubishi L3A - 61TG, overhead valve, vertical in-line, 4 cycle diesel
Combustion Chamber	Swirl chamber type
Number of Cylinders	3
Bore x Stroke	65 x 70 mm (2.56 x 2.76 in.)
Total Displacement	696 cc (42.5 $in.^3$)
Compression Ratio	23:1
Firing Order	1 - 3 - 2
Dry Weight (approximate)	75 kg (165 lb.)
Fuel	Diesel
Fuel Injection Pump	Bosch type NC
Governor	Centrifugal weight type
Fuel Injector Nozzle	Throttle type
Fuel Injection Pressure	(140 kg/cm^2) 1990 psi
Lubrication System	Forced lubrication
Oil Pump	Gear type
Oil Filter	Paper element filter (full flow type)
Crankcase Oil Capacity: including filter of 0.5 liter (0.6 qt.) capacity - FULL / LOW	3.6 / 1.8 liter (3.8 / 1.9 qt.)
Cooling System	Forced circulation, water cooling
Water Pump	Centrifugal type
Cooling System Capacity Engine Only Total System (approximate)	 1.8 liter (1.9 qt.) 6.1 liter (6.4 qt.) with expansion tank
Starter	Solenoid shift type 1.6 kW (12 volt)
Alternator	AC type 12 volt 40A
Glow Plug	Sheathed type

Engine

Item	Standard Specification	Repair Limit	Service Limit
Governor	Mechanical/Centrifugal		
Operating Speed (no load)	2800 rpm		$^{+0}_{-50}$ rpm
Idle Speed (no load)	1700 rpm		$^{+50}_{-0}$ rpm
Compression	28 kg/cm^2 (398 psi) at 280 rpm	25 kg/cm^2 (356 psi)	22 kg/cm^2 (93 psi)
Pressure Difference Between Cylinders	2.5 kg/cm^2 (36 psi) max.		
Cylinder Injection Order	1 - 3 - 2		
Injection Timing	17° B.T.D.C. (at smoke set position) ± 1.5°	17° ± 2°	
Cylinder Head Bottom Surface Flatness (distortion) Valve Guide I.D. Valve Seat Angle Valve Seat Width Valve Seat Sinkage	 Within 0.05 mm (0.002 in.) 6.6 mm (0.26 in.) 45° 1.3 - 1.8 mm (0.051 - 0.071 in.)	 0.1 mm (0.004 in.) 2.5 mm (0.1 .in.)	 –1 mm (– 0.039 in.)
Valve Clearance (cold) (both intake and exhaust)	0.25 mm (0.01 in.)		
Valves Valve Head Dia. (IN) Valve Head Dia. (EX) Overall Length Valve Stem O.D. Stem to Guide Clearance (IN) Stem to Guide Clearance (EX) Valve Seat Face Angle Valve Head Thickness (margin width) Valve Head Sinkage (from cyl. head bottom face)	 26.7 mm (1,051 in.) 24.7 mm (0.972 in.) 94 mm (3.701 in.) 6.6 mm (0.260 in.) 45° 1 mm (0.039 in.) 0.5 mm (0.020 in.)		 0.10 mm (0.004 in.) 0.15 mm (0.006 in.) 0.5 mm (0.020 in.) 1.5 mm (0.06 in.)
Valve Spring Free Length Installed Load/Height (IN) Installed Load/Height (EX) Squareness	 40.5 mm (1.595 in.) 5.94 kg/35.5 mm (13.1 lb./1.4 in.) 14.84 kg/28 mm (32.7 lb./1.1 in.) 3°	 39.3 mm (1.547 in.)	 –15% –15% 3°
Rocker Arm I.D. Rocker Arm to Shaft Clearance	12 mm (0.472 in.)		 0.2 mm (0.008 in.)
Cylinder Block Cylinder Bore Tolerance on Oversize Cylinder Bore Taper Gasket Fitting Surface Distortion Camshaft Hole Diameter Front No. 2 No. 3 Rear	 65 mm (2.559 in.) Each Oversize 0 to 0.03 mm (0.001 in.) Within 0.01 mm (0.0004 in.) Within 0.05 mm (0.002 in.) 42 mm (1.654 in.) (ball bearing hole) 33 mm (1.299 in.) 33 mm (1.299 in.) 33 mm (1.299 in.)	 +0.2 mm (0.008 in.) 0.1mm (0.004 in.)	 +0.45 mm (0.018 in.)

Engine (cont.)

Item	Standard Specification	Repair Limit	Service Limit
Piston			
Type	Solid		
Material	Aluminum alloy		
Piston Outside Diameter (skirt end)	65 mm (2.559 in.)		
Piston to Cylinder Wall Clearance			0.3 mm (0.012 in.)
Oversize	0.25, 0.50 mm (0.01, 0.02 in.)		
Protrusion from cylinder block top surface	0.9 mm (0.035 in.)		
Piston Pin			
Type	Semi-floating		
Outside Diameter	18 mm (0.709 in.)		
Pin to Piston Clearance			0.08 mm (0.003 in.)
Pin to Connecting Rod Clearance	Press-fit load: 1000 ± 500 kg (2200 ± 1100 lb.)		
Piston Rings			
Number of Rings			
2 Compression	No. 1: Chrome plated, semi-keystone type No. 2: Tapered		
1 Oil	Chrome plated ring with coil expander		
Compression Ring Width	2 mm (0.079 in.)		
Oil Ring Width	3 mm (0.118 in.)		
Compression Ring Side Clearance (No. 2)	0.05 - 0.09 mm (0.002 - 0.004 in.)		0.2 mm (0.008 in.)
Oil Ring Side Clearance	0.03 - 0.07 mm (0.001 - 0.003 in.)		0.2 mm (0.008 in.)
Ring Gap	0.15 - 0.40 mm (0.006 -0.016 in.)		1.5 mm (.060 in.)
Connecting Rod			
Type	Forged I-beam		
Bend and Twist	Within 0.05 mm (0.002 in.)		0.15 mm (0.006 in.) max.
Big End Thrust Clearance	0.1 - 0.35 mm (0.004 - 0.014 in.)		0.5 mm (0.02 in.)
Connecting Rod Bearings			
Oil Clearance			0.15 mm (0.006 in.)
Undersize	0.25, 0.50 mm (0.01, 0.02 in.)		
Crankshaft			
Type	Fully counterbalanced		
Bend	Within 0.03 mm (0.001 in.)		0.05 mm (0.002 in.)
End Play	0.05 - 0.175 mm (0.002 - 0.007 in.)		
Journal O.D.	43 mm (1.693 in.)	– 0.15 mm (– 0.006 in.)	– 0.70 mm (– 0.028 .in)
Pin O.D.	40 mm (1.575 in.)	– 0.15 mm (– 0.006 in.)	– 0.70 mm (– 0.028 .in)
Finish Undersize			
Journal U.S. 0.25 mm (0.01 in.)	42.715 - 42.730 mm (1.6817 - 1.6823 in.)		
Journal U.S. 0.50 mm (0.02 in.)	42.465 - 42.480 mm (1.6719 - 1.6724 in.)		
Pin U.S. 0.25 mm (0.01 in.)	39.715 - 39.730 mm (1.5636 - 1.5642 in.)		
Pin U.S. 0.50 mm (0.02 in.)	39.465 - 39.480 mm (1.5537 - 1.5543 in.)		
Main Bearings			
Oil Clearance			0.10 mm (0.004 in.)
Undersize	0.25, 0.50 mm (0.01, 0.02 in.)		

Engine (cont.)

Item	Standard Specification	Repair Limit	Service Limit
Camshafts			
Drive System	Gear		
Front Journal	Ball bearing		
Journal to Cylinder Block Hole Clearance			0.15 mm (0.006 in.)
Cam Lobe Major Diameter (both intake and exhaust)	27.37 mm (1.078 in.)		– 1.0 mm (– 0.0433 in.)
Cam Lobe Major Diameter (pump cam)	30 mm (1.224 in.)		– 0.7 mm (– 0.028 in.)
Tappets			
Outside Diameter	19 mm (0.748 in.)		
Tappet to Cylinder Block Hole Clearance			0.15 mm (0.006 in.)
Push Rod Bend	Within 0.3 mm (0.012 in.)		

Lubrication System

Item	Standard Specification	Repair Limit	Service Limit
Oil Capacity	3.6 liter (3.8 qt.) including oil filter		
API Service Class	CD		
Viscosity			
Above 68°F (20°C)	SAE 30 or 10W-30		
41°F to 68°F (5° to 20°C)	SAE 20 or 10W-30		
Below 41°F (5°C)	SAE 10W-30		
Oil Pump			
Type	Gear type		
Check Valve Opening Pressure	3 ± 0.3 kg/cm^2 (42.66 ± 4.27 lb/in^2) at 1000 rpm		
Outer Rotor to Housing Clearance	0.100 - 0.196 mm (0.004 - 0.008 in.)	0.3 mm (0.012 in.)	
Outer Rotor Thrust Clearance	0.04 - 0.10 mm (0.002 - 0.004 in.)	0.25 mm (0.01 in.)	
Oil Pressure Switch			
Indicator Lamp Lighting Pressure	7.1 lbs/in^2 (0.5 kg/cm^2)		

Fuel System

Item	Standard Specification	Repair Limit	Service Limit
Fuel Pump Delivery Rate	225 cc (13.73 in^3) or more (15 sec., 12V)		
Fuel Injection Pump Model Injection Timing (B.T.D.C.)	 ND-PFR-NC 17° ± 1.52° (at SS)	 17° ± 2°	
Nozzles Type Injection Start Pressure	 Throttle type 140 kg/cm^2 (1992 psi)	 140 ± 10 kg/cm^2 (1992 ± 142 psi)	

Governor System

Item	Standard Specification	Repair Limit	Service Limit
Type	Centrifugal weight type		

Cooling System

Item	Standard Specification	Repair Limit	Service Limit
Coolant Capacity Engine Only Total System (approximate)	 1.8 liter (1.9 qt.) 6.1 liter (6.4 qt.) with expansion tank		
Thermostat Type Full Opening Valve Temperature Valve Lift	 Wax type 90° ± 1.5°C (194° ± 3°F) 8 mm (0.314 in.)		

Electrical System

Item	Standard Specification	Repair Limit	Service Limit
Starter			
Type	Solenoid shift type		
Nominal Output	1.6 kW - 12V		
Direction of Rotation	Clockwise as viewed from pinion side		
No-load Characteristics (Cold)			
Terminal Voltage	11.5V		
Current	100A or less		
Speed	3000 rpm or more		
Load Characteristics			
Terminal Voltage	7.7 V		11.5V
Current (torque)	300A (0.98 kg/m (6.7 ft-lb) or more)		0.7 kg/m (5 ft-lb)
Speed	980 rpm or more		
Height of Brush	17 mm (0.67 in.)		6 mm (0.24 in.)
Spring Pressure	3 kg (6.6 lb.)		
Commutator O.D.	38.7 mm (1.52 in.)		– 1.0 mm (– 0.4 in.)
Depth of Commutator Undercut	0.5 mm (0.02 in.)		0.2 mm (0.008 in.)
Pinion Gap	0.5 - 2.0 mm (0.02 - 0.08 in.)		
Thrust Gap	0.5 (0.02 in.) or less		
Alternator			
Nominal Output	12V - 40A		
Direction of Rotation	Clockwise as viewed from pulley side		
Output Characteristics - Hot			
Regulated Voltage	13.5V		
Current / Speed	21A / 2500 rpm 37A/5000 rpm		
Glow Plugs			
Rated Voltage	10.5V DC		
Rated Current (when rated voltage is applied for 30 seconds)	9.7A ± 1.0A		
Resistance	0.16 ohm (at room temperature)		
Glow Plug Indicator			
Rated Current	29A		
Voltage Across Terminals (at 29A)	1.7V ± 0.2V		

Tightening Torque

The Mitsubishi diesel engine has many bolts and capscrews of special materials and sizes. It is very important that special care be used to replace all bolts and capscrews in their proper location during assembly of the engine. The torque specifications in American Standard and Metric as listed below MUST be followed in order to have the assembled engine conform to the original specifications.

Item	Specification
Cylinder Head Bolt,Main (Wet) Cylinder Head Bolt, Sub. (Wet)	7.5 - 8.5 KgM (54 - 62 ft-lb) 2.0 - 3.0 Kgm (15 - 22 ft-lb)
Connecting Rod Cap Nut	3.2 - 3.5 KgM (23 - 25 ft-lb)
Flywheel Bolt	8.5 - 9.5 KgM (62 - 69 ft-lb)
Crankshaft Pulley Nut	10.0 - 12.0 KgM (72 - 87 ft-lb)
Main Bearing Cap Bolt	5.0 - 5.5 KgM (36 - 40 ft-lb)
Rocker Stay Bolt	1.5 - 2.2 KgM (11 - 16 ft-lb)
Rocker Cover Nut	0.5 - 0.7 KgM (4 - 5 ft-lb)
Nozzle Holder (fitting to engine)	5.0 - 6.0 KgM (36 - 43 ft-lb)
Nozzle Union Collar Fixing Nut	2.5 - 3.0 KgM (18 - 22 ft-lb)
Nozzle Retaining Nut	3.5 - 4.0 KgM (25 - 29 ft-lb)
Fuel Injection Pipe Nut	2.5 - 3.5 KgM (18 - 25 ft-lb)
Delivery Valve Holder	3.5 - 3.9 KgM (25 - 28 ft-lb)
Injection Pump Hollow Screw	1.0 - 1.5 KgM (7 - 11 ft-lb)
Injection Pump Air Vent Screw	0.5 - 0.7 KgM (4 - 5 ft-lb)
Solenoid Locknut	4.0 - 5.0 KgM (29 - 36 ft-lb)
Water Temperature Gauge Joint	2.0 - 3.0 KgM (15 - 22 ft-lb)
Thermoswitch	1.9 - 2.7 KgM (14 - 20 ft-lb)
Thermo Gauge Unit	1.9 - 2.7 KgM (14 - 20 ft-lb)
Oil Filter	1.1 - 1.3 KgM (8 - 9 ft-lb)
Oil Relief Plug	4.0 - 5.0 KgM (29 - 36 ft-lb)
Oil Drain Plug	5.0 - 6.0 KgM (36 - 43 ft-lb)
Glow Plug	5.0 - 6.0 KgM (36 - 43 ft-lb)
Glow Plug Lead Wire Fitting Nut	10 - 15 KgCM (9 - 13 in-lb)

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.

Filter cleaner (Fig. 3). Mix with water and use solution to wash the Donaldson air cleaner element.

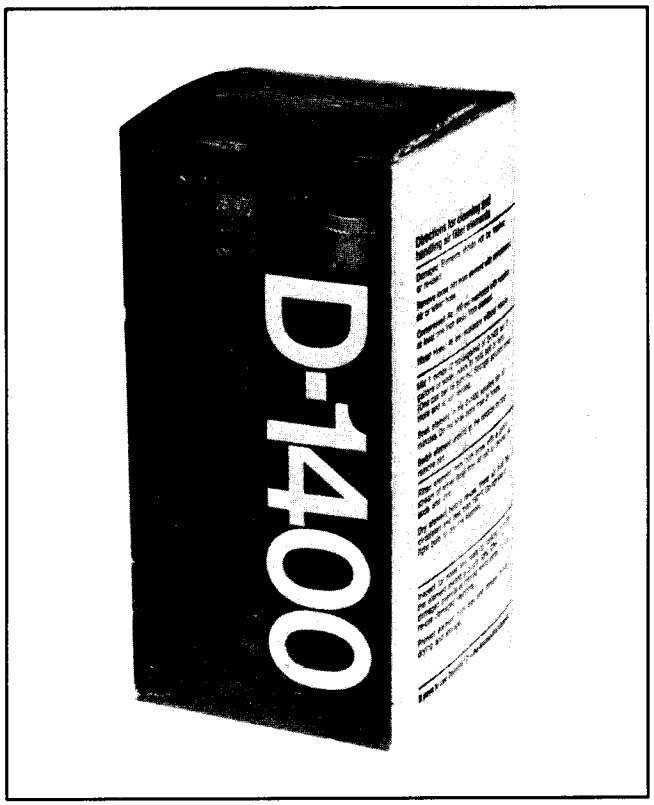


Figure 3

Compression gauge adapter (Fig. 4). Connects compression gauge into glow plug hole.

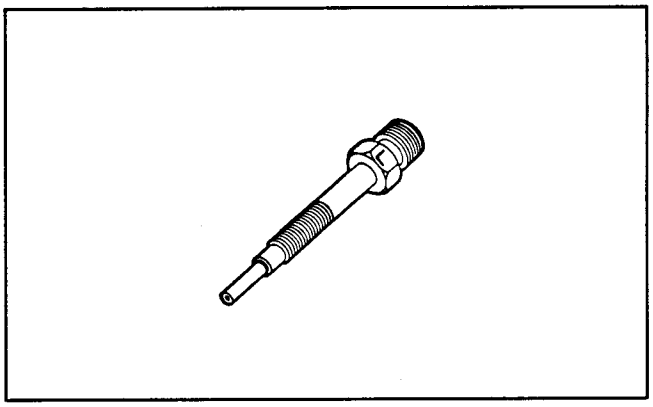


Figure 4

High pressure compression gauge (Fig. 5). Special high pressure gauge (0 - 1000 psi) (0 - 32 kg/cm^2) to test cylinder compression of Greensmaster® 3000-D diesel engine.

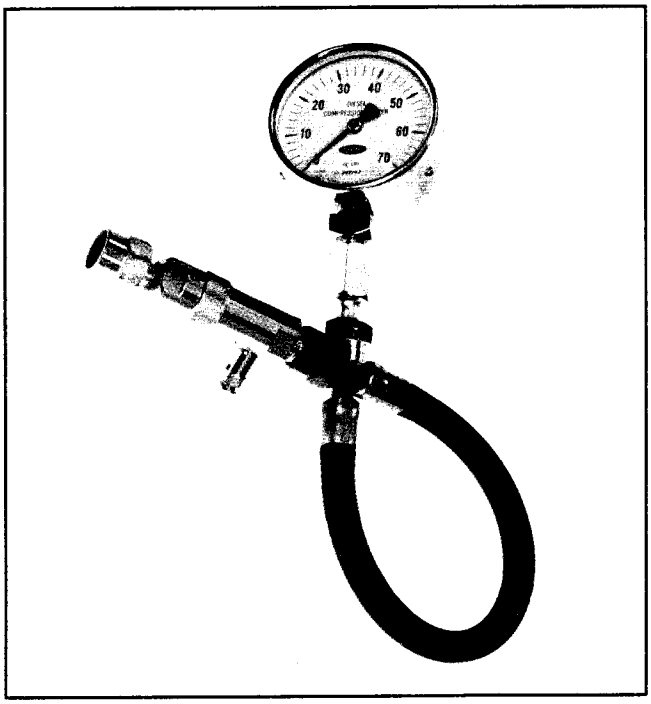


Figure 5

Piston pin tool (Fig. 6). For piston pin removal, the tool body is used with a 6000 lb (2700 kg) press. The tool body, push rod and appropriate guide are used with a press to install (set) the piston pin into the piston.

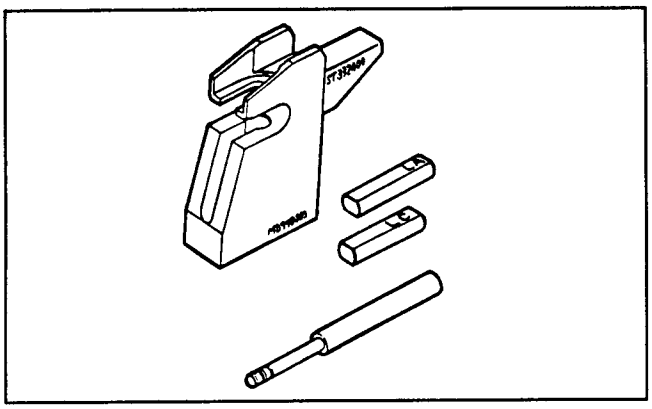


Figure 6

Nozzle tester (Fig. 7). Tests condition and opening pressure of fuel injector nozzles. Nozzle tester adapter (Fig.8) is required to test Greensmaster® diesel engine nozzles.

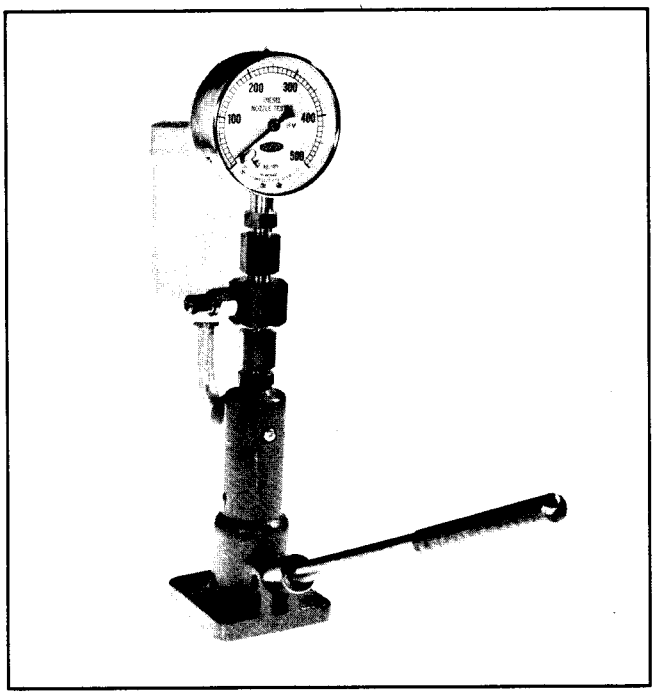


Figure 7

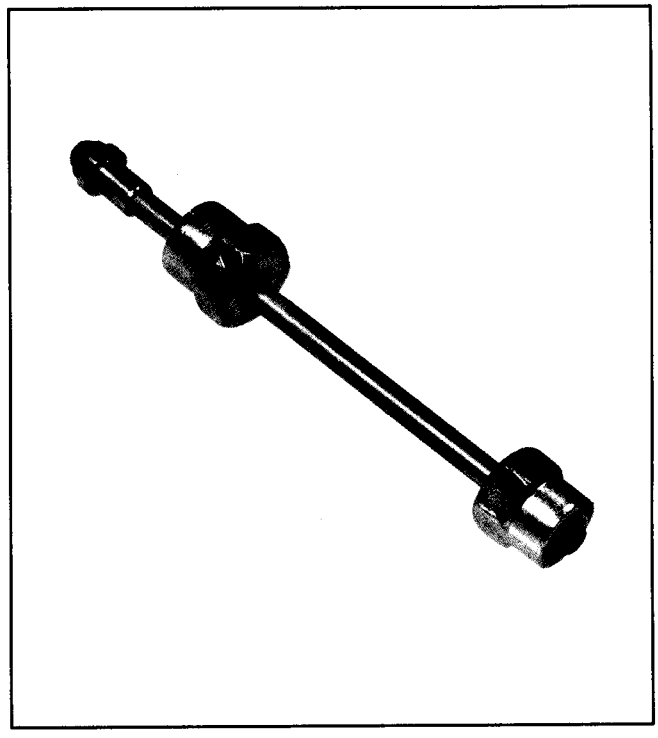


Figure 8

Valve Clearance

Check the valve clearance after the first 50 hours of operation and every 400 hours of operation after that.

1. The engine must be cold when the valve clearance is checked.

2. Remove the air breather hose from the rocker cover.

3. Remove the rocker cover nuts and washers. Remove the rocker cover.

4. Tighten the cylinder head bolts to the proper torque. The rocker assembly must be removed before tightening the cylinder head bolts. When tightening the cylinder head bolts, lower the coolant level in the engine, loosen the bolts slightly and then re-tighten in the sequence shown (Fig. 9).

M10 head bolt torque: 7.5 - 8.5 KgM (54 - 62 ft-lb)
M8 head bolt torque: 2.0 - 3.0 KgM (15 - 22 ft-lb)
Rocker stay bolt torque: 1.5 - 2.2 KgM (11 - 16 ft-lb)

5. Rotate the crankshaft until the TDC mark (located next to the injection timing mark(s) on the pulley lines up with the registration mark on the gear case (Fig. 10). This will be TDC on cylinder No. 1.

NOTE: There are two TDC positions (compression and intake strokes). At compression TDC the rocker arms will not move when the crankshaft pulley is rotated a small distance each way. Compression TDC is where the valves are to be adjusted.

6. Measure the valve clearance by using a thickness gauge inserted between the valve stem and rocker arm. The correct valve clearance for both the intake and exhaust valves is 0.25 mm (0.01 in.).

7. To adjust the valve clearance, loosen the adjusting lock nut and turn the rocker arm adjusting screw clockwise or counterclockwise until you get the correct clearance (Fig. 11). Tighten the locknut securely. Check to make sure that the clearance was not changed while tightening the locknut.

8. Perform steps 6 and 7 of this procedure for cylinder No. 2 and 3 while at their TDC position. Turn the crankshaft 240° clockwise to get No. 3 cylinder TDC. Turn the crankshaft an additional 240° clockwise to get No. 2 cylinder TDC.

9. Install the rocker cover. Install the rocker cover nuts and washers. Install the air breather hose on the rocker cover.

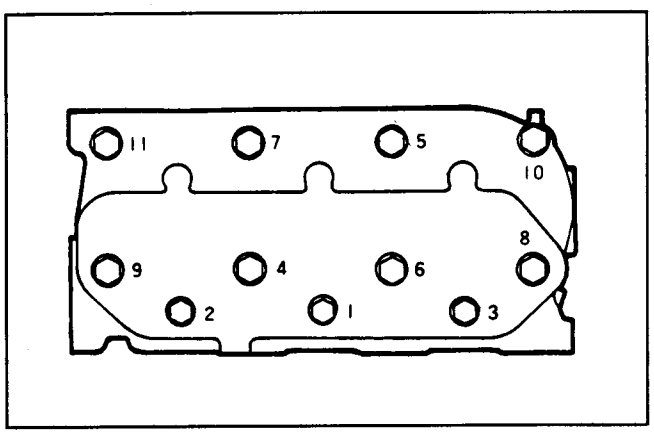


Figure 9

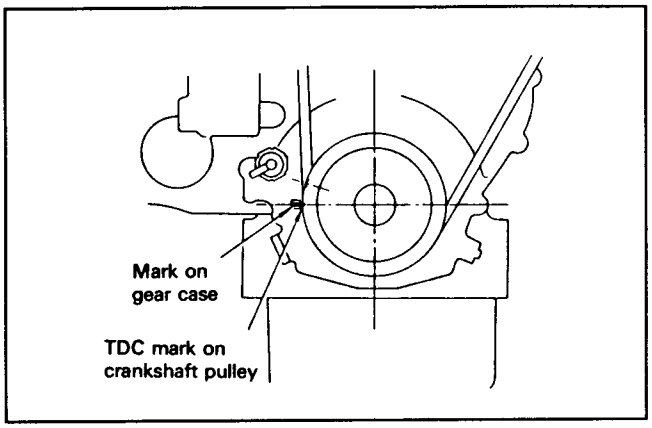


Figure 10

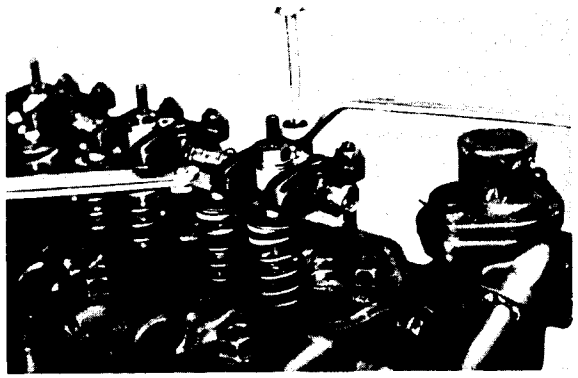


Figure 11

Engine Speed Adjustments

Adjustments to the engine speed settings are not normally necessary unless the throttle linkage, injection pump, or governor mechanism have been repaired, rebuilt, replaced or are not operating correctly.

Since there is no ignition system from which to power an electronic tachometer, a vibration-type tachometer must be used to set engine speed.

High Speed Adjustment

NOTE: Specified rpm is with no load on engine (fan drive and hydraulic pump coupler disconnected).

The high speed set bolt has been set properly and sealed at the factory. Never tamper with the seal unless necessary.

1. The engine should be at operating temperature. Make sure the parking brake is engaged.

2. Open the hood.

3. Loosen the lock nut on the high speed set bolt (Fig. 12).

4. Adjust maximum engine speed to 2800 $^{+0}_{-50}$ rpm by rotating the high speed set bolt. Tighten the lock nut.

5. Install a wire and lead seal on the high speed set bolt.

Idle Speed Adjustment

NOTE: Specified engine rpm is with no load on engine (fan drive and transmission coupler disconnected).

1. The engine should be at operating temperature. Make sure the parking brake is engaged.

2. Move the throttle control lever to the idle position (against the stop plate). Open the hood.

3. Loosen the lock nut on the low speed set bolt (Fig. 12).

4. Adjust idle speed to 1700 $^{+50}_{-0}$ rpm by rotating the low speed set bolt. Tighten the lock nut.

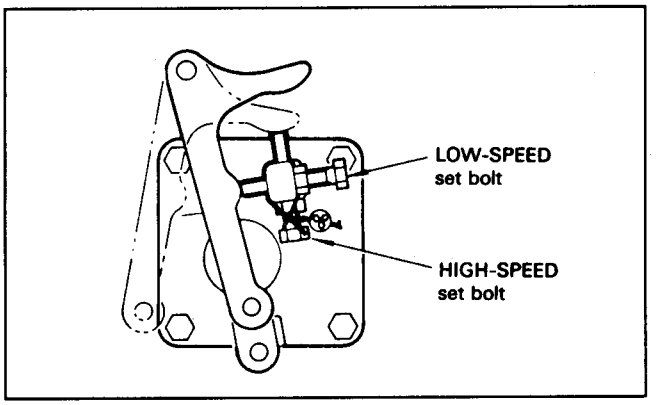


Figure 12

Throttle Linkage Adjustment

1. Loosen the capscrew and nut securing the throttle cable to the governor lever (Fig. 14)

2. Push the governor lever all the way back so it is contacting the high speed set screw.

3. Move the throttle lever (Fig. 13) to the maximum speed position (all the way forward).

4. Tighten the cap screw and nut securing the throttle cable to the governor lever.

5. Make sure the throttle cable conduit does not interfere with the full range of motion of the throttle lever or governor lever.

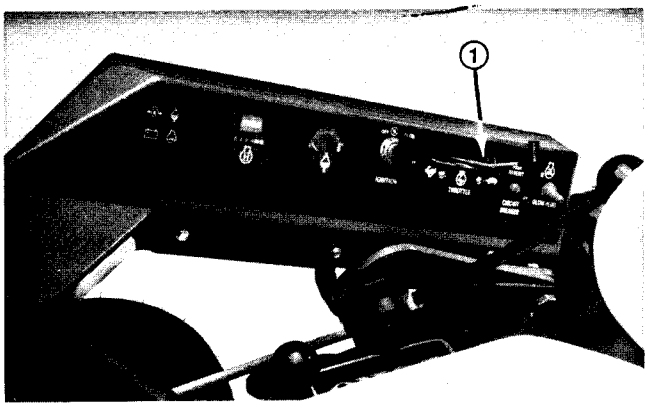


Figure 13

1. Throttle lever

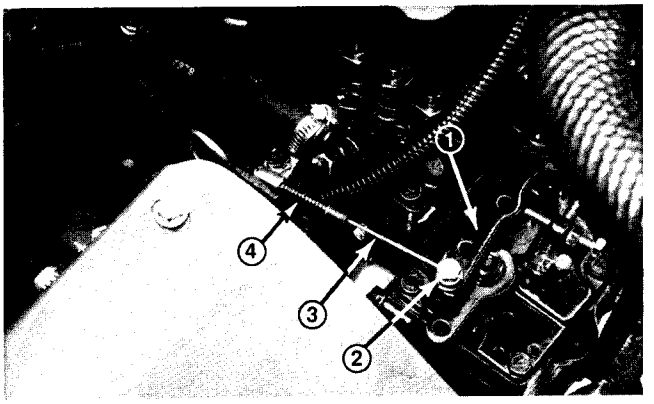


Figure 14

1. Governor lever
2. Cap screw and nut
3. Throttle cable
4. Throttle cable conduit

Troubleshooting

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

Never make more that 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.

(1) Engine Fails to Start

Problem/Probable Cause	Possible Remedy
● Slow Cranking Speed	
1. Engine oil viscosity is too high.	Use correct oil.
2. Battery is discharged.	Charge the battery.
3. Battery plates sulfated.	Replace the battery.
4. Battery terminal dirty or poor connection.	Clean the terminals/repair or tighten cables.
5. Starter failure.	Repair or replace starter.

(1) Engine Fails to Start (continued)

Problem/Probable Cause	Possible Remedy
● Injection system	
1. Air in fuel line.	Purge air from the fuel system.
2. Fuel filter is clogged.	Clean/replace filters.
3. Injection pressure is low.	Adjust injection pressure of nozzle.
4. Poor nozzle spray.	Clean or replace the nozzle.
5. Poor injection pump pressure.	Repair or replace injection pump.
6. Incorrect fuel.	Use recommended fuel.
7. Injection timing is advanced.	Adjust injection timing.
● Low Compression	
1. Valve clearance is incorrect.	Adjust valve clearance.
2. Valve seat surface is rough, or burnt.	Finish surface by lapping. Replace valve and guide.
3. Valve spring is broken.	Replace the spring.
4. Leaking cylinder head gasket.	Replace the gasket.
5. Piston rings are seized.	Overhaul the engine.
6. Piston rings and cylinder are worn.	Overhaul the engine.
● Glow plug is burnt out.	Replace the glow plug.
● Glow plug does not glow red hot.	Poor wiring connection.
● Governor lever position incorrect.	Adjust governor lever.
● Governor spring broken or disconnected.	Repair governor spring.

(2) Low Power

Problem/Probable Cause	Possible Remedy
● Low Compression	Refer to "starting failure, low compression."
● Injection system faulty	
1. Injection timing is incorrect.	Adjust the injection timing.
2. Injection volume is insufficient.	Repair or replace pump.
3. Injection pressure is low.	Inspect the injection nozzle, adjust pressure.
● Lack of fuel	
1. Air in fuel system.	Inspect fuel line connections.
2. Filter is clogged.	Clean/replace filters.
3. Fuel tank is contaminated.	Clean the fuel tank.
● Air cleaner is clogged	Clean the air cleaner; replace the element if unserviceable.
● Engine overheats	
1. Low or incorrect coolant level.	Check coolant.
2. Improper belt tension.	Adjust belt tension.
3. Defective water pump.	Replace water pump.
4. Radiator clogged, or leaks pressure.	Clean/repair the radiator, inspect hoses and cap.
5. Injection timing is incorrect.	Adjust the injecting timing.
6. Engine oil is low.	Add engine oil.
7. Defective thermostat.	Replace thermostat.
● Carbon build-up in muffler.	Decarbon muffler.

(3) Excessive Oil Consumption

Problem/Probable Cause	Possible Remedy
● Oil leaks	
1. Oil seals worn.	Check for wear, and replace if worn.
2. Gaskets leaking.	Replace the gasket.
3. Loose fasteners.	Retighten fasteners.
4. Drain plug is loose.	Tighten the plug.
5. Pipe plugs at oil pump loose.	Tighten the plugs.
● Burning Oil	
1. Ring end gaps positioned wrong.	Stagger end gaps properly.
2. Connecting rod bent or twisted.	Overhaul engine.
3. Piston rings worn.	Replace the rings. Overhaul engine.
4. Piston and cylinder are worn.	Overhaul engine.
5. Faulty valve stem seal.	Replace valve stem seal.
6. Valves or valve guides worn.	Replace the valves or valve guides.

(4) Abnormal Engine Noises

Problem/Probable Cause	Possible Remedy
● Crankshaft and main bearing	
1. Worn crankshaft.	Repair or replace crankshaft; inspect bearings.
2. Worn or damaged bearings.	Replace bearings; inspect crankshaft.
● Connecting rod and bearings	
1. Connecting rod bearing worn.	Replace bearing; inspect crankshaft.
2. Worn crankpin.	Repair or replace crankshaft; inspect bearing.
3. Twisted connecting rod.	Replace connecting rod.
● Piston, piston pin, and piston rings	
1. Cylinder is worn.	Overhaul engine.
2. Piston pin is worn.	Replace piston and pin, inspect cylinder, rod, and rings.
● Rocker arm mechanism and relative parts	
1. Camshaft is worn.	Replace camshaft.
2. Excessive valve clearance.	Adjust the valve clearance.
3. Worn timing gear.	Replace the timing gear; inspect mating gears.
4. Worn fan shaft bearings.	Replace the bearing/shaft.

(5) Engine Runs Rough

Problem/Probable Cause	Possible Remedy
● Injection pump mechanism	
1. Irregular injection pump volume.	Repair or replace injection pump.
2. Faulty control rack function.	Repair or replace injection pump.
3. Worn delivery valve.	Replace the delivery valve.
4. Faulty injection nozzle.	Repair or replace nozzle.
● Governor mechanism	
1. Governor lever sticking.	Inspect/repair governor.
2. Stretched or weak governor spring.	Replace the spring.

Glow Plug Test

CAUTION

Be careful while handling or testing glow plugs. Glow plugs become extremely hot. Accidental contact with the heated plug tip could cause personal injury.

1. Disconnect the wire lead(s) to the glow plug.

2. Remove the glow plug.

3. Inspect the glow plug for signs of a burnt glow plug end tube.

NOTE: If the metal of the glow plug end is melted, it is a sign of cylinder overheating. (See Engine Overheats in the Troubleshooting section of this chapter.)

4. Connect the positive (+) battery terminal to the glow plug terminal, and the negative (–) battery terminal to the plug body (Fig. 15). If the glow plug glows red-hot, the glow plug is operating correctly.

5. Replace any glow plugs that do not operate correctly.

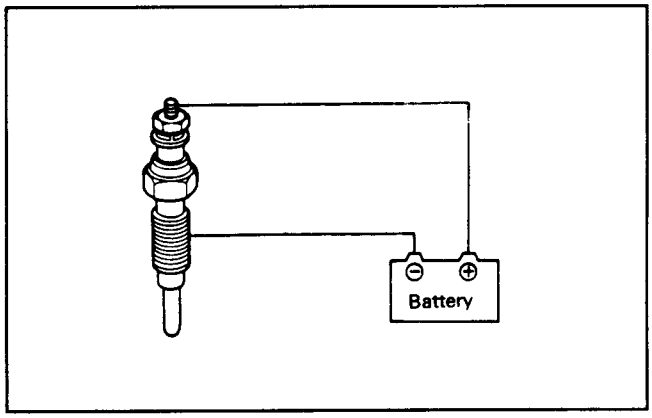


Figure 15

Compression Test

Normal cylinder compression is 28 kg/cm^2 (398 psi) at 280 rpm (normal cranking speed). The engine should be warm - coolant temperature of 50° C (120° F).

IMPORTANT: DO NOT put oil into the combustion chamber before performing a compression test. Damage may result because of "hydraulic" forces acting upon the piston and connecting rod.

1. Remove the glow plug lead wires and glow plugs from all three cylinders.

2. Insert the compression gauge adapter into the glow plug hole. (See the Special Tools section of this chapter.)

3. Connect the high pressure compression gauge to the adapter (Fig. 16).

4. Disconnect the fuel stop solenoid electrical connector to prevent fuel delivery during the compression test (Fig. 17). This will prevent wash-down of the cylinders and inaccurate readings.

5. Crank the engine with the starter motor until you get a stable gauge reading.

6. Normal compression is 28 - 32 kg/cm^2 (398 - 455 psi). If the pressure is less than 25 kg/cm^2 (356 psi) it will be necessary to find the cause of low compression. (See Engine Fails to Start - Low Compression in the Troubleshooting section of this chapter.)

7. Repeat the test for the other two cylinders. Difference between cylinders should be no more than 2.5 kg/cm^2 (36 psi).

8. Connect the fuel stop solenoid electrical connector.

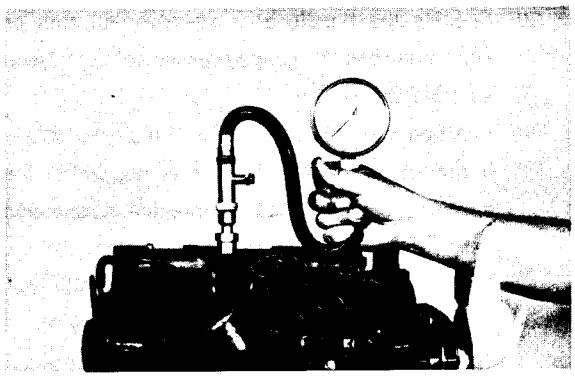


Figure 16

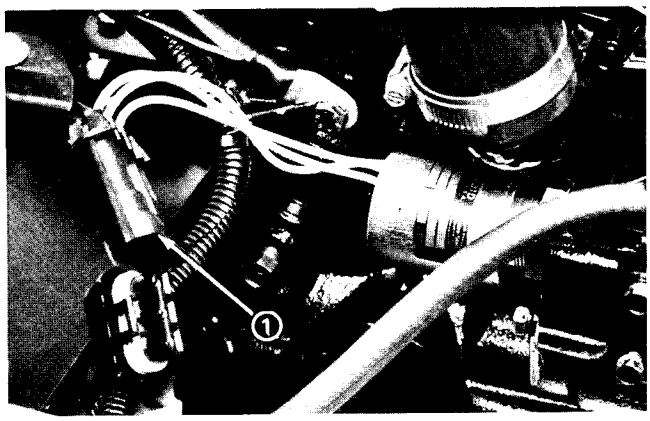


Figure 17

1. Fuel stop solenoid electrical connector

Nozzle Tests

There are several tests to examine the condition of the injection nozzles. These tests require the use of a nozzle tester and nozzle tester adapter. (See the Special Tools section of this chapter.)

DANGER

The nozzle tester forces fuel from the nozzle under extremely high pressure. Always point the nozzle tip away from yourself and any other personnel. Contact with the fuel stream, even though it appears to be a mist can cause fuel to penetrate clothing and skin. If fuel is injected into the skin get proper medical attention from a doctor immediately. A serious infection or other reaction can develop if the injury is not properly treated. Tighten all adapter fittings to prevent leaks. If a leak is suspected, use a piece of cardboard, not your hands to search for a leak.

CAUTION

To prevent possible injury, wear eye protection when operating the nozzle tester.

IMPORTANT: Always use fresh filtered fuel in the nozzle tester. Use of dirty fuel can damage the precision parts of the injector nozzle. It is a good practice to:

1. Bolt the tester securely to the test bench.

2. Use a drain pan to catch fuel.

3. Flush the adapter by pumping the handle of the tester slowly several times before attaching the nozzle to be tested.

Injection Pressure Test

The diesel engine requires that fuel be sprayed into the combustion chamber at a precise point in the compression stroke. The point at which this fuel injection occurs is determined by the injection timing. If the nozzle is defective, damaged or adjusted incorrectly, starting failures, low power output, or engine knocking can occur.

1. Securely fasten the nozzle to the adapter.

2. Pump the handle several times to purge air from the nozzle mechanism.

3. Allow pressure to dissipate before performing the test.

4. Operate the pump handle slowly and observe the gauge to determine the pressure at which the nozzle opens and the fuel is sprayed.

5. Verify that starting pressure is within the following limits: Minimum starting pressure is 130 kg/cm^2 (1850 psi); Maximum starting pressure is 150 kg/cm^2 (2134 psi).

6. Starting pressure can be adjusted by adding or removing shims from the nozzle. (See Nozzle Service in the Fuel System Repairs section of this chapter.) A 0.1 mm shim will cause a 10 kg/cm^2 (140 psi) starting pressure difference. Shims are available from 1.25 mm to 1.7 mm thick in 0.5 mm increments.

7. Repeat the test after installing shim to verify that a correct starting pressure has been obtained.

Chattering Test

Proper and free operation of the nozzle valve can be determined by the chattering test.

1. Securely fasten the nozzle to be tested to the adapter.

2. Operate the pump handle slowly (ten strokes per minute). As the pump pressure reaches the starting pressure the nozzle valve will chatter as it opens and closes rapidly. A nozzle which does not chatter may be the result of a binding or bent nozzle valve.

Nozzle Leakage Test

A nozzle that leaks fuel from the nozzle orifice must be replaced.

1. Securely fasten the nozzle to the adapter.

2. Wipe all fuel from the nozzle.

3. Operate the pump until the pressure is approximately 108 kg/cm^2 (1500 psi). Maintain this pressure to the nozzle.

4. Watch for leaks where the threaded nozzle body threads into the retaining nut. Leaks in this area would indicate a bad seat between the distance piece and/or the body or nozzle assembly.

5. If leakage occurs, verify that the body is tightly fastened in the retaining nut. If the leak continues, replace the nozzle.

6. While pressure is being applied, watch for an accumulation of fuel at the tip of the nozzle (Fig. 18). A small amount of fuel may be present due to a previous chattering test - this would be normal. If the fuel accumulates and drips down during the test (about ten seconds) the nozzle assembly is defective and must be replaced.

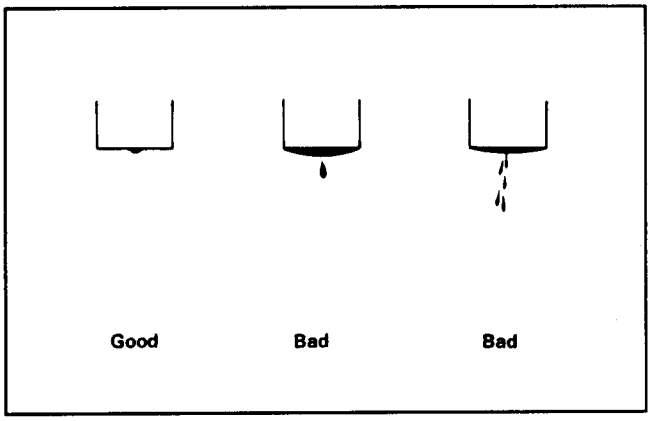


Figure 18

Spray Test

For proper combustion, the nozzle must effectively atomize the injected fuel.

1. Operate the pump handle at a rate of 20 - 30 strokes per minute.

2. Observe the injector nozzle spray. The spray pattern should be finely atomized in a broad, straight stream (Fig. 19).

3. If the nozzle fails to spray properly, it must be cleaned, repaired or replaced. (See Nozzle Service in the Fuel System Repairs section of this chapter.)

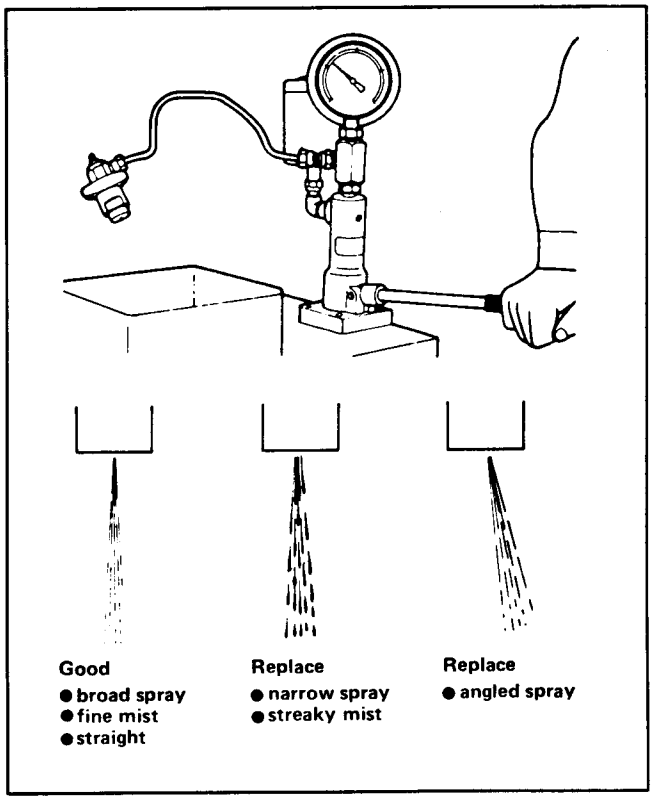


Figure 19

Injection Pump Test

Calibration of fuel delivery volumes, pressure and distribution between pump barrels should be performed by a professional diesel engine service shop. Special test fixtures and equipment are required.

It is possible to determine if the fuel injection pump requires service through a process of elimination using other fuel system tests. The following test procedure will help isolate fuel system difficulties.

1. Make sure that fuel is being supplied to the injector pump. (See Fuel Pump Test in this section and Bleeding Air From the Fuel System in the Fuel System Repairs section of this section.)

2. Check the operating condition of the injection nozzles to make sure that the injection pressure is correct. (See Injection Pressure Test in this section of the book.)

3. Make sure that the injection pump is providing sufficient fuel pressure to operate the nozzle by performing the following procedures:

A. Loosen the fuel delivery pipe from the number one nozzle.

B. Remove the nozzle from the cylinder head.

C. Connect the fuel delivery pipe to the nozzle assembly so the tip of the nozzle is pointed away from the engine. Tighten the fitting securely.

D. Put the throttle control in the FAST position. Turn the ignition key to the START position to crank the engine. Observe the nozzle.

DANGER

The injection pump forces fuel from the nozzle under extremely high pressure. Always point the nozzle tip away from yourself and any other personnel. Contact with the fuel stream, even though it appears to be a mist can cause fuel to penetrate clothing and skin. If fuel is injected into the skin get proper medical attention from a doctor immediately. A serious infection or other reaction can develop if the injury is not properly treated. Tighten all adapter fittings to prevent leaks. If a leak is suspected, use a piece of cardboard, not your hands to search for a leak.

If the nozzle produces an atomized mist of fuel the injector pump for that cylinder is operating properly. Failure of the nozzle to inject fuel can indicate a injection pump cylinder that is not operating correctly.

5. Repeat the test for the other cylinders.

Injection Timing Test

Injection timing can be adjusted by installing shims under the pump body. The timing is important because it determines when the fuel enters the combustion chamber.

The most accurate method of timing is done with an electronic diesel timing tester (available from major tool supply companies).

The following method is an initial setting for starting the machine.

1. Remove the number one injection pipe from both the pump and nozzle. (The number one cylinder is opposite from the flywheel end of the engine.)

2. Set up the injection pump for the test:

   A. Remove the delivery valve holder (Fig. 20). Remove the delivery valve and spring. The valve seat must remain in place.

   B. Replace the valve holder and tighten it in place.

   C. Connect the fuel injection pipe to the nozzle holder so the open end of the pipe will discharge fuel into a container.

3. Put the throttle control in the middle of its range of travel.

4. Slowly rotate the crankshaft counterclockwise from the flywheel end (normal rotation) until the IT marks (injection timing marks) on the crankshaft pulley are approximately 1/2 in. (21 mm) from alignment with the stationary pointer on the engine gear case (Fig. 21). Make sure the number one cylinder compression stroke is approaching by checking the push rods. Both push rods on the number one cylinder should be loose and the valves closed. If either push rod is tight, rotate the engine crankshaft one full revolution and inspect the push rods again.

5. Turn the ignition switch ON so the fuel pump will supply fuel through the injection pump and out the number one injection pipe.

6. Rotate the engine crankshaft slowly in the normal direction until the flow from the number one injection pipe just stops. This is the moment of actual injection timing. (A screwdriver inserted between the transmission drive hub and rubber coupler will provide control and leverage to slowly rotate the engine crankshaft.)

NOTE: Wear of the internal parts in the injection pump may allow the fuel to continue to drip from the injection pipe. If the slowest flow rate exceeds 1 drop in 5 seconds, repair of the pump should be considered.

7. Standard injection timing can be confirmed by the IT marks on the crankshaft pulley and the stationary pointer on the crankcase (Fig. 21).

The center mark on the pulley represents 17° BTDC; standard fuel injection timing. The outside marks represent 19° BTDC and 15° BTDC; the acceptable range of injection timing.

Shims are available in different sizes from 0.2 to 1.0 mm thick. Adding or removing a shim, 0.1 mm thick, will change injection timing by 1°. Increase shim thickness if injection is too early. Decrease shim thickness if injection is too late. (See Injection Pump Service in the Fuel System Repairs section of this chapter.)

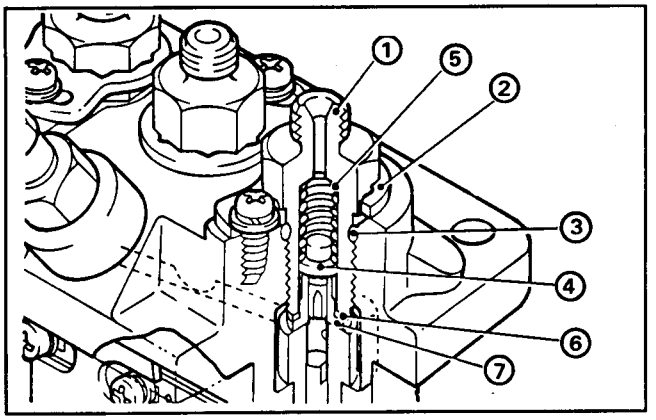


Figure 20

1. Delivery valve holder
2. Holder stopper
3. O-ring
4. Delivery valve
5.Spring
6. Gasket
7. Valve seat

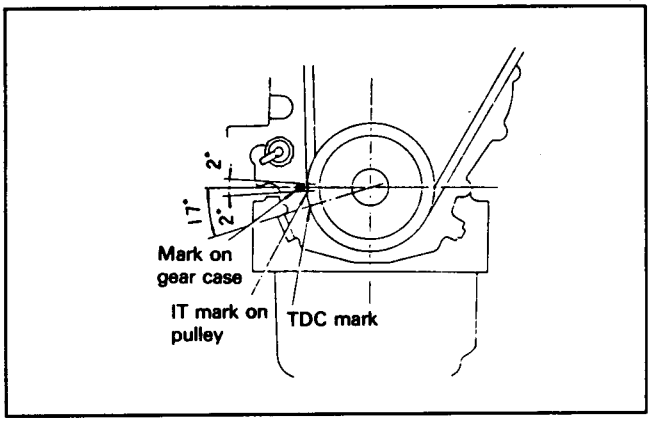


Figure 21

Fuel Pump Test

1. Turn the ignition switch to the ON position. Test for pump operation by listening for the pump oscillating sound, or by feeling for vibration which indicates the pump is operating.

2. If no pumping action occurs when the ignition switch is turned on, connect a 12 volt DC battery directly to the pump (Fig. 22). If the pump now operates, check for an electrical failure of the pump circuit, eg. fuses, connections, wires, etc.

3. The delivery of the fuel pump may be checked by disconnecting the fuel lines from the water separator and fuel filter and routing them to a can of filtered diesel fuel and a drain pan (Fig. 22). Activate the pump and measure the amount of fuel pumped in during a 15 second time interval. The standard pump rate is approximately 8 ounces (225 cc) in 15 seconds.

4. If the fuel delivery rate is below the standard value the pump should be disassembled and checked. (See Fuel Pump Service in the Fuel System Repairs section of this chapter.)

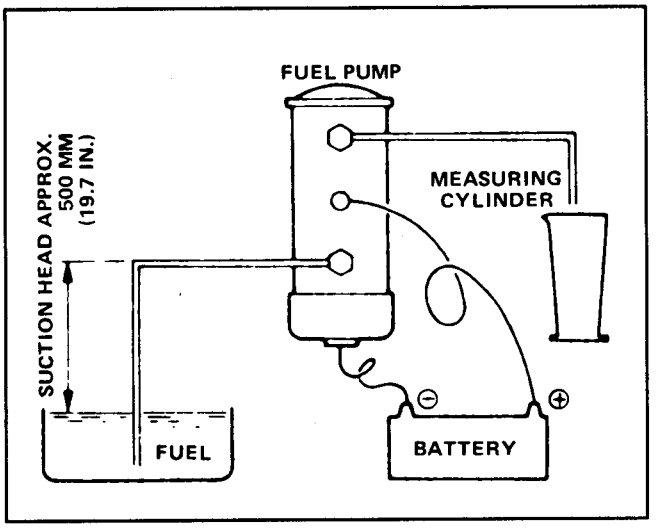


Figure 22

Thermostat Test

If the engine overheats and a faulty thermostat is suspected, the thermostat should be tested.

1. Remove the thermostat (see Thermostat Removal and Installation in the External Engine Component Repair section of this chapter).

2. Put the thermostat in a container of water with a thermometer and heat the water (Fig. 23).

Valve cracking temperature: 76.5° C (177° F).
Full-open temperature: 90° C (194° F)
Valve lift: 8 mm (0.314 in.)

3. If the thermostat fails to open, only partially opens, or sticks, it should be replaced.

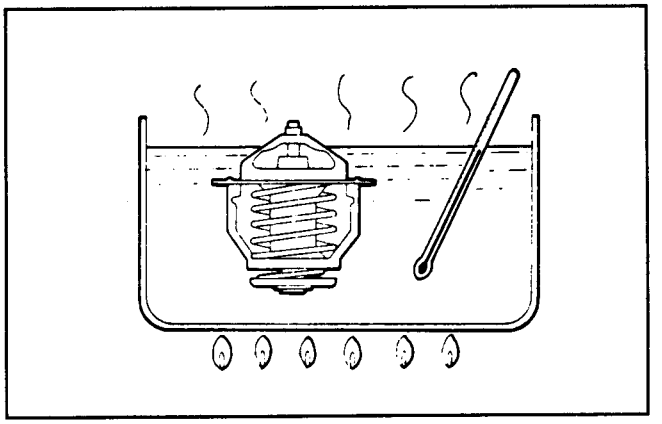


Figure 23

Preparation for Engine Repair

1. Before cleaning and disassembly, carefully check for problems that cannot be found after the engine has been cleaned or disassembled (e.g. oil leaks from cracked components, gaskets or loose fittings, damaged air cleaner or breather hoses that could cause cylinder wear, etc.). Make a note of any problems that you find.

2. Clean or wash the engine exterior thoroughly before disassembly.

IMPORTANT: Do not spray water on a hot engine. Injection pump seizure or other failures could result.

3. Do not disassemble or remove parts that do not require disassembly.

4. Disassemble the engine in proper order, arranging the parts the disassembled parts neatly. Apply clean engine oil to disassembled parts, as necessary to prevent rust.

5. Keep the work area clean; dirt causes engine failures.

6. Be very careful when working on fuel system components. Cover the work area with clean paper. Store components of the nozzles or injector pump in clean fuel oil. Do not allow components to strike each other or other objects. Wet hands with clean diesel fuel before handling these parts.

Engine Compression

The time interval to overhaul the engine can most accurately be determined by regular and systematic cylinder compression measurement. (See Compression Test in the Testing section of this chapter.)

Cylinder and Cylinder Block Overhaul

Before removing any parts, disassembly or overhaul of the Mitsubishi engine, it is very important to understand the nature and probable cause of the problem that made an overhaul necessary.

When the engine trouble is caused by worn cylinders, rings or valves, one or more of the following symptoms will occur:

1. Low engine power, and a decrease in compression pressure.

2. Increased fuel consumption.

3. Increased lubricating oil consumption.

4. Poor engine starting.

5. Loud noises in the engine.

It is important to find the cause of the engine failure before beginning repair. Symptoms 2 and 3 in the above list can be a result of excessive fuel injection, improper injection timing, or nozzle and injection pump wear. Poor starting may be a result of electrical problems. Noises may be associated with a mechanical part outside the engine. Excess fuel or oil consumption may be the result of leaks. (See the Troubleshooting section of this chapter.)

Another indicator of the need for an overhaul is oil consumption. Make sure the engine does not leak oil. when the oil consumption between the oil change maintenance interval is approximately 1-1/2 times normal (150%), engine overhaul should be considered.

With a good knowledge of how the engine operates, access to maintenance and compression test records, and information in the Troubleshooting section of this chapter, unnecessary disassembly and inspection can be eliminated.

Fan Belt Replacement

1. Put the machine on a level surface, engage the parking brake, turn the engine off and remove the key from the switch. Open the hood.

2. Loosen alternator brace bolt and support bolt (Fig. 24). Push the alternator in towards the engine.

3. Remove the belt from the pulleys and work it around the cooling fan.

4. Install the new belt.

5. Insert a pry bar between the alternator and engine and pry out the alternator. Apply only enough pressure to get the correct belt tension.

6. Hold the alternator in position after you get proper belt tension and tighten alternator brace bolt. Tighten alternator support bolt. For proper tension, belt should deflect 7/16 in. (9 to 11 mm) when 10 Kg (22 lb.) of force is applied midway between alternator and crankshaft pulleys.

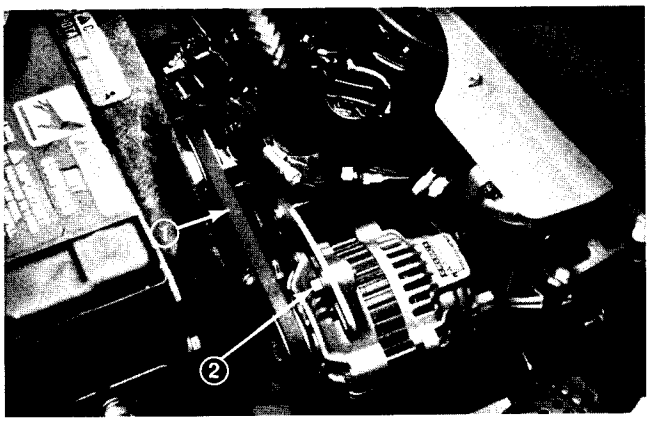


Figure 24

1. Fan belt
2. Alternator brace bolt

Alternator Removal and Installation

1. Disconnect the negative (–) cable from the battery.

2. Disconnect the wire from terminal "B" on the back of the alternator.

3. Disconnect the alternator wiring harness connector.

4. Loosen alternator brace bolt and alternator support bolt (Fig. 25). Push the alternator toward the engine and remove the belt.

5. Remove the alternator.

6. Reverse steps 1 - 5 to install the alternator. Make sure the spacer and shim is installed on the alternator support bolt between the alternator lower rear bracket and gear case bracket (Fig. 26).

7. Insert a pry bar between the alternator and engine and pry out alternator. Apply only enough pressure to get the correct belt tension.

8. Hold the alternator in position after you get proper belt tension and tighten the alternator brace bolt. Tighten the alternator support bolt. For proper tension, the belt should deflect 7/16 in. (9 to 11 mm) when 10 Kg (22 lb.) of force is applied midway between alternator and crankshaft pulleys.

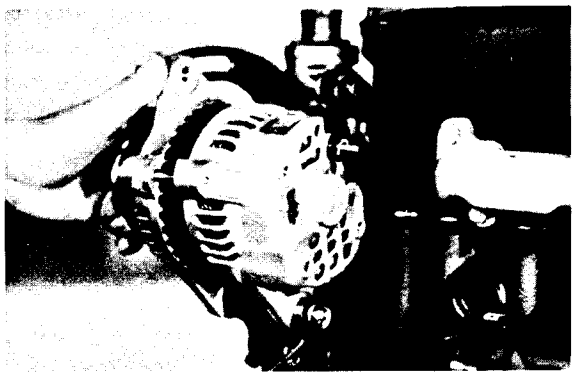


Figure 25

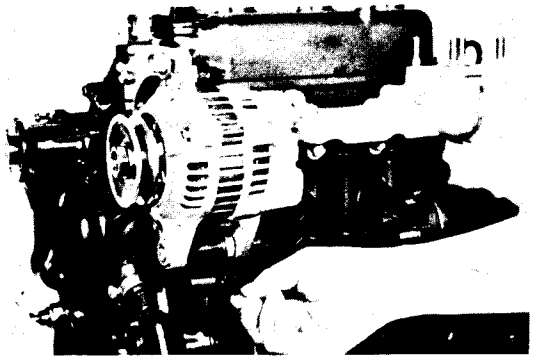


Figure 26

Starter Removal and Installation

1. Disconnect the negative (–) cable from the battery.

2. Disconnect the wires from the starter solenoid (Fig. 27).

3. Remove the two cap screws and washers securing the starter to the bracket.

4. Remove the starter.

5. Reverse steps 1 - 4 to install the starter.

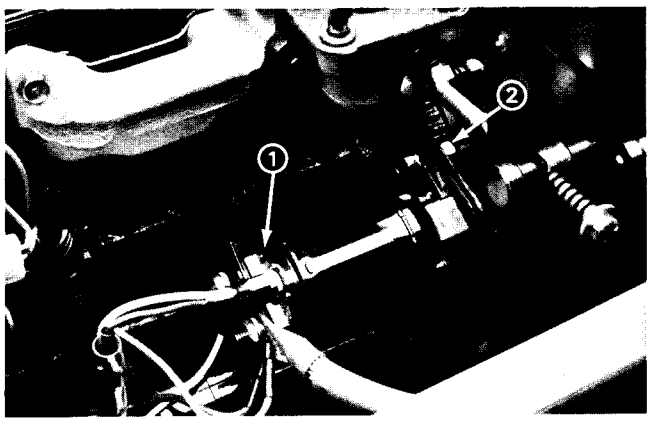


Figure 27

1. Starter solenoid **2. Cap screw and washer (2)**

Replacing and/or Adjusting Engine Stop Solenoid

See Chapter 6 - Electrical System for information about testing the engine stop solenoid.

An improperly adjusted stop solenoid can result in failure of the engine to stop when the key switch is turned off or could cause injection pump damage or malfunction.

Removing the Stop Solenoid

1. Stop the engine. If the engine will not stop when the ignition key switch is turned off, manually push the stop lever (Fig. 28) toward the rear of the machine until the engine stops.

2. Disconnect the solenoid electrical connector.

3. Loosen the nut securing the solenoid to the engine and unscrew the solenoid.

4. If you will be installing a new solenoid, remove the gasket and nut from the old solenoid and install them on the new solenoid. Thread the nut completely on the new solenoid.

Installing and/or Adjusting the Stop Solenoid

1. Remove the governor tie rod cover (Fig. 28).

2. Apply thread sealant to the solenoid threads.

3. Thread the solenoid into the engine.

4. Thread the solenoid into the engine while moving the tie rod back and forth (Fig. 29). Stop screwing the solenoid into the engine when there is no free play in the tie rod.

5. Turn the solenoid outward (counterclockwise) 1/4 to 1/2 turn. There should be a small amount of free play in the injector pump control rack 0.01 - 0.03 in. (0.3 - 0.7 mm).

IMPORTANT: No free play in the control rack with the solenoid de-energized (plunger out) may cause injection pump damage or malfuntion. Excess free play 0.04 in. (1 mm) or more will prevent the engine from stopping when the solenoid is de-energized.

6. Remove the cover cap screw from the engine to get access to the solenoid nut (Fig. 28).

7. Hold the solenoid body to prevent it from turning and tighten the nut against the engine to secure the adjustment. Do not over tighten the nut. If the nut is over tightened, the solenoid may become distorted and will not operate correctly.

8. Install the cover cap screw that was removed from the engine in step 6.

9. Connect the solenoid electrical connector.

10. Install the governor tie rod cover.

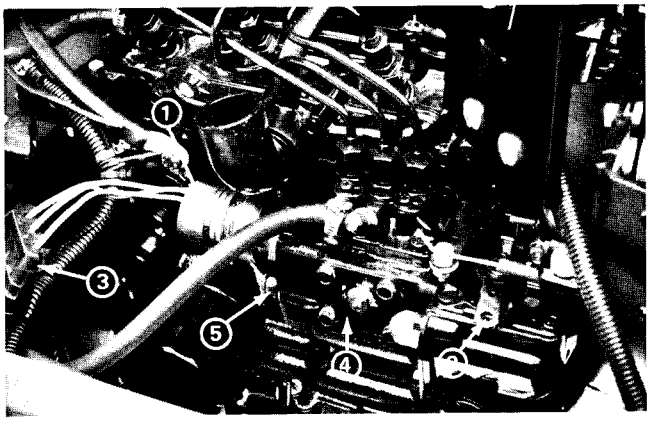


Figure 28

1. Stop solenoid
2. Stop lever
3. Solenoid electrical connector
4. Governor tie rod cover
5. Cover cap screw

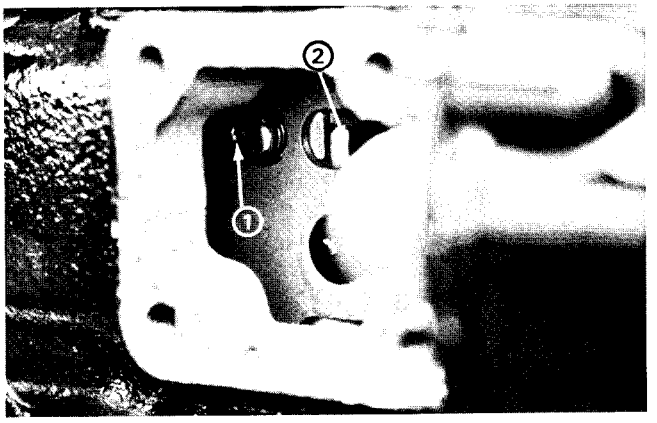


Figure 29

1. Solenoid plunger
2. Tie rod

Glow Plug Replacement

Replace the glow plug(s) if they do not operate correctly. (See Glow Plug Test in the Testing section of this chapter.)

1. Remove the nut and lead wire.

2. Clean the area around the glow plug. This will prevent dirt or other contamination from falling through the glow plug hole into the cylinder.

3. Remove the glow plug.

4. Install a new glow plug. Tighten the glow plug to a torque of 11-14.5 ft-lb (1.5-2 KgM).

5. Install the lead wire and nuts.

Oil Pressure Switch Replacement

The engine is equipped with an oil pressure switch (Fig. 30). This switch activates a lamp on the control panel and a buzzer if the oil pressure drops below safe levels during operation.

Pressure switch ON pressure: 0.5 kg/cm^2 (7 psi)

Replace the switch if it is not operating correctly. Before installing the switch put a small amount of LOCTITE #567 Thread Sealant (or equivalent) on the switch threads. When installing the switch make sure the sealant does not block the oil hole in the switch.

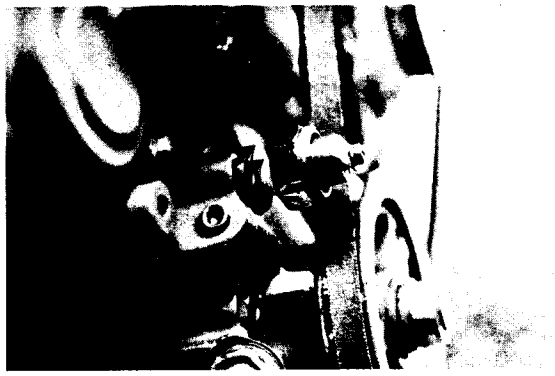


Figure 30

Thermostat Removal and Installation

1. Lower the coolant level to below the thermostat.

2. Loosen the hose clamp and disconnect the hose from the water outlet fitting.

3. Remove the water outlet fitting and gasket (Fig. 31).

4. Replace the thermostat if necessary (See Thermostat Test in the Testing section of this chapter).

5. Do not allow the thermostat flange to protrude from the water outlet fitting joint. Do not place thermostat stay in the direction of thermoswitch hole. Use a new gasket when installing the water outlet fitting.

6. Check for damaged hoses or damaged hose clamps. Replace as required. Install the hose on the water outlet fitting and tighten the hose clamp.

7. Fill the cooling system to the proper level with a 50/50 solution of clean, soft water and ethylene glycol antifreeze (See Checking the Cooling System and Changing Coolant in the Maintenance section of this book.).

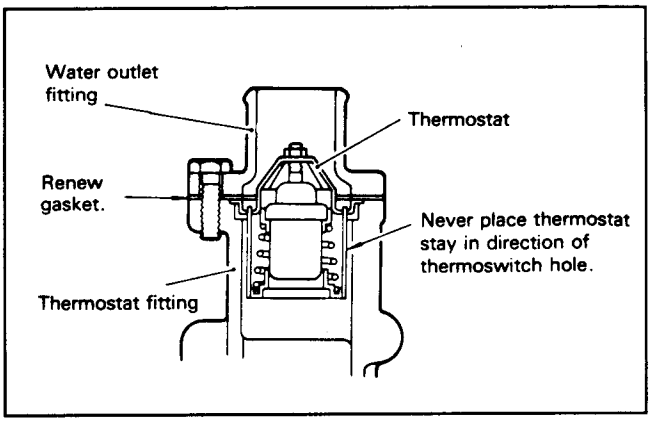


Figure 31

Water Pump Service

1. Drain the cooling system (see Changing Coolant in the Maintenance section of this chapter).

2. Remove the drive belt from the water pump and alternator.

3. Loosen the hose clamp and disconnect the hose from the water pump.

4. Remove the water pump (Fig. 32).

5. Check the water pump for cracks or leaks. Rotate the water pump shaft by hand. If the bearings do not rotate smoothly, or are noisy replace the water pump with a new water pump. There are no replaceable parts in the water pump.

6. Install the water pump and a new gasket onto the cylinder block.

7. Check for damaged hoses or damaged hose clamps. Replace as required. Install the hoses on the water pump and tighten the hose clamps.

8. Install the alternator / water pump drive belt.

9. Insert a pry bar between the alternator and engine and pry out alternator. Apply only enough pressure to get the correct belt tension.

10. Hold the alternator in position after you get proper belt tension and tighten the alternator brace bolt. Tighten alternator the support bolt. For proper tension, belt should deflect 7/16 in. (9 to 11 mm) when 10 Kg (22 lb.) of force is applied midway between alternator and crankshaft pulleys.

11. Fill the cooling system with a 50/50 solution of clean, soft water and ethylene glycol antifreeze. (See Checking the Cooling System and Changing Coolant in the Maintenance section of this book.)

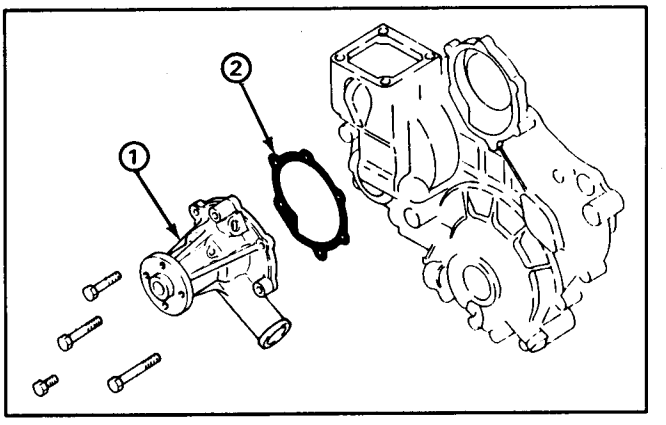


Figure 32

1. Water pump
2. Gasket

Governor System Repairs

Governor Operation

The governor keeps the engine operating at a constant speed by balancing the centrifugal force acting on the governor weights and the governor spring tension. As the engine picks up speed, the governor weights open to move the sliding shaft forward. The shaft pushes on the governor lever to move the injector control rack and decrease the fuel injection rate. At the same time the governor spring is pulled by the governor lever until the spring force is balanced with the centrifugal force of the governor weights, thus maintaining constant engine speed.

When the speed control lever is pulled toward high speed, the governor spring is pulled. The spring pulls on the governor lever to move the governor control rack and increase the fuel injection rate. As engine speed increases, the governor weight centrifugal force also increases until it is balanced with the governor spring force, thus maintaining a constant engine speed.

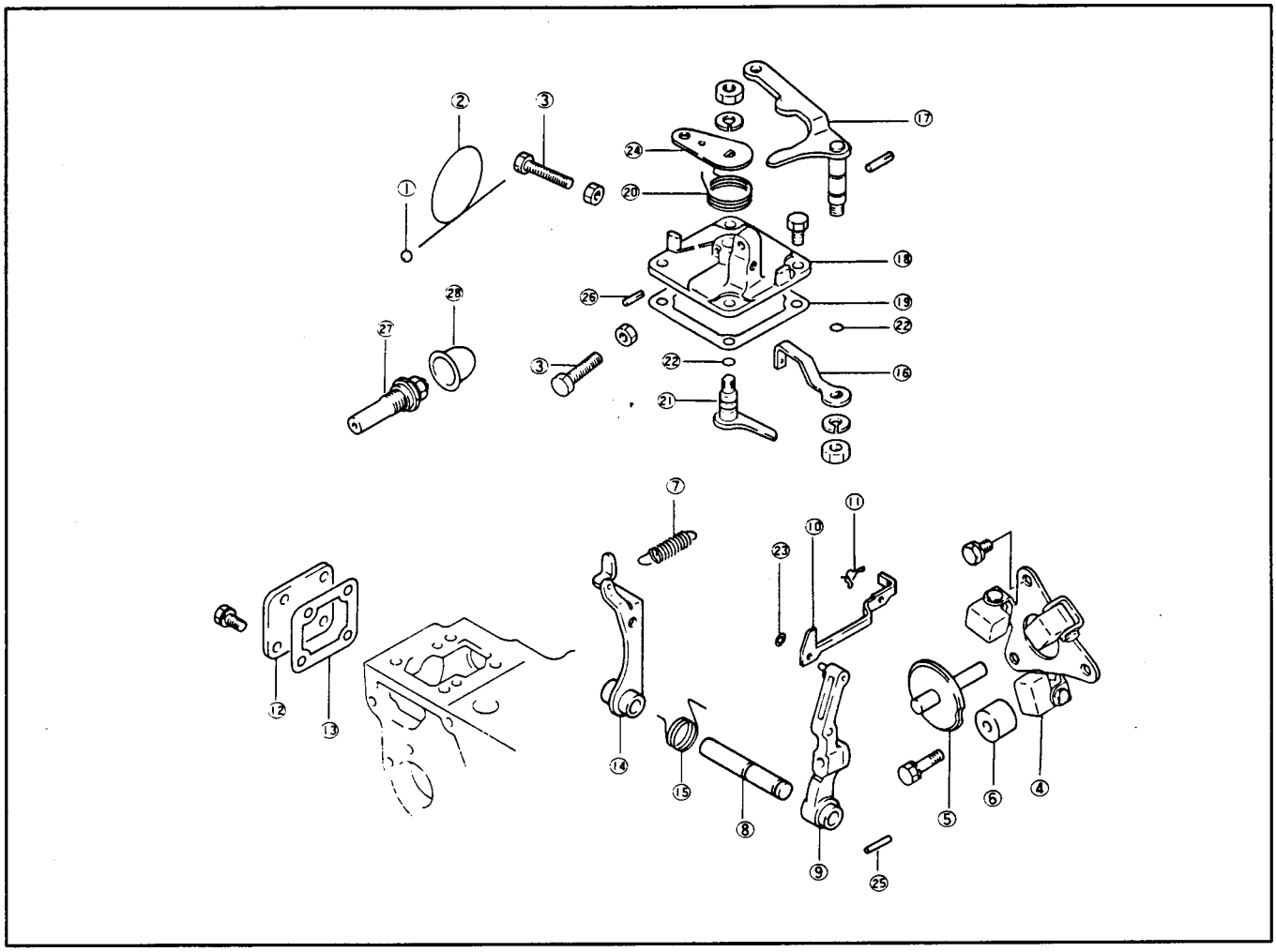


Figure 33

1. Sealing metal
2. Sealing wire
3. Speed adjustment screw
4. Governor weight assembly
5. Sliding shaft
6. Stopper
7. Governor spring
8. Governor shaft
9. Governor lever
10. Tie rod
11. Tie rod clip
12. Tie rod cover
13. Tie rod cover gasket
14. Tension lever
15. Start spring
16. Governor spring lever
17. Speed control lever ass'y
18. Governor cover gasket
19. Governor cover gasket
20. Return spring
21. Stop lever assembly
22. O-ring
23. Snap ring
24. Stop lever
25. Grooved pin (3 x 20 mm)
26. Grooved pin (3 x 14 mm)
27. Torque spring set
28. Sealing cap

Governor Inspection

A governor failure can cause engine starting failure, loss of engine speed control, or engine surging (hunting). Before removal and disassembly of the engine the following inspections are recommended:

1. Stop the engine, lower the implement and engage the parking brake. Open the engine hood.

2. Remove the governor tie rod cover (Fig. 28).

3. While holding the stop lever (Fig. 33) in the stop position (towards the rear of the machine) turn the ignition key switch quickly to the START position and release it to the ON positon. This will retract the stop solenoid plunger, allowing movement of the injection pump control rack.

4. Push the tie rod forward only with only enough force to overcome the spring pressure and operate the speed control lever (or throttle lever). You should feel the governor lever, under spring tension, move the tie rod and control rack as the lever is operated.

5. If the control rack does not move move correctly, disconnect the tie rod from the injection pump control rack. Make sure the injection pump control rack moves freely. If it does not, check for injection pump problems.

6. Failure of the speed control lever or governor lever to move when the tie rod is disconnected may indicated a problem with internal parts of the governor.

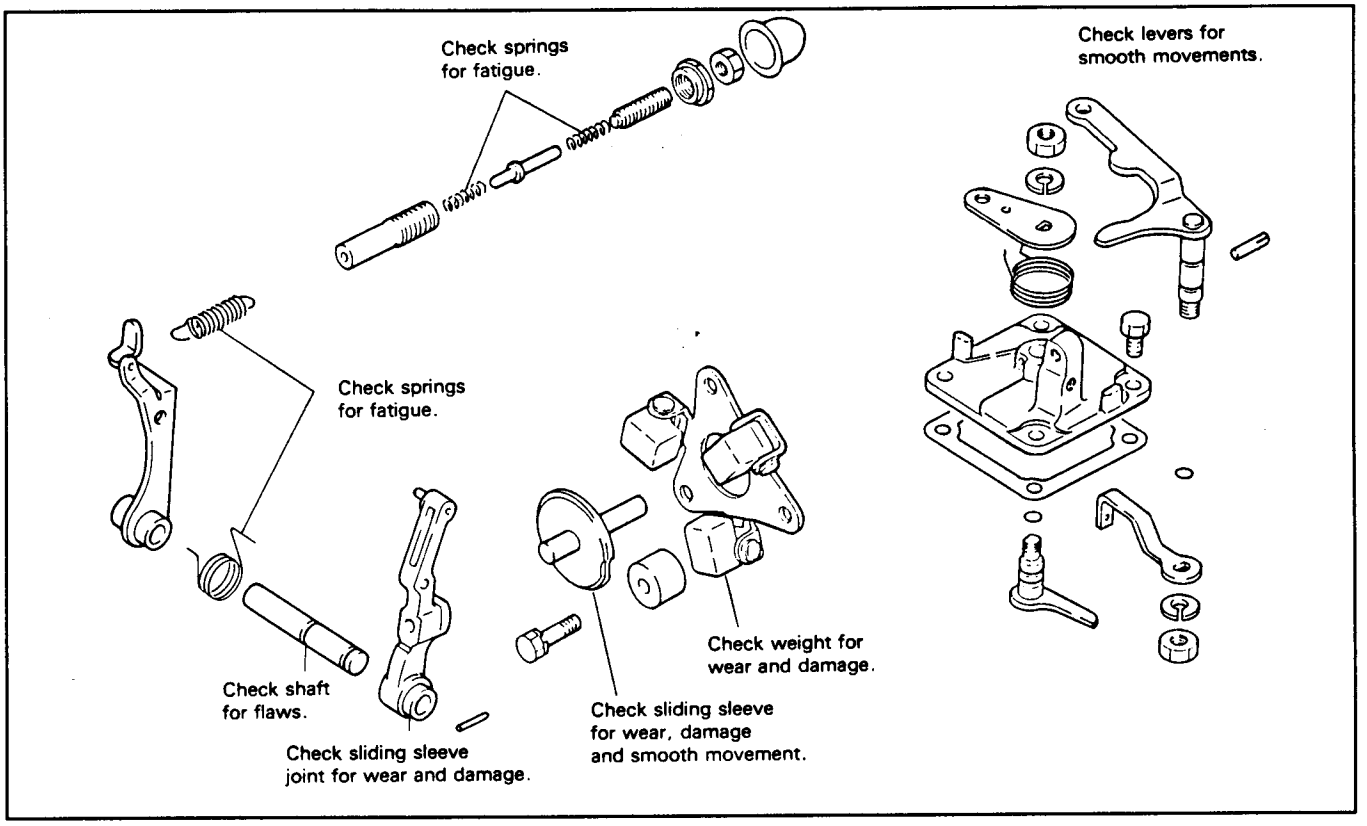


Figure 34

Governor Service

1. Remove the tie rod cover (Fig. 33).

2. Remove the tie rod clip and disconnect the tie rod from the injection pump control rack.

3. Disconnect the governor spring from the tension lever.

4. Remove the cover assembly.

5. Removing the levers:

   A. To remove the levers, pull out the grooved pins from the governor lever, stop lever and speed control lever.

   B. Loosen the bolts securing the levers and shafts.

6. Installing the levers:

   A. Coat the o-rings with oil before installation.

   B. Install the levers and shafts. After press fitting each grooved pin, check the shaft for smooth operation.

   C. Install the governor spring lever and speed control lever so there is a minimum play of angle between levers (Fig. 35) .

   D. The governor spring should not deflect more than 20 mm (0.8 in.) when installed.

9. Inspect all parts for wear or damage and smooth operation.

10. Reverse steps 1 - 4 to reassemble. After assembly, make sure that the governor mechanism operates smoothly.

NOTE: Further governor repairs require removal of the gear case (See Gear Case and Oil Pump in the Cylinder Block Overhaul section of this chapter).

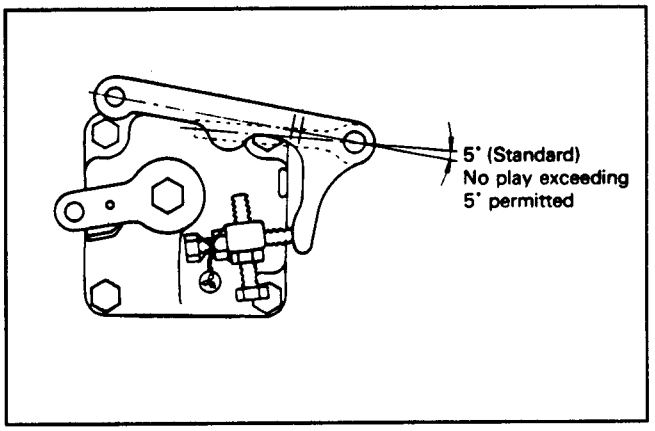


Figure 35

Installation of Torque Spring Set

IMPORTANT: Torque spring set adjustment has been done and sealed at the factory. Do not remove, disassemble or adjust this device unless necessary. The torque spring set adjustment is very sensitive. Improper adjustment can vary fuel delivery to under power or over fuel the engine.

1. Engage the parking brake. Make sure the high speed set bolt is adjusted to the correct engine speed of 2800 $^{+50}_{-0}$ rpm (See Adjusting Engine Speed in the Maintenance section of this chapter).

NOTE: Specified rpm is with no load on engine (fan drive and pump coupler disconnected).

2. Operate the engine at high idle speed.

3. Turn the torque spring set (Fig. 36) clockwise until engine speed drops approximately 50 rpm from high idle speed.

4. From this position, turn the back the torque spring set (counterclockwise) "N" turns (2.5 turns). Lock the torque spring set in position with the special nut.

5. Install the sealing cap.

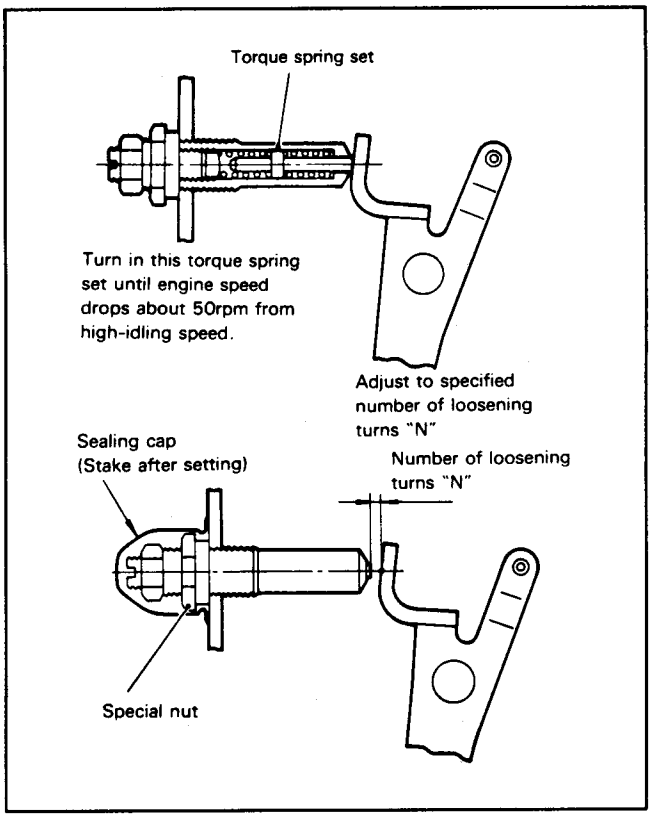


Figure 36

Assembly of Torque Spring Set

If the torque spring set has been disassembled or parts replaced, reassemble and adjust the torque spring set using the following procedure.

IMPORTANT: The torque spring set has been adjusted and sealed at the factory. Do not remove, disassemble or adjust this device unless necessary. The torque spring set adjustment is very sensitive. Improper adjustment can vary fuel delivery to under power or over fuel the engine.

1. Assemble the torque spring set as shown in Figure 37.

2. Use a screwdriver operated by fingertips to lightly tighten adjustment screw until resistance to rotation is felt. Lightly lock the screw in position with locknut.

3. Set dial on spring scale to zero (0). Tighten spring case until a value of 570 $^{+10}_{-0}$ grams is obtained. Lock the spring case in that position with special nut.

4. Temporarily loosen adjustment screw until to get a value of 370 grams then retighten the screw until a value of 570 $^{+10}_{-0}$ grams is attained. Lock the adjustment screw in position with locknut.

5. To inspect torque spring set for proper adjustment, use a test set up as shown (Fig.). Gradually push scale against torque spring set until stopper is moved (or pointer of dial indicator moves). Check that the load applied to the torque spring at that moment is 550 $^{+20}_{-30}$ grams.

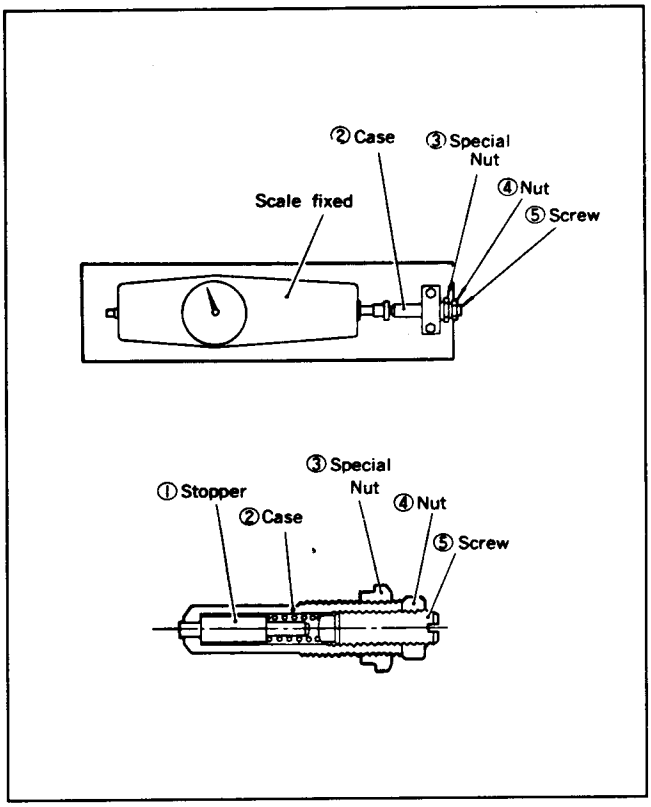


Figure 37

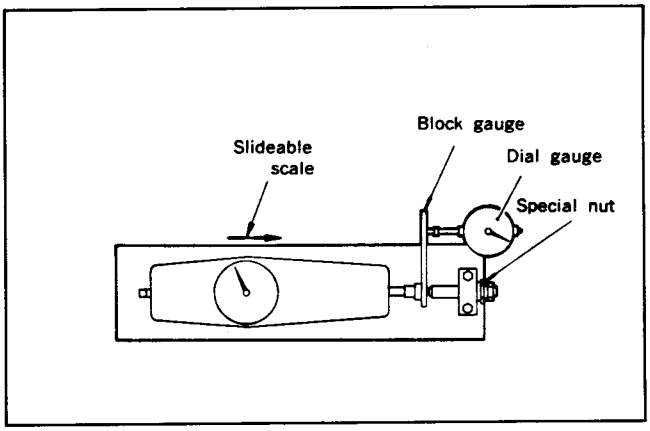


Figure 38

Fuel System Repairs

When cleaning the engine, DO NOT spray water onto a hot injection pump. This could cause the fuel pump to seize and be damaged.

When working on the fuel system, ALWAYS make sure that the equipment and work area is clean. The close tolerance parts of the fuel system can be easily damaged by dirt.

Wash fuel system parts in clean fresh diesel fuel. If parts are removed for a period of time, store them in containers of clean diesel fuel to prevent corrosion.

Bleeding the Fuel System

1. Stop the engine and engage the parking brake. Open the hood.

2. Loosen the air bleed screw on the fuel filter / water separator (Fig. 39).

3. Turn the ignition key switch to the ON position. The electric fuel pump will begin to operate and force fuel out around the screw loosened in step 2. Fuel will fill the filter bowl and then flow out around the screw. When a solid stream of fuel flows out around the screw, tighten the screw and turn the key switch OFF.

4. Open the air vent screw on the fuel injection pump (Fig. 40).

5. Turn the ignition key switch to the ON position. The electric fuel pump will begin to operate and force fuel out around the injection pump air vent screw. When a solid stream of fuel flows out around the screw, tighten the screw and turn the key switch OFF.

NOTE: Normally the engine should start after this procedure. If the engine does not start, air may be trapped between the injection pump and injectors (See Bleeding Air From the Injectors in this section of the book.)

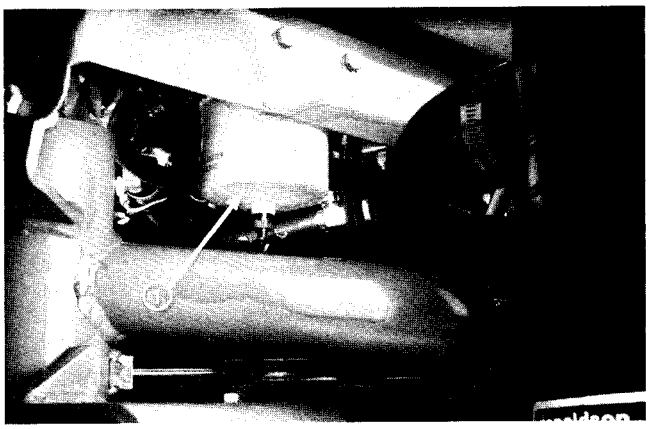


Figure 39

1. Fuel filter / water separator

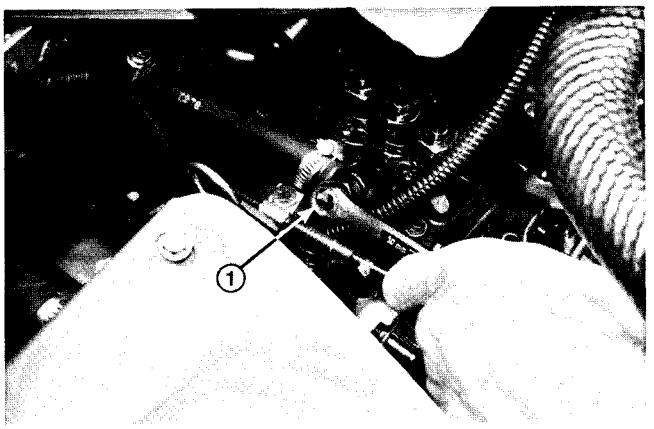


Figure 40

1. Fuel injection pump air vent screw

Bleeding Air From the Injectors

This procedure should only be used if the fuel system has been purged of air. (See Bleeding the Fuel System in this section of the book.)

1. Loosen the pipe connection at the number one nozzle and holder assembly on the cylinder head (Fig. 41).

2. Move the throttle control to the FAST position.

3. Turn the ignition key to the START position to crank the engine and pump fuel to the nozzles. Turn the ignition key to the OFF position when a steady stream of fuel flows out of the loose pipe connection.

4. Tighten the pipe connector.

5. Repeat steps 1 - 4 for the No. 2 and No. 3 injector nozzle and holder.

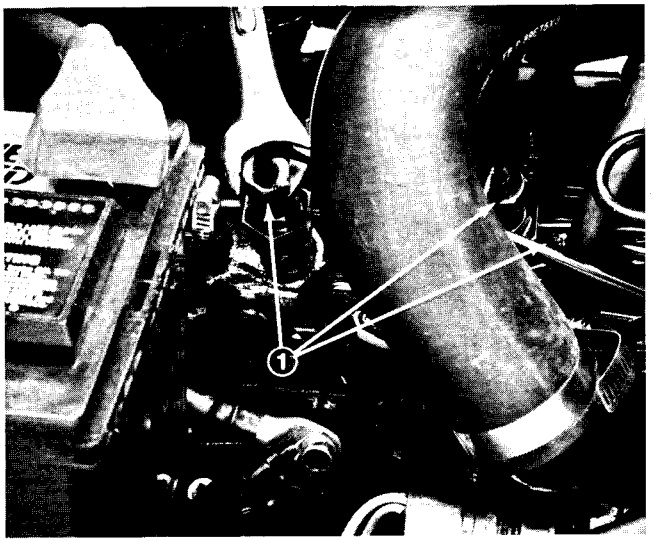


Figure 41

1. Fuel injector nozzle and holder (3)

Fuel Pump Service

The only serviceable parts of the fuel pump are the magnet, filter, and the gaskets on each end of the filter.

1. Disconnect the fuel pump wires from the wiring harness and ground connection.

2. Disconnect the fuel hoses from the pump. Plug the fuel lines.

3. Remove the two screws which secure the pump to the frame.

4. Use a 17 mm wrench to remove the cover from the fuel pump (Fig. 42). Remove the gasket, magnet and filter element.

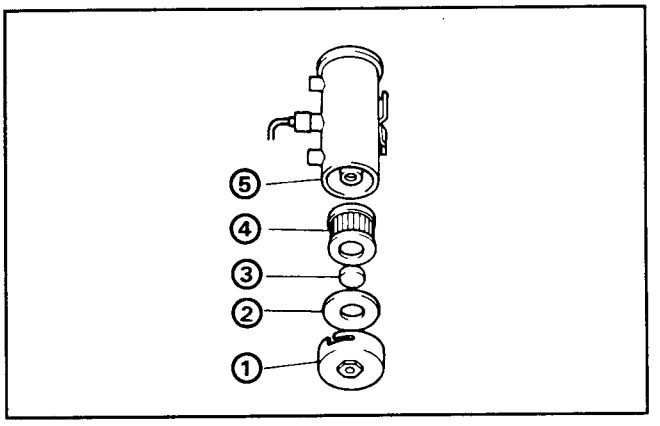


Figure 42

1. Cover
2. Cover gasket
3. Magnet
4. Filter
5. Body

5. Carefully remove the spring retainer from the end of the plunger tube (Fig. 43). Remove the washer, o-ring, valve, plunger spring and plunger.

IMPORTANT: Be careful not to bend or deform the plunger tube while disassembling the fuel pump. If the plunger tube is bent, the fuel pump plunger will bind and the pump will need to be replaced.

6. Install the plunger (valve side out), plunger spring, valve, o-ring, washer and spring retainer. Make sure the plunger operates freely.

7. Install the filter and cover gaskets, magnet, filter and cover. Tighten the cover to prevent air leaks.

8. Install the fuel pump to the frame. Connect the fuel lines and electrical wires.

9. Bleed the fuel system. (See Bleeding the Fuel System in this section of the book.)

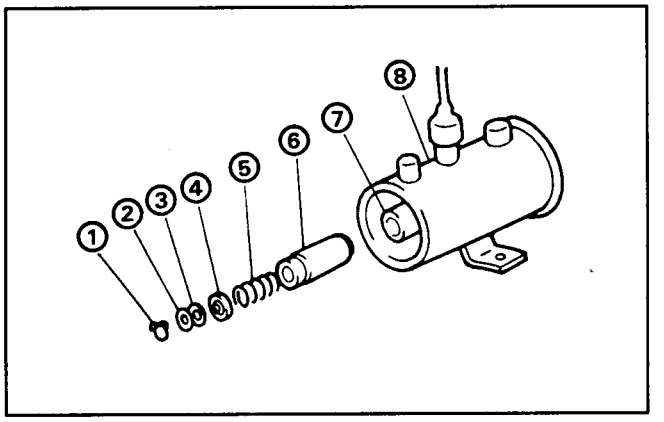


Figure 43

1. Spring retainer
2. Washer
3. O-ring
4. Valve
5. Plunger spring
6. Plunger
7. Plunger tube
8. Body

Injection Pump Service

Do not attempt the disassemble the injection pump unless it is necessary. If the pump is damaged or defective, it is recommended to replace the pump.

IMPORTANT: Clean the injection pump and the area near the injection pump before removing or servicing it. DO NOT spray water onto a hot injection pump.

Removing and Installing the Injection Pump

1. Remove the engine stop solenoid (Fig. 44). (See Replacing and/or Adjusting Engine Stop Solenoid in the External Engine Component Repair section of this chapter.)

2. Disconnect the fuel pipes from the injector nozzles and injection pump delivery valve holders. Loosen the hose clamp and disconnect the fuel hose.

3. Remove the tie rod cover. Remove the tie rod clip and disconnect the tie rod from the injection pump control rack (Fig. 45).

4. Remove the four (4) injection pump mounting bolts. Remove the injection pump from the cylinder block. Make a note of the number and thickness of the adjusting shims under the pump. (The shims determine the injection timing.)

5. Reverse steps 1 - 4 to install the injection pump. Make sure the Engine Stop Solenoid is adjusted correctly. (See Replacing and/or Adjusting Engine Stop Solenoid in the External Engine Component Repair sectoin of this chapter.)

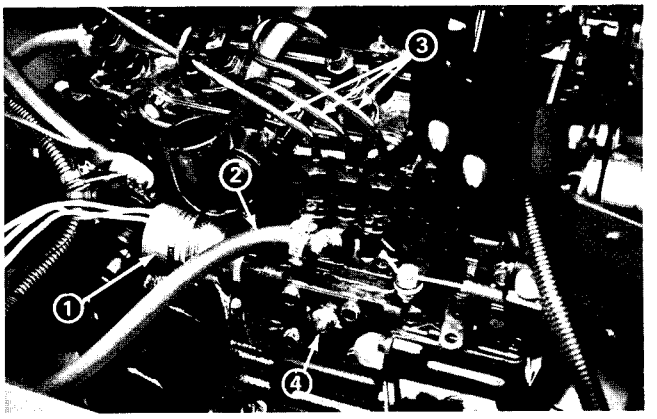


Figure 44

1. Engine stop solenoid
2. Fuel hose
3. Fuel pipes
4. Tie rod cover

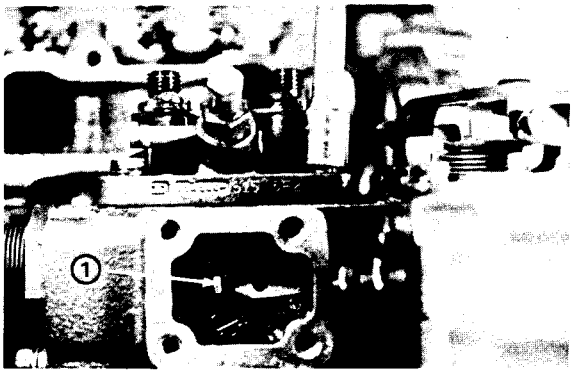


Figure 45

1. Tie rod (disconnected)

Injection Pump Disassembly

IMPORTANT: Do not mix the delivery valves, delivery valve seats, plungers or plunger barrels from one cylinder to another. These are parts are "matched sets". Handle these parts carefully. Place the parts in a container of clean diesel fuel to prevent corrosion.

1. Remove the stopper holder. Remove the delivery valve holder (Fig. 46).

2. Remove the valve spring, delivery valve and o-ring. Remove the gasket and valve seat.

3. Remove the tappet roller and stopper pin. Remove the tappet and adjusting shim.

4. Remove the lower seat from the plunger. Remove the plunger spring and upper seat

5. Remove the two screws securing the bracket to the pump housing. Remove the control rack.

IMPORTANT: DO NOT loosen the adjusting screws on the control rack for each cylinder. If these parts are removed, it is necessary to measure fuel injection quantity with a pump tester and cam box.

7. Remove the sleeve and plunger. Remove the plunger barrel upward from the pump housing.

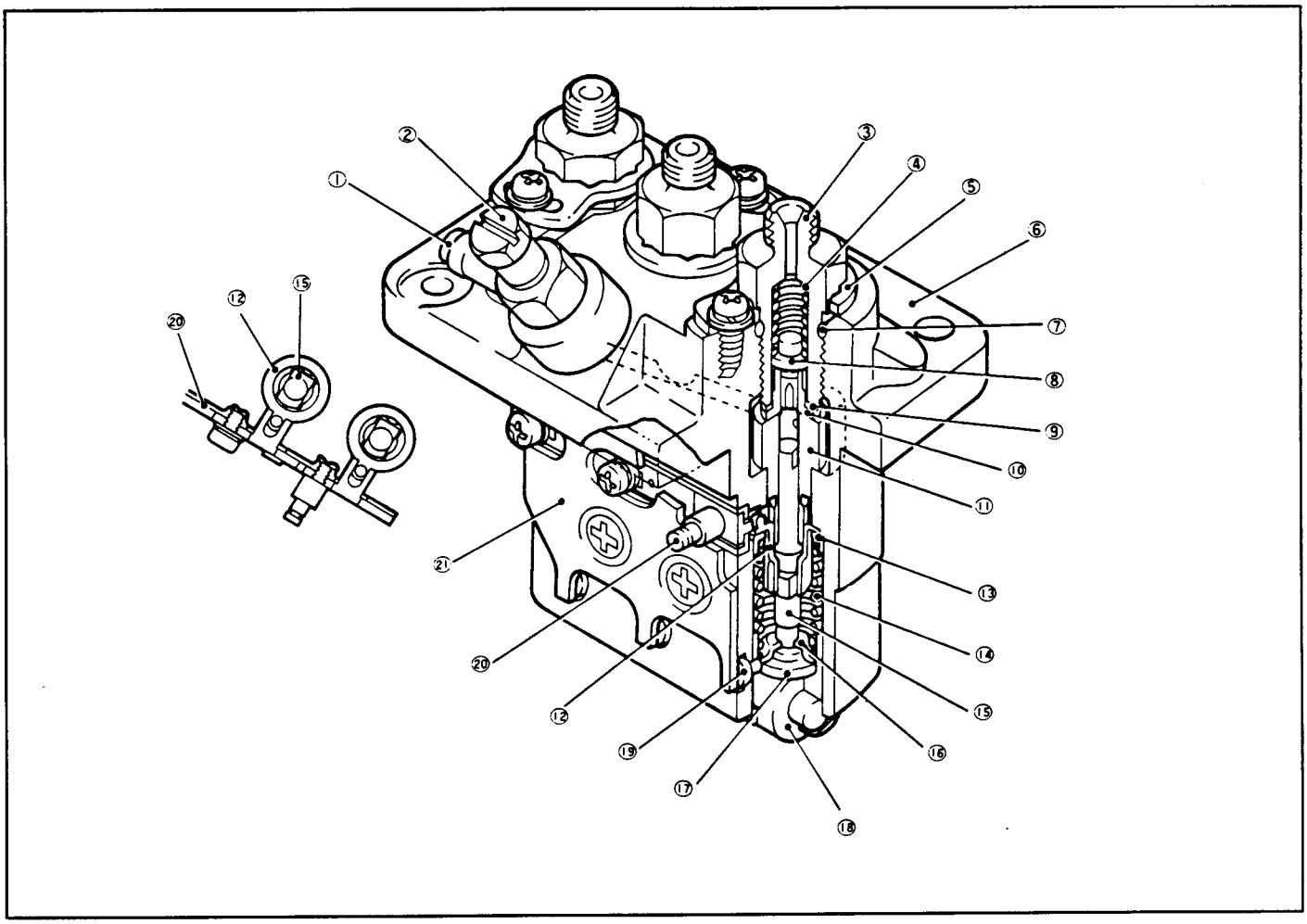


Figure 46

1. Union collar
2. Air vent screw
3. Delivery valve holder
4. Valve spring
5. Holder stopper
6. Housing
7. O-ring
8. Delivery valve
9. Gasket
10. Valve seat
11. Plunger barrel
12. Sleeve
13. Upper seat
14. Plunger spring
15. Plunger
16. Lower seat
17. Adjusting shim
18. Tappet roller
19. Pin
20. Control rack
21. Bracket

Injection Pump Inspection

Inspect the injection pump parts for proper operation, wear, corrosion, seizure, etc. (Fig. 47). Replace worn or damaged parts.

Injection Pump Assembly

1. Insert the plunger barrel into the housing.

2. Install the delivery valve seat, gasket, delivery valve and valve spring. Install the o-ring on the delivery valve holder. Temporarily tighten,the delivery valve holder.

3. Insert the control rack. Insert the sleeve. Align the match mark on the rack with that on the pinion (sleeve).

4. Insert the upper seat. Insert the plunger spring.

5. Fit the lower seat to the plunger. Insert the plunger into the barrel (Fig. 48).

6. Push in the tappet roller assembly and install the stopper pin.

7. Tighten the delivery valve holder to a torque of 3.5 - 3.9 Kgm (25 - 28 ft-lb). Install the holder stopper.

9. Before installing the injection pump, make sure the control rack slides smoothly, with little resistance. If the control rack binds, it is assembled incorrectly or parts are dirty. The pump must then be reassembled correctly and/or cleaned.

10. Install the injection pump to the cylinder block. Make sure that the same number and size shims that were under the pump when it was removed are installed.

11. Install the fuel line and delivery pipes.

12. Bleed air from the fuel system. (See Bleeding the Fuel System and Bleeding Air From the Injectors in this section of the book.)

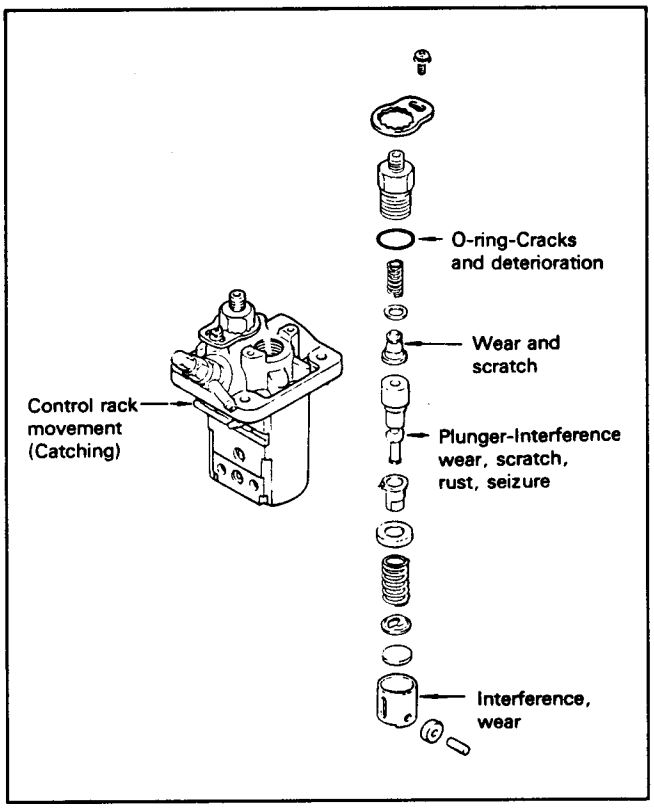


Figure 47

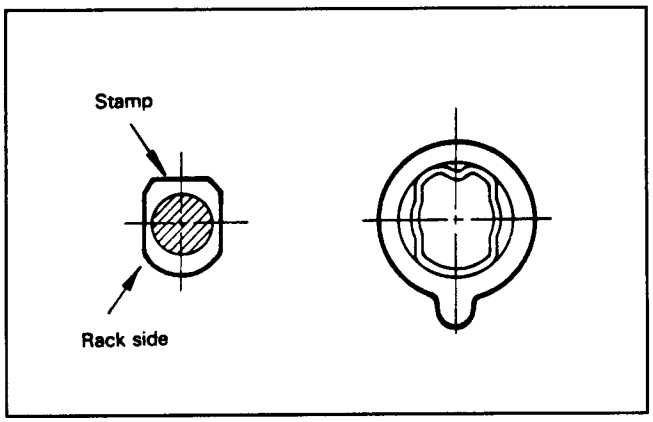


Figure 48

Nozzle Service

IMPORTANT: When servicing the injection nozzles make sure that the engine and fuel delivery pipes are clean to prevent dirt from entering cylinder or nozzle. Do not mix components of one nozzle with the other.

Nozzle Removal and Disassembly

1. Disconnect the injection pipes and fuel return pipe.

2. Remove the injector nozzle from the cylinder head.

NOTE: Further disassembly of the nozzle is not required for the nozzle to be tested. (See Nozzle Tests in the Testing section of this chapter.)

3. Secure the nozzle holder in a vise that has aluminum or brass jaw plates. To prevent deformation do not clamp the vise onto the retaining nut (Fig. 49).

4. Remove the retaining nut, shim washer, spring, pin, and distance piece.

6. Remove the nozzle assembly from the retaining nut. If it is difficult to remove, tap it lightly with a rubber or wooden mallet. IMPORTANT: Be careful not to hit or damage the protruding tip of the nozzle needle valve.

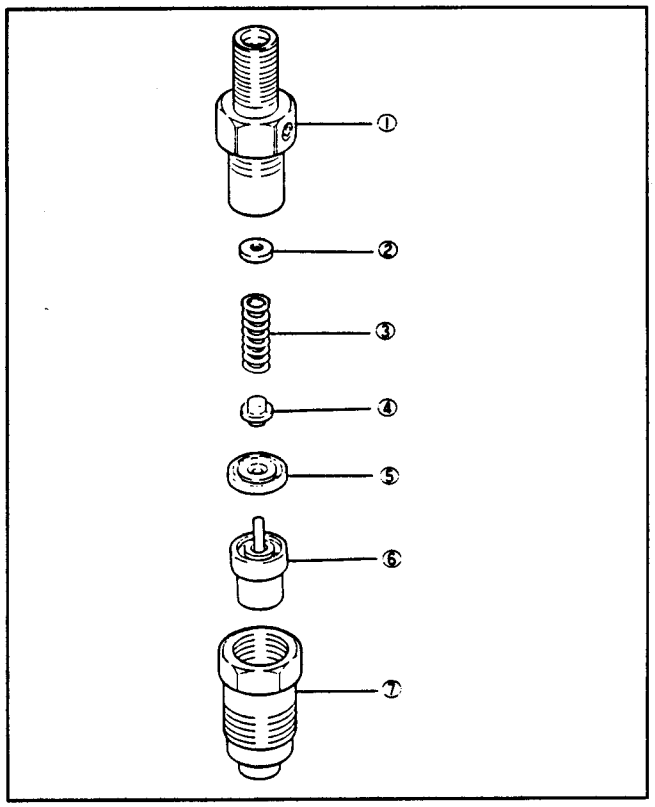


Figure 49

1. **Body**
2. **Shim washer**
3. **Pressure spring**
4. **Pin**
5. **Distance piece**
6. **Nozzle assembly**
7. **Retaining nut**

Nozzle Inspection and Cleaning

1. Clean the inside and outside of the retaining nut in clean diesel fuel or kerosene to remove carbon or fuel deposits. Inspect the lower seating surface for rust or damage. The sealing area may be restored with emery cloth.

2. Remove carbon or lacquer deposits from the nozzle by cleaning in clean diesel fuel or kerosene. Stubborn deposits can be removed with a brass wire brush.

IMPORTANT: Do not use a steel brush, steel wool, etc. Take special care not to scratch the needle valve in the nozzle assembly.

3. Clean the body, shim, spring, pin and distance piece in clean diesel fuel or kerosene.

4. Inspect the removed parts (Fig. 50). Replace any worn or damaged parts.

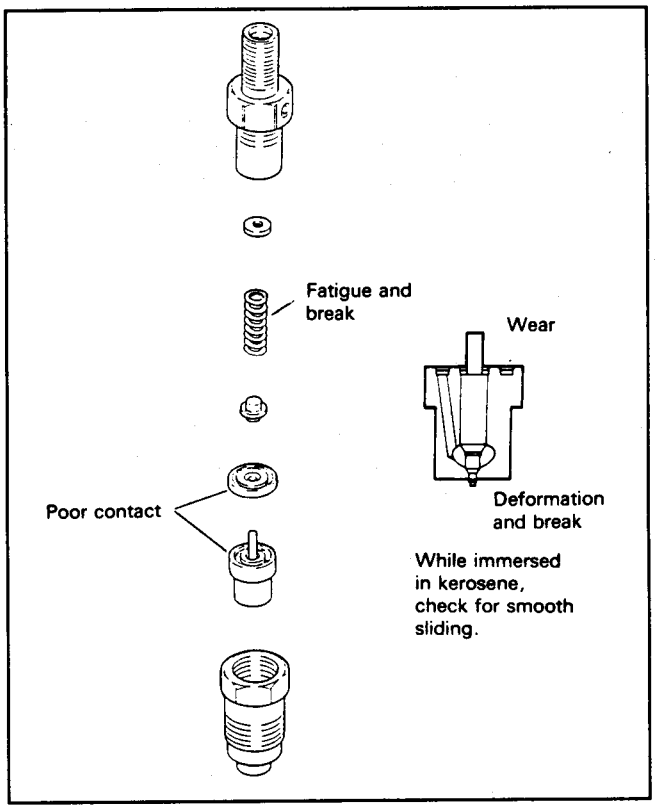


Figure 50

Nozzle Assembly and Testing

1. Install the nozzle assembly, distance piece and pin into the retaining nut.

2. Install the shim and pressure spring the body. Assemble the body to the retaining nut. Put the nozzle holder in a vise. Tighten the body and nut to a torque of 3.5 - 4.0 KgM (25 - 29 ft-lb) (Fig. 51).

3. Test the nozzle for proper operation. (See Nozzle Tests in the Testing section of this chapter.)

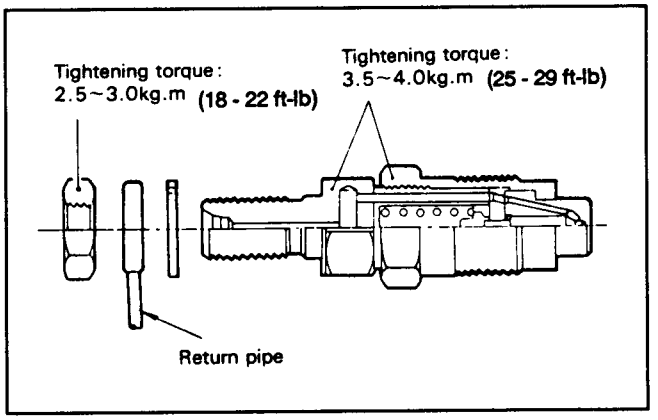


Figure 51

Nozzle Installation

1. Clean the nozzle holder fitting surface on the cylinder head. Install a new nozzle holder gasket onto the nozzle.

2. Install the nozzle holder into the cylinder head and tighten to a torque of 5.0 - 6.0 KgM (36 - 43 ft-lb).

3. Install the fuel return pipe. Tighten the retaining nut to a torque of 2.5 - 3.0 KgM (18 - 22 ft-lb) (Fig. 49).

4. Install the fuel injection pipes. Tighten the nut to a torque of 2.5 - 3.5 KgM (18 - 25 ft-lb).

5. Bleed air from the fuel system (See Bleeding the Fuel System and Bleeding Air From the Injectors in this section of the book.)

Removing and Installing the Fuel Tank and Tank Base

1. Stop the engine and engage the parking brake.

2. Close the fuel shut off valve (Fig. 52). To drain the tank, disconnect the fuel line from the inlet fitting on the electric fuel pump. Open the fuel shut off valve and drain the fuel into a suitable container. Reconnect the fuel line to the electric fuel pump.

3. Remove the negative (–) and positive cables from the battery (Fig. 53). Loosen the battery retaining bolt and remove the battery.

4. Disconnect the fuel line feed line from the fuel injection pump. Disconnect the fuel return line from the fuel injector return pipe.

5. Remove the two capscrews securing the electrical plate (Fig. 54). Push the electrical plate through the opening in the tank base (keep components and wires attached).

6. Remove the two capscrews securing the front of the tank base to the frame (Fig. 54).

7. Remove the two capscrews securing the rear of the tank base to the frame (Fig. 55). Lift the tank base and tank off of the machine.

8. Reverse steps 2 - 7 to install the fuel tank and tank base.

NOTE: The fuel tank is secured to the tank base with four pan head screws that install into grommets in the bottom of the tank. When installing the tank to the tank base, tighten the screws to a torque of 70 - 80 in-lb (81 - 92 KgCm). Do not overtighten.

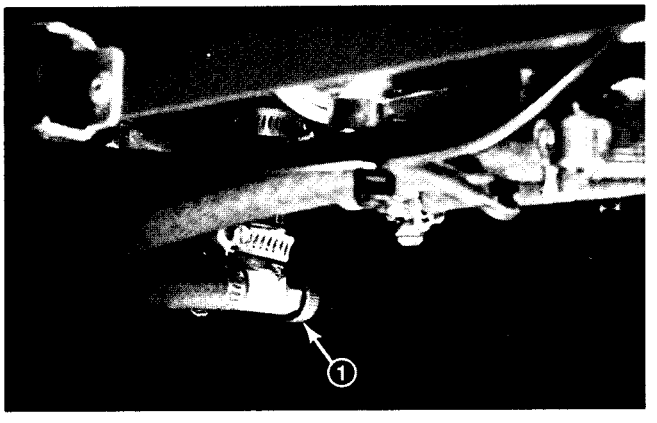


Figure 52

1. Fuel shut off valve

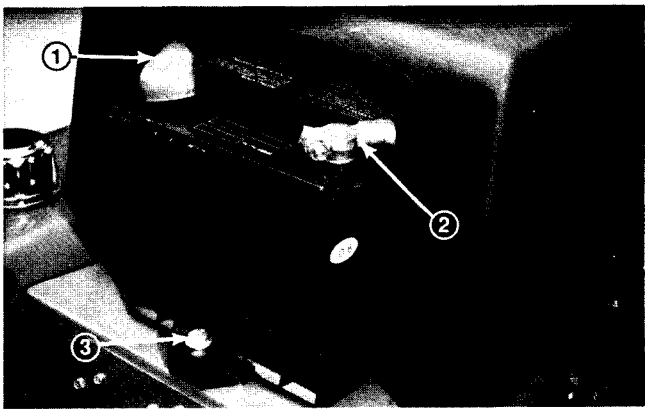


Figure 53

1. Positive (+) battery cable
2. Negative (–) battery cable
3. Battery retaining bolt and clamp

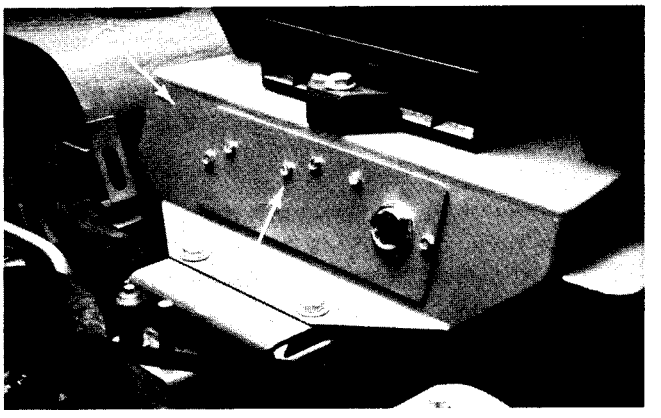


Figure 54

1. Electrical plate **2. Tank base**

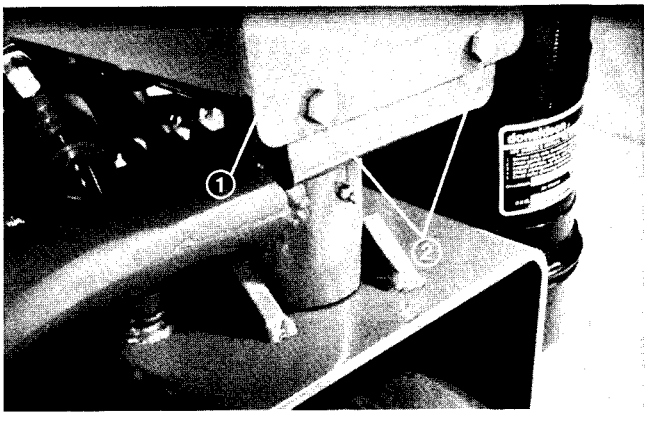


Figure 55

1. Tank base **2. Capscrews (2)**

Removing and Installing the Engine

Removing the Engine

1. Put the machine on a level surface and engage the parking brake. Turn the engine OFF and remove the key from ignition switch. Allow the engine and radiator to cool.

2. Remove the battery. Remove fuel tank and base. (See Removing and Installing the Fuel Tank and Tank Base in this section of the book.)

3. Open the radiator cap. Put a drain pan under the radiator. Open the radiator drain valve or loosen the hose clamp and disconnect the lower radiator hose from the radiator (Fig. 56). Allow the coolant to drain into the drain pan.

CAUTION

DO NOT open the radiator cap or drain the coolant if the engine or radiator is hot. Pressurized, hot coolant can escape and cause burns.

Ethylene-glycol antifreeze is poisonous. Dispose of it properly or store in a properly labeled container away from children or pets.

4. Loosen the hose clamps and disconnect the upper radiator hose from the engine and radiator (Fig. 56). Loosen the hose clamps and disconnect the air intake hose from the engine air intake fitting and air cleaner.

5. Remove the muffler (Fig. 56).

6. Disconnect and tag wires that attach to the engine or engine components:

Alternator
Starter motor and solenoid
Ground cable
Oil pressure switch
Temperature gauge sender
Thermoswitch
Engine stop solenoid

7. Disconnect the steering cylinder from the frame and rear castor (Fig. 56). Do not disconnect the hydraulic lines.

8. Loosen the two set screws securing the pump hub on the engine shaft with an allen wrench (Fig. 57). Remove the two capscrews securing the pump to the pump mount. Do not disconnect any hydraulic lines.

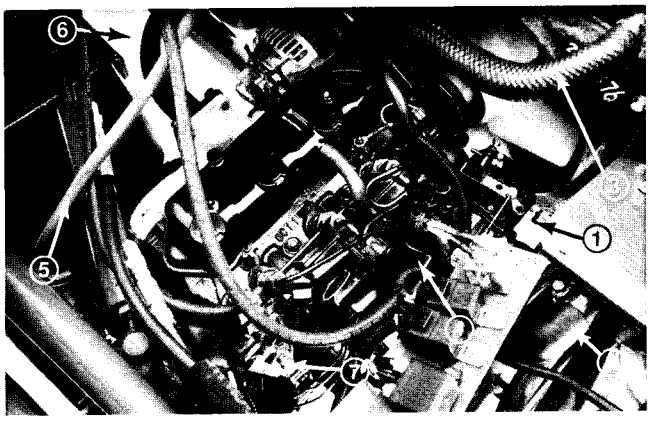


Figure 56

1. Radiator drain valve
2. Lower radiator hose
3. Upper radiator hose
4. Air intake fitting
5. Steering cylinder
6. Muffler
7. Coolant drain plug

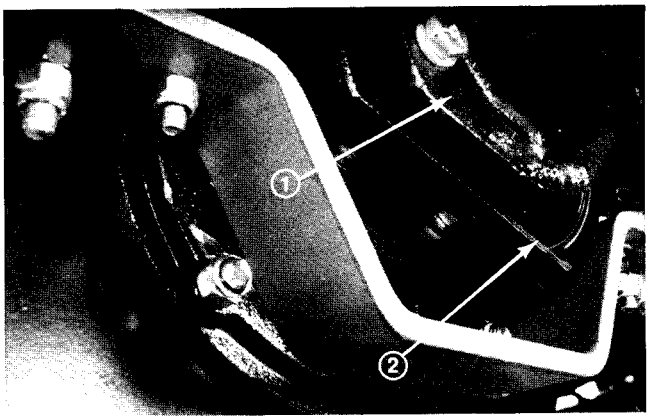


Figure 57

1. Hydraulic pump
2. Pump mount

9. Loosen the cap screw and nut to disconnect the throttle cable from the speed control lever on the engine (Fig. 58). Loosen the clamp and remove the throttle cable.

10. Remove the locknut, rebound washer and bolt securing the engine to each of four rubber engine mounts (Fig. 59).

11. Attach a short section of chain (approximately 13 inches (330 mm) between the two hanger brackets on the engine. Connect the hoist or block and tackle chain at the center of the short section of chain. One person should operate the hoist or block and tackle and the other person should help guide the engine out of the chassis. Remove the engine from the chassis. Be careful when removing the engine to prevent damage to the engine, fan, radiator or other parts. Mount the engine in an engine rebuilding stand.

12. Drain the oil from the engine and remove the engine oil filter.

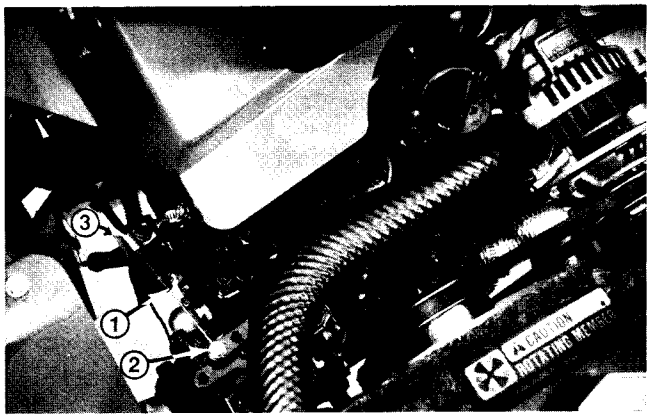


Figure 58

1.Throttle cable **3. Clamp**
2.Speed control lever

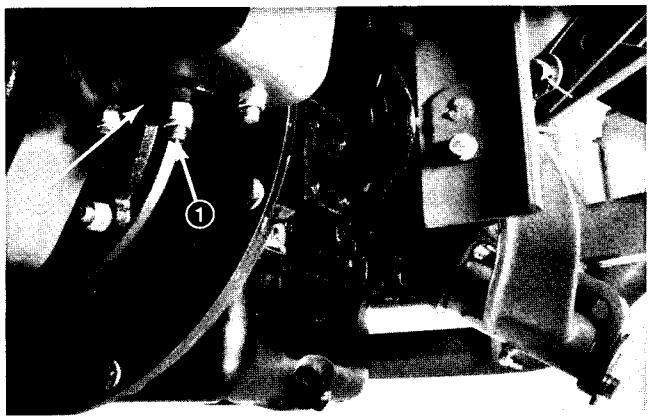


Figure 59

1. Bolt and locknut **2. Rebound washer**

Installing the Engine

1. To install the engine, perform steps 2-12 of Removing the Engine in reverse order.

2. Install a new engine oil filter. Fill the engine with the correct oil. (See Checking Oil Level in the Maintenance section of this chapter.) Fill the cooling system with a 50/50 solution of ethylene glycol antifreeze and clean, soft water (see Checking Cooling System in the Maintenance section of this chapter). Check for oil and coolant leaks and repair as necessary.

3. Adjust the throttle linkage (See Throttle Linkage Adjustment in the Adjustments section of this chapter).

Cylinder Head Overhaul

Cylinder Head Removal

1. If the engine will not be removed from the traction unit, lower the coolant level in the engine. Loosen the hose clamp and remove the upper radiator hose from the thermostat housing. Disconnect the coolant bypass hose from the thermostat housing.

2. Remove the plug from the cylinder block (Fig. 56) to drain the coolant from the head and cylinder block.

3. Remove the muffler.

4. Remove the alternator (see Alternator Removal and Installation in the External Engine Component Repair section of this chapter).

5. Remove the glow plug lead wires.

6. Remove the fuel injection pipes and return pipe.

7. Remove the rocker cover and gasket.

8. Loosen the rocker stay attaching bolts. Remove the rocker assembly (Fig. 60a).

9. Loosen the cylinder head bolts. Use the sequence shown in Figure 60b. Remove the cylinder head assembly including the intake and exhaust manifolds.

10. Remove the cylinder head gasket. Use a scraper tool to remove the cylinder head gasket from the cylinder head and cylinder block. Make sure all of the gasket material is removed. Do not damage or scratch the cylinder head or cylinder block surfaces.

11. Remove the intake and exhaust manifolds from the cylinder head. Remove thermostat housing and thermostat.

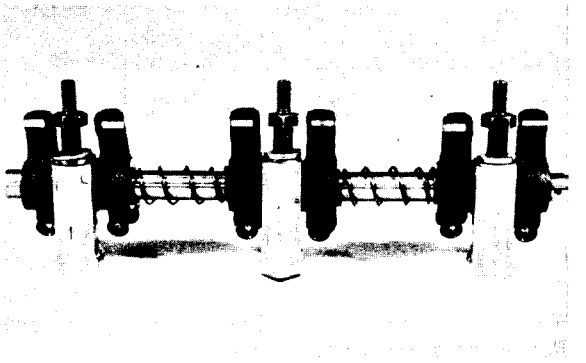


Figure 60a

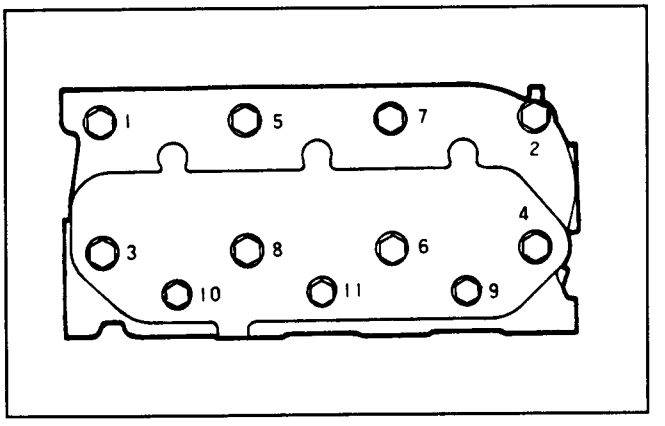


Figure 60b

Cylinder Head Service

1. Use a valve lifter tool to compress the valve spring (Fig. 61). To remove each valve retainer, depress the retainer against the valve spring and remove the retainer lock (Fig. 62). Remove the valve retainer, spring and valve. Keep each valve and other parts for each cylinder separate so they can be reinstalled in the same cylinder.

2. Examine each valve for burning, pitting, heavy carbon deposits or wear. The condition of the valves can give important information about other components that may require service (example: improper valve clearance, worn valve guides, damaged seals, etc.). Remove the valve seals.

3. Inspect the cylinder head for coolant leaks or damage before cleaning.

4. Remove all of the carbon deposits from the combustion chamber using a scraper and wire brush.

5. Clean the cylinder head thoroughly with solvent or degreasing solution and allow it to dry. Inspect carefully for cracks.

6. Remove all carbon deposits from the valve guide bores with a valve guide cleaner. Use a valve guide bristle brush to remove loosened carbon deposits in the valve guide. Push a solvent soaked cloth through the valve guides to remove all foreign material.

7. Use compressed air to clean out the oil passages. Make sure the oil passages are not plugged.

CAUTION

Warn other personnel in the area before using compressed air. To prevent injury, wear safety glasses, goggles or a face shield.

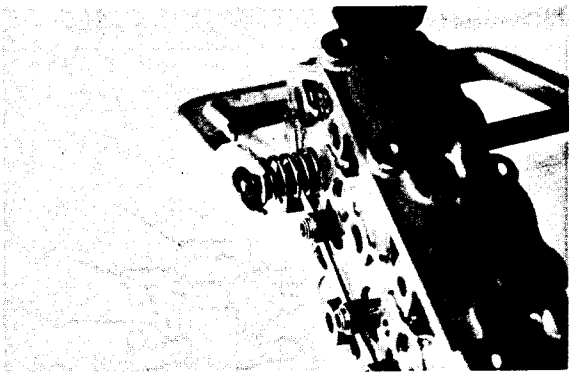


Figure 61

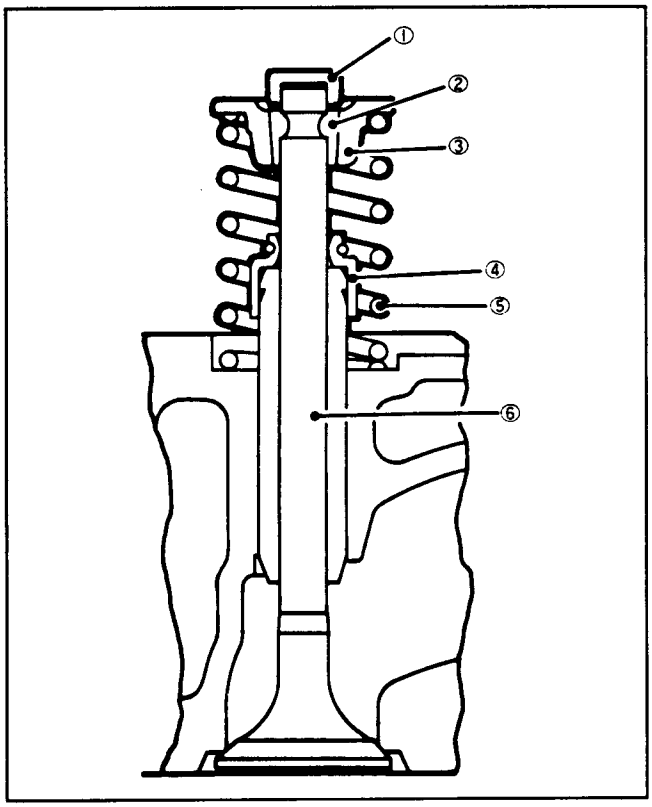


Figure 62

1. Valve stem cap
2. Retainer lock
3. Valve spring retainer
4. Valve stem seal
5. Valve spring
6. Valve

8. Use a straight edge and feeler gauge to check the flatness of the cylinder head lower surface (Fig. 63). Be sure to check the surface variation crosswise, lengthwise, and diagonally. If the variation in surface flatness exceeds (0.05 mm) 0.002 in. , the cylinder head or cylinder block must be replaced or resurfaced.

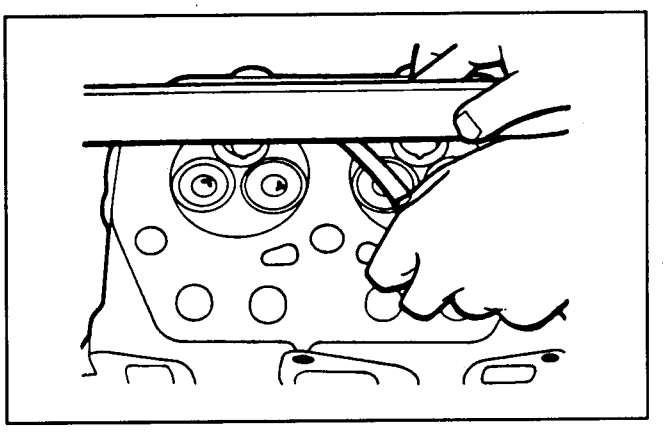


Figure 63

Valve Guides

1. Use a micrometer and a small hole gauge to check the valve guide to valve stem clearance. The valve and valve guide should be replaced if the clearance exceeds the following limits:

Valve guide to valve stem clearance

Intake valve: 0.10 mm (0.004 in.)
Exhaust valve: 0.15 mm (0.006 in.)

2. Use a valve guide removing mandrel with a pilot section to remove the valve guide. Push the valve guide up from the bottom of the cylinder head.

3. To install the new valve guide press it in from the top of the cylinder head, using the valve guide mandrel. Install the valve guide so the installed height is 13.5 - 14.5 mm (0.531 - 0.571 in.) above the cylinder head (Fig. 64).

4. After installing the new valve guide, check the valve guide to stem clearance. If the clearance is smaller than standard, it will be necessary to ream the valve guide bore to get the proper clearance.

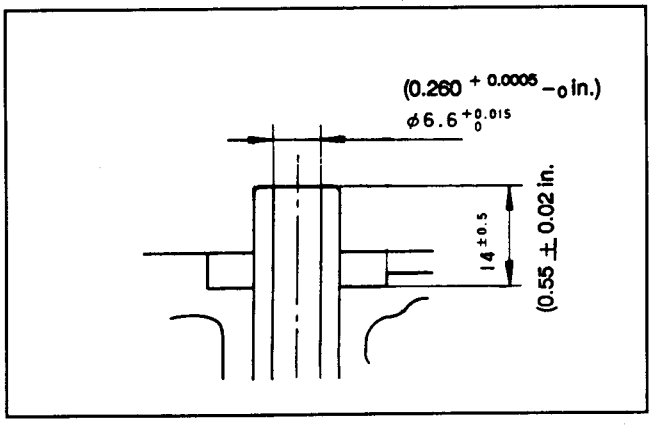


Figure 64

Valves

1. Carefully clean each valve with a wire wheel to remove all carbon deposits.

2. Check the valve face and valve stem for excessive wear, damage, cracks or deformation. If any of these conditions exist, the valve must be replaced. It is possible to reface the valve if the valve head thickness (margin width) is not less than the service limit (Fig.65). If the margin of the resurfaced valve is less than the service limit, replace the valve.

Minimum valve head thickness (margin width):
0.5 mm (0.020 in.)

3. Check the tip of the valve stem for wear or pitting. Replace the valve if the tip is worn.

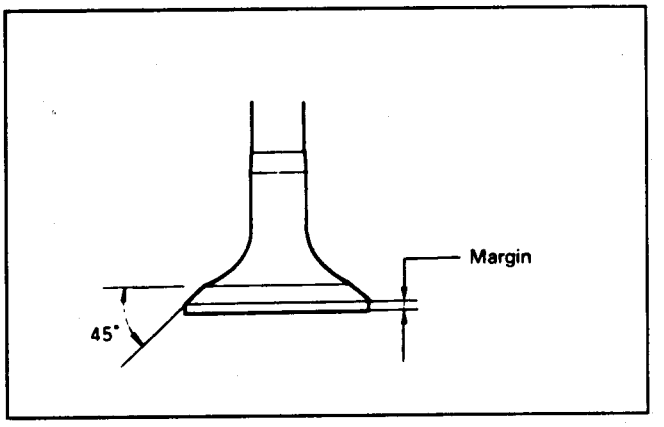


Figure 65

Valve Seats

1. Check the valve seats for damage and indications of incorrect contact (Fig. 66).

Maximum valve sinkage: 1.5 mm (0.06 in.)

2. The valve seat can be resurfaced (Fig. 67). Resurface the valve seat so it contacts the mid-portion of the valve face.

3. After cutting new valve seats, use lapping compound to lap the valve to the seat. After lapping, thoroughly clean the valve seat and valve areas to remove any traces of lapping compound.

4. Put a light coat of Prussion blue dye on the valve seat area. Install the valve. Hold the valve down and rotate it 1/4 turn, then turn the valve back to the original position. Remove the valve and examine the valve seat. The valve seat should show an even wear pattern from contact with the valve. Examine the valve. The dye should be evenly distributed around the valve and in the center of the valve face.

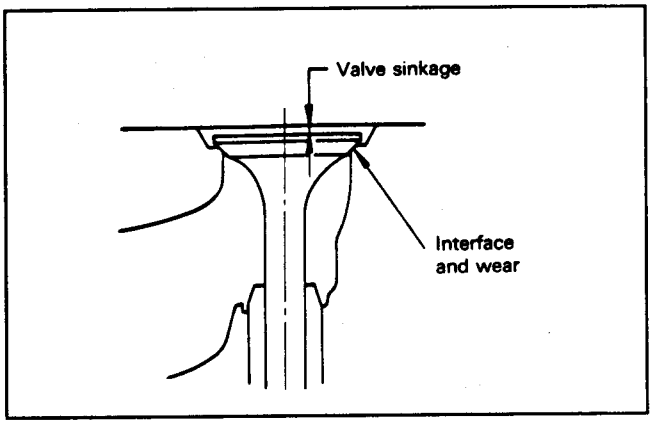


Figure 66

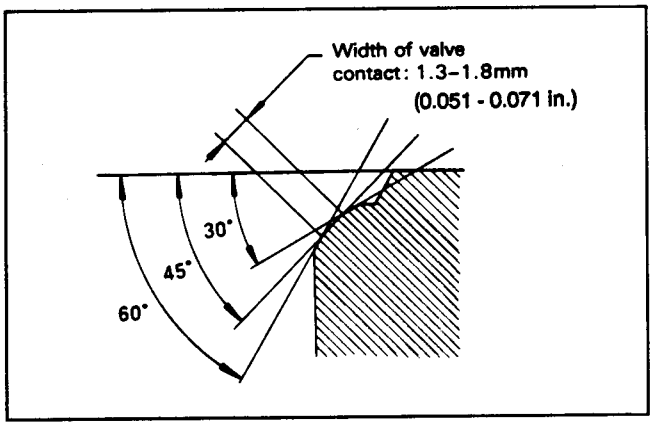


Figure 67

Valve Springs

1. Check the valve springs for rust, pitting, cracks or other damage.

2. Check the squareness of the valve spring by putting it upright on a level surface. Any spring that is 3° or more out of square must be replaced.

3. Measure the spring free length. Any spring that has a free length of 39.3 mm (1.55 in.) or less must be replaced.

4. Over a period of time, valve springs can lose some of their tension. The spring must be replaced if the tension is less than the service limit. (Fig. 68)

Minimum Installed Load/Height

(IN) 5.05 kg / 35.5 mm (11 lb. / 1.4 in.)
(EX) 12.61 kg / 28 mm (27 lb. / 1.1 in.)

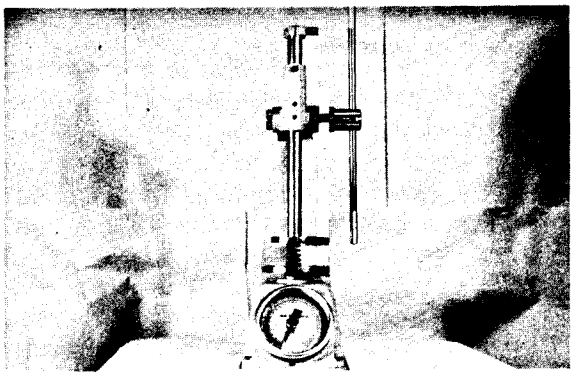


Figure 68

Rocker Arm and Rocker Shaft

1. Remove the snap ring on each end of the rocker shaft. Remove the rocker arm stay bolts. Remove rocker arm stays, spring and rocker arms from the shaft (Fig. 69).

2. Inspect each rocker arm for wear at the valve tip and push rod contact surfaces. Replace any worn or damaged rocker arms.

3. Inspect the rocker shaft for wear or damage. Replace the rocker shaft if it is worn or damaged.

4. Measure the rocker arm inside diameter and the shaft outside diameter. Replace the shaft if the rocker arm to shaft clearance is more than 0.02 mm (0.008 in.).

5. Make sure the oil passages in the rocker shaft and rocker arms are open. Clean if necessary.

IMPORTANT: When assembling the rocker assembly, make sure the identification mark (small drilled hole near the end of the shaft) is at the front and facing the valve side.

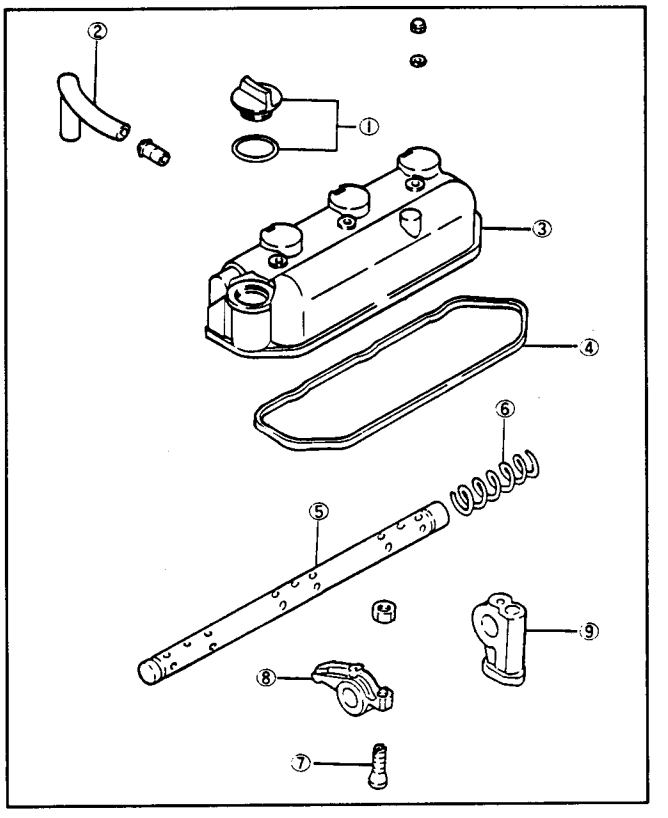


Figure 69

1. Oil filler cap
2. Breather hose
3. Rocker cover
4. Rocker cover gasket
5. Rocker shaft
6. Rocker spring
7. Adjusting screw
8. Rocker arm
9. Rocker stay

Cylinder Head Assembly and Installation

1. Install the thermostat housing. Use a new gasket.

2. Install the intake and exhaust manifolds. Use new gaskets.

3. Make sure the valve guides are properly installed (Fig. 64).

4. Install new valve stem seals onto the valve guides (Fig. 70). DO NOT install used seals.

5. Apply a coating of oil to the valve stems and insert them in proper order, into the valve guides. Install the valve springs and valve retainers. Compress the spring with a valve lifter, then install the retainer lock.

IMPORTANT: Be careful not to damage the spring and stem seal by over compressing the spring during installation.

6. Install the nozzle holders in the cylinder head and tighten to a torque of 5.0 - 6.0 KgM (36 - 43 ft-lb).

7. Install the glow plugs in the cylinder head and tighten to a torque of 5.0 - 6.0 KgM (36 - 43 ft-lb).

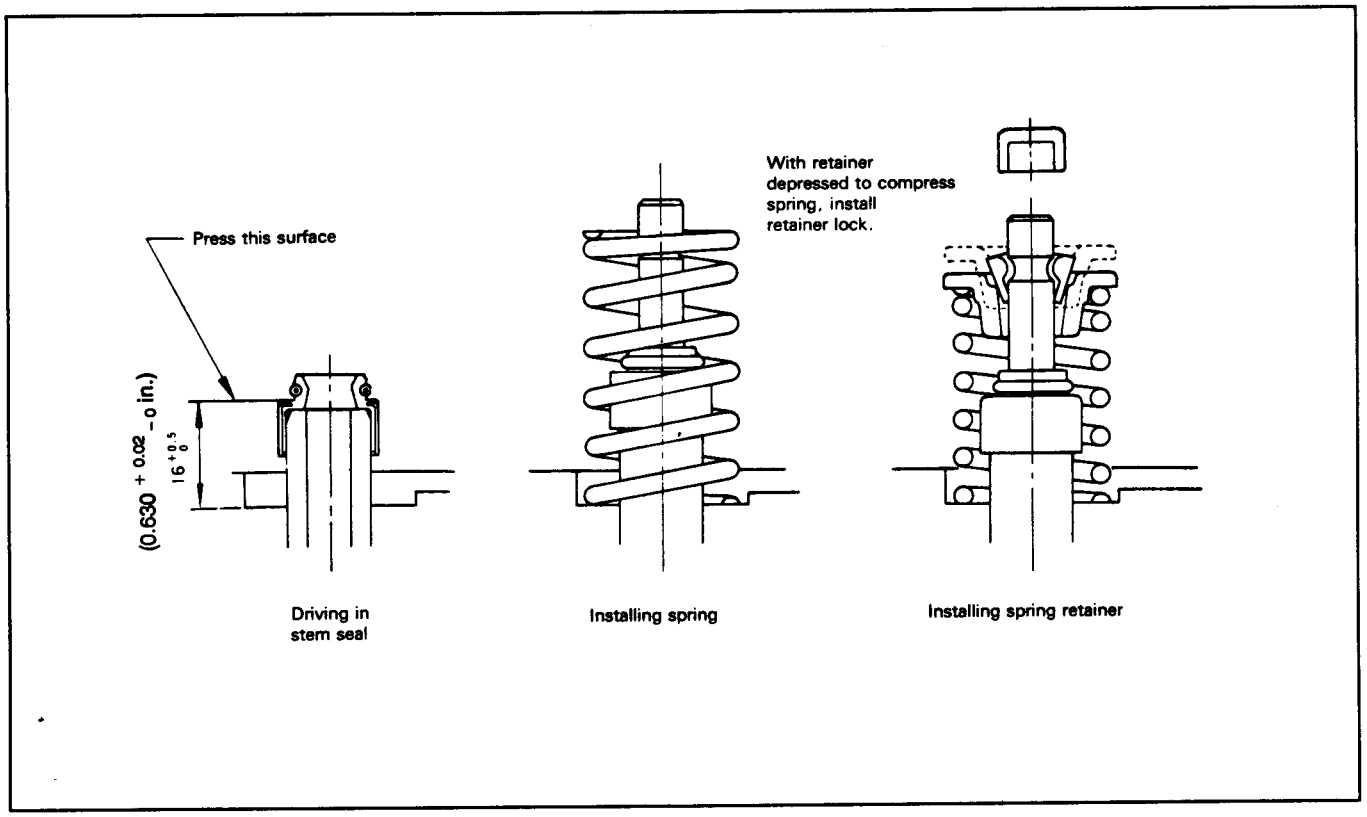


Figure 70

8. Make sure that the cylinder head and cylinder block surfaces are clean. Put a new gasket on the cylinder head. Insert dowel pins into two cylinder head bolt holes to assist in mounting the head onto the block. Carefully put the cylinder head into position on the cylinder block. Remove the dowel pins. Insert the cylinder head bolts.

IMPORTANT: Do not put any sealant on the cylinder head gasket.

9. Tighten the cylinder head bolts in the order shown in Figure 71. Tighten the bolts to approximately one-third the specified torque, then two-thirds and finally to the final specified torque.

M10 head bolt torque: 7.5 - 8.5 KgM (54 - 62 ft-lb)
M8 head bolt torque: 2.0 - 3.0 KgM (15 - 22 ft-lb)

10. Install the fuel return pipe. Install the fuel delivery pipes. When tightening the nut on each end of the pipe hold the delivery valve holder or nozzle holder with a wrench to prevent turning.

11. Apply engine oil to the inside surface of the rocker arm bushings. Install the rocker arms, spring and rocker arm stays on the rocker shaft. Install the rocker shaft so the identification mark (small drilled hole near the end of the shaft) is at the front and facing the valve side. Install the bolts through each stay and into the shaft. Install the snap ring on each end of the shaft.

12. Install the rocker arm and shaft assembly on the cylinder head. Tighten the rocker arm stay bolts to a torque of 1.5 - 2.2 KgM (11 - 16 ft-lb)

13. Adjust the valve clearance. (See Checking and Adjusting Valve Clearance in the Maintenance section of this chapter.)

14. Install the rocker cover and gasket. Install the breather hose to the rocker cover and intake manifold.

15. Install the glow plug lead wires.

16. Install the alternator.

17. Install the muffler.

18. Install the upper radiator hose and tighten the hose clamps. Install the coolant bypass hose to the thermostat housing and tighten the hose clamps.

19. Fill the cooling system with a 50/50 solution of ethylene glycol antifreeze and clean, soft water (see Checking Cooling System in the Maintenance section of this chapter). Check for oil and coolant leaks and repair as necessary.

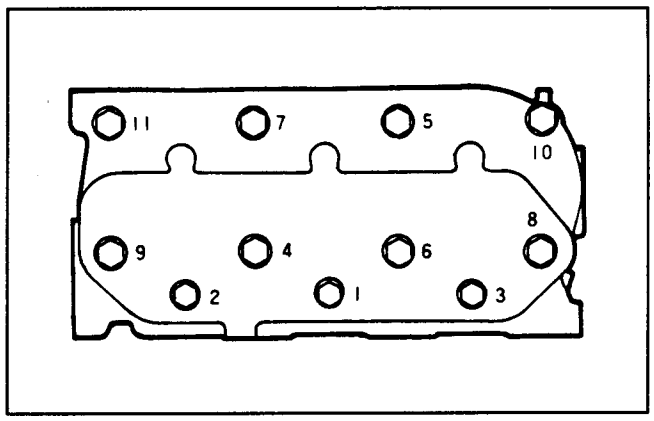


Figure 71

Cylinder Block Overhaul

NOTE: The engine must be removed from the traction unit chassis and put in an engine stand. (See the Removing and Installing The Engine section of this chapter.)

Gear Case and Oil Pump

1. Remove the crankshaft pulley.

2. Remove the fuel injection pump. (See Injection Pump Service in the Fuel System Repairs section of this chapter.)

3. Disconnect the governor spring from the tension lever. Remove the governor cover assembly from the gear case. (See the Governor System Repairs section of this chapter.)

4. Remove the water pump. (See Water Pump Service in the External Engine Component Repair section of this chapter.)

5. Remove the alternator. (See Alternator Removal and Installation in the External Engine Component Repair section of this chapter.)

6. Remove the gear case assembly (Fig. 72).

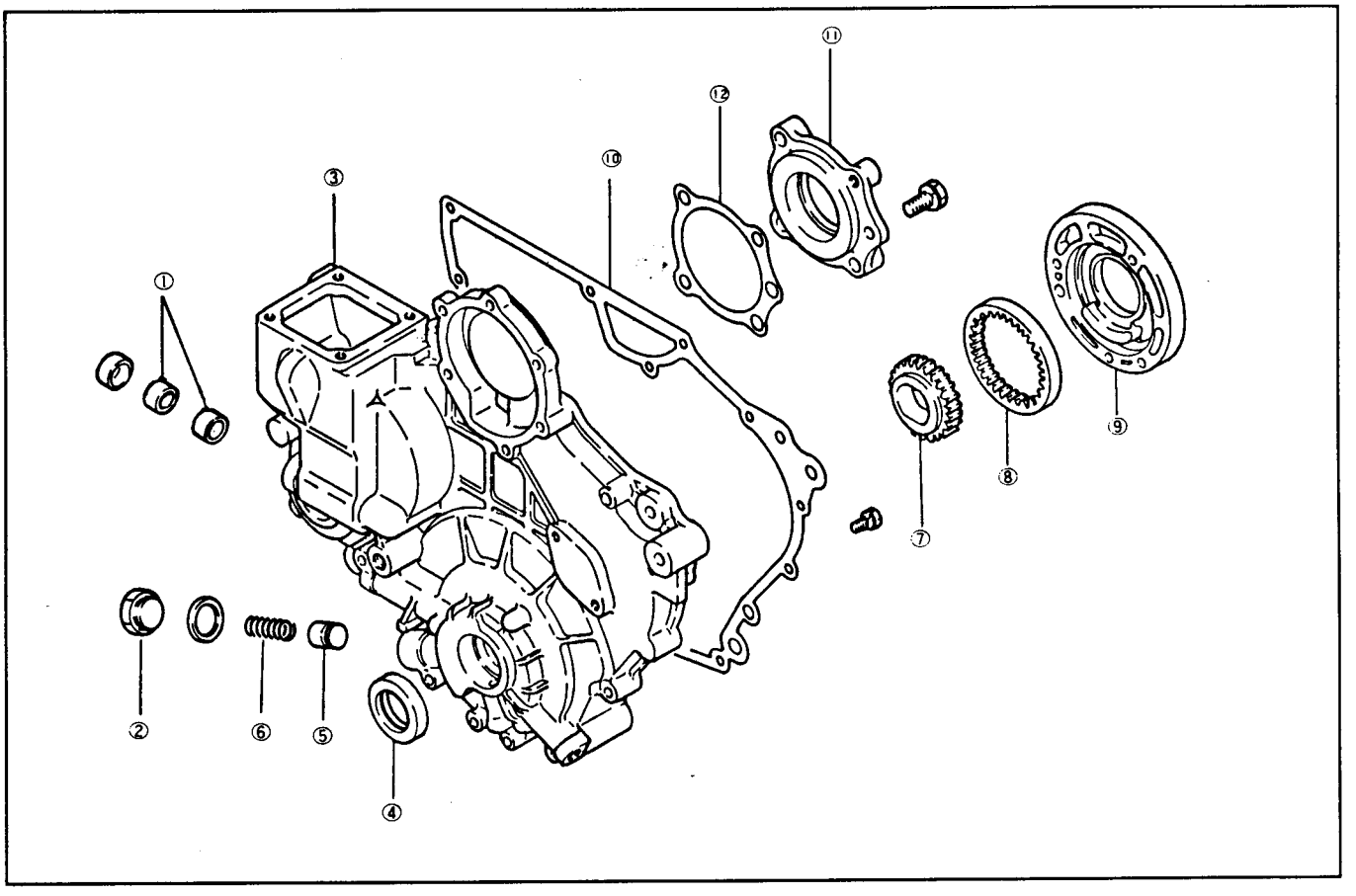


Figure 72

1. Bushings
2. Plug
3. Gear case
4. Front oil seal
5. Relief plunger
6. Relief spring
7. Oil pump inner gear
8. Oil pump outer gear
9. Oil pump housing
10. Gear case gasket
11. High pressure pump gear housing
12. Housing gasket

7. Check removed parts for wear or damage (Fig. 73).
Replace parts as necessary.

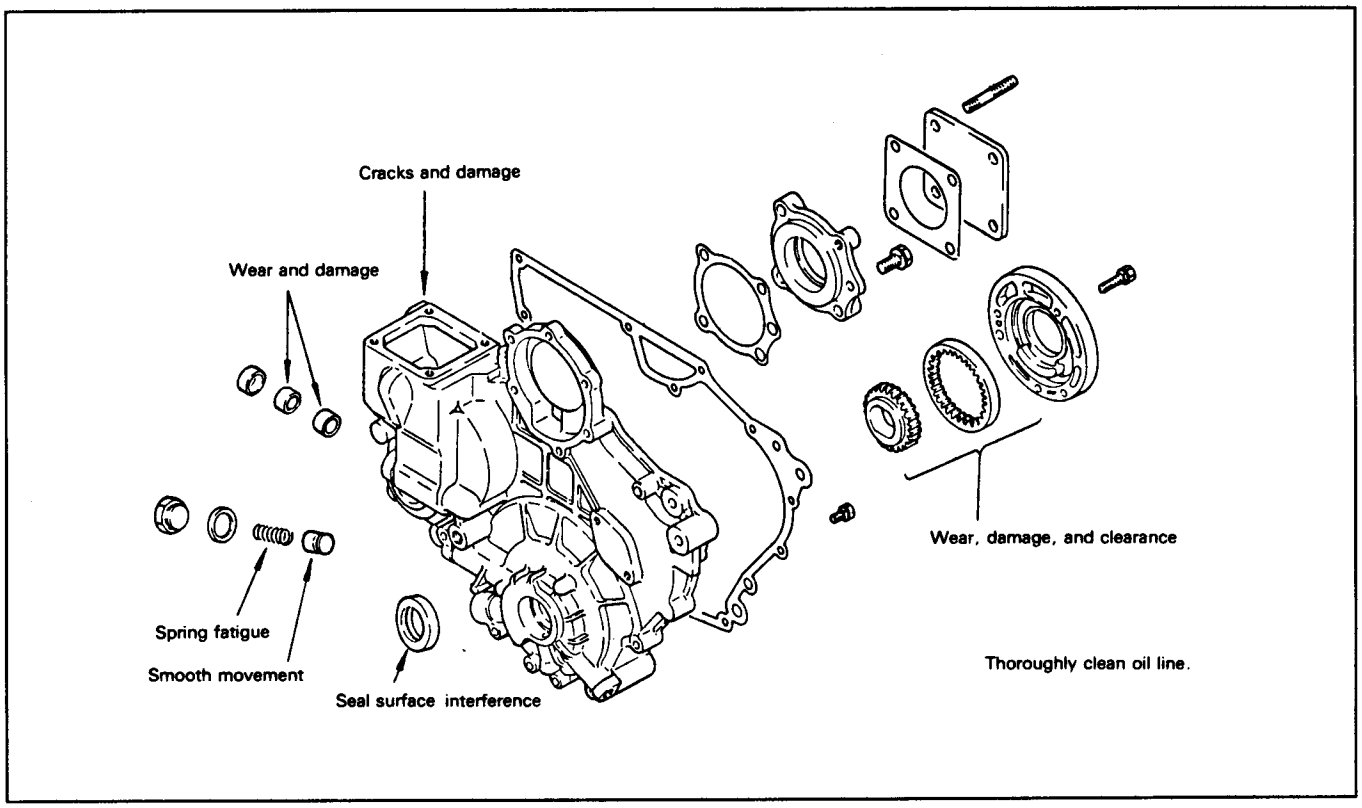


Figure 73

8. Check the governor parts for wear or damage (Fig 74). Replace parts as necessary.

A. Remove the expansion plug (Fig 75). Be careful to not scratch the gear case.

B. Pull out the grooved pin.

C. Remove the shaft, spring and levers.

D. If necessary replace the governor bushings (Fig. 76).

E. Install the shaft, spring and levers. Press fit the expansion plug into the hole in the gear case.

9. Reverse steps 1 - 6 to reassemble the gear case. Use new gaskets when assembling the gear case.

IMPORTANT: Install a new front oil seal before installing the gear case. Apply a thin coat of oil to the circumference and lip of the oil seal.

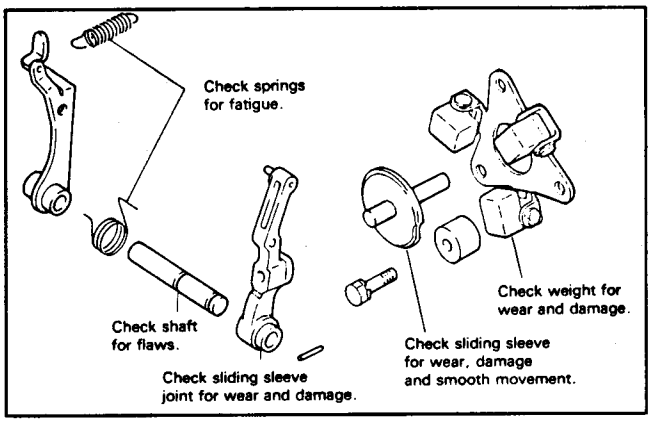


Figure 74

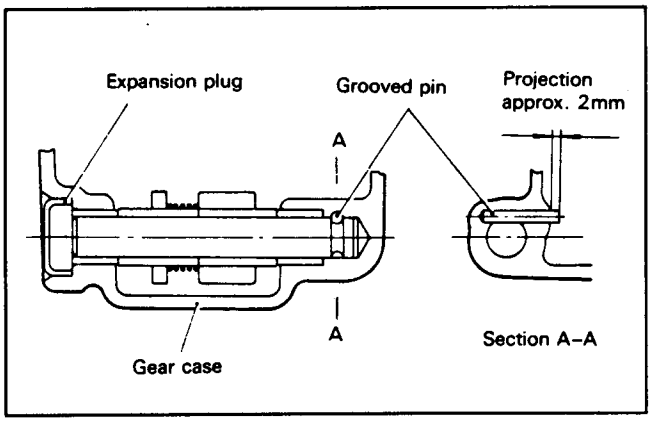


Figure 75

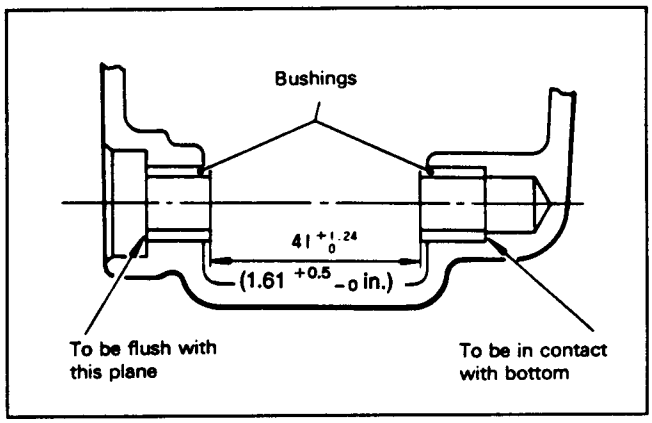


Figure 76

Timing Gears and Camshafts

1. Remove the cylinder head (see Cylinder Head Removal in the Cylinder Head Overhaul section of this chapter).

2. Remove the gear case (see Gear Case and Oil Pump in this section).

3. Remove the snap ring and remove the idle gear (Fig. 77).

4. To remove the injection pump camshaft:

   A. Remove the governor weight assembly (Fig. 33).

   B. Remove camshaft rear cover.

   C. Remove the stopper bolt (Fig. 78).

   D. Pull out the camshaft from the front of the cylinder block.

5. To remove the valve camshaft:

   A. Pull the push rods and tappets out of the cylinder block.

   B. Remove the camshaft stopper bolt.

   C. Pull the camshaft out of the cylinder block (Fig 79).

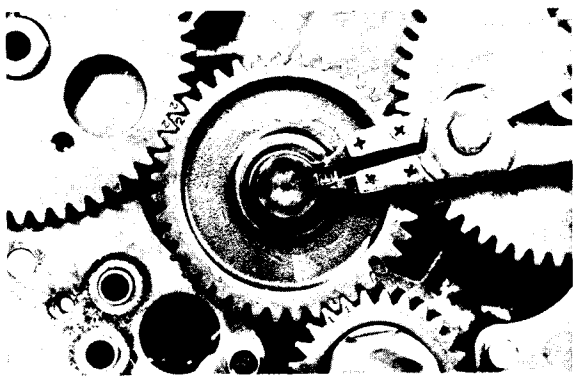


Figure 77

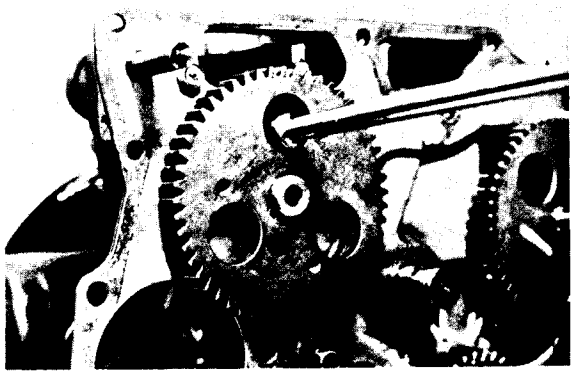


Figure 78

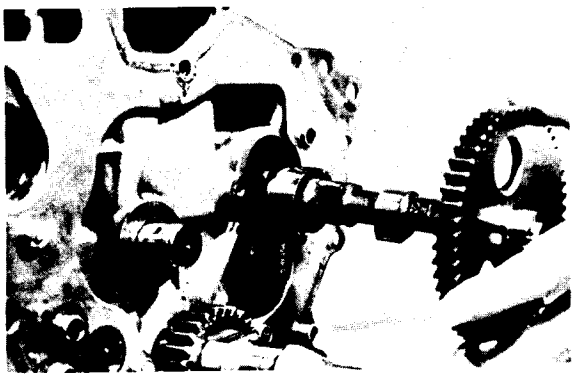


Figure 79

6. Check the gears for incorrect tooth contact, wear and damage. Replace any gears that are badly worn or damaged.

Maximum idle gear bushing to shaft clearance:
0.2 mm (0.008 in.)

Maximum backlash between gears in mesh:
0.3 mm (0.012 in.)

7. Inspect the camshaft parts (Fig. 80). Replace any parts that are worn or damaged.

Major diameter of cam:
Injection pump cam: 29.3 - 30 mm (1.154 - 1.181 in.)
Valve cam: 26.37 - 27.37 mm (1.038 - 1.078 in.)

Push rod bend: within 0.3 mm (0.012 in.)

Tappet to cylinder block hole clearance:
0.15 mm (0.006 in.) maximum

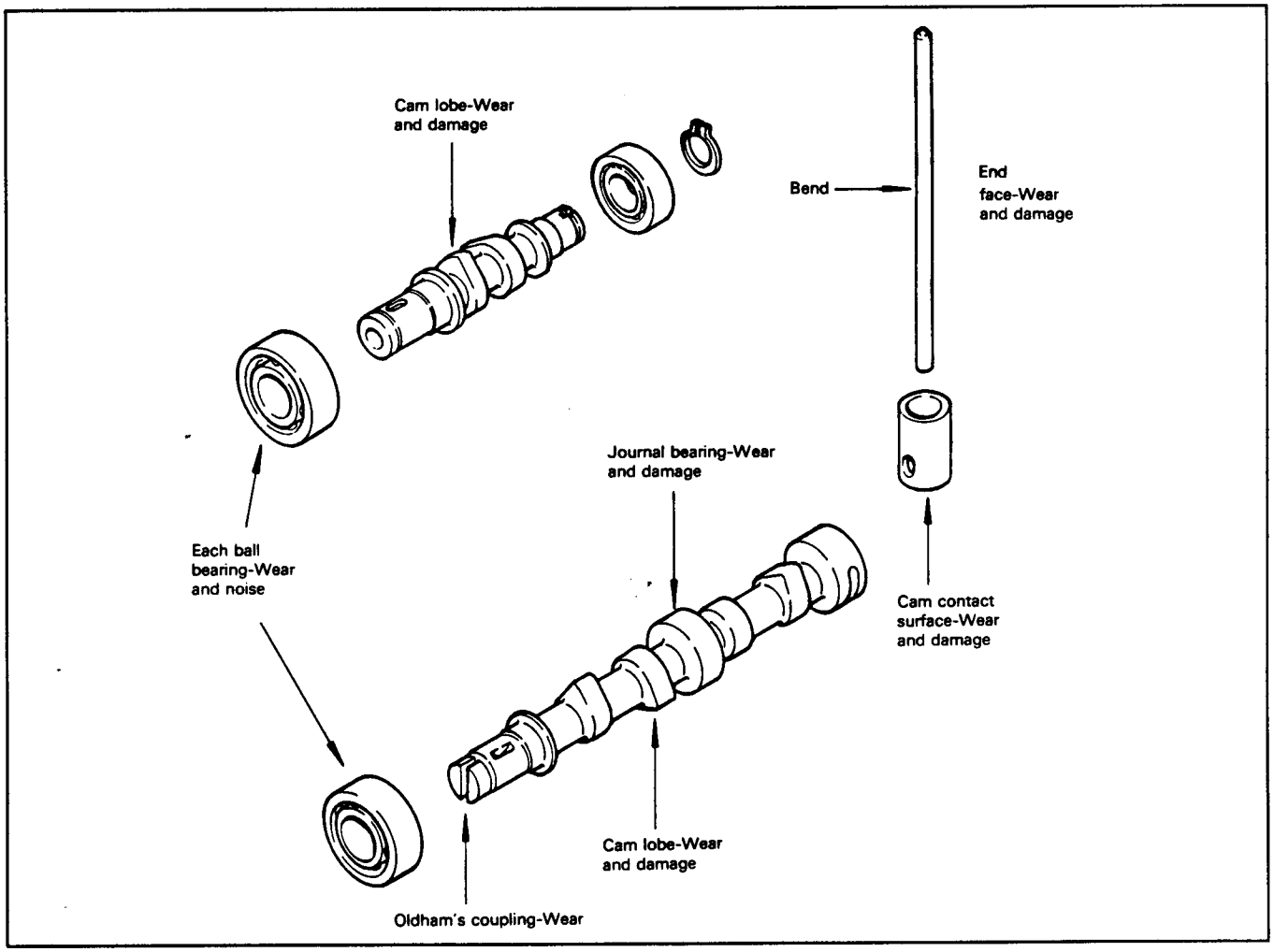


Figure 80

8. Before installing the camshafts and timing gears, turn the crankshaft to set the No. 1 cylinder to top dead center (TDC) of the compression stroke. Reverse steps 1 - 5 to install the camshafts and timing gears (Fig. 81).

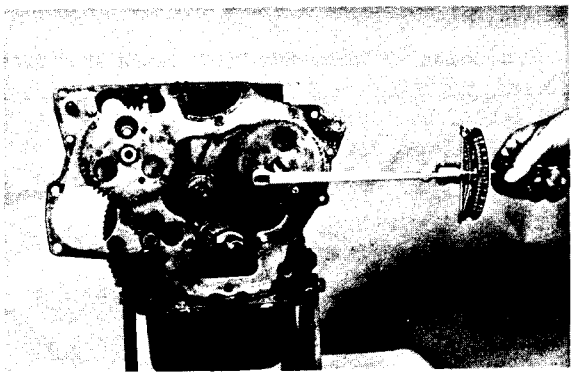


Figure 81

9. With the crankshaft set to No. 1 cylinder TDC, install the idle gear so the timing marks on all the gears are in alignment (Fig. 82).

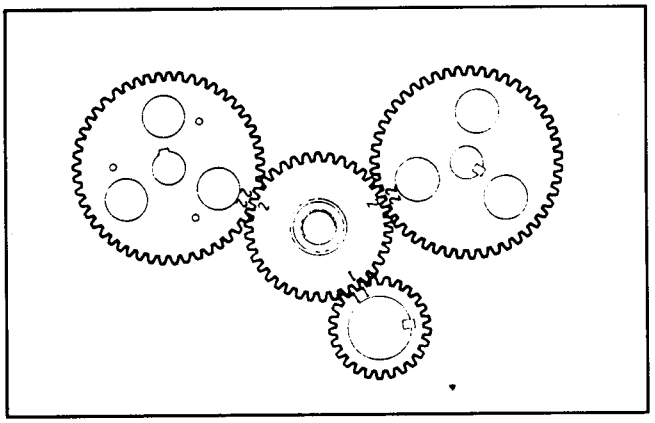


Figure 82

Piston and Connecting Rod

1. Remove the cylinder head (see Cylinder Head Removal in the Cylinder Head Overhaul section of this chapter).

2. Remove the oil pan and gasket.

3. Remove the oil screen

NOTE: Before removing the pistons, mark the number of the cylinder onto the top of each piston and on the side face of each connecting rod (on the large end). When the piston and connecting rod is removed be careful to prevent damage to the piston or bearing surfaces.

4. Use a ridge removing tool to remove the ring ridge from each cylinders. This will prevent damage to the rings and pistons.

5. Remove the connecting rod end caps and bearings (Fig 83). Keep these parts in cylinder number order so they can be reinstalled in the same cylinder. Use a wood block to push the pistons and connecting rods up out from the bottom of the block. Take care not to scratch the crankshaft pin and cylinder.

6. Check each piston for wear, signs of seizure or nicks. Replace the piston if it is damaged.

7. Thoroughly clean the carbon deposits from the piston and ring grooves. A ring groove cleaner, or piece of discarded ring may be used to clean the ring grooves.

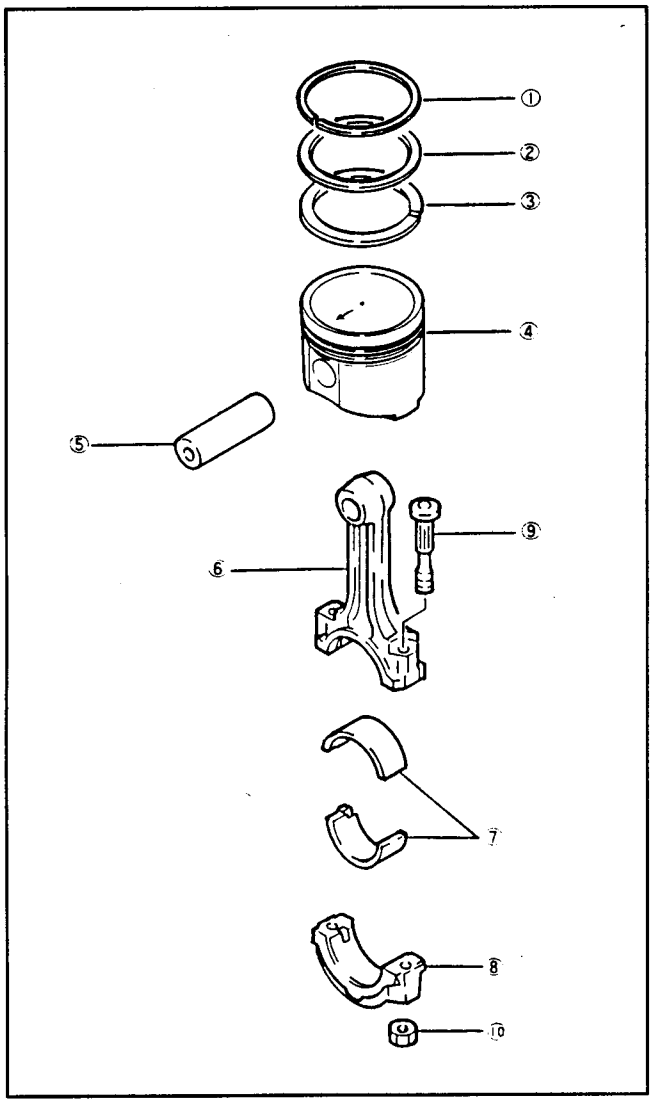


Figure 83

1. Piston ring No. 1
2. Piston ring No. 2
3. Oil ring
4. Piston
5. Piston pin
6. Connecting rod
7. Connecting rod bearing
8. Connecting rod cap
9. Connecting rod bolt
10. Connecting rod nut

8. Measure the piston outside diameter (Fig. 84). (See Cylinder Block in this section).

Maximum piston to cylinder wall clearance:
0.3 mm (0.012 in.)

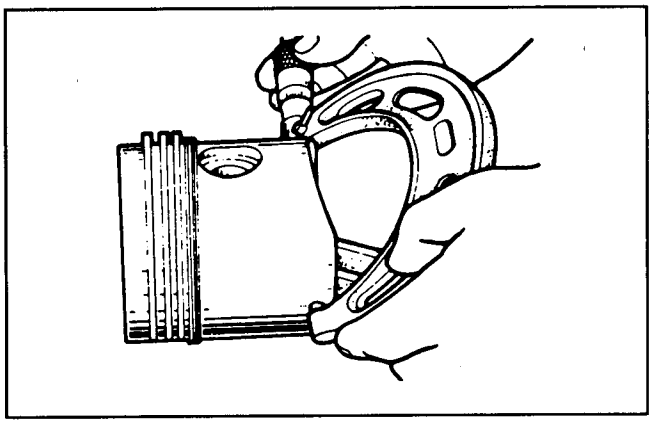


Figure 84

9. Use a thickness gauge to check the piston ring side clearance (Fig. 85).

If the piston ring side clearance exceeds the service limit, the ring must be replaced. If the clearance still does not meet specifications with a new ring the piston must be replaced. (See the Specifications section of this chapter.)

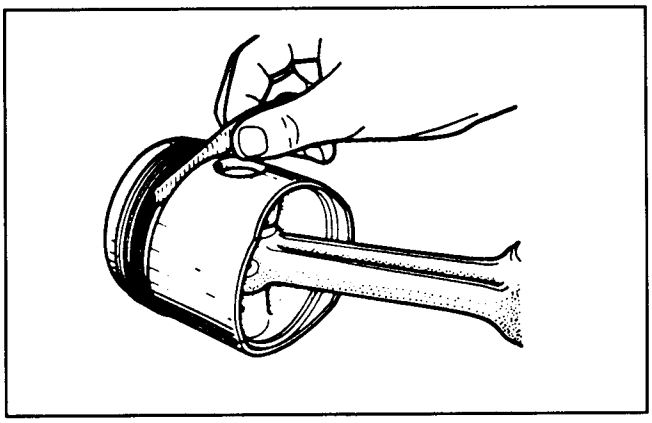


Figure 85

10. Measure the piston ring end gap. Insert the ring into the least worn area of the cylinder by pushing it into place with the piston (Fig. 86). If the gap exceeds 1.5 mm (0.060 in.) the ring must be replaced.

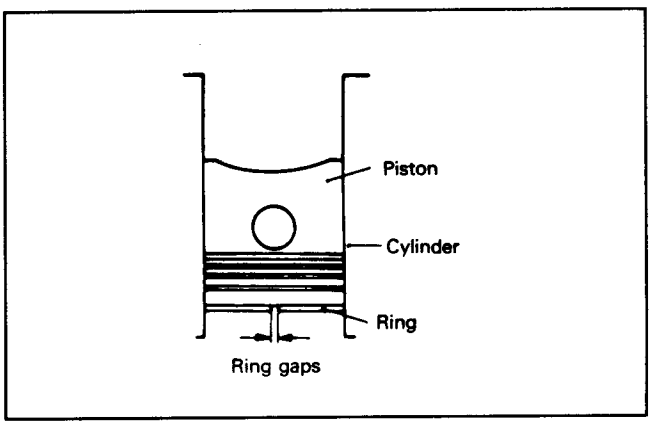


Figure 86

11. To remove the piston from the connecting rod press the piston pin from each piston. Use the piston setting tool (Fig. 87).

IMPORTANT: Do not attempt to remove the piston pins by driving then out with a hammer. A stuck piston pin, requiring excessive pressure to remove, should be replaced. Standard pin removal force is 500 - 1500 kg (1100 - 3300 lb.).

CAUTION

Do not put a load of more than 3000 kg (6600 lb.) on the piston pin setting tool.

12. Check for bending or distortion of the connecting rod. The service limit for bend and distortion is 0.15 mm (0.006 in.). Replace the connecting rod if damaged or out of specification.

13. To assemble the piston to the connecting rod, press the piston pin into the set position. Use the piston pin setting tool (Fig. 88). Make sure the identification mark of the rod and the arrow mark on the piston head are directed up.

Pin press fitting force: 500 - 1500 kg (1100 - 3300 lb.)

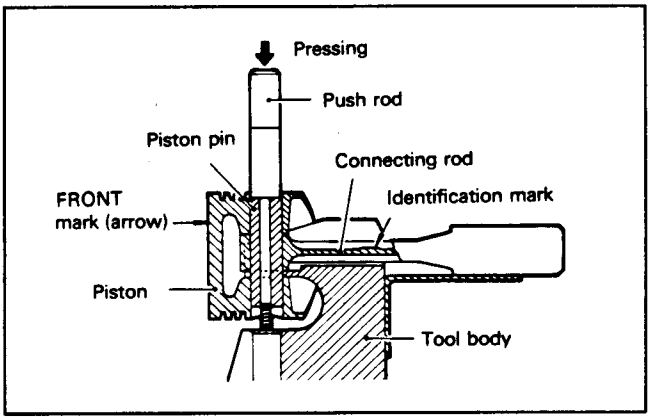


Figure 87

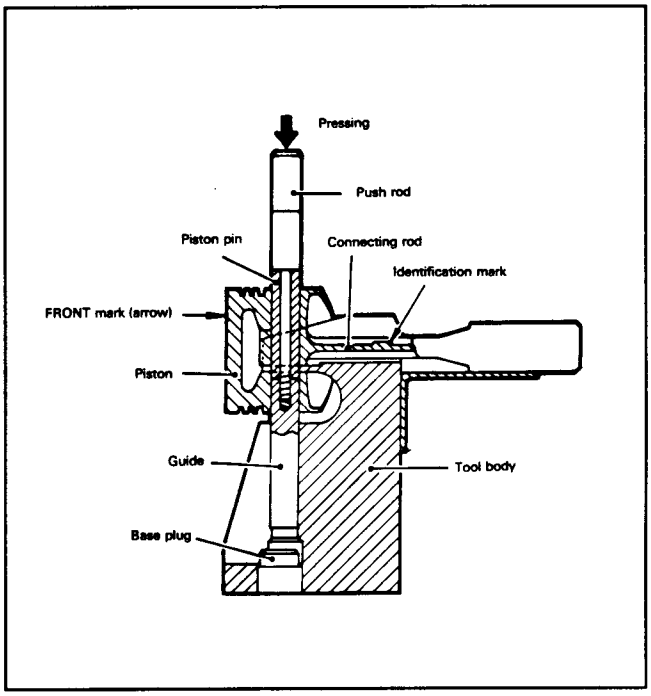


Figure 88

14. Assemble each connecting rod and bearing to the crankshaft in proper order. Use a feeler gauge to measure the side clearance between the connecting rod end and crankshaft (Fig. 89). Replace the connecting rod assembloy if the side clearance is more than the specified amount.

Maximum connecting rod side clearance: 0.5 mm (0.02 in.)

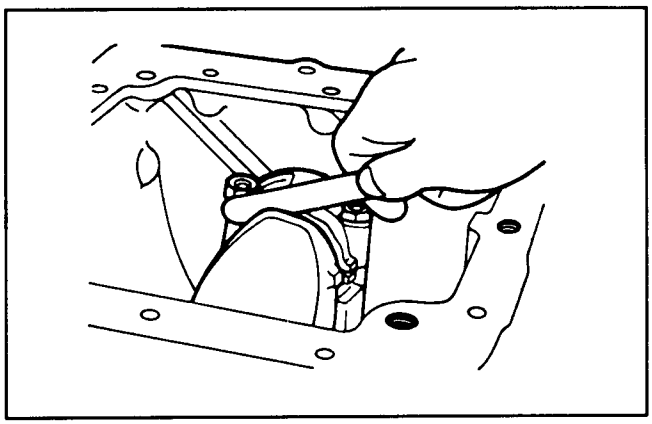


Figure 89

15.Install the piston rings. Each piston ring has different shape. Make sure they are installed in the proper position and with the ring gaps in the directions as illustrated (Fig. 90).

16. Insert the piston and connecting rod assembly into the cylinder block using a ring compressor and a wooden block. Make sure the arrow mark on top of the piston is facing toward the front of the engine.

17. Install the connecting rod bearings and end caps. Make sure the notches on the bearings and connecting rod are aligned. Tighten the end cap retaining bolts to a torque of 3.2 - 3.5 KgM (23 - 25 ft-lb).

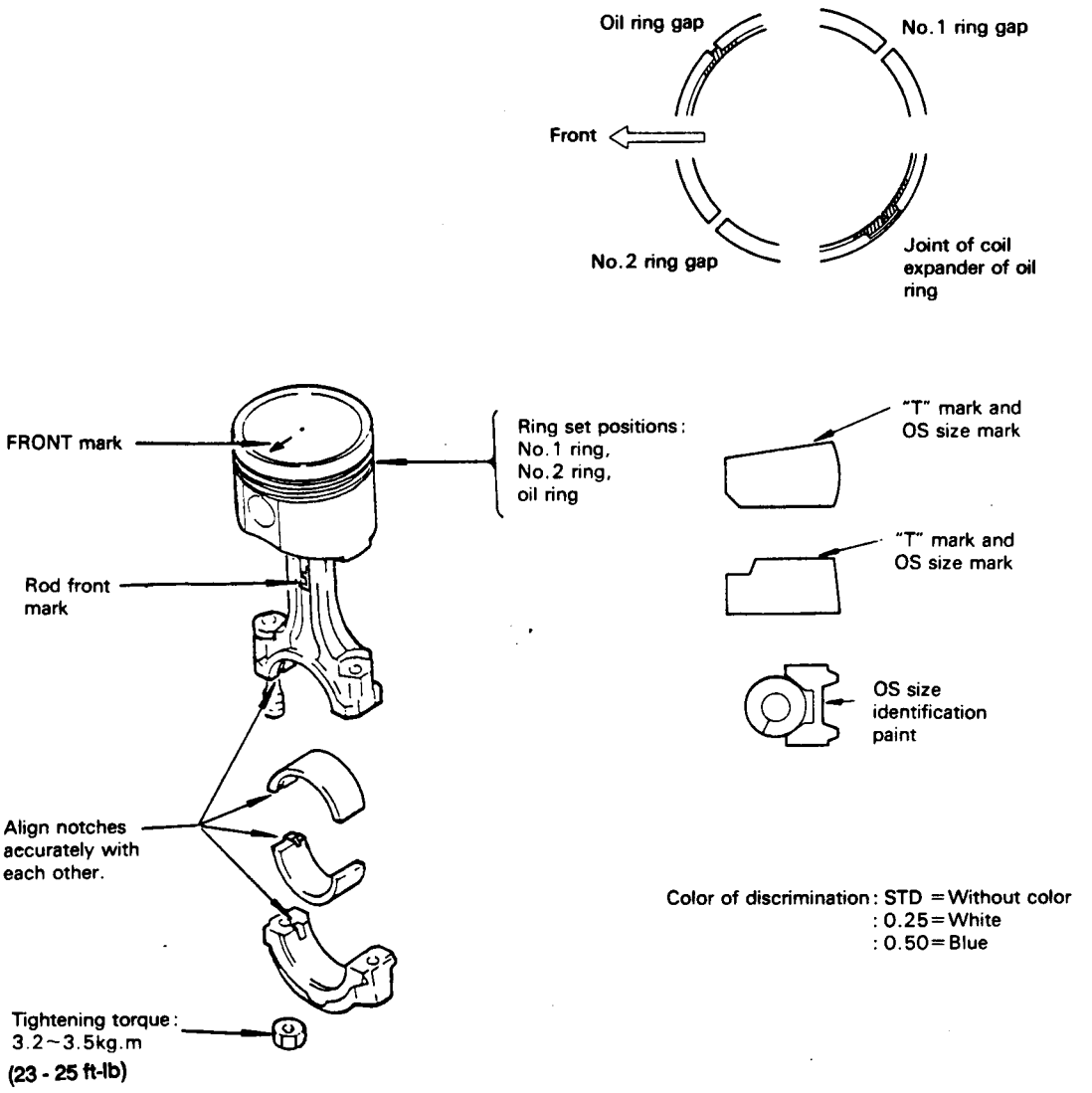


Figure 90

Crankshaft

1. Perform steps 1 - 5 under Piston and Connecting Rod in this section.

2. Remove the flywheel.

3. Remove the rear oil seal case.

4. Remove the main bearing caps (Fig. 91). Keep each set of bearings together with its bearing cap.

5. Remove the crankshaft.

6. Inspect the removed parts. Repair or replace any worn or damaged parts (Fig. 92).

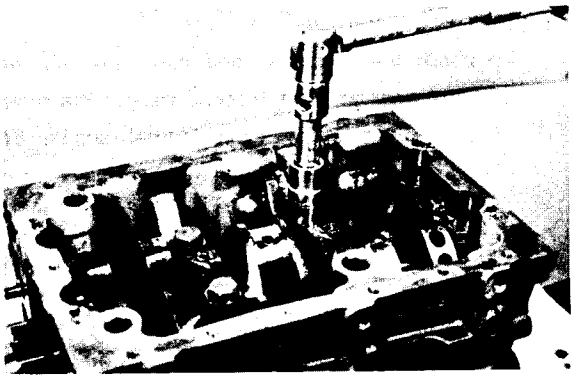


Figure 91

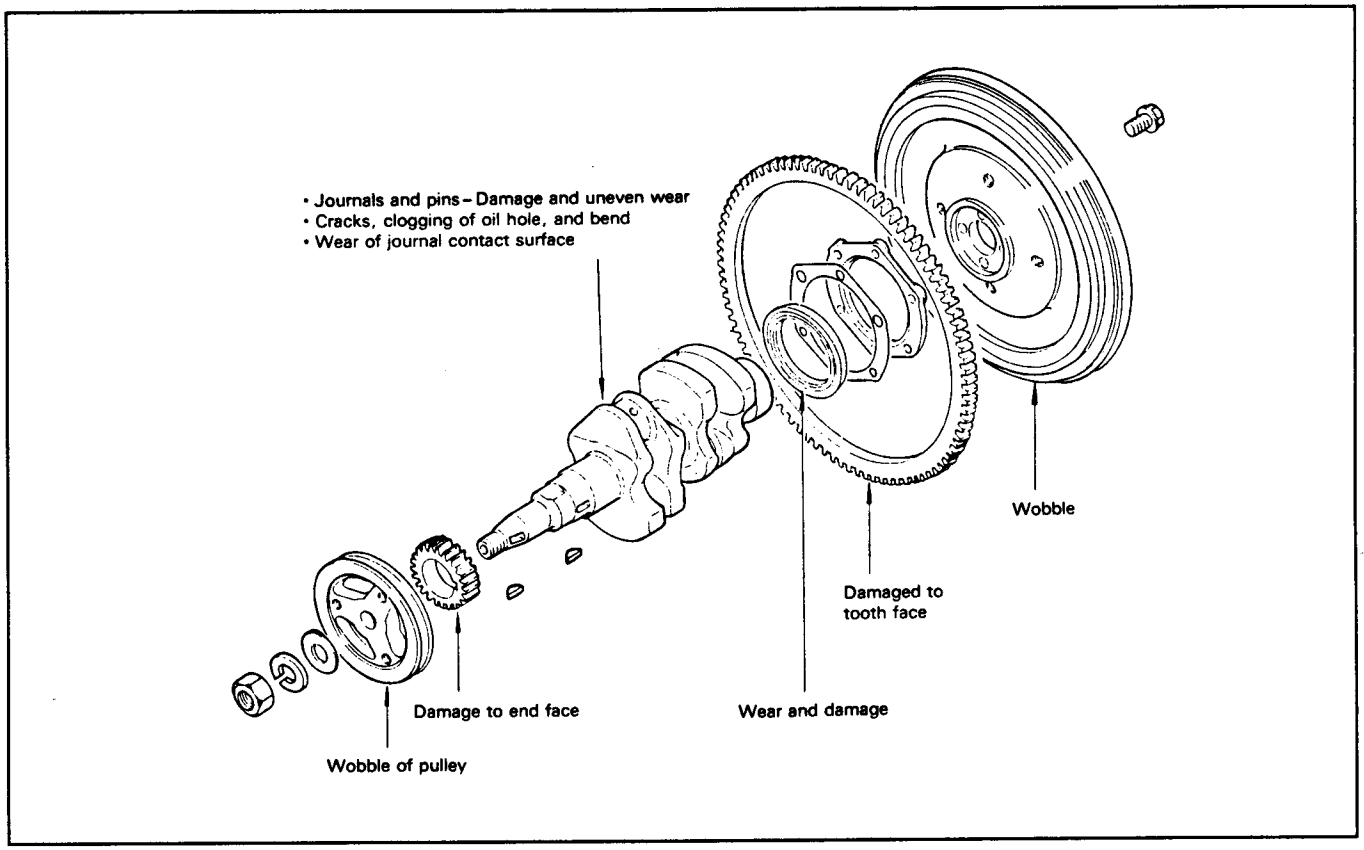


Figure 92

6. Measure the crankshaft for "run-out" (bend). Mount the crankshaft in a pair of V-blocks (or live centers) and use a dial indicator to measure the run-out in the crankshaft (Fig. 103). The maximum allowable crankshaft run-out is 0.05 mm (0.002 in.).

7. Check the crank journals and crankpins for damage, out of round wear or tapering wear. The diameter of each crankpin or main journal should be measured at two places, "1" and "2", in two directions, "A" and "B" (Fig. 104).

Main journal diameter: 42.3 mm (1.665 in.) minimum
Crankpin diameter: 39.3 mm (1.547 in.) minimum

8. Check the crankshaft oil clearance. Oil clearance is calculated by subtracting the diameter of the main journal or crankpin from the inside diameter of the main bearing or rod bearing. The inside diameter of each crankpin or main journal should be measured at two places, "1" and "2", in two directions, "A" and "B" (Fig. 105) after the bearing cap is installed at the proper torque. If the oil clearance exceeds the service limits, install a new bearing. If installing the new bearing does not reduce the clearance to within service limits, the crankshaft must be reground and oversize bearings installed.

Tightening Torque:
Main bearing cap bolt 5.0 - 5.5 KgM (23 - 25 ft-lb)
Rod bearing cap nut 3.2 - 3.5 KgM (36 - 40 ft-lb)

Crankpin oil clearance: 0.15 mm (0.006 in.)
Journal oil clearance: 0.10 mm (0.004 in.)

NOTE: If using Plastigauge to measure the oil clearance, put a piece of Plastigauge onto the crankpin or journal, and tighten the bearing cap (with bearing) in place. DO NOT rotate connecting rod or crankshaft when the Plastigauge is in place. Rotating will destroy the Plastigauge. Remove the bearing cap and measure the width of the Plastigauge to determine the clearance. If the oil clearance exceeds the service limits, install a new bearing. If installing the new bearing does not reduce the clearance to within service limits, the crankshaft must be reground and oversize bearings installed.

9. To install a new oil seal, pry the seal out with a screwdriver and drive a new seal into the oil seal case.

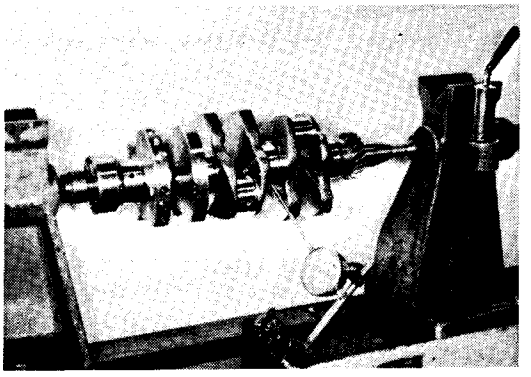


Figure 93

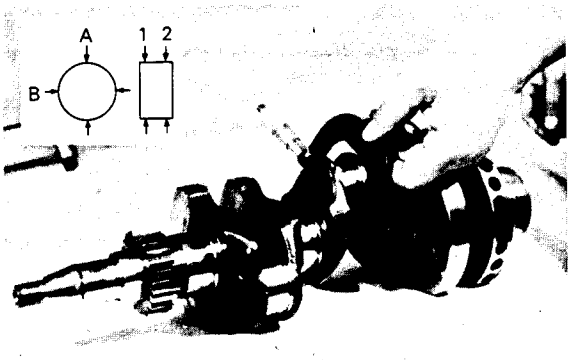


Figure 94

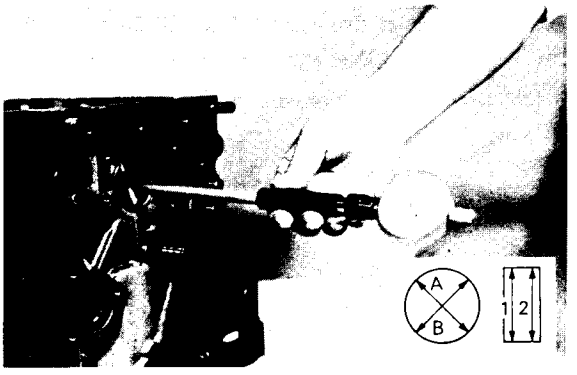


Figure 95

10. Reverse steps 1 - 5 to install the crankshaft (Fig. 97). When installing the No. 1 and No. 4 bearing caps, apply sealant (Permatex No. 2 or equivalent) to the upper surface that meets with the cylinder block.

11. Use a dial indicator to measure the crankshaft end play. If end play exceeds specifications, replace all the main bearings.

Crankshaft end play: 0.05 - 0.175 mm (0.002 - 0.007 in.)

12. Apply sealant (Permatex No. 2 or equivalent) to the outside surface of the side seals. Install the side seals with the radius towards the outside of the engine (Fig. 96).

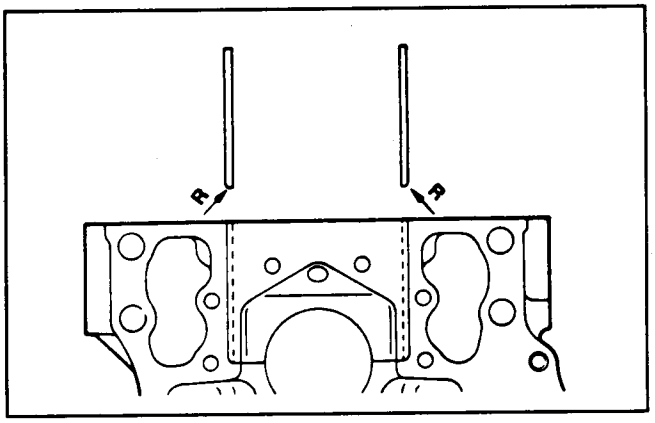


Figure 96

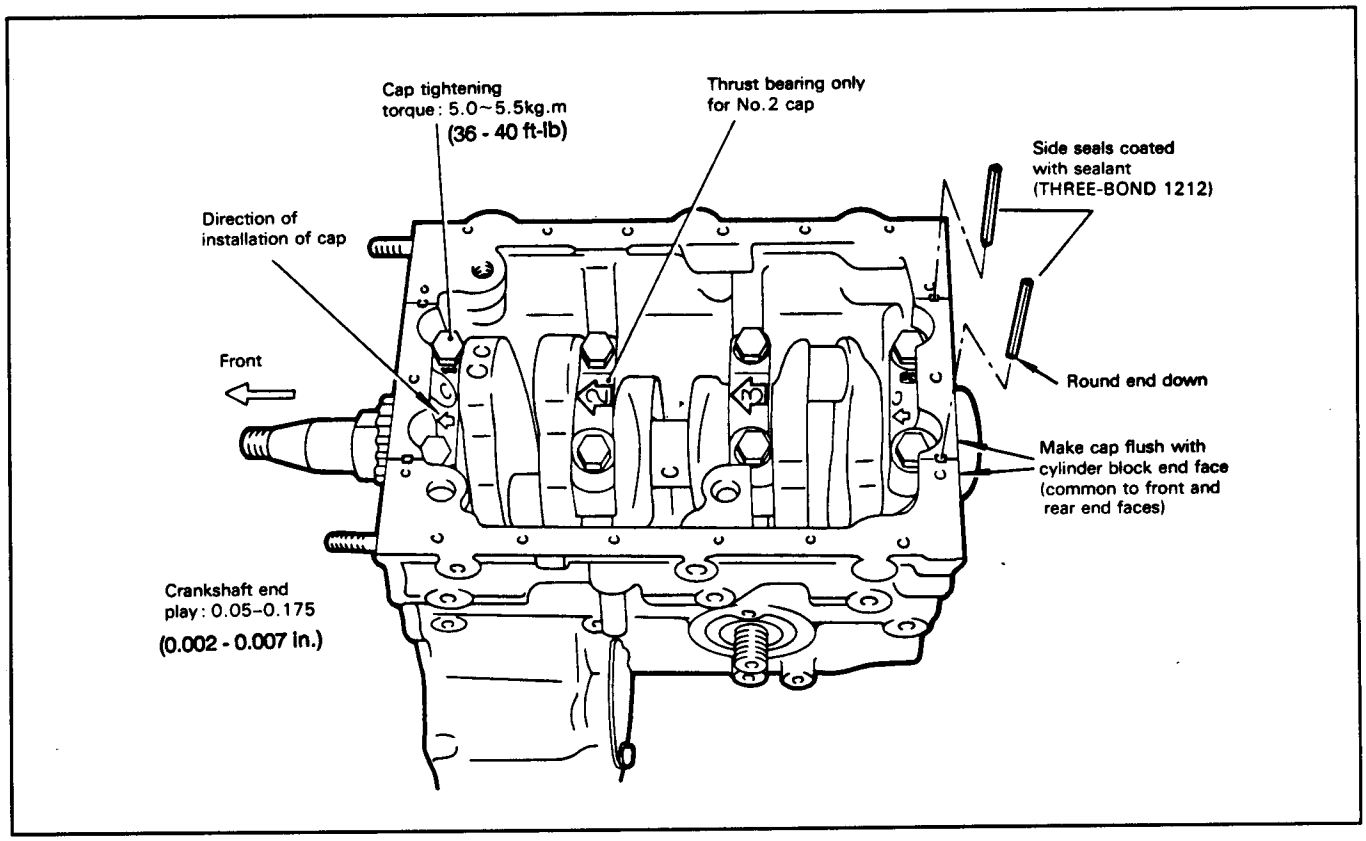


Figure 97

Cylinder Block

Before cleaning check the cylinder block for coolant leaks, oil leaks or damage. Clean all parts to remove dirt, oil, carbon deposits and water scale.

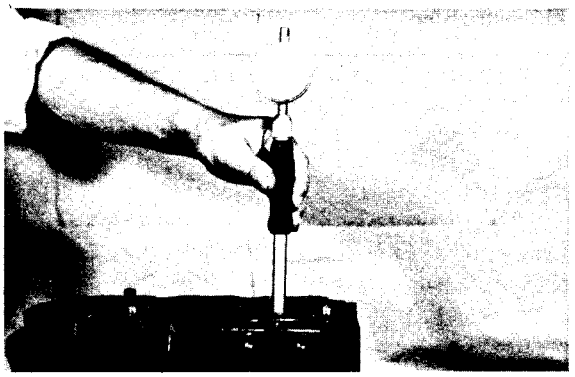
Check the cylinder block for cracks or other damage. Check the water jacket for water scale and rust. Replace the cylinder block if necessary.

Measure each cylinder bore size in six locations (Fig. 108). The standard bore diameter is 65 mm (2.559 in.). The cylinder must be rebored and over-sized piston and rings installed if the diameter exceeds the standard by 0.2 mm (0.008 in.). Examine the cylinder bore diameter readings to determine the amount of taper in the cylinder. If the taper exceeds 0.01 mm (0.0004 in.), the cylinder must be rebored and oversized piston and rings installed.

IMPORTANT: If one cylinder is rebored, all cylinders must be rebored to the same specifications.

NOTE: See the Specifications section of this chapter for oversize finishing sizes. After machining, install the piston and piston rings corresponding to the reworked cylinder size.

NOTE: When the cylinder bore is worn a small amount and the only the piston rings require replacement, check for groove wear in the upper part of the cylinder. Hone the cylinder if necessary.



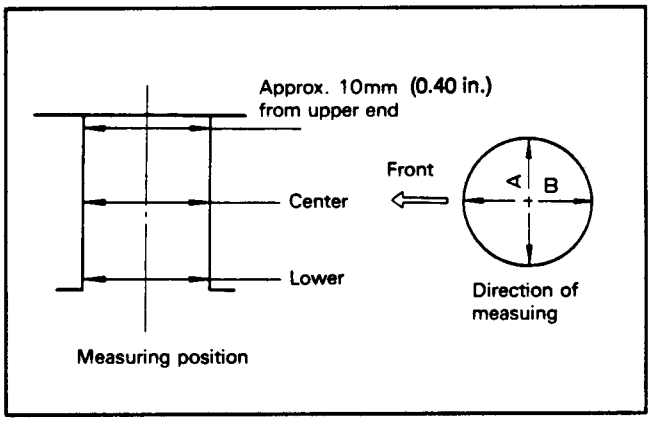


Figure 98

Reboring Cylinder

1. Select a piston:

   0.25, 0.50 mm (0.01, 0.02 in.) oversize

2. Measure the piston diameter (Fig. 84).

3. Reboring finish dimension = (Piston O.D.) + (Clearance) – (Honing allowance).

   Clearance: 0.071 - 0.084 mm (0.0028 - 0.0033 in.)
   Honing allowance = 0.02 mm (0.0008 in.)

TORO

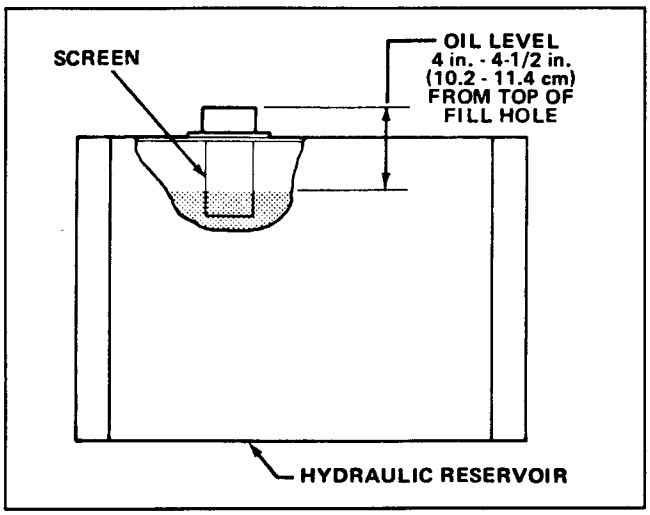
Chapter 5

Hydraulic System

Table of Contents

Specifications

Item	Description
Hydraulic Pump (Greensmaster 3000, Model 04350))	Webster, 4 section, external gear type
Hydraulic Pump (Greensmaster 3000-D, Model 04375) Steering relief pressure	Webster, 5 section, external gear type 850 psi
Wheel Motor (2) (Greensmaster 3000, Model 04350)	TRW Torqmotor, MAB Series, orbit rotor type
Wheel Motor (2) (Greensmaster 3000-D, Model 04375)	Nichols-Gray 110 Series, orbit rotor type
Reel Motor (3)	Webster YB Series, external gear type
Control Valve Main and No. 1 section port relief pressure No. 2 and 3 section port relief pressure No. 4 (traction) section port relief pressure: (Greensmaster 3000, Model 04350) (Greensmaster 3000-D, Model 04375)	Gresen V20, 5 spool sections 2000 psi 2000 psi 1350 psi 1850 psi
Power Steering Control (Greensmaster 3000-D, Model 04375 only)	Eaton Char-Lynn Steering Control Unit
Hydraulic Oil (Greensmaster 3000, Model 04350 and Greensmaster 3000-D, Model 04375, S/N 90001 & UP)	* Mobil DTE 26 or equivalent (red dye added at the factory)
Hydraulic Oil (Greensmaster 3000, Model 04350, S/N Thru 89999)	SAE 10W30 or 10W40 engine oil
Reservoir	4.5 U.S. gal. capacity
Oil filter	Screw-on cartridge type, 25 micron, 905 in^2 filter area



*** 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

Hydraulic Hose and Fitting 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 reel motor hoses, are more susceptible to these conditions than others. Inspect the hoses frequently for signs of deterioration or damage. To prevent possible problems it is recommended that hoses are replaced periodically, regardless of condition.

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 stopping the engine and lowering the cutting units to the ground.

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. 1).

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 (Fig. 2). 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

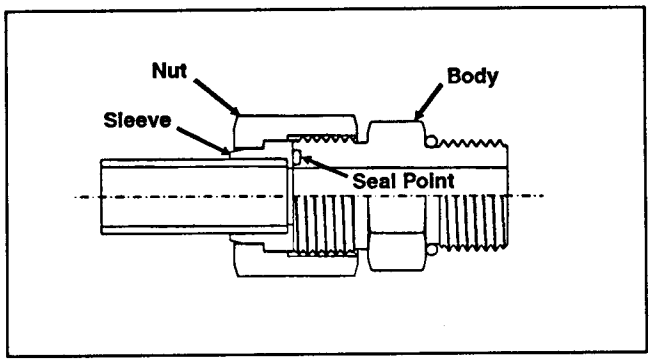


Figure 1

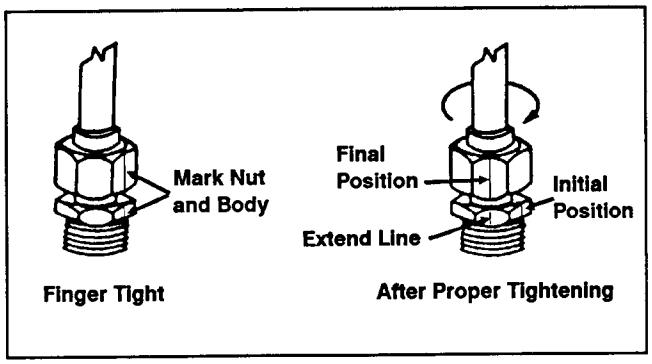


Figure 2

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

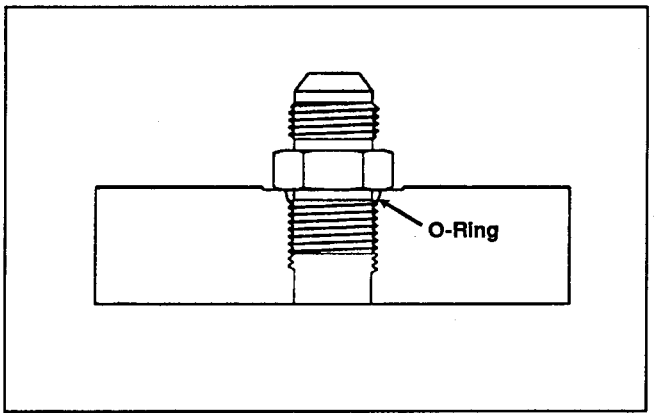


Figure 3

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 (Fig. 5, Step 1).

5. Install the fitting into the port and tighten finger tight until the washer contacts the face of the port (Fig. 5, Step 2).

6. To put the fitting in the desired position, unscrew it by the required amount, but no more than one full turn (Fig. 5, 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.) (Fig. 5, 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

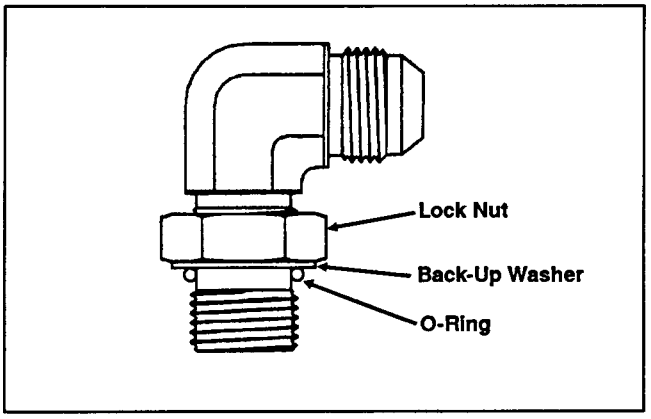


Figure 4

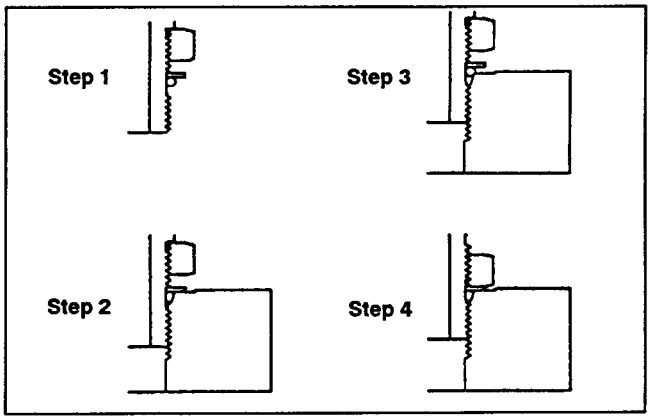
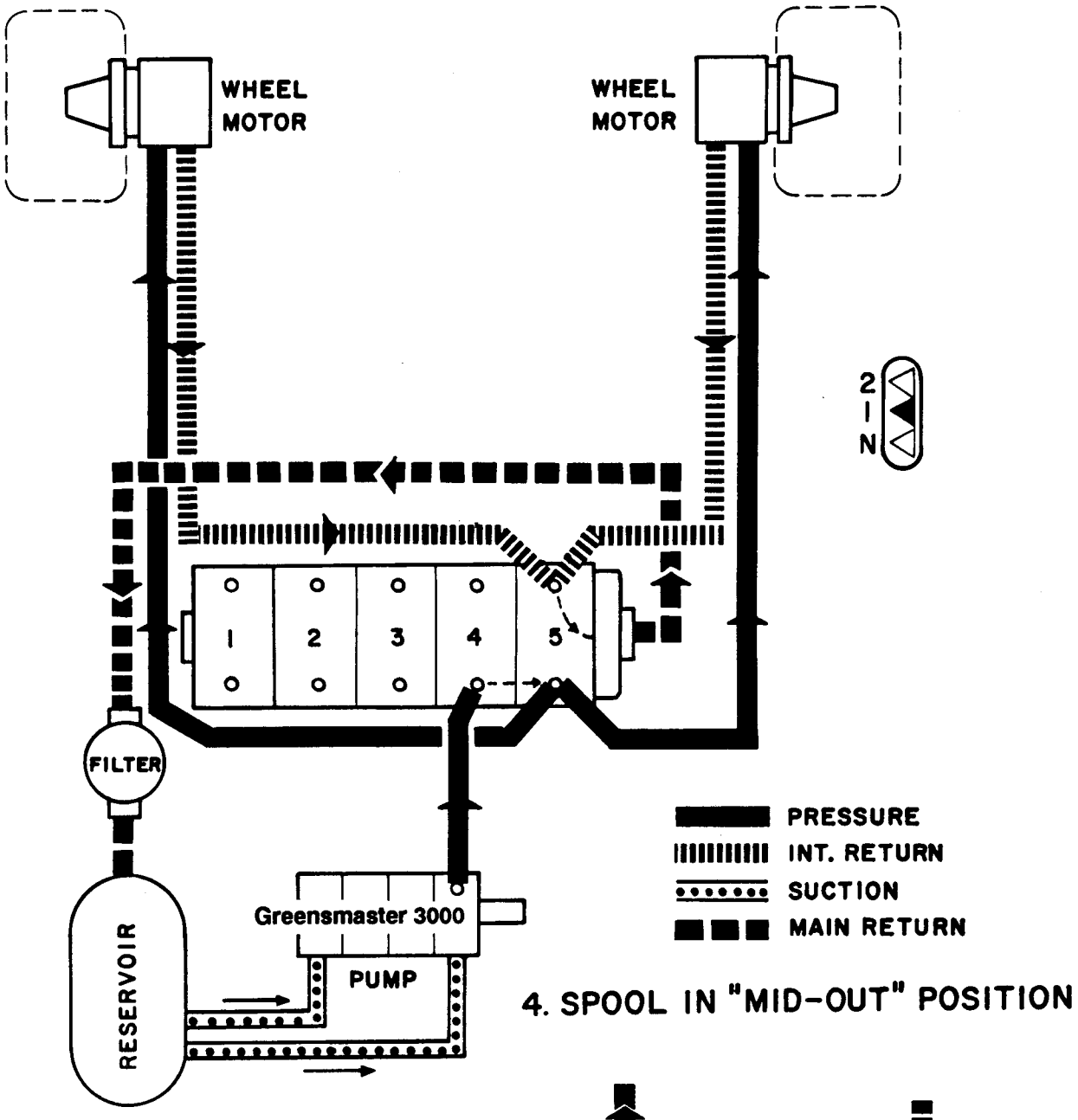


Figure 5

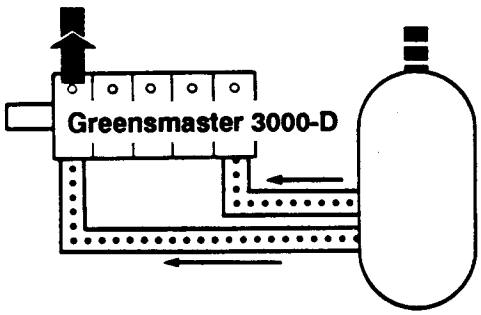
Hydraulic Flow Diagrams

Traction, No. 1 Position

When engine is started, pump draws oil from reservoir through two suction lines. Oil from one section of pump passes through fitting in No. 4 spool valve into valve. Traction lever, when located in No. 1, positions spool so oil is directed to flow into the No. 5 metering valve section. When the traction pedal is pushed forward oil flows out lines at rear of metering valve section to each motor to drive the motors. Low pressure oil returns to valve through valve and main return line, through filter to reservoir.

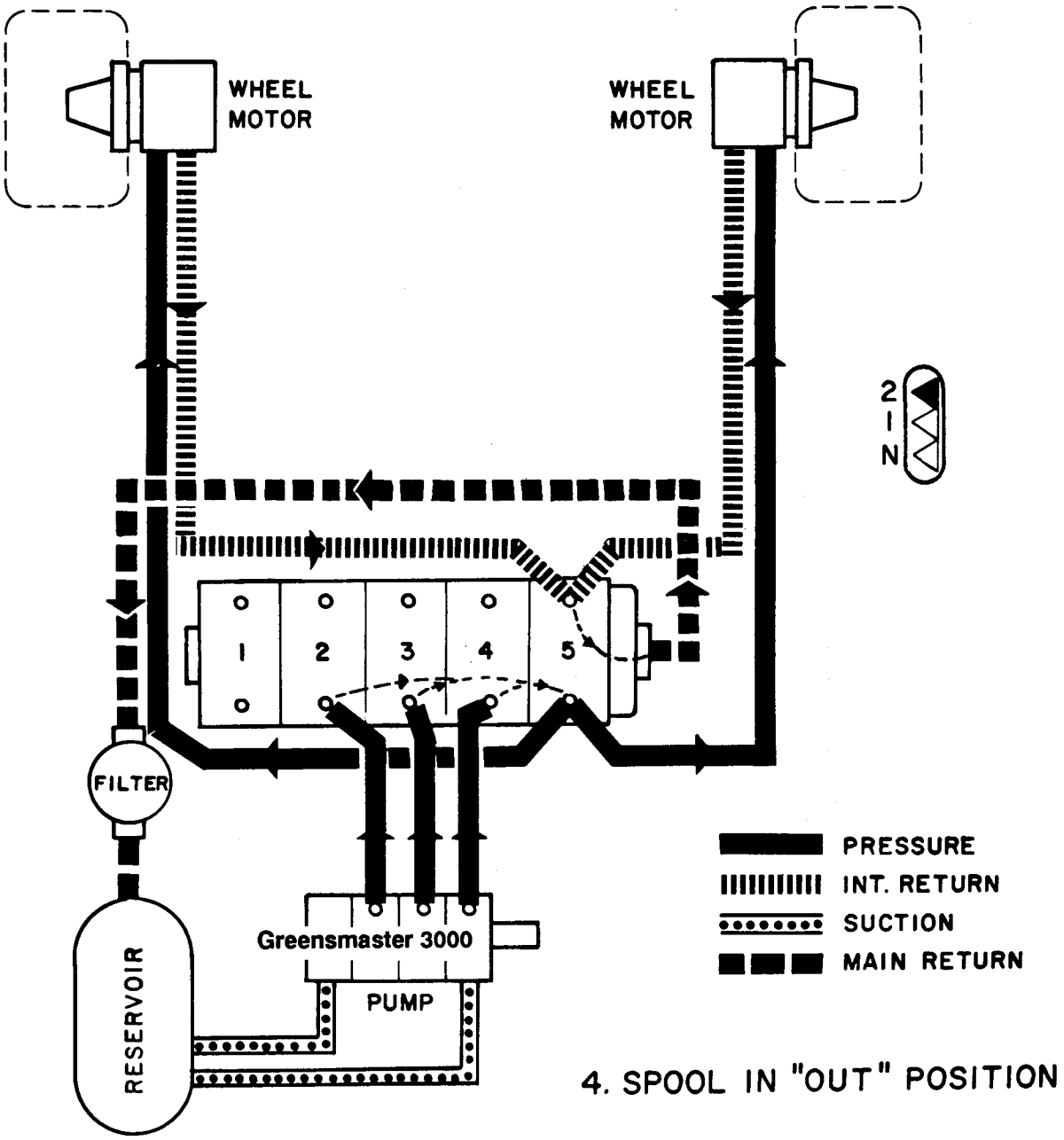


4. SPOOL IN "MID-OUT" POSITION

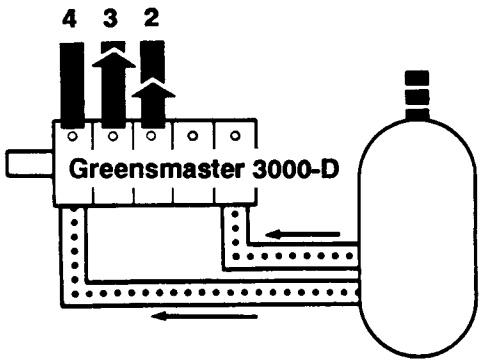


Traction, No. 2 Position

When the traction lever is positioned in No. 2, flow from one pump section passes through same lines as for No. 1 traction position. This flow is joined by additional flow from two other pump sections. The additional flow increases the RPM of the wheel motors to increase ground speed.

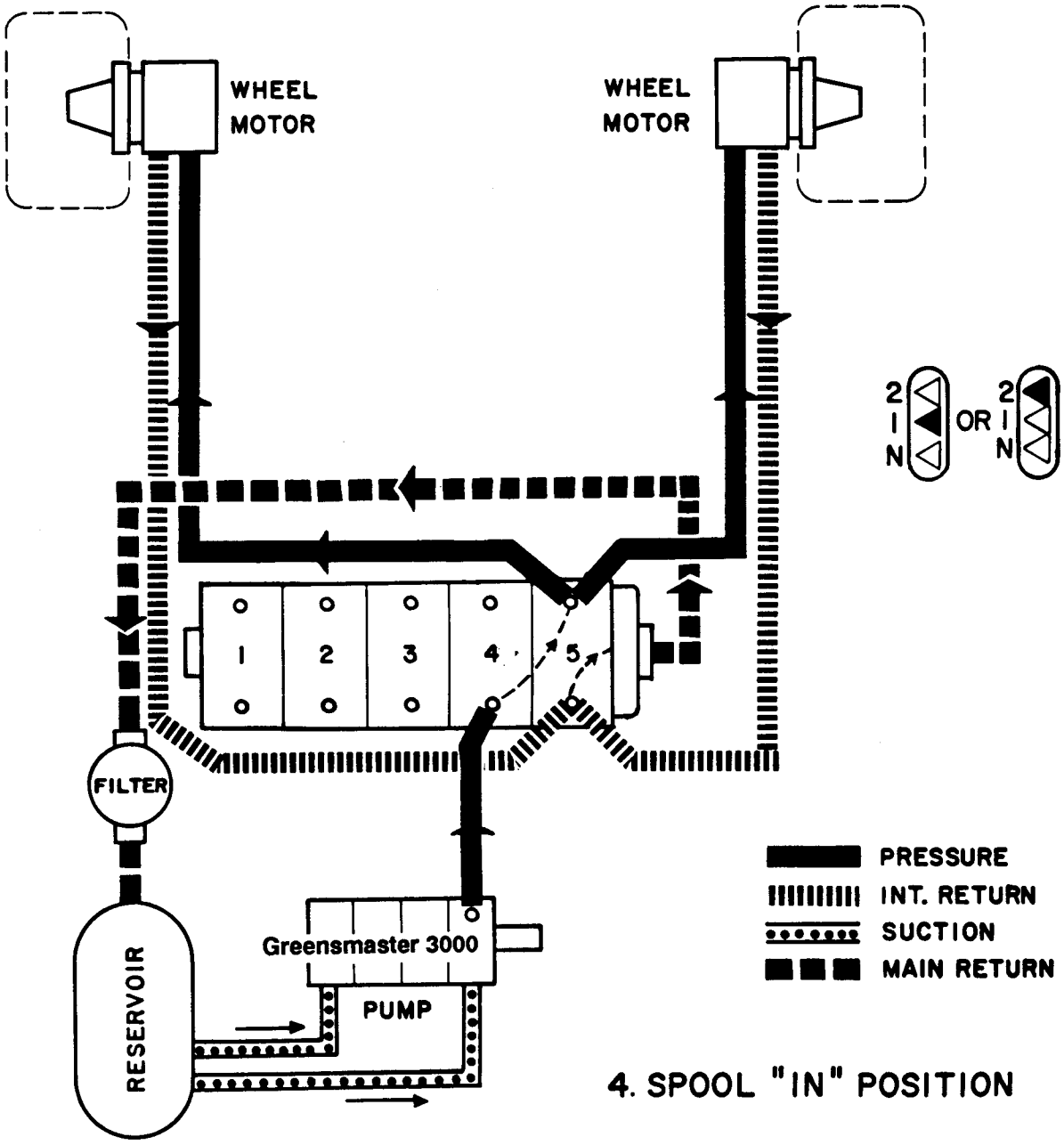


4. SPOOL IN "OUT" POSITION

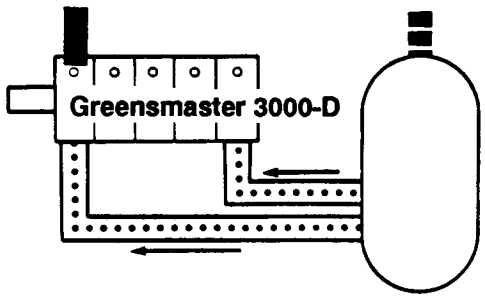


Traction, Reverse Position

Traction lever is positioned in No. 1 or No. 2. When traction pedal is pushed rearward, flow from one pump section goes through No. 4 selector valve section into No. 5 metering section and out the lines at the front of the valve to the traction motors, which drive the traction wheels, to operate in reverse.



4. SPOOL "IN" POSITION

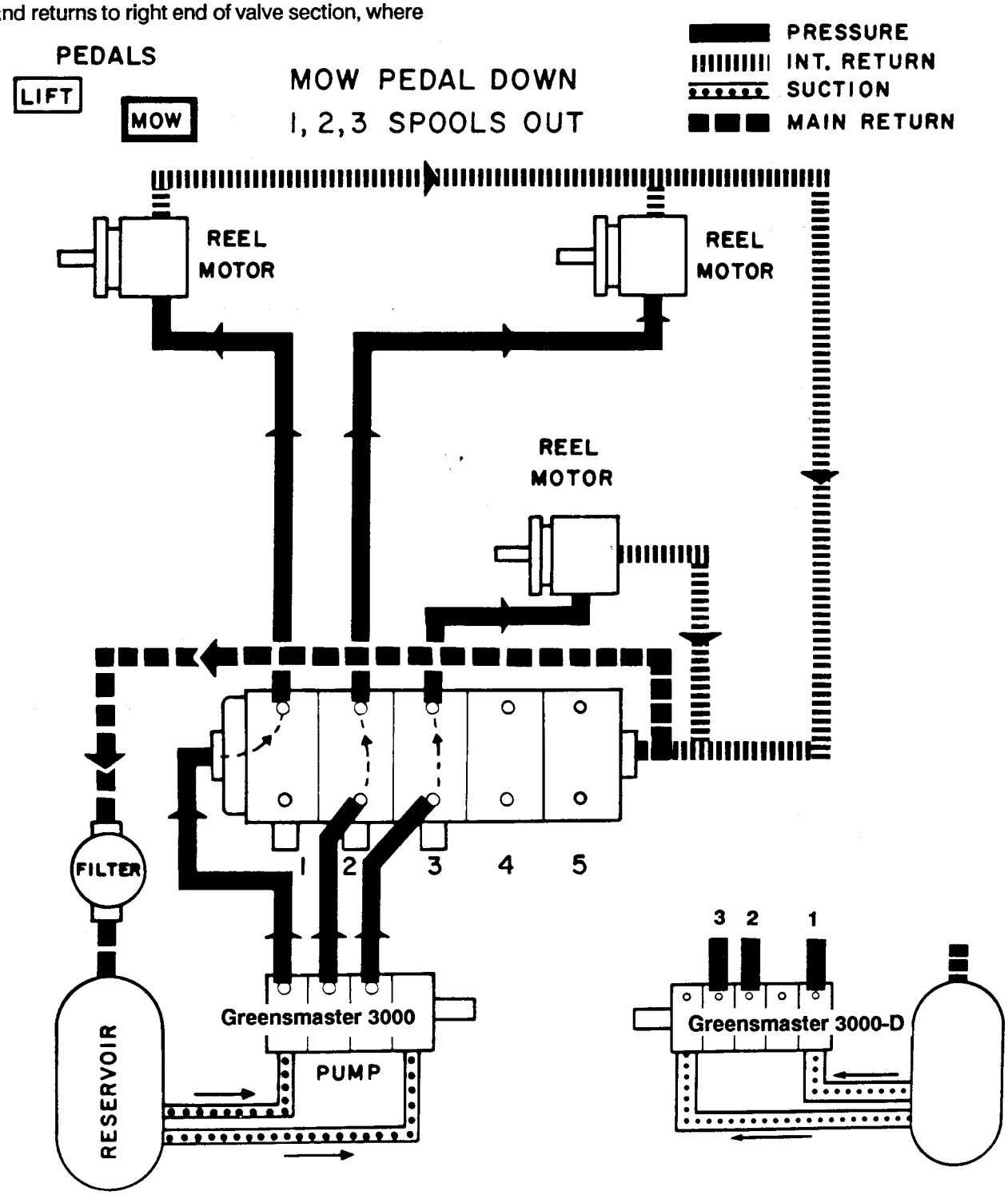


Reel Drive, Mowing Operation

The MOW pedal is depressed, which causes the No. 1, 2 and 3 spools to be positioned fully out of valve bank. This directs flow from one pump section to pass through left end cover and out line leading to left front cutting unit drive motor. Flow causes motor to turn, driving reel.

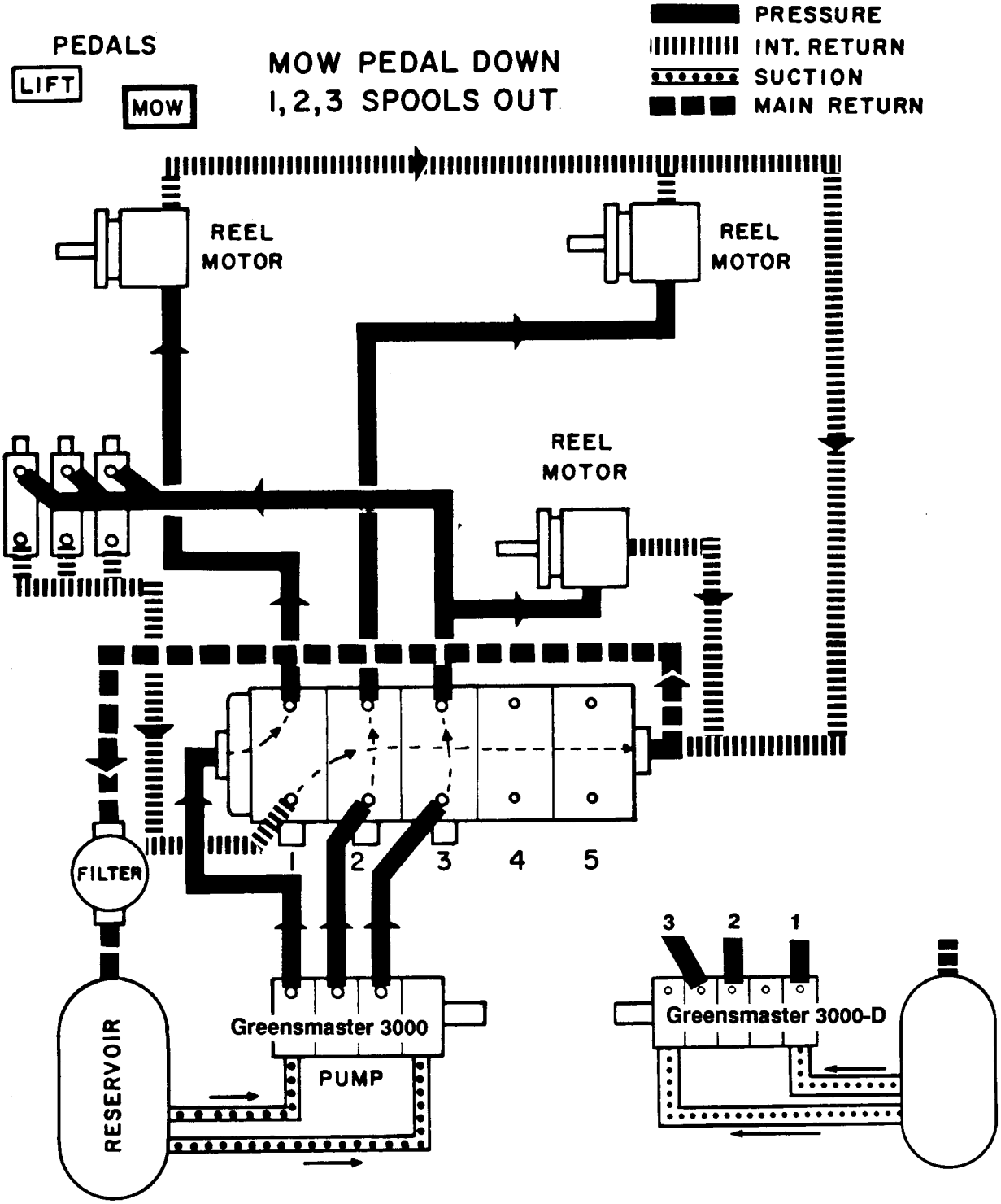
Flow from separate pump section passes through No. 2 valve section and out a line to right front cutting unit motor. Return oil from two front cutting units joins together and returns to right end of valve section, where is passes into the main return line and flows back to reservoir.

Flow from another separate pump section passes through No. 3 spool section and out through a line to the rear cutting unit drive motor. Return oil from the motor passes through a line leading to the right hand end of the valve bank, where it also joins with the main return line back to the reservoir.



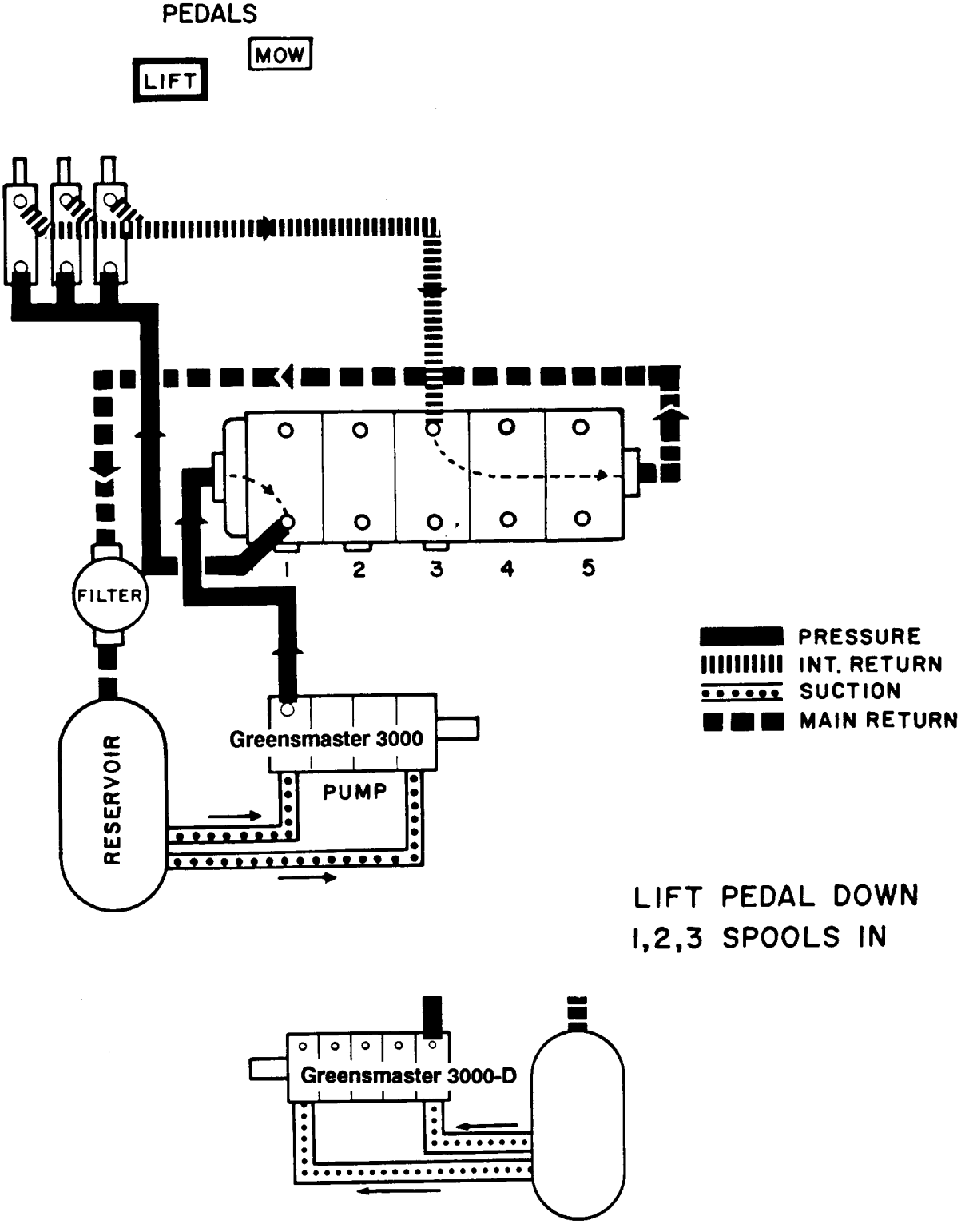
Reel Drive, Lower Cutting Units

The MOW pedal is depressed to start reel drive operation, flow from one pump section passes through No. 3 spool section and out three lines, each leading to a lift cylinder. This actuates the lift cylinders and lowers the cutting units. Oil is returned to a three-way fitting on the No. 1 spool section through lines on the top end of each cylinder, where it passes through the valve section and returns to the reservoir through the main return line. When the cylinders complete their travel, oil flow from the No. 3 spool section is then directed to the rear cutting unit drive motor.



Reel Drive, Raising Cutting Units

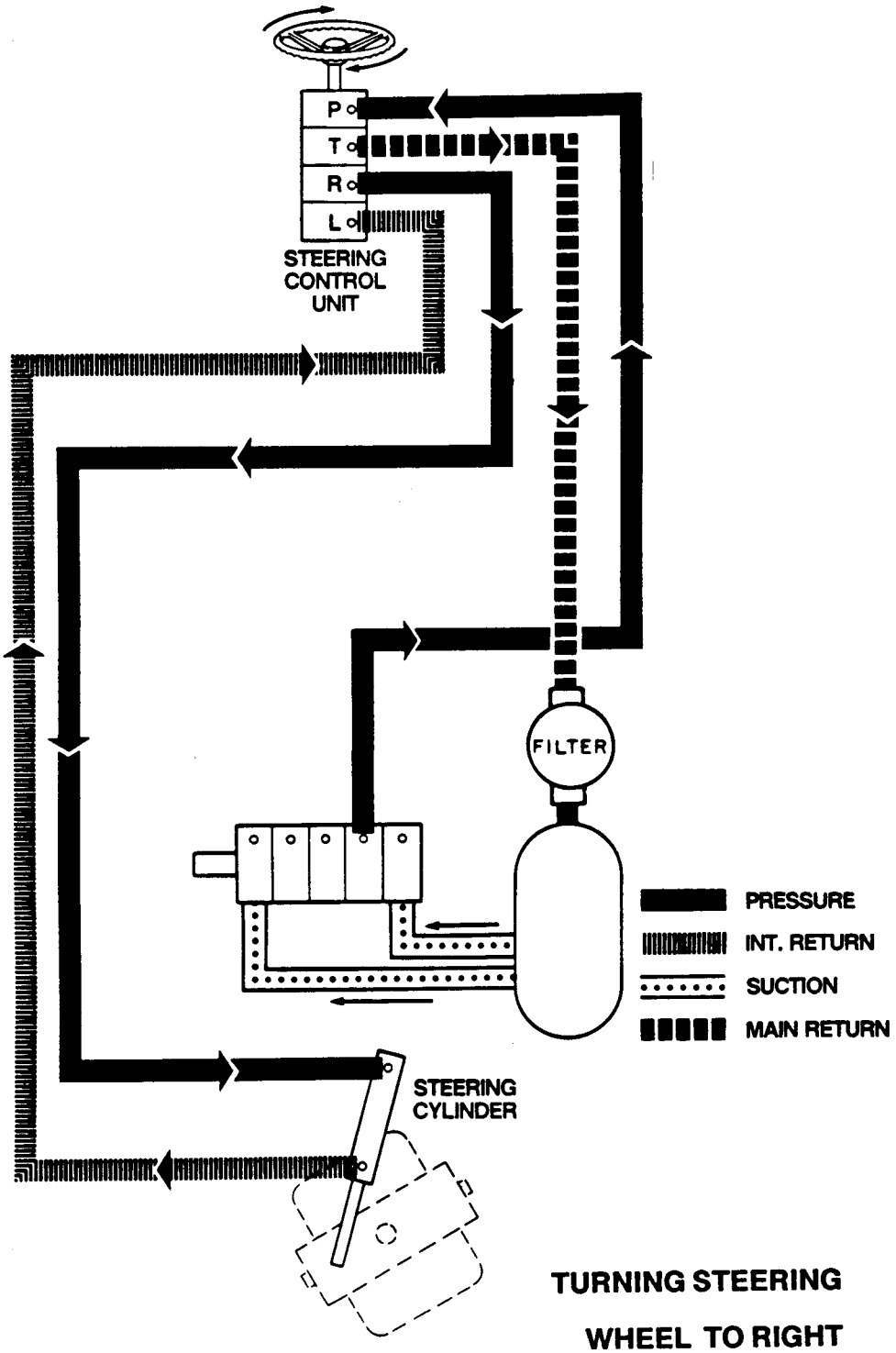
When the LIFT pedal is depressed, No. 1, 2 and 3 spools are pushed inward. When spools pass neutral, cutting units stop operation. Holding pedal depressed keeps spools fully in. This directs flow from one pump section to pass through end cover and No. 1 spool valve, out three lines leading to lift cylinders, causing cylinders to raise the cutting units. Oil forced out of cylinders travels through lines leading to No. 3 spool section, through the valve bank and back to reservoir through main return line.



Power Steering, R.H. Turn
(Greensmaster 3000-D, Model 04375 only)

Oil is supplied to port "P" of the steering control unit from the pump steering section. When the steering wheel is turned to the right, the control section within the steering valve shifts to direct oil supplied by the pump to the metering section of the steering valve. As the steering wheel turns, system oil is metered out port "R" to the steering cylinder. Oil displaced by the other end of the steering cylinder returns to the steering valve through port "L" which directs it out port "T" back to reservoir.

When the steering wheel stops turning, the control section within the steering valve shifts back to neutral allowing all oil from the pump to flow through the steering valve out port "T" back to reservoir. Oil in the rest of the steering circuit is then trapped.



TURNING STEERING WHEEL TO RIGHT

Special Tools

NOTE: Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*. Some tools may be listed in the Greensmaster 3000 or 3000-D Parts Catalog. Some tools may also be available from a local supplier.

Hydraulic Tester

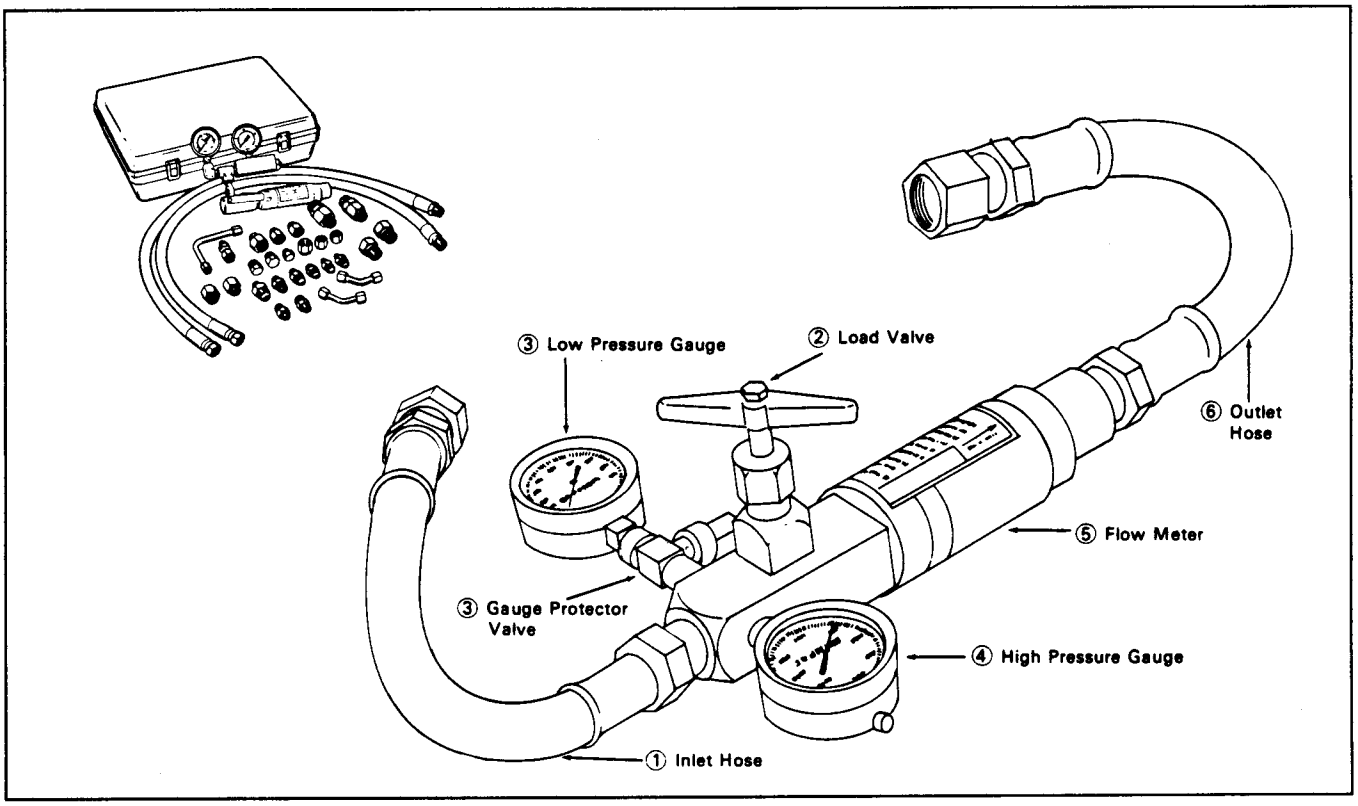


Figure 6

You must have o-ring face seal (ORFS) adapter fittings for this tester to use it on the Greensmaster 3000/3000-D.

1. INLET HOSE: Hose connected from the system circuit to the inlet side of the hydraulic tester.

2. LOAD VALVE: If required, upon turning the valve to restrict flow, a simulated working load is created in the circuit.

3. LOW PRESSURE GAUGE: Low range gauge to provide accurate reading at low pressure, 0 - 1000 psi (0 - 6895 kPa).

This gauge has a protector valve which cuts out when pressure is about to exceed the normal range for the gauge. The cutout pressure is adjustable.

4. HIGH PRESSURE GAUGE: High range gauge to accommodate pressure beyond the capacity of the low pressure gauge, 0 - 5000 (0 - 34475 kPa).

5. FLOW METER: This meter measures actual oil flow in the operation circuit. The reading is given in gallons per minute (GPM) and liters per minute (LPM) with a gauge rated at 15 GPM (57 LPM).

6. OUTLET HOSE: Hose from the outlet side of the hydraulic tester to be connected to the hydraulic system circuit.

Seal Protector

Slide the protector over the reel motor shaft before installing the shaft seal to protect the seal from damage. Apply a light coating of clean oil to the seal protector to ease movement of the seal over the tools. Use with seal installer tool.

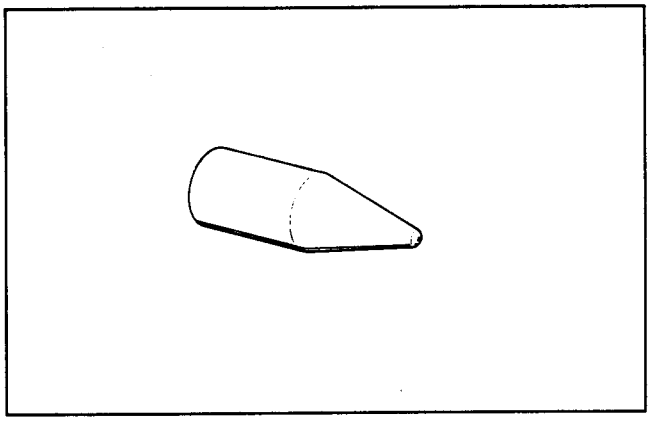


Figure 7

Seal Installer

Use the installer and a small hammer to drive the reel motor shaft seal into position in the bore of the reel motor body. Use with seal protector tool.

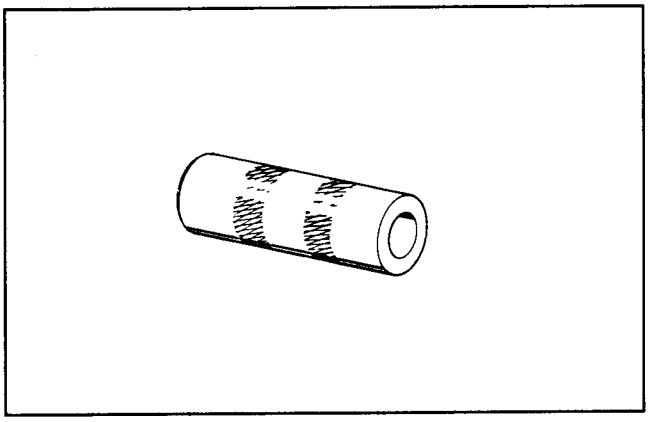


Figure 8

Detent Installation Tool

Use this tool with a 3/8 in. drive torque wrench to tighten the detent stud in the No. 1 spool of the control valve. Apply Loctite 222 or equivalent to the threads of the detent stud. Tighten the stud to a torque of 10 - 14 ft-lb.

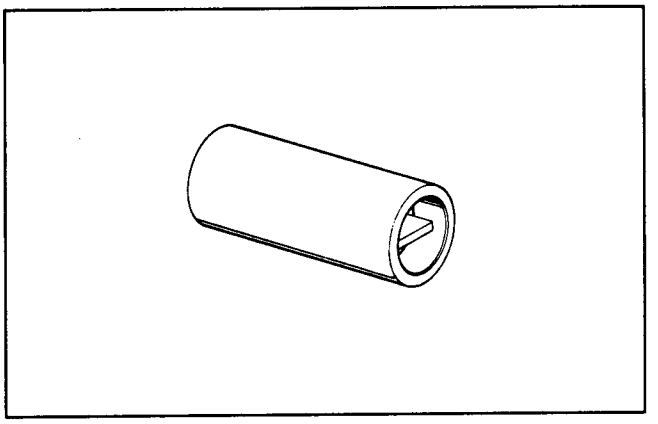


Figure 9

Seal Installation Tool (Greensmaster 3000, Model 04350 only)

Use to assure proper fit and positioning of lip seals used in the TRW Torqmotor hydraulic wheel motor. Put the seal inside the ring with the seal lip toward the motor. Slide the main tube of the tool into the ring. Put the tool into position in the bore of the motor housing. Tap against the main tube of the tool to seat the seal.

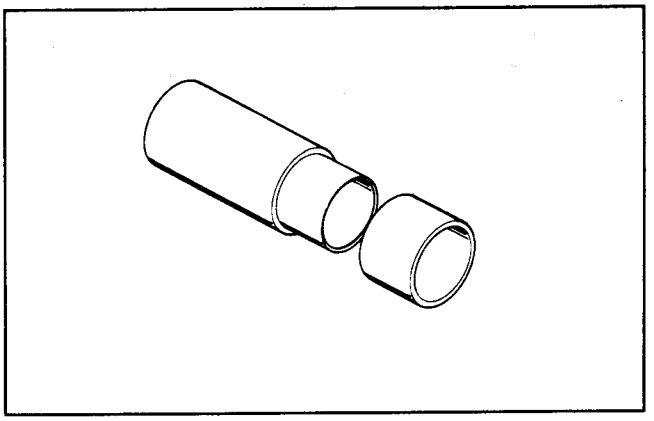


Figure 9

Assembly Studs (Greensmaster 3000, Model 04350 only)

Use for proper alignment of internal parts during disassembly and repair of the TRW Torqmotor hydraulic wheel motor.

IMPORTANT: The wheel motor geroters are indexed and must be kept in their original position.

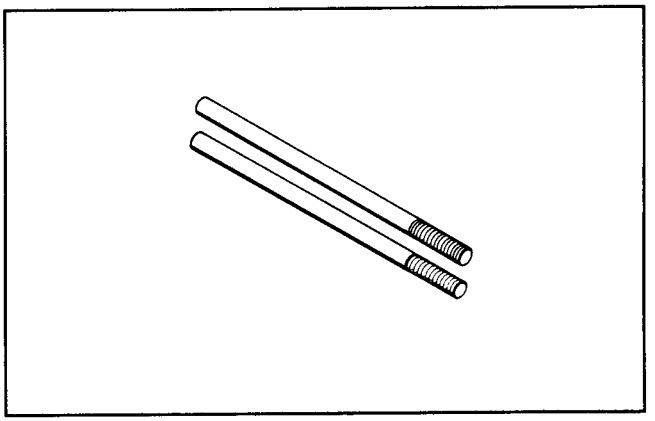


Figure 10

Control Valve Spool Seal Installation Tools

This tool can be made to the dimensions shown (Fig. 11).

Soak new seal in clean hydraulic fluid before installing. Install seal into end of large diameter tool with open side of seal facing out. Install small diameter tool into large diameter tool against flat (closed) side of seal. Carefully install seal and tools over valve spool, hold large tool against valve body and push seal into bore with small diameter tool.

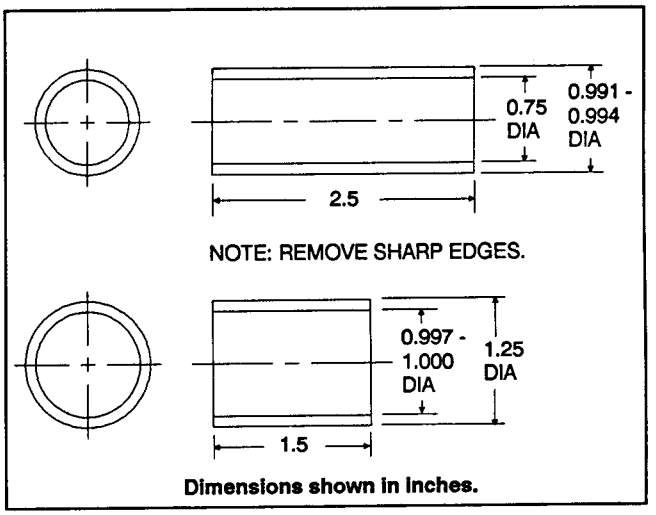


Figure 11

Troubleshooting

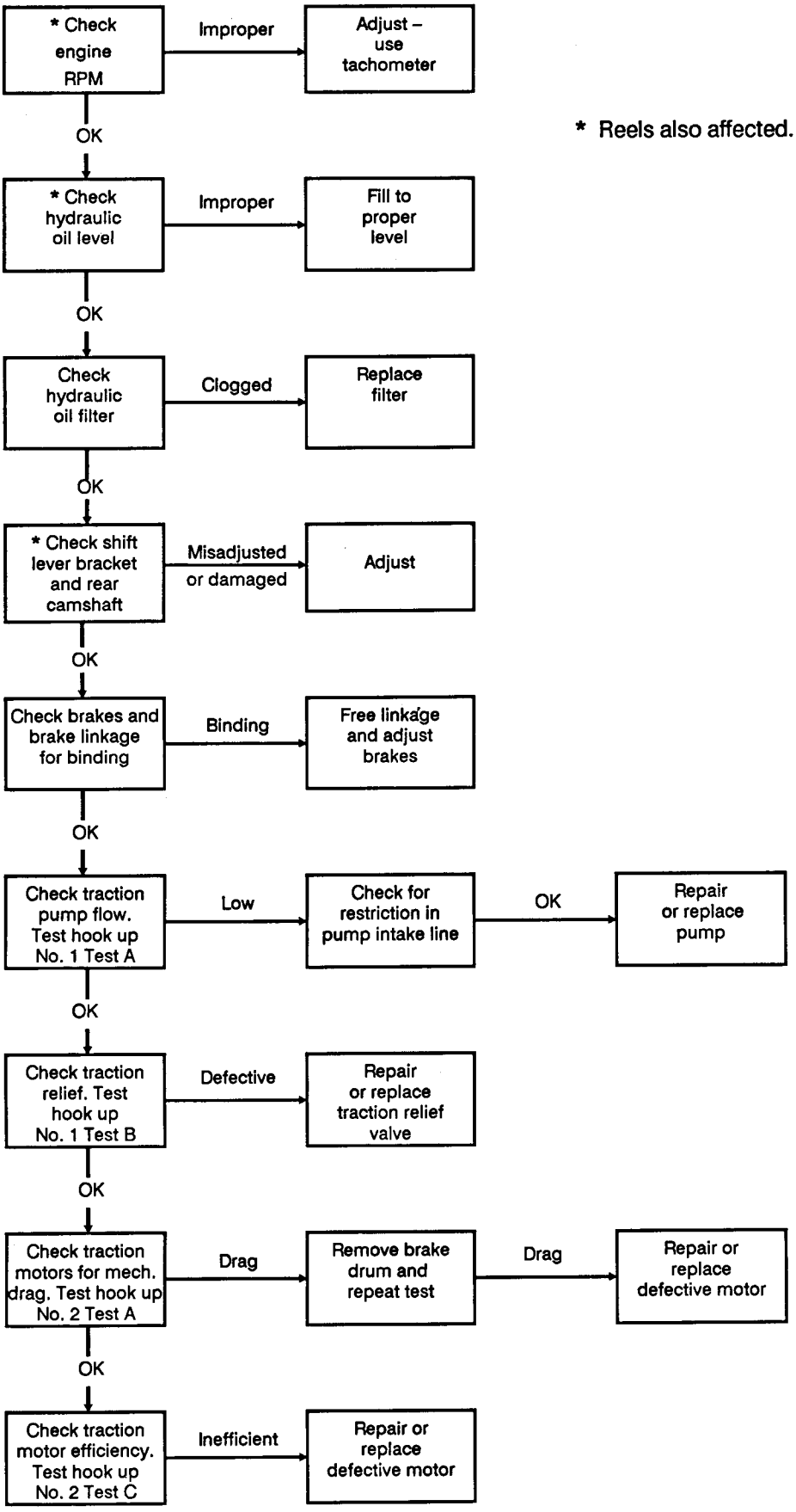
The cause of an improperly functioning hydraulic system is best diagnosed with the use of proper testing equipment (Fig. 6) and a thorough understanding of the complete hydraulic system.

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 system 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; do not deviate from this procedure.

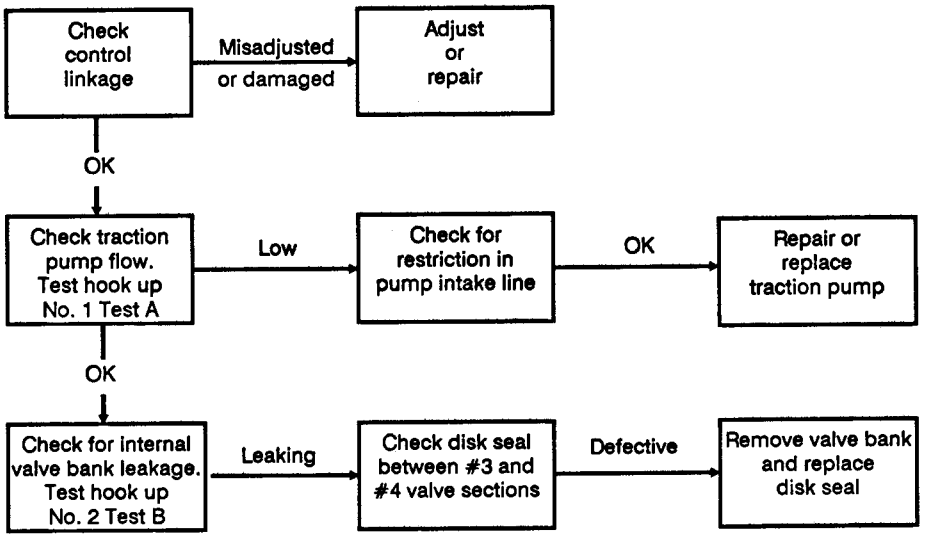
Refer to the Testing section of this Chapter for precautions and specific test procedures.

Slow Groundspeed in All Traction Selections

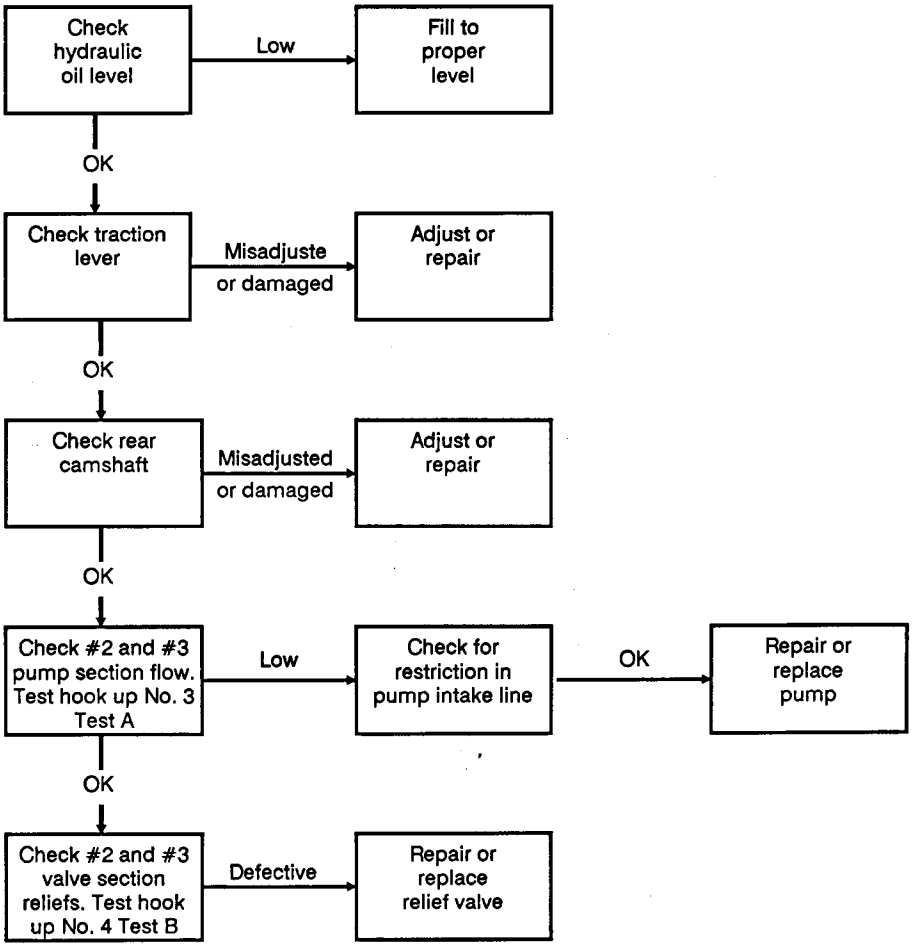


* Reels also affected.

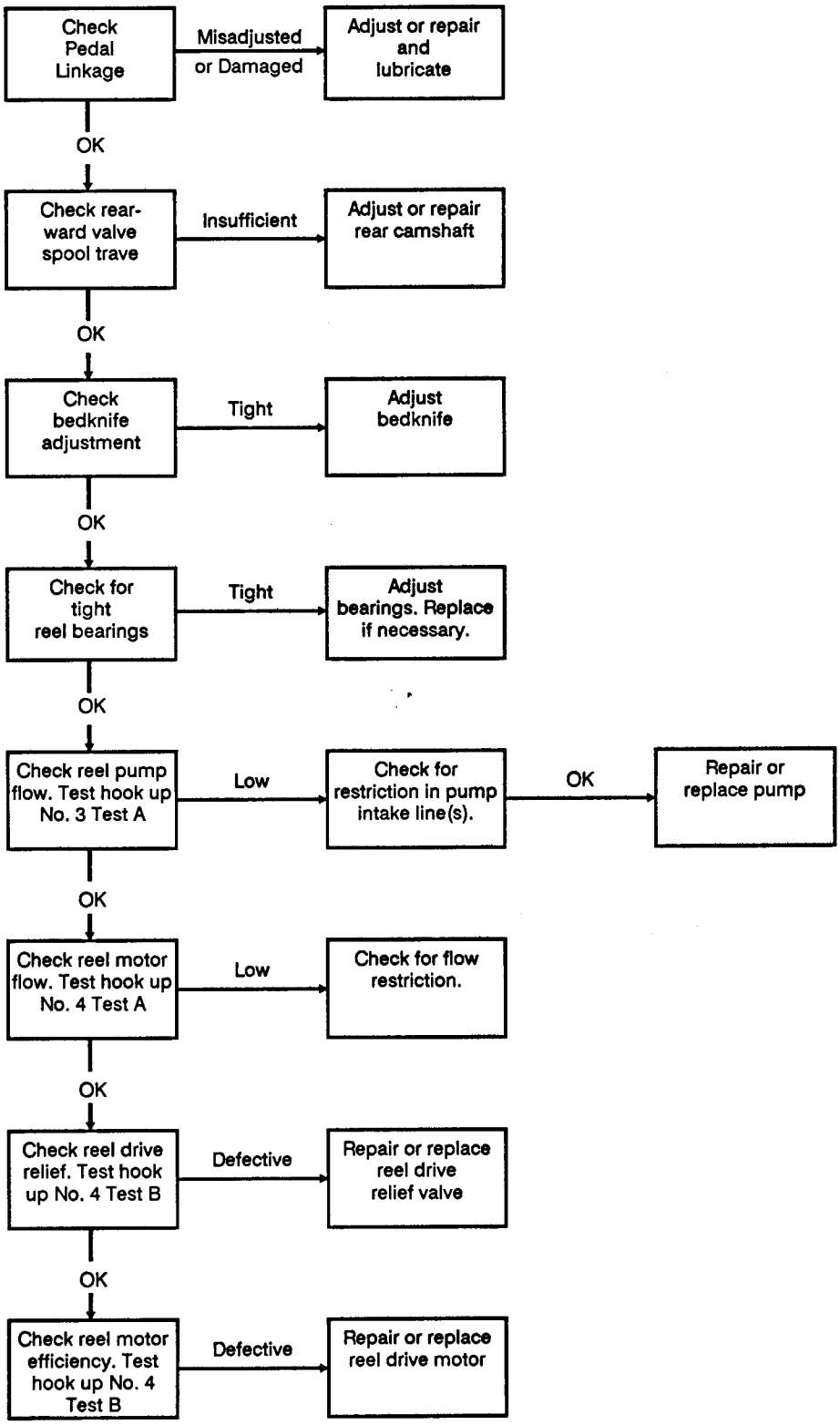
Slow or No Ground Speed in No. 1 and Reverse
No. 2 Appears Normal



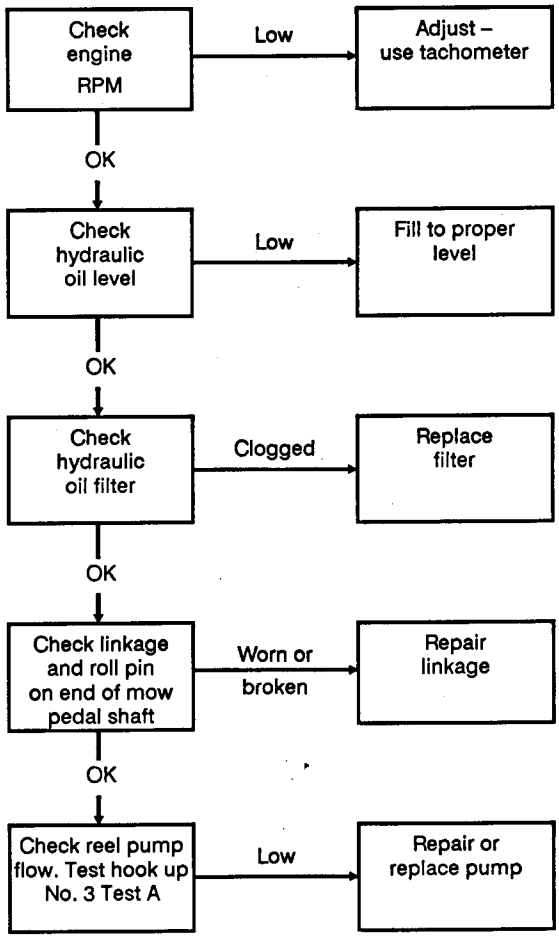
No Increase in Speed from No. 1 to No. 2



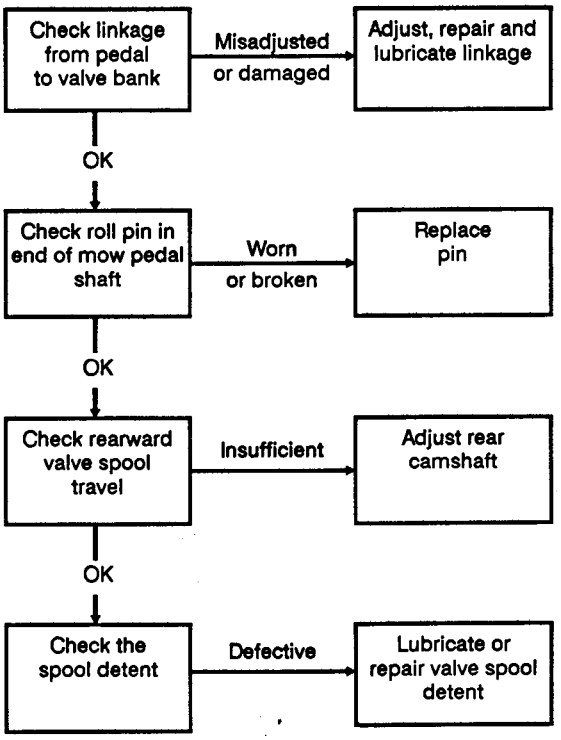
One or More Cutting Units Slow or No Reel Drive Action



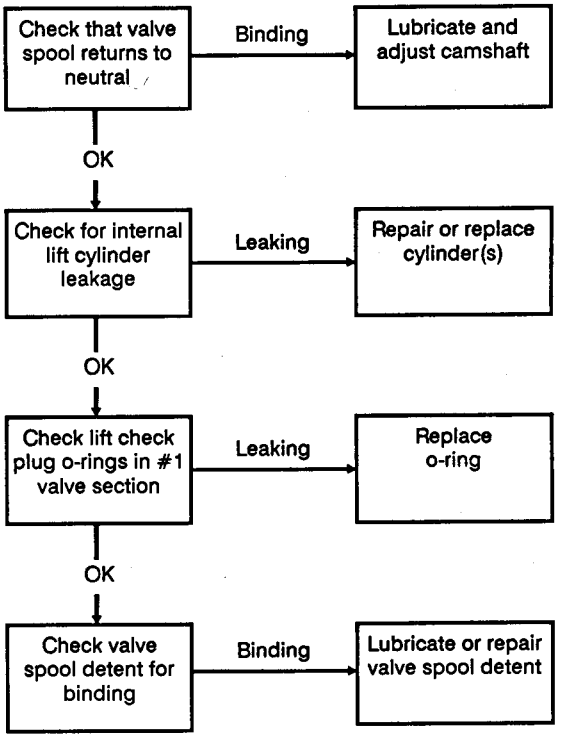
All Reels Slow or Will Not Turn



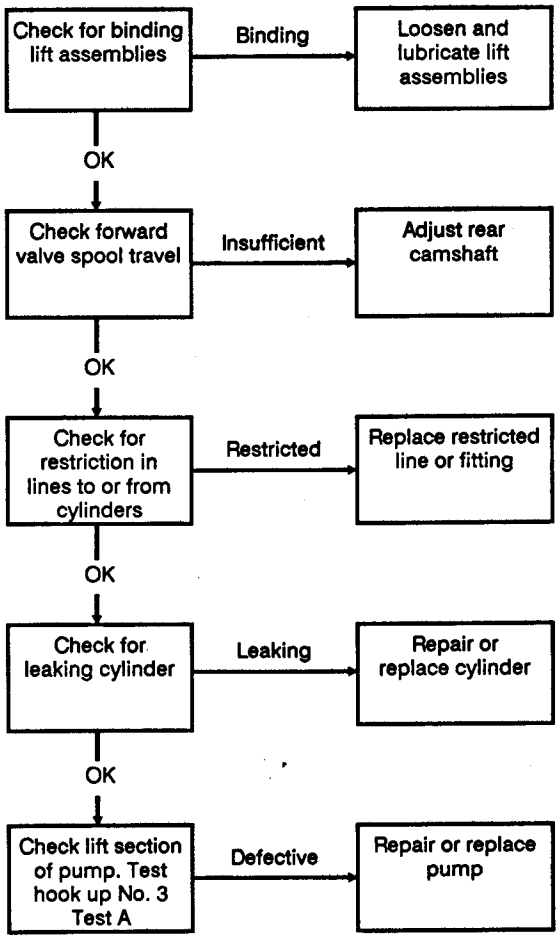
Mow Pedal Won't Stay Engaged – Reels Slow Down or Stop



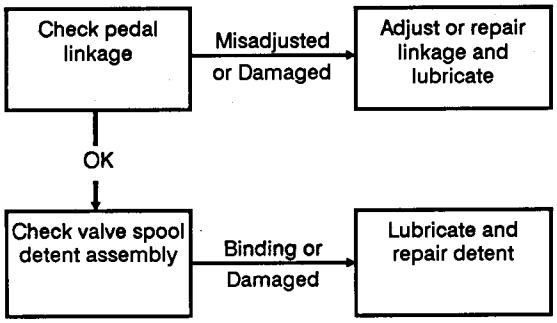
Cutting Unit(s) Drop During Transport



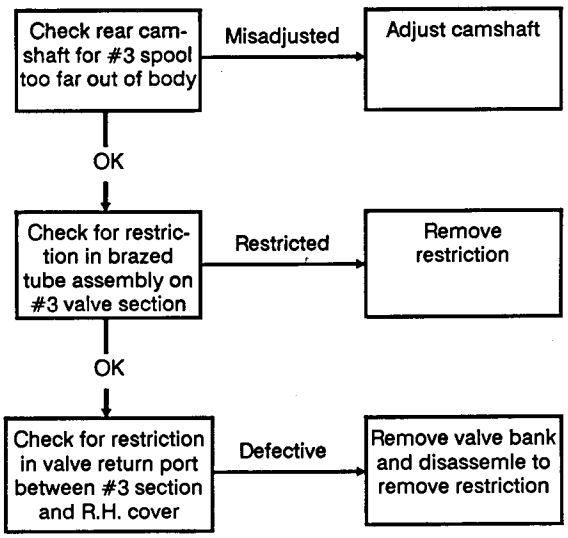
Cutting Units Lift Too Slowly or Not At All



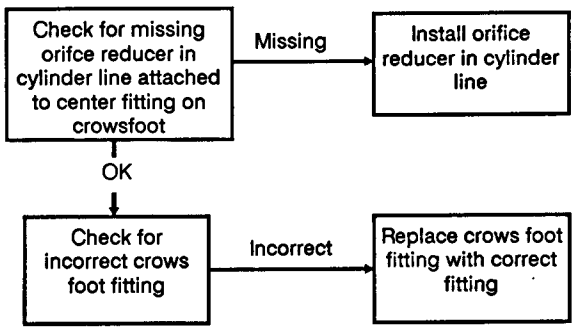
Lift Pedal Binding



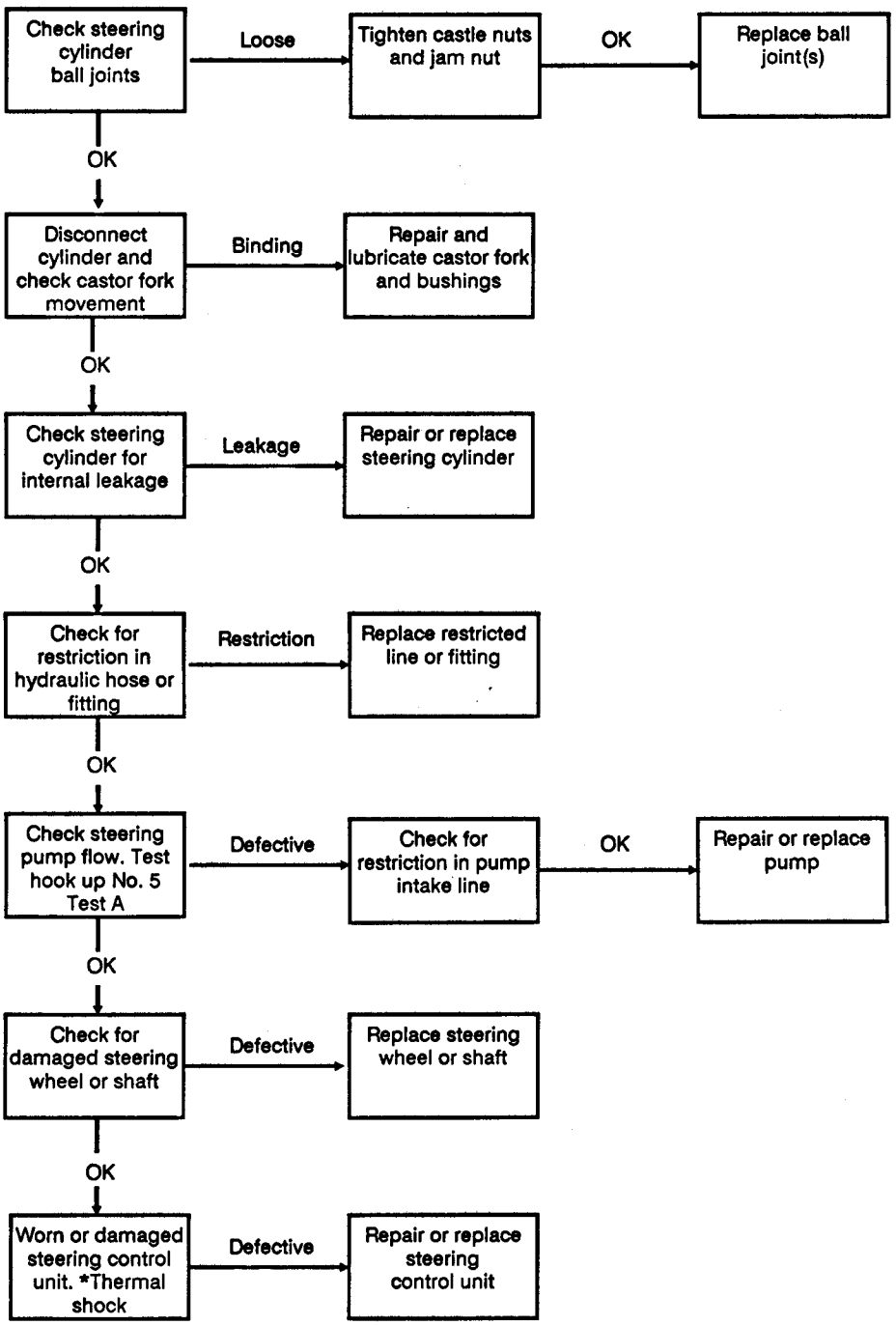
Center (#1) Cutting Unit Operates in Raised Position



Center (#1) Cutting Unit Drops Before Front Cutting Units or Drops Too Fast



Steering Loss, Steering Wander or Free Play (Greensmaster 3000-D, Model 04375 only)



* Thermal shock - A condition caused when the hydraulic system is operated for some time without turning the steering wheel so that fluid in the reservoir and system is hot and the steering control unit is relatively cool (more than 50° F temperature differential). This can also happen when washing the machine. When the steering wheel is turned quickly the result is temporary seizure and possible damage to internal parts of the steering control unit. The temporary seizure may be followed by total free wheeling.

Testing

The most effective method for isolating troubles 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.)

Hydraulic testers may vary significantly in size, construction, accuracy, and cost. The decision as to which tester to purchase should be influenced by what type of tests will be performed on all of the hydraulically-powered equipment in the shop.

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 stopping the engine and lowering the implement to the ground.

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.

Before Performing Hydraulic Tests

1. Thorough 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 the 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 the components, completely open the load valve by turning it counterclockwise (tester with pressure and flow capabilities).

IMPORTANT: The pump used on the Greensmaster 3000/3000-D is a positive displacement type. If its output flow is completely restricted or stopped, damage to the pump or other components could occur.

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 HOOK UP NO. 1

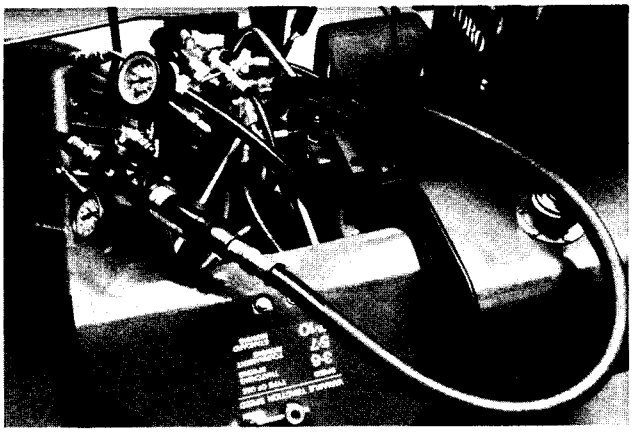
Traction Pump Flow
Traction Relief Setting

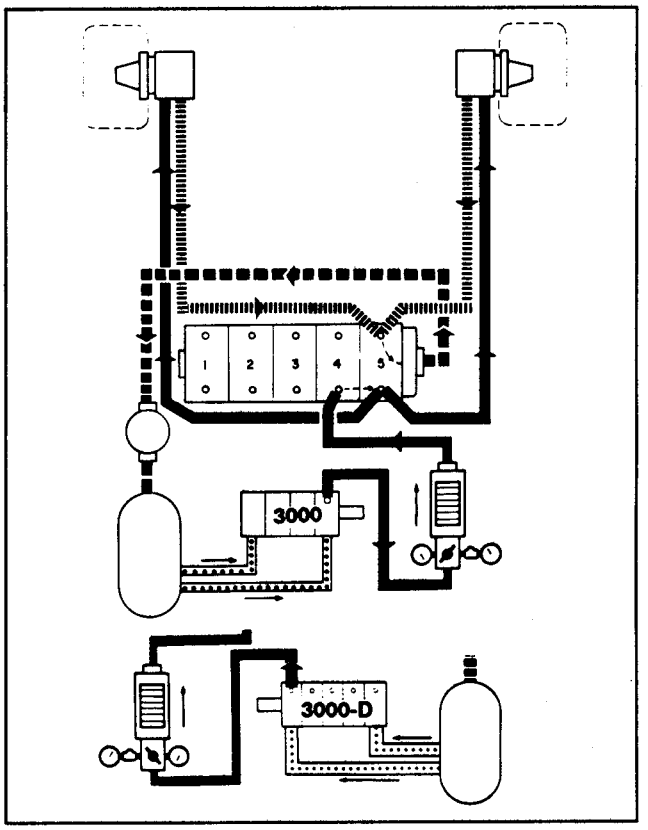
TESTER CONNECTION:

Tester in series between traction pump outlet line and valve bank port on No. 4 section of valve bank.

(Tester Flow Control Valve Open)

⚠ CAUTION: Keep everyone away from the front of the machine during traction system tests. Operator must be on seat or the safety interlock will stop the engine when the traction lever is engaged.





TEST A: TRACTION PUMP FLOW

PROCEDURE

Traction lever in neutral.

Engine RPM 2800 RPM.

Hydraulic oil at operating temperature.

While watching flow and pressure gauges, slowly close flow control valve until 1000 PSI is obtained.

TESTER READINGS

Flow not lower than 5 GPM at 1000 PSI.

Record pressure and flow readings.

If flow is lower than 5 GPM or a pressure of 1000 PSI cannot be obtained, check for restriction in pump intake line. If not restricted, remove pump and repair as necessary.

TEST HOOK UP NO. 1 *(continued)*

TEST B: RELIEF VALVE SETTING

PROCEDURE

Tester flow control valve open.

Block up traction wheels off floor.

Apply brakes and engage park lock.

Engine RPM 2800.

Hydraulic oil at normal operating temperature.

Engage transmission lever to No. 1 position.

Push traction pedal to forward position.

TESTER READINGS

Pressure:

1200 PSI min. - 1350 PSI max. (Greensmaster 3000, Model 04350)
1700 PSI min. - 1850 PSI max. (Greensmaster 3000-D, Model 04375)

If pressure is not in listed range, remove traction relief cartridge and examine for contamination or damage.

TEST HOOK UP NO. 2

Traction Motors Mechanical Drag
Valve Bank Leakage
Traction Motors Efficiency

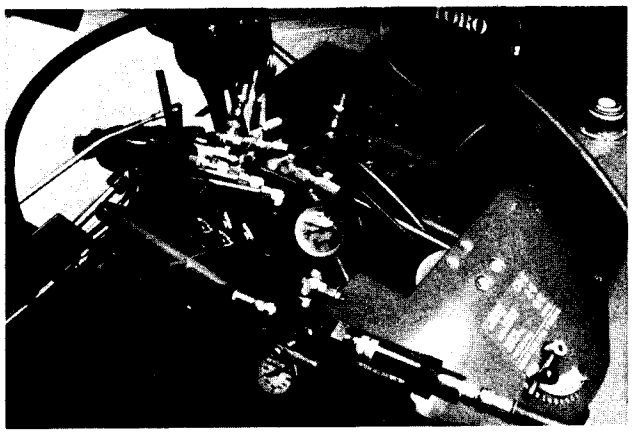
TESTER CONNECTION:

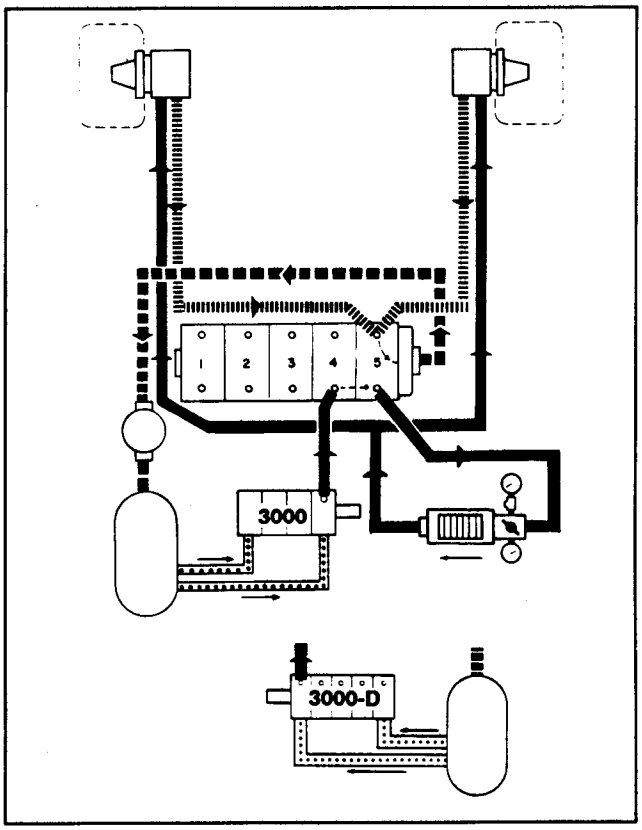
Tester in series between No. 5 section rear outlet port and tee fitting.

(Tester Flow Control Valve Open)

NOTE: Remove "U" tube and install tester between two exposed fittings.

CAUTION: Keep everyone away from the front of the machine during traction system tests. Operator must be on seat or the safety interlock will stop the engine when the traction lever is engaged.





TEST A: TRACTION MOTORS MECHANICAL DRAG

PROCEDURE

Block up traction wheel off floor.

Disconnect brake control rod on wheel being tested.

Apply brake and engage park lock.

Engine RPM 2800.

Hydraulic oil at normal operating temperature.

Engage transmission lever to No. 1 position.

Push traction pedal to forward position. (Wheel not locked by brake should rotate.)

TEST HOOK UP NO. 2 *(continued)*

TESTER READINGS

Pressure not to exceed 400 PSI.

If higher reading is obtained, check pressure line to and from motor for restriction. If no restriction, remove wheel and brake drum. Repeat test.

If pressure still excessive, remove traction motor and repair as necessary.

Repeat the test for the opposite wheel.

NOTE: Reconnect brake rod after each test is completed.

TEST B: VALVE BANK LEAKAGE

PROCEDURE

Use the same procedure as Hook Up No. 2, Test A. (either wheel).

Push traction pedal to forward position. (Wheel not locked by brake should rotate.)

While watching flow and pressure gauges, slowly close flow control valve until 1000 psi is obtained.

TESTER READINGS

Flow not less than 5 GPM at minimum 1000 PSI

If flow is lower than 5 GPM or pressure of 1000 PSI cannot be obtained, there is internal valve bank leakage. Check:

1. Relief valve
2. No. 4 spool position
3. Disc seal between No. 3 and No. 4 sections

TEST C: TRACTION MOTOR EFFICIENCY

PROCEDURE

Tester flow control valve open.

Cap fitting and plug line to wheel motor not being tested.

Traction wheels blocked off floor.

Apply brakes and engage park lock.

Engine RPM 2800.

Hydraulic oil at operating temperature.

Engine traction lever to No. 1 position.

Push traction pedal to forward position.

TESTER READINGS

Flow not more than 1.5 GPM at a pressure of
1200 PSI min. - 1350 PSI max. (Greensmaster 3000, Model 04350)
1700 PSI min. - 1850 PSI max. (Greensmaster 3000-D, Model 04375)

If flow is higher than 1.5 GPM, remove traction motor and repair as necessary. Make tester connection on other side of tee fitting to check other traction motor.

If pressure is not in listed range, remove traction relief cartridge and examine for contamination or damage.

TEST HOOK UP NO. 3

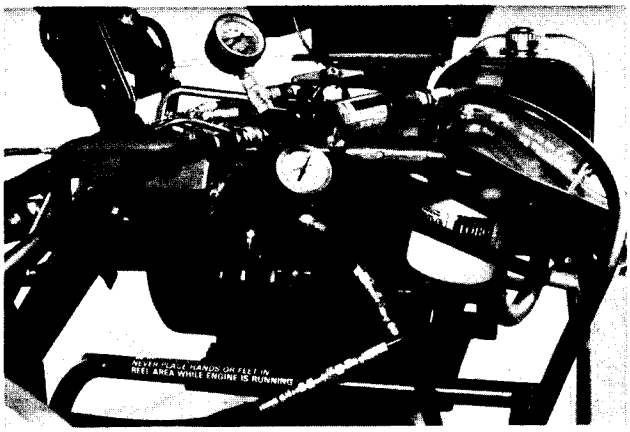
Reel Drive Pump Efficiency

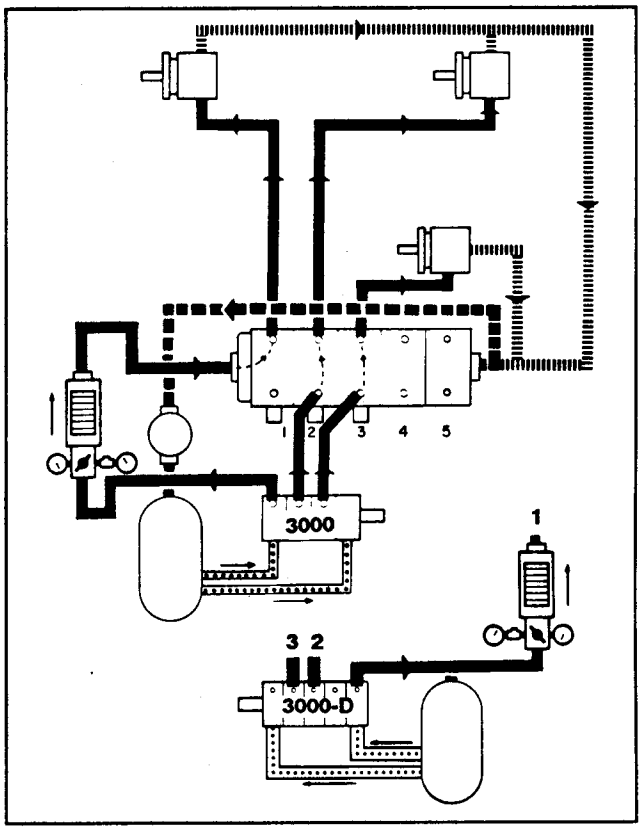
TESTER CONNECTION:

Tester in series between reel pump outlet hose on suspected bad section and its valve bank fitting. Section being checked should be one that supplies oil for reel unit not operating properly.

(Tester Flow Control Open)

⚠ CAUTION: Keep everyone away from the front of the machine during reel system tests. Operator must be on seat or the safety interlock will stop the engine when the mow pedal is engaged.





<u>TEST A:</u> REEL DRIVE PUMP EFFICIENCY

PROCEDURE

Traction lever in neutral position.

Engine RPM 2800.

Hydraulic oil at operating temperature.

While watching pressure gauges, slowly close flow control valve until 1000 PSI is obtained. Read flow gauge.

TESTER READINGS

Flow not less than 2.5 GPM at 1000 PSI.

If unable to get 1000 PSI or flow is below 2.5 GPM, check for restriction in intake line to reel drive pump. If not restricted, remove pump and repair as necessary.

TEST HOOK UP NO. 4

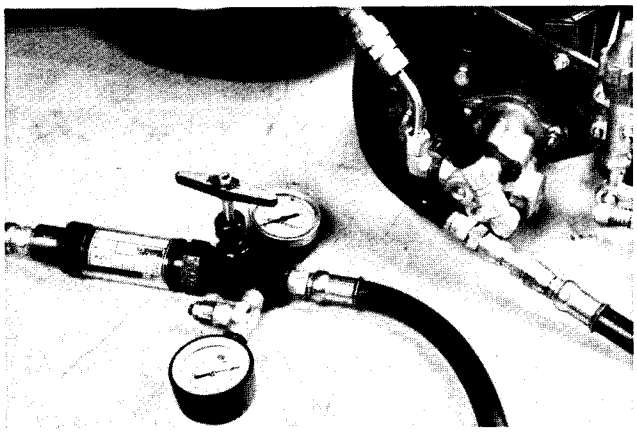
Reel Drive Motor Flow
Reel Drive Relief Setting
Reel Motor Efficiency

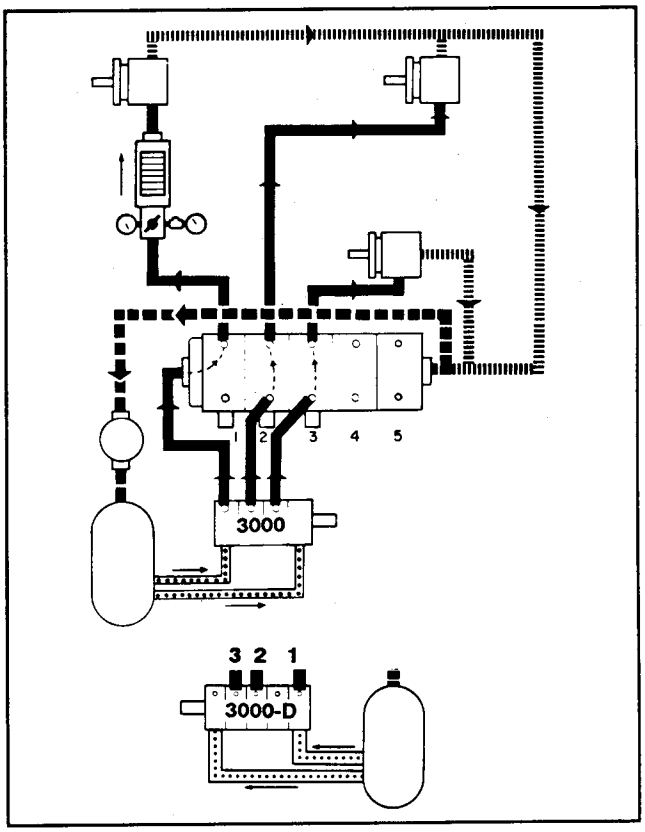
TESTER CONNECTION:

Tester in series between pressure hose and motor fitting on suspected bad motor.

(Tester Flow Control Valve Open)

⚠ CAUTION: Keep everyone away from the front of the machine during reel system tests. Operator must be on seat or the safety interlock will stop the engine when the mow pedal is engaged.





TEST A: REEL DRIVE MOTOR FLOW

PROCEDURE

Engine RPM 2800.

Mow pedal engaged.

While watching pressure gauges, slowly close flow control valve until 1000 PSI is obtained. Read flow gauge.

TESTER READINGS

Flow not less than 2.5 GPM at 1000 PSI.

If unable to get 1000 PSI or flow is below 2.5 GPM, check rearward spool travel. If spool position is good, remove relief cartridge and examine for contamination or wear.

TEST HOOK UP NO. 4 *(continued)*

TEST B: REEL DRIVE RELIEF SETTING AND REEL MOTOR EFFICIENCY

PROCEDURE

With engine off, insert a block of wood between cutting unit reel blades and front cross tube to prevent reel from turning.

Engine RPM 2800.

Hydraulic oil at operating temperature.

Engage mow pedal.

TESTER READINGS

Flow not more than 0.5 GPM at minimum 1700 PSI and maximum 2000 PSI.

If flow is above 0.5 GPM, remove motor and repair as necessary.

If pressure is higher than 2000 PSI or lower than 1700 PSI, remove relief valve controlling reel being checked and examine for wear or contamination.

GREENSMASTER 3000-D, MODEL 04375 only
TEST HOOK UP NO. 5

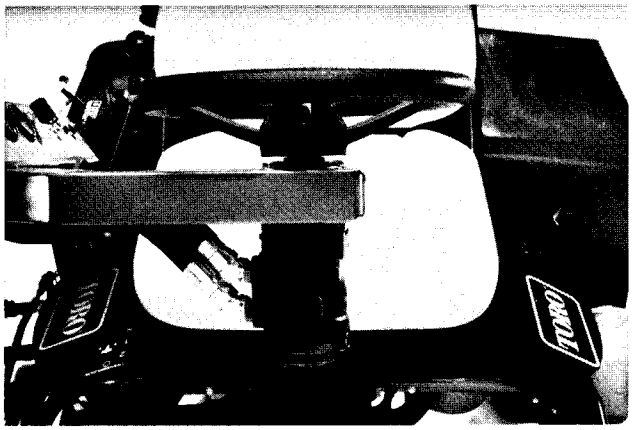
Steering Pump Flow and Relief Pressure

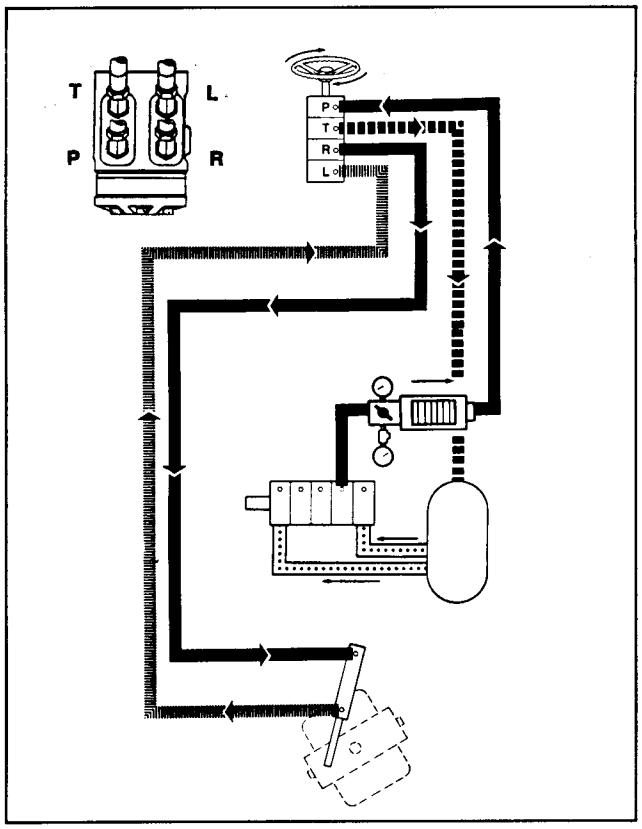
TESTER CONNECTION:

Tester in series between steering pump outlet line and fitting on P (pressure) port of steering control unit.

(Tester Flow Control Valve Open)

CAUTION: Keep everyone away from the front of the machine during steering system tests.





TEST A: STEERING PUMP FLOW

PROCEDURE

Traction Lever in neutral.

Engine RPM 2800.

Hydraulic oil at operating temperature.

While watching flow and pressure gauges, slowly close flow control valve until 600 PSI is obtained.

TESTER READINGS

Flow not lower than 1.5 GPM at 750 PSI min. and 850 PSI max.

If flow is less than 1.5 GPM, check for restriction in pump intake line. If not restricted, remove pump and repair as necessary.

If pressure not within listed range, remove steering relief cartridge and examine for contamination or damage. Adjust steering relief valve if necessary.

Lift and Mow Pedal Height Adjustment

Adjust the lift and mow pedal to equal height to gain proper spool travel in the valve bank as follows:

1. Put 1, 2 and 3 spools in neutral (center of travel) and remove transfer rod guard from foot panel (Fig. 12).

2. Loosen jam nut securing yoke on front of long control rod, remove cotter pin and clevis pin. (Fig. 13).

3. Move adjustment lever by hand to level the mow and lift pedals and adjust yoke on control rod until hole in yoke lines up with the adjustment lever hole.

4. Install the clevis pin and cotter pin. tighten the jam nut and install the transfer rod guard (Fig. 12).

5. Actuate the mow pedal by hand. Be sure the lift pivot under the pedals clears the stop welded to the frame, thereby allowing full spool travel.

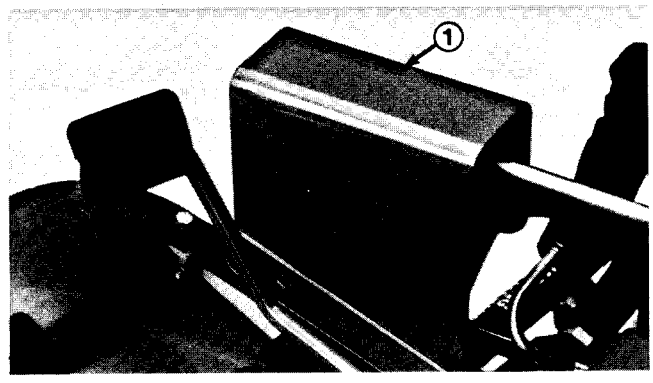


Figure 12

1. Transfer rod guard

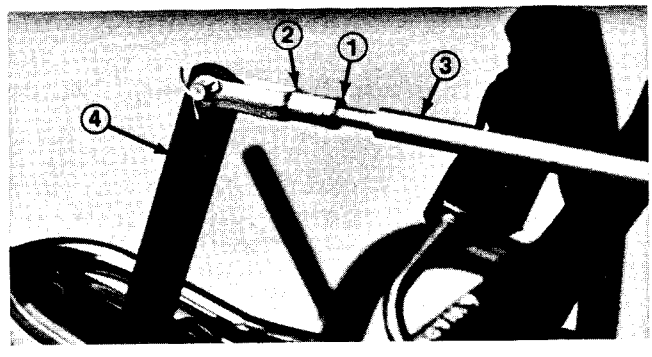


Figure 13

1. Jam nut
2. Yoke
3. Control rod
4. Adjustment lever

Traction Pedal Adjustment

To check forward and reverse operation of traction pedal use the following procedure:

Reverse

1. Push down on rear of traction pedal (reverse) until No. 5 section spool valve is completely pushed in.

2. Check distance between bottom of pedal and footrest (Fig. 14). Distance should be approximately 3/16 in. If distance is greater or less than 3/16 in. dimension, an adjustment to the traction control rod is required.

3. Remove jamnut and balljoint securing control rod to traction shaft pivot.

4. Loosen jamnuts securing balljoints to control rod and adjust balljoints and control rod to get 3/16 in..

Forward

1. Push the traction pedal fully forward until No. 5 section valve spool is completely pulled out.

2. Pedal should contact pedal stop. If pedal contacts stop before spool is completely out, or if pedal does not make contact with stop, an adjustment to the stop is necessary (Fig. 14).

3. Loosen hex nut securing threaded rod to frame. Turn flange nut on rod to raise or lower stop (rod), while checking pedal.

4. When completed, retighten nut.

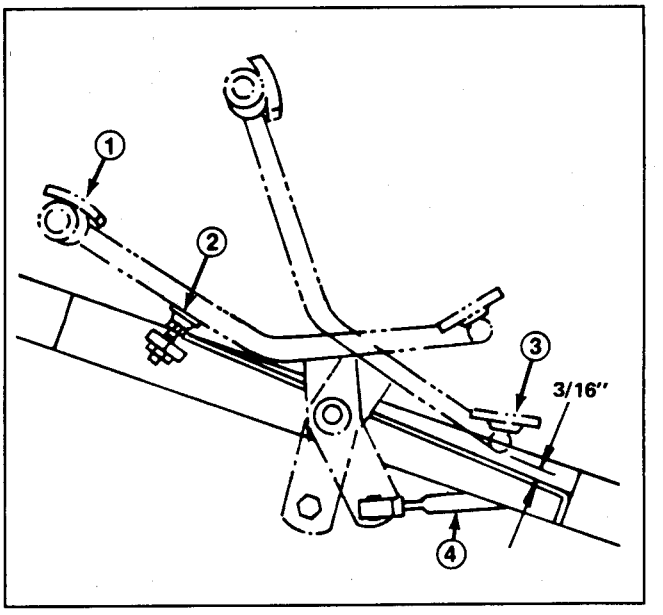


Figure 14

1. Fully forward
2. Pedal stop
3. Reverse
4. Control rod

Rear Camshaft Adjustment

1. A camshaft misaligned with the valve bank may cause the following:

   A. No increase in ground speed in No. 2 (transport) traction selection.

   B. Mow pedal will not stay depressed (in detent) without foot pressure.

   C. Slow lift of the cutting units.

   D. Slow or no drive to the cutting units.

If one or more malfunctions occur, loosen the rear camshaft mounting capscrews and relocate the camshaft until the condition is corrected (Fig. 15).

Retighten the capscrews.

CAUTION

You must readjust the mow-lift switch when the camshaft adjustment is completed. (See Mow-Lift Switch Adjustment in the Adjustments section of Chapter 6 - Electrical System). The lift and mow pedal height must also be adjusted. (See Lift and Mow Pedal Height Adjustment in this section.)

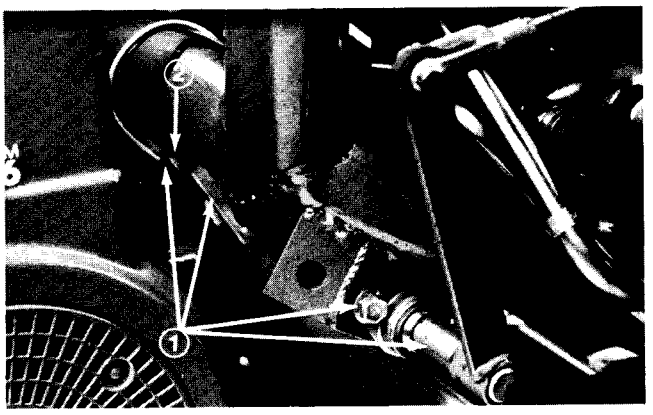


Figure 15

1. Mounting capscrews
2. Cam blocks

Reel Motor Removal and Installation

1. Disconnect hydraulic lines. Put caps or plugs on fittings and hoses to prevent contamination. Tag hydraulic lines for proper reassembly.

2. Loosen motor mount nuts (Fig. 16).

3. Rotate motor clockwise so motor flanges clear studs and pull motor out.

4. Reverse steps 1 - 3 to reinstall motor.

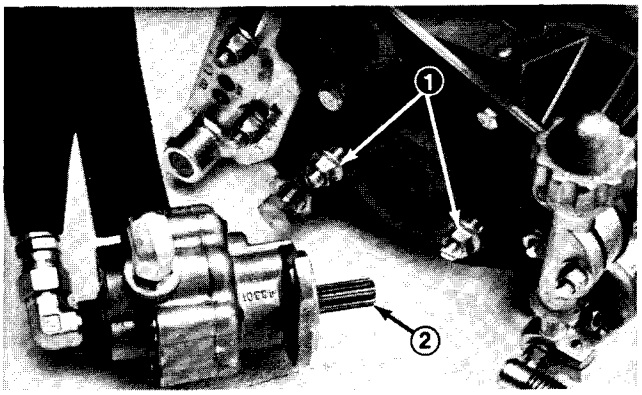


Figure 16

1. Motor mount nuts **2. Motor**

Reel Motor Shaft Seal Replacement

1. Disconnect and reverse hydraulic lines on affected motor (connect pressure line to outlet fitting on motor and return line to inlet fitting on motor).

IMPORTANT: Make sure hydraulic lines are connected properly after shaft seal is replaced.

2. Loosen motor mount nuts (Fig. 16).

3. Rotate motor clockwise so motor flanges clear studs and pull motor out.

4. Remove snap ring from motor (Fig. 18).

5. Start the engine. DO NOT engage the mow pedal. Back pressure in the hydraulic system will push shaft seal out of motor. Stop the engine.

NOTE: Seal may also be removed by punching two holes in face of seal 180° apart, installing metal screws and pulling seal out by grasping the screws.

6. Disconnect hydraulic lines from motor.

7. Remove and discard shaft seal and spacer.

8. Install a new spacer on motor shaft.

9. Put seal protector on motor shaft (Fig. 17) or apply tape on the shaft. Be careful to prevent the shaft spline from damaging the new seal.

10. Apply "Loctite 515 Gasket Eliminator" or equivalent to outside diameter of new seal.

11. Apply generous amount grease to inside diameter of new shaft seal.

12. Use seal installation tool to install new shaft seal (Fig. 11). Make sure seal is installed square with the seal bore.

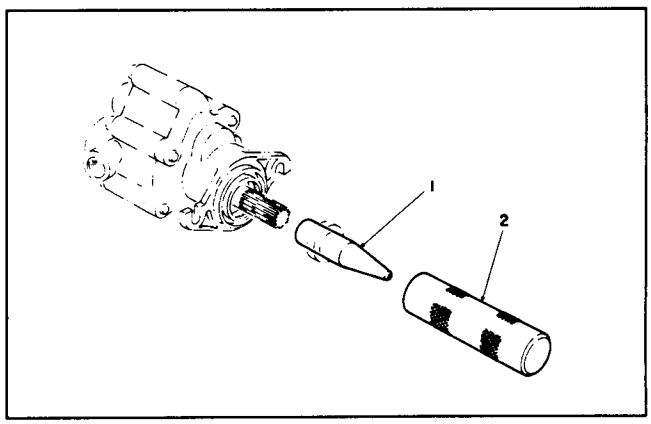


Figure 17

1. Seal protector
2. Seal installation tool

Reel Motor Repair

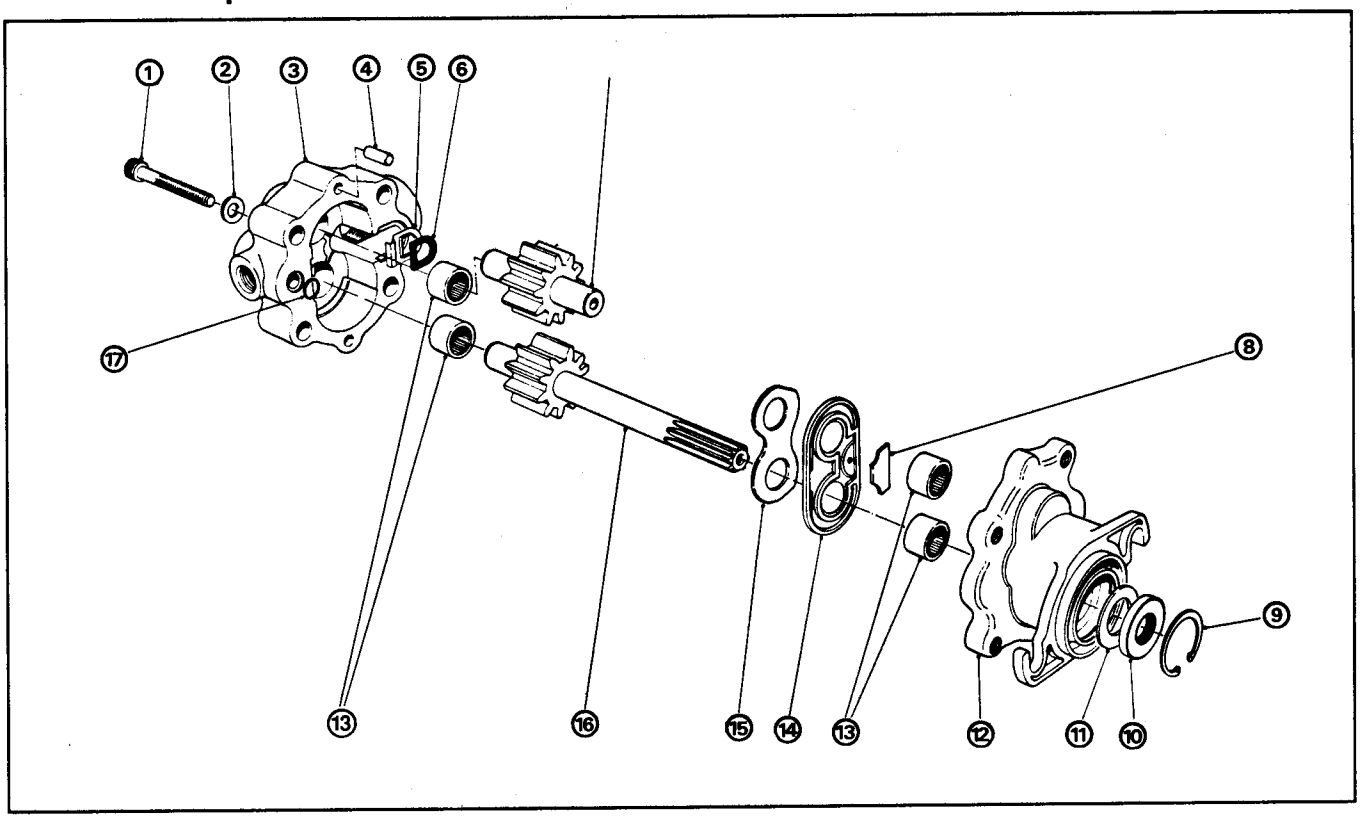


Figure 18

1. Capscrew
2. Washer
3. Cover
4. Dowel pin
5. Bridging insert
6. Gasket insert
7. Idler gear
8. Anti-extrusion block
9. Snap ring
10. Shaft seal
11. Spacer
12. Body
13. Needle bearing
14. Seal assembly
15. Wear plate
16. Drive shaft and gear
17. O-ring

1. Plug ports and wash exterior of motor with mineral spirits or solvent. Make sure parts and work area are clean.

IMPORTANT: Extreme caution must be used when using a vise to avoid distorting any parts.

2. Draw a line across the seam areas on the motor case with a scribe or marker to ensure proper reassembly.

3. Remove four socket head capscrews (Fig. 18).

4. Put you hand on the cover assembly and gently tap the drive shaft with a soft face hammer to separate the body from the cover. Be careful not to drop parts or disengage gear mesh.

5. Before removing gear set, apply marking dye to mating teeth to retain "timing" when reassembling.

6. Be careful when disassembling. The needle bearings may be of the loose grease retained type. Pack these with general purpose grease to retain them for reassembly. It is recommended NOT to remove the bearing races from the cover and body.

7. Remove and discard the bridging insert, gasket insert, anti-extrusion block, snap ring, shaft seal, spacer, seal assembly, wear plate and o-ring, (Fig. 18, Items 5, 6, 8-11, 14, 15 and 17). These items are available in a repair kit.

8. Clean all parts and check for burrs, scoring, nicks, etc.

9. Rub mating surfaces of body and cover with 400 grit or finer sandpaper to remove any Loctite residue. Wash body and cover to remove abrasive material.

10. Apply grease to bridging insert and put in cover, tab side down.

11. Apply grease to gasket insert and put in place over bridging insert.

12. Stone gears if wear plate appears scored. Replace as set if necessary. Oil the inside of cover and insert the gear set, maintaining the original timing and locations.

13. Apply grease to wear plate and slip over shafts with wider cross section next to bridging insert. If the wear plate is made of steel backed bronze, the bronze side must face gears.

14. Apply grease to anti-extrusion block and put in recess of seal assembly, with ground face showing.

15. Apply grease to seal assembly and put in body counterbore. Anti-extrusion block must face body on the tank port side when the motor is assembled (same side as bridging insert).

16. Mating surfaces of body and cover must be clean, free of oil and dry. Clean both surfaces with "Locquick" primer or clean shop solvent. Spread a thin, even coating of "Loctite 515 Gasket Eliminator" or equivalent on one surface.

17. Assemble the body to the cover, making sure that none of the parts become displaced. Insert the capscrews and washers and hand tighten.

18. Before tightening the capscrews, rotate the drive shaft in the direction of normal rotation (counterclockwise) to check for binding. You may not be able to rotate the drive shaft by hand. Protect the shaft if using a pliers.

19. Tighten the capscrews evenly in a crossing pattern to a torque of 190-210 in-lb.

20. Carefully install a new spacer, shaft seal and snap ring. (Perform steps 8 - 12 under Reel Motor Shaft Seal Replacement in this section of the book).

21. Allow 60 minutes for liquid gasket material to harden before operating motor.

Hydraulic Pump Removal and Installation

Disassembly

1. Drain the hydraulic reservoir (Fig. 19).

2. Remove the hydraulic lines from the pump. Put plugs in the pump ports. Put covers on the fittings.

IMPORTANT: When disassembling hydraulic lines make sure hydraulic plugs are placed in the open end of the hydraulic line to prevent debris from contaminating hydraulic fluid. It is also a good idea to tag hydraulic lines when disassembling so that they can be properly reassembled. Keep all hydraulic and suction lines clean and free from debris. During replacement avoid overtightening fittings (see the Hydraulic Hose and Fitting Information section of this chapter). Check hydraulic lines for breaks or cracks. Check the hydraulic reservoir for proper fluid level after replacement of any large component.

3. Loosen the set screws securing the pump hub (Fig. 20) to the shaft, remove the capscrews mounting the pump to the pump mount and remove the pump.

Reassembly

1. Fill the pump with clean hydraulic fluid and cap the fittings.

2. Assemble the pump to the engine in reverse of the disassembly procedures. Check all lines for clearance from the frame and other components.

3. Start the machine and check it for proper performance.

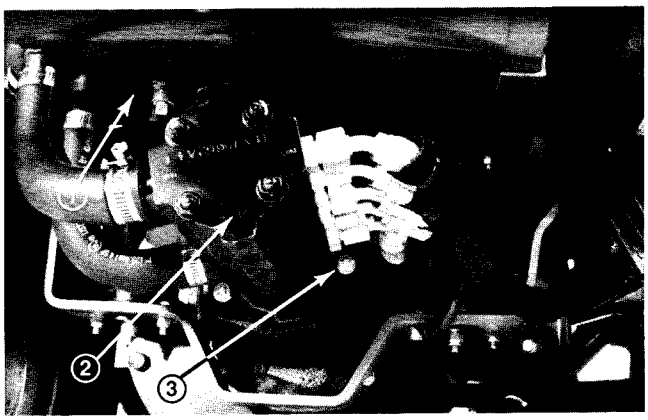


Figure 19
(Greensmaster 3000-D shown)

1. Hydraulic reservoir
2. Hydraulic pump
3. Mounting capscrews

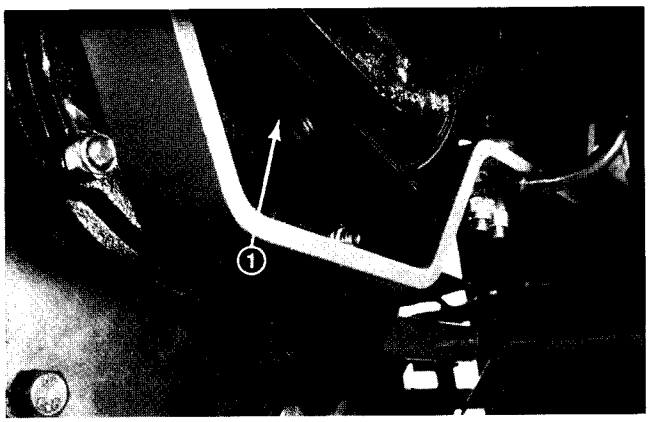


Figure 20

1. Pump hub

Pump Repair (Greensmaster 3000, Model 04350)

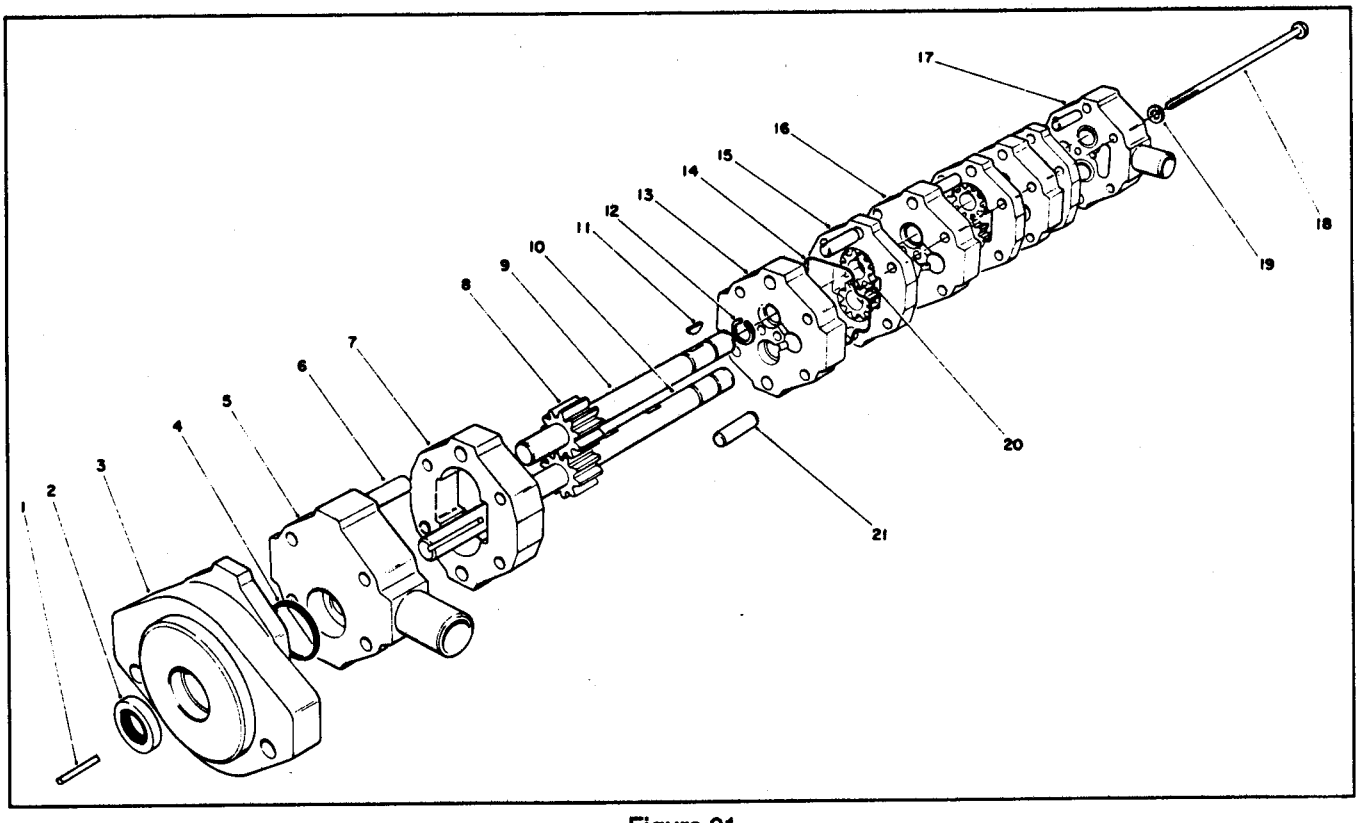


Figure 21

1. Square key
2. Oil seal
3. Flange assembly
4. O-ring
5. Body assembly
6. Dowel (2)
7. Gear plate
8. Gear - 59B (2)
9. Idler shaft
10. Drive shaft
11. Woodruff key (4)
12. Retaining ring (2)
13. Plate assembly
14. Seal ring (8)
15. Gear plate - 30B (3)
16. Plate assembly (2)
17. Cover assembly
18. Capscrew (4)
19. Washer (4)
20. Gear - 30B (5)
21. Dowel

1. Plug ports and wash exterior of pump with mineral spirits or solvent. Make sure parts and work area are clean.

2. Draw a line across the seam areas on the pump case with a scribe or marker to ensure proper reassembly.

IMPORTANT: Use caution when using a vise to avoid distorting any parts.

3. Secure the flange end of the pump (Fig. 21, Item 3) in a vise with the drive shaft (Item 10) pointing down.

4. Remove four capscrews.

5. Put your hand on the pump case and gently tap the pump case with a soft face hammer to loosen the pump sections. Be careful not to drop parts or disengage gear mesh.

6. Before removing each gear set, apply marking dye to mating teeth to retain "timing" when reassembling.

7. Be careful when disassembling. The needle bearings in the flange assembly (Item 3) may be of the loose grease retained type. Pack these with general purpose grease to retain them for reassembly. It is recommended NOT to remove the bearing races from the flange assembly.

8. Remove and discard the oil seal, o-ring and seal rings (Fig. 21, Items 2, 4 and 14) as the pump is disassembled.

9. Clean all parts. All parts must be check for burrs, scoring, nicks, etc. Check the bushings in the plate assemblies (Items 13 and 16) and cover assembly (Item 17 for excessive wear or scoring. Replace the assemblies as necessary. The bushings are not serviceable.

10. Stone gears if plate surfaces appear scored (Items 5, 13 and 16). Replace gears as sets if necessary. Oil the inside of gear plates (Items 7 and 15) and insert gear sets, maintaining the original timing and locations.

11. Assemble pump sections. Install woodruff keys (Item 11) and align keyways in gears as they are installed over the shafts. Apply grease to new seal rings (Item 14) before installing.

12. Apply grease to the new o-ring (Item 4) before installing. Install flange assembly (Item 3), and hand tighten the four capscrews.

13. Tighten the capscrews by hand. Rotate the drive shaft to check for binding. Protect the shaft if using a pliers.

14. Tighten the capscrews evenly in a crossing pattern to a torque of 17 to 19 ft-lb.

15. Before installing oil seal (Item 2) put seal protector on pump shaft or apply tape on the shaft.

16. Before installing fill volume between lips of new seal with Master Lubricant Co. "Lubrico M-6", Lubriplate "Aero Lube" or equivalent. Apply grease to inside diameter of new oil seal. Carefully install a new oil seal. Assemble spring loaded lip of seal toward bearing.

Pump Repair (Greensmaster 3000-D, Model 04375)

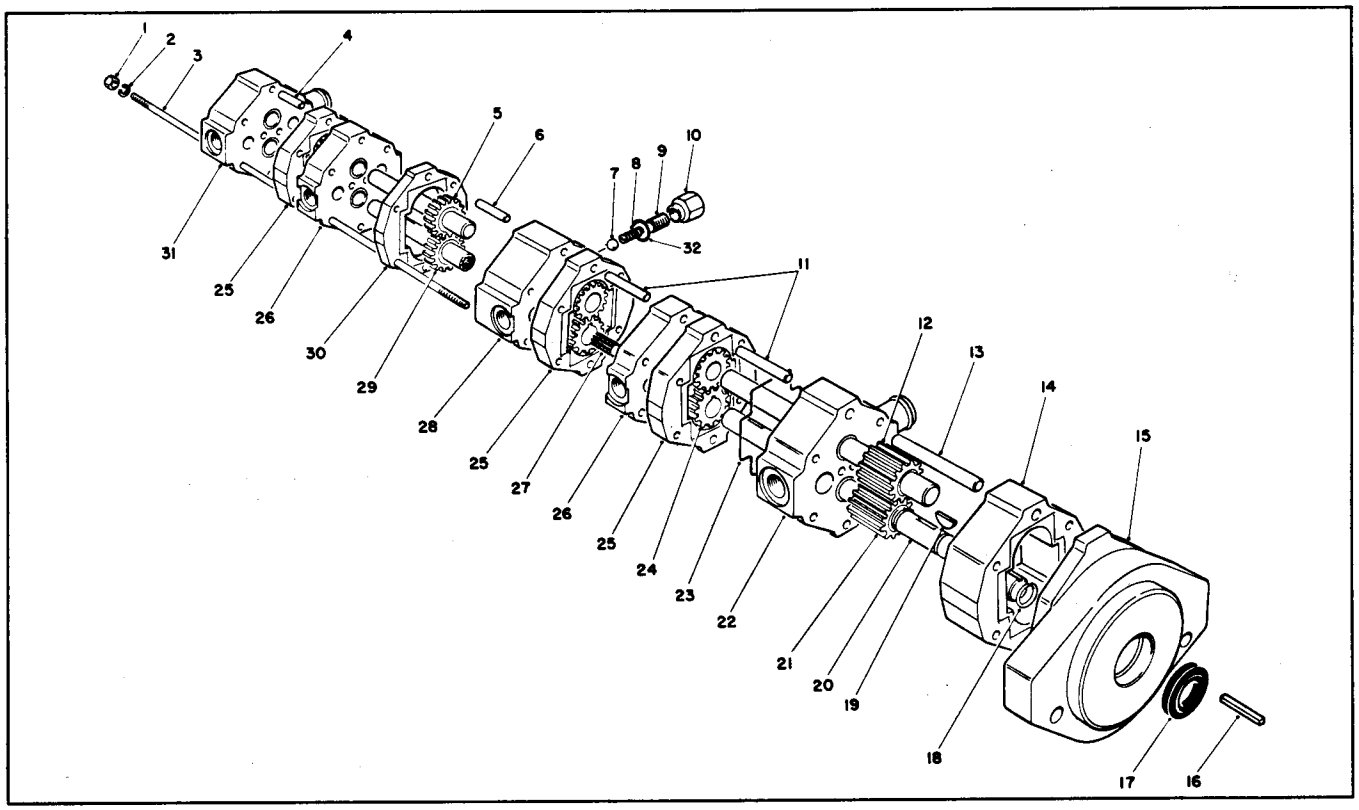


Figure 22

1. Locknut (4)
2. Lockwasher (4)
3. Stud (4)
4. Dowel pin (2)
5. Rear idler shaft & gear
6. Dowel pin (2)
7. Ball
8. Spring
9. Valve adjuster
10. Cap
11. Dowel pin (2)
12. Front idler shaft & gear
13. Dowel pin (2)
14. Gear plate - 66B
15. Body assembly
16. Square key
17. Shaft seal
18. Retaining ring (2)
19. Woodruff key (4)
20. Drive shaft
21. Gear - 66B
22. Bearing plate assembly
23. Seal ring (10)
24. Gear - 33B (6)
25. Gear Plate - 33B (3)
26. Bearing plate assembly (2)
27. Splined adapter
28. Bearing plate assembly
29. Drive shaft & gear
30. Gear plate - 18B
31. Rear cover assembly
32. Gasket

Relief Valve Service

1. Remove cap (Fig. 22, Item 10). Remove valve adjuster (Item 9), spring (Item 8), and ball (Item 7).

2. Remove o-ring (Item 32) from cap.

3. Inspect ball for burrs or roughness. Inspect relief valve bore and seat in bearing plate (Item 28).

4. Inspect spring for damage.

5. Clean and dry all parts. Apply hydraulic oil to parts. Install ball, spring and valve adjuster.

6. Install new o-ring on cap and install cap.

7. Before operating the machine, check steering relief pressure and adjust to 800 psi. To adjust, remove cap, turn adjuster clockwise to increase pressure and counterclockwise decrease pressure. (See Test Hook Up No. 5, Steering Pump Flow and Steering Pump Relief Setting in the Testing section of this chapter.)

Pump Service

1. Plug ports and wash exterior of pump with mineral spirits or solvent. Make sure parts and work area are clean.

2. Draw a line across the seam areas on the pump case with a scribe or marker to ensure proper reassembly.

IMPORTANT: Use caution when using a vise to avoid distorting any parts.

3. Secure the flange end of the pump (Fig. 22, Item 15) in a vise with the drive shaft (Item 20) pointing down.

4. Remove the four locknuts (Item 1) and lockwashers (Item 2).

5. Put your hand on the pump case and gently tap the pump case with a soft face hammer to loosen the pump sections. Be careful not to drop parts or disengage gear mesh.

6. Before removing each gear set, apply marking dye to mating teeth to retain "timing" when reassembling.

7. Be careful when disassembling. The needle bearings in the body assembly (Item 15) may be of the loose grease retained type. Pack these with general purpose grease to retain them for reassembly. It is recommended NOT to remove the bearing races from the flange assembly.

8. Remove and discard the oil seal and seal rings (Items 17 and 23) as the pump is disassembled.

9. Clean all parts. All parts must be check for burrs, scoring, nicks, etc. Check the bushings in the plate assemblies (Items 22, 26 and 28) and cover assembly (Item 31) for excessive wear or scoring. Replace the assemblies as necessary. The bushings are not serviceable.

10. Stone gears if plate surfaces appear scored. Replace gears as sets if necessary. Oil the inside of gear plates (Items 14, 25 and 30) and insert gear sets, maintaining the original timing and locations.

11. Assemble pump sections starting at the body assembly (Item 15). Install woodruff keys (Item 19) and align keyways in gears as they are installed over the shafts. Apply grease to new seal rings (Item 23) before installing.

12. After pump has been assembled, tighten locknuts by hand. Rotate the drive shaft to check for binding. Protect the shaft if using a pliers.

13. Tighten the locknuts evenly in a crossing pattern to a torque of 17 to 19 ft-lb.

14. Before installing oil seal (Item 17) put seal protector on pump shaft or apply tape on the shaft.

15. Before installing fill volume between lips of new seal with Master Lubricant Co. "Lubrico M-6", Lubriplate "Aero Lube" or equivalent. Apply grease to inside diameter of new oil seal. Carefully install a new oil seal. Assemble spring loaded lip of seal toward bearing.

Control Valve Removal and Installation

1. Remove knob from the shift lever and disassemble the right side panel from the machine.

2. Remove the seat or secure it in an up position, disconnect the wires from the safety switch located on the valve bank and place a drain pan under the valve bank.

3. Disassemble the chain links from all five (5) spools.

4. Tag and identify the lines leading to the valve bank, disconnect and cap the lines and fittings with plastic plugs.

5. Loosen the capscrews securing the valve bank to the frame and remove the valve bank.

NOTE: Shims may be installed between the bank and frame. Note the quantity and mounting location and install in proper location upon reassembly.

6. Reverse steps 1 - 5 to install the valve bank. Do not over-tighten fittings. Use two wrenches to secure flexible line connectors, one wrench to prevent the Line from twisting, the other to tighten the connection. (See the Hydraulic Lines and Fittings section of this chapter.)

7. Check to be sure all lines are routed correctly and are not in contact with one another or other components. It should be possible to slip a strip of paper between any lines and other components in close relationship. Relocate if necessary.

8. Adjust the traction linkage, switches and reel drive camshaft as necessary.

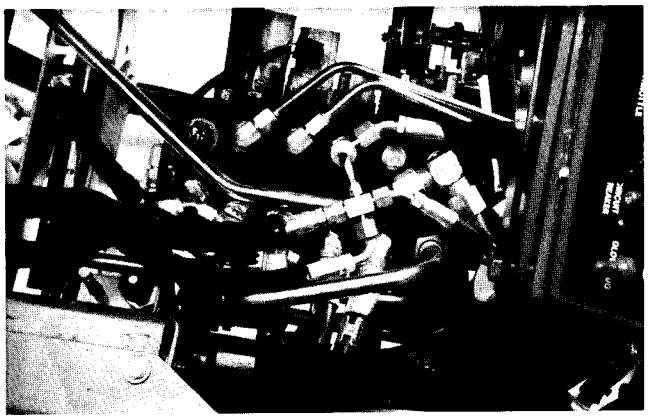


Figure 23

Relief Valve Removal and Installation

1. Be careful not to interchange parts, such as springs or shims, between relief valves. The same number and thickness of shims must be installed when reassemblintg the relief valve.

2. Clean and inspect relief valve parts (Fig. 27) and the valve section housing. Replace parts as necessary. Install new seals and back-up rings. Apply hydraulic oil to parts before installing.

3. Before operating the machine, check the relief pressure for the affected relief valve. (See the Testing section of this chapter.) Adjust relief valve by adding or removing shims between the spring and poppet.

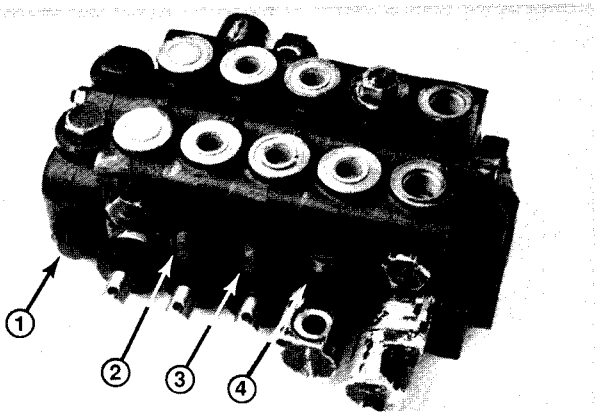


Figure 24

1. Main & No. 1 section relief
2. No. 2 section port relief
3. No. 3 section port releif
4. No. 4 (traction) relief

Control Valve Spool Seal Replacement

IMPORTANT: To prevent leakage, make sure you keep foreign material such as dirt, sand or paint chips out of valve body seal grooves.

NOTE: Except for the seal under No. 4 spool bonnet, the valve bank does not normally have to be removed from the machine to replace spool seals.

Front (Chain Link) Side

1. Remove the chain link, boot and breather washer from the spool (Fig. 25).

2. Remove the seal retainer, back-up washer and lip seal from the valve body. Clean the seal groove.

3. Soak the new seal in clean hydraulic fluid. INSTALL THE SEAL WITH THE OPEN (LIP) SIDE FACING IN TOWARDS THE VALVE BODY. Install the back-up washer and seal retainer

4. Install the breather washer, boot and chain link. Start the engine and check for leaks.

Rear (Bonnet) Side

1. Remove the bonnet (Fig. 26).

NOTE: The valve bank must be removed in order to replace the spool seal under the bonnet on No. 4 spool.

2. Disassemble the components attached to the rear of the spool. (See Control Valve No. 1 Spool Detent Replacement and Control Valve No. 4 Spool Detent Replacement in this section of the book.)

NOTE: The assemblies under each spool bonnet are different from one another. Pay close attention to how they are disassembled so they will be reassembled correctly.

3. Remove the seal retainer, back-up washer, and lip seal from the valve body and clean the seal groove.

4. Soak the new seal in clean hydraulic fluid. INSTALL THE SEAL WITH THE OPEN (LIP) SIDE FACING IN TOWARDS THE VALVE BODY. Install the back-up washer, seal retainer and remaining components.

IMPORTANT: Make sure the switch is correctly positioned and adjusted when bonnet is installed on No. 2 or No. 4 spool. (See Mow/Lift Switch Replacement and Adjustment or Traction Switch Replacement and Adjustment in Chapter 6 - Electrical System.)

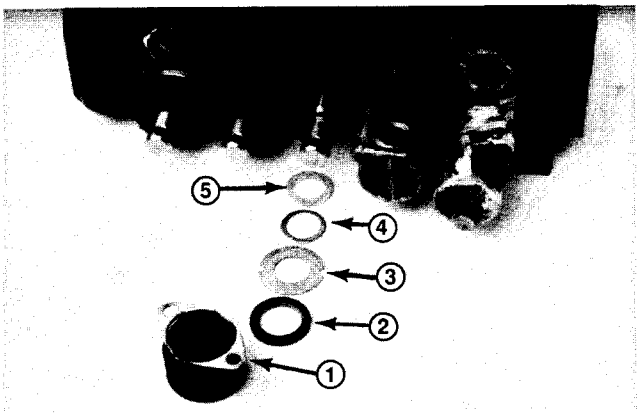


Figure 25

1. Boot
2. Breather washer
3. Seal retainer
4. Back-up washer
5. Lip seal

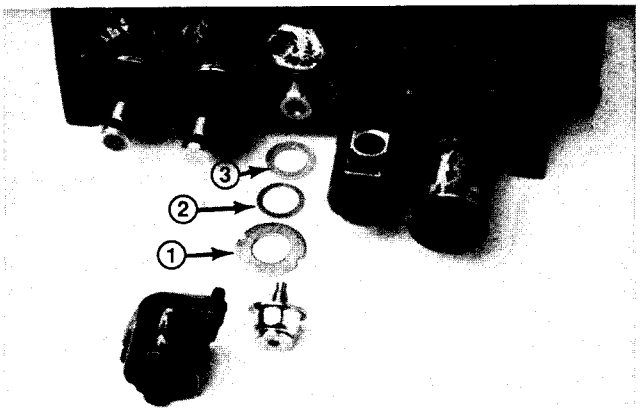


Figure 26

1. Seal retainer
2. Back-up washer
3. Lip seal

Control Valve Internal Seal Replacement

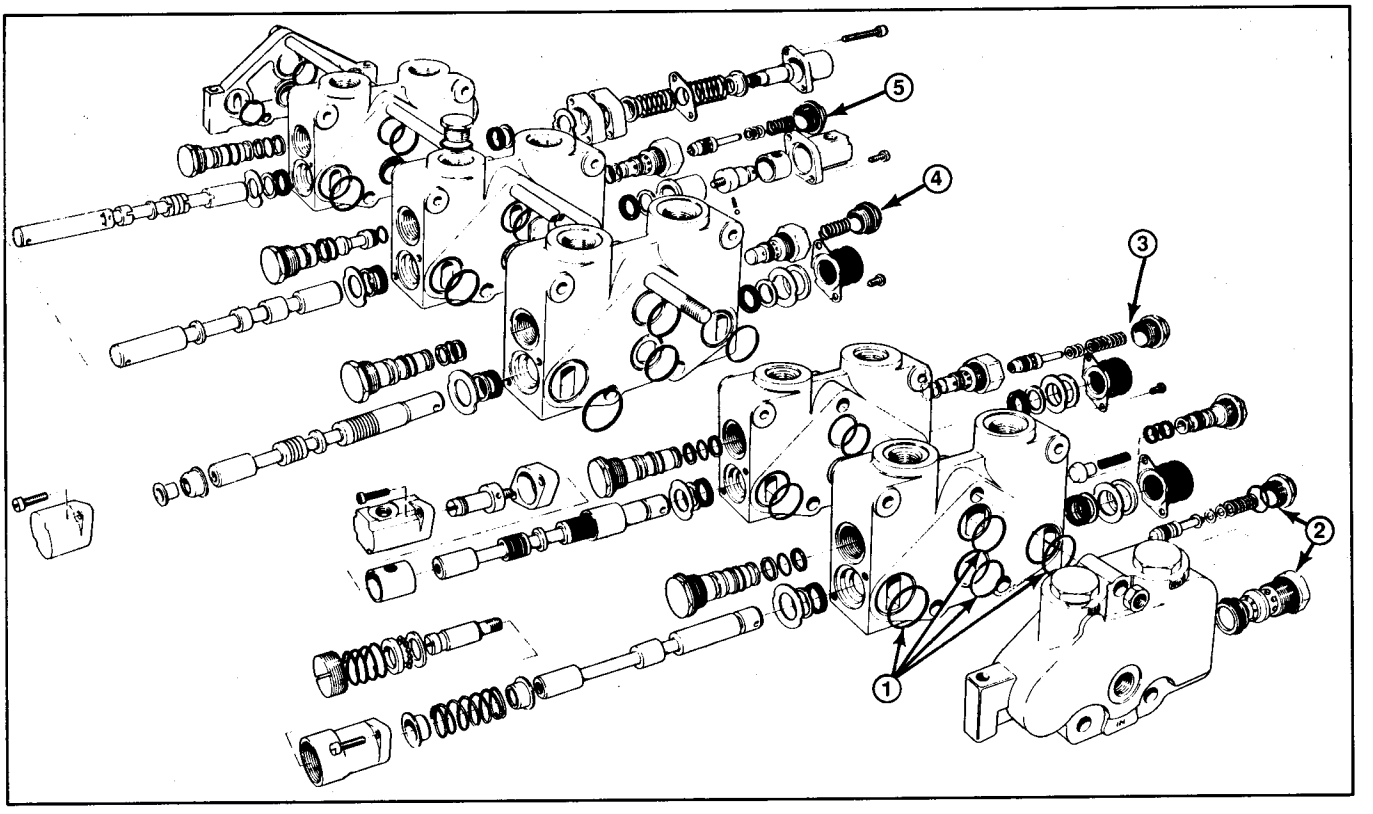


Figure 27

1. Internal seals (4 between ea. sect.)
2. Main & No. 1 section relief valve
3. No. 2 section relief valve
4. No. 3 section relief valve
5. No. 4 (traction) section relief valve

NOTE: Replace all internal seals whenever valve sections are disassembled. Original seals may not seal after the valve assembly is installed on the machine.

1. Remove the valve bank. (See Control Valve Removal and Installation in this section of the book.)

2. Put the valve bank in a vertical position in a bench vise, and remove the locknuts from the three (3) bolts securing the sections together (Fig. 27).

3. Slide each section off the studs. Identify them so they will not be reassembled in the wrong location.

4. Remove all original o-ring seals, clean the o-ring grooves and check the mating surfaces of each section for any imperfections or contaminants which could cause leakage to occur.

5. Soak the replacement o-rings in clean hydraulic fluid and install them into the ring grooves as you stack each section on top of another.

6. Install the locknuts onto the studs and torque them to 15-20 ft-lb (20.4-27.2 Nm).

IMPORTANT: Do not overtorque. This will distort the valve bodies and cause binding of the spools.

7. Install the valve bank onto the machine.

Control Valve No. 1 Spool Detent Replacement

NOTE: These procedures can be done with the control valve assembly installed on the machine.

1. Remove the entire detent assembly (Fig. 28 and 29) from the control valve. Keep the backup washer, seal retainer and seal with the spool.

2. Apply Locktite 222 or equivalent to threads of detent stud (Item 9) and assemble into spring and stop collars (Items 6 and 8). Thread the assembly into the No. 1 spool. The spring (Item 6) needs to be compressed to get detent stud started. Anchor the slotted end of the spool and apply 10-14 ft-lb (13.6-19 Nm) torque to detent stud (Item 9).

3. Slip bonnet (Item 1) over the entire assembly and secure it to the valve body with the two capscrews. Be sure slot in mounting face of bonnet is at bottom before installation.

4. Install the thrust plate (Item 5) into the bonnet (Item 1) so it bottoms out. Apply approximately 1/4 in. (6 mm) of #2 multi-purpose Lithium-base grease on top of thick washer (Item 5).

5. Install twelve balls (Item 4) into thrust plate (Item 5).

IMPORTANT: If the detent bonnet contains a vent pocket, do not let the balls fall into the vent.

6. Insert race (Item 3) on top of balls with ramp of race facing inward as shown. Rotate race (Item 3) until you are sure all balls are resting properly against the surfaces of the race and thrust plate (Items 3 and 5).

7. Insert spring (Item 2) into bonnet (Item 1).

8. Apply Locktite 222 or equivalent to the threads of adjustment cap (Item 10) and thread into bonnet. Turn adjustment cap in to compress the spring (Item 2). Actuate the spool assembly, then turn the adjustment cap until the desired detent action is obtained. This will usually be within three turns from bottoming out the adjustment cap..

NOTE: Each turn of adjustment cap (Item 10) changes the "Feel" of the detent action about 20%.

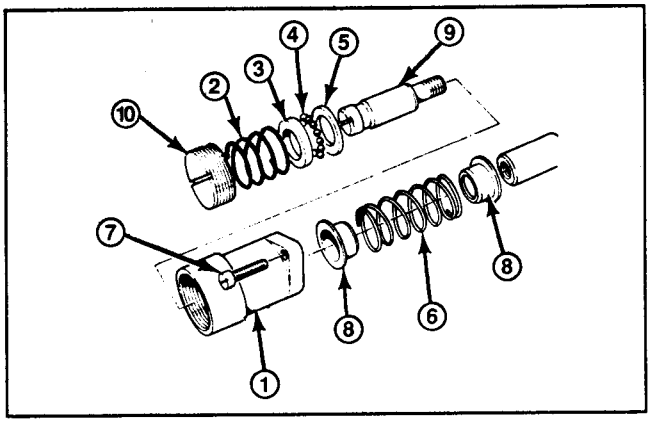


Figure 28

1. Bonnet
2. Spring
3. Race
4. Ball
5. Thrust plate
6. Spring
7. Capscrew
8. Stop collars
9. Detent stud
10. Adjustment cap

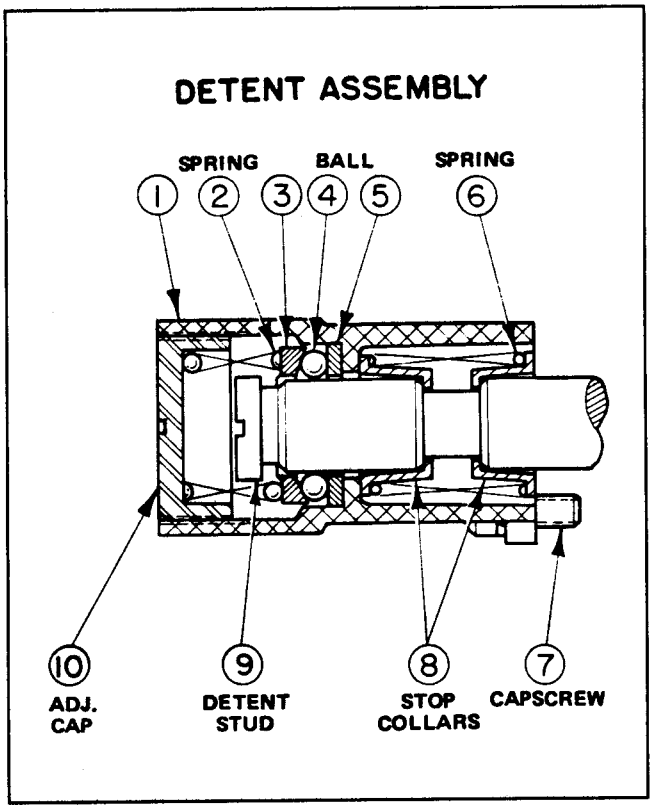


Figure 29

Control Valve No. 4 Spool Detent Replacement

NOTE: The control valve assembly must be removed to replace this assembly. (See Control Valve Removal and Installation in this section of the book.)

1. Be sure No. 4 spool is in neutral and remove the bonnet, large spring, and stop collar. (Fig. 30).

2. Hold one hand in front of detent sleeve and push the front of the spool in very slowly until the detent balls pop out. Be sure to remove all four (4) balls.

3. Push the front of the spool in carefully until the holes in the detent adapter are just past the edge of the detent sleeve.

IMPORTANT: Do not push the spool too far or the rear spool seal may be cut by the spool.

4. Hold the front of the spool from turning, insert a drift punch through the holes in the adapter and rotate the adapter counter-clockwise to remove it from the spool.

5. Remove the detent sleeve.

Reassemble With the Following Procedures:

1. Mount the detent sleeve and the detent adapter. Lock the adapter securely to the spool.

2. Apply a light coat of grease to the adapter holes, insert the small spring, the four balls, and the ball follower.

3. Stand the valve bank assembly up so the front (clevis end) of No. 4 spool is facing downward.

4. Slide the detent sleeve up to the four balls. Apply light pressure against the balls with the sleeve. Push against the center of the ball follower with a drift punch to allow the balls to slip into the adapter holes and the sleeve to slide over the assembly.

IMPORTANT: Do not push spool too far or the rear spool seal may be cut by the spool.

5. Assemble the stop collar, large spring and bonnet to the valve body. Check the spool for proper detent operation and mount the valve bank onto the machine.

6. Adjust the traction switch. (See Traction Switch Removal, Installation and Adjustment in the Repairs section of Chapter 6 - Electrical System.)

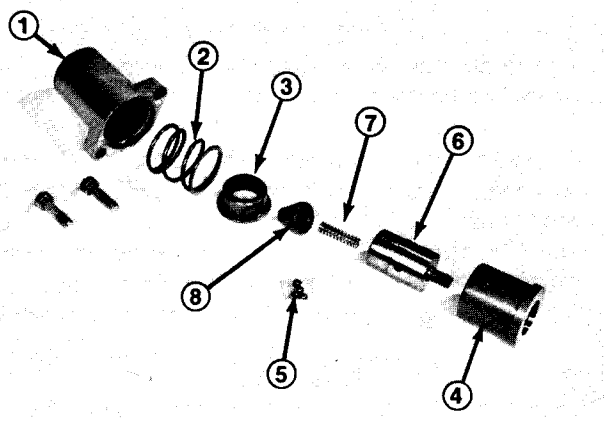


Figure 30

1. Bonnet
2. Spring
3. Stop collar
4. Detent sleeve
5. Balls (4)
6. Detent adapter
7. Spring
8. Ball follower

Lift Cylinder Removal and Installation

No. 1 (Center) Lift Cylinder
(Greensmaster 3000, Model 04350)

1. Put drain pan under machine.

2. Remove hydraulic lines.

3. Remove capscrews securing top and bottom of cylinder to machine (Fig. 31). Remove cylinder from both pivots simultaneously.

4. Reverse steps 2 and 3 to install the lift cylinder.

NOTE: On some machines it may be necessary to remove the four engine mount bolts and slide the engine over to gain clearance for cylinder removal.

IMPORTANT: When disassembling hydraulic lines make sure hydraulic plugs are placed in the open end of the hydraulic line to prevent foreign debris from contaminating hydraulic oil. It is also a good idea to tag the hydraulic lines when disassembling so they can be properly reassembled. Keep all hydraulic lines clean and free from foreign debris. During replacement of lift cylinder, avoid over-tightening fittings. Check hydraulic lines for cracks or breaks. If a hydraulic leak should appear after replacement of lift cylinder, replace the fitting or line that is leaking. Check hydraulic reservoir for level of hydraulic fluid after replacement of lift cylinder.

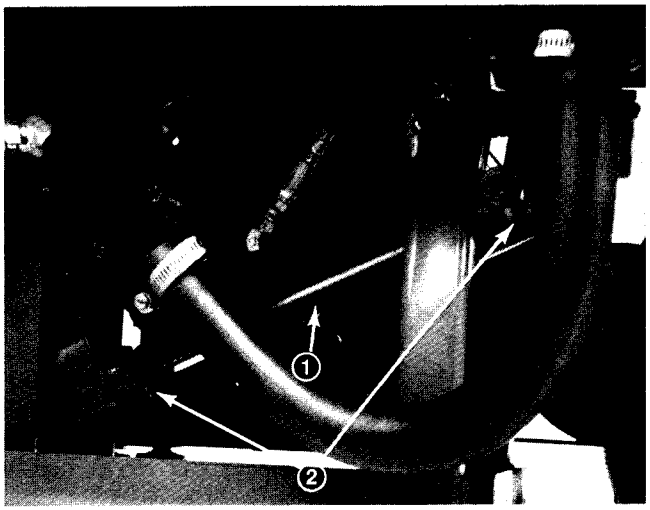


Figure 31

1. No. 1 (center) lift cylinder
2. Capscrew (2)

No. 1 (Center) Lift Cylinder

(Greensmaster 3000-D, Model 04375)

1. Put drain pan under machine.

2. Remove hydraulic lines.

3. Remove capscrew and locknut securing pin in barrel end of cylinder.

4. Remove pin securing barrel end of cylinder to the frame (Fig. 32).

5. Remove cylinder by lowering barrel end and sliding shaft/clevis end off of the lift arm.

6. Reverse steps 2 - 5 to install the cylinder. Coat cylinder pivot on lift arm with Never-Seez or grease to achieve free pivot action of lift arm in cylinder clevis before reinstalling.

IMPORTANT: When disassembling hydraulic lines make sure hydraulic plugs are placed in the open end of the hydraulic line to prevent foreign debris from contaminating hydraulic oil. It is also a good idea to tag the hydraulic lines when disassembling so they can be properly reassembled. Keep all hydraulic lines clean and free from foreign debris. During replacement of lift cylinder, avoid over-tightening fittings. Check hydraulic lines for cracks or breaks. If a hydraulic leak should appear after replacement of lift cylinder, replace the fitting or line that is leaking. Check hydraulic reservoir for level of hydraulic fluid after replacement of lift cylinder.

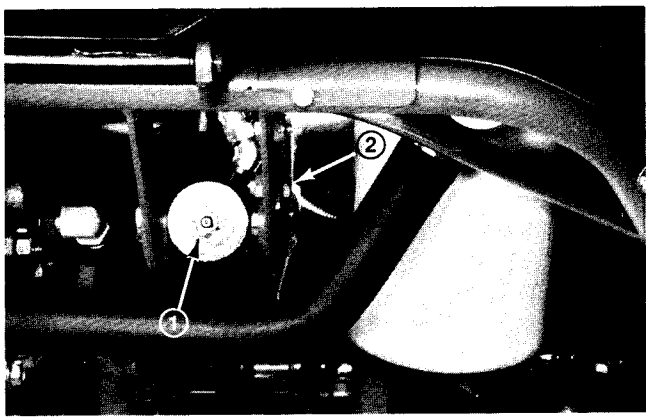


Figure 32

1. No. 1 (center) lift cylinder
2. Capscrew and locknut

No. 2 and 3 Lift Cylinders

1. Remove the tool box to gain access to No. 2 cylinder. Remove the cover plate to gain access to No. 3 cylinder. Other disassembly procedures are the same for both cylinders.

2. Put drain pan under machine and remove hydraulic lines.

3. Remove cotter pin and clevis pin from cylinder rod (Fig. 33).

4. Remove capscrew securing hinge pin through top of cylinder and remove hinge pin to free cylinder from machine.

5. Reverse steps 2 - 5 to install the lift cylinder. Coat the hinge pin with Never-Seez or grease to achieve free pivot action of the cylinder before reassembling.

IMPORTANT: When disassembling hydraulic lines make sure hydraulic plugs are placed in the open end of the hydraulic line to prevent foreign debris from contaminating hydraulic oil. It is also a good idea to tag the hydraulic lines when disassembling so they can be properly reassembled. Keep all hydraulic lines clean and free from foreign debris. During replacement of lift cylinder, avoid over-tightening fittings. Check hydraulic lines for cracks or breaks. If a hydraulic leak should appear after replacement of lift cylinder, replace the fitting or line that is leaking. Check hydraulic reservoir for level of hydraulic fluid after replacement of lift cylinder.

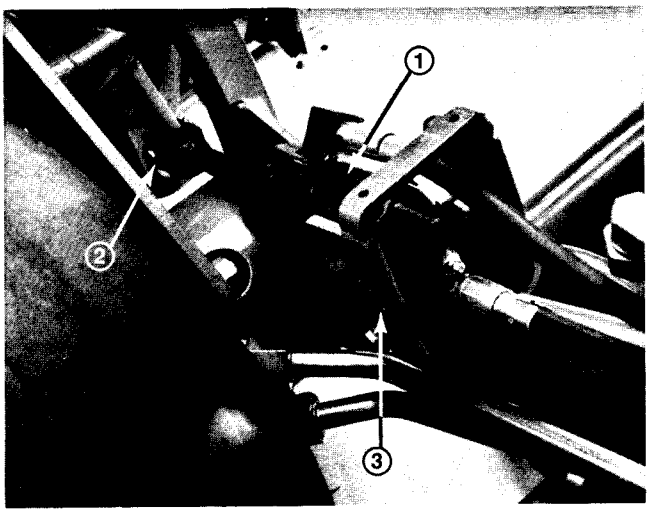


Figure 33

1. No. 2 (L.H.) lift cylinder
2. Cotter pin and clevis pin
3. Hinge pin

Lift Cylinder Repair – No. 1 (Center)

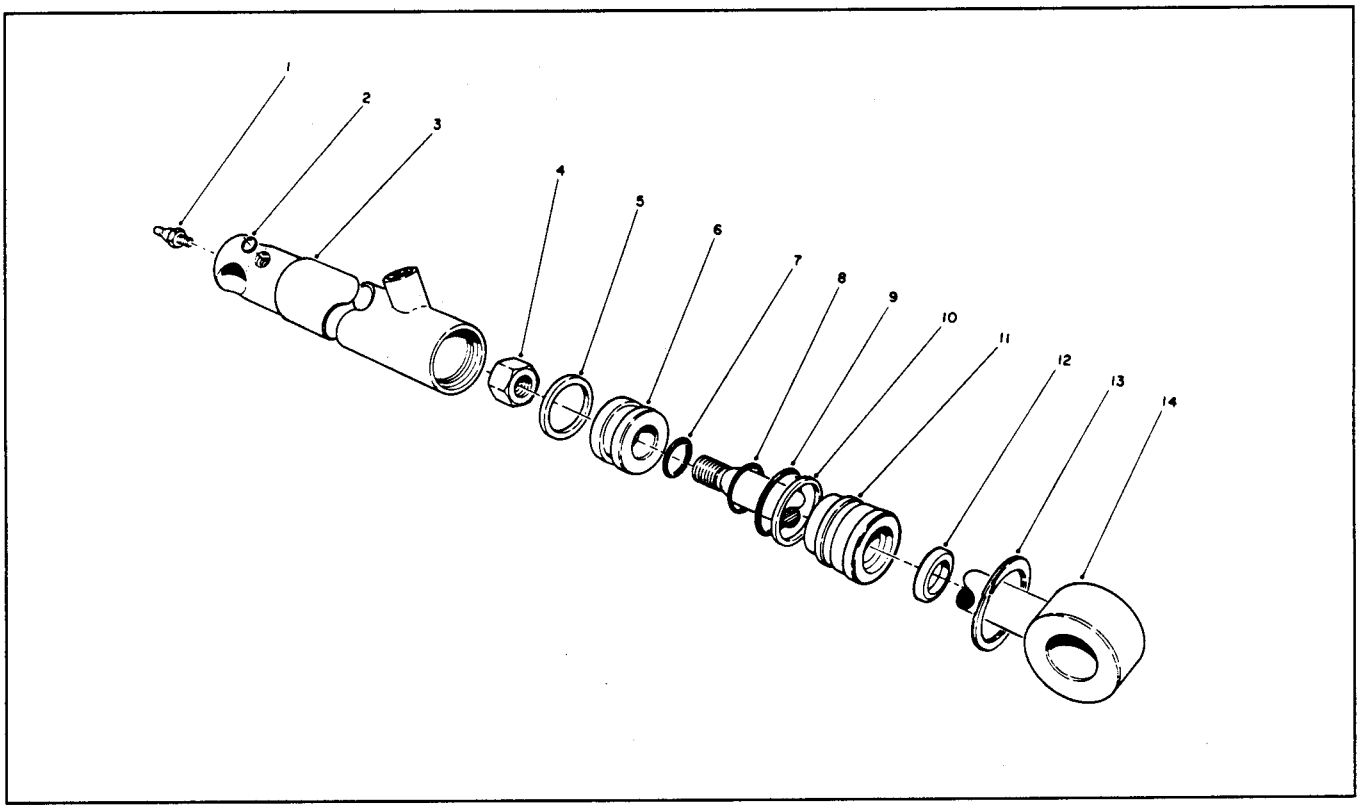


Figure 34

1. Grease fitting
2. O-ring
3. Barrel
4. Nut
5. Uniring seal
6. Piston
7. O-ring
8. Poly-pack seal
9. O-ring
10. Back-up ring
11. Head
12. Dust seal
13. Retaining ring
14. Shaft

NOTE: The parts shown in the illustration above (Fig. 34) may not be the same as on your machine. Refer to the Parts Catalog (with the correct Model and Serial Number of your machine) for the correct parts illustration.

IMPORTANT: To prevent damage when clamping the cylinder barrel in a vise, clamp only on the pivot end. Do not clamp the vise jaws against the smooth shaft surface. Protect the shaft surface before mounting in the vise.

1. After removing the cylinder, pump the oil out of the cylinder into a drain pan by SLOWLY moving the cylinder's piston in and out of the cylinder bore.

2. Plug the ports and clean the outside of the cylinder.

3. Mount the cylinder in a vise so the shaft end of the cylinder is tilted up slightly. Do not close the vise so firmly that the barrel could become distorted.

4. Remove the retaining ring (Fig. 34). Grasp the clevis end of the shaft and use a twisting and pulling motion to carefully extract the piston, shaft, and head from the barrel.

5. Securely mount the shaft in a vise and remove the lock nut from the piston end of the shaft. Remove the piston. Slide the head off of the shaft.

6. Remove and discard all seals and back-up rings.

7. Wash the parts in a safe solvent. Dry the parts with compressed air. DO NOT wipe them dry with a cloth or paper as lint and dirt may remain.

8. Inspect the internal surface of the barrel for damage (deep scratches, out-of-round, etc.). Inspect the head, shaft and piston for evidence of excessive scoring, pitting, or wear. Replace any defective parts.

9. Put a light coating of hydraulic oil on all new seals and back-up washers. Install the new seals and back-up washers. Install the head onto the piston rod. Install the piston onto the shaft and tighten the lock nut.

10. Put a light coating of hydraulic oil on all cylinder parts to ease assembly. Slide the shaft assembly and head into the barrel. Install the retaining ring to secure the assembly in the barrel.

Lift Cylinder Repair – No. 2 and 3 (Left and Right)

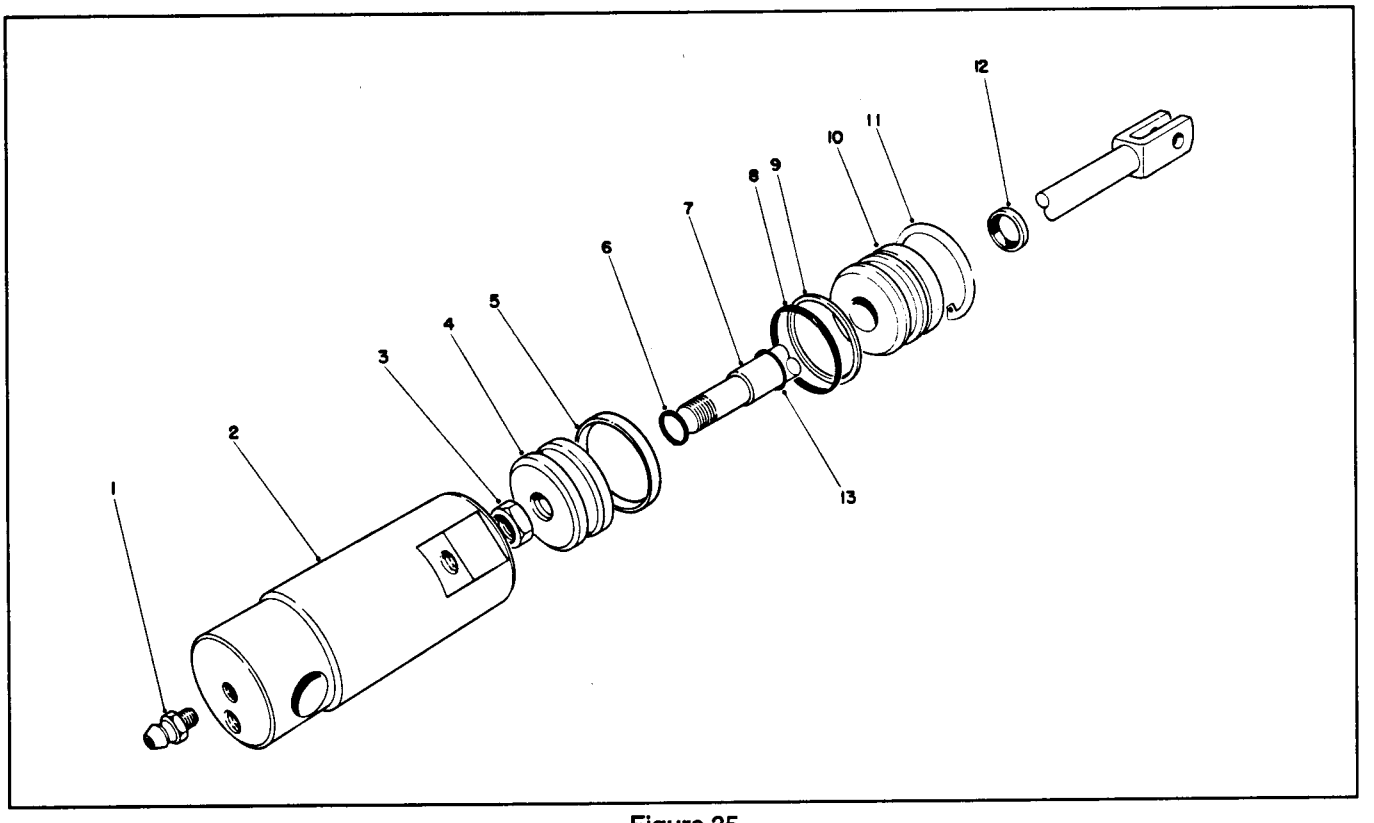


Figure 35

1. Grease fitting
2. Barrel
3. Lock nut
4. Piston
5. Uniring seal
6. O-ring
7. Shaft
8. O-ring
9. Back-up washer
10. Head
11. Retaining ring
12. Dust seal
13. Polypack seal

NOTE: The parts shown in the illustration above (Fig. 35) may not be the same as on your machine. Refer to the Parts Catalog (with the correct Model and Serial Number of your machine) for the correct parts illustration.

IMPORTANT: To prevent damage when clamping the cylinder barrel in a vise, clamp only on the pivot end. Do not clamp the vise jaws against the smooth shaft surface. Protect the shaft surface before mounting in the vise.

1. After removing the cylinder, pump the oil out of the cylinder into a drain pan by SLOWLY moving the cylinder's piston in and out of the cylinder bore.

2. Plug the ports and clean the outside of the cylinder.

3. Mount the cylinder in a vise so the shaft end of the cylinder is tilted up slightly. Do not close the vise so firmly that the barrel could become distorted.

4. Remove the retaining ring (Fig. 35). Grasp the clevis end of the shaft and use a twisting and pulling motion to carefully extract the piston, shaft, and head from the barrel.

5. Securely mount the shaft in a vise and remove the lock nut from the piston end of the shaft. Remove the piston. Slide the head off of the shaft.

6. Remove and discard all seals and back-up rings.

7. Wash the parts in a safe solvent. Dry the parts with compressed air. DO NOT wipe them dry with a cloth or paper as lint and dirt may remain.

8. Inspect the internal surface of the barrel for damage (deep scratches, out-of-round, etc.). Inspect the head, shaft and piston for evidence of excessive scoring, pitting, or wear. Replace any defective parts.

9. Put a light coating of hydraulic oil on all new seals and back-up washers. Install the new seals and back-up washers. Install the head onto the piston rod. Install the piston onto the shaft and tighten the lock nut.

10. Put a light coating of hydraulic oil on all cylinder parts to ease assembly. Slide the shaft and head into the barrel. Install the retaining ring to secure the assembly in the barrel.

Wheel Motor Removal and Installation

1. Put blocks on each side off opposite drive wheel. Lift the frame with a jack and put blocks under wheel motor to support the frame.

2. Remove wheel nuts and remove wheel. Remove large nut from wheel hub.

3. Mount a wheel puller to wheel mount studs and remove wheel hub and brake drum (Fig. 36). Remove key from wheel motor shaft.

4. Disconnect hydraulic lines from fittings on wheel motor. Put caps on open lines and fittings to prevent contamination.

5. Remove four (4) capscrews, nuts and lockwashers to remove wheel motor and brake brackets from frame.

6. Reverse steps 1 - 6 to install the wheel motor.

IMPORTANT: When disassembling hydraulic lines make sure hydraulic plugs are placed in the open end of the hydraulic line to prevent foreign debris from contaminating hydraulic oil. It is also a good idea to tag the hydraulic lines when disassembling so they can be properly reassembled. Keep all hydraulic lines clean and free from foreign debris. During replacement of wheel motor, avoid over-tightening fittings. Check hydraulic lines for cracks or breaks. If a hydraulic leak should appear after replacement of lift cylinder, replace the fitting or line that is leaking. Check hydraulic reservoir for level of hydraulic fluid after replacement of lift cylinder.

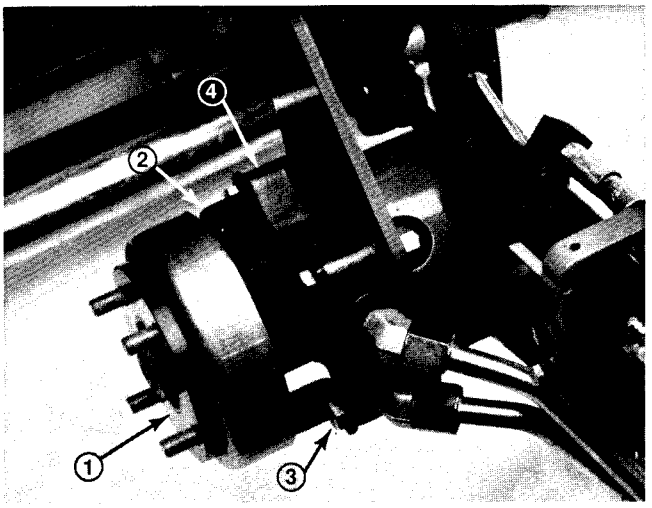


Figure 36

1. **Wheel hub and brake drum**
2. **Brake bracket**
3. **Capscrews, nuts and lockwashers (4)**
4. **Wheel motor**

Wheel Motor Shaft Seal and/or Shaft Replacement – Nichols Gray
(Greensmaster 3000-D, Model 04375)

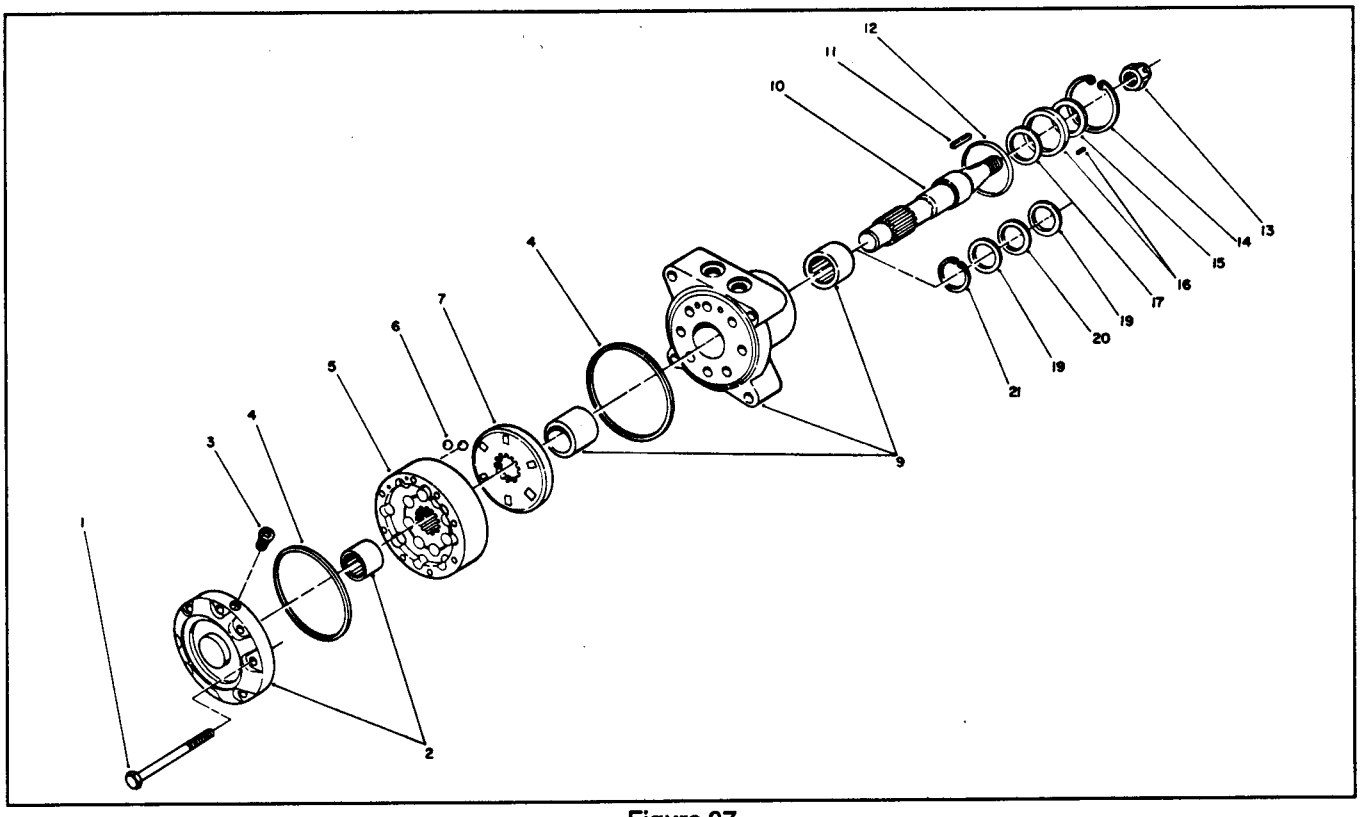


Figure 37

1. Screw
2. Cover & bearing ass'y
3. Plug
4. Seal
5. IGR assembly
6. Check ball
7. Valve plate
9. Body & bearing assembly
10. Shaft
11. Key
12. O-ring
13. Nut
14. Snap ring
15. Dust seal
16. Retainer pin
17. Lip seal
19. Thrust washer
20. Thrust bearing
21. Snap ring

Disassembly of Shaft and Front Seal Assembly

1. Put the motor on a clean, flat surface with the shaft facing up. Clean the front end of the motor to avoid contaminating the internal parts during the procedure.

2. Remove key (Figure 37, Item 11) from the shaft.

3. Remove the snap ring (Item 14) using a snap ring pliers.

4. Pull the shaft (Item 10) out vertically.

IMPORTANT: When pulling shaft vertically, do not rotate the shaft or move the motor as this may alter internal timing.

5. With the seal retainer assembly and shaft assembly removed, remove all the parts from the shaft and inspect the various parts of the seal assembly (Item 15, 16, 17), shaft (Item 10) and thrust bearing assembly (Item 19, 20, 21). Replace any worn or damaged parts. Always replace the seal retainer assembly (Item 15, 16, 17). The shaft should have smooth polished surfaces in the bearing and seal areas. If the shaft is lightly scratched in these areas, polish with fine emery paper in a circumferential direction. However, if the shaft has any pitting or deep scratches, the entire motor should be disassembled for inspection.

Assembly of Shaft and Front Seal Assembly

1. Assemble the thrust washers (Figure 37, Item 19) and thrust bearing (Item 20) on the shaft using the snap ring (Item 21). The snap ring sharp edges MUST face away from the thrust washers with the thrust bearing (Item 20) between the washers.

2. Slowly lower the spline end of the shaft (Item 10) assembly into the motor body using caution not to rotate the internal parts once the shaft spline starts to engage.

3. Put the lightly oiled o-ring (Item 12) into the groove in the body bore.

4. Gently slide the oiled seal retainer assembly (Item 15, 16, 17) over the shaft, chamfered side first, and press into the body bore. When fully in place, the body snap ring groove will be visible.

5. Install the snap ring (Item 14) into its body groove with the snap ring's sharp edges facing outward and the retainer pin between the snap ring lugs, Be sure the snap ring is completely seated in the groove.

Wheel Motor Repair – Nichols-Gray (Greensmaster 3000-D, Model 04375)

IMPORTANT: Before DISASSEMBLING the motor, plug open ports and clean all dirt from the outside of the motor.

IMPORTANT: Before ASSEMBLING the motor, lightly oil all seals, rollers and threaded bolt ends.

Disassembly of Cover Section of Motor

1. Remove the key (Figure 37, Item 11) from the shaft.

2. Mount the motor in a vice or other holding device with the shaft facing down.

3. Remove the eight bolts (Item 1).

4. Remove the cover/bearing assembly (Item 2) and the square ring seal (Item 4).

5. Remove the IGR set components (Item 5) starting with the outer locating ring, rollers, outer rolls, inner rotor and valve plate (Item 7). If any of these components are damaged, the entire IGR assembly must be replaced.

6. Remove the two check balls (Item 6).

NOTE: The check balls may fall into the body tapered holes or into the body valve ports during disassembly. Be sure that the check balls are removed.

Disassembly of Shaft Section of Motor

(See Disassembly of Shaft and Front Seal Assembly under Main Shaft Seal and/or Shaft Replacement.)

Assembly of Complete Motor

1. Before assembly, all parts must be cleaned with a suitable solvent and free of nicks and burrs.

2. Mount the body with the pilot and bearing facing up in a vise or other holding mechanism.

3. Insert the shaft (Figure 37, Item 10) and install seals and thrust bearings. (See Assembly of Shaft and Front Seal Assembly under Main Shaft Seal and/or Shaft Replacement.)

4. Mount the body with the pilot and bearing facing down in a vise or other holding fixture.

5. Put the rotary valve (Item 7) on the shaft spline with "T" shaped slots on first.

6. Next put the IGR inner member on the shaft spline with the semi-circular roll pockets between the rotary valve ports.

7. Put the contour member of the IGR over the inner and insert seven rolls into the inner pockets (large diameter rolls).

8. Lightly oil the square ring seal (Item 4) and put in the body groove.

9. Put the check balls (Item 6) over the two 1/8" inch diameter holes in the body. Be sure the check balls do not fall into the body tapped holes.

10. Put the locating ring section (4.5 inch diameter) of the IGR (Item 5) onto the body with the check ball holes facing downward over the balls. Align the eight bolt holes in the locating ring with the eight holes in the body. The holes align in only one position.

NOTE: Be sure not to dislodge the body square ring seal while moving the locating ring.

11. Install the eight locating ring rollers (small diameter rolls) into their pockets and oil lightly.

12. Put the other lightly oiled square ring seal (Item 4) into the groove in the cover and put the cover over the shaft end and align the bolt holes.

13. Install the eight bolts with the lightly oiled thread ends into the bolt holes and tighten diagonally to 30 ft-lb. The motor is now ready for installation.

NOTE: The shaft may not turn freely after assembly. A short running period may be required.

When installing the wheel hub onto the motor shaft, tighten the castle nut (Item 13) to 80-90 ft-lb, then continue tightening until the cotter pin slot lines up the hole in the shaft.

Steering Cylinder Removal and Installation (Greensmaster 3000-D, Model 04375)

1. Disconnect the hydraulic hoses from the steering cylinder (Fig. 38). Put caps or plugs on all the fittings and hoses to prevent contamination.

NOTE: To ease reassembly, tag each of the hoses to show their correct position on the steering cylinder.

2. Remove cotter pins and castle nuts securing cylinder ends to frame and castor fork.

3. Remove the cylinder.

IMPORTANT: Before installing the cylinder make sure the distance between ball joint centers is 14.4 in. with cylinder rod completely retracted. Loosen jam nut and adjust ball joint if necessary, then tighten jam nut.

4. Reverse steps 1 - 3 to install the steering cylinder. Tighten each castle nut to 25 - 30 ft-lb, then loosen until slot in nut is aligned with hole in threaded ball joint. Install cotter pins.

5. After installing the cylinder, start the engine and turn the steering wheel left and right from lock to lock several times to get air out of the cylinder.

IMPORTANT: When disassembling hydraulic lines make sure hydraulic plugs are placed in the open end of the hydraulic line to prevent foreign debris from contaminating hydraulic oil. It is also a good idea to tag the hydraulic lines when disassembling so they can be properly reassembled. Keep all hydraulic lines clean and free from foreign debris. During replacement of steering cylinder, avoid over-tightening fittings. Check hydraulic lines for cracks or breaks. If a hydraulic leak should appear after replacement of lift cylinder, replace the fitting or line that is leaking. Check hydraulic reservoir for level of hydraulic fluid after replacement of lift cylinder.

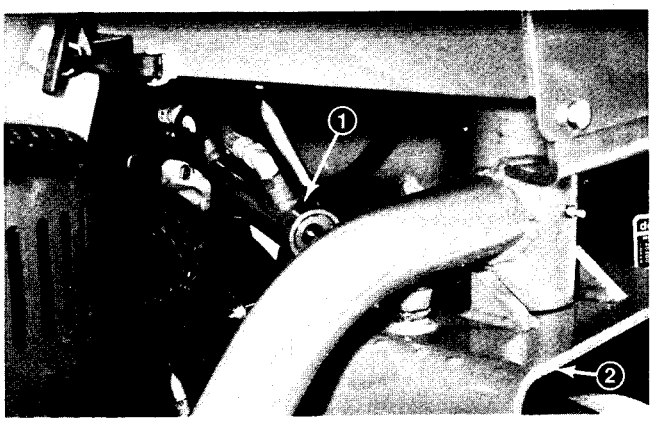


Figure 38

1. **Steering cylinder**
2. **Castle nut and cotter pin (not shown)**

Steering Cylinder Repair (Greensmaster 3000-D, Model 04375)

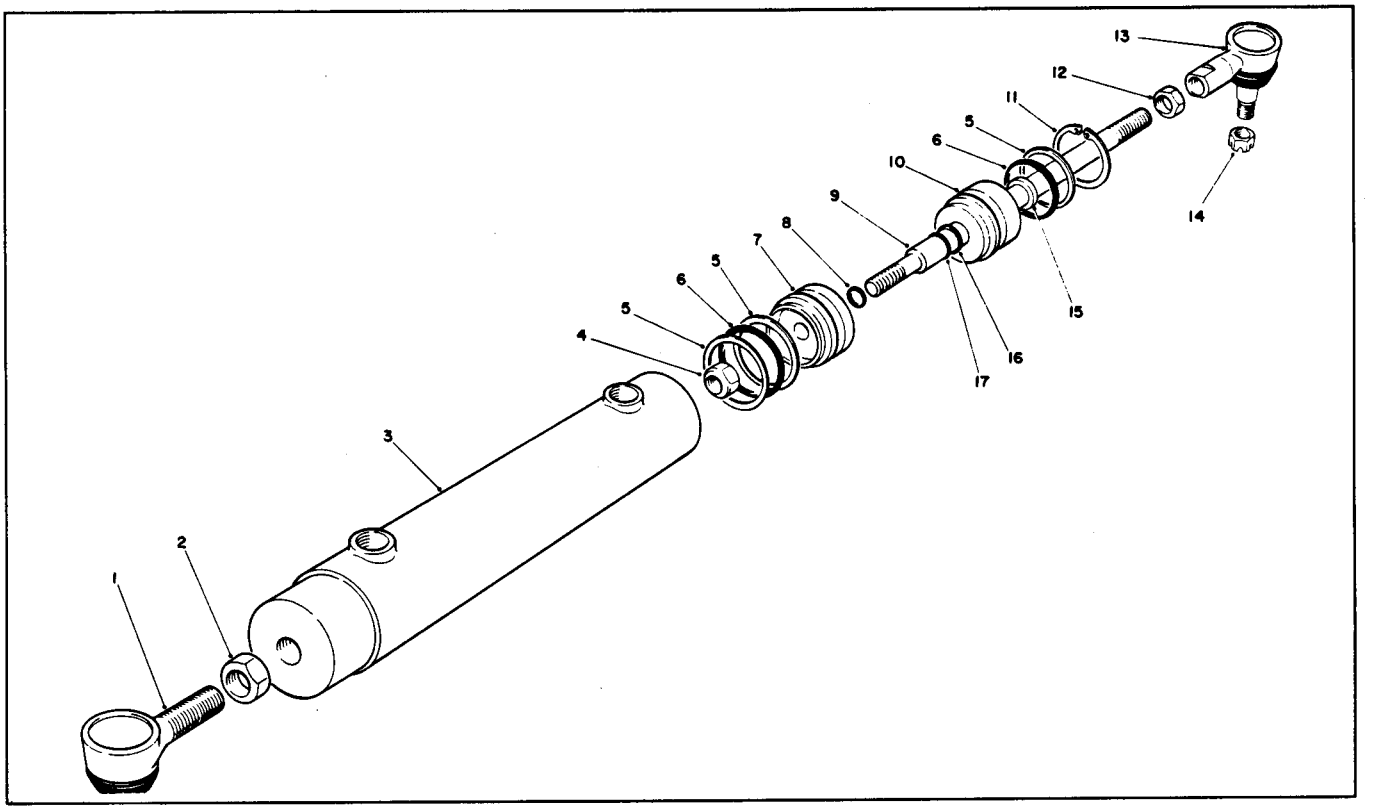


Figure 39

1. Ball joint
2. Jam nut
3. Barrel
4. Lock nut
5. Back-up washer (3)
6. O-ring seal (2)
7. Piston
8. O-ring seal
9. Shaft
10. Head
11. Retaining ring
12. Jam nut
13. Ball joint
14. Castle nut (2)
15. Dust seal
16. Back-up washer
17. Dust seal

IMPORTANT: To prevent damage when clamping the cylinder barrel in a vise, clamp only on the pivot end. Do not clamp the vise jaws against the smooth shaft surface. Protect the shaft surface before mounting in the vise.

1. After removing the cylinder, pump the oil out of the cylinder into a drain pan by SLOWLY moving the cylinder's piston in and out of the cylinder bore.

2. Plug the ports and clean the outside of the cylinder.

3. Mount the cylinder in a vise so the shaft end of the cylinder is tilted up slightly. Do not close the vise so firmly that the barrel could become distorted.

4. Remove the retaining ring (Fig. 39).

5. Grasp the ball joint end of the shaft and use a twisting and pulling motion to carefully extract the piston, shaft, and head from the barrel.

6. Securely mount the shaft in a vise and remove the lock nut from the piston end of the shaft.

7. Remove the piston. Slide the head off of the shaft.

8. Remove and discard all seals and back-up rings.

9. Wash the parts in a safe solvent. Dry the parts with compressed air. DO NOT wipe them dry with a cloth or paper as lint and dirt may remain.

10. Inspect the internal surface of the barrel for damage (deep scratches, out-of-round, etc.). Inspect the head, shaft and piston for evidence of excessive scoring, pitting, or wear. Replace any defective parts.

11. Put a light coating of hydraulic oil on all new seals and back-up washers. Install the new seals and back-up washers.

12. Install the head onto the piston rod. Install the piston onto the shaft and tighten the lock nut.

13. Put a light coating of hydraulic oil on all cylinder parts to ease assembly. Slide the shaft assembly and head into the barrel. Install the snap ring to secure the assembly in the barrel.

Steering Valve Removal and Installation (Greensmaster 3000-D, Model 04375)

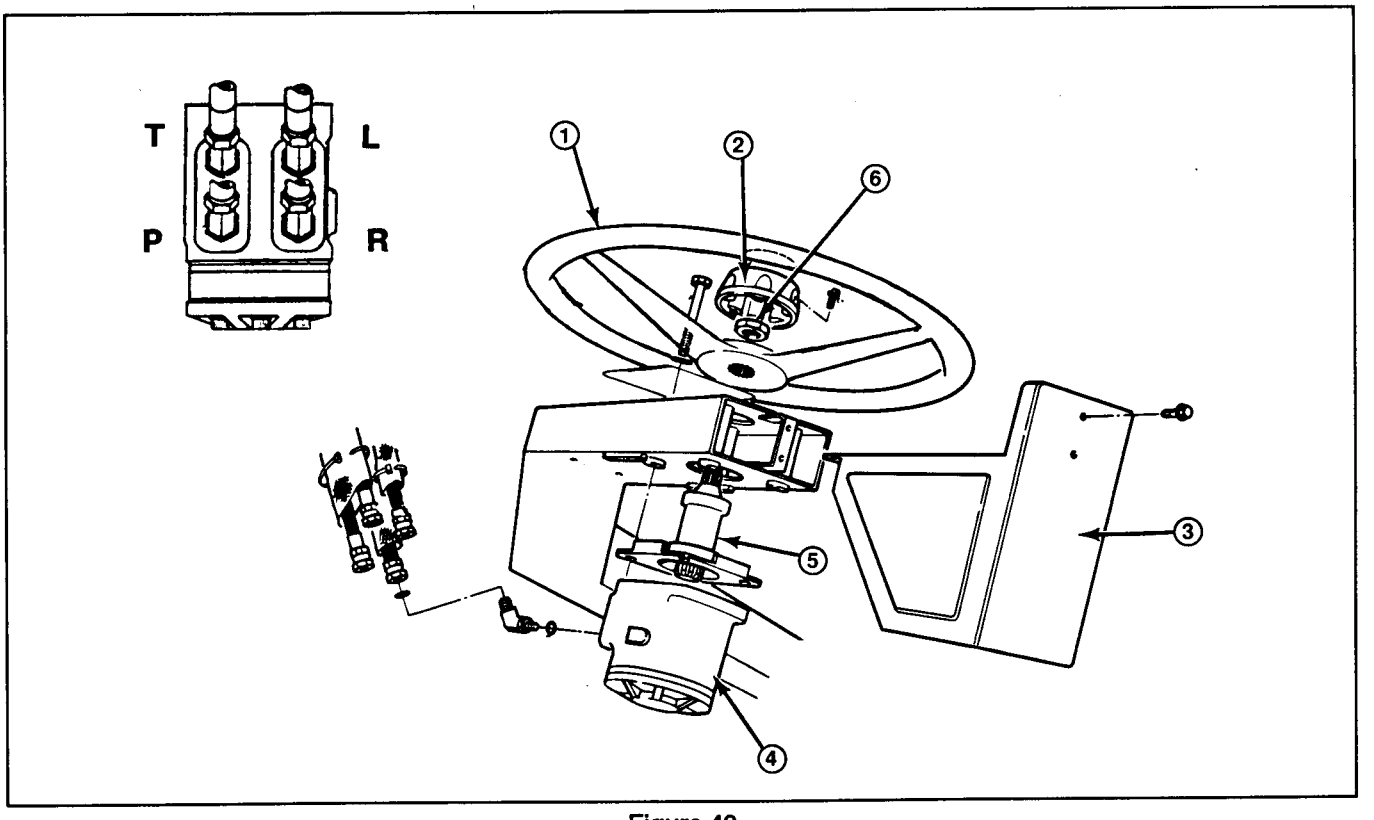


Figure 40

1. Steering wheel
2. Steering wheel cap
3. Steering valve cover
4. Steering valve
5. Steering column
6. Nut

1. Remove four capscrews and remove the steering cover.

2. Clean the outside of the steering valve and the area around the hydraulic fittings. Disconnect the hydraulic hoses from the steering valve (Fig. 40). Put caps or plugs on all the fittings and hoses and tubes to prevent contamination.

NOTE: To ease reassembly, tag each of the hoses to show their correct position on the steering valve.

3. Remove the steering wheel cap from the steering wheel. Remove the locknut that secures the steering wheel to the shaft. Pull the steering wheel off the shaft.

NOTE: It may be necessary to use a jaw-type puller to remove the steering wheel from the steering shaft.

IMPORTANT: DO NOT hit the steering shaft with a hammer. This could damage the steering valve components.

4. Remove four capscrews and lower the steering valve and steering column out of the steering arm.

5. Reverse steps 1 - 4 to install the steering valve. Tighten the steering wheel nut so the top surface of the nut is flush with the top of the steering column.

IMPORTANT: When disassembling hydraulic lines make sure hydraulic plugs are placed in the open end of the hydraulic line to prevent foreign debris from contaminating hydraulic oil. It is also a good idea to tag the hydraulic lines when disassembling so they can be properly reassembled. Keep all hydraulic lines clean and free from foreign debris. During replacement of steering valve, avoid overtightening fittings. Check hydraulic lines for cracks or breaks. If a hydraulic leak should appear after replacement of lift cylinder, replace the fitting or line that is leaking. Check hydraulic reservoir for level of hydraulic fluid after replacement of lift cylinder.

TORO

Chapter 6

Electrical System

Table of Contents

See **Chapter 3 - Kohler Engine** for information about the engine electrical system and components.

See **Chapter 4 - Mitsubishi Diesel Engine** for information about removal and installation of glow plugs, oil pressure switch, alternator, starter and engine stop solenoid. Also see Chapter 4 for testing of electric fuel pump and glow plugs and servicing the fuel pump.

Wiring Schematics

Greensmaster 3000 (Model 04350)

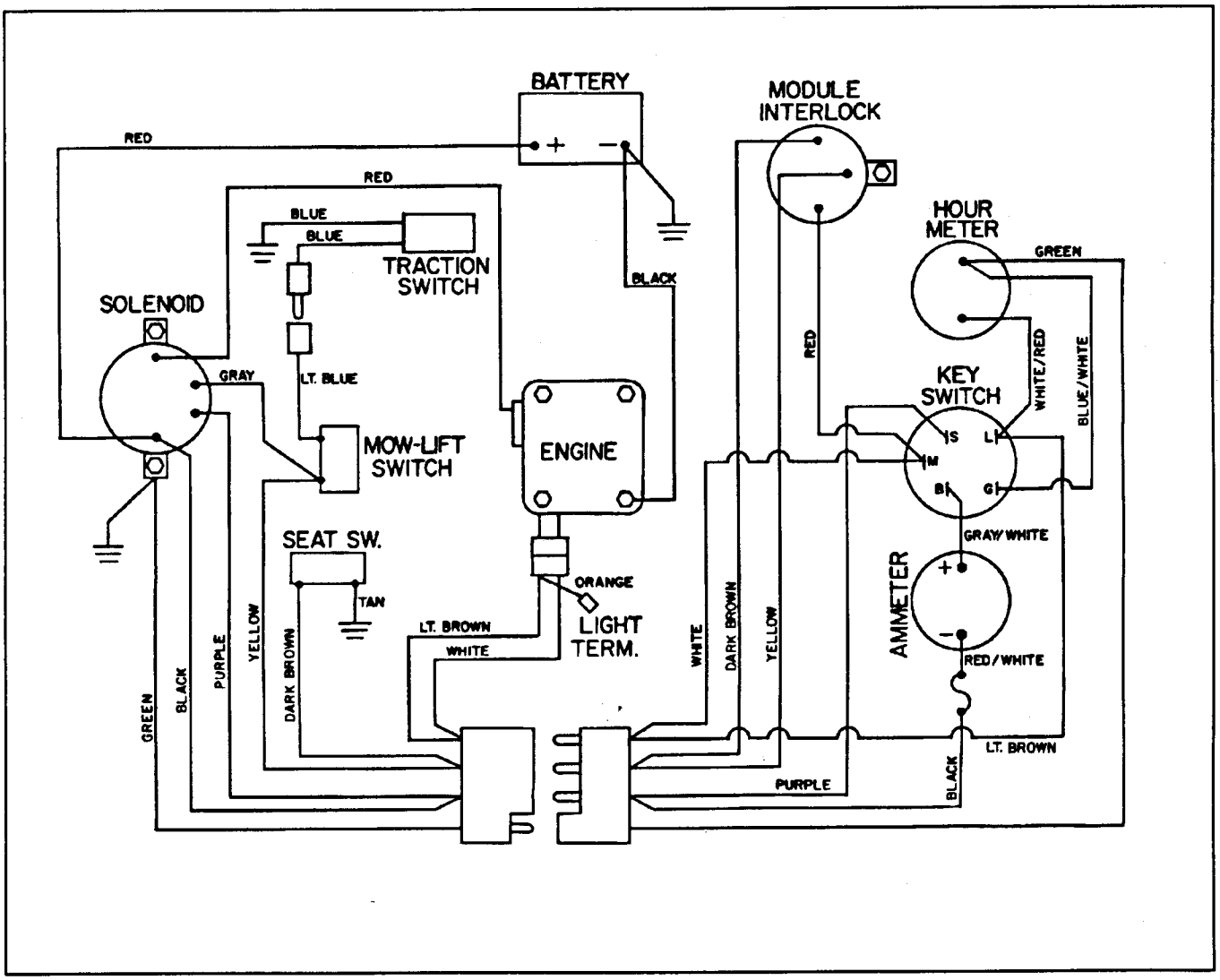


Figure 1

Greensmaster 3000-D (Model 04375)

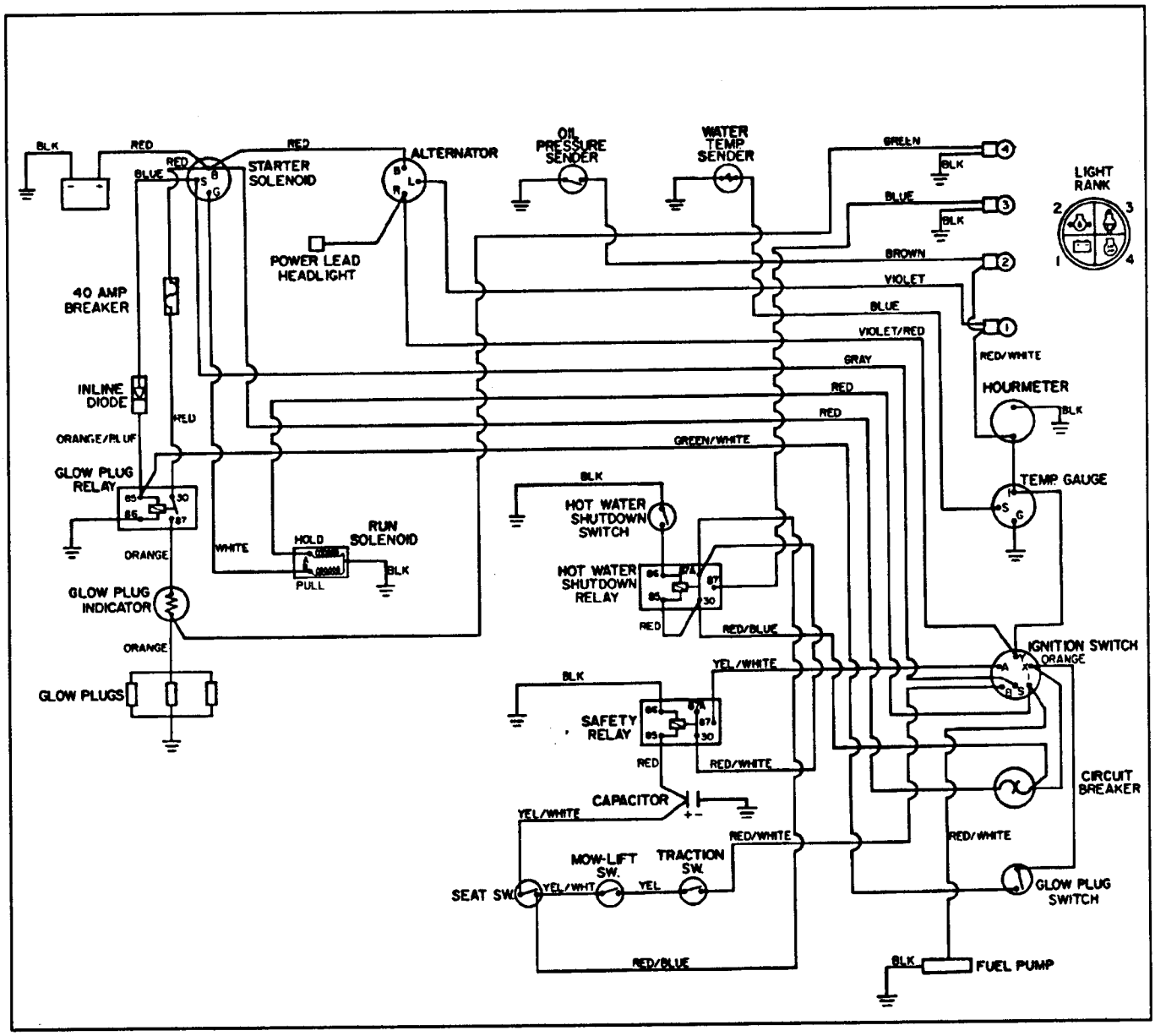


Figure 2

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. 3).

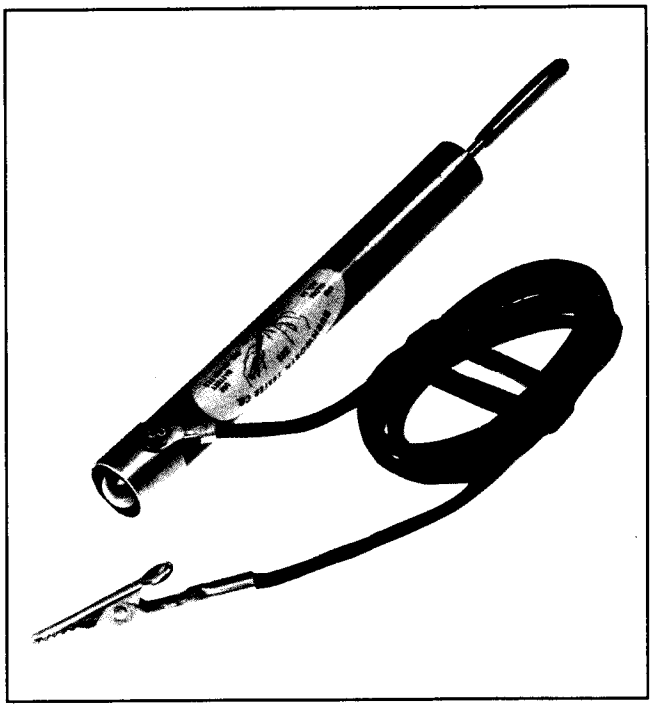


Figure 3

Volt - Ohm - Amp Meter

The meter (Fig. 4) can test electrical components and circuits for current, resistance, or voltage draw.

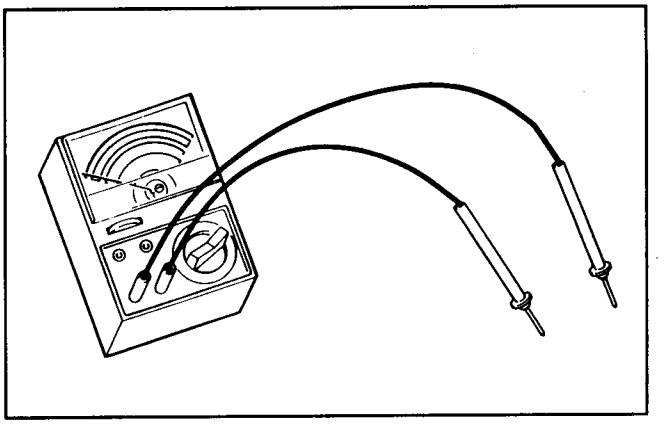


Figure 4

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. 5).

Figure 5

Troubleshooting (Greensmaster 3000, Model 04350)

CAUTION

Remove all jewelry, especially rings and watches, before doing any electrical troubleshooting. 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. Tools such as a volt/ohm multimeter will help find problems in the circuitry.

Studying the operating characteristics preceding an electrical failure will help in identifying 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 two systems at once will lead to confusion.

NOTE: The interlock switches are described as normally open (NO) or normally closed (NC). The NC-NO description indicates the switch contact position with the switch installed in the machine with MOW OFF, TRANSMISSION in NEUTRAL, and OPERATOR OFF of seat. Should the machine being repaired have these components by-passed, they should be reconnected for proper troubleshooting and safety.

Condition	Cause	Correction
1. Engine starts (but should not) when shift selector is in gear.	Traction switch adjusted incorrectly or is malfunctioning.	Adjust or replace traction switch.
2. Engine starts (but should not) when mow pedal is depressed (reels engaged).	Mow/lift switch adjusted incorrectly or is malfunctioning.	Adjust or replace mow/lift switch.
3. Engine fails to crank, regardless of shift selector or mow pedal position.	Mow/lift switch and/or traction switch out of adjustment or malfunctioning.	Adjust or replace traction switch and/or mow/lift switch.
	Loose or corroded battery connections.	Clean and tighten connections.
	Mow/lift switch or traction switch wires are loose.	Check wires and connect properly.
	Battery is dead.	Charge or replace battery.
	Starter solenoid is malfunctioning.	Replace solenoid.
	Ignition switch is malfunctioning.	Replace ignition switch.
	Starter is malfunctioning.	Replace or repair starter.
	Engine is seized.	Repair engine.
	Key switch, ammeter or solenoid wires loose.	Connect wires.
4. Engine fails to crank with controls in "neutral" when operator is off seat, but does crank when operator is on seat.	Wiring harness connected wrong.	Connect wiring harness correctly: refer to Electrical Schematic.
	Wiring harness malfunctioning.	Install new wiring harness.

Problem	Cause	Correction
5. Engine cranks but does not start when shift selector and mow pedal are in neutral.	If engine cranks, cause of problem is unrelated to interlock wiring system.	All interlock switches are OK; refer to next cause.
	Engine or rectifier plug loose.	Connect wire.
	"I" terminal of key switch loose.	Connect wire
	Engine problem or no fuel.	Find problem and correct.
6. Engine does not stop when mow pedal is pushed down (cutting units engaged) as you get off of the seat.	Mow/lift switch or seat switch out of adjustment or malfunctioning.	Adjust or replace mow/lift switch or seat switch.
	Rear camshaft out of adjustment.	Adjust rear camshaft.
	Seat return pin spring broken, missing or stuck in down position.	Replace, loosen and lubricate parts so pin operates freely.
	Seat pivot does not rotate freely.	Loosen and lubricate seat pivot pin to make sure if pivots freely.
7. Engine does not stop when shift selector is in No. 1 or No. 2 position as you get off of the seat.	Traction switch or seat switch out of adjustment or malfunctioning.	Adjust or replace traction switch or seat switch.
	Seat return pin spring broken, missing or stuck in down position.	Replace, loosen and lubricate parts so pin operates freely.
	Seat pivot does not rotate freely.	Loosen and lubricate seat pivot pin to make sure if pivots freely.
8. Engine does not continue to run when sitting on seat and shift selector is placed in No.1 or No.2 position or mow pedal is pushed down.	Seat switch adjusted incorrectly or malfunctioning.	Adjust or replace seat switch.
	Seat return spring jammed in up position.	Loosen and lubricate jammed parts so pin operates freely. Replace spring if necessary.
9. Engine stops regardless of shift selector or mow pedal position (even if both are in "neutral") as you get off of the seat.	Mow/lift switch and/or traction switch out of adjustment or malfunctioning.	Adjust or replace mow/lift switch and/or traction switch.
	Rear camshaft out of adjustment.	Adjust rear camshaft.
	Mow/lift and/or traction switch wires are loose.	Connect wires.
	Traction switch extension plug wires are loose.	Connect wires.
	"B" terminal wire of key switch is loose.	Connect wires.
10. Engine seems to "cut-out" too much during transport.	Seat is lifting off seat switch button too easily.	Adjust seat switch. Instruct operator to sit back in seat during transport.

Problem	Cause	Correction
11. Engine does not stop when ignition key is rotated to OFF position.	Loose wire(s) in electrical system.	Check all connections and repair as necessary.
	Ignition switch is malfunctioning.	Replace ignition switch.
	Engine timing or carburetor out of adjustment.	Adjust carburetor or engine timing.
12. Battery does not charge.	Open or missing fuse.	Install new fuse.
	Loose wire(s) in electrical system.	Check all connections and make all necessary repairs.
	Malfunctioning regulator or engine charging circuit.	Install new regulator or repair engine charging circuit.
	Faulty battery.	Test and replace if necessary.

Verify Interlock Operation

The interlock system is designed to stop the engine when the operator is off of the seat, while the traction selector is in the No. 1 or No. 2 position or the mow pedal is pushed down. The system also prevents the engine from starting in the same situation.

CAUTION

Do not disconnect or bypass the interlock switches. Check the operation of the switches to assure that the interlock system is operating correctly. If a switch is malfunctioning or out of adjustment, adjust or replace it before operating the machine. To assure maximum safety, replace all interlock switches every two years or 1000 hours, whichever comes first.

To check the operation of the interlock switches:

1. Set on the seat and engage the parking brake. Push the lift pedal down all the way and release it. Move the shift selector to the No. 1 position and try to start the engine. The engine should not crank. Move the shift selector to the No. 2 position and try to start the engine. The engine should not crank. If the engine did not crank in either position, the traction switch is operating properly – proceed to step 2. If the engine cranked, refer to Troubleshooting (Greensmaster 3000, Model 04350) in this chapter.

2. Sit on the seat and engage the parking brake. Push the lift pedal down all the way and release it. Move the shift selector to the neutral (N) position and try to start the engine. The engine should start and continue to run, which means that the traction switch and mow/lift switch is operating correctly - proceed to step 3. If the engine cranked, but did not start, the problem is not in the interlock system. If the engine did not crank, refer to Troubleshooting (Greensmaster 3000, Model 04350) in this chapter.

3. Sit on the seat and engine the parking brake. Move the shift selector to the neutral (N) position. Push the mow pedal down and try to start the engine. The engine should not crank, which means the mow/lift switch is operating correctly - proceed to step 4. If the engine cranked, refer to Troubleshooting (Greensmaster 3000, Model 04350) in this chapter.

4. Sit on the seat and engage the parking brake. Move the shift selector to neutral (N). Push lift pedal down and release it. Start the engine, release the parking brake and drive the machine to an open area that is free of debris and foreign objects. Keep all people, especially children away from the front of the machine and out of the area of operation. Move shift selector to neutral (N), make sure the mow pedal is disengaged, set the throttle control at half speed and engage the parking brake. Hold the steering wheel, brace your feet on the foot deck and brake pedal, and move the shift selector to the No. 1 position. Carefully lift off the seat; the engine should stop. Repeat procedure with shift selector in No. 2 position. If engine stops while lifting off the seat with shift selector in No. 1 and No. 2 positions, interlock system is operating correctly. If engine does not stop, stop the engine and correct the problem before operating the machine. Refer to Troubleshooting (Greensmaster 3000, Model 04350) in this chapter.

Troubleshooting (Greensmaster 3000-D, Model 04375)

CAUTION

Remove all jewelry, especially rings and watches, before doing any electrical troubleshooting. 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. Tools such as a volt/ohm multimeter will help find problems in the circuitry.

Studying the operating characteristics preceding an electrical failure will help in identifying 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 two systems at once will lead to confusion.

NOTE: The interlock switches are described as normally open (NO) or normally closed (NC). The NC-NO description indicates the switch contact position with the switch installed in the machine with MOW OFF, TRANSMISSION in NEUTRAL, and OPERATOR OFF of seat. Should the machine being repaired have these components by-passed, they should be reconnected for proper troubleshooting and safety.

Condition	Cause	Correction
1. Engine starts (but should not) when shift selector is in gear.	Traction switch adjusted incorrectly or is malfunctioning.	Adjust or replace traction switch.
2. Engine starts (but should not) when mow pedal is depressed (reels engaged).	Mow/lift switch adjusted incorrectly or is malfunctioning.	Adjust or replace mow/lift switch.
3. Engine fails to crank (and solenoid does not click), regardless of shift selector or mow pedal position (engine not overheated).	Mow/lift switch, or traction switch out of adjustment or malfunctioning.	Adjust or replace traction switch, mow/lift switch, or seat switch.
	Battery connections loose corroded.	Clean or tighten terminals.
	Mow/lift switch, traction switch wires are loose.	Check wires and connect them properly.
	Battery is dead.	Charge or replace battery.
	Starter solenoid is malfunctioning.	Replace solenoid.
	Ignition switch is malfunctioning.	Replace ignition switch.
	Key switch or solenoid wires loose.	Connect wires.
	Circuit breaker open.	Check circuit breaker and reset if necessary.
	High temp. shut-down switch or relay malfunctioning.	Test high temp. shut-down switch and relay. Replace if necessary.
	High temp. shut-down switch or relay wires are loose.	Connect wires.
4. Engine cranks (but should not) when glow plug switch is on.	Diode in wiring harness installed backwards.	Install diode correctly.

Problem	Cause	Correction
5. Starter solenoid clicks, but starter will not crank (if solenoid clicks, interlock circuit is not at fault).	Faulty battery.	Test and replace if necessary.
	Loose or corroded battery cables and loose or corroded ground.	Clean and tighten or replace as necessary.
	Loose or damaged wiring at starter. Loose starter mounting bolts.	Tighten or repair as necessary.
	Malfunctioning starter or solenoid.	Jump "B" and motor terminal on the starter. If starter does not crank replace starter. If starter cranks replace solenoid.
6. Engine fails to crank (and solenoid does not click) with controls in "neutral" when operator is off seat, but does crank when operator is on seat.	Wiring harness connected wrong.	Connect wiring harness correctly: refer to Electrical Schematic.
	Wiring harness malfunctioning.	Install new wiring harness.
7. Engine cranks but does not start when shift selector and mow pedal are in neutral.	If engine cranks, cause of problem is unrelated to interlock wiring system.	All interlock switches are OK; refer to next cause.
	Glow plug circuit malfunctioning.	Check glow switch, glow plug relay, glow plug indicator (resistor) and glow plugs; test and repair if necessary.
		Check glow plug circuit wiring and connectors.
		Check glow light with key switch in "START" position and glow switch off. If light is off check wiring or diode and repair if necessary.
	Fuel pump malfunctioning.	Repair or replace fuel pump.
	Plugged fuel system.	Check fuel lines and filter.
	"I" terminal wire of key switch loose.	Connect wire.
	ETR solenoid malfunctioning.	Check connections, test and replace if necessary.
	Engine trouble or out of fuel.	Find and correct problem.

Problem	Cause	Correction
8. Engine does not stop when mow pedal is pushed down (cutting units engaged) as you get off of the seat.	Rear camshaft out of adjustment.	Adjust rear camshaft.
	Mow/lift switch or seat switch out of adjustment or malfunctioning.	Adjust or replace mow/lift switch or seat switch.
	Seat return pin spring broken, missing or stuck in down position.	Replace, loosen and lubricate parts so pin operates freely.
	Seat pivot does not rotate freely.	Loosen and lubricate seat pivot pin to make sure if pivots freely.
9. Engine does not stop when shift selector is in No. 1 or No. 2 position as you get off of the seat.	Traction switch or seat switch out of adjustment or malfunctioning.	Adjust or replace traction switch or seat switch.
	Seat return pin spring broken, missing or stuck in down position.	Replace, loosen and lubricate parts so pin operates freely.
	Seat pivot does not rotate freely.	Loosen and lubricate seat pivot pin to make sure if pivots freely.
10. Engine does not continue to run when sitting on seat and shift selector is placed in No.1 or No.2 position or mow pedal is pushed down.	Seat switch adjusted incorrectly or is malfunctioning.	Adjust or replace seat switch.
	Seat return spring jammed in up position.	Loosen and lubricate jammed parts so pin operates freely. Replace spring if necessary.
11. Engine stops regardless of shift selector or mow pedal position (even if both are in "neutral") as you get off of the seat.	Mow/lift switch and/or traction switch out of adjustment or malfunctioning.	Adjust or replace mow/lift switch and/or traction switch.
	Rear camshaft out of adjustment.	Adjust rear camshaft.
	Mow/lift and/or traction switch wires are loose.	Connect wires.
	Key switch "B" terminal wire loose.	Connect wires.
12. Engine seems to "cut-out" too much during transport.	Seat is lifting off seat switch button too easily.	Adjust seat switch. Instruct operator to sit back in seat during transport.
	Capacitor (time delay) is malfunctioning	Test capacitor and replace if necessary.
13. Engine does not stop when ignition key is rotated to OFF position.	ETR solenoid malfunctioning.	Test and replace if necessary.
	Ignition switch is malfunctioning.	Replace ignition switch.
	Wires in connector have shorted.	Repair affected wires.
14. Battery does not charge.	Loose wire(s) in electrical system.	Check all connections repair.
	Malfunctioning alternator.	Check alternator belt tension. Test alternator and replace if necessary.
	Faulty battery.	Test and replace if necessary.

Problem	Cause	Correction
15. Engine starts, but kills when ignition switch returns to "ON" position with operator on seat and shift selector and mow pedal are in neutral.	Malfunctioning ignition switch.	Test and replace ignition switch if necessary.
	Malfunctioning ETR solenoid.	Test ETR solenoid and repair wiring or replace solenoid if necessary.

Verify Interlock Operation

The interlock system is designed to stop the engine when the operator is off of the seat, while the traction selector is in the No. 1 or No. 2 position or the mow pedal is pushed down. The system also prevents the engine from starting in the same situation.

CAUTION

Do not disconnect or bypass the interlock switches. Check the operation of the switches to assure that the interlock system is operating correctly. If a switch is malfunctioning or out of adjustment, adjust or replace it before operating the machine. To assure maximum safety, replace all interlock switches every two years or 1000 hours, whichever comes first.

To check the operation of the interlock switches:

1. Set on the seat and engage the parking brake. Push the lift pedal down all the way and release it. Move the shift selector to the No. 1 position and try to start the engine. The engine should not crank. Move the shift selector to the No. 2 position and try to start the engine. The engine should not crank. If the engine did not crank in either position, the traction switch is operating properly - proceed to step 2. If the engine cranked, refer to Troubleshooting (Greensmaster 3000-D, Model 04375) in this chapter.

2. Sit on the seat and engage the parking brake. Push the lift pedal down all the way and release it. Move the shift selector to the neutral (N) position and try to start the engine. The engine should start and continue to run, which means that the traction switch and mow/lift switch is operating correctly - proceed to step 3. If the engine cranked, but did not start, the problem is not in the interlock system. If the engine did not crank, refer to Troubleshooting (Greensmaster 3000, Model 04350) in this chapter.

3. Sit on the seat and engine the parking brake. Move the shift selector to the neutral (N) position. Push the mow pedal down and try to start the engine. The engine should not crank, which means the mow/lift switch is operating correctly - proceed to step 4. If the engine cranked, refer to Troubleshooting (Greensmaster 3000-D, Model 04375) in this chapter.

4. Sit on the seat and engage the parking brake. Move the shift selector to neutral (N). Push the lift pedal down and release it. Start the engine, release the parking brake and drive the machine to an open area that is free of debris and foreign objects. Keep all people, especially children away from the front of the machine and out of the area of operation. Move the shift selector to neutral (N), make sure the mow pedal is disengaged, set the throttle control at half speed and engage the parking brake. Hold the steering wheel, brace your feet on the foot deck and brake pedal, and move the shift selector to the No. 1 position. Carefully lift off the seat; the engine should stop after a 1to 2 second delay. Repeat procedure with shift selector in No. 2 position. If engine stops while lifting off the seat with shift selector in No. 1 and No. 2 positions, interlock system is operating correctly. If engine does not stop, stop the engine and correct the problem before operating the machine. Refer to Troubleshooting (Greensmaster 3000-D, Model 04375) in this chapter.

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 isolated from the electrical system.

For accurate resistance and/or continuity checks, electrically disconnect the component being tested from the circuit.

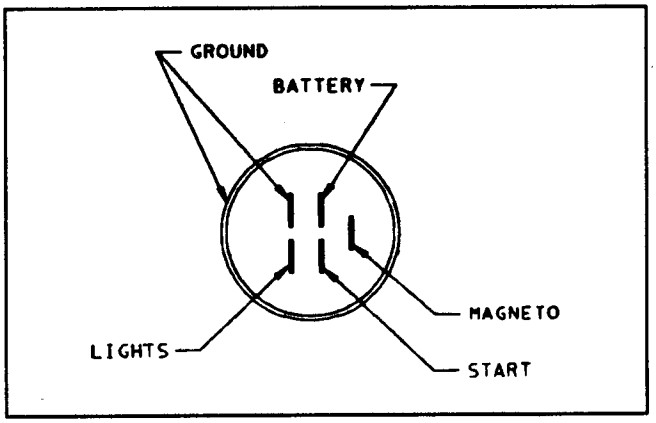
CAUTION

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 6a and 6b.

The circuitry of the ignition switch is shown in the charts (Fig. 6a, 6b). 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.



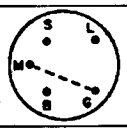
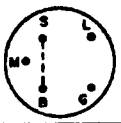
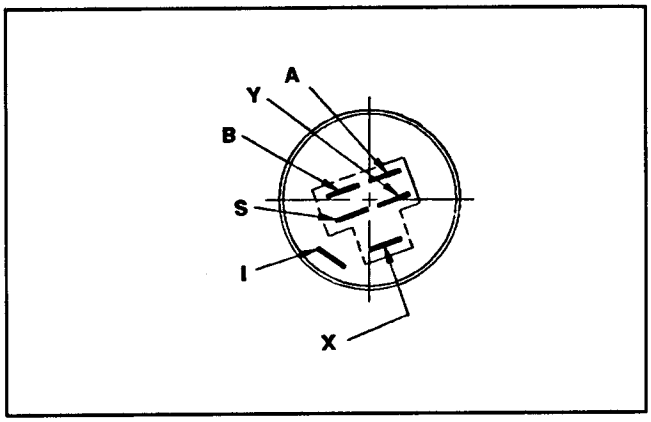
POSITION	CONTINUITY AMONG TERMINALS	CIRCUITS MADE
1. OFF	 G + M	GROUND & MAGNETO
2. RUN	 B + L	BATTERY & LIGHTS
3. START	 B + S	BATTERY & START

Figure 6a
Greensmaster 3000, Model 04350



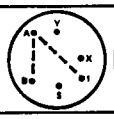
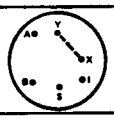
POSITION	CONTINUITY AMONG TERMINALS	OTHER CIRCUITS MADE
1. OFF	NONE	NONE
2. RUN	 B+I+A	 X+Y
3. START	 B+I+S	NONE

Figure 6b
Greensmaster 3000-D, Model 04375

Seat Switch

1. Disconnect the seat switch wire connector and install a continuity tester or ohm meter between the two leads of the seat switch (Fig. 7).

2. 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 indicate a reading 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 on operator on the seat.

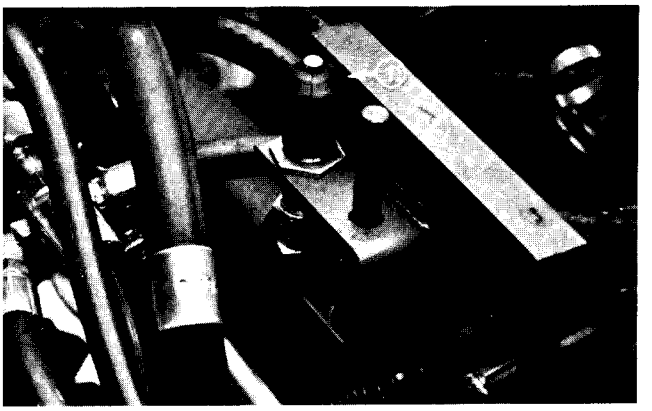


Figure 7

1. Seat switch

Traction (Neutral) Switch

1. Disconnect the traction switch wire connector and install a continuity tester or ohm meter between the two leads of the traction switch (Fig. 8).

2. Make sure the shift selector is in the neutral (N) position. There should be continuity when the shift selector is in the neutral (N) position. If there is no continuity adjust or replace the switch. (See Traction (Neutral) Switch Replacement and Adjustment in the Repairs section of this book.)

3. Move the shift selector to the No.1 and No. 2 positions. There should not continuity when shift selector is in either of these positions. If there is continuity adjust or replace the switch. (See Traction (Neutral) Switch Replacement and Adjustment in the Repairs section of this book.)

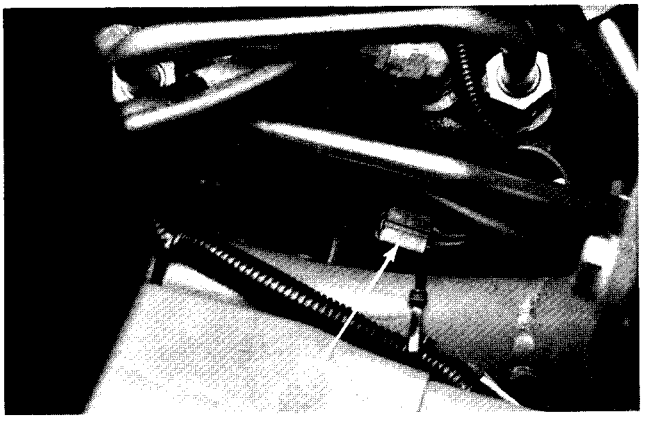


Figure 8

1. Traction (neutral) switch

Mow/Lift Switch

1. Disconnect the mow/lift switch wire connector and install a continuity tester or ohm meter between the two leads of the mow/lift switch (Fig. 9).

2. Push down on the lift pedal and release it. There should be continuity when the mow pedal is disengaged. If there is no continuity, adjust or replace the switch. (See Mow/Lift Switch Replacement and Adjustment in the Repairs section of this book.)

3. Push down on the mow pedal and release it. There should not be continuity. If there is continuity, adjust or replace the mow/lift switch. (See Mow/Lift Switch Replacement and Adjustment in the Repairs section of this book.)

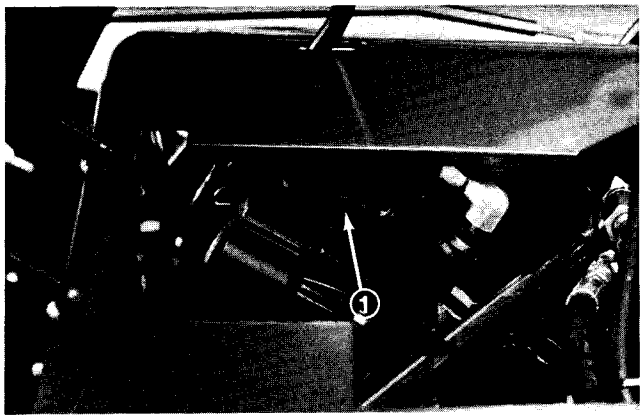


Figure 9

1. Mow/lift switch

Interlock Module (Greensmaster 3000, Model 04350)

The interlock module senses the condition of the seat switch, traction switch, and mow/lift switch (Fig. 10). All of the switches must be CLOSED before the engine will crank. Once the engine is running, the seat switch must remain CLOSED while the traction switch or mow/lift switch is OPEN.

The "closed to operate" requirement of the interlock module makes sure that the engine will not start if switch leads are broken or become disconnected.

Because of the solid-state circuitry built into the interlock module, there is no direct method to test it. The module may be damaged if an attempt is made to test it with an electrical test device such as a volt-ohm meter.

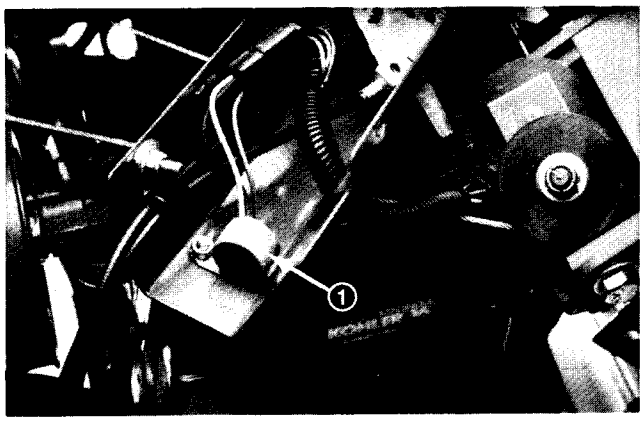


Figure 10

1. Interlock module

Safety Relay and Capacitor (Time Delay)
(Greensmaster 3000-D, Model 04375)

The seat switch (Fig. 7) is a normally open (NO) switch. With no operator on the seat there is an open circuit to the time delay (capacitor) and relay coil. If the mow switch or traction switch is open with no operator on the seat the engine will stop after a delay of approximately 2 seconds.

Check the seat switch by engaging the brakes, then with the engine running, engage the traction lever to the No. 1 or 2 position or engage the mow pedal. When you raise off the seat, the engine should stop after an approximately 1 to 2 second delay. If there is no time delay, the capacitor is faulty or the capacitor wires are touching.

Relay Test

Disconnect the relay wire connector and install a continuity tester between the relay terminals (terminals 30 and 87) (Fig. 11b). The relay should make and break continuity as 12 V.D.C. connected and disconnected between the winding terminals (terminals 85 and 86).

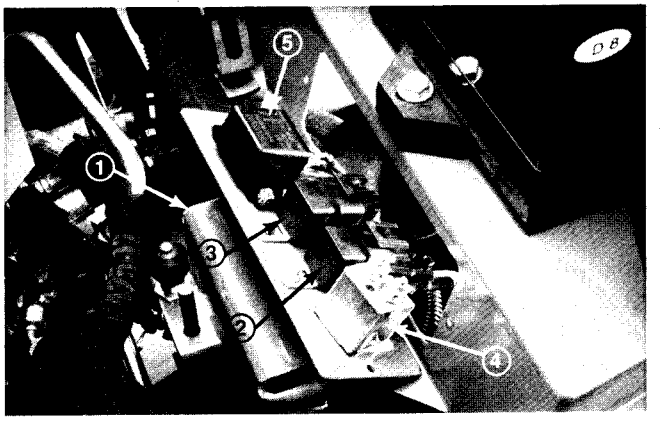


Figure 11a

1. **Time delay (capacitor) - not shown**
2. **Safety relay**
3. **High temp. shut-down relay**
4. **Glow indicator (resistor)**
5. **Glow relay**

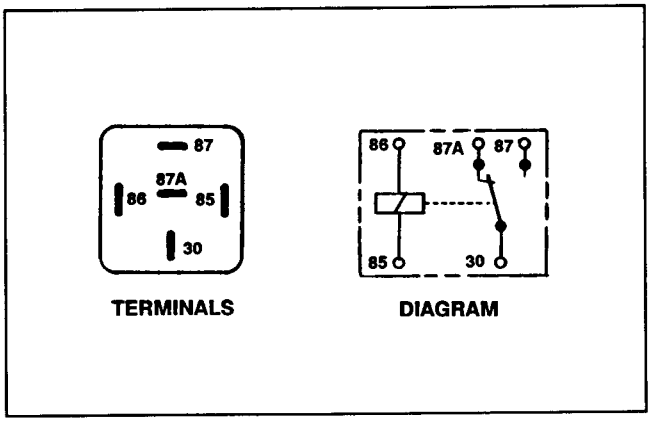


Figure 11b

Safety relay and high temp. shut-down relays

High Temperature Shut-down Relay

To test the high temperature shut-down relay (Fig. 11a) Disconnect the relay wire connector and install a continuity tester between the relay terminals (terminals 30 and 87) (Fig. 11b). The relay should make and break continuity as 12 V.D.C. connected and disconnected between the winding terminals (terminals 85 and 86).

Glow Relay
(Greensmaster 3000-D, Model 04375)

To test the glow relay (Fig. 11a), disconnect the relay wire connector and install a continuity tester between the relay terminals (terminals 30 and 87) (Fig. 12). The relay should make and break continuity as 12 V.D.C. connected and disconnected between the winding terminals (terminals 85 and 86).

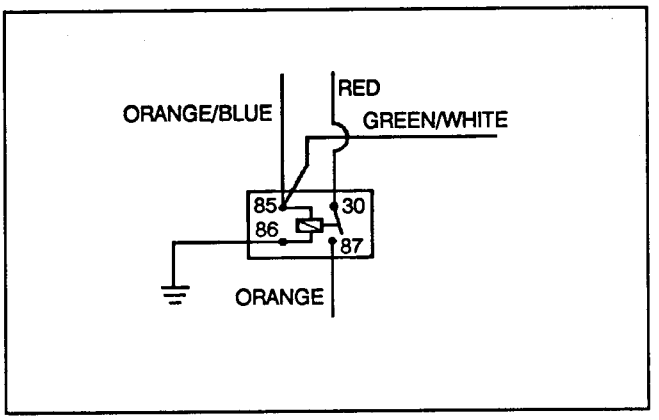


Figure 12

Battery

Terminal Voltage Test

1. Use a volt-ohm meter to measure the voltage between the battery terminals.

2. If the voltage is less than 12.3 V.D.C., the battery should be charged.

Indicator Lights (Greensmaster 3000-D, Model 04375)

Oil Pressure Light

Oil pressure lamp should come on when the ignition key switch is in the RUN position with the engine not running or if the oil pressure switch closes during operation - oil pressure below 7 psi (0.5 kg/cm^2).

Test the lamp by disconnecting the wires and applying 12 V.D.C. between the terminals.

Amp Light

The amp light should come on when the ignition key switch is in the RUN position with the engine not running or if the charging circuit is not operating properly during operation.

Test the lamp by disconnecting the wires and applying 12 V.D.C. between the terminals.

Glow Light

The glow light should be on when the glow switch is ON or the ignition key switch is in the START position.

Test the lamp by disconnecting the wires and applying 12 V.D.C. between the terminals.

Temperature Light

The temperature light should come on only if the high temperature shut-down switch and relay has stopped the engine - coolant temperature above 225° F (108° C). The light will remain on if the engine is overheated whether the ignition key switch is ON or OFF.

Test the lamp by grounding the wire that is connected to the high temperature shut-down switch (Fig. 14). The light should come on when the wire is grounded.

Hourmeter

Test the hourmeter by disconnecting the wires and applying 12 V.D.C. between the terminals.

Temperature Gauge (Greensmaster 3000-D, Model 04375)

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.

High Temperature Shut-Down Switch (Greensmaster 3000-D, Model 04375)

1. Lower the coolant level in the engine and remove the high temperature shut-down switch (Fig. 13).

2. Put the switch in a container of oil with a thermometer and heat the oil (Fig. 14).

3. The switch is normally open (NO) and should close at 226 - 237° F (108 - 114° C).

Switch ON (closed) temperature 226 - 237° F (108 - 114° C)

CAUTION

Handle hot oil with special care to prevent personal injury or fire.

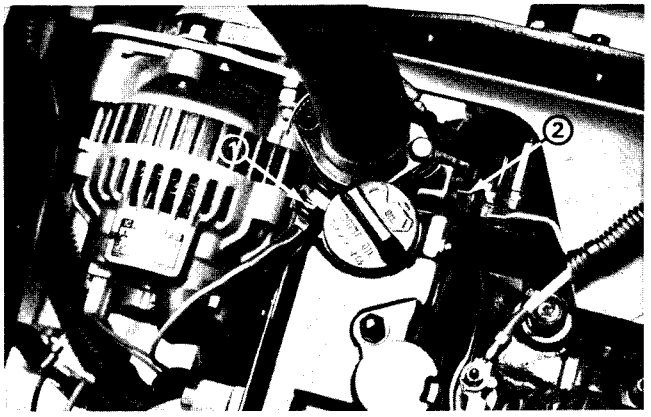


Figure 13

1. High temperature shut-down switch
2. Temperature gauge sender

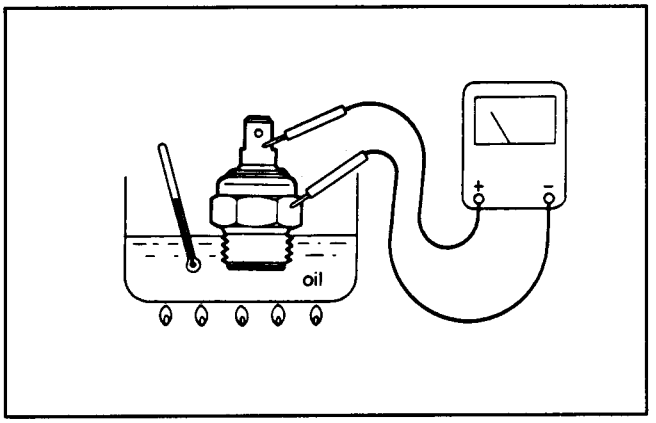


Figure 14

Temperature Gauge Sender (Greensmaster 3000-D, Model 04375)

1. Lower the coolant level in the engine and remove the temperature gauge sender (Fig. 13).

2. Put the switch in a container of oil with a thermometer and heat the oil (Fig. 15).

90.5 - 117.5 ohm at 160° F (70° C)
21.3 - 26.3 ohm at 207° F (115° C)

CAUTION

Handle hot oil with special care to prevent personal injury or fire.

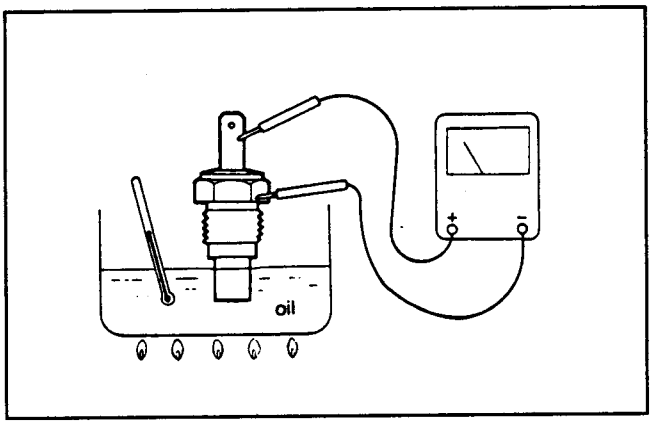


Figure 15

Fuel Stop (ETR) Solenoid (Greensmaster 3000-D, Model 04375)

The Greensmaster® 3000-D has an energize-to-run (ETR) fuel stop solenoid. The solenoid will stop injector pump fuel delivery with any electrical failure in the RUN circuit.

1. Disconnect the wire connector and remove the fuel stop solenoid from the engine (Fig. 16).

2. Connect a 12 volt battery so the positive (+) battery terminal is connected to terminals A (hold) and B (pull) (Fig. 17). Connect the negative (–) battery terminal to solenoid terminal C (common). The plunger should retract to the dimension shown.

IMPORTANT: Do not connect terminal B (pull) for more than 30 seconds or damage to the solenoid coil could result.

3. With the battery connected the same as step 2, disconnect the battery from solenoid terminal B (pull). The plunger should remain pulled in.

4. Disconnect the battery from terminal A (hold). The plunger should return to the extended position.

5. Check the solenoid internal spring tension. The spring must have 9.2 lbs (4.2 kg) minimum force with the plunger in the extended position.

Replace the fuel stop solenoid if it fails any of the above tests. (See Replacing and/or Adjusting Stop Solenoid in the External Engine Component Repair section of Chapter 4 - Mitsubishi Diesel Engine.)

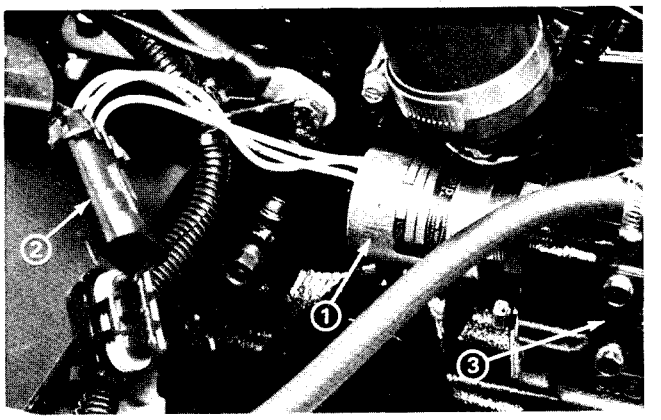


Figure 16

1. Fuel stop (ETR) solenoid
2. Wire connector
3. Governor tie rod cover

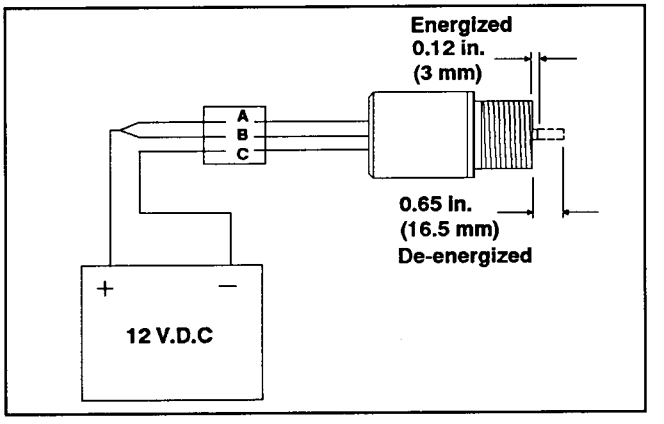


Figure 17

A. Hold
B. Pull
C. Common (ground)

To Test While Connected to Wire Harness

1. Remove the governor tie rod cover so you can observe the solenoid plunger.

2. Hold the manual fuel stop lever back to prevent fuel delivery. Turn the key switch to the START position and quickly return it to the ON position. The solenoid plunger should be retracted.

3. Turn the key switch to the OFF position. The solenoid plunger should extend.

NOTE: You can also test operation without removing the governor tie rod cover. Listen for an audible "click" as the solenoid extends and retracts while doing steps 2 and 3 of the above procedure. This will not show if the solenoid is adjusted correctly or if it is fully extending and retracting. (See Replacing and/or Adjusting the Stop Solenoid in the External Engine Component Repair section of Chapter 4 - Mitsubishi Diesel Engine.)

Checking Starter Pinion Gap (Greensmaster 3000-D, Model 04375)

1. Install 12 volt battery between the "S" terminal and the starter body (Fig. 18). The pinion should protrude and stop.

IMPORTANT: Never apply battery voltage to the starter for longer than 10 seconds.

2. Lightly push the pinion back and measure the return stroke (called pinion gap).

3. If the pinion gap is not within standard range of 0.5 - 2.0 mm (0.02 - 0.08 in.), adjust it by increasing or decreasing the number of packings on the magnetic switch. The gap is decreased as the number of packings increases.

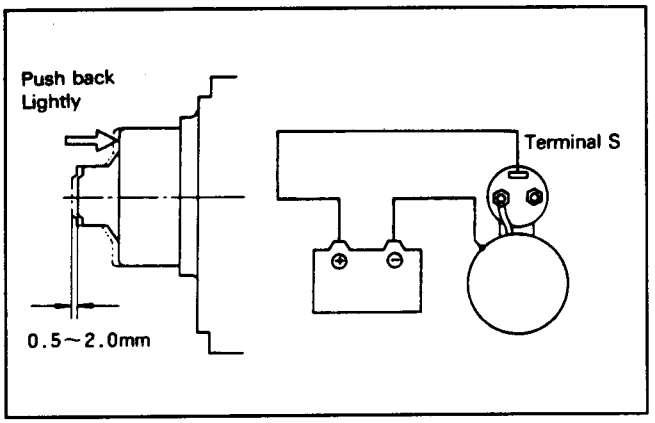


Figure 18

Starter No-Load Test (Greensmaster 3000-D, Model 04375)

1. Connect a 12 volt battery, ammeter and voltmeter to the starter as shown (Fig. 19).

2. When terminals "S" and "B" are connected the pinion should protrude and the starter should run smoothly.

Terminal voltage: 11.5V
Current: 100 A
Speed: 3000 rpm

No-Load Test Results

Low speed and high current draw:

- High friction (faulty bearings, bent armature shaft).
- Shorted armature.
- Grounded armature or fields.

Failure to operate with high current draw:

- Direct ground in terminals or fields.
- "Frozen" bearings.

Failure to operate with no current draw:

- Open field circuit.

Low speed and low current draw:

- Open armature coils - check commutator for badly burned bars after disassembly.

High speed and high current draw:

- Poor contact between brushes and commutator (broken brush springs, worn brushes, high insulation between commutator bars).
- High internal resistance (poor connections, damaged leads, dirty commutator or open field circuit).

Shorted fields.

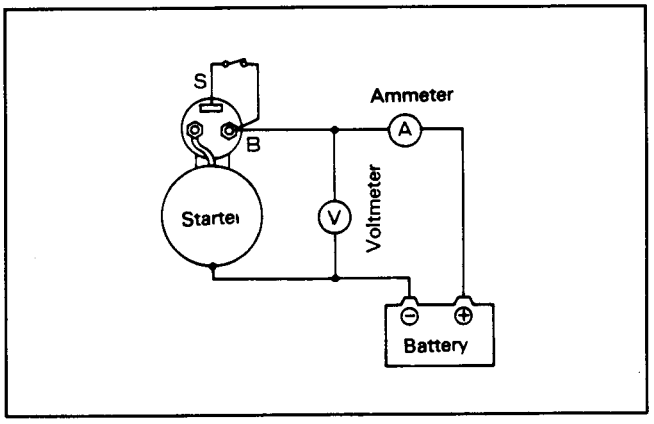


Figure 19

Magnetic Switch (Solenoid) Attraction Test (Greensmaster 3000-D, Model 04375)

1. Disconnect the wire from terminal "M" (Fig. 20).

2. Connect a 12 volt battery to the magnetic switch terminals "S" and "M". The pinion must protrude.

IMPORTANT: Never apply battery voltage to the starter for longer than 10 seconds.

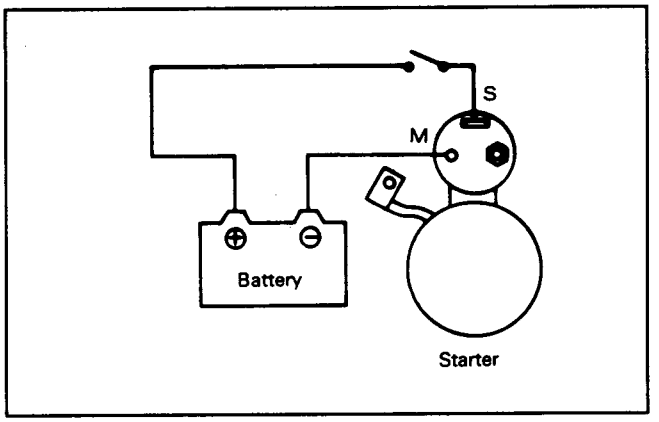


Figure 20

Magnetic Switch (Solenoid) Holding Test (Greensmaster 3000-D, Model 04375)

1. Disconnect the wire from terminal "M" (Fig. 21).

2. Connect a 12 volt battery to the magnetic switch terminal "S" and the starter body. Pull out the pinion fully. The pinion must remain at that position even when released.

IMPORTANT: Never apply battery voltage to the starter for longer than 10 seconds.

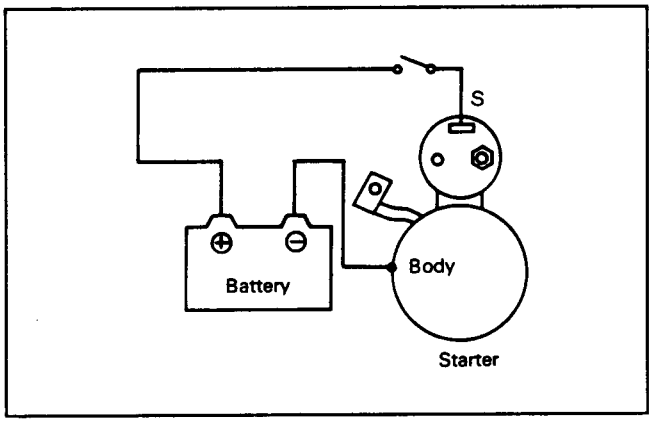


Figure 21

Magnetic Switch (Solenoid) Return Test (Greensmaster 3000-D, Model 04375)

1. Disconnect the wire from terminal "M" (Fig. 22).

2. Connect a 12 volt battery to the magnetic switch terminal "M" and the starter body. Pull out the pinion fully. The pinion must return to its original position when released.

IMPORTANT: Never apply battery voltage to the starter for longer than 10 seconds.

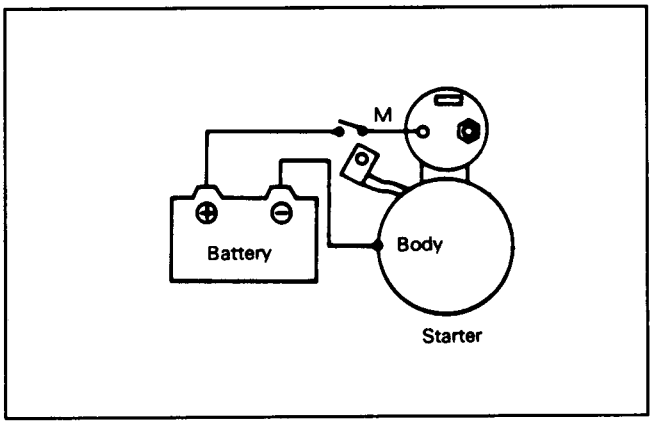


Figure 22

Alternator Regulated Voltage Test (Greensmaster 3000-D, Model 04375)

1. Install an ammeter between the positive (+) terminal of the battery and terminal "B" of the alternator (Fig. 23).

2. Ground alternator terminal "L" through a voltmeter.

3. Note that the voltmeter shows 0 volts when the ignition key switch is in the OFF position. The voltmeter will show voltage lower than battery voltage when the ignition key switch is in the ON position (engine not running).

4. Start the engine.

5. Run the engine with the alternator at 1300 and 2500 rpm and observe the voltmeter with all accessories OFF, Ammeter below 5 A. Regulated voltage will decrease slightly as alternator temperature increases.

Regulated voltage: 13.5 V

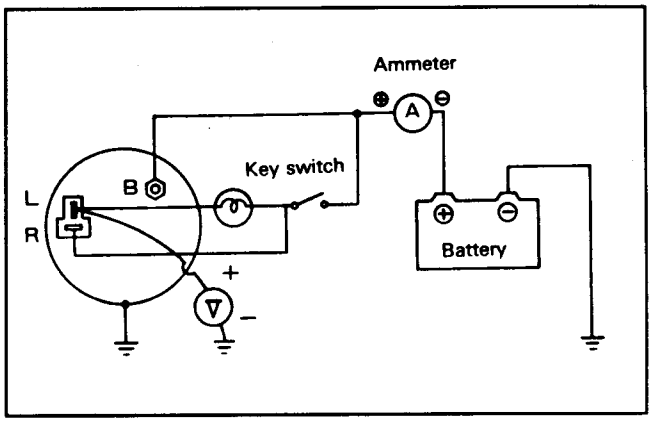


Figure 23

Alternator Output Test (Greensmaster 3000-D, Model 04375)

1. Disconnect the battery ground (–) cable.

2. Install an ammeter between the positive (+) terminal of the battery and terminal "B" of the alternator (Fig. 24).

3. Ground alternator terminal "B" through a voltmeter.

4. Connect the battery ground (–) cable.

5. Start the engine.

6. Run the engine with the alternator at 2500 and 5000 rpm and observe the voltmeter with all electrical load applied. Read the maximum indication on the ammeter with the voltmeter showing 13.5 V.

Output Characteristics (Hot):

21 A at 2500 rpm
37 A at 5000 rpm

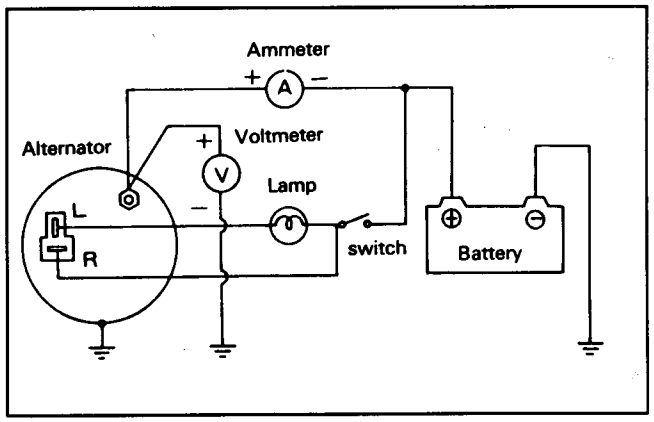


Figure 24

Diode (Glow Plug) (Greensmaster 3000-D, Model 04375)

There is a diode in the starting circuit to energize the glow plug relay when the starter is cranking. If the glow plug functions correctly when holding the glow switch, but does not heat when the engine is cranking the diode may be causing an open circuit.

General Safety Interlock Switch Service

The following procedures should be followed whenever a switch requires adjustment or replacement:

1. Be sure rubber boot is reinstalled in both switch grooves on the button end of seat switch after it is properly adjusted.

IMPORTANT: Rubber boot on button end must be in place to make sure all dirt, moisture and grease are kept from the plunger sides.

2. Spread Skin-Over grease heavily over the terminal end and inside the terminal cover of all switches before installing the connectors and terminal cover. Be sure the wires are fully connected.

3. Make sure terminal cover is fully installed over end of switch.

Seat Switch Replacement and Adjustment

1. Pivot seat forward and block or tie it securely to prevent it from falling accidentally and possibly causing injury.

2. Remove boot from button end of seat switch and retain for installation on replacement switch. Pull connectors off switch terminals.

3. Loosen the jam nut and unscrew the switch from mounting bracket.

4. Screw new switch through mounting bracket until switch button is about 1/16 inch (1.6 mm) shorter than the top of the seat return spring pin. Install the boot into the mount grooves (Fig. 25).

5. Carefully release the seat to its normally down position, but do not sit or apply force on the seat. There should be a slight gap between the switch and the seat plate.

6. Make sure switch terminals face front of machine and lock switch in place by tightening the jam nut to 75 in.-lb (8.5 Nm) against the mounting bracket.

IMPORTANT: Switch threads will be damaged if the jam nut is over-tightened.

7. Connect continuity tester of ohm meter to switch terminals. With seat in the down position and no one on the seat, the switch circuit should not have continuity. If there is continuity, repeat steps 4-6. If there is no continuity, proceed to

8. Sit on the seat. The seat switch should have continuity. If there is no continuity, repeat steps 4-7. If there is continuity proceed to step Q.

9. Fill terminal end of switch and wiring harness cover with skin-over grease and push connectors onto switch terminals. Be sure connectors are fully connected and slide cover over bottom of switch body.

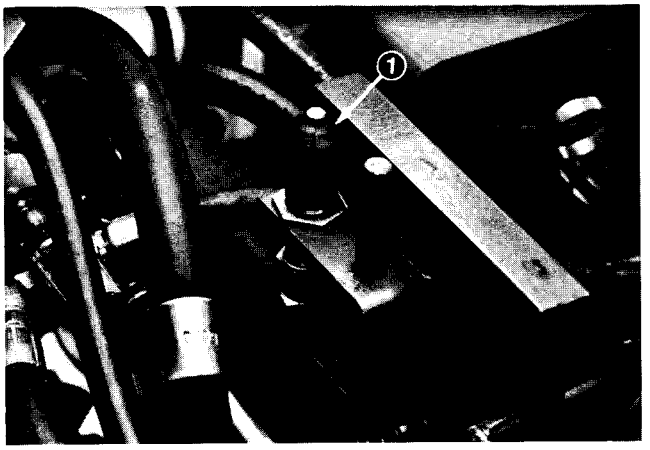


Figure 25

1. Seat switch

Traction (Neutral) Switch Replacement and Adjustment

1. Pull connector off switch terminals of traction switch installed in valve bank bonnet on selector valve section (Fig. 26).

2. Loosen the jam nut and unscrew the switch from the mounting bracket.

3. Move shift selector to Neutral.

4. Partially screw new switch into bonnet.

5. Connect a continuity tester or ohm meter to the switch terminals and continue to turn the switch in until there is continuity. Then rotate switch in 1/2 turn (180).

6. Secure jam nut to 75 in.-lb (8.5 Nm) against the bonnet.

IMPORTANT: Switch threads will be damaged if the jam nut is over-tightened.

7. Connect continuity tester or ohm meter to switch terminals and move shift selector to the No. 1 and No. 2 positions. There should not be continuity when shift selector is in either of these positions. If there is continuity, repeat steps 4 and 5.

8. Move the shift selector lever to Neutral and connect continuity tester or ohm meter to switch terminals. The switch should show continuity. This means the switch is operating correctly.

9. Fill terminal end of switch and wiring harness cover with skin-over grease and push connectors onto switch terminals.

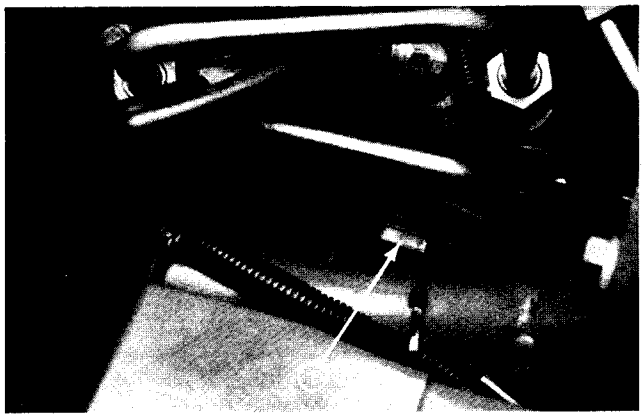


Figure 26

1. Traction switch

Mow/Lift Switch Replacement and Adjustment

IMPORTANT: Spool travel for 1, 2 and 3 spools must be correct before Mow/Lift switch can be adjusted. (See Rear Camshaft Adjustment in the Adjustments section of Chapter 5 - Hydraulic System.)

1. Pull connector off switch terminals from end of mow/lift switch installed in the valve bank bonnet (Fig. 27).

2. Loosen jam nut and unscrew switch from valve bank bonnet.

3. While holding lift pedal in fully depressed position (valve bank spools fully IN) partially screw new switch into bonnet.

4. Connect continuity tester on ohm meter across switch terminals and turn switch in until continuity occurs. Then rotate switch in 1/2 turn (180) and secure jam nut to 75 in.-lb. (8.5 Nm) against the bonnet.

IMPORTANT: Switch threads will be damaged if the jam nut is over-tightened.

5. Connect continuity tester or ohm meter to switch terminals and depress the mow pedal. There should not be continuity. If there is continuity, repeat step 3. Proceed to step 6 if there is no continuity.

6. Depress the lift pedal and release it (neutral position). The switch circuit should have continuity.

7. Fill terminal end of switch and wiring harness cover with skin-over grease and push connectors onto switch terminals.

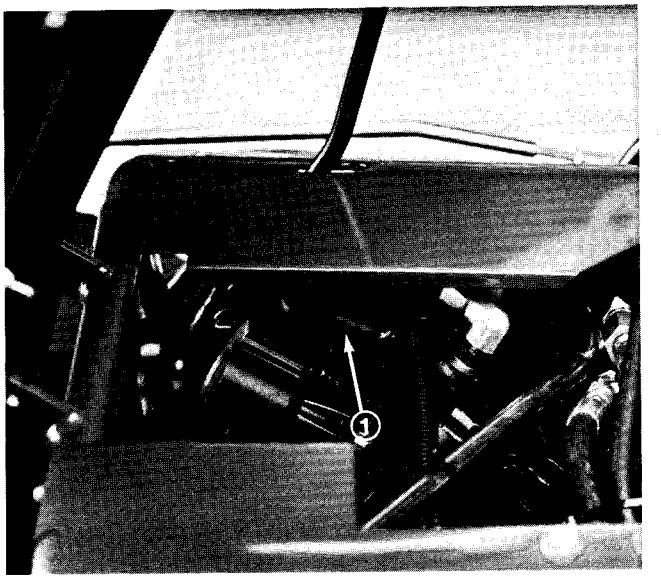


Figure 27

1. Mow/lift switch

Wiring Harness Service

Prevent corrosion of the wiring terminals by applying skin-over grease to the inside of all harness connectors whenever the harness is disconnected.

Always disconnect the battery cables, negative (–) cable first, to prevent possible wiring damage from short-outs whenever working with the electrical system.

Starter Service (Greensmaster 3000-D, Model 04375)

Disassembly and Inspection

1. Remove the starter from the engine (see Starter Removal and Installation in the External Engine Component Repair section of Chapter 4 - Mitsubishi Diesel Engine).

2. Disconnect wire from magnetic switch terminal "M".

3. Loose two screws securing the magnetic switch (Fig. 28). Remove the magnetic switch.

4. Remove two through bolts and screws securing the brush holder. Remove the rear bracket.

5. With the two brushes in the floating state, remove the yoke and brush holder assembly. Pull the armature out.

6. Remove the cover, pry the snap ring out and remove the washer.

7. Unscrew the bolts and remove the center bracket. As the bracket is removed, washers for pinion shaft end play adjustment will come off.

8. Pull out the reduction gear lever and lever spring from the front bracket.

9. Pry the snap ring out on the pinion side and pull out the pinion and pinion shaft.

10. Remove the ball bearings from each end of the armature with a bearing puller. The bearing that is press-fitted in the front bracket cannot be removed. Replace the bracket assembly if the bearing is worn or damaged.

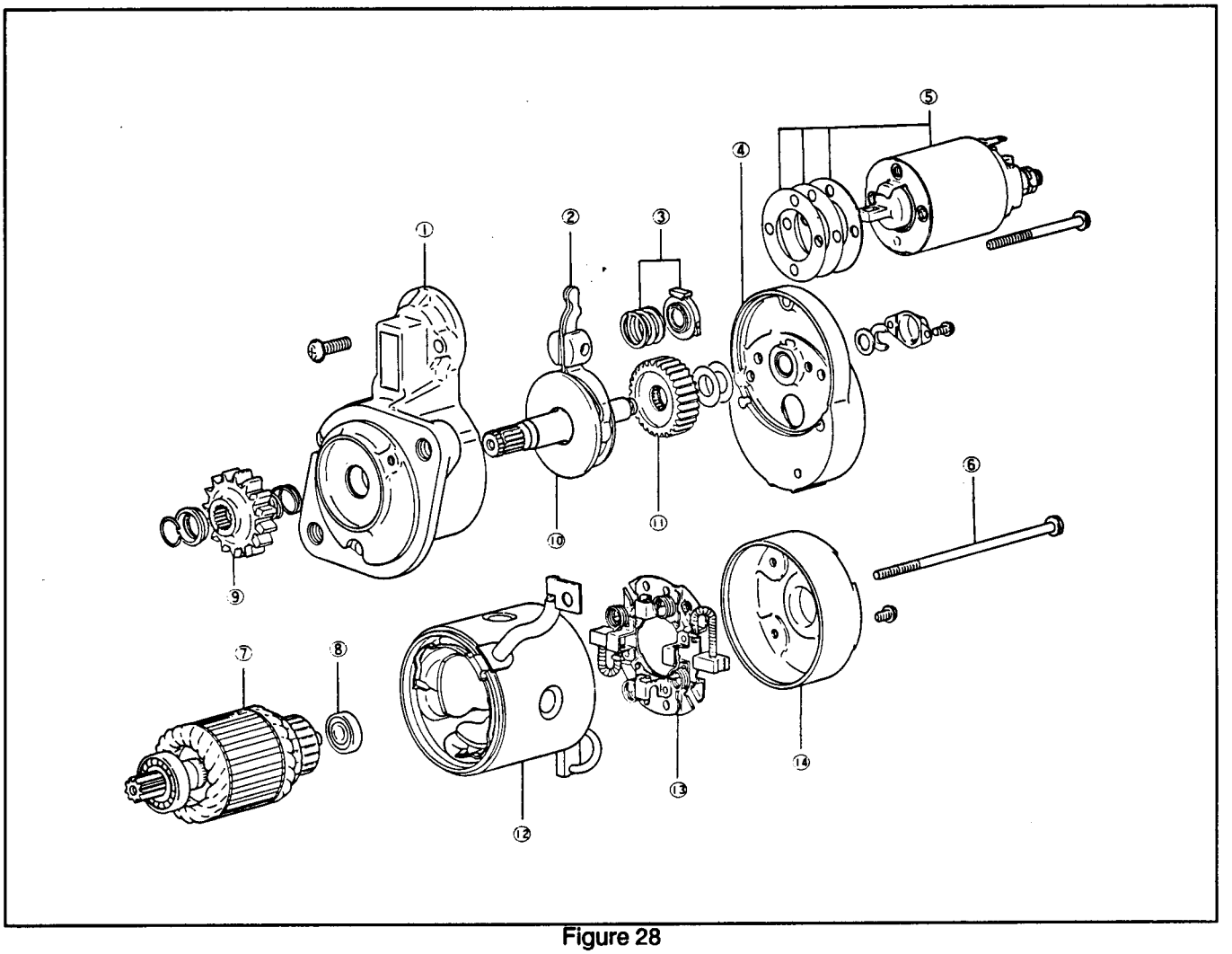


Figure 28

1. Front bracket assembly
2. Lever assembly
3. Spring set
4. Center bracket assembly
5. Switch assembly
6. Through bolt
7. Armature
8. Rear bearing
9. Pinion
10. Pinion shaft assembly
11. Gear
12. Yoke assembly
13. Brush holder assembly
14. Rear bracket

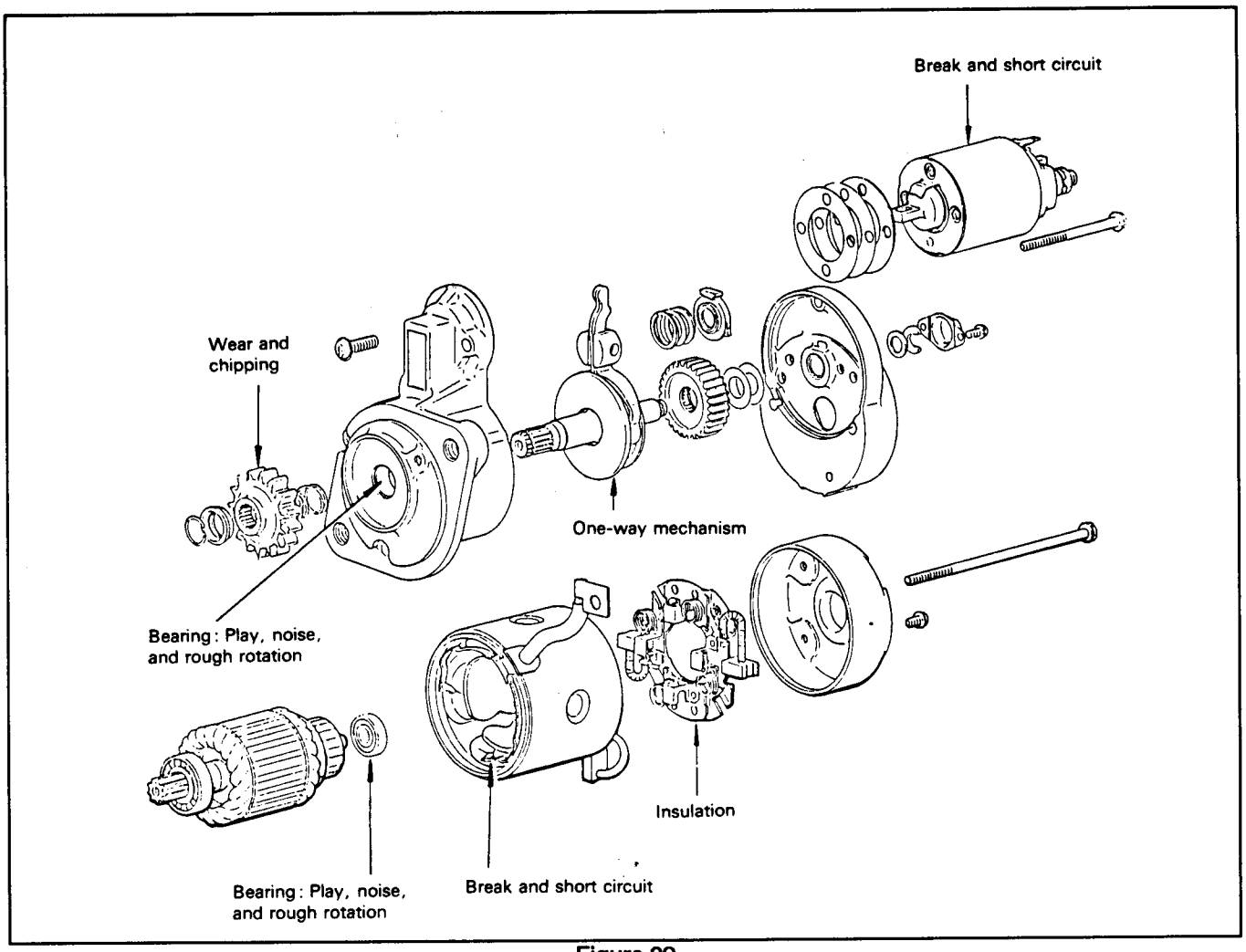


Figure 29

10. Check the magnetic switch for continuity between terminals "S" and "M" and between terminals "S" and body (Fig. 30). If there is continuity (or zero ohm is indicated), replace the magnetic switch.

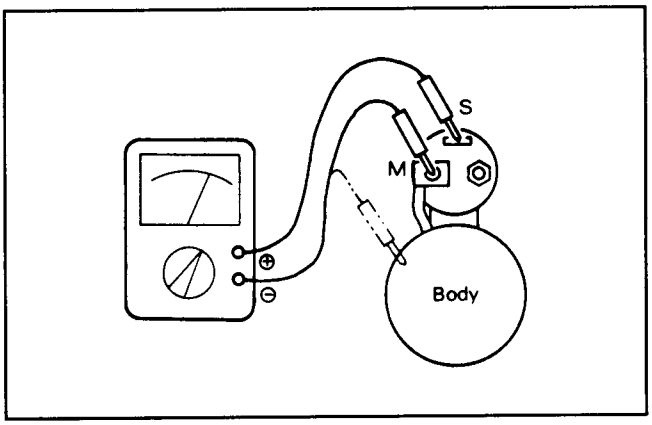


Figure 30

11. Put the armature on a growler tester to check for a shorted armature (Fig. 31). A burned commutator bar is an indication of a shorted armature. With the growler turned on, put a thin strip of steel or a hacksaw blade on the armature as it is slowly rotated. If the metal strip vibrates over a winding, that winding is short circuited. Short circuited windings are sometimes caused by metal in the commutator bridging the gap from on commutator bar to the next. By removing the bridged metal, this condition can be corrected. If this does not correct the short replace the armature.

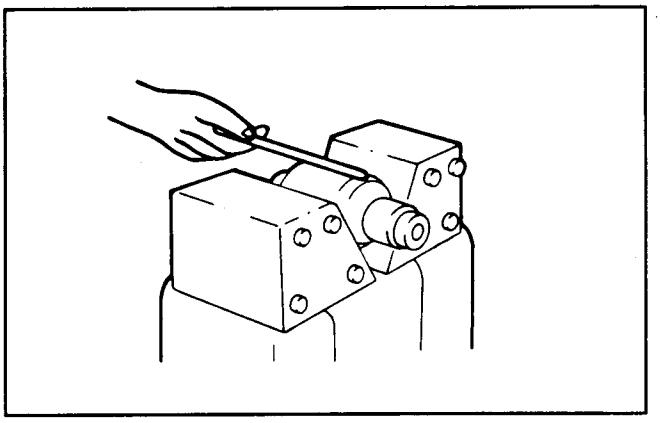


Figure 31

12. Measure the commutator O.D. and depth of undercut. Repair or replace if the service limit is exceeded. Check the commutator outside surface for dirt and roughness. If rough, polish the commutator with fine (00 or 000) sandpaper. DO NOT use emery cloth.

Item	Standard	Service Limit
Commutator O.D.	38.7 mm (1.52 in.)	– 1.0 mm (– 0.4 in.)
Depth of Undercut	0.5 mm (0.02 in.)	0.2 mm (0.008 in.)

13. Check the brushes (Fig. 32). Replace if worn beyond the service limit. Check the brush spring tension. Replace the springs if tension is less than the service limit. Check for insulation between the positive brush holder and holder base. If poorly insulated, replace the holder assembly. Check the brush holders for proper staking.

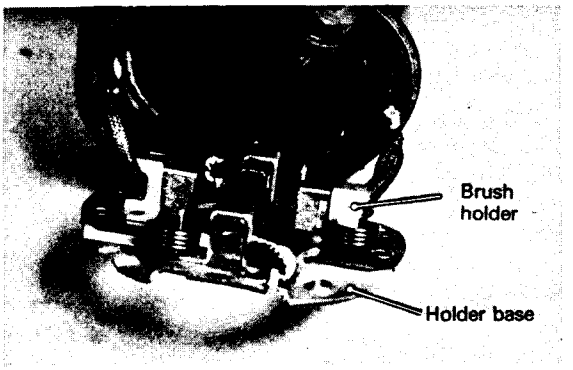


Figure 32

Item	Standard	Service Limit
Height of Brush	17 mm (0.67 in.)	6 mm (0.24 in.)
Spring Pressure	3 kg (6.6 lb.)	

14. Check for continuity between one end of field coil (brush) and yoke (Fig. 33). There should be no continuity. Check for continuity between both ends of coil (brushes). There should be continuity if the field coil is good. Check the poles and coil for tightness.

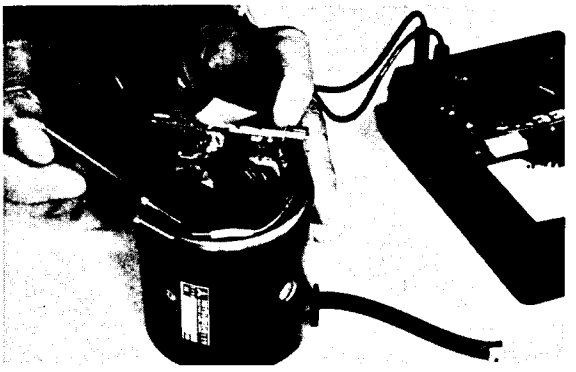


Figure 33

Assembly and Adjustment of Starter

1. Reverse steps 1 - 10 under Disassembly and Inspection and also following the following instructions:

2. Set the pinion shaft end play (thrust gap) to 0.5 mm (0.02 in.) or less by inserting an adjusting washer between the center bracket and reduction gear (Fig. 34).

   A. Fit the pinion shaft, reduction gear washer and snap ring to the center bracket.

   B. Measure end play by moving the pinion shaft in and out. If end play exceeds 0.5 mm (0.02 in.), increase the number of adjusting washers.

3. Put grease on the following parts whenever the starter has been overhauled:

   Armature shaft gear and reduction gear
   All bearings
   Bearing shaft washers and snap rings
   Bearing sleeves
   Pinion
   Sliding part of lever

IMPORTANT: Never put grease on terminals, brushes, commutator or surface that mounts to the engine.

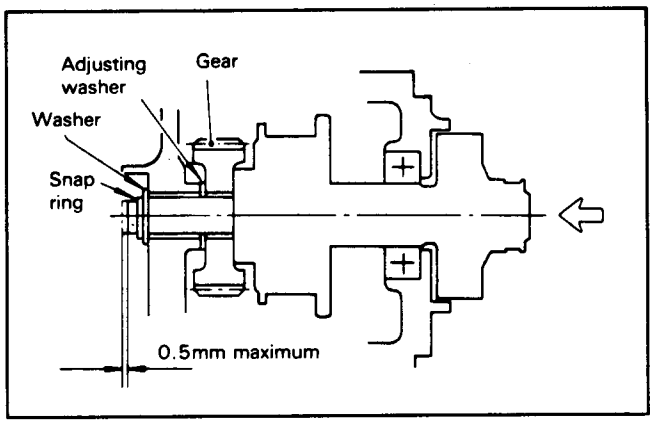


Figure 34

Alternator Service (Greensmaster 3000-D, Model 04375)

Disassembly and Inspection

1. Remove the alternator from the engine (see Alternator Removal and Installation in the External Engine Component Repair section of Chapter 4 - Mitsubishi Diesel Engine).

2. Remove the three through bolts (Fig. 35).

3. Use a solder iron to heat the rear bracket around the rear bearing to 120 - 140° F (50 - 60° C). Separate the front and rear brackets by prying with a screwdriver blade inserted between the brackets.

IMPORTANT: Be careful not to insert the blade too far causing damage to the windings.

4. Put the rotor in a vise. Remove pulley nut and pull off the pulley and spacer.

5. Pull the rotor assembly from the front bracket.

6. Unsolder the stator core lead wires. Remove the stator assembly.

IMPORTANT: To prevent damage to the diodes, heat the stator core lead wires only long enough to remove.

7. Disconnect the capacitor from terminal "B".

8. Loosen the screws securing the rectifier and remove the rectifier.

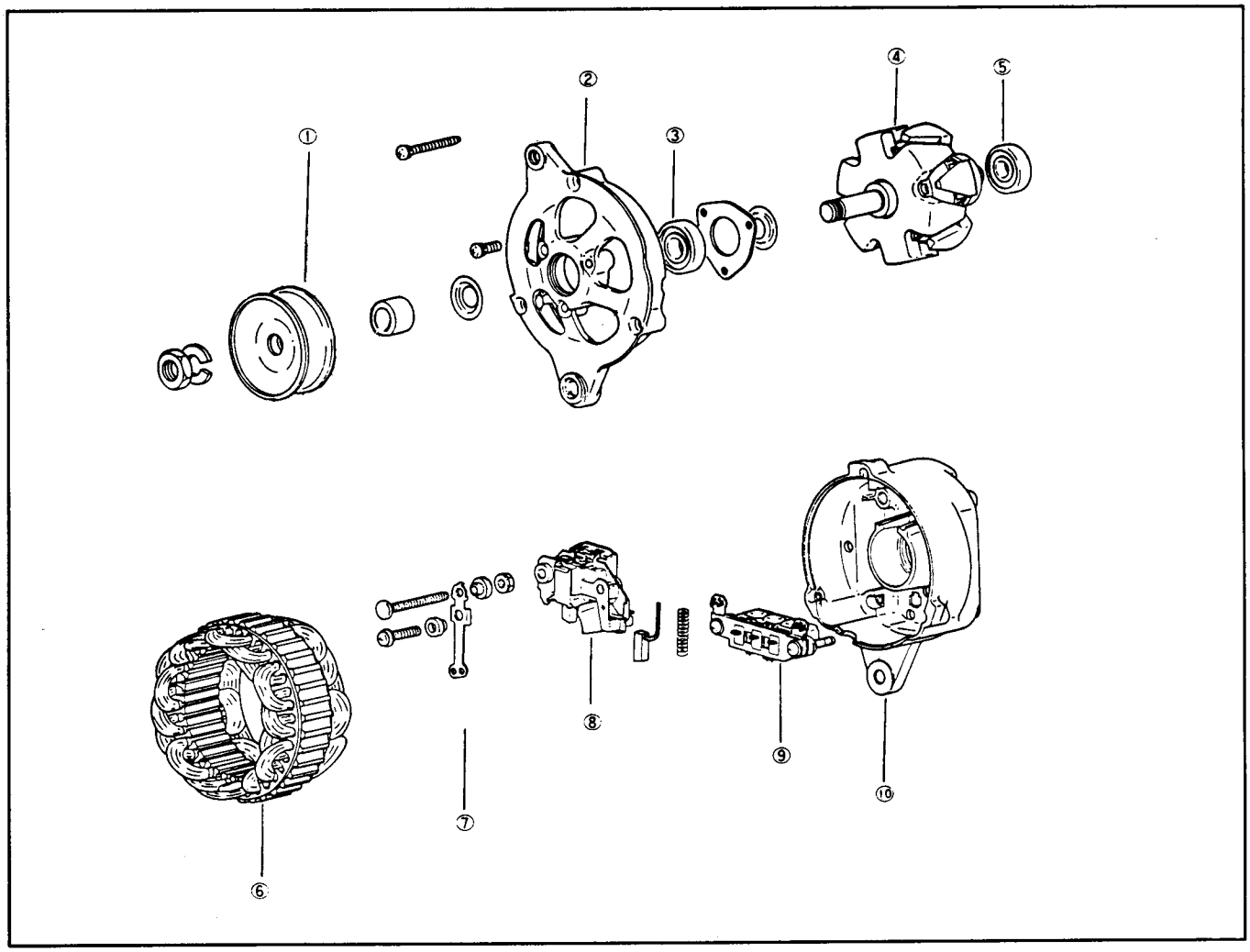


Figure 35

1. Pulley
2. Front bracket assembly
3. Front bearing
4. Rotor assembly
5. Rear bearing
6. Stator
7. Terminal set assembly
8. Regulator assembly
9. Rectifier assembly
10. Rear bracket assembly

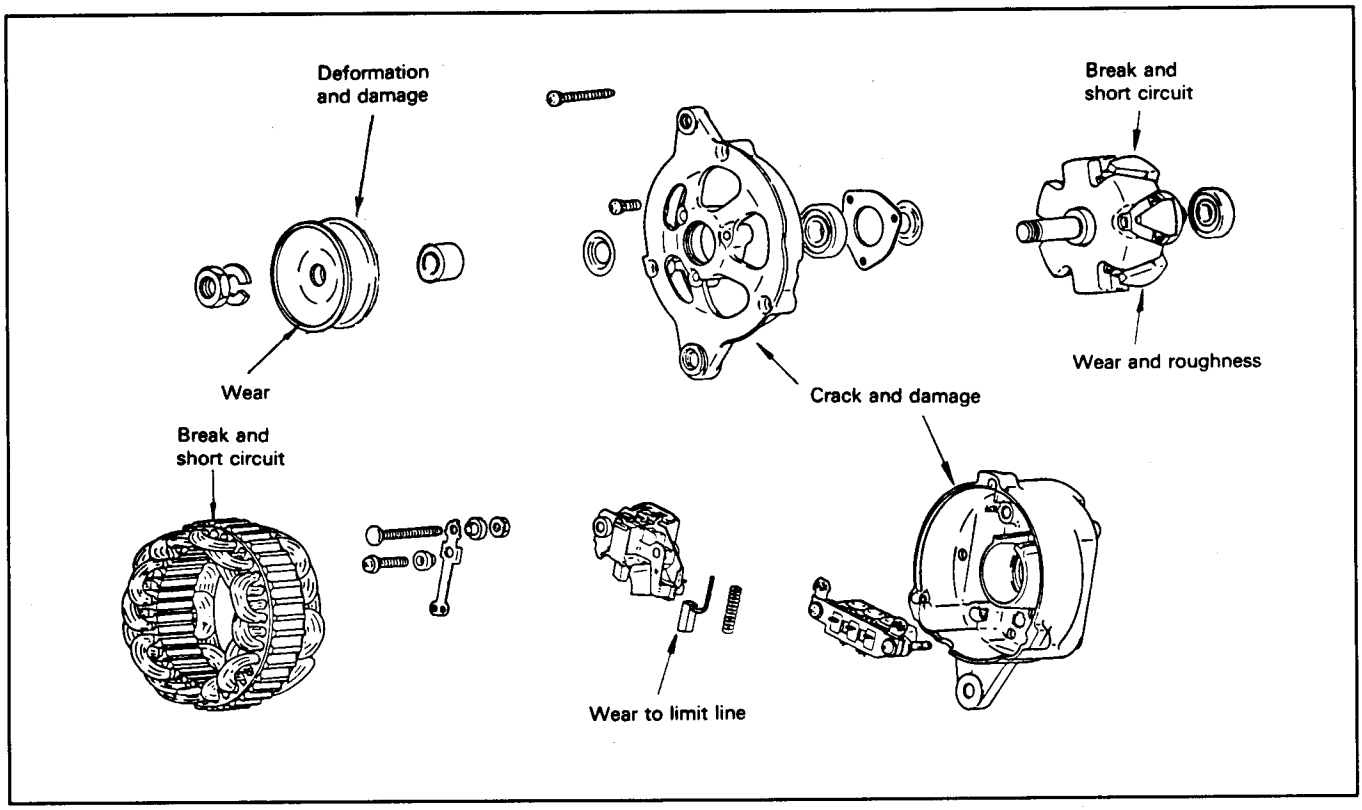


Figure 36

9. Check each diode in the rectifier for conduction (Fig. 37). Connect an ohm meter across the lead wire and diode case. The diode is normal if its resistance is large in one direction and small in the reverse direction. If there is equal resistance in both directions the diode is damaged. Replace the rectifier assembly if a diode is damaged.

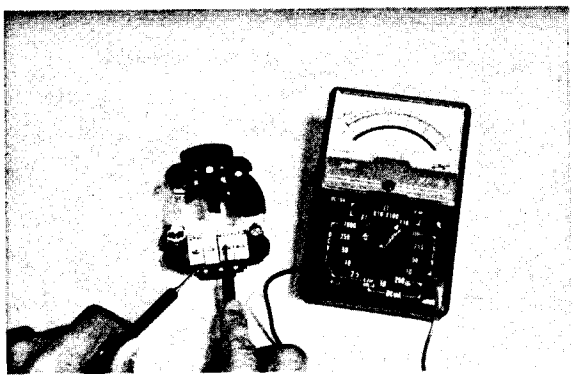


Figure 37

10. Check the field coil for continuity between the slip rings (Fig. 38). If there is no continuity, replace the field coil.

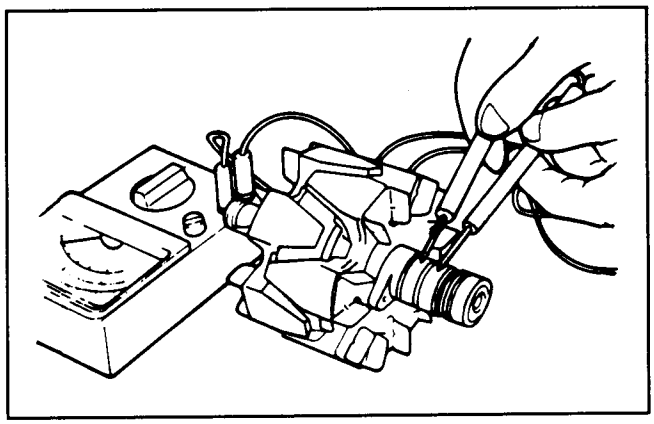


Figure 38

11. Check for continuity between a slip ring and shaft (core) (Fig. 39). Replace the field coil if there is continuity.

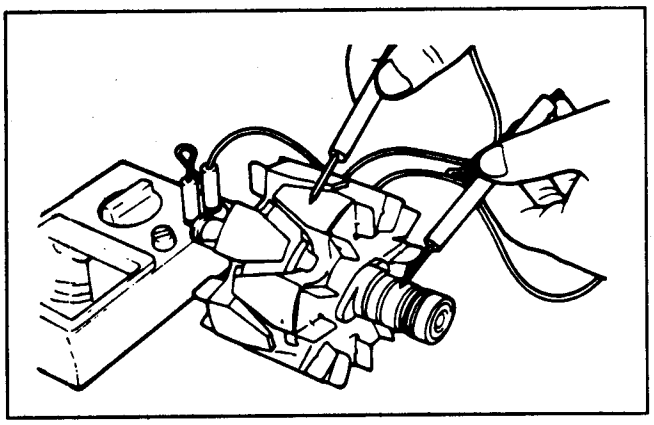


Figure 39

12. Check for continuity between lead wires of the stator coil (Fig. 40). Replace the stator coil if there is no continuity.

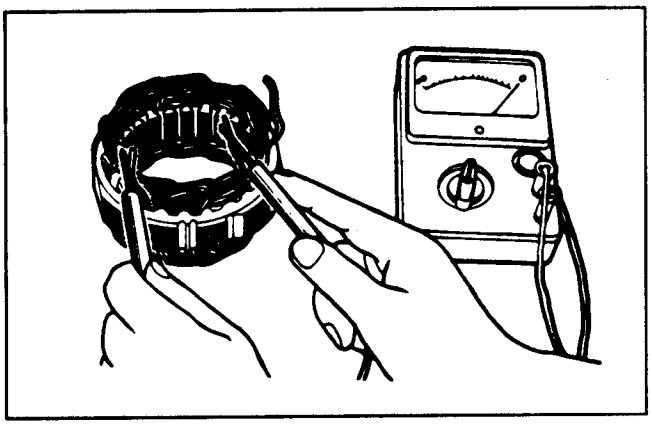


Figure 40

13. Check for continuity between each lead wire and stator core (Fig.41). Replace the stator coil if there is continuity.

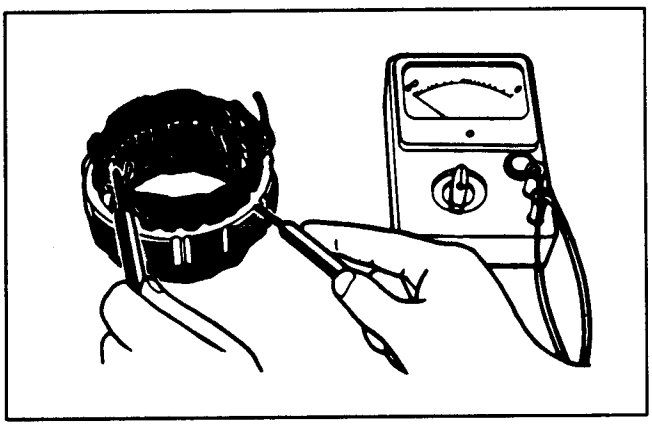


Figure 41

Assembly of Alternator

1. Reverse steps 1 - 8 under Disassembly and Inspection and also following the following instructions:

2. The rear bearing has an eccentric groove. Install the snap ring so its projection fits in the deepest part of the groove.

3. When installing a new rear bearing, press fit the bearing with its groove facing the slip ring side.

4. Heat the rear bracket when press fitting the rear bearing into the bracket.

IMPORTANT: Put a wire through the small hole in the rear bracket to lift the brushes before installing the rotor to the rear bracket (Fig. 42). Remove the wire after the rotor is installed.

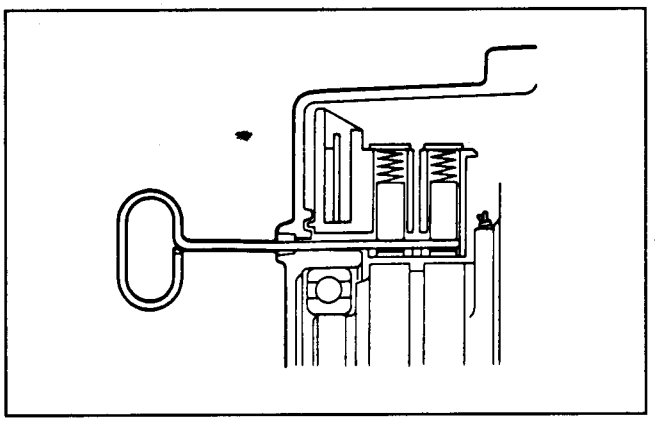


Figure 42

Battery Service

IMPORTANT: Before welding on the machine, disconnect the negative (–) battery cable from the battery to prevent damage to the electrical system (Fig. 43).

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. 44). 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.

Electrolyte Specific Gravity

Fully charged: 1.250 - 1.280
Discharged: less than 1.240

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.

Greensmaster 3000 (Model 04350)
Battery Specifications

BCI Group U1 Battery
200 Amp Cranking Performance at 0° F (17 ° C)
32 min. Reserve Capacity at 80° F (27 ° C)

Greensmaster 3000-D (Model 04375)
Battery Specifications

BCI Group 26 Battery
530 Amp Cranking Performance at 0° F (–17 ° C)
85 min. Reserve Capacity at 80° F (27 ° C)

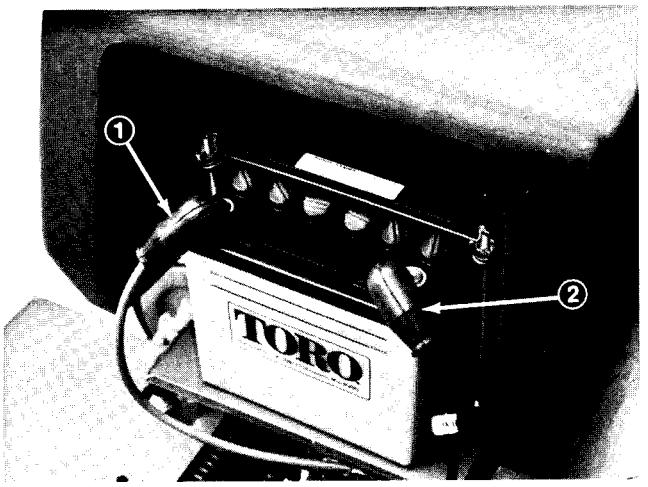


Figure 43
(Greensmaster 3000, Model 04350 shown)

1. Positive (+) terminal
2. Negative (–) terminal

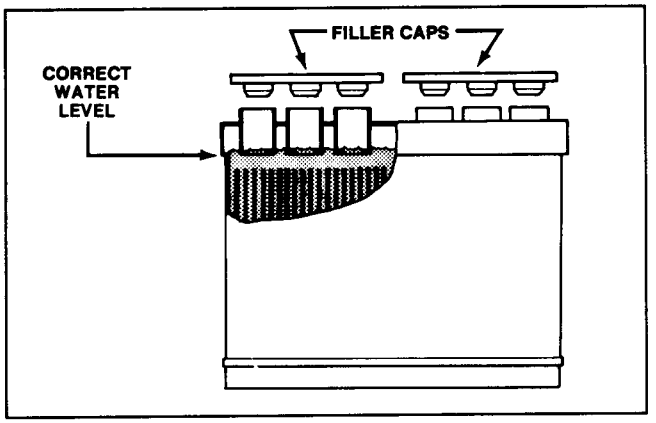


Figure 44

Chapter 7

Steering and Brakes

Table of Contents

See **Chapter 5 - Hydraulic System** for information about the power steering system used on the Greensmaster 3000-D, Model 04375.

Steering Cable Adjustment (Greensmaster 3000, Model 04350)

Steering cable tension should be adjusted whenever there is steering wheel lash (free play). A loose steering cable will make it difficult to steer a straight line. However, over-tightening cables will cause undue wear to pulleys and cause the cable to stretch and fail prematurely.

1. Remove slack from both cable ends by securing the cable end hex with an open end wrench and turning the nut on the cable end with another wrench (Fig. 1).

2. If all threads on the cable end have been used, replace cables. If necessary, service the pulley and steering cable under the steering wheel by removing the cover on the end of the steering column (Fig. 2).

3. Periodically check the setscrews securing the rear steering drum to the caster fork shaft for tightness. Loosen the jam nuts, tighten the setscrews and retighten the jam nuts as necessary (Fig. 1).

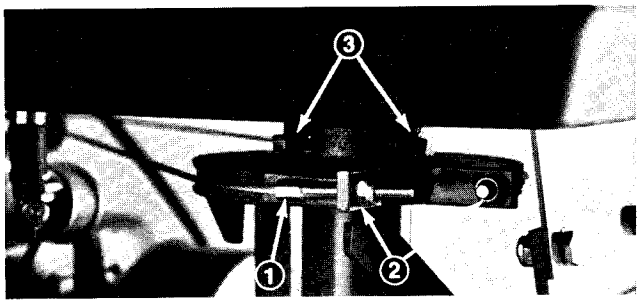


Figure 1

1. Hold with wrench
2. Turn to remove slack
3. Set screws

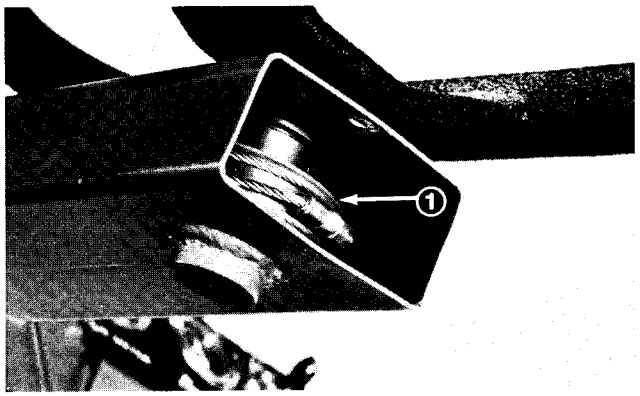


Figure 2

1. Pulley and steering cable

Brake Adjustment

A brake adjustment rod is located on each side of the machine so the brakes can be equally adjusted (Fig. 3).

1. Push down on the brake pedal while driving the machine; both wheels should lock equally.

CAUTION

As a safety precaution, always check brakes in a wide, open spaced, flat area which is free of other persons and obstructions before and after adjustment.

2. If both wheel do not lock equally, disconnect the brake rods by removing cotter pin and clevis pin (Fig. 3).

3. Loosen jam nut and adjust clevis.

4. Assemble clevis to brake shaft.

5. Check brake pedal free travel. There should be 1/2 in. to 1 in. travel before the brake shoes make contact with the brake drums. Adjust again, if necessary, to get this setting (Fig. 4).

6. Push down on the brake pedal while driving the machine; both wheels should lock equally. Repeat steps 2 - 5 if necessary.

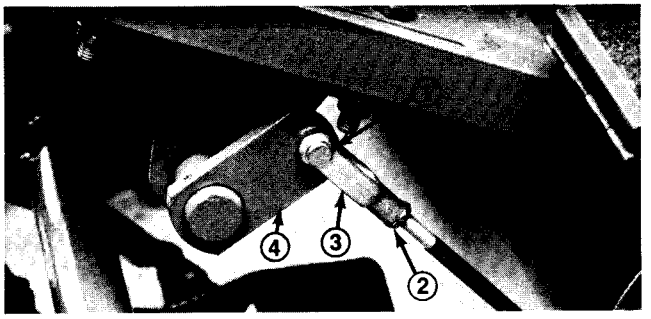


Figure 3

1. Clevis pin and cotter pin
2. Jam nut
3. Clevis
4. Brake shaft

Figure 4

1. 1/2 - 1 in. travel

Steering Cable Replacement (Greensmaster 3000, Model 04350)

NOTE: The steering cable can be replaced without removing the steering wheel and steering wheel pulley. To do this you will need the following tools: 6 in. C-clamp, flexible magnetic pick-up tool, long flat blade screwdriver, and a 24 in. long piece of stiff (16 ga.) wire. Tie the wire to a 5/16" UNF stud that has been drilled, then install a 5/16" UNF lock nut on the stud so it can be attached to the steering cable in step 5 (Fig. 8).

1. Disconnect the wiring harness connector. Remove six (6) screws and remove instrument panel. Do not disconnect throttle and choke control cables.

2. Remove two (2) screws and remove cover from end of steering arm (under steering wheel). Disconnect cable ends from steering drum and remove cable by pulling out through steering wheel end of steering arm.

3. Install a 6 in. C-clamp through hole in steering wheel and tighten to steering arm (Fig. 5). This will prevent the steering wheel and pulley from turning.

4. Form end of right hand cable into a loop and insert into steering arm to right of steering pulley – threaded end closest to pulley (Fig. 6). Release threaded cable end as loop is pushed past pulley so cable expands behind pulley. Use a magnetic pick-up tool to pull threaded cable end out of steering arm so it comes around left side of pulley (Fig. 7).

5. Fasten a 24 in. long piece of stiff (16 ga.) wire, to threaded cable end pulled out of steering arm in step 4. Insert and hold pin at center of cable in hole of steering wheel pulley. Push wire through steering arm to right of steering wheel pulley (Fig. 8). Right hand cable must wrap counterclockwise around pulley so it goes above pin in cable (Fig. 11). As wire is pushed into steering arm, make sure wire and cable go above pulleys inside middle of steering arm.

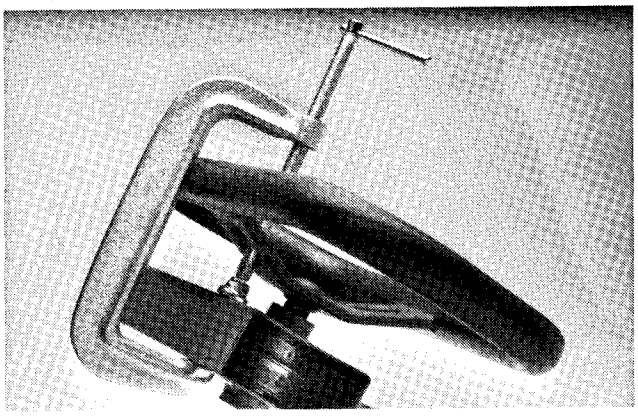


Figure 5

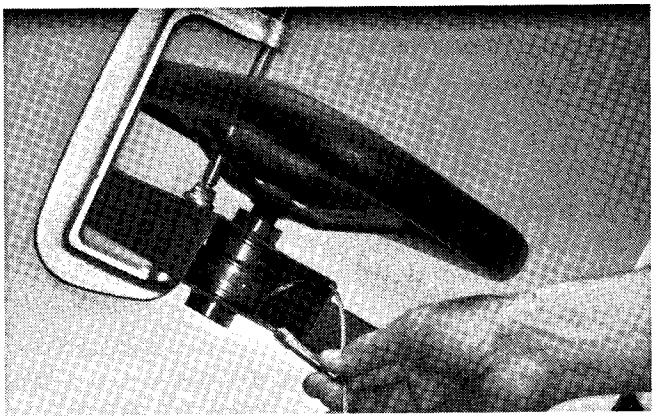


Figure 6

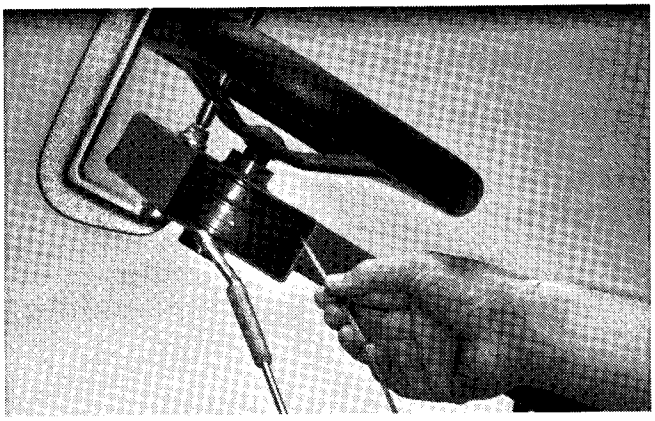


Figure 7

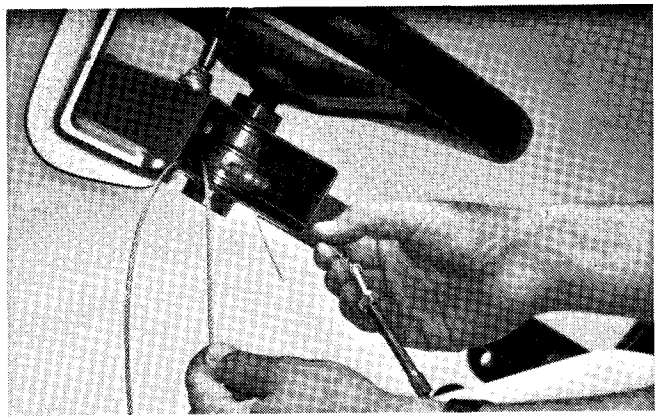


Figure 8

6. Pull cable through steering arm (Fig. 9). Hold cable and use a long flat blade screw driver to guide cable onto upper pulley inside steering arm.

7. While holding cable tight around upper internal steering arm pulley, make sure cable is correctly wrapped around steering wheel pulley. Continue to keep tension on cable near middle steering arm pulleys and insert threaded cable end through lower part of steering arm and around upper (right hand) pulley (Fig. 10).

8. Pull on lower end of cable while keeping tension near middle pulleys until entire cable is tight and in proper pulley grooves. Continue to keep tension on cable, then attach cable end to right side of steering drum and tighten nut to keep cable in tension (Fig. 12).

9. Go to steering wheel end of steering arm, form end of left hand cable into a loop and insert into steering arm to left of steering wheel pulley. Release loop so cable expands behind pulley (under previously installed cable), then use magnetic pick up tool to pull threaded cable end out of steering arm so it comes around right side of pulley.

10. Left hand cable must wrap clockwise around steering wheel pulley so it goes below other cable and center pin (Fig. 11). Repeat steps 5 - 8 for this cable putting cable around lower set of pulleys and attaching to left side of steering drum.

11. Adjust the steering cable. (See Steering Cable Adjustment in the Adjustments section of this chapter.)

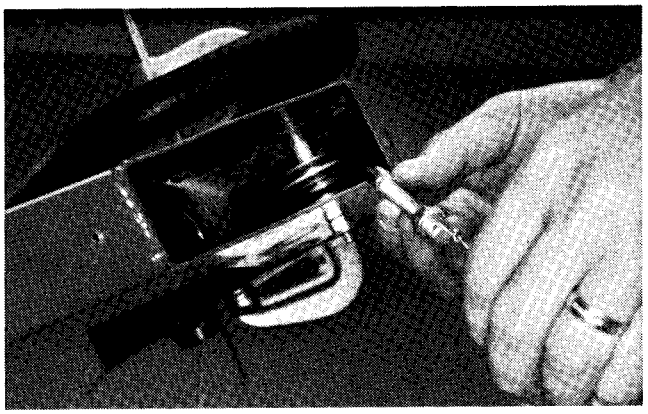


Figure 9

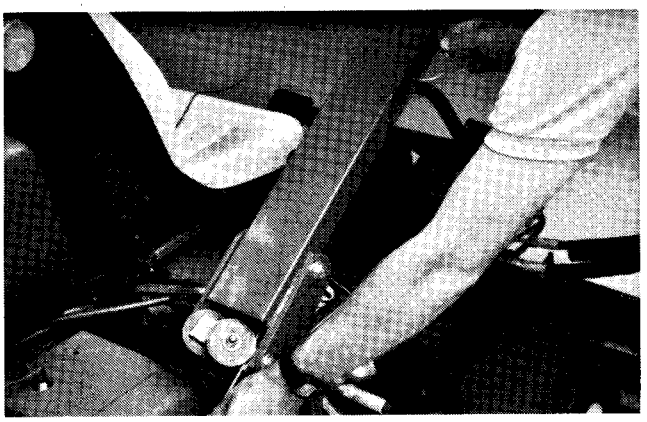


Figure 10

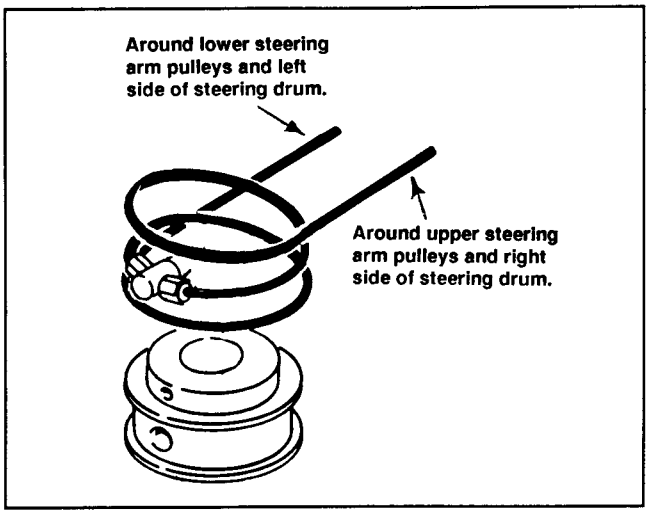


Figure 11

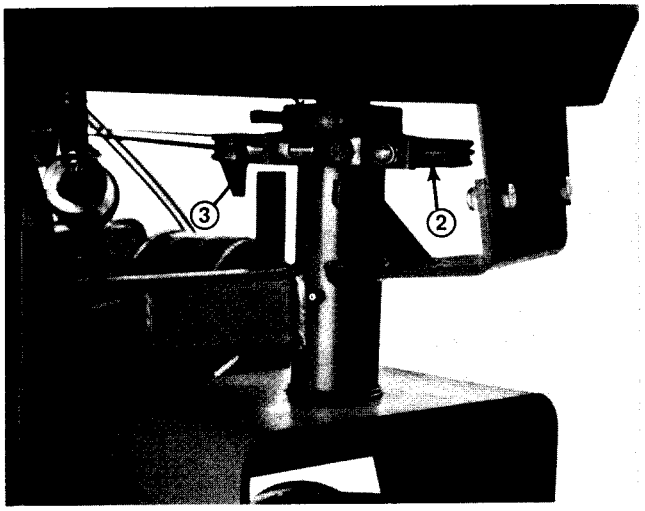


Figure 12

1. Steering drum
2. Cable from upper steering arm pulleys
3. Cable from lower steering arm pulleys

Brake Service

CAUTION

The asbestos brake linings contain asbestos fibers. Breathing dust containing asbestos fibers may be hazardous to your health and may cause serious respiratory or other bodily harm. When servicing wheel brake parts, do not create dust by grinding, sanding or filing brake linings or by cleaning wheel brake parts with a dry brush or compressed air. (Use a water dampened cloth.) Use proper protective equipment when working with asbestos materials.

Brake Disassembly

1 Place blocks on each side of opposite wheel, jack machine up and place blocks beneath frame under wheel motor.

2. Remove wheel nuts and remove wheel. Remove large nut securing wheel hub to motor shaft.

3. Mount a wheel puller to the wheel mount studs and remove wheel hub. Remove key from motor shaft (Fig. 13).

4 Remove brake shoe springs and brake shoes. Disconnect brake linkage (Fig. 14 & 15).

5.Repair or replace parts as necessary.

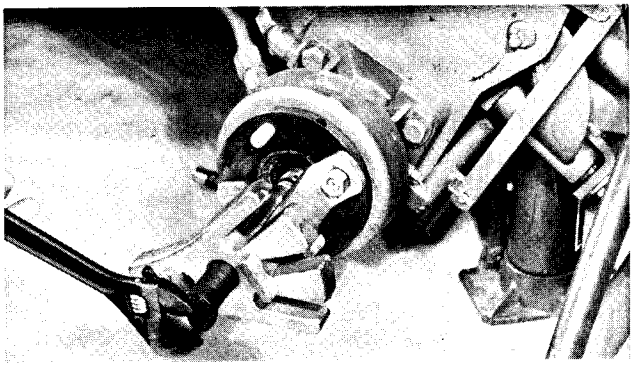


Figure 13

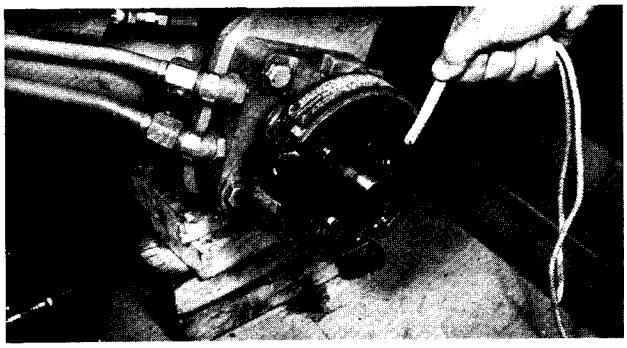


Figure 14

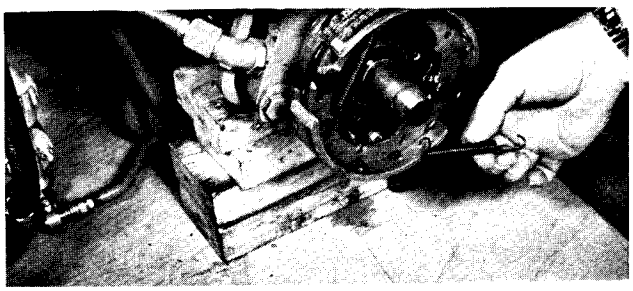


Figure 15

Reassembly

1. If equipped with anti-vibration springs (Model 04350, S/N 91696 and below), insert them into backing plate from underside and hook them onto the brake shoes (Fig. 16).

2. Insert small hook end of tension springs into the hole in each brake shoe plate from the outside. Connect large spring ends into opposite shoe plate. The springs should be in opposite direction from each other.

3. Install actuator shaft. Connect actuating linkage and secure clevis locknut with a cotter pin.

4. Mount key in wheel shaft so top of key is in line with taper of shaft and install wheel hub and nut. Tighten nut to a torque of 250 to 400 ft-lb.

5. Install wheel assembly. Tighten wheel nuts to a torque of 40-50 ft-lb.

6. Adjust and check brakes. (See Brake Adjustment in the Adjustments section of this chapter.)

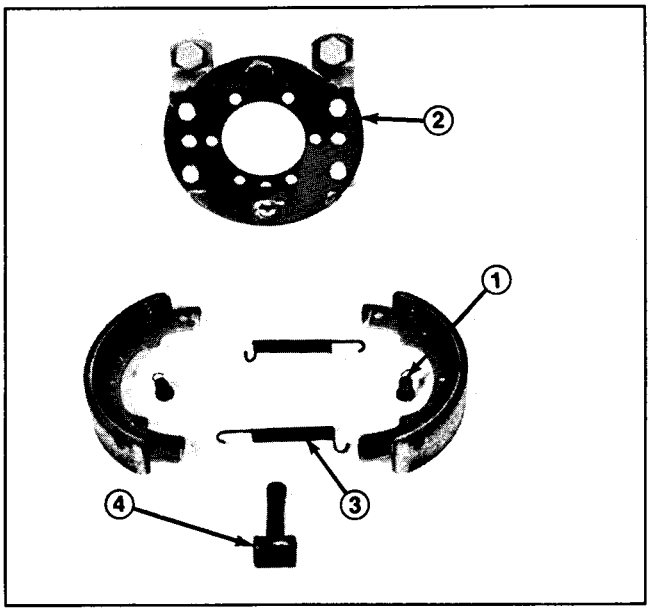


Figure 16

1. Antivibration springs
2. Backing plate
3. Tension springs
4. Brake actuator shaft

TORO®

Chapter 8

4 Bolt Adjust Cutting Units

Table of Contents

Introduction

This chapter gives service information for Model 04407 and 04408 cutting units.

See **Chapter 10 - Grooming Reel Cutting Units** for information about cutting units equipped with the Model 04455 Grooming Reel Kit

Specifications

Height of Cut: 3/16 (0.1875) in. to 11/16 (0.6875) in.

Clip Frequency and Optimum Height of Cut Range:

Model No.	Clip (max.)	Optimum Height of Cut Range
Model 04407, 04408:	0.25 in.	3/16" - 5/16"

Roller Adjustment:
Front: Micrometer hand adjustment with bolted camp lock (1 turn = 0.025 in. height of cut change).
Rear: Pivot arm change on slot in side plate with locking nuts for paralleling roller to reel and adjusting bedknife attitude.

Bedknife To Reel Adjustment: Bedknife adjusts against reel, with opposed screw adjustment on each end of bedbar.

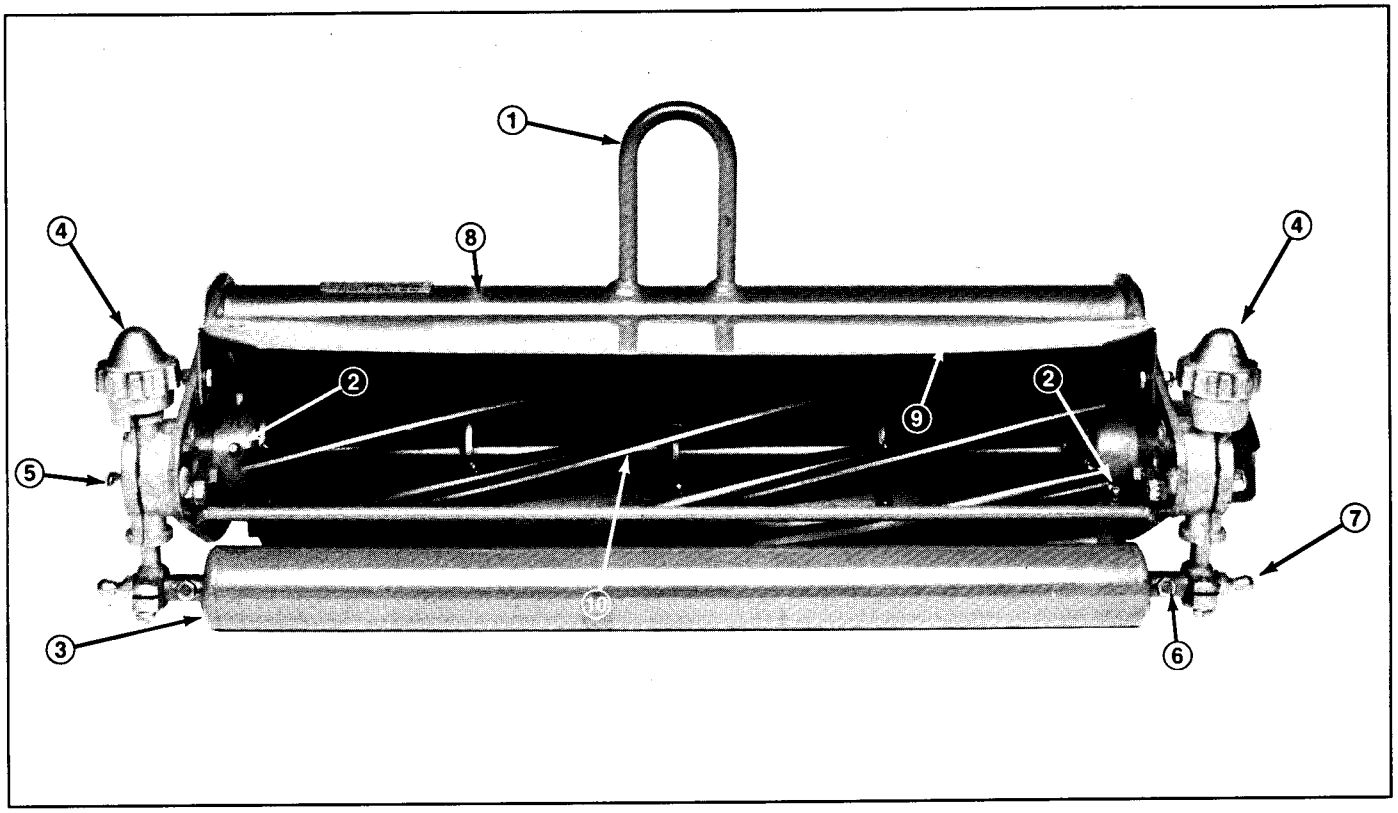
Reel Speed: 1940 rpm (engine speed 2800 rpm).

Bedknife Screw Torque: 200 in-lb.

Reel Splined Drive Nut Torque: 40 to 60 ft-lb.

Reel Bearing Rolling Torque: 7 in-lb. max.

Front or Rear Roller Run-Out: 0.14 in. max.



1. Lift bail
2. Grease fittings - reel bearings
3. Grease fittings - roller
4. Height of cut adjustment knob (2)
5. Height of cut adjustment locknut
6. Scraper adjusting nut (4)
7. Pull rod studs (2)
8. Grass shield
9. Adjustable grass shield bar
10. Reel

Special Tools

NOTE: Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*. Some tools may be listed in the Greensmaster 3000 or 3000-D Parts Catalog. Some tools may also be available from a local supplier.

Roller Bearing Replacement Tool

Puller is used to remove bearings from front and rear rollers. Driving tubes are used to install bearings into rollers. Refer to instructions supplied with tool. Used on swaged, full and wiehle rollers.

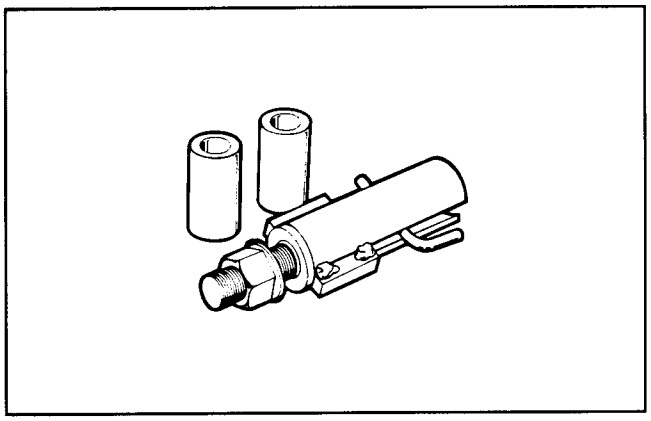


Figure 1

Plastic Plug

Insert plug in cutting unit bearing housing in place of reel motor when sharpening or grinding the reel.

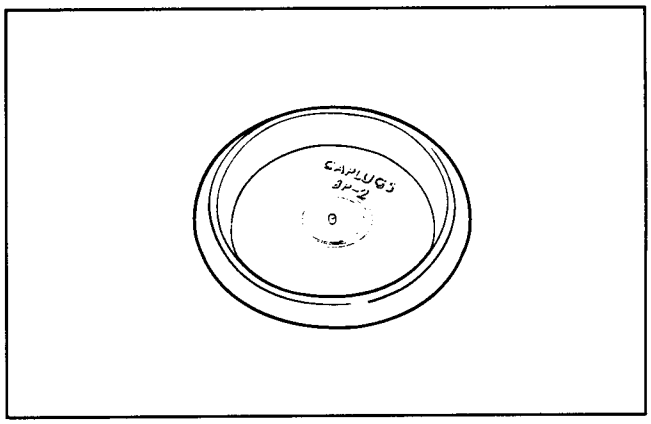


Figure 2

Handle Assembly

For applying lapping compound to cutting units while keeping hands a safe distance from the rotating reel assembly.

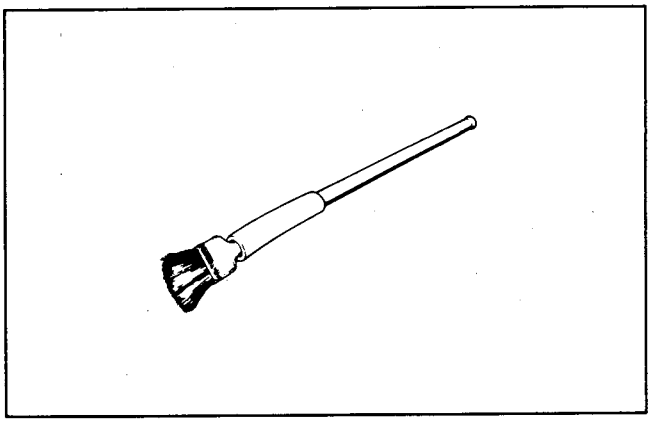


Figure 3

Bedknife Screw Tool

Fits Toro bedknife attaching screws. Use with torque wrench to secure bedknife to bedbar. With clean bedbar threads and new screws, tighten to a torque of 200 in-lb.

NOTE: Remove all rust, scale and corrosion from bedbar surface before installing bedknife.

DO NOT use an air impact wrench with this tool.

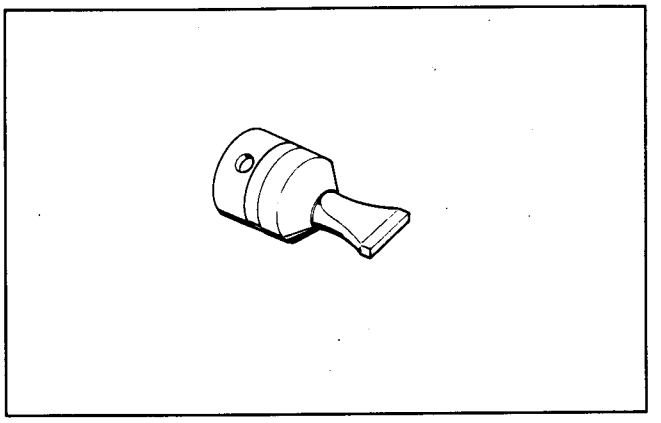


Figure 4

Troubleshooting

There are a number of factors that can contribute to unsatisfactory quality of cut, some of which may be turf conditions. Turf conditions such as excessive thatch, "sponginess" or attempting to cut off too much grass height may not always be overcome by adjusting the machine. It is important to remember that the lower the height of cut, the more critical these factors are. See the Adjustments and Repairs sections for detailed adjustment and repair information.

Factors Affecting Quality of Cut

Factor	Possible Problem/Correction
1. Tire pressure.	Check tire pressure adjust to specification if necessary. Must be equal in two front tires.
2. Engine governed speed.	Check maximum governed engine speed. Adjust to specification if necessary - affects reel speed.
3. Reel bearing condition/adjustment.	Check and adjust to specification. Replace bearings if worn or damaged. Bearing cones must be installed square to bearing housing - make sure there is no "flash", paint or other foreign material in housing before installing new bearing cone.
4. Reel and bedknife sharpness.	Reel and/or bedknife that has rounded edge cannot be corrected by tightening bedknife to reel contact. Grind reel to remove taper (cone shape) and/or rifling (grooved or ribbed appearance). Grind bedknife to sharpen and/or remove rifling. (Most common cause of rifling is bedknife to reel contact that is too tight.) NOTE: New bedknife must be ground after installing on bedbar to match bedknife to bedbar.
5. Bedknife to reel contact.	Reel must have light contact all across bedknife. No contact will dull the cutting edges. Excessive contact accelerates wear; quality of cut may be adversely affected. Adjust, backlap or grind if necessary.
6. Bedknife attitude.	Adjust rear roller brackets to proper location in slots of side plate. (See Leveling Rear Roller to Reel in the Adjustments section.)
7. Rear roller parallel to reel.	Check and adjust as necessary to avoid mismatch between cutting units.
8. Height of cut.	All cutting units set at same height of cut. Set with front roller – must be equal at both ends of roller. Bench set height of cut and actual (effective) height of cut are different. Effective height of cut depends on cutting unit weight, cutting unit accessories and turf conditions.
9. Proper bedknife for height of cut.	If bedknife is too thick for effective height of cut, poor quality of cut will result.
10. Front roller scraper and comb Adjustment.	Set scraper 1/32 in. clearance from roller. Set comb the same on all cutting units for height of cut and turf conditions. Must be same height at both ends of comb.

Factor	Possible Problem/Correction
11. Stability of bedbar.	Make sure bed bar pivot bolts are securely seated (maximum 40 ft-lb.) Make sure opposing bedknife adjustment screws are tight. To prevent distortion of the adjustment screw mounting plate and bedbar breakage, do not over-tighten the screws.
12. Number of reel blades.	Use cutting unit model with correct number of blades for clip frequency and optimum height of cut range. (Variable speed traction kit can be used to adjust clip frequency.)
13. Cutting unit alignment and pull frame ground following.	Check pull frame alignment on all cutting units. Adjust or repair as necessary. Check lift arms, pull frames for binding, bushing wear or damage. Repair if necessary.
14. Roller condition	All rollers must rotate freely. Grease when needed or repair bearings if necessary.
15. Reel speed.	All reels must rotate at same speed (within 100 rpm). All cutting units must have equal bedknife to reel contact and reel bearing adjustment before checking. Do not run the reel to long or it may get hot and rifle when no grass is being cut. See Troubleshooting in Chapter 5 - Hydraulic System.
16. Traction speed.	Check maximum governed engine speed. Adjust to specification if necessary. See Troubleshooting in Chapter 5 - Hydraulic System Install Variable Speed Traction Kit if necessary to control traction speed in varying conditions or with different attachments. Will allow change in traction speed while maintaining full engine rpm and reel motor rpm.
17. Cutting drop speed and sequence.	Center cutting unit must drop after front cutting unit. (See Troubleshooting in Chapter 5 - Hydraulic System.

Set Up and Adjustments

Adjustment Summary and Check List

DETAILED ADJUSTMENT INSTRUCTIONS FOLLOW THIS SUMMARY AND CHECK LIST. Study this information and refer to it often to get maximum life and performance from the cutting units.

Daily Performance Checks

NOTE: It is not necessary to remove the cutting units from the traction unit to perform these daily checks. It is recommended that mowers be washed after each use. Always remove key from ignition switch when working on the machine.

1. Purge all water and debris from all of the bearings by greasing them. Use No. 2 multi-purpose lithium base grease.

2. Visually check for sharp reel and bedknife.

- Remove burrs, nicks, and rounded edges.

3. Lower cutting units to the ground (setting on both rollers). Remove reel motor and rotate the reel backwards by hand. Light contact between the bedknife and reel should be felt and heard.

- It should be possible to pinch newspaper when inserted form the front and cut paper when inserted at a right angle (along entire length of bedknife).
- It should be possible to cut paper with minimum bedknife to reel contact. Should excessive reel drag be evident you must back lap or grind the cutting unit.
- No contact will dull the cutting edges.
- Excessive contact accelerates wear, and quality of cut may be adversely affected.

Weekly Checks

1. Check reel bearing adjustment and bearing condition.

2. Make sure bed bar pivot bolts are securely seated (maximum 40 ft-lb.).

3. Using a gauge bar, verify correct height of cut setting and adjust as necessary.

Monthly Adjustments

NOTE: Remove cutting unit from traction unit before doing these checks and adjustments (See Cutting Unit Removal and Installation in the Repairs section of this chapter.)

1. Visually check for sharp reel and bedknife. Backlap or grind reel and bedknife if necessary.

2. Adjust rear roller for proper bedknife angle and parallel to reel.

3. Adjust front roller scraper to be 1/32 in. from roller.

4. Set comb or brush adjustment for desired action on grass.

- Light, medium, or aggressive setting.

5. Check grass shield adjustment.

- 4-3/4 in. from crossbar - normal.
- Dry grass - lower shield.
- Wet grass - raise shield.

6. Set top bar (cut-off bar) adjustment.

- 0.060 in. from reel - normal.

7. Lower cutting units to the ground (setting on both rollers), remove reel motor and adjust bedknife to reel contact.

8. Using a gauge bar, set the height of cut adjustment.

Special Notes

1. A "rifled" reel and/or bedknife must be corrected by grinding.

2. If reel bearings will not hold adjustment during operation, loosen adjustment nut, tighten reel shaft *spline nut* to a torque of 40 to 60 ft-lb, then adjust reel bearings.

Reel Bearing Service and Adjustment

1. Adjust the bedknife so it is not in contact with the reel.

2. Reel bearing drag should not exceed 7 in-lb. This can be measured with a torque wrench (Fig. 5). If bearing drag does not meet above specification, adjust the reel bearings.

NOTE: If you do not have an inch-pound torque wrench, do steps 1 - 3 under Reel Bearing Adjustment below.

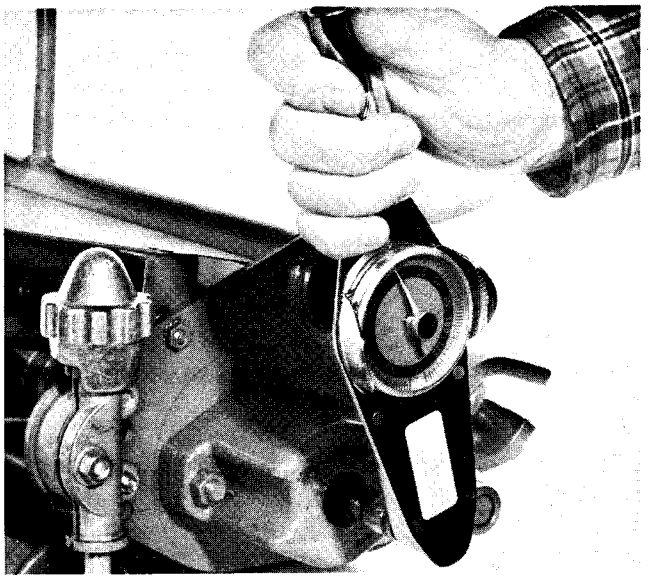


Figure 5

Reel Bearing Adjustment

1. Remove the mounting nuts from the counterbalance end cap and remove end cap from the mounting studs (Fig. 6).

2. Remove bolt mounted on the end of reel shaft. This will make it possible for a large socket wrench to be mounted on the reel bearing adjusting nut inside the side plate.

CAUTION

Do not use your hand to prevent reel from turning while servicing; this can result in personal injury. Use a 1/2 in. thick x 3 in. wide x 8 in. long piece of hardwood inserted into front of cutting unit between reel blades.

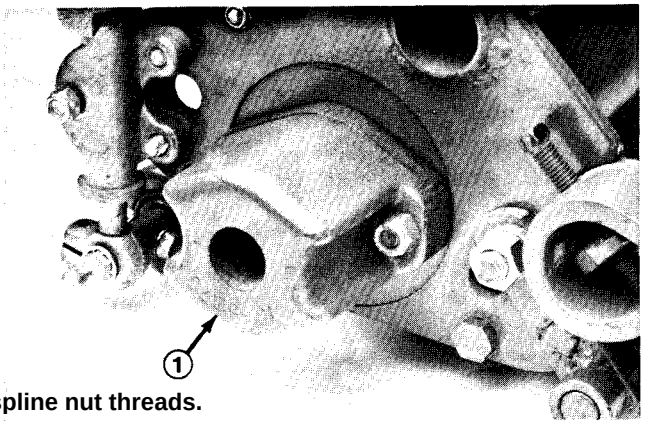


Figure 6

1. Counterbalance end cap

NOTE: If reel bearings will not hold adjustment during operation, loosen adjustment nut, tighten reel shaft spline nut on right hand end of reel shaft to a torque of 40 to 60 ft-lb, then adjust reel bearings. Use Loctite 271 on spline nut threads.

3. Loosen large reel bearing adjustment nut (Fig. 7). Tighten nut until all reel shaft end play is removed, then tighten an additional 1/16 to 1/8 turn. Be certain to remove all end play, but do not overtighten.

NOTE: Adjustment nut must have enough resistance against reel shaft threads to retain bearing adjustment. Replace adjustment nut if necessary.

4. Install bolt into end of reel shaft and check rolling torque with an inch-pound torque wrench (Fig. 7). Reel bearing rolling torque should not exceed 7 in-lb. Repeat setps 2 and 3 if necessary.

5. If bearings require replacement, see Reel Removal and Bearing Replacement in the Repairs section of this chapter.

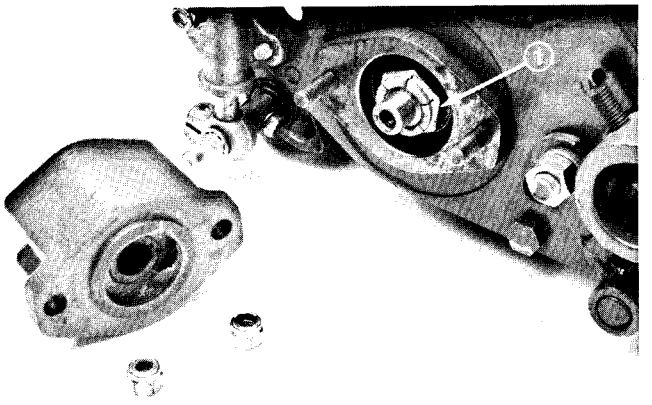


Figure 7

1. Reel bearing adjustment nut

Bedknife To Reel Adjustment

IMPORTANT: For adjusting bedknife to reel, use a 3/8 in. open end wrench that is 3 to 6 in. in length. A longer wrench will provide too much leverage and may cause distortion of the adjustment screw mounting plate or bedbar breakage.

1. To move bedbar closer to reel blades, loosen bottom screw on each side of cutting unit (Fig. 8), then tighten top adjustment screw on each side of cutting unit (Fig. 9). To move bedknife away from reel blades, loosen top screw on each side of cutting unit (Fig. 8), then tighten bottom adjustment screw on each side of cutting unit (Fig. 9).

2. After adjusting bedknife to reel, make sure that both the top and the bottom adjustment screws are secured at both ends of cutting unit (Fig. 8, 9).

3. After adjustment, check to see if reel can pinch paper when inserted from the front, and cut paper when inserted at a right angle (Fig. 10). It should be possible to cut paper with minimum contact between the bedknife and reel blades.

IMPORTANT: If excessive bedknife to reel contact is maintained; bedknife and reel wear will be accelerated. Uneven wear can result, and quality of cut may be adversely affected.

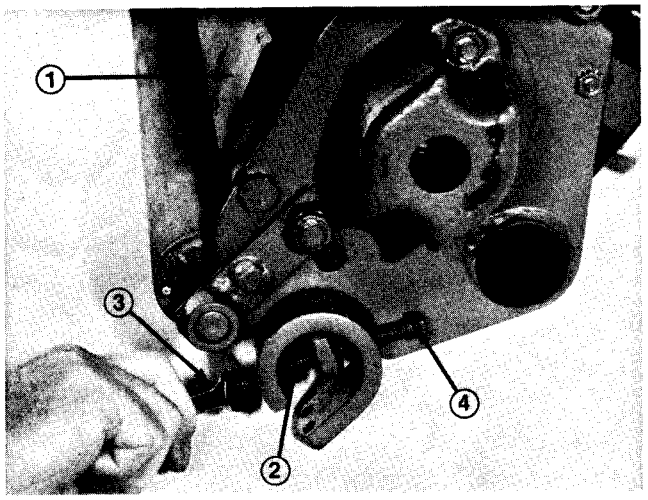


Figure 8

1. Bedknife
2. Bottom adjustment screw
3. 3/8 inch wrench
4. Top adjustment screw

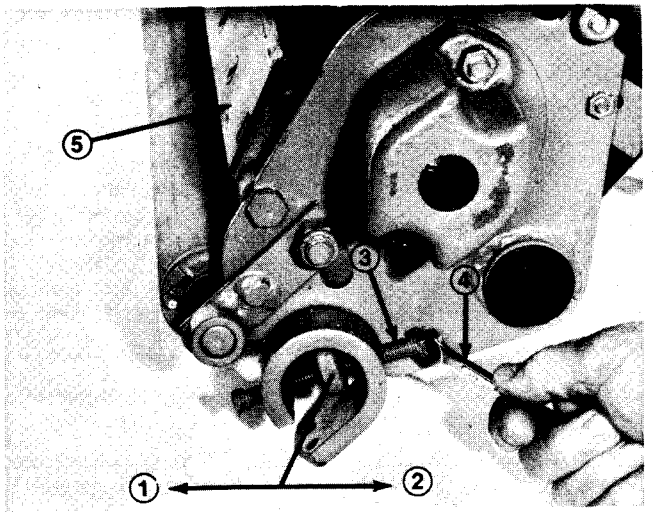


Figure 9

1. Bedknife closer to reel
2. Bedknife further from reel
3. Top adjustment screw
4. 3/8 inch wrench
5. Bedknife

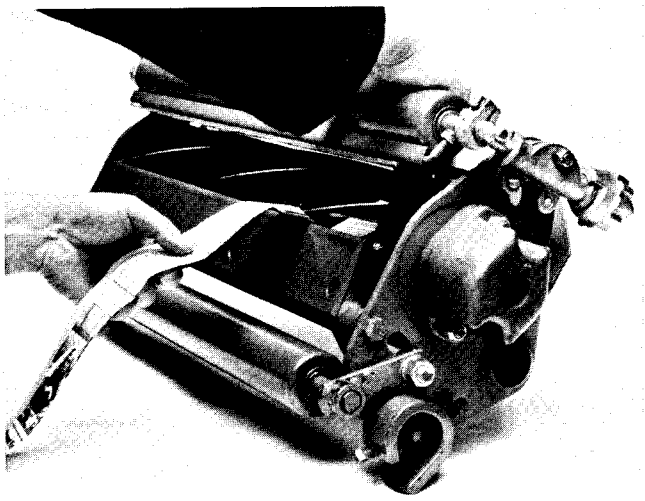


Figure 10

Leveling Rear Roller To Reel

1. Loosen rear roller brackets. Adjust one bracket and tighten the nut on the capscrew. See the table below for the proper adjustment. Leave bracket on the other side mounted loosely (Fig. 11).

Height of Cut	Distance from bottom of rear roller bracket (not bolt) to bottom of slot
1/8 (0.125) in. or below	1/16 (0.0625) in.
5/32 (0.156) to 1/8 (0.125) in.	1/8 (0.125) in.
1/4 (0.25) in. or above	center bracket in slot

NOTE: Position of rear roller bracket determines bedknife angle. Recommendations for rear roller bracket position in above chart are designed to give the best rear roller position (and bedknife angle) for different heights of cut.

IMPORTANT: Rear roller bracket position must be identical on all three (3) cutting units so bedknifes are at the same angle. If bedknifes are not at the same angle there will be a difference in the appearance of the cut grass (mismatch) for each cutting unit.

2. Place a 1/4 inch (6 mm) or thicker plate under the reel blades and against the cutting edge of the bedknife (Fig. 11).

NOTE: Be sure the plate covers the full length of reel blades.

3. With cutting unit reel blades positioned on the plate, hold cutting unit securely and push down on the rear roller assembly until it contacts the working surface across the full length of the roller (Fig. 12).

4. Tighten nut on rear roller bracket that was not tightened in step 1 to secure roller in place.

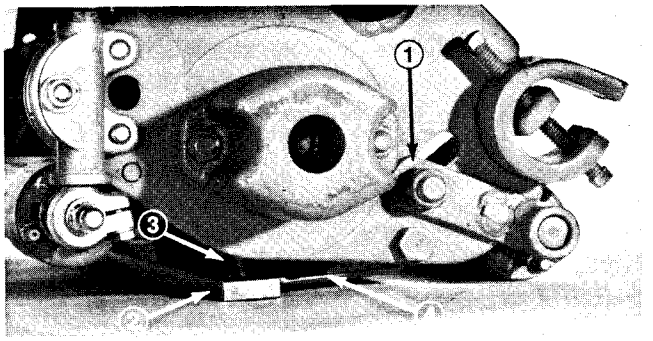


Figure 11

1. Rear roller bracket
2. 1/4 inch (6 mm) steel plate
3. Reel blades
4. Bedknife

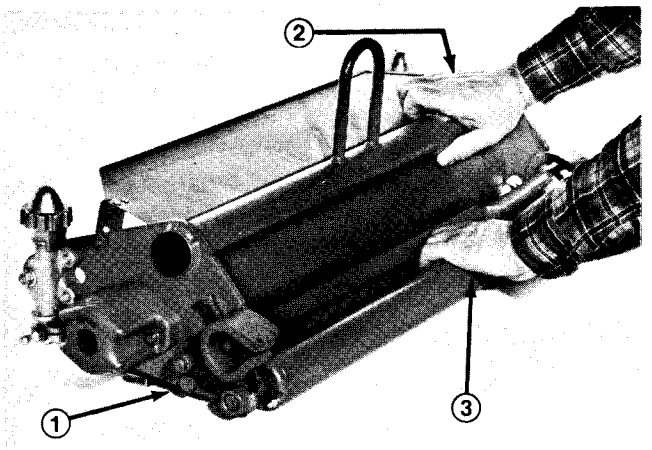


Figure 12

1. Unit on level surface
2. Hold unit securely
3. Push down on roller

Height Of Cut

Height of cut, as measured in the turf and on the cutting unit is different. The grass prevents the cutting unit from settling all the way to the ground line as the machine moves across the turf. Because of this, the actual (effective) height of cut is higher than the bench set height of cut.

Machine conditions, such as cutting unit weight, roller type, bedknife thickness, speed of travel and clip, influence effective height of cut. Turf conditions, such as grass type, grass density, and amount of thatch also influence effective height of cut.

Changing the machine (such as adding a wiehle roller) will increase penetration into the turf and lower the effective height of cut. Changing from a heavier single point adjust cutting unit to a lighter 4-bolt adjust cutting unit will reduce penetration into the turf and raise the effective height of cut.

Height of Cut Adjustment

IMPORTANT: Lower heights of cut are limited by thickness of bedknife. Select proper bedknife for desired height of cut. If bedknife is too thick for height of cut, poor quality of cut will result and excessive pressure from turf on bottom of bedknife can cause "rifling" of bedknife and reel.

1. To adjust height of cut, cutting unit should be turned over and the locknuts on each end of the cutting unit securing the height of cut adjusting knob loosened (Fig. 13).

2. On gauge bar (Part No. 1-8789), set head of screw to desired height of cut. This measurement is from bar face to underside of screw head.

3. Put the bar across the front and rear rollers and adjust the height of cut knob until the underside of the screw head engages the bedknife cutting edge (Fig. 10).

IMPORTANT: Do step 3 on each end of the bedknife. Tighten height of cut adjustment locknuts on both ends.

Changing To A Different Type of Cutting Unit or Adding Cutting Unit Accessories

When changing to a different type of cutting unit or adding cutting unit accessories, it is recommended that you change only one cutting unit, and keep the other two existing cutting units on the machine.

1. Set the new cutting unit to a height of cut approximately 1/16 (0.06) in. higher than the old cutting unit.

2. Do a mowing test and compare results between the new cutting unit and old cutting units.

3. Adjust the new cutting unit to match the cut of the old cutting units.

4. The other two cutting units can now be replaced. Adjust these two new cutting units so they are the same as the other new cutting unit that was tested.

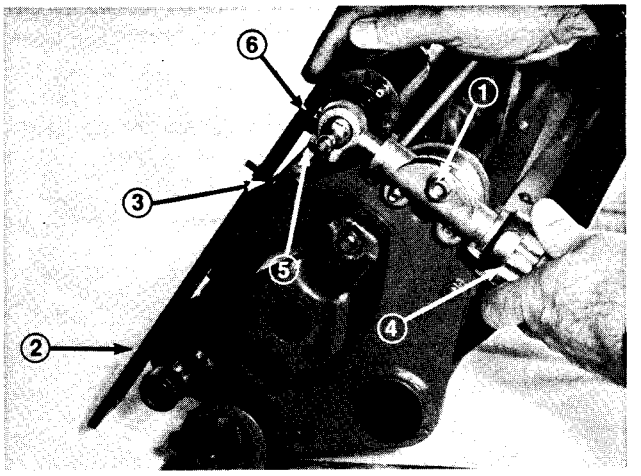


Figure 13

1. Height of cut knob locknut
2. Gauge bar (1-8789)
3. Gauge bar screwhead
4. Height of cut knob
5. Roller shaft clamp bolt
6. Comb assembly

Front Roller Scraper Adjustment

The front roller scraper should be adjusted so there is a clearance of approximately 1/32 of an inch between the scraper and roller (Fig. 14).

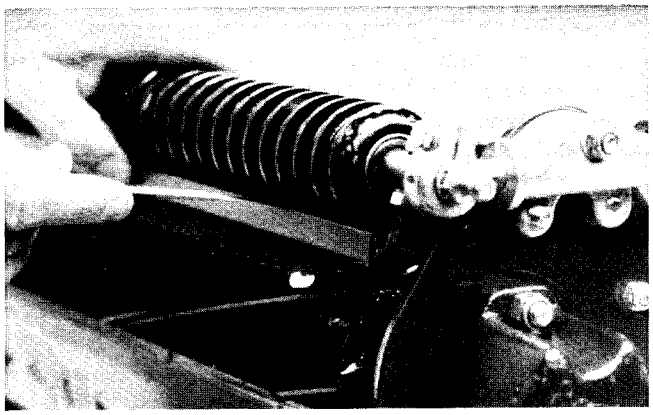


Figure 14

Comb Adjustment

1. Make sure rear roller is in the desired height of cut position. Loosen the bolts anchoring the front roller shaft (Fig. 15). Rotate the shaft.

2. To adjust the aggressiveness of the comb teeth (Fig. 15), proceed as follows:

   A. Teeth touching the adjusting gauge bar gives an **aggressive** setting.

   B. Adjustment of the comb assembly so it is midway between the adjusting gauge bar and the cutting edge of the bedknife gives a **medium** setting.

   C. Adjusting the comb assembly so it is even with the cutting edge of the bedknife gives a **light** setting.

NOTE: Securing one end of the comb assembly at a time simplifies the above procedure.

3. Tighten the roller shaft bolts.

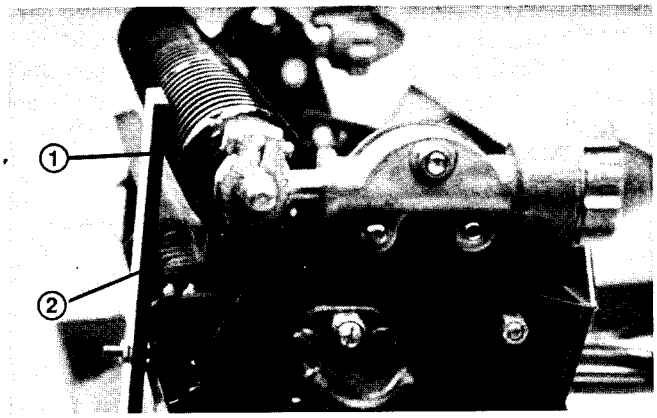


Figure 15

1. Roller shaft clamp bolt **2. Comb teeth**

Shield Height Adjustment

Adjust shield to get proper grass clipping discharge into basket:

1. Set cutting unit in normal cutting position and measure distance from top of front crossbar to shield at each end of cutting unit (Fig. 16).

2. Height of shield from crossbar for normal cutting conditions should be 4 3/4 inches. Loosen cap-screws and nuts securing shield to each side-plate, adjust shield to correct height and tighten fasteners (Fig. 16).

3. Repeat adjustment on remaining cutting units and adjust top bar. (See Top Bar Adjustment in this section of the book.)

NOTE: Shield can be lowered in dry grass conditions (clippings fly over top of baskets) or raised to allow for heavy wet grass conditions (clippings build up on rear edge of basket.

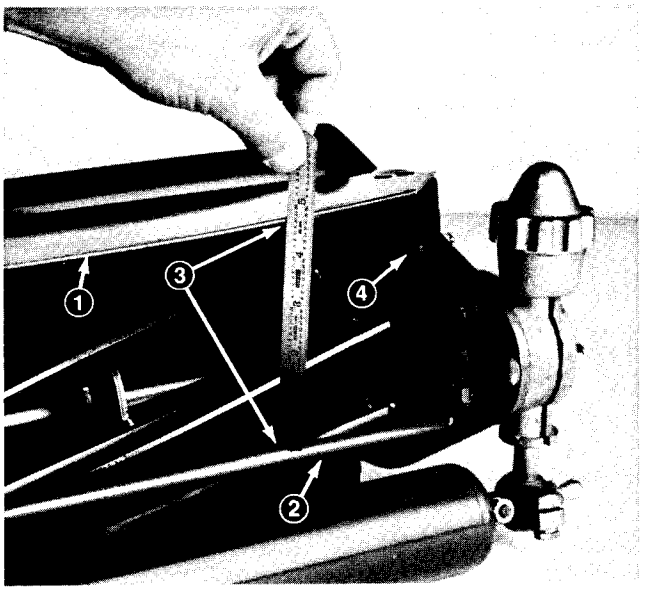


Figure 16

1. Shield
2. Front crossbar
3. 4-3/4 inches (12.1 cm)
4. Shield fasteners

Top (Cut Off) Bar Adjustment

Adjust top bar to make sure clippings are cleanly discharged from reel area:

1. Loosen screws securing top bar (Fig. 17). Insert 0.060 inch feeler gauge between top of reel and bar and tighten screws (Fig. 17). Make sure bar and reel are equal distance apart across complete reel.

2. Repeat settings on remaining cutting units.

NOTE: Bar is adjustable to compensate for changes in turf conditions. Bar should be adjusted closer to reel when turf is extremely wet. By contrast, adjust bar further away from reel when turf conditions are dry. Bar should be parallel to reel for optimum performance and should be adjusted whenever shield height is adjusted or whenever reel is sharpened on a reel grinder.

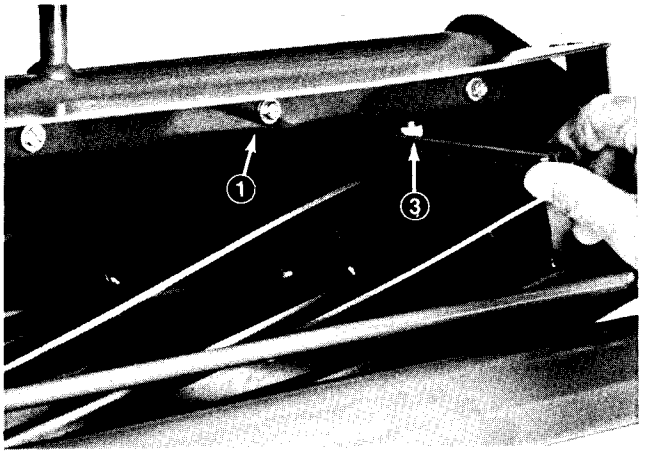


Figure 17

1. Top bar
2. Bar mounting screws
3. Feeler gauge

Pull Frame Adjustment

1. Put the basket on the pull frame.

2. Level baskets to cutting unit by loosening nut at one end of pull frame roller. Loosen bolt and move roller shaft in slot as necessary. Tighten bolt.

3. Loosen the jam nuts on the pull arms and adjust the ball sockets until there is 1/4 in. to 1/2 in. (6 to 13 mm) clearance between the lip of the basket and the reel blades (Fig. 18a). This prevents grass clippings from dropping on the ground.

4. Make sure the basket lips are the same distance from the reel blades at both ends of the reel. If the basket is too close to the reel, it is possible for the reel to contact the basket at the instant the cutting unit is raised off the ground.

5. Make sure each of the three (3) cutting units track straight with the traction unit:

A. On a smooth, level surface, draw a straight line on the floor (Fig. 18b). Push traction unit forward (removing slack from pull arms) so center of each front wheel is on top of the line. Use a plumb bob or square to make sure each wheel is centered on the line.

B. Measure from each end of cutting unit front roller to chalk line. Distance from each end of roller to line must be equal within 3/16 (0.187) in.

C. Loosen jam nuts on pull arms and adjust ball sockets so distance from each end of roller to line is within 3/16 (0.187) in.

NOTE: If a cutting unit cannot be adjusted to track correctly with the traction unit, the pull frame, or lift arm is damaged and/or the lift arm and pull frame bushings are worn and must be replaced.

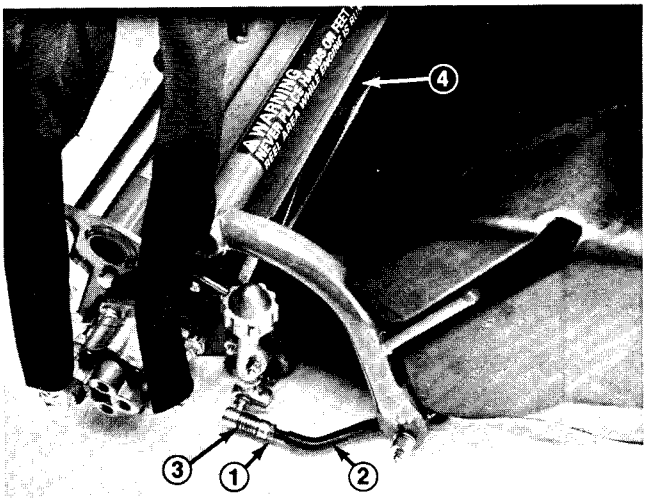


Figure 18a

1. Jam nut **3. Ball joint - adjust for clearance**
2. Pull arm **4. 1/4 - 1/2 in. (6 - 13 mm) clearance**

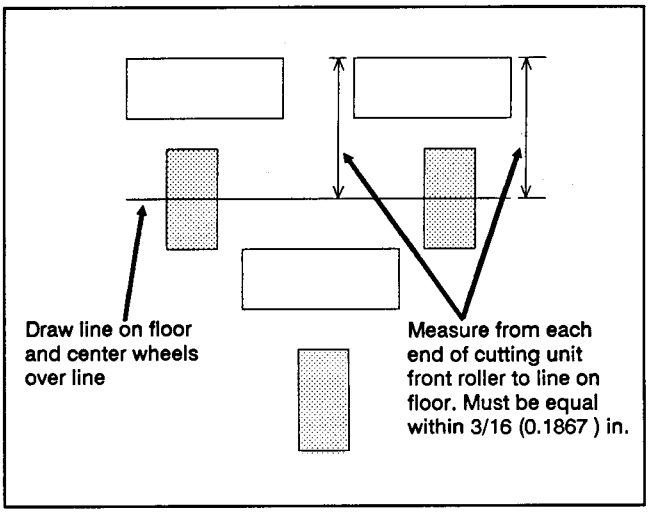


Figure 18b

Cutting Unit Removal and Installation

Remove cutting unit from traction unit before doing adjustments or repairs.

1. Remove basket from pull frame.

2. Loosen reel motor mounting nuts (Fig. 19). Rotate the motor clockwise so motor flanges clear studs and pull motor off of cutting unit.

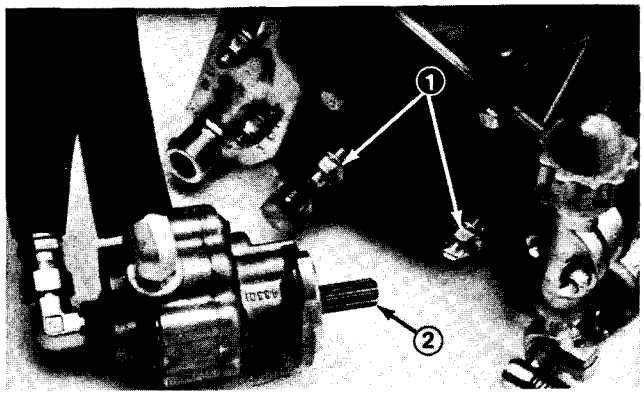


Figure 19

1. Motor mount nuts
2. Motor shaft

3. Slide the sleeve back on the ball joint and disconnect the pull arm from each side of the cutting unit (Fig. 20).

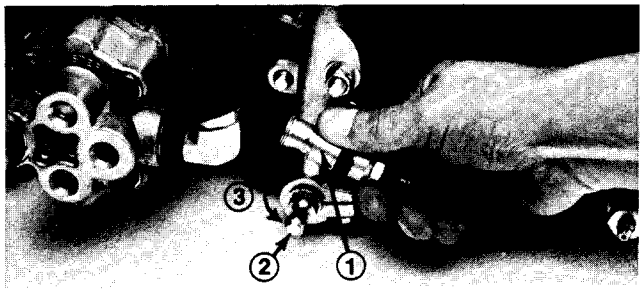


Figure 20

1. Slide back to mount
2. Ball stud
3. Swing up to remove, down to install

4. Slide cutting unit out from under pull frame, disengaging the lift arm from the lift ball (Fig. 21).

5. Reverse steps 1 - 4 to install the cutting unit.

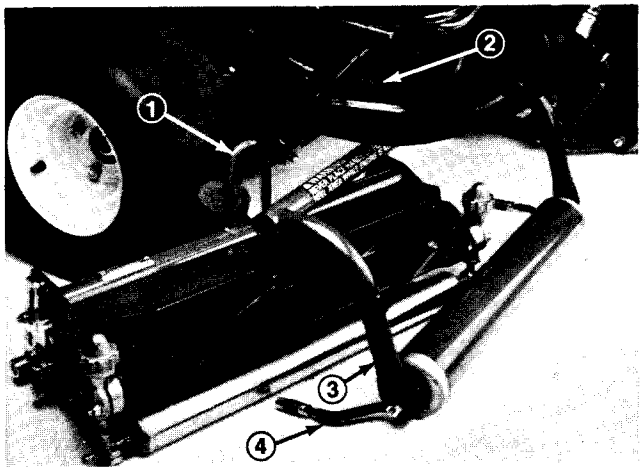


Figure 21

1. Lift ball
2. Lift arm
3. Pull frame
4. Pull arm

Reel Lapping

Check reel bearing adjustment and correct if necessary before backlapping. Connect a lapping machine to the cutting unit with an extension coupler, and a 9/16 socket. The 9/16 socket can be positioned onto the capscrew on the reel shaft inside the counter-balance weight on the end of the cutting unit (Fig. 22). Backlap according to procedures in the Toro publication "Sharpening Reel & Rotary Mowers, Form No. 80-300-PT.

NOTE: For a better cutting edge, run a file across the front face of the bedknife when the lapping operation is completed. This will remove any burrs or rough edges that may have built up on the cutting edge.

CAUTION

Be careful when lapping the reel because contact with the reel or other moving parts can result in personal injury.

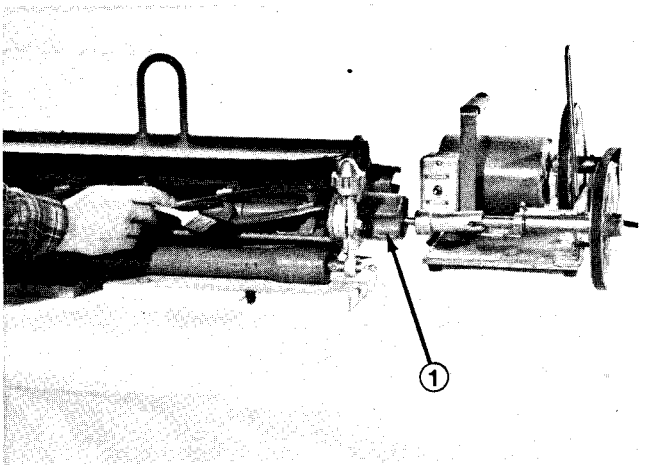


Figure 22

1. Counterbalance weight

Bedbar Removal and Installation

1. Remove rear roller assembly.

2. Remove capscrew and nut anchoring the rear roller height-of-cut bracket to the side plate on both ends of the cutting unit (Fig. 23).

3. Loosen allen set screws securing the roller shaft (Fig. 23).

4. Remove the rear roller height-of-cut brackets from both side plates.

5. Remove the bedbar mounting bolts from each end of the cutting unit (Fig. 23). Then loosen the bedknife adjusting screws at each end of the cutting unit (Fig. 23). The bedknife assembly can then be removed by rotating it away from the reel.

IMPORTANT: When installing the bedbar assembly, be sure to position the center portion of the grass shield over the rear edge of the bedbar (Fig. 24). Securely seat the (2) bedbar pivot bolts to a maximum torque of 40 ft-lbs. Always check reel bearing adjustment after installing bedbar.

NOTE: For proper grinding of bedknife follow procedures in the Toro publication "Sharpening Reel & Rotary Mowers", Form No. 80-300-PT.

6. Reverse steps 1 - 5 to install the bedbar.

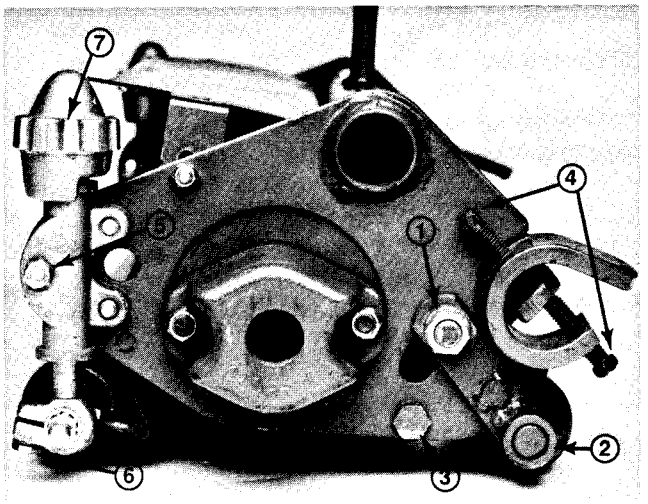


Figure 23

1. Rear roller height of cut bracket
2. Allen set screw
3. Bedbar mounting bolts
4. Bedknife adjusting screws
5. Height of cut rod locknuts
6. Roller shaft clamp bolts
7. Height of cut adjustment knob

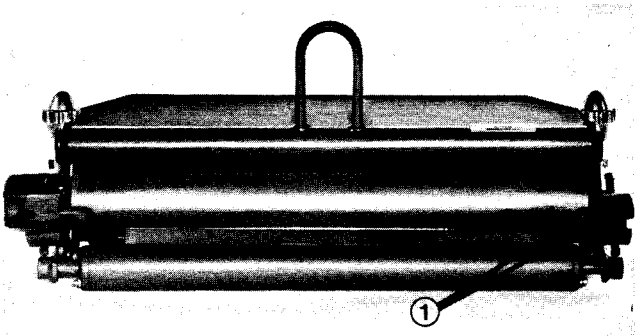


Figure 24

1. Bedbar under lip of shield

Bedknife Replacement

1. Remove bedbar.

2. Remove bedknife screws and remove bedknife.

3. Remove all rust, scale and corrosion from bedbar surface before installing the bedknife.

4. Install new bedknife with the proper bedknife screws (57-4910). Bedknife screws must bottom out on the bedknife, not the bedbar. Tighten the screws to a torque of 200 in-lb, working from the center toward each end of the bedbar (Fig. 25).

5. Grind the new bedknife to match it to the bedbar.

NOTE: For proper grinding of bedknife, follow procedures in the Toro publication "Sharpening Reel and Rotary Mowers", Form No. 8O-300-PT.

6. Install the bedbar.

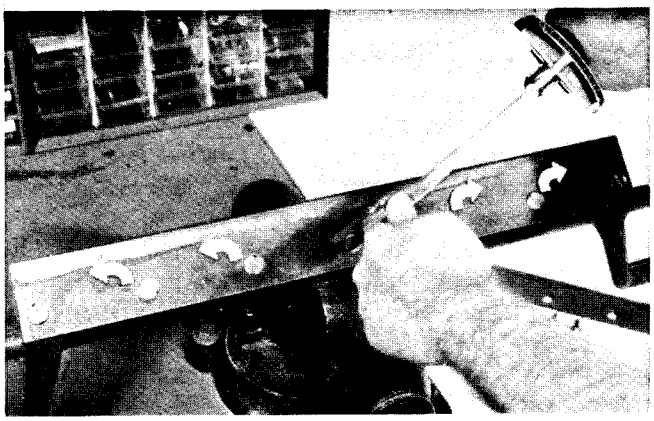


Figure 25

Preparing Reel For Grinding

IMPORTANT: Adjust reel bearings before grinding reel. (See Reel Bearing Service and Adjustment in the Adjustments section of this chapter.

1. Remove bedbar.

NOTE: Some reel grinders may require rear roller assembly be mounted to the cutting unit for proper support in reel grinder. Rear roller must be parallel to reel shaft to remove taper when grinding.

2. If necessary, remove front roller assembly.

   A. Loosen the locknuts securing height of cut adjusting rods at both ends of the cutting unit and the roller shaft clamp bolts (Fig. 26).

   B. Turn height of cut adjustment knobs until they are disconnected from the height of cut adjusting rods (Fig. 26). The roller assembly can then be removed from the cutting unit by pulling evenly on both sides.

For proper grinding of reel, follow procedures in the Toro publication "Sharpening Reel & Rotary Mowers, Form No. 80-300-PT.

3. Install bedbar. After grinding, assemble cutting unit, do all adjustments. Back lap if necessary to get desired fit between reel and bedknife.

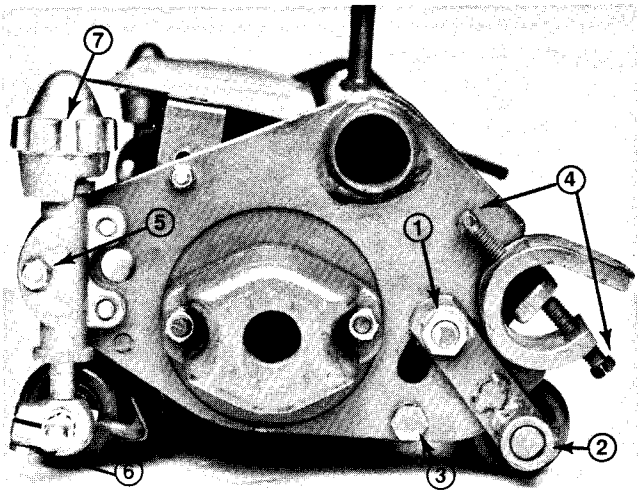


Figure 26

1. Rear roller height of cut bracket
2. Allen set screw
3. Bedbar mounting bolts
4. Bedknife adjusting screws
5. Height of cut rod locknuts
6. Roller shaft clamp bolts
7. Height of cut adjustment knob

Reel Removal and Bearing Replacement

1. Remove the front and rear roller assembly. Remove bedbar.

2. Remove counterbalance end cap from left hand side of cutting unit (Fig. 27). Remove large bearing adjustment nut from left hand end of reel shaft (Fig. 27) and special spline nut from opposite end of reel shaft.

3. Remove machine screws securing bearing housing on each end of cutting unit (Fig. 28). Machine screw heads will have to be cut off before screw can be completely removed:

A. Unscrew machine screw approximately two turns.

B. Cut head off of machine screw.

C. Use a screw driver to back out remaining part of screw from side plate (outwards, not inwards towards reel). If machine screw does not have a screw driver slot, use a pliers to back out screw.

IMPORTANT: Remove grease fittings from bearing housing at each end of cutting unit. Note that the straight fitting is on the right end, and 90° fitting at the left end (when viewed in the direction of travel).

4. Use a plastic headed hammer to rotate bearing housing slightly, install bolts from outside of housing and turn bolts alternately against side plate to remove bearing housing (Fig. 29). Bearing housing will slip out of side plates and reel assembly can be removed as soon as bearing housings are disassembled from side plates.

5. Before installing reel, install new special machine screws from inside of frame to secure bearing housing.

6. If necessary, install new bearings and seals:

A. Remove outer seal (in counterbalance weight), bearing cup, bearing cone and inner seal.

B. Bearing housing must be completely free of paint and foreign material before installing bearing cup. If necessary, remove any "flash" from bearing housing that may interfere with accurate seating of bearing. Install new inner seal. Install bearing cup.

C. Install bearing housing to frame. Pack bearing cone with grease and install over reel shaft into bearing cup. Install outer seal (in counterbalance weight).

7. After installing reel, tighten spline nut to 40 - 60 ft-lb, then adjust bearings (See Reel Bearing Service and Adjustment in the Adjustments section of this chapter.)
Use Loctite 271 on spline nut threads.

8. Install bedbar. Install front and rear roller assembly.

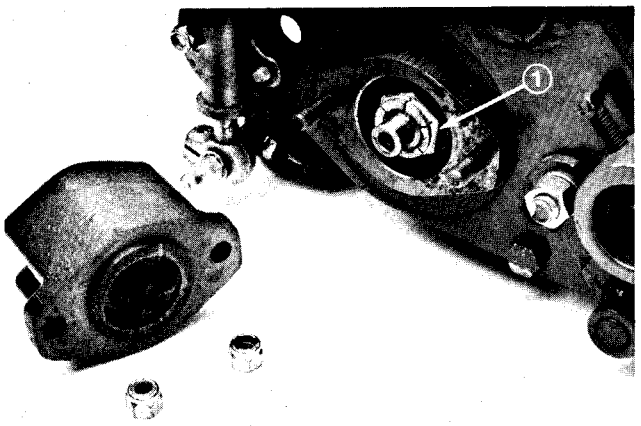


Figure 27

1. Reel bearing adjustment nut

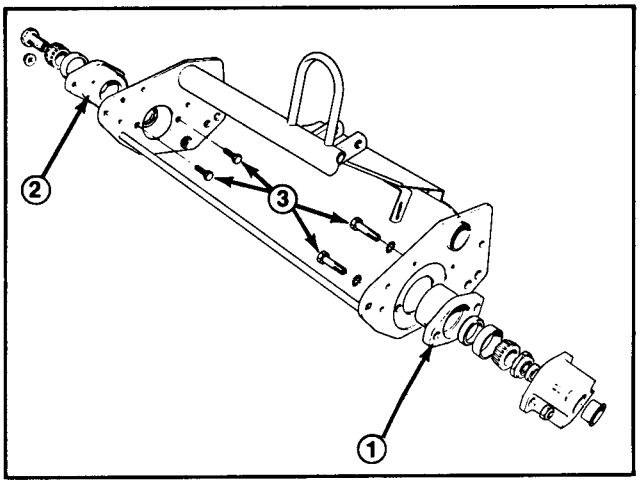


Figure 28

1. Left reel bearing housing
2. Right reel bearing housing
3. Machine screws

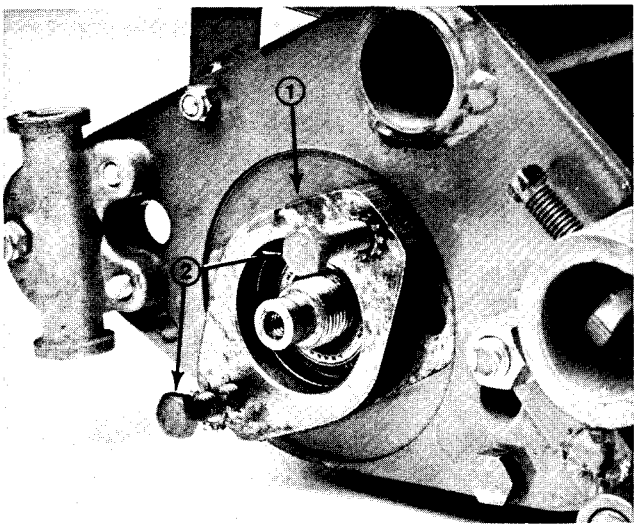


Figure 29

1. Bearing housing - rotate slightly
2. Bearing housing mount bolts - thread against side plate to remove housing

Lift Bail Replacement

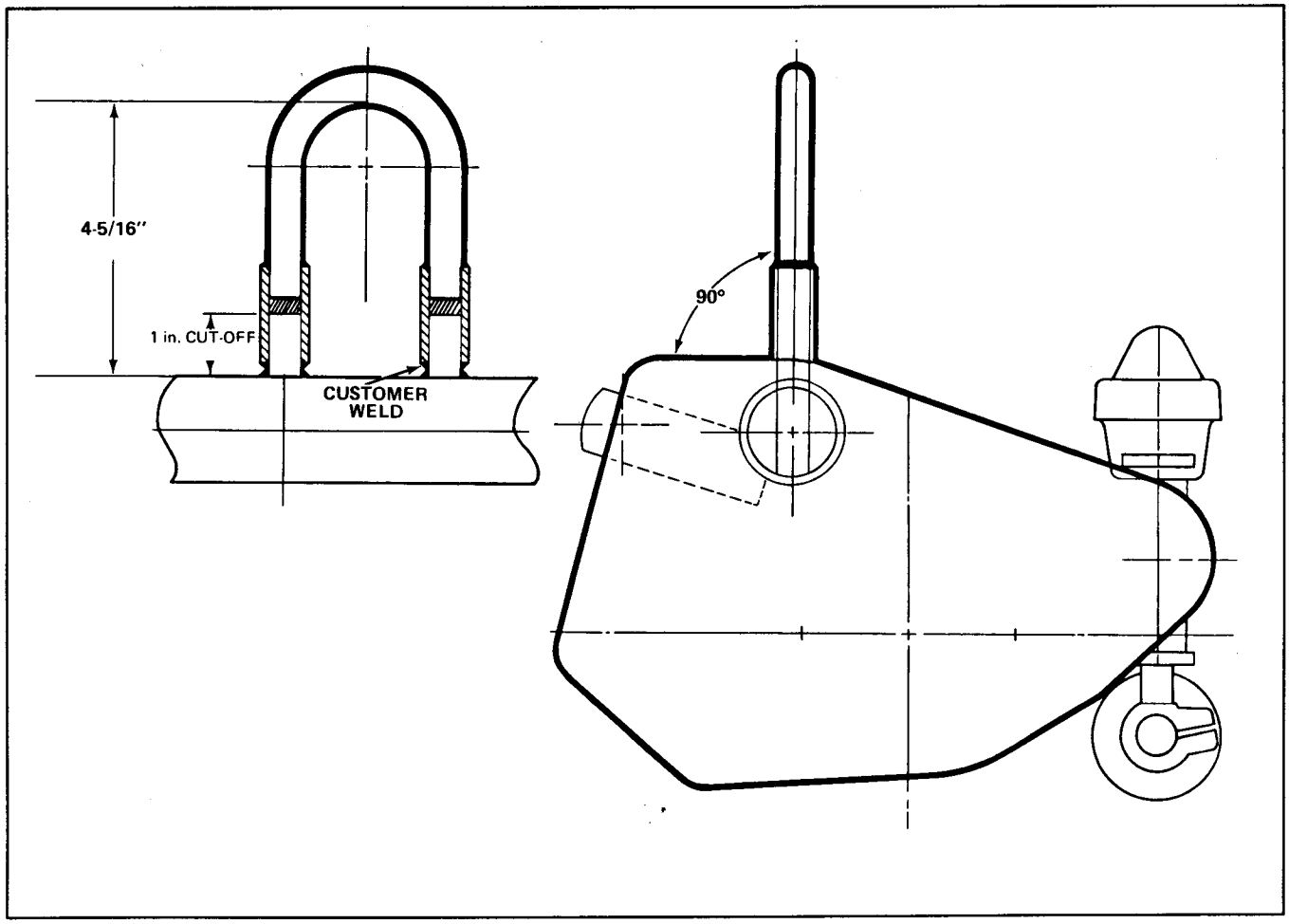


Figure 30

1. Use a saw to cut the lift bail off of the cutting unit. Make the cut 1 inch from the horizontal frame tube (Fig. 30).

2. Use a grinder to remove burrs from the stubs of the lift bail remaining on the cutting unit.

3. Install the repair lift bail (Part No. 71-1600).

4. Support the lift bail so the bottom radius is 4 5/16 inches from the top of the horizontal frame tube. Make sure the lift bail is square to the side frame.

5. Weld all around the bottom of the repair lift bail with mild steel rod, both sides.

Chapter 9

Single Point Adjust Cutting Units

Table of Contents

Introduction

This chapter gives service information for the following cutting units:

- Model 04445
- Model 04458, 04468
- Model 04450

This chapter also gives information for Model 04440 and 04448 cutting units that have been updated to the current single point adjust configuration.

See **Chapter 10 - Grooming Reel Cutting Units** for information about cutting units equipped with the Model 04455 Grooming Reel Kit.

Specifications

Height Of Cut: 3/32 (0.094) in. to 3/4 (0.75) in.

Clip Frequency and Optimum Height of Cut Range:

Model No.	Clip (max.)	Optimum Height of Cut Range
Model 04445:	0.40 in.	5/16" - 1/2"
Model 04458, 04468:	0.25 in.	3/16" - 5/16"
Model 04450:	0.18 in.	1/8" - 7/32"

Roller Adjustment:
Front: Micrometer hand adjustment with bolted clamp lock (1 turn 0.025 in. height of cut change).
Rear: Roller brackets allow adjustment for different height of cuts. Screw adjustment for leveling.

Bedknife To Reel Adjustment: Bedknife adjusts against reel, with positive adjustment control knob located at center of bedbar. Adjustment knob contains detent with .001 inch movement of bed-knife for each indexed position. Pivot point at top of bedbar is greaseable.

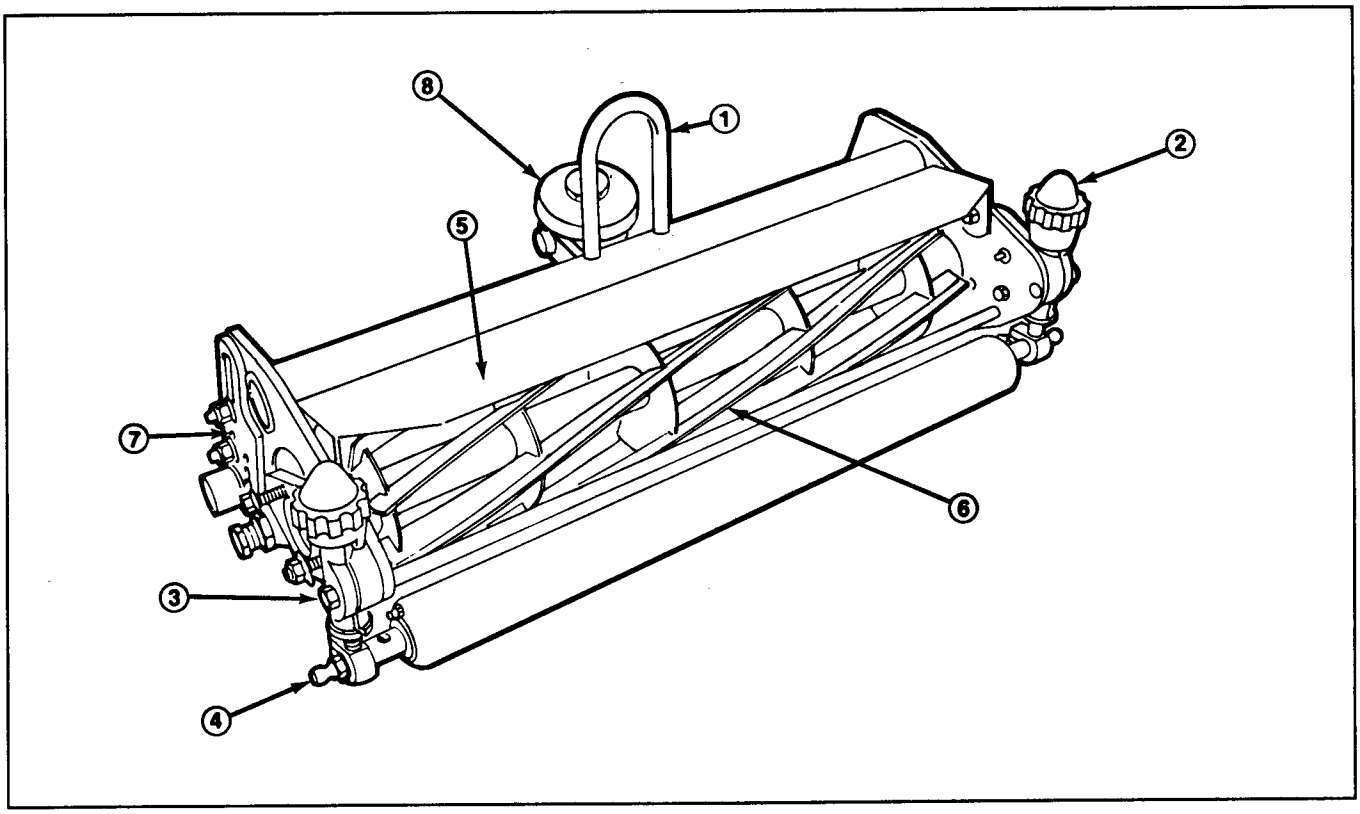
Reel Speed: 1940 rpm (engine speed 2800 rpm).

Bedknife Screw Torque: 200 in-lb.

Reel Splined Drive Nut Torque: 40 to 60 ft-lb.

Reel Bearing Rolling Torque: 7 in-lb. maximum with bedknife to reel contact removed.

Front or Rear Roller Run-Out: 0.014 in. max.



1. Lift bail
2. Height of cut adjustment knob
3. Height of cut adjustment locknut
4. Pull rod studs
5. Grass shield
6. Reel
7. Height of cut brackets (2)
8. Bedknife adjusting knob

Special Tools

NOTE: Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*. Some tools may be listed in the Greensmaster 3000 or 3000-D Parts Catalog. Some tools may also be available from a local supplier.

McLube

Aerosol or liquid lubricant. Apply to bedbar pivot and bedbar pivot bolts.

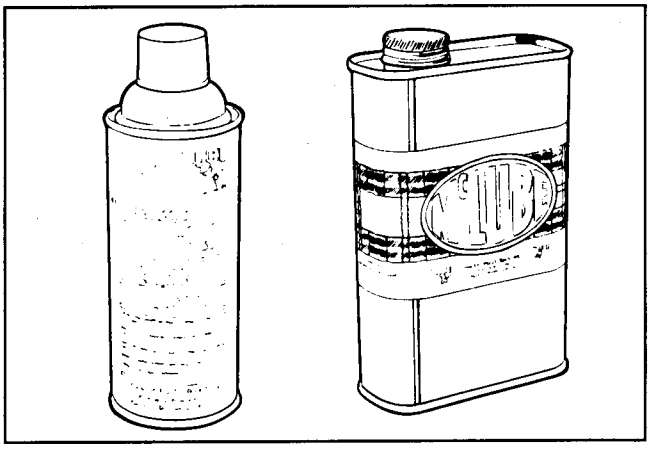


Figure 1

Roller Bearing Replacement Tool

Puller is used to remove bearings from front and rear rollers. Driving tubes are used to install bearings into rollers. Refer to instructions supplied with tool. Used on swaged, full and wiehle rollers.

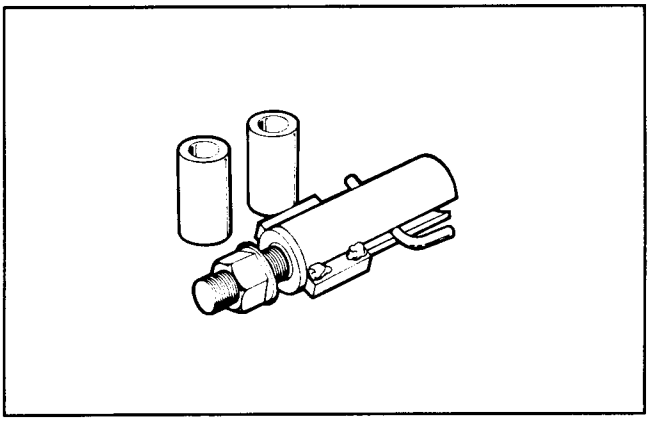


Figure 2

Plastic Plug

Insert plug in cutting unit bearing housing in place of reel motor when sharpening or grinding the reel.

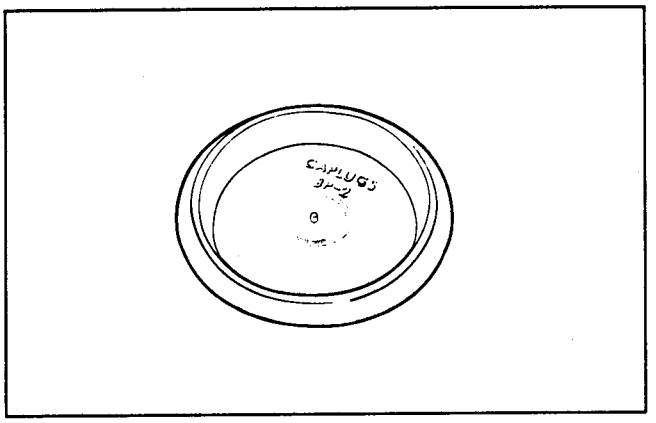


Figure 3

Handle Assembly

For applying lapping compound to cutting units while keeping hands a safe distance from the rotating reel assembly.

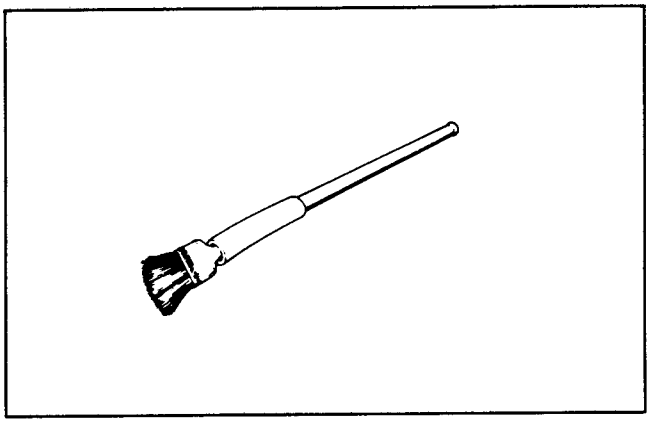


Figure 4

Bedknife Screw Tool

Fits Toro bedknife attaching screws. Use with torque wrench to secure bedknife to bedbar. With clean bedbar threads and new screws, tighten to a torque of 200 in-lb.

NOTE: Remove all rust, scale and corrosion from bedbar surface before installing bedknife.

DO NOT use an air impact wrench with this tool.

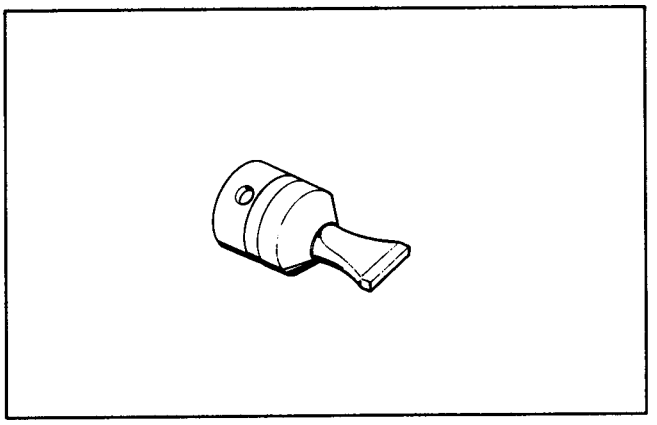


Figure 5

Troubleshooting

There are a number of factors that can contribute to unsatisfactory quality of cut, some of which may be turf conditions. Turf conditions such as excessive thatch, "sponginess" or attempting to cut off too much grass height may not always be overcome by adjusting the machine. It is important to remember that the lower the height of cut, the more critical these factors are. See the Adjustments and Repairs sections for detailed adjustment and repair information.

Factors Affecting Quality of Cut

Factor	Possible Problem/Correction
1. Tire pressure.	Check tire pressure and adjust if necessary. Must be equal in both front tires.
2. Engine governed speed.	Check maximum governed engine speed. Adjust to specification if necessary – affects reel speed.
3. Reel bearing condition/adjustment.	Check and adjust to specification. Replace bearings if worn or damaged. Bearing cones must be installed square to bearing housing - make sure there is no "flash", paint or other foreign material in housing before installing new bearing cone.
4. Reel and bedknife sharpness.	Reel and/or bedknife that has rounded edge cannot be corrected by tightening bedknife to reel contact. Grind reel to remove taper (cone shape) and/or rifling (grooved or ribbed appearance). Grind bedknife to sharpen and/or remove rifling. (Most common cause of rifling is bedknife to reel contact that is too tight.) NOTE: New bedknife must be ground after installing on bedbar to match bedknife to bedbar.
5. Bedknife parallel to reel.	Check and adjust as necessary.
6. Bedknife to reel contact.	Check before operating with cutting unit on ground. Remove reel motor and rotate reel by hand. Turn adjusting knob one (1) click at a time until first contact between reel and bedknife is felt or heard, then tighten one (1) more click to get light contact. No contact dulls cutting edges. Excessive contact increases wear.
7. Bedknife attitude (rear roller bracket hole position).	Set to recommendations in chart on Page 9 - 12.
8. Rear roller parallel to reel.	Check and adjust as necessary.
9. Height of cut.	All cutting units set at same height of cut. Set with front roller – must be equal at both ends of roller. Bench set height of cut and actual (effective) height of cut are different. Effective height of cut depends on cutting unit weight, cutting unit accessories and turf conditions.
10. Proper bedknife for height of cut.	If bedknife is too thick for effective height of cut, poor quality of cut will result.
11. Front roller scraper and comb adjustment.	Set scraper for 1/32 in. clearance from roller. Set comb the same on all cutting units for height of cut and turf conditions. Must be same height at both ends of comb.

Factor	Possible Problem/Correction
12. Stability and position of bedbar.	Make sure bedbar bolt plastic washers are snug against bedbar. Bedbar must pivot without binding. Check bedbar end bushings, pivot bushings and nylon flange bushings for wear or damage and replace if necessary. Make sure proper bushings are installed in each location (bedbar end bushings are different). Check adjustment knob to make sure detent holds adjustment. Repair if necessary. With adj. knob/pivot assembly removed, pivot set screws installed, and frame on level surface, measure from flat surface up to end of each setscrew. If not within 1/16 in. of each other, bend ears on cutting unit frame to line up screws. Check to make sure adj. knob/pivot assembly is centered in bedbar arm yoke and frame ears so that an equal gap exists on each side of pivot housing before pivot screws are installed. Make sure bedknife adj. knob/pivot assembly is held firmly in place between frame supports.Tighten pivot screws if necessary.
13. Number of reel blades.	Use cutting unit model with correct number of blades for clip frequency and optimum height of cut range. (Variable speed traction kit can be used to adjust clip frequency.)
14. Cutting unit alignment and pull frame ground following.	Check pull frame alignment on all cutting units. Adjust or repair as necessary. Check pull frames and lift arms for damage, binding or bushing wear. Repair if necessary.
15. Roller condition	All rollers must rotate freely. Grease when needed or repair bearings if necessary.
16. Reel speed.	All reels must rotate at same speed (within 100 rpm). All cutting units must have equal bedknife to reel contact and reel bearing adjustment before checking. Do not run the reel to long or it may get hot and rifle when no grass is being cut. See Troubleshooting in Chapter 5 - Hydraulic System.
17. Traction speed.	Check maximum governed engine speed. Adjust to specification if necessary. See Troubleshooting in Chapter 5 - Hydraulic System Install Variable Speed Traction Kit if necessary to control traction speed in varying conditions or with different attachments. Will allow change in traction speed while maintaining full engine rpm and reel motor rpm.
18. Cutting drop speed and sequence.	Center cutting unit must drop after front cutting unit. (See Troubleshooting in Chapter 5 - Hydraulic System.

Set Up and Adjustments

Adjustment Summary and Check List

DETAILED ADJUSTMENT INSTRUCTIONS FOLLOW THIS SUMMARY AND CHECK LIST. Study this information and refer to it often to get maximum life and performance from the cutting units.

Daily Performance Checks

NOTE: It is not necessary to remove the cutting units from the traction unit to perform these daily checks. It is recommended that mowers be washed after each use. Always remove key from ignition switch when working on the machine.

1. Purge all water and debris from all of the bearings by greasing them. Use No. 2 multi-purpose lithium base grease.

2. Visually check for sharp reel and bedknife.

- Remove burrs, nicks, and rounded edges.

3. Lower cutting units to ground (setting on both rollers) and remove reel motor. Rotate the reel by hand. TURN ADJUSTING KNOB ONE (1) CLICK AT A TIME UNTIL FIRST CONTACT BETWEEN REEL AND BEDKNIFE IS FELT AND HEARD THEN TIGHTEN ONE (1) MORE CLICK TO GET LIGHT CONTACT *.

- No contact will dull the cutting edges.
- Excessive contact accelerates wear; quality of cut may be adversely affected.

* It is best to make the reel to bedknife adjustment in the morning, immediately before each day of mowing.

Weekly Checks

1. Check reel bearing adjustment and bearing condition.

2. Make sure bed bar bolt "plastic washers" are SNUG against the bedbar.

3. Make sure bedknife adjustment knob/pivot assembly is held FIRMLY in place between frame supports.

4. Using a gauge bar, verify the correct height of cut setting.

Monthly Adjustments

NOTE: Remove cutting unit from traction unit.

1. Parallel bedknife to reel.

- Use newspaper as a feeler gauge.
- Dot on eccentric bolt must face rear of mower.
- Turn S.P.A. adjustment knob to hold paper on right-hand end of bedknife.
- Turn eccentric (left) bedbar bolt to hold paper on left-hand end of bedknife.
- Hold eccentric bedbar bolt while securing locknut.

2. Adjust rear roller parallel to reel; eccentric bolt faces to rear.

3. Adjust the front roller scraper to be 1/32 in. from roller.

4. Set comb or brush adjustment for desired action on grass.

- Light, medium, or aggressive setting.

5. Check grass shield adjustment.

- 4-3/4 in. from crossbar - normal.
- Dry grass - lower shield.
- Wet grass - raise shield.

6. Set top bar (cut-off bar) adjustment.

- 0.060 in. from reel - normal.

7. Set cutting unit on ground (setting on both rollers) and remove reel motor. Adjust bedknife to reel contact.

8. Use a gauge bar to set the height of cut.

Special Notes

1. Replace the bedbar bushings and nylon flange bushings every two years.

2. A "rifled" reel and/or bedknife must be corrected by grinding.

3. After extended running, notches will eventually develop at both ends of the bedknife. These notches must be rounded off or filed flush with cutting edge of bedknife to assure smooth operation.

4. If reel bearings will not hold adjustment during operation, loosen adjustment nut, tighten reel shaft *spline nut* on right hand end of reel shaft to a torque of 40 to 60 ft-lb, then adjust reel bearings.

Bedknife to Reel Contact

NOTE: The single knob bedknife-to-reel adjustment system simplifies the adjustment procedure needed to get the best mowing performance. The precise adjustment possible with the single knob/bedbar design gives the necessary control to provide a continual self-sharpening action – thus maintaining sharp cutting edges, assuring good quality-of-cut, and greatly reducing the need for routine backlapping. In addition, the rear roller positioning system permits optimum bedknife attitude and location for varying heights-of-cut and turf conditions.

IMPORTANT: Bedknife to reel contact must be checked and adjusted every day even though quality of cut is acceptable.

1. Shut off engine and remove key. Lower cutting units to the ground.

2. Remove grass baskets.

3. On each cutting unit, loosen (2) flange nuts securing reel motor to cutting unit. Twist motor clockwise to disengage from cutting unit and remove motor.

4. Slowly rotate reel, listening for reel-to-bedknife contact. If no contact is evident, TURN BEDKNIFE ADJUSTING KNOB CLOCKWISE, ONE (1) CLICK AT A TIME, UNTIL FIRST CONTACT IS FELT AND HEARD THEN TIGHTEN ONE (1) MORE CLICK TO GET LIGHT CONTACT (Fig. 6).

5. If contact is felt, turn bedknife adjusting knob counterclockwise, one (1) click at a time until no contact is evident. Turn bedknife adjusting knob one (1) click at a time clockwise, until first contact is felt and heard then tighten one (1) more click to get light contact.

6. Install hydraulic motor to cutting unit.

IMPORTANT: LIGHT CONTACT MUST BE MAINTAINED AT ALL TIMES. If light contact is not maintained, bedknife and reel edges will not self-sharpen sufficiently. This will result in dull cutting edges after a period of operation. If excessive contact is maintained bedknife/reel wear will be accelerated. Uneven wear can result, and quality of cut may be adversely affected.

NOTE: As the reel blades continue to run against the bedknife a slight burr will appear on the front cutting edge surface the full length of the bedknife. If a file is occasionally run across the front edge to remove this burr, improved cutting performance can be obtained.

NOTE: After extended running, notches will eventually develop at both ends of the bedknife. These notches must be rounded off or filed flush with cutting edge of bedknife to assure smooth operation.

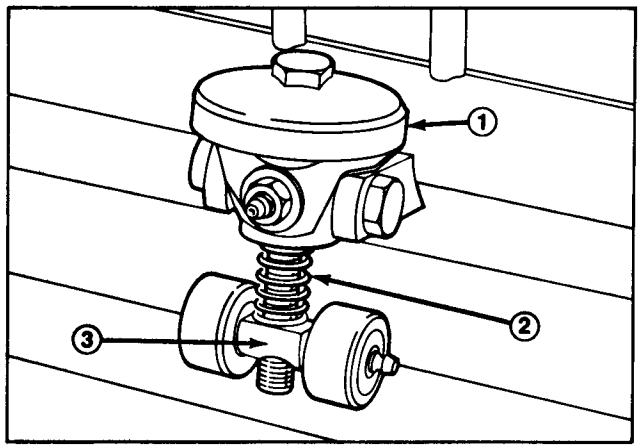


Figure 6a
(Tool-adjustable knob)

1. Bedknife adjusting knob **3. Pivot bar**
2. Compression spring

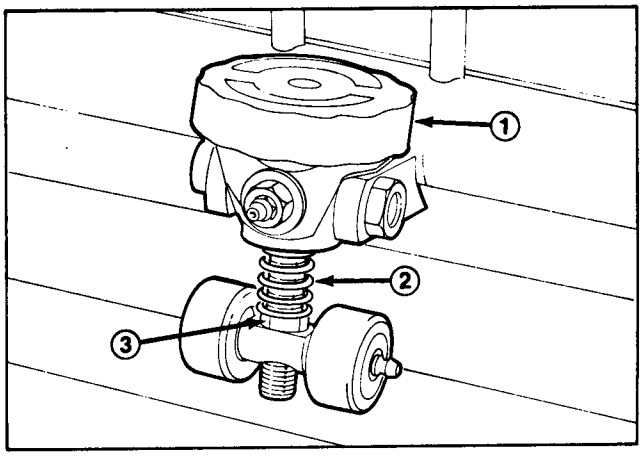


Figure 6b
(Hand-adjustable knob)

1. Bedknife adjusting knob **3. Locknut (left-hand thread)**
2. Compression spring

Reel Bearing Service and Adjustment

1. First, make sure bedknife to reel contact is removed by turning bedknife adjustment knob counterclockwise (Fig. 6).

2. Reel bearing rolling torque should not exceed 7 in-lb. Measure with an inch-pound torque wrench (Fig. 7). If bearing drag does not meet above specifications, adjust reel bearings.

NOTE: If you do not have an inch-pound torque wrench, do steps 1 - 3 under Reel Bearing Adjustment below.

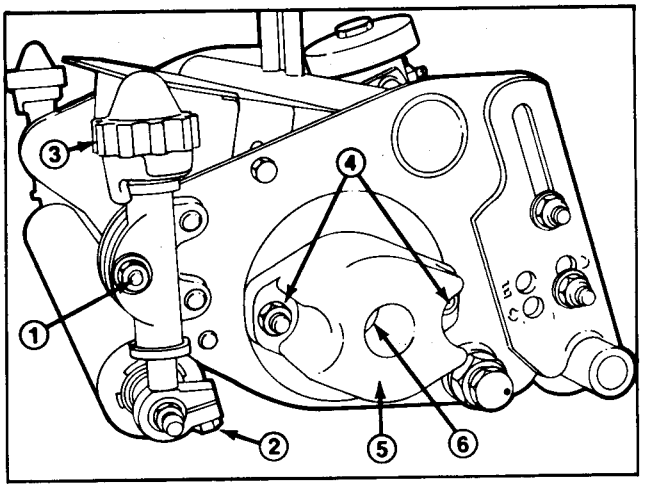


Figure 7

1. Height of cut locknut
2. Roller shaft clamp bolt
3. Height of cut knob
4. End cap mounting nuts
5. Counterbalance end cap
6. Reel bearing adjustment nut

Reel Bearing Adjustment

1. Remove mounting nuts from counterbalance end cap and remove end cap from mounting studs (Fig. 7).

2. Remove bolt mounted on the end of reel shaft. This will make it possible for a large socket wrench to be mounted on the reel bearing adjusting nut inside the side plate.

CAUTION

Do not use your hand to prevent reel from turning while servicing; this can result in personal injury. Use a 1/2 in. thick x 3 in. wide x 8 in. long piece of hardwood inserted into front of cutting unit between reel blades.

NOTE: If reel bearings will not hold adjustment during operation, loosen adjustment nut, tighten reel shaft *spline nut* on right hand end of reel shaft to a torque of 40 to 60 ft-lb, then adjust reel bearings. Use Loctite 271 on spline nut threads.

3. Tighten the large reel bearing adjustment nut (Fig. 7) until all reel shaft end play is removed, then tighten an additional 1/16 to 1/8 turn. Be certain to remove all end play, but do not over-tighten.

NOTE: Adjustment nut must have enough resistance against reel shaft threads to retain bearing adjustment. Replace adjustment nut if necessary.

4. Install bolt into end of reel shaft and check rolling torque with an inch-pound torque wrench. Reel bearing rolling torque, should not exceed 7 in-lb. Repeat steps 2 and 3 if necessary.

5. If bearings require replacement, see Reel Removal and Bearing Replacement in the Repairs section of this chapter.

Parallel Bedknife to Reel

1. Remove mower from traction unit and position on a level work surface. Make sure reel contact is removed by turning bedknife adjustment knob counterclockwise.

2. On right-hand end of reel, insert a long strip of newspaper between front side of reel and bedknife. While slowly rotating reel forward, turn bedknife adjusting knob (Fig. 8) clockwise, one click at a time, until paper is pinched lightly, which results in a slight drag when paper is pulled.

3. Check for light contact at other end of reel using paper. If light contact is not evident at both ends, bedknife is not parallel to reel, proceed to step 4.

4. Loosen jam nut on left hand bedbar pivot bolt so bolt can be turned. Left hand pivot bolt (eccentric bolt) has offset thread which, when rotated, acts as a cam to raise or lower the bedbar. Identification dot on bolt head denotes offset of bolt. When dot is in up position (Fig. 9) left end of bedbar is raised. As bolt is turned clockwise and dot is lowered, so is left end of bedbar. Identification dot must be positioned within rear (180°) position when adjusting.

5. Rotate left hand (eccentric) pivot bolt to raise or lower bedbar as required.

6. Check adjustments by repeating steps 2 and 3.

7. After getting light contact on paper at each end of bedknife, tighten left hand jam nut while holding pivot bolt in position. Check to make sure pivot bolt did not get out of adjustment when turning jam nut. Adjust again if necessary.

NOTE: If the reel has worn so you cannot get the bedknife parallel to the reel by turning the eccentric bolt, the reel will require grinding to remove taper. The reel normally wears faster on the lead-in side, which results in the described taper.

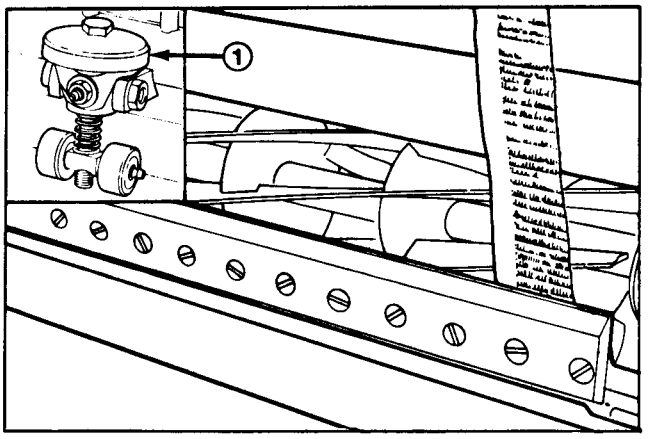


Figure 8

1. Bedknife adjusting knob

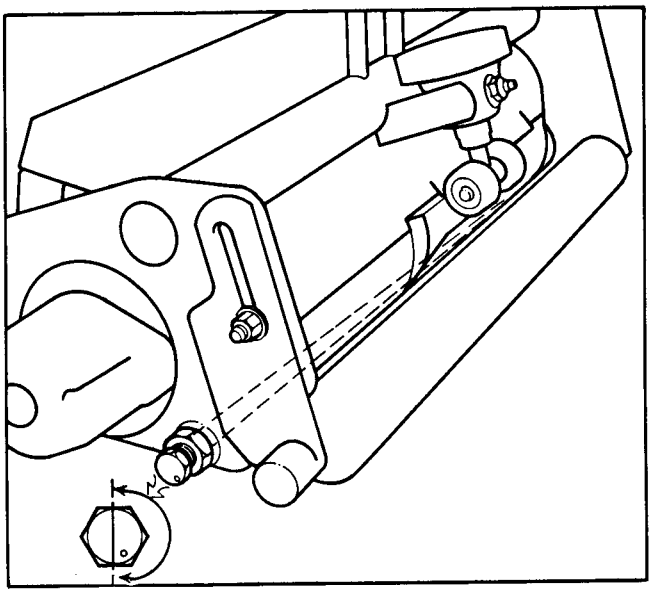


Figure 9

Leveling Rear Roller to Reel

1. Put cutting unit on a flat, level surface.

2. Assemble rear height of cut brackets to desired position, by loosening top capscrew and nut and removing bottom nut on right and left hand sides of cutting unit (Fig. 10).

3. Slide bolts thru each bracket until brackets can be realigned with appropriate mounting hole. See table for proper position on brackets.

NOTE: The different rear roller bracket positioning holes (B thru E) are designed to optimize bedknife location for different heights of cut.

Rear Roller Bracket Hole Position – 8 Blade Cutting Units
Height of cut 3/16 (.187) in. and below use the **B** position Height of cut 5/32 (.156) in. and above Use the **C** position Height of cut between 5/32 (.156) and 3/16 (.187) in., try **C** first; if not satisfactory, use **B** NOTE: For Height of Cut 5/32 (.156) in. and lower use 3/32 in. (tournament) bed knife. Tournament bed knife should not be necessary with the rear roller in the C position.
Rear Roller Bracket Hole Position – 11 Blade Cutting Units
Height of cut 3/16 (.187) in. and below use the **B** position Height of cut 5/32 (.156) in. and above Use the **C** position Height of cut between 5/32 (.156) and 3/16 (.187) in., try **B** first; if not satisfactory, use **C** NOTE: For Height of Cut 3/16 (.187) in. and lower use 3/32 in. (tournament) bed knife. Tournament bed knife should not be necessary with the rear roller in the C position.

NOTE: The "B" hole position normally is the best rear roller location for most low (3/32" - 1/8") cutting conditions.

It may be necessary to change from the above suggested ranges in certain turf conditions.

4. After putting bracket into correct height-of-cut hole position make sure right hand rear roller bracket capscrews are tightened securely (Fig. 11).

5. Left hand rear roller bracket capscrews are to be tightened only enough to remove excessive looseness in assembly, but allow bracket to slide freely on side plate.

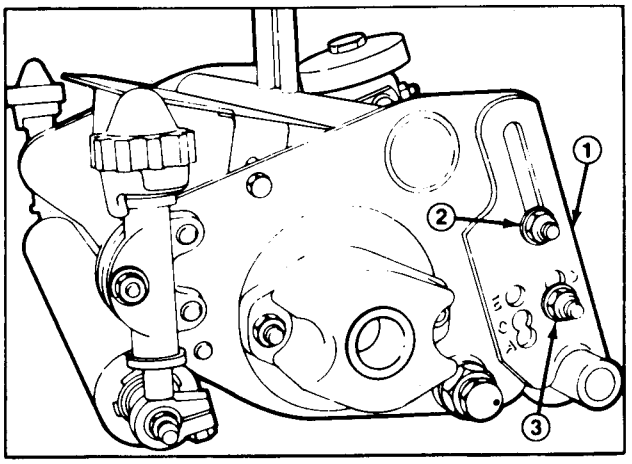


Figure 10

1. Rear height of cut bracket 3. Bottom nut
2. Top capscrew and nut

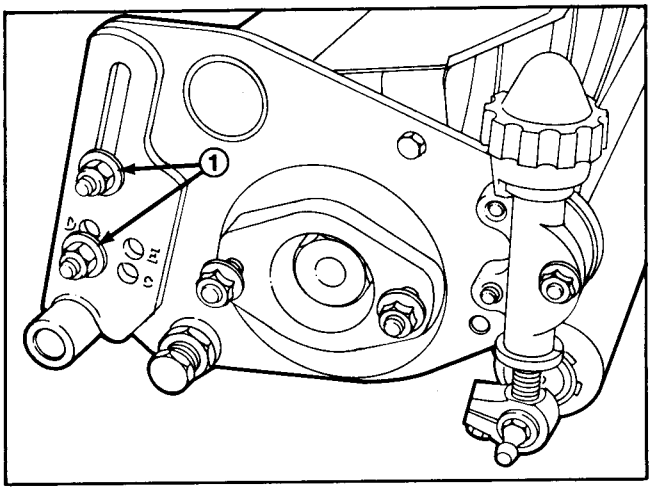


Figure 11

1. Right rear roller bracket capscrews

6. Position a 1/4 inch or thicker plate under the reel blades and against the front face of the bed-knife (Fig. 12).

NOTE: Make sure plate covers full length of reel blades, and (3) blades contact plate (8 blade reel).

7. While holding reel securely on plate, level roller by rotating lower left roller pivot bolt. The pivot bolt has an offset thread which when rotated, acts as a cam to raise or lower the roller. On the bolt head there is an identification dot (Fig. 13) which denotes the offset of the bolt. Dot indicates in which direction left end of roller moves when bolt is turned.

8. To verify if roller is level, try inserting a piece of paper under each end of roller.

9. When roller is level, tighten left capscrew and pivot bolt securely. Hold the eccentric pivot bolt while tightening the nut to keep the proper roller position.

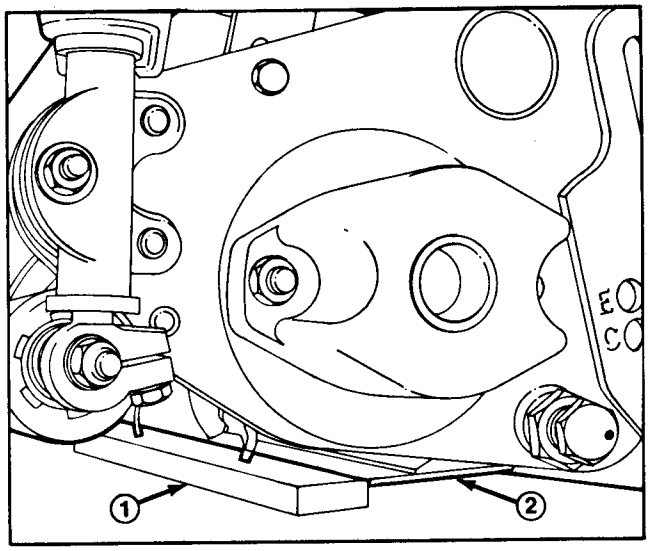


Figure 12

1. 1/4" plate
2. Bedknife

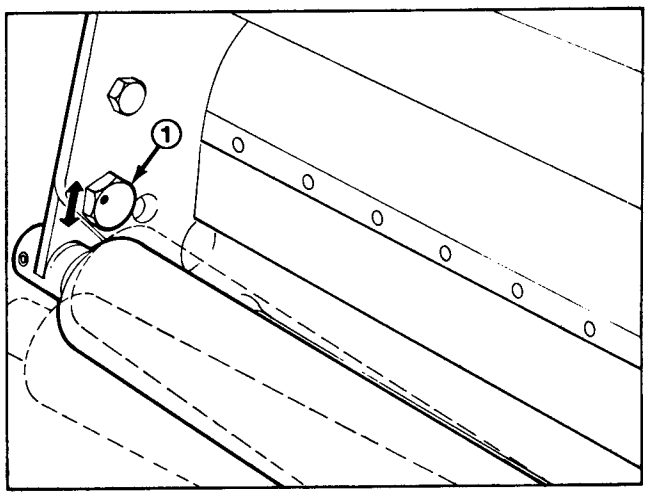


Figure 13

1. Pivot bolt

Height of Cut

Height of cut, as measured in the turf and on the cutting unit is different. The grass prevents the cutting unit from settling all the way to the ground line as the machine moves across the turf. Because of this, the actual (effective) height of cut is higher than the height of cut setting on the cutting unit (bench set height of cut) (Fig. 14).

Machine conditions, such as cutting unit weight, roller type, bedknife thickness, speed of travel and clip frequency, influence effective height of cut. Turf conditions, such as grass type, grass density, and amount of thatch also influence effective height of cut.

Changing the machine (such as adding a wiehle roller, or changing from a 4-bolt adjust cutting unit to a heavier single point adjust cutting unit) will increase penetration into the turf and lower the effective height of cut.

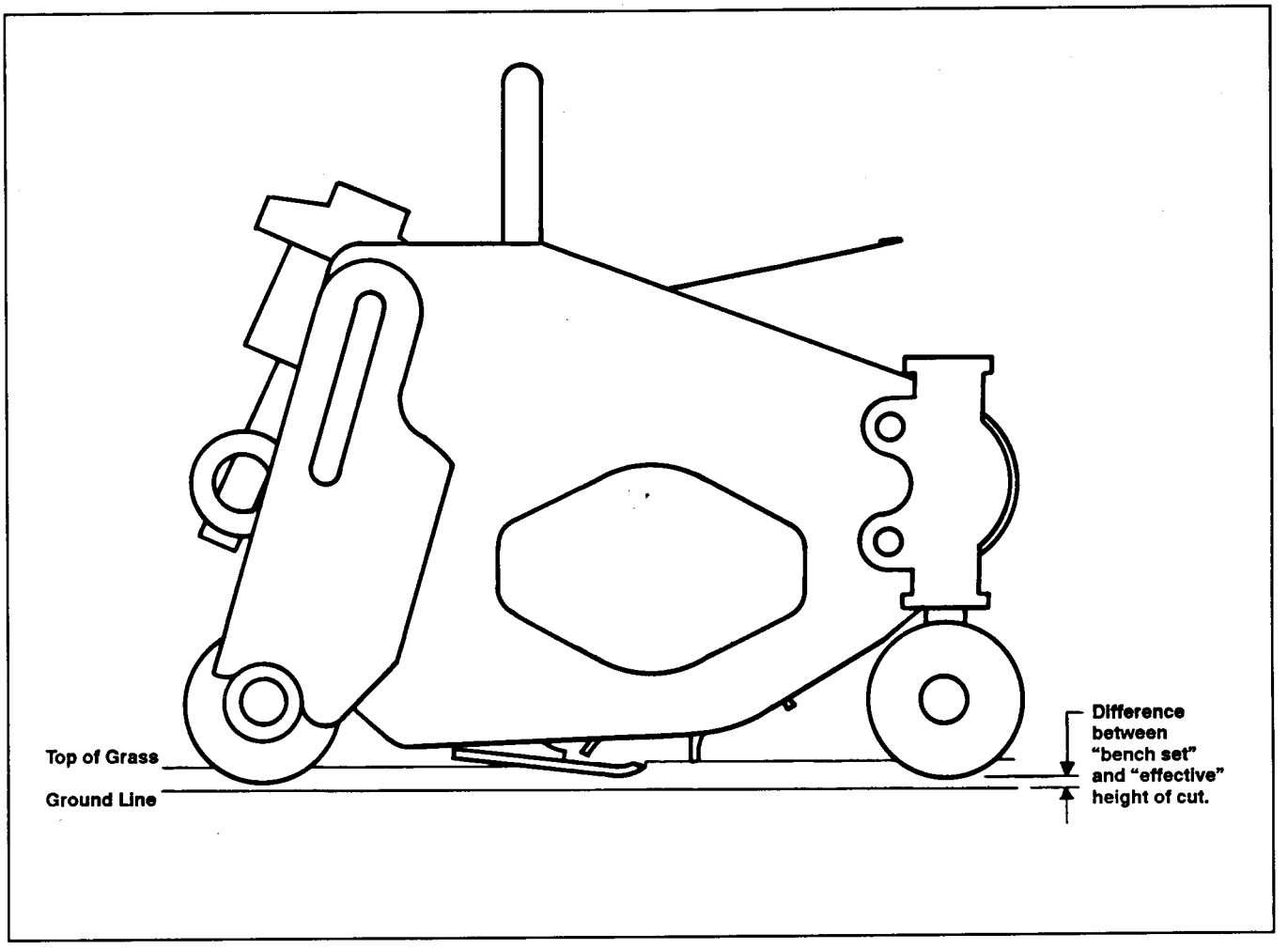


Figure 14

Height of Cut Adjustment

IMPORTANT: Lower heights of cut are limited by thickness of bedknife. Select proper bedknife for desired height of cut. If bedknife is too thick for height of cut, poor quality of cut will result and excessive pressure from turf on bottom of bedknife can cause "rifling" of bedknife and reel.

1. Make sure that rear roller brackets are in correct hole positions for desired height of cut and that rear roller is level. Also, check that bedknife to reel contact is correct.

2. Turn cutting unit over and loosen locknuts securing front roller adjusting screws to height of cut brackets (Fig. 15).

3. On gauge bar (Part No. 1-8789), set head of screw to desired height of cut. This measurement is from bar face to underside of screw head.

4. Place bar across front and rear rollers and adjust height of cut knob until underside of screw head engages bedknife cutting edge (Fig. 14). Check and adjust on each end of bedknife, then tighten height of cut adjustment locknuts on each end.

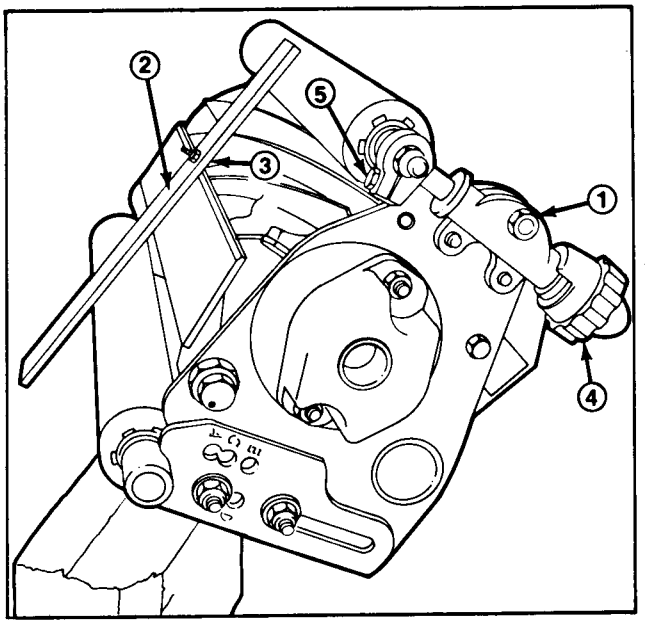


Figure 15

1. Height of cut knob locknut
2. Gauge bar (1-87891)
3. Gauge bar screw head
3. Height of cut knob
5. Roller shaft clamp bolt

Changing To A Different Type of Cutting Unit or Adding Cutting Unit Accessories

When changing to a different type of cutting unit or adding cutting unit accessories, it is recommended that you change only one cutting unit, and keep the other two existing cutting units on the machine.

1. Set the new cutting unit to a height of cut approximately 1/16 (0.06) in. higher than the old cutting unit.

2. Do a mowing test and compare results between the new cutting unit and old cutting units.

3. Adjust the new cutting unit to match the cut of the old cutting units.

4. The other two cutting units can now be replaced. Adjust these two new cutting units so they are the same as the other new cutting unit that was tested.

Front Roller Scraper Adjustment

The front roller scraper should be adjusted so there is a clearance of approximately 1/32 of an inch between the scraper and roller (Fig. 16).

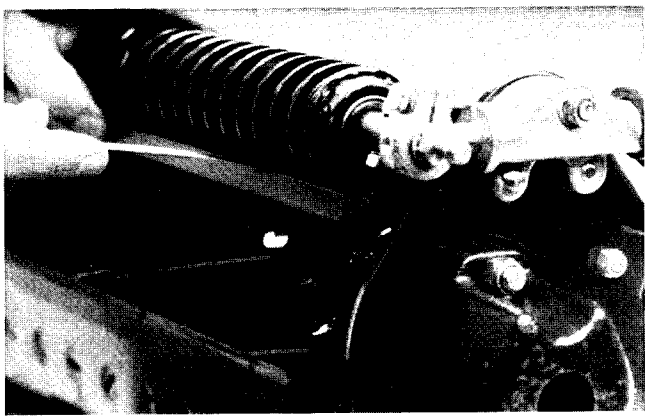


Figure 16

Comb Adjustment

1. Make sure rear roller is in the desired height of cut position. Loosen the bolts anchoring the front roller shaft (Fig. 17). Rotate the shaft.

2. To adjust the aggressiveness of the comb teeth (Fig. 17), proceed as follows:

   A. Teeth touching the adjusting gauge bar give an **aggressive** setting.

   B. Teeth midway between the adjusting gauge bar and the cutting edge of the bedknife give a **medium** setting.

   C. Teeth even with the cutting edge of the bedknife give a **light** setting.

NOTE: Securing one end of the comb assembly at a time simplifies the above procedure.

3. Tighten the roller shaft bolts.

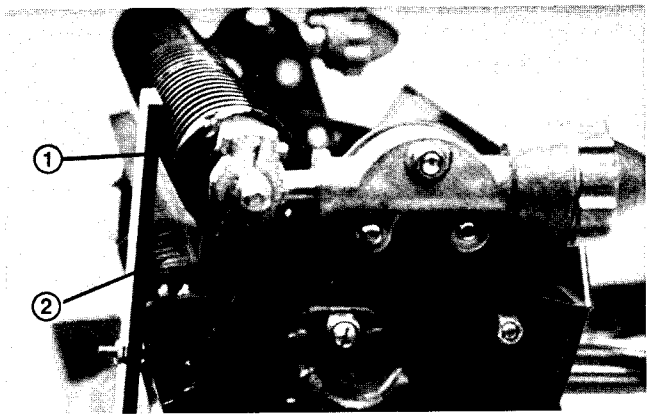


Figure 17

1. Roller shaft clamp bolt **2. Comb teeth**

Shield Height Adjustment

Adjust shield to get proper grass clipping discharge into basket:

1. Set cutting unit in normal cutting position and measure distance from top of front crossbar to shield at each end of cutting unit (Fig. 18).

2. Height of shield from crossbar for normal cutting conditions should be 4-3/4 inches. Loosen capscrews and nuts securing shield to each side plate, adjust shield to correct height and tighten fasteners (Fig. 18).

3. Repeat adjustment on remaining cutting units and adjust top bar. (See Adjusting Top Bar in this section of the book.)

NOTE: Shield can be lowered in dry grass conditions (clippings fall over top of baskets) or raised to allow for heavy wet grass conditions (clippings build up on rear edge of baskets).

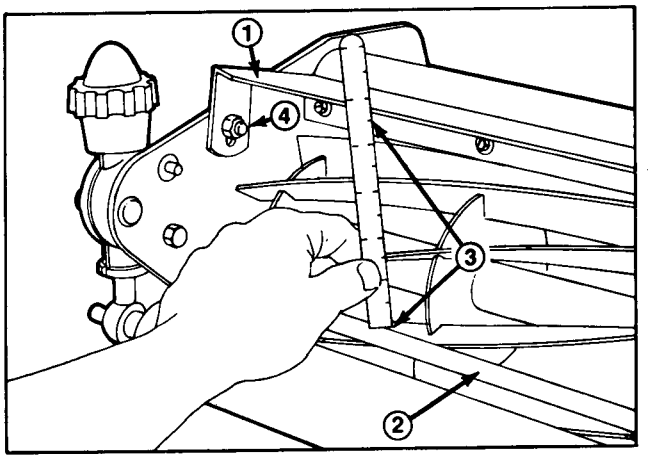


Figure 18

1. Shield
2. Front crossbar
3. 4-3/4 inches
4. Shield fasteners

Top (Cut-Off) Bar Adjustment

Adjust top bar to make sure clippings are cleanly discharged from reel area:

1. Loosen screws securing top bar (Fig. 19). Insert 0.060 inch feeler gauge between top of reel and bar and tighten screws. Make sure bar and reel are equal distance apart across complete reel.

2. Repeat settings on remaining cutting units.

NOTE: Bar is adjustable to compensate for changes in turf conditions. Bar should be adjusted closer to reel when turf is extremely wet. By contrast, adjust bar further away from reel when turf conditions are dry. Bar should be parallel to reel to get optimum performance and should be adjusted whenever shield height is adjusted or whenever reel is Sharpened on a reel grinder.

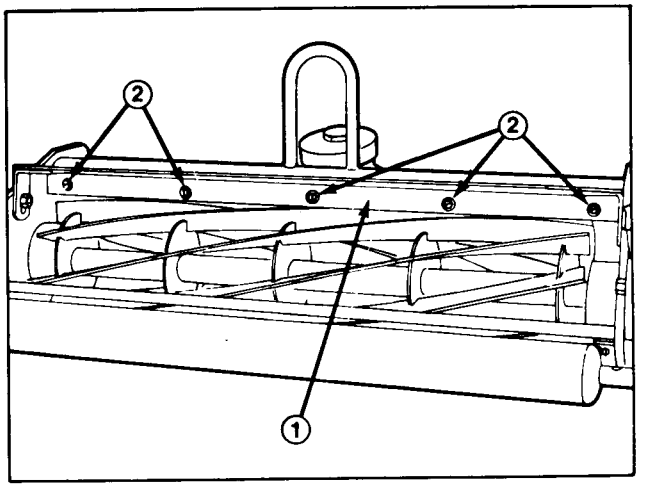


Figure 19

1. Top bar **2. Bar mounting screws**

Pull Frame Adjustment

1. Put the basket on the pull frame.

2. Level baskets to cutting unit by loosening nut at one end of pull frame roller. Loosen bolt and move roller shaft in slot as necessary. Tighten bolt.

3. Loosen the jam nuts on the pull arms and adjust the ball sockets until there is 1/4 in. to 1/2 in. (6 to 13 mm) clearance between the lip of the basket and the reel blades (Fig. 20). This prevents grass clippings from dropping on the ground.

4. Make sure the basket lips are the same distance from the reel blades at both ends of the reel. If the basket is too close to the reel, it is possible for the reel to contact the basket at the instant the cutting unit is raised off the ground.

5. Make sure each of the three (3) cutting units track straight with the traction unit:

A. On a smooth, level surface, draw a straight line on the floor (Fig. 20b). Push traction unit forward (removing slack from pull arms) so center of each front wheel is on top of the line. Use a plumb bob or square to make sure each wheel is centered on the line.

B. Measure from each end of cutting unit front roller to chalk line. Distance from each end of roller to line must be equal within 3/16 (0.187) in.

C. Loosen jam nuts on pull arms and adjust ball sockets so distance from each end of roller to line is within 3/16 (0.187) in.

NOTE: If a cutting unit cannot be adjusted to track correctly with the traction unit, the pull frame, or lift arm is damaged and/or the lift arm and pull frame bushings are worn and must be replaced.

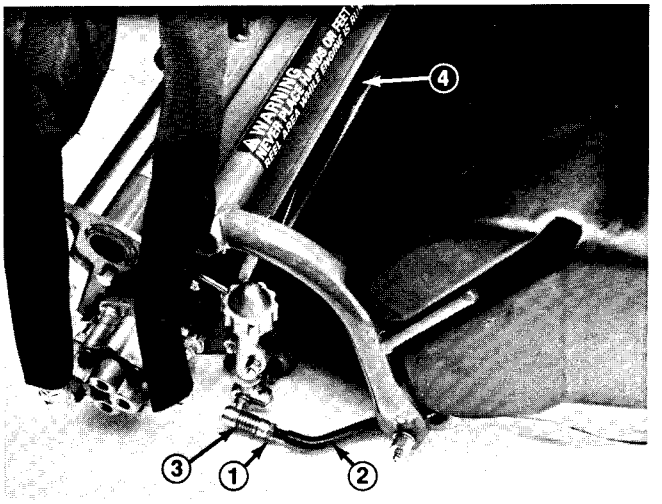


Figure 20a

1. Jam nut
2. Pull arm
3. Ball joint - adjust for clearance
4. 1/4 - 1/2 in. (6 - 13 mm) clearance

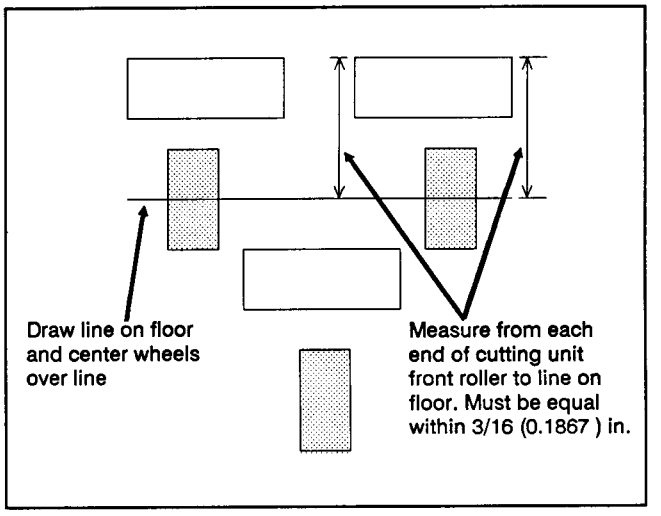


Figure 20b

Cutting Unit Removal and Installation

Remove cutting unit from traction unit before doing adjustments or repairs.

1. Remove basket from pull frame.

2. Loosen reel motor mounting nuts (Fig. 21). Rotate the motor clockwise so motor flanges clear studs and pull motor off of cutting unit.

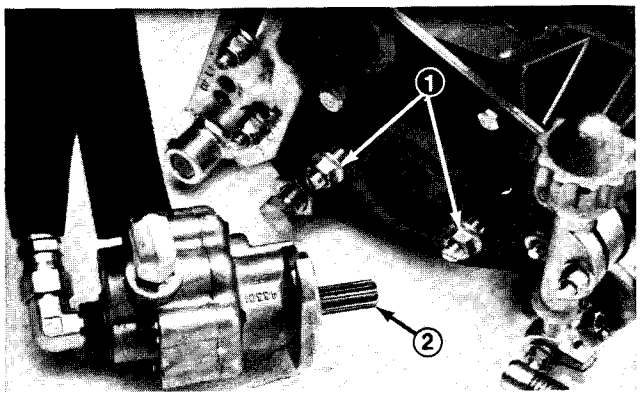


Figure 21

1. Motor mount nuts
2. Motor shaft

3. Slide the sleeve back on the ball joint and disconnect the pull arm from each side of the cutting unit (Fig. 22).

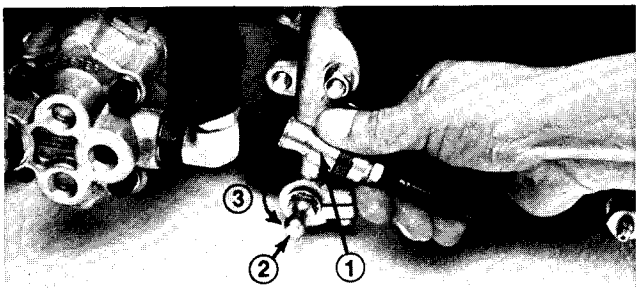


Figure 22

1. Slide back to mount
2. Ball stud
3. Swing up to remove, down to install

4. Slide cutting unit out from under pull frame, disengaging the lift arm from the lift bail (Fig. 23).

5. Reverse steps 1 - 4 to install the cutting unit.

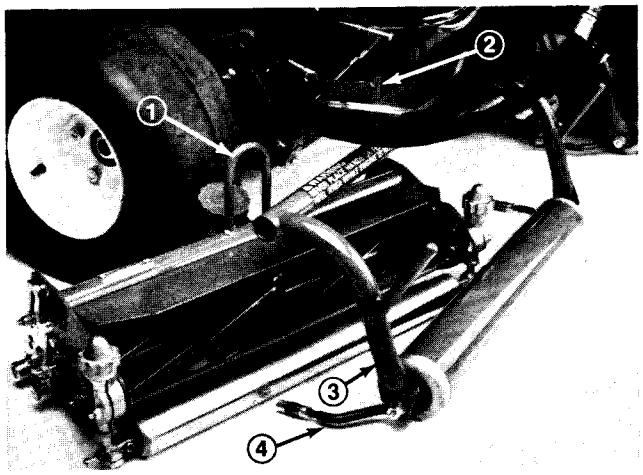


Figure 23

1. Lift bail
2. Lift arm
3. Pull frame
4. Pull arm

Reel Lapping

Check reel bearing adjustment and correct if necessary before backlapping. Connect lapping machine to cutting unit with an extension coupler, and a 9/16 in. socket. The 9/16 in. socket can be installed onto the capscrew on the reel shaft inside the counter-balance weight on the end of the cutting unit. Backlap according to procedures in the Toro publication "Sharpening Reel & Rotary Mowers" Form No. 80-300-PT.

NOTE: For a better cutting edge, run a file across front face of bedknife when lapping operation is completed. This will remove any burrs or rough edges that may have built up on the cutting edge.

CAUTION

Be careful when lapping the reel because contact with the reel or other moving parts can result in personal injury.

Bedbar Removal and Installation

1. Loosen pivot screws securing bedknife pivot assembly to reel frame supports (Fig. 24).

2. Rotate adjustment knob and pivot assembly clockwise (left hand thread) until it is unthreaded from bedbar pivot (Fig. 24).

3. Loosen jam nuts retaining right and left bedbar pivot bolts. Remove pivot bolts (Fig. 24).

IMPORTANT: Note position of plastic washer and steel washer on right end of bedbar, and plastic washer on left end of bedbar for reinstallation.

4. Slide bedbar down and out from under cutting unit. Do not misplace washers.

5. Replace and/or grind bedknife to renew cutting edges.

NOTE: For proper grinding of bedknife, follow procedures in the Toro publication, "Sharpening Reel and Rotary Mowers", Form No. 80-300-PT.

6. Adjust the reel bearings. (See Reel Bearing Service and Adjustment in the Adjustments section of this chapter.)

7. Grind the reel to remove any taper and renew cutting edges. (See Preparing Cutting Unit for Reel Grinding in this section of the book.)

8. Check size of hole in bedbar end bushings every time bedbar is removed. Insert flange bushing into rubber bushing (Fig. 25). Insert clean shoulder bolt into flange bushing/rubber bushing assembly. If bolt slides easily into bushing, replace all four bedbar bushings. (See Bedbar Bushing Replacement in this section of the book.)

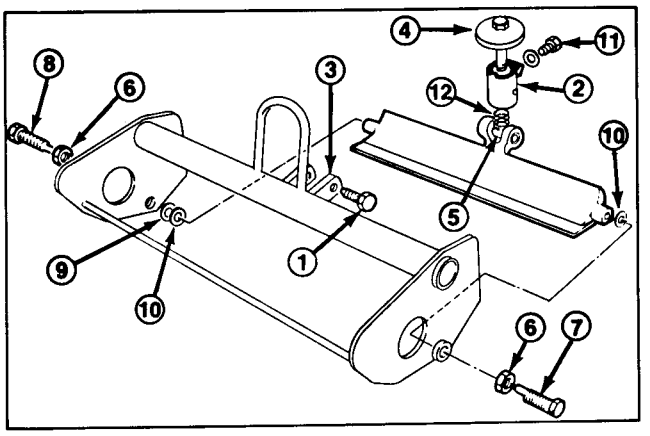


Figure 24

1. Pivot screw
2. Bedknife pivot ass'y
3. Frame supports
4. Adjustment knob
5. Bedbar pivot
6. Jam nuts
7. Left bedbar pivot bolt
8. Right bedbar pivot bolt
9. Steel washer
10. Plastic washer
11. Spring arm retaining capscrew
12. Compression spring

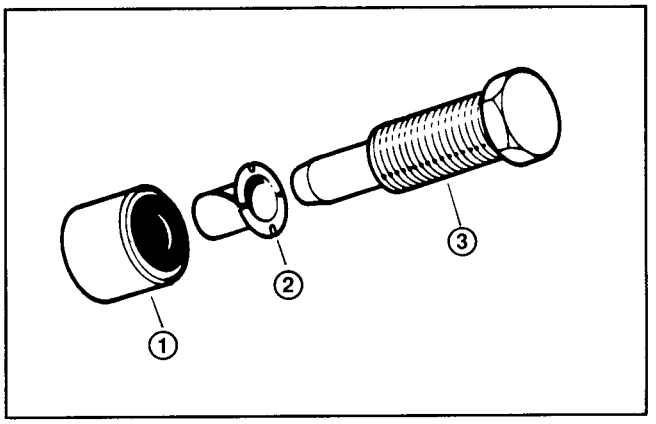


Figure 25

1. Rubber bushing
2. Flange bushing
3. Shoulder (pivot) bolt

9. With frame on level surface and pivot set screws installed, measure from flat surface up to end of each setscrew (Fig. 26). If not within 1/16 in. of each other, carefully bend frame supports to line up screws. Remove pivot set screws. Measure distance between frame pivot supports (Fig. 26). If dimension is not between 1-9/16 in. and 1-5/8 in., carefully bend supports until correct.

10. To install bedbar, slide it into into position between side plates, making sure each end of bedbar is under shield (Fig. 27).

IMPORTANT: Always use McLUBE (Toro Part No. 505-35) on bedbar pivot and pivot bolts.

11. Install jam nut on eccentric pivot bolt. Put plastic washer between left side of bedbar and side plate. Thread pivot bolt into side frame until distance from top of pivot bolt to side plate is 1-5/16 in. with identification dot toward the rear (Fig. 28). Do not tighten jam nut.

12. Install jam nut on straight pivot bolt. Put plastic washer and steel washer between right side of bedbar and side plate with plastic washer closest to bedbar. Thread pivot bolt into side plate. Adjust right-hand pivot bolt until left end of bedbar firmly seats against side plate, clamping the plastic washer snugly. This removes end-play from bedbar. Bedbar must pivot without binding. Hold right-hand pivot bolt to keep it from moving and tighten jam nut.

IMPORTANT: Apply NEVER-SEEZ or equivalent to the threads of the handle assembly.

13. Thread adjustment knob and pivot assembly into flat side of bedbar pivot (left-hand thread). Make sure there is an equal gap between each side of pivot assembly housing and frame supports (Fig. 29). Adjust (before installing pivot screws) by sliding bedbar pivot sideways.

IMPORTANT: On hand-adjustable type knobs, check to make sure die spring is compressed to 13/16 in. by tightening locknut (left-hand thread) (Fig. 6b).

14. If equipped with hex head type pivot screws, tighten pivot screws to 60 ft-lb. If equipped with hex socket head set screws and jam nuts, tighten set screws finger tight then tighten an additional 1/2 turn (total - not each). Tighten jam nuts.

15. Secure spring arm to pivot assembly. If spring arm is adjustable, adjust upward until a solid clicking sound is achieved when adjusting knob is turned.

16. Level bedknife to reel. Level rear roller to reel. Set height of cut. If necessary, backlap to get desired fit between reel and bedknife.

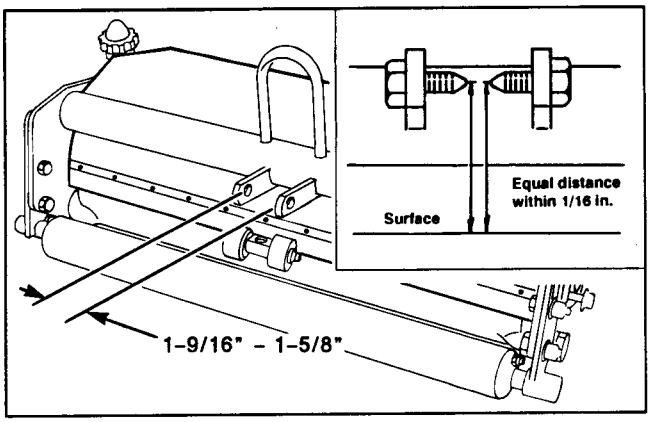


Figure 26

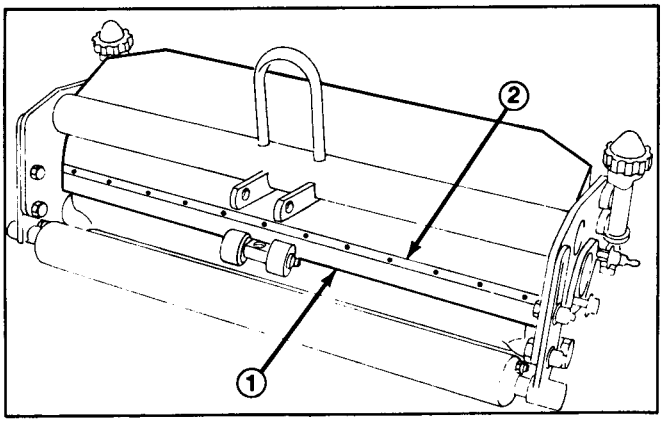


Figure 27

1. Bedbar 2. Shield

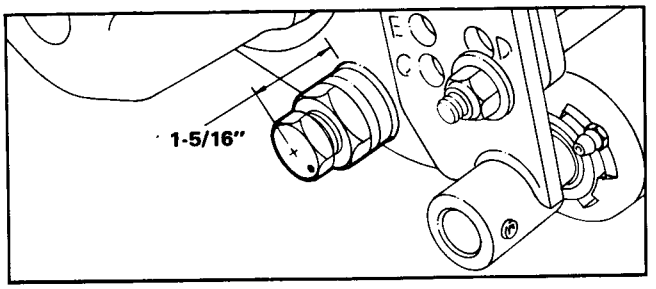


Figure 28

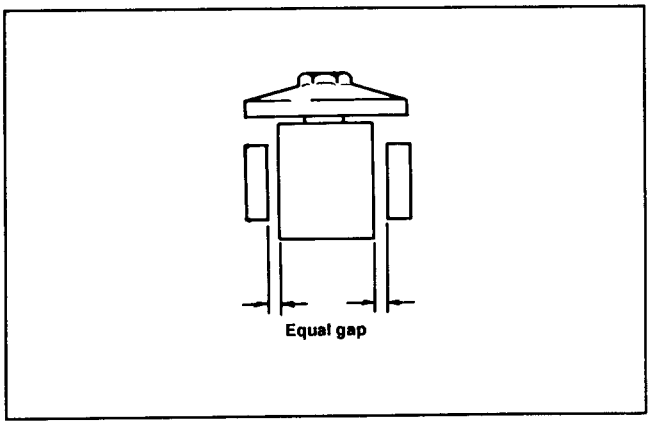


Figure 29

Bedbar Bushing Replacement

NOTE: Only after making sure that all normal cutting unit adjustments are correct, should the bushings be suspected as causing quality of cut problems.

The bedbar end bushings and pivot bushings (Fig. 30) contain rubber and are exposed to severe conditions. It is recommended to replace these bushings and the plastic flange bushings every two years.

1. Do steps 1 - 4 under Bedbar Removal and Installation in this section of the book.

2. Remove bedbar end bushings with a punch and hammer (Fig. 31). Alternate from one side to other on bushing (there are two slots in bedbar bushing boss).

IMPORTANT: Apply NEVER-SEEZ or equivalent to outside surface of bedbar end bushings and pivot bushings before installing in bedbar.

3. Press end bushings into bedbar far enough so plastic sleeve collar is below bedbar end face (Fig. 32).

NOTE: Bedbar end bushings have less rubber and more steel which is visible than bedbar pivot bushings. Do not use bedbar end bushings in the pivot area as they are too rigid.

4. Use an arbor press to remove bedbar pivot bushings (Fig. 33). DO NOT hammer on pivot boss of bedbar without support. You will break the casting.

5. Press center pivot bushings into place (Fig. 33). DO NOT hammer on pivot boss of bedbar without support. You will break the casting.

6. Do steps 5 - 16 under Bedbar Removal and Installation in this section of the book.

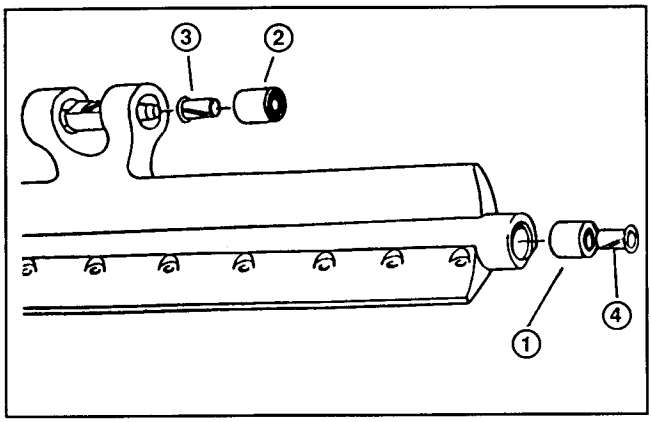


Figure 30

1. Bedbar end bushing (2)
2. Bedbar pivot bushing (2)
3. Flange bushing (4)

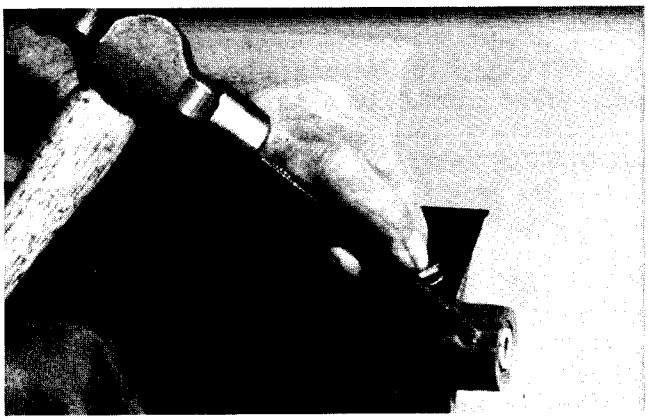


Figure 31

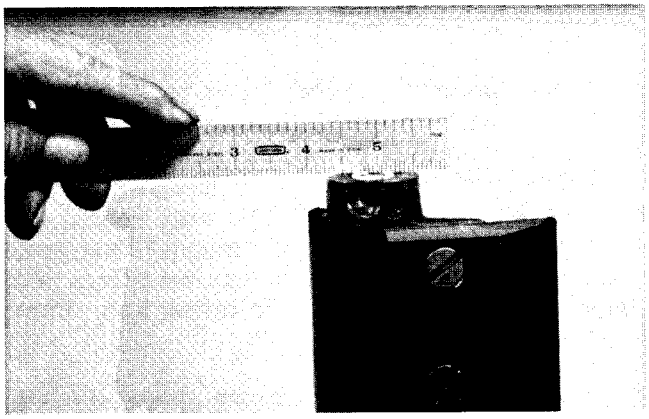


Figure 32

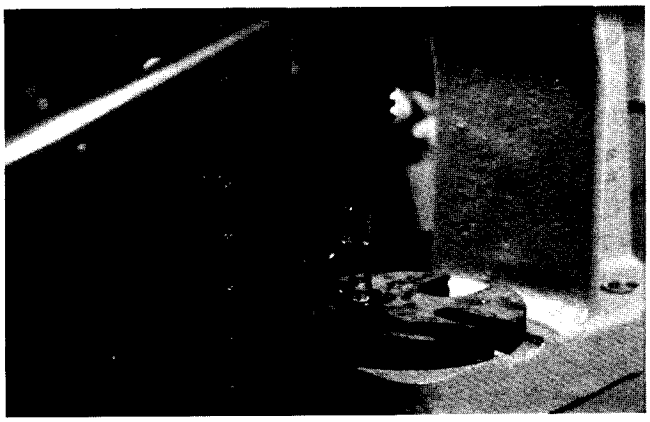


Figure 33

Bedknife Replacement

1. Do steps 1 - 4 under Bedbar Removal and Installation in this section of the book.

2. Remove bedknife screws and remove bedknife.

3. Remove all rust, scale and corrosion from bedbar surface before installing new bedknife.

4. Install new bedknife with the proper bedknife screws (57-4910). Bedknife screws must bottom out on bedknife, not bedbar. Tighten screws to a torque of 200 in-lb, working from the center toward each end of the bedbar (Fig. 34).

5. Grind new bedknife to match it to bedbar.

NOTE: For proper grinding of bedknife, follow procedures in the Toro publication "Sharpening Reel and Rotary Mowers", Form No. 80-300-PT..

6. Do steps 6 - 16 under Bedbar Removal and Installation in this section of the book.

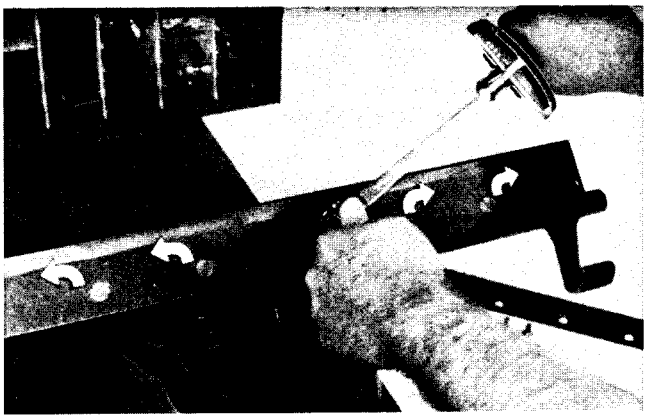


Figure 34

Preparing Cutting Unit for Reel Grinding

IMPORTANT: Adjust reel bearings before grinding reel. (See Reel Bearing Service and Adjustment in the Adjustments section of this chapter

1. Do steps 1 - 6 under Bedbar Removal and Installation in this section of the book.

NOTE: Some reel grinders require rear roller assembly be mounted to cutting unit for proper support in reel grinder. Rear roller must be parallel to reel shaft to remove taper when grinding.

2. Raise or remove front roller assembly.

   A. Loosen locknuts securing height of cut adjusting rods at both ends of cutting unit and roller shaft clamp bolts (Fig. 35).

   B. Turn height of cut adjustment knobs to raise roller out of the way or remove roller if necessary (Fig. 35).

For proper grinding, follow procedures in Toro publication "Sharpening Reel and Rotary Mowers Form No. 80-300-PT.

3. Do steps 8 - 16 under Bedbar Removal and Installation in this section of the book. After grinding, assemble cutting unit, check bearing adjustment and adjust top shield and bar. Back lap if necessary to get desired fit between reel and bedknife.

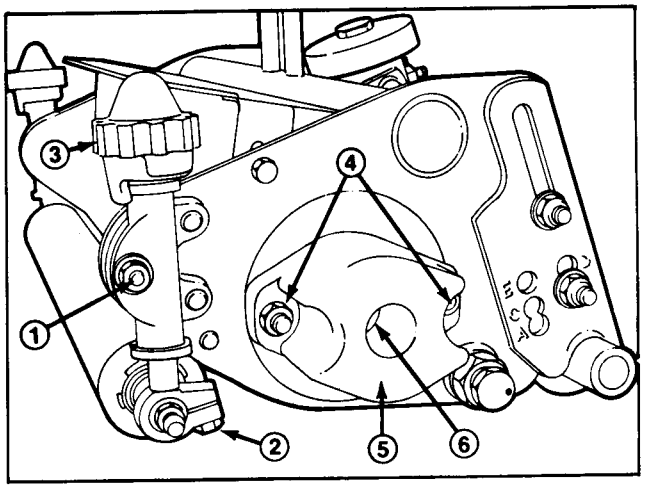


Figure 35

1. Height of cut locknut
2. Roller shaft clamp bolt
3. Height of cut knob
4. End cap mounting nuts
5. Counterbalance end cap
6. Reel bearing adjustment nut

Reel Removal and Bearing Replacement

1. Do steps 1 - 4 under Bedbar Removal and Installation in this section of the book.

2. Remove counterbalance end cap from left hand side of the cutting unit (Fig. 35). Remove large bearing adjustment nut from one end of reel shaft (Fig. 35) and special spline nut at opposite end of reel shaft.

3. Remove machine screws securing bearing housing on each end of cutting unit (Fig. 36). The machine screw heads will have to be cut off before the screw can be completely removed:

A. Unscrew machine screw approximately two turns.

B. Cut off machine screw head.

C. Back out remaining part of screw from side plate with a screw driver (outwards, not inwards towards reel). If machine screw does not have a screw driver slot, use a pliers to back out screw.

IMPORTANT: Remove grease fittings from bearing housing at each end of cutting unit. Note that the straight fitting is on the right end, and 90° fitting at the left end (when viewed in the direction of travel).

3. Use a soft face hammer to rotate bearing housing slightly. Install bolts from outside of housing and turn bolts alternately against side plate to remove bearing housing (Fig. 37). Bearing housing will slip out of side plates. Reel can be removed as soon as bearing housings are disassembled from side plates.

4. Before installing reel, install new special machine screws from inside of frame to secure bearing housings.

5. If necessary, install new bearings and seals:

A. Remove outer seal (in counterbalance weight), bearing cup, bearing cone and inner seal.

B. Bearing housing must be completely free of paint and foreign material before installing bearing cup. If necessary remove any "flash" from bearing housing that may interfere with accurate seating of bearing. Install new inner seal. Install bearing cup.

C. Install bearing housing to frame. Pack bearing cone with grease and install over reel shaft into bearing cup. Install new outer seal in counterbalance weight).

6. After installing reel, tighten spline nut to a torque of 40 to 60 ft-lb, then adjust bearings (See Reel Bearing Service and Adjustment in the Adjustments section of this chapter.) **Use Loctite 271 on spline nut threads.**

7. Do steps 5 - 16 under Bedbar Removal and Installation in this section of the book.

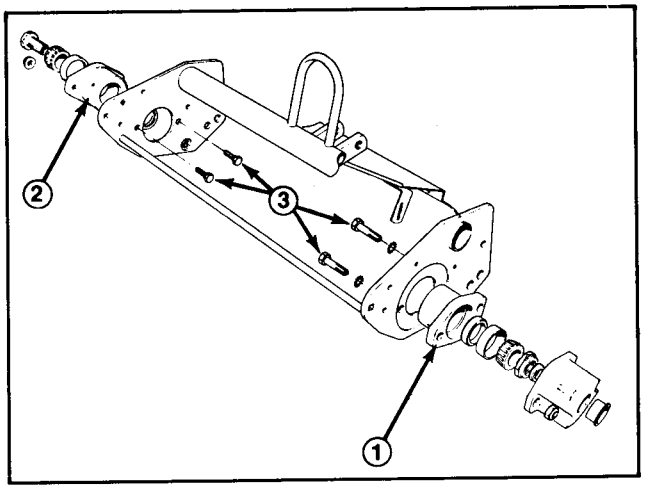


Figure 36

1. Left reel bearing housing
2. Right reel bearing housing
3. Machine screws

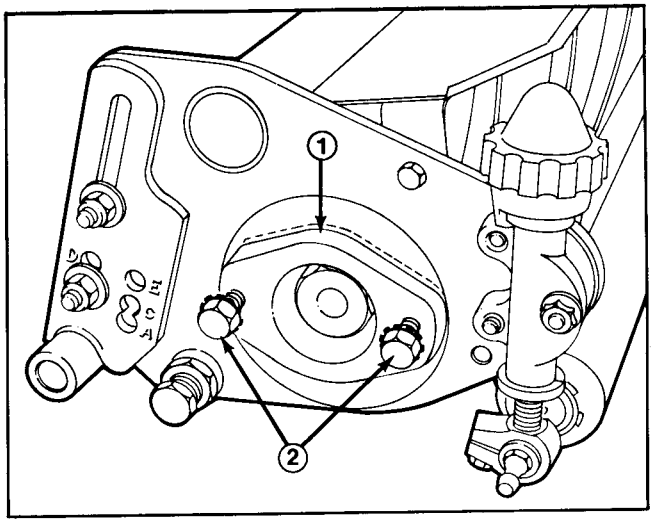


Figure 37

1. Bearing housing
2. Bolt

Bedknife Adjustment Knob Bearing Service

1. Turn bedknife adjustment knob counterclockwise to remove bedknife to reel contact.

2. Remove two (2) pivot screws (Fig. 38).

3. Rotate adjustment knob and pivot assembly clockwise (left-hand thread) until it is unthreaded from the bedbar pivot.

4. If necessary, remove locknut securing die spring to shaft (Fig. 6b). Slide pivot housing off adjustment knob threaded shaft (Fig. 38).

5. Pull inner races from pivot housing. Pull bearings from pivot housing. Check condition of inner races and bearings and replace if necessary.

6. Install new o-ring on each race if necessary.

7. Install bearings and races in pivot housing. Slide pivot housing onto shaft of knob.

8. Install spring over adjusting knob threaded shaft and thread adjustment knob and pivot assembly into flat side of bedbar pivot. Make sure there is an equal gap between each side of pivot assembly housing and frame supports (Fig. 29). Adjust (before installing pivot screws) by sliding bedbar pivot sideways.

IMPORTANT: On hand-adjustable type knobs, check to make sure die spring is compressed to a dimension of 13/16 in. by tightening locknut (left-hand thread) (Fig. 6b).

9. If equipped with hex head type pivot screws, tighten pivot screws to 60 ft-lb. If equipped with hex socket head set screws and jam nuts, tighten set screws finger tight then tighten 1/2 turn more (total - not each). Tighten jam nut.

10. Adjust bedknife to reel contact.

NOTE: If quality of cut has deteriorated or the reel and bedknife have become "rifled" , you must grind the reel and bedknife to remove rifle pattern.

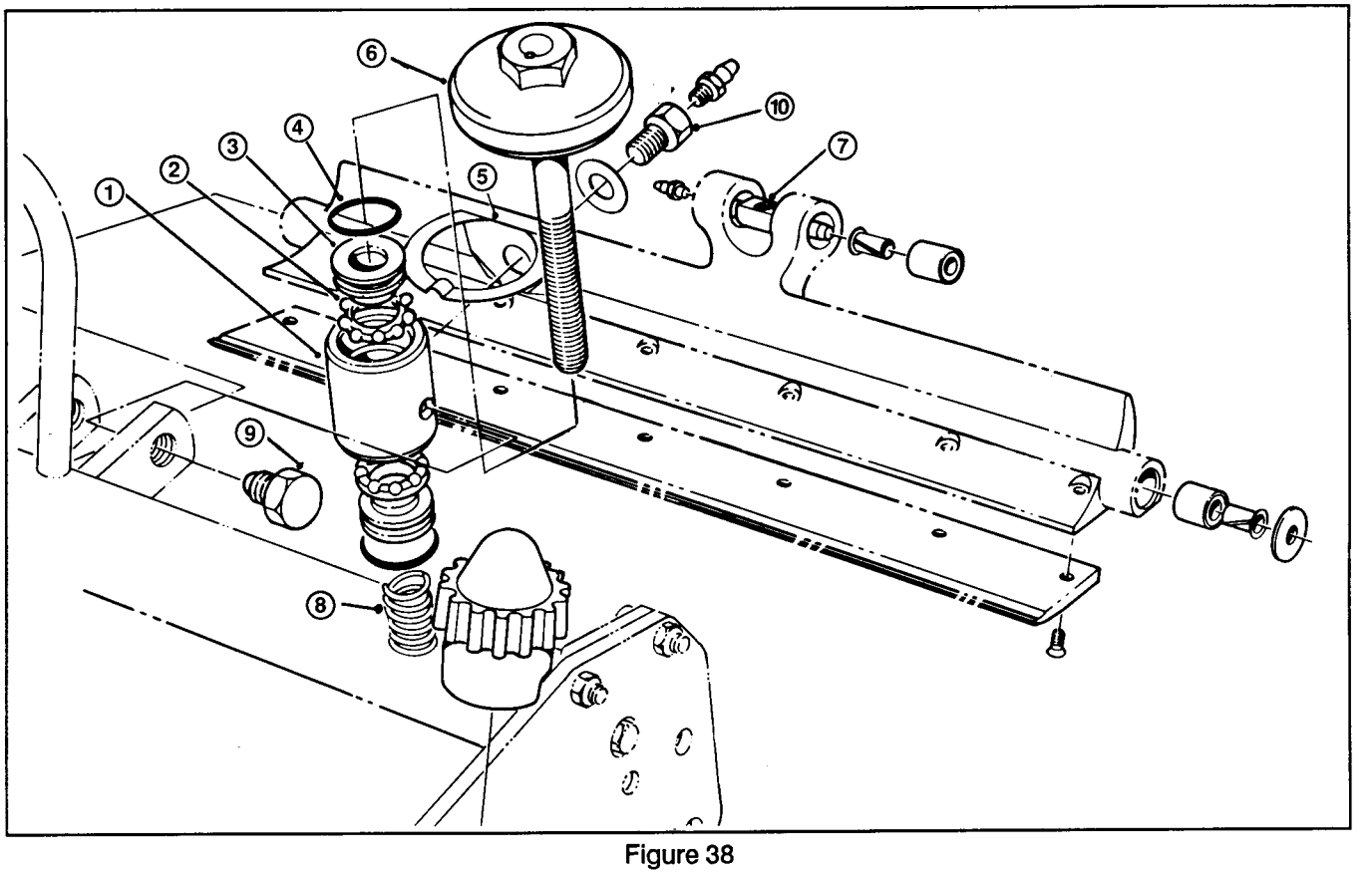


Figure 38

1. Pivot housing
2. Bearing (2)
3. Inner race (2)
4. O-ring (2)
5. Spring arm
6. Adjustment knob
7. Bedbar pivot
8. Spring
9. Pivot screw (2)
10. Spring arm bolt

Lift Bail Replacement

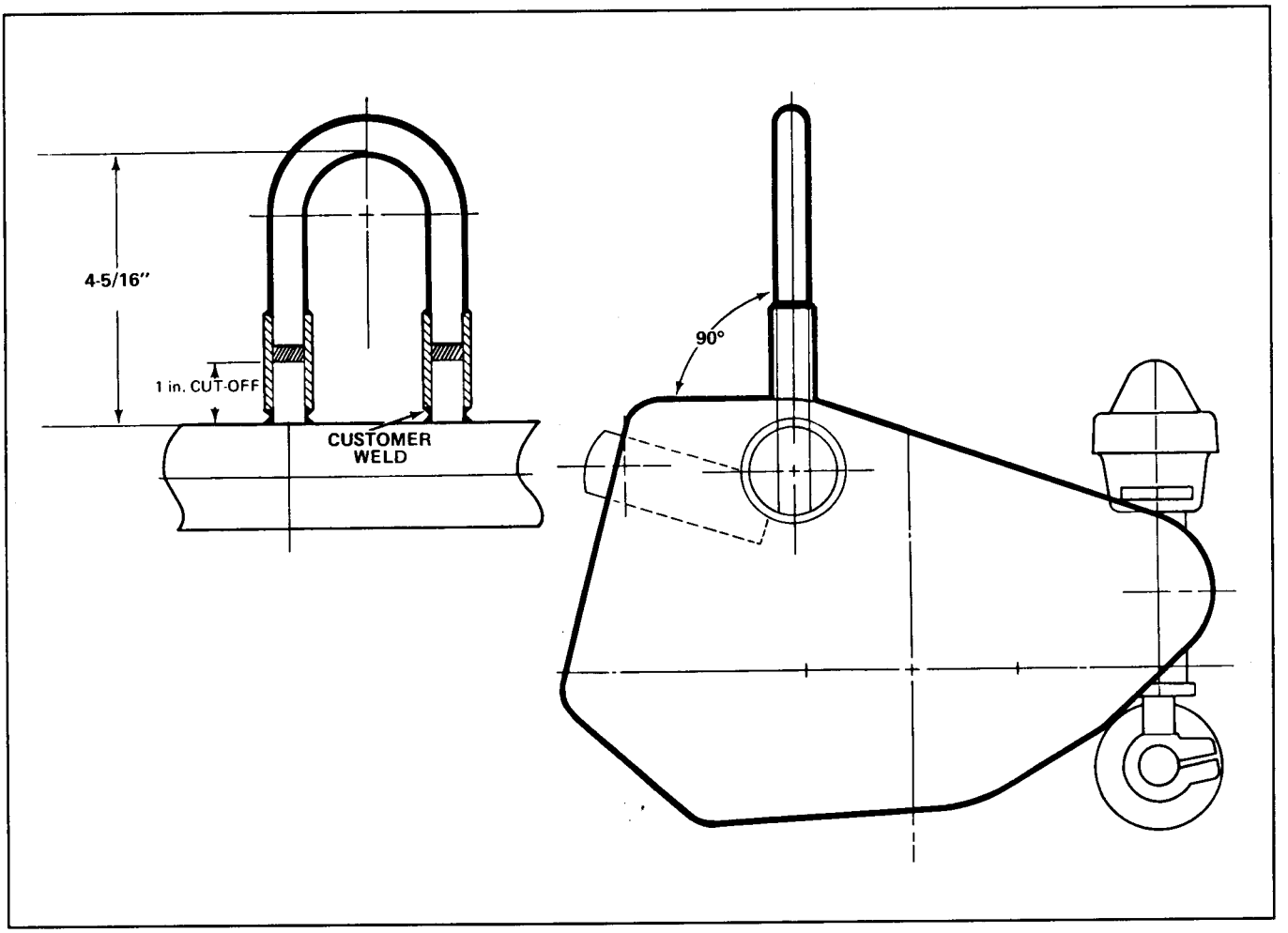


Figure 39

1. Use a saw to cut the lift bail off of the cutting unit. Make the cut 1 inch from the horizontal frame tube (Fig. 38).

2. Use a grinder to remove burrs from the stubs of the lift bail remaining on the cutting unit.

3. Install the repair lift bail (Part No. 71-1600).

4. Support the lift bail so the bottom radius is 4 5/16 inches from the top of the horizontal frame tube. Make sure the lift bail is square to the side frame.

5. Weld all around the bottom of the repair lift bail with mild steel rod, both sides.

TORO®

Chapter 10

Grooming Reel Cutting Units

Table of Contents

Introduction

This chapter gives service information for Model 04460 and 04465 Cutting Units with Groomer Reel.

This chapter also gives information for single point adjust cutting units equipped with the Model 04455 Grooming Reel Kit.

See **Chapter 8 - 4 Bolt Adjust Cutting Units** for specific information about Model 04407 and 04408 Cutting Units equipped with the Model 04455 Grooming Reel Kit. Specific information for 4-Bolt Adjust Cutting Units (i.e., bedknife to reel adjustment, bedbar removal and installation, and leveling rear roller to reel) is not covered in this chapter.

Specifications

Height Of Cut: 3/32 (0.094) in. to 3/4 (0.75) in.

Clip Frequency and Optimum Height of Cut Range:

Model No.	Clip (max.)	Optimum Height of Cut Range
04460 (8 blade reel):	0.25 in.	3/16" - 5/16"
04465 (11 blade reel):	0.18 in.	1/8" - 7/32"

Roller Adjustment:
Front: Micrometer hand adjustment with bolted clamp lock (1 turn 0.025 in. height of cut change).
Rear: Roller brackets allow adjustment for different height of cuts. Single screw adjustment for leveling.

Bedknife To Reel Adjustment: Bedknife adjusts against reel, with positive adjustment control knob located at center of bedbar. Adjustment knob contains detent with .001 inch movement of bed-knife for each indexed position..

Groomer Reel Depth: 0.18 in. maximum below height of cut

Groomer Reel Raised Height: 5/16 (0.312) in. from grooming reel height/depth adjustment.

Reel Speed: 1940 rpm (engine speed 2800 rpm).

Groomer Reel Speed: 3200 rpm.

Bedknife Screw Torque: 200 in-lb.

Reel Splined Drive Nut Torque: 40 to 60 ft-lb.

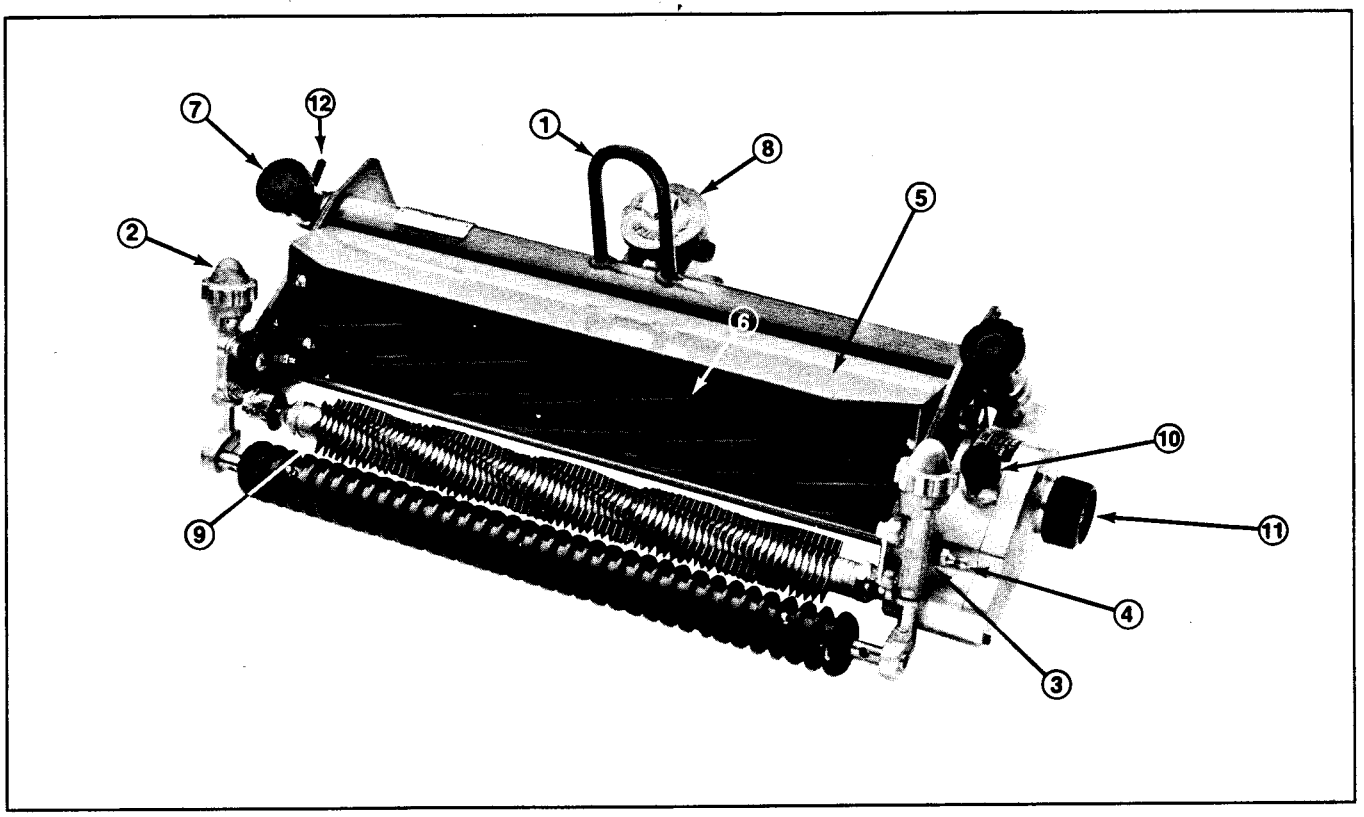
Reel Bearing Rolling Torque: 7 in-lb. maximum with bedknife to reel contact removed.

Front or Rear Roller Run-Out: 0.14 in. max.

Groomer Reel Drive Belt Tension: 1/4 in. deflection when a force of 5 - 10 lb. is applied midway between drive pulley and driven pulley.

Clutch Adapter Torque: 170 to 210 in-lb.

Clutch Assembly Locknut Torque: 140 in-lb (removing all end play).



1. Lift bail
2. Height of cut adjustment knob (2)
3. Height of cut adj. locknut (2)
4. Pull rod studs (2)
5. Grass shield
6. Reel
7. Groomer micro adj. locknut (2)
8. Bedknife adjustment knob
9. Groomer reel
10. Groomer clutch snubber
11. Clutch engage/disengage knob
12. Groomer quick up/down lever (2)

Special Tools

NOTE: Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*. Some tools may be listed in the Greensmaster 3000 or 3000-D Parts Catalog. Some tools may also be available from a local supplier.

McLube

Aerosol or liquid lubricant. Apply to bedbar pivot and bedbar pivot bolts.

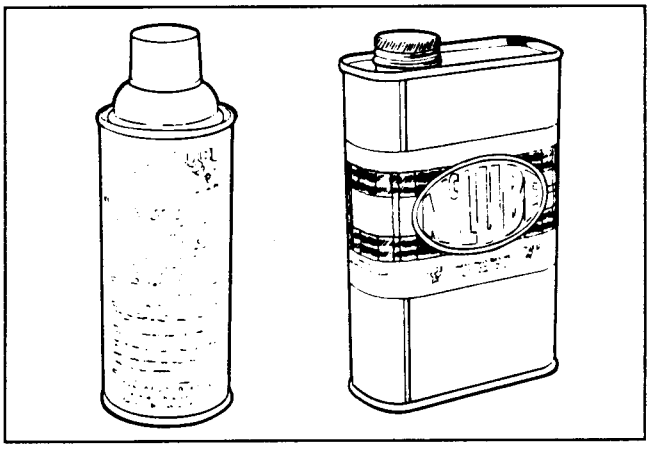


Figure 1

Roller Bearing Replacement Tool

Puller is used to remove bearings from front and rear rollers. Driving tubes are used to install bearings into rollers. Refer to instructions supplied with tool. Used on swaged, full and wiehle rollers.

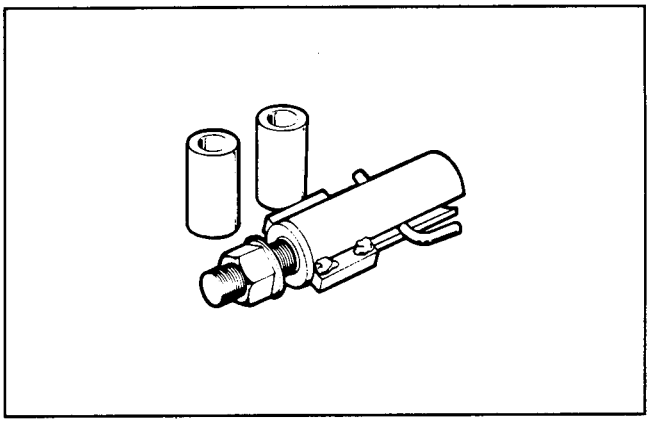


Figure 2

Plastic Plug

Insert plug in cutting unit bearing housing in place of reel motor when sharpening or grinding the reel.

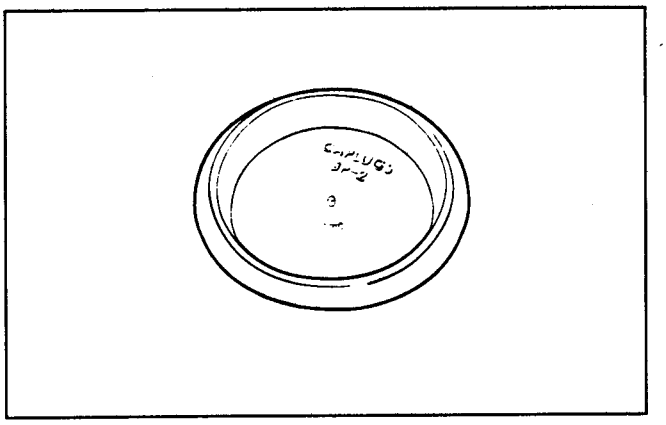


Figure 3

Handle Assembly

For applying lapping compound to cutting units while keeping hands a safe distance from the rotating reel assembly.

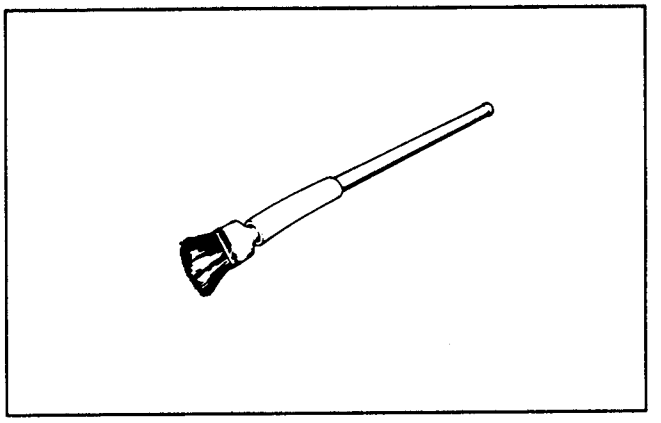


Figure 4

Bedknife Screw Tool

Fits Toro bedknife attaching screws. Use with torque wrench to secure bedknife to bedbar. With clean bedbar threads and new screws, tighten to a torque of 200 in-lb.

NOTE: Remove all rust, scale and corrosion from bedbar surface before installing bedknife.

DO NOT use an air impact wrench with this tool.

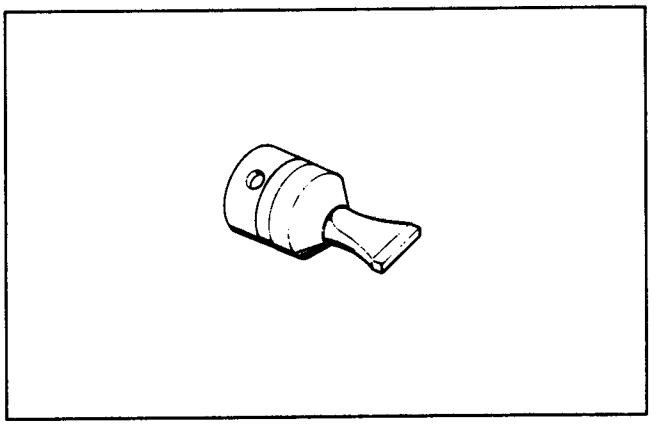


Figure 5

Factors Affecting Quality of Cut

There are a number of factors that can contribute to unsatisfactory quality of cut, some of which may be turf conditions. Turf conditions such as excessive thatch, "sponginess" or attempting to cut off too much grass height may not always be overcome by adjusting the machine. It is important to remember that the lower the height of cut, the more critical these factors are. See the Adjustments and Repairs sections for detailed adjustment and repair information.

Factor	Possible Problem/Correction
1. Tire pressure.	Check tire pressure adjust to specification if necessary. Must be equal in both front tires.
2. Engine governed speed.	Check maximum governed engine speed. Adjust if necessary – affects reel speed, traction speed and clip frequency.
3. Reel bearing condition/adjustment.	Check and adjust to specification. Replace bearings if worn or damaged. Bearing cones must be installed square to bearing housing - make sure there is no "flash", paint or other foreign material in housing before installing new bearing cone.
4. Reel and bedknife sharpness.	Reel and/or bedknife that has rounded edge cannot be corrected by tightening bedknife to reel contact. Grind reel to remove taper (cone shape) and/or rifling (grooved or ribbed appearance). Grind bedknife to sharpen and/or remove rifling. (Most common cause of rifling is bedknife to reel contact that is too tight.) NOTE: New bedknife must be ground after installing on bedbar to match bedknife to bedbar.
5. Bedknife parallel to reel.	Check and adjust as necessary.
6. Bedknife to reel contact.	Check before operating with cutting unit on ground. Rotate the reel backwards by hand. Turn adjusting knob one (1) click at a time until first contact between reel and bedknife is felt or heard, then tighten one (1) more click to get light contact. No contact will dull the cutting edges. Excessive contact accelerates wear.
7. Bedknife attitude (rear roller bracket hole position).	Set to recommendations in chart on Page 10 - 14.
8. Rear roller parallel to reel.	Check and adjust as necessary.
9. Height of cut.	All cutting units set at same height of cut. Set with front roller – must be equal at both ends of roller. Bench set height of cut and actual (effective) height of cut are different. Effective height of cut depends on cutting unit weight, cutting unit accessories and turf conditions.
10. Proper bedknife for height of cut.	If bedknife is too thick for effective height of cut, poor quality of cut will result.

Factor	Possible Problem/Correction
11. Stability and position of bedbar.	Make sure bedbar bolt plastic washers are snug against bedbar. Bedbar must pivot without binding. Check bedbar end bushings and pivot bushings for wear or damage and replace if necessary. Make sure proper bushings are installed in each location (bedbar end bushings are different from pivot bushings). Check adjustment knob to make sure detent holds adjustment. Repair if necessary. With adj. knob/pivot assembly removed, pivot screws installed, and frame on level surface, measure from flat surface up to end of each setscrew. If not within 1/16 in. of each other, bend ears on cutting unit frame to line up screws. Check to make sure adj. knob/pivot assembly is centered in bedbar arm yoke and frame ears so that an equal gap exists on each side of pivot housing before pivot screws are installed. Make sure bedknife adj. knob/pivot assembly is held firmly in place between frame supports.Tighten pivot screws if necessary.
12. Number of reel blades.	Use cutting unit model with correct number of blades for clip frequency and optimum height of cut range. (Variable speed traction kit can be used to adjust clip frequency.)
13. Cutting unit alignment and pull frame ground following.	Check pull frame alignment on all cutting units. Adjust or repair as necessary. Check pull frames and lift arms for damage, binding and bushing wear. Repair if necessary.
14. Roller condition	All rollers must rotate freely. Grease when needed or repair bearings if necessary.
15. Reel speed.	All reels must rotate at same speed (within 100 rpm). All cutting units must have equal bedknife to reel contact and reel bearing adjustment before checking. Do not run the reel to long or it may get hot and rifle when no grass is being cut. See Troubleshooting in Chapter 5 - Hydraulic System.
16. Traction speed.	Check maximum governed engine speed. Adjust to specification if necessary. See Troubleshooting in Chapter 5 - Hydraulic System Install Variable Speed Traction Kit if necessary to control traction speed in varying conditions or with different attachments. Will allow change in traction speed while maintaining full engine rpm and reel motor rpm.
17. Cutting drop speed and sequence.	Center cutting unit must drop after front cutting unit. (See Troubleshooting in Chapter 5 - Hydraulic System.

Factors Affecting Grooming

There are a number of factors that can affect the performance of grooming. These factors vary for different golf courses and from green to green on the same golf course. It is important to inspect the turf frequently and vary the grooming practice with the need.

It is important to remember that Factors Affecting Quality of Cut also affect grooming performance.

IMPORTANT: Improper or over-aggressive use of the groomer reel (i.e., too deep or too frequent grooming) may cause unnecessary stress on the turf, leading to severe turf damage. Use the groomer cautiously. READ AND UNDERSTAND THE OPERATOR'S MANUAL BEFORE OPERATING OR TESTING GROOMER PERFORMANCE.

Variables That Affect The Use and Performance of Grooming Reels:

1. Time or year (i.e., growing season) and weather patterns.

2. General turf conditions.

3. Frequency of grooming/cutting - how many cuttings per week and how many passes per cutting.

4. Grooming reel blade spacing.

5. Height of cut. NOTE: Because of weight difference, "bench set height of cut" should be approximately 0.020 to 0.040 in. higher on groomer equipped cutting units to get the same "effective height of cut" as cutting units without groomer reels.

6. Grooming depth.

7. How long grooming reel has been in use on a particular turf area.

8. Type of grass.

9. Overall turf management program (i.e., irrigation, fertilizing, weed, disease and pest control, coring, overseeding, sand dressing, etc.).

10. Amount of traffic on turf.

11. Stress periods for turf (i.e., high temperatures, high humidity, unusually high traffic).

Grooming Reel Mechanical Problems

Problem	Possible Cause/Correction
1. Groomer rotates when in raised position with clutch disengaged.	Normal condition - the groomer may still rotate in raised position (with minimal force) when clutch disengaged because of friction in the clutch assembly. This condition may change over a period of time. Clutch not fully disengaged. Make sure clutch knob set screws are tight against flats on release disk and does not allow knob to slip. IMPORTANT: When engaging or disengaging clutch, be sure to push snubber down and turn knob all the way (will come to a firm stop) Clutch pulley bearing seized. Replace bearing. Clutch damaged or assembled incorrectly. Repair or replace clutch if necessary.
2. Clutch is engaged but does not provide power to groomer reel.	Clutch not fully engaged. Make sure clutch knob set screws are tight against flats on release disk and does not allow knob to slip. IMPORTANT: When engaging or disengaging the clutch, be sure to push the snubber down and turn the knob all the way (it will come to a firm stop) Clutch damaged or assembled incorrectly. Repair or replace clutch if necessary. Belt is out of adjustment. If belt has slipped. it will probably be damaged and must be replaced. Belt broken or damaged. Repair or replace belt if necessary. A broken or worn belt could be the result of improper belt adjustment or seized groomer reel bearings.
3. Turf damage or uneven grooming.	Bent, damaged or missing groomer blades. Replace blades if necessary. Bent or damaged groomer reel shaft. Replace groomer shaft. Grooming depth not equal on both ends of groomer reel. Adjust if necessary. Check and adjust cutting unit set up (level bedknife to reel, level rear roller to reel, set height of cut, etc.)
4. Groomer reel does not raise completely to transport position – quick-up levers do not rotate completely to rear or have free play.	Groomer reel interfering with cutting unit frame side plate. Check side plate for proper cut-out and modify if necessary. Incorrect front roller extension plate installed. Single Point Adjust and 4-Bolt Adjust cutting units require different front roller extension plates.

Set Up and Adjustments

Adjustment Summary and Check List

DETAILED ADJUSTMENT INSTRUCTIONS FOLLOW THIS SUMMARY AND CHECK LIST. Study this information and refer to it often for maximum life and performance of cutting units.

Daily Performance Checks

NOTE: It is not necessary to remove the cutting units from the traction unit to perform these daily checks. It is recommended that mowers be washed after each use. Always remove key from ignition switch when working on the machine.

1. Purge all water and debris from all bearings by greasing them. Use No. 2 multi-purpose lithium base grease.

2. Visually check for sharp reel and bedknife.

- Remove burrs, nicks, and rounded edges.

3. Visually check groomer reel for wear and damage.

- Straighten bent blades.
- Replace worn blades or reverse groomer reel to put sharpest blade edge forward.
- Make sure right and left shaft end nuts are tight.

4. Lower cutting units to the ground (setting on both rollers) and remove reel motor. Rotate the reel by hand. TURN ADJUSTING KNOB ONE (1) CLICK AT A TIME UNTIL FIRST CONTACT BETWEEN REEL AND BEDKNIFE IS FELT AND HEARD THEN TIGHTEN ONE (1) MORE CLICK TO GET LIGHT CONTACT *.

- No contact will dull the cutting edges.
- Excessive contact accelerates wear; quality of cut may be adversely affected.

* It is best to make the reel to bedknife adjustment in the morning, immediately before each day of mowing.

Weekly Checks

1. Check reel bearing adjustment and bearing condition.

2. Make sure bed bar bolt "plastic washers" are SNUG against the bedbar.

3. Make sure bedknife adjustment knob/pivot assembly is held FIRMLY in place between frame supports.

4. Use a gauge bar to check height of cut setting.

5. Use a gauge bar to check groomer depth setting.

Monthly Adjustments

NOTE: Remove cutting unit from traction unit.

1. Parallel bedknife to reel.

- Use newspaper as a feeler gauge.
- Dot on eccentric bolt must face rear of mower.
- Turn bedknife adjustment knob to hold paper on right-hand end of bedknife.
- Turn eccentric (left) bedbar bolt to hold paper on left-hand end of bedknife.
- Hold eccentric bedbar bolt while securing locknut.

2. Adjust rear roller parallel to reel; eccentric bolt faces to rear.

3. Check grass shield adjustment.

- 4-3/4 in. from crossbar - normal.
- Dry grass - lower shield.
- Wet grass - raise shield.

4. Set top bar (cut-off bar) adjustment.

- 0.060 in. from reel - normal.

5. Set cutting unit on ground (setting on both rollers) and remove reel motor. Adjust bedknife to reel contact.

6. Use a gauge bar to check height of cut and adjust as necessary.

7. Use a gauge bare to check groomer depth and adjust as necessary.

Special Notes

1. Replace bedbar bushings and nylon flange bushings every two years.

2. A "rifled" reel and/or bedknife must be corrected by grinding.

3. After extended running, notches will develop at both ends of bedknife. These notches must be rounded off or filed flush with cutting edge of bedknife to assure smooth operation.

4. If reel bearings will not hold adjustment during operation, loosen adjustment nut, tighten reel shaft *spline nut* on right hand end of reel shaft to a torque of 40 to 60 ft-lb., then adjust reel bearings.

Bedknife to Reel Contact

NOTE: The single knob bedknife-to-reel adjustment system simplifies the adjustment procedure needed to deliver optimum mowing performance. The precise adjustment possible with the single knob/bedbar design gives the necessary control to provide a continual self-sharpening action – thus maintaining sharp cutting edges, assuring good quality-of-cut, and greatly reducing the need for routine backlapping. In addition, the rear roller positioning system permits optimum bedknife attitude and location for varying heights-of-cut and turf conditions.

IMPORTANT: Bedknife to reel contact must be checked and adjusted every day even though quality of cut is acceptable.

1. Shut off engine and lower cutting units to ground. Remove the key.

2. Remove grass baskets.

3. Make sure the groomer reel is in the raised position. Raise the groomer reel by rotating the right and left quick up levers so they face to the rear (Fig. 6.)

4. Make sure the groomer reel is disengaged. Push the clutch snubber down and turn the clutch knob clockwise to disengage the clutch (Fig. 6).

IMPORTANT: When engaging or disengaging the clutch, be sure to turn the knob all the way (it will come to a firm stop). Failure to do so could cause damage to the clutch.

5. On each cutting unit, loosen (2) flange nuts securing reel motor to cutting unit. Twist motor clockwise to disengage from cutting unit and remove motor.

6. Slowly rotate reel, listening for reel-to-bedknife contact. If no contact is evident, TURN BEDKNIFE ADJUSTING KNOB CLOCKWISE, ONE (1) CLICK AT A TIME, UNTIL FIRST CONTACT IS FELT AND HEARD, THEN TIGHTEN ONE (1) MORE CLICK TO GET LIGHT CONTACT (Fig. 7).

7. If contact is felt, turn bedknife adjusting knob counterclockwise, one (1) click at a time until no contact is evident. Turn bedknife adjusting knob one (1) click at a time clockwise, until first contact is felt and heard, then tighten one (1) more click to get light contact.

8. Install hydraulic motor to cutting unit.

IMPORTANT: LIGHT CONTACT MUST BE MAINTAINED AT ALL TIMES. If light contact is not maintained, bedknife and reel edges will not self-sharpen sufficiently. This will result in dull cutting edges after a period of operation. If excessive contact is maintained bedknife/reel wear will be accelerated. Uneven wear can result, and quality of cut may be adversely affected.

NOTE: As the reel blades continue to run against the bedknife a slight burr will appear on the front cutting edge surface the full length of the bedknife. If a file is occasionally run across the front edge to remove this burr, improved cutting performance can be obtained.

NOTE: After extended operation, notches will eventually develop at both ends of the bedknife. These notches must be rounded off or filed flush with cutting edge of bedknife to assure smooth operation.

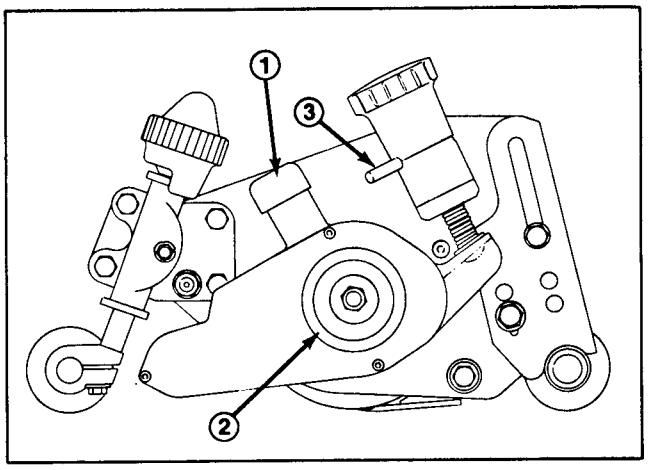


Figure 6

1. Clutch snubber
2. Clutch knob
3. Quick up lever (2)

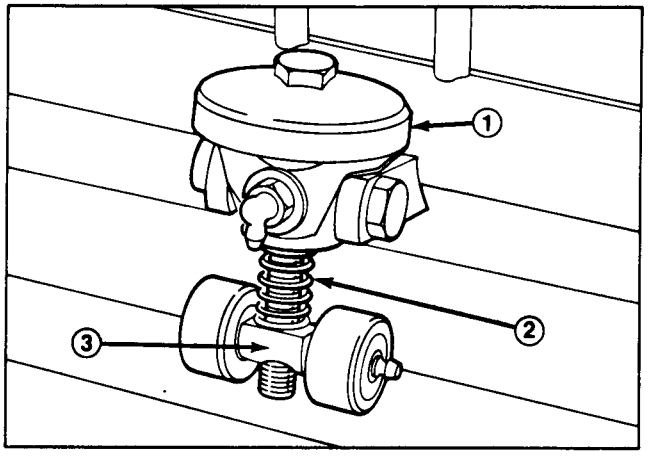


Figure 7

1. Bedknife adjusting knob
2. Compression spring
3. Pivot bar

Reel Bearing Service and Adjustment

1. Remove bedknife to reel contact by turning bedknife adjustment knob counterclockwise (Fig. 7).

2. Loosen two (2) set screws and remove clutch knob (Fig. 6). Remove groomer reel housing cover from left side of cutting unit (Fig. 8). Loosen idler pulley and remove drive belt. (Fig. 9).

3. Reel bearing rolling torque should not exceed 7 in-lb. Measure with a torque wrench at the spline nut on the right-hand end of the reel shaft.

NOTE: If bearing drag does not meet above specification or if you do not have an inch-pound torque wrench, do remaining steps in this procedure.

4. Remove nut and washer from clutch adapter shaft. Pull clutch assembly off adapter shaft (Fig. 9). Remove clutch adapter from reel shaft (Fig. 10).

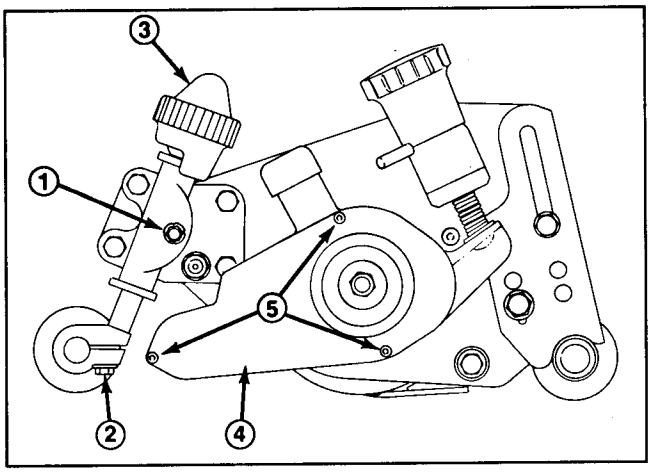


Figure 8

1. Height of cut locknut
2. Roller shaft clamp bolt
3. Height of cut knob
4. Grooming reel cover
5. Cover screws & washers

CAUTION

Do not use your hand to prevent reel from turning while servicing; this can result in personal injury. Use a 1/2 in. thick x 3 in. wide x 8 in. long piece of hardwood inserted into front of cutting unit between reel blades.

NOTE: If reel bearings will not hold adjustment during operation, loosen adjustment nut, tighten reel shaft *spline nut* on right hand end of reel shaft to a torque of 40 to 60 ft-lb, then adjust reel bearings. Use Loctite 271 on spline nut threads.

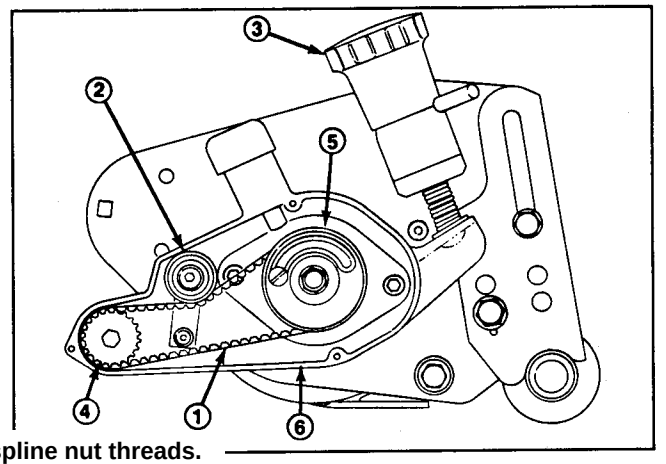


Figure 9

1. Drive belt
2. Drive belt idler pulley
3. Grooming reel adjustment knob assembly
4. Groomer driven pulley
5. Clutch assembly
6. Groomer reel housing

5. Loosen large reel bearing adjustment nut (Fig. 10). Tighten nut until all reel shaft end play is removed, then tighten an additional 1/16 to 1/8 turn. Be certain to remove all end play, but do not over-tighten. Rolling torque should not exceed 7 in-lb.

NOTE: Adjustment nut must have enough resistance against reel shaft threads to retain bearing adjustment. Replace adjustment nut if necessary.

6. If bearings require replacement, see Reel Removal and Bearing Replacement in the Repairs section of this chapter.

7. Install clutch adapter on reel shaft (Fig. 10) and tighten to a torque of 170 - 210 in-lb.

8. Hold belt on drive pulley and slide clutch on clutch adapter while sliding belt on driven pulley. Install washer and nut (removed in step 4) on clutch adapter shaft and tighten nut to a torque of 7 - 10 ft-lb. Adjust drive belt tension before installing cover. (See Groomer Reel Drive Belt Adjustment in this section of the book.)

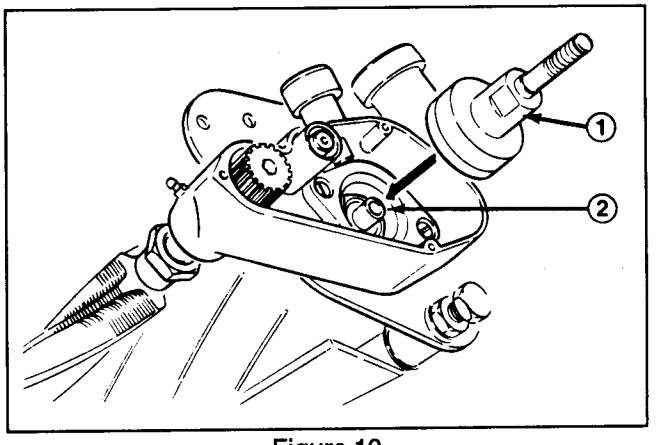


Figure 10

1. Clutch adapter shaft
2. Reel shaft and bearing adjustment nut

Parallel Bedknife to Reel

1. Remove mower from traction unit and put on a level work surface. Make sure reel contact is removed by turning bedknife adjustment knob counterclockwise.

2. On right-hand end of reel, insert a long strip of newspaper between the reel and bedknife. While slowly rotating reel forward, turn bedknife adjusting knob (Fig. 11) clockwise, one click at a time, until paper is pinched lightly resulting in a slight drag when paper is pulled.

3. Check for light contact at other end of reel using paper. If light contact is not evident at both ends, bedknife is not parallel to reel, proceed to step 4.

4. Loosen jam nut on left hand bedbar pivot bolt so bolt can be turned. Left hand pivot bolt (eccentric bolt) has offset thread which, when rotated, acts as a cam to raise or lower the bedbar. Identification dot on bolt head denotes offset of bolt. When dot is in up position (Fig. 12) left end of bedbar is raised. As bolt is turned clockwise and dot is lowered, so is left end of bedbar. Identification dot must be positioned within rear (180°) position when adjusting.

5. Rotate left hand (eccentric) pivot bolt to raise or lower bedbar as required.

6. Check adjustments by repeating steps 2 and 3.

7. After getting light contact on paper at each end of bedknife, hold left-hand pivot bolt in position and tighten jam nut. Make sure pivot bolt did not get out of adjustment when turning jam nut. Adjust again if necessary.

NOTE: If the reel has worn so you cannot get the bedknife parallel to the reel by turning the eccentric bolt, the reel will require grinding to remove taper. The reel normally wears faster on the lead-in side, which results in the described taper.

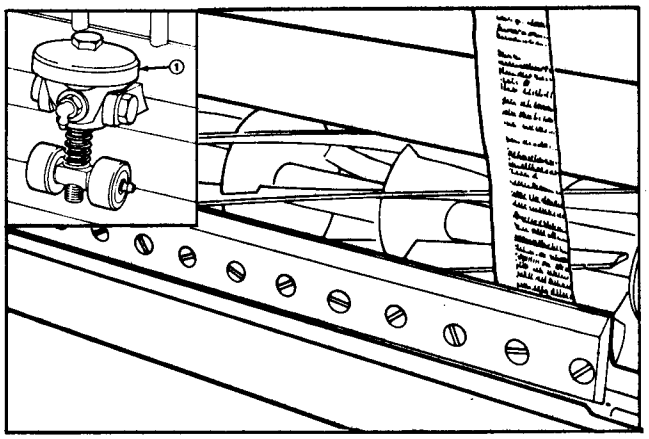


Figure 11

1. Bedknife adjusting knob

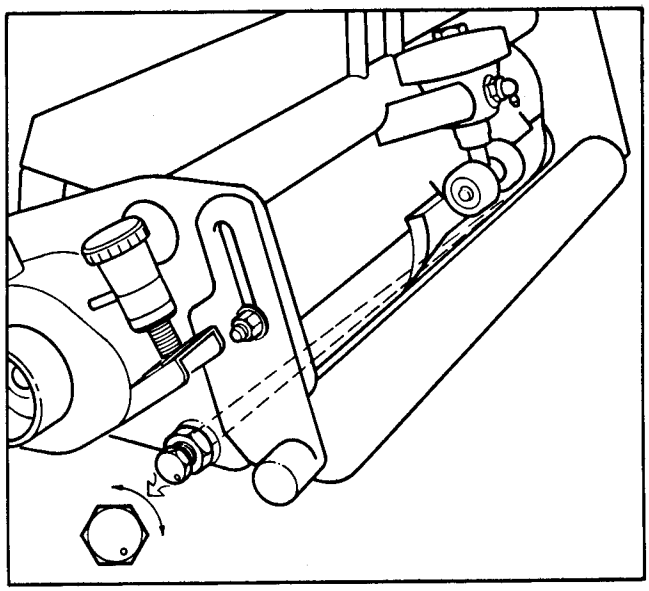


Figure 12

Leveling Rear Roller to Reel

1. Put cutting unit on a flat, level surface.

2. Assemble rear height of cut brackets to desired position, by loosening top capscrew and nut and removing bottom nut on right and left hand sides of cutting unit (Fig. 13).

3. Slide bolts thru each bracket until brackets can be realigned with appropriate mounting hole. See table for proper position on brackets.

NOTE: The different rear roller bracket positioning holes (B thru E) are designed to optimize bedknife location for different heights of cut.

Rear Roller Bracket Hole Position – 8 Blade Cutting Units

Height of cut 3/16 (.187) in. and below use the **B** position
Height of cut 5/32 (.156) in. and above Use the **C** position
Height of cut between 5/32 (.156) and 3/16 (.187) in., try **C** first; if not satisfactory, use **B**

NOTE: For Height of Cut 5/32 (.156) in. and lower use 3/32 in. (tournament) bed knife. Tournament bed knife should not be necessary with the rear roller in the C position.

Rear Roller Bracket Hole Position – 11 Blade Cutting Units

Height of cut 3/16 (.187) in. and below use the **B** position
Height of cut 5/32 (.156) in. and above Use the **C** position
Height of cut between 5/32 (.156) and 3/16 (.187) in., try **B** first; if not satisfactory, use **C**

NOTE: For Height of Cut 3/16 (.187) in. and lower use 3/32 in. (tournament) bed knife. Tournament bed knife should not be necessary with the rear roller in the C position.

NOTE: The "B" hole position normally is the best rear roller location for most low (3/32" - 1/8") cutting conditions.

It may be necessary to change from the above suggested ranges in certain turf conditions.

4. After putting bracket into correct height-of-cut hole position make sure right hand rear roller bracket capscrews are tightened securely (Fig. 14).

5. Left hand rear roller bracket capscrews are to be tightened only enough to remove excessive looseness in assembly, but allow bracket to slide freely on side plate.

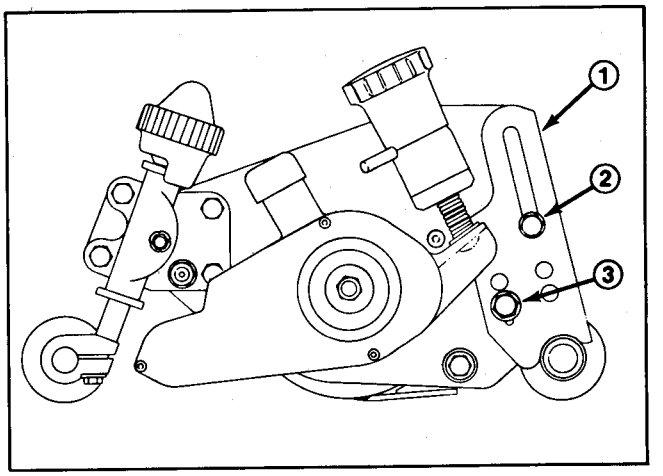


Figure 13

1. Rear height of cut bracket 3. Bottom nut
2. Top capscrew and nut

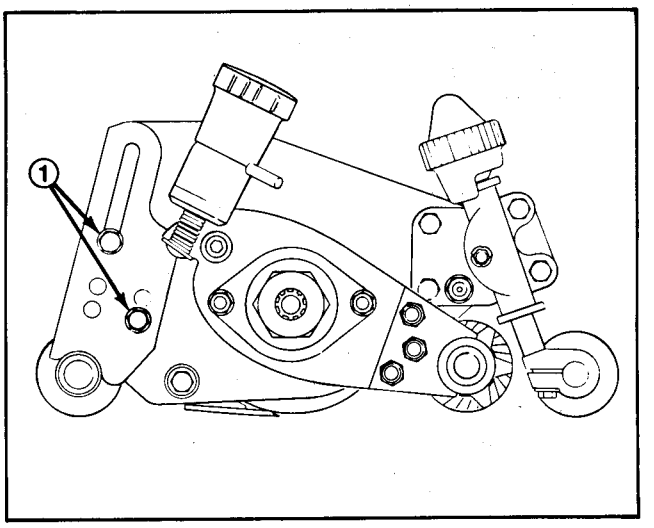


Figure 14

1. Right rear roller bracket capscrews

6. Position a 1/4 inch or thicker plate under the reel blades and against the front face of the bed-knife (Fig. 15).

NOTE: Make sure plate covers full length of reel blades, and (3) blades contact plate (8 blade reel).

7. While holding reel securely on plate, level roller by rotating lower left roller pivot bolt. The pivot bolt has an offset thread which when rotated, acts as a cam to raise or lower the roller. On the bolt head there is an identification dot (Fig. 16) which denotes the offset of the bolt. Dot indicates in which direction left end of roller moves when bolt is turned.

8. To verify if roller is level, try inserting a piece of paper under each end of roller.

9. When roller is level, tighten left capscrew and pivot bolt nuts securely. Hold the eccentric pivot bolt while tightening the nut to keep the proper roller position.

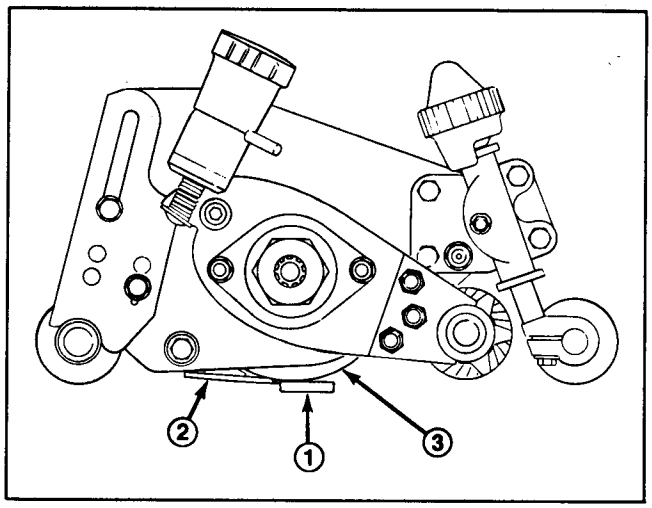


Figure 15

1. 1/4" plate
2. Bedknife
3. Reel

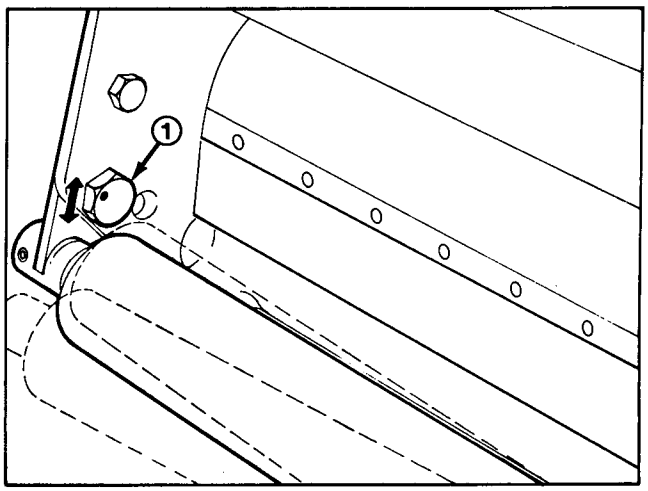


Figure 16

1. Pivot bolt

Height of Cut

Height of cut, as measured on the cutting unit and in the turf is different. The grass prevents the cutting unit from settling all the way to the ground line as the machine moves across the turf. Because of this, the actual (effective) height of cut is higher than the height of cut setting on the cutting unit (bench set height of cut) (Fig. 17).

Machine conditions, such as cutting unit weight, roller type, bedknife thickness, speed of travel and clip frequency, influence effective height of cut. Turf conditions, such as grass type, grass density, and amount of thatch also influence effective height of cut.

Changing the machine (such as adding a wiehle roller, or changing to a heavier grooming reel cutting unit) will increase penetration into the turf and lower the effective height of cut.

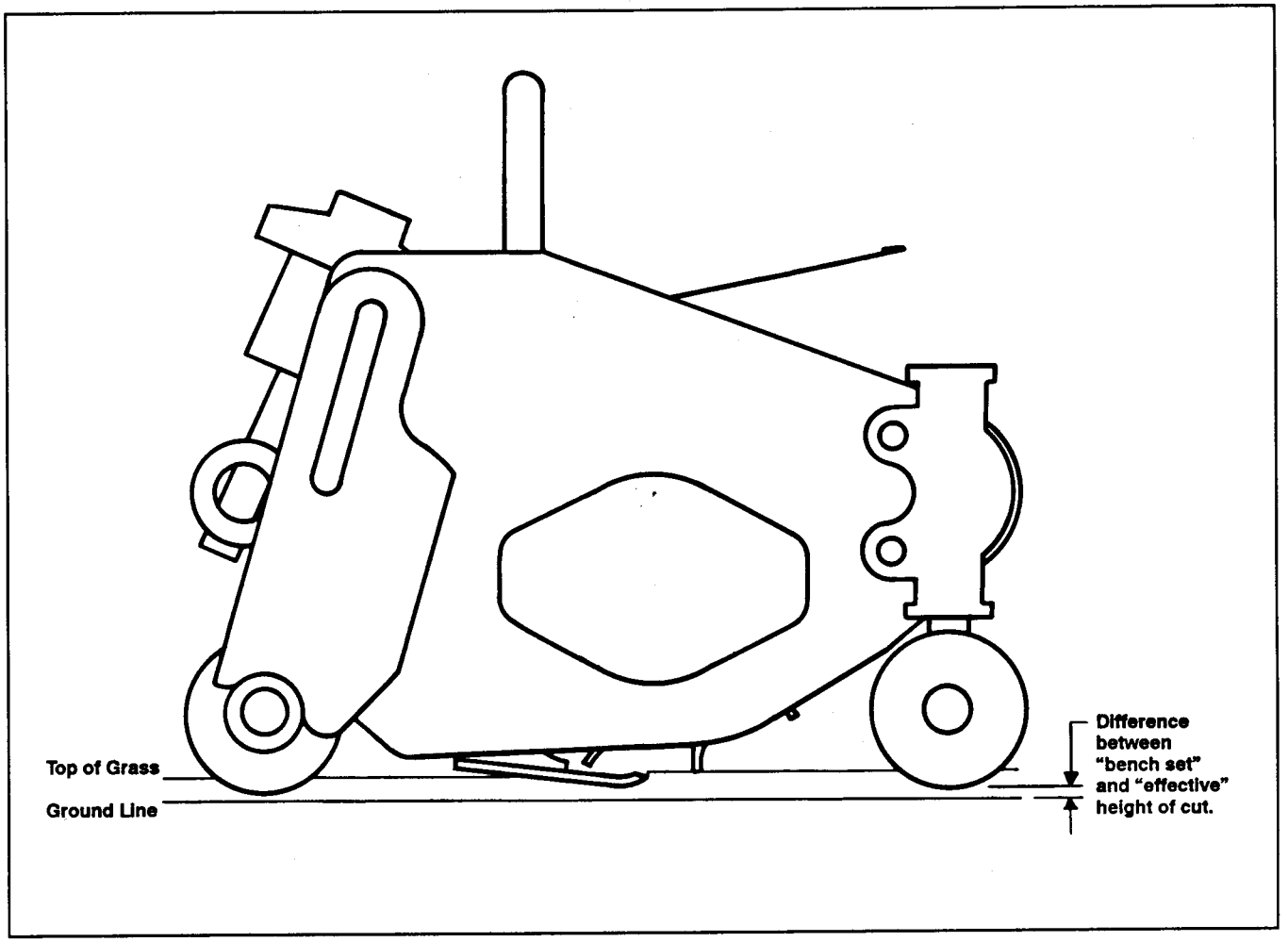


Figure 17

Height of Cut Adjustment

IMPORTANT: Lower heights of cut are limited by thickness of bedknife. Select proper bedknife for desired height of cut. If bedknife is too thick for height of cut, poor quality of cut will result and excessive pressure from turf on bottom of bedknife can cause "rifling" of bedknife and reel.

NOTE: Because of weight difference, "bench set height of cut" should be approximately 0.020 to 0.040 in. higher on grooming reel cutting units to get the same "effective height of cut" as cutting units without groomers.

1. Make sure that rear roller brackets are in correct hole positions for desired height of cut and that rear roller is level. Also, check that bedknife to reel contact is correct.

2. Turn cutting unit over and loosen locknuts securing front roller adjusting screws to height of cut brackets (Fig. 18).

3. On gauge bar (Part No. 1-8789), set head of screw to desired height of cut. This measurement is from bar face to underside of screw head.

4. Place bar across front and rear rollers and adjust height of cut knob until underside of screw head engages bedknife cutting edge (Fig. 18). Check and adjust on each end of bedknife, then tighten height of cut adjustment locknuts on each end.

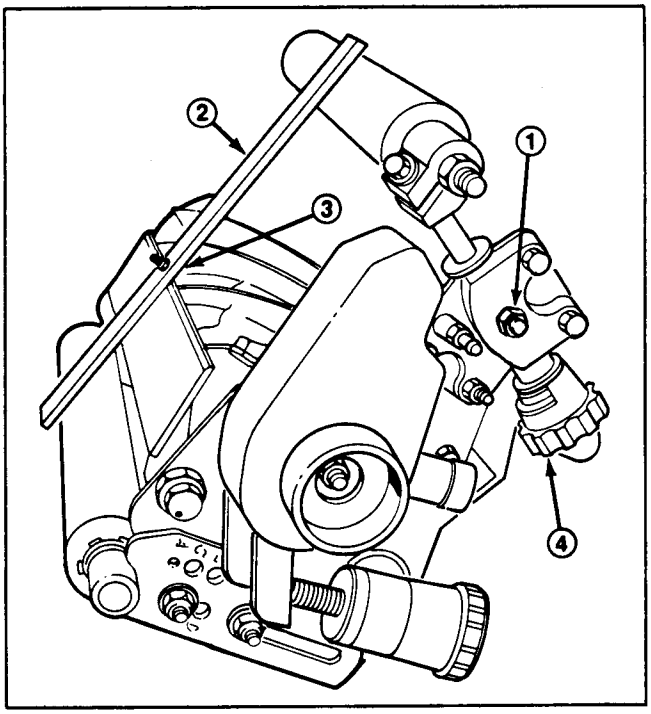


Figure 18

1. Height of cut knob locknut
2. Gauge bar (1-8789)
3. Screw head over bedknife
4. Adjustment knob

Changing To A Different Type of Cutting Unit or Adding Cutting Unit Accessories

When changing to a different type of cutting unit or adding cutting unit accessories, it is recommended that you change only one cutting unit, and keep the other two existing cutting units on the machine.

1. Set the new cutting unit to a height of cut approximately 1/16 (0.06) in. higher than the old cutting unit.

2. Do a mowing test and compare results between the new cutting unit and old cutting units.

3. Adjust the new cutting unit to match the cut of the old cutting units.

4. The other two cutting units can now be replaced. Adjust these two new cutting units so they are the same as the other new cutting unit that was tested.

Groomer Reel Depth Adjustment

1. Adjust cutting unit height of cut before doing groomer reel depth adjustment.

2. Hold clutch snubber down and rotate the clutch clockwise to disengage the clutch (Fig. 6). Rotate both quick up levers to lower the grooming reel into grooming position.

3. Hold a straight bar securely against the front and rear rollers on one side of the cutting unit (Fig. 19). While holding the bar in place, lift and turn the micro adjustment knob until the groomer blade just touches the bar (rotating the groomer reel by hand will assist in determining if blades are lightly touching the bar).

4. Repeat step 3 on the opposite side of the cutting unit, then check the adjustment on the other side again. Adjust again if necessary.

5. Each notch on the micro adjustment knob equals approximately 0.007 in. of groomer height/depth. Divide the desired height/depth setting of the groomer reel by 0.007 to determine how many notches to turn the micro adjustment knob. Make sure each knob is turned the same number of notches. Turn counterclockwise to raise groomer reel and clockwise to lower.

Example: Desired groomer setting of 1/32 (0.03125) in. higher than bottom of rollers:

0.03125 ÷ 0.007 = 4.46 (4 or 5 notches)

6. Rotate both quick up levers to raise the grooming reel into transport position. Make sure the clutch is disengaged.

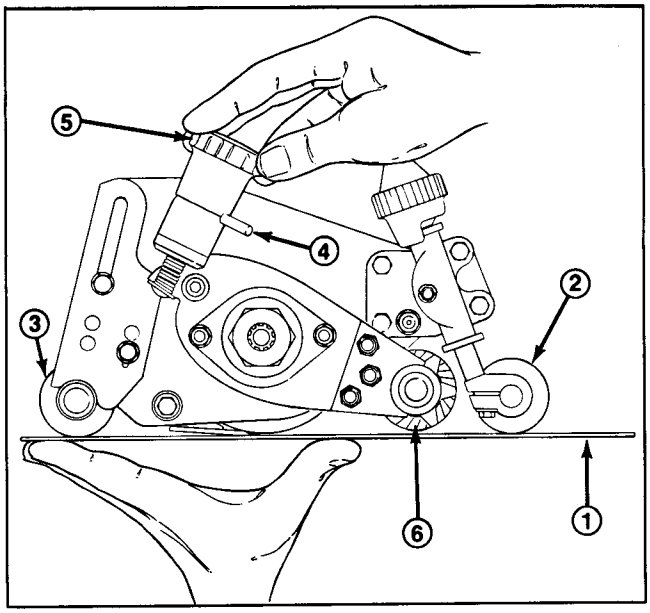


Figure 19

1. Bar
2. Front roller
3. Rear roller
4. Quick up lever (2)
5. Micro adjustment knob (2)
6. Groomer reel touching bar

Shield Height Adjustment

Adjust shield to get proper grass clipping discharge into basket:

1. Set cutting unit in normal cutting position and measure distance from top of front crossbar to shield at each end of cutting unit (Fig. 20).

2. Height of shield from crossbar for normal cutting conditions should be 4-3/4 inches. Loosen capscrews and nuts securing shield to each side plate, adjust shield to correct height and tighten fasteners (Fig. 20).

3. Repeat adjustment on remaining cutting units and adjust top bar. (See Adjusting Top Bar in this section of the book.)

NOTE: Shield can be lowered in dry grass conditions (clippings fall over top of baskets) or raised to allow for heavy wet grass conditions (clippings build up on rear edge of baskets).

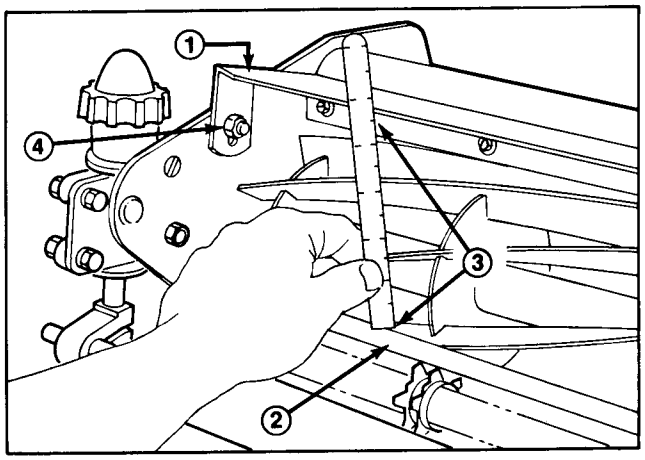


Figure 20

1. Shield
2. Front crossbar
3. 4-3/4 inches
4. Shield fasteners

Top (Cut Off) Bar Adjustment

Adjust top bar to make sure clippings are cleanly discharged from reel area:

1. Loosen screws securing top bar (Fig. 21). Insert 0.060 inch feeler gauge between top of reel and bar and tighten screws. Make sure bar and reel are equal distance apart across complete reel.

2. Repeat settings on remaining cutting units.

NOTE: Bar is adjustable to compensate for changes in turf conditions. Bar should be adjusted closer to reel when turf is extremely wet. By contrast, adjust bar further away from reel when turf conditions are dry. Bar should be parallel to reel to get optimum performance and should be adjusted whenever shield height is adjusted or whenever reel is sharpened on a reel grinder.

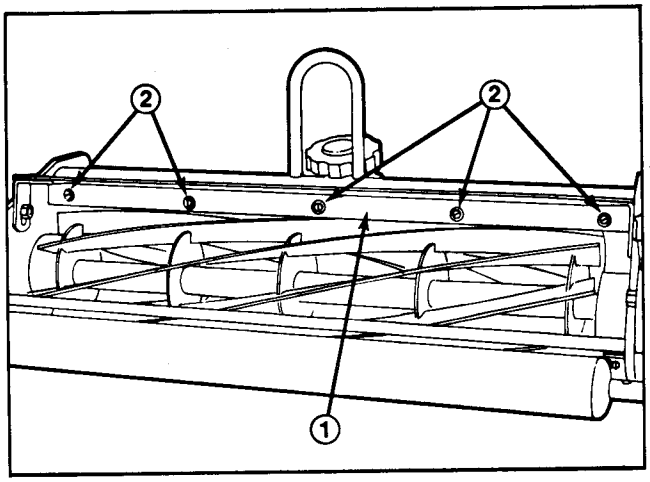


Figure 21

1. Top bar
2. Bar mounting screws

Groomer Reel Drive Belt Adjustment

1. Loosen two (2) set screws and remove clutch knob (Fig. 6). Remove groomer reel housing cover from left side of cutting unit (Fig. 8).

2. Apply 5-10 lb. of force on the belt midway between the pulleys to check tension on the drive belt. There should be 1/4 inch belt deflection. If deflection is not 1/4 inch, loosen the idler pulley pivot screw (Fig. 22). Pivot the idler to get proper tension and tighten the allen head screw to a torque of 7-10 ft-lb.

3. Install groomer reel housing cover. Install clutch knob and tighten two (2) set screws against flats on release disk.

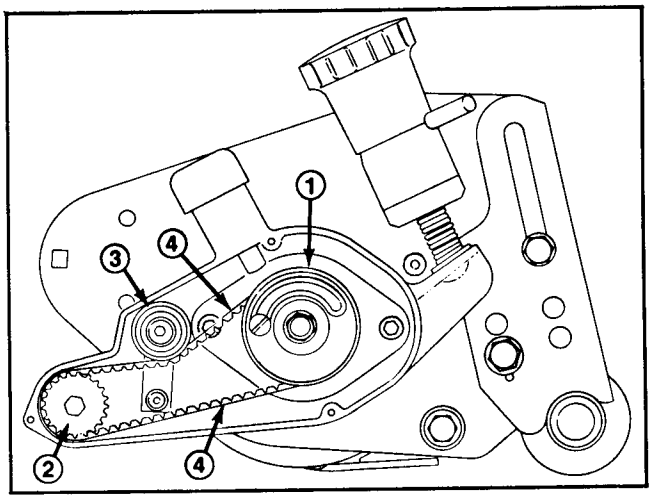


Figure 22

1. Drive pulley and clutch assembly
2. Driven pulley
3. Drive belt (backside) idler pulley
4. Drive belt

Pull Frame Adjustment

1. Put the basket on the pull frame.

2. Level baskets to cutting unit by loosening nut at one end of pull frame roller. Loosen bolt and move roller shaft in slot as necessary. Tighten bolt.

3. Loosen the jam nuts on the pull arms and adjust the ball sockets until there is 1/4 in. to 1/2 in. (6 to 13 mm) clearance between the lip of the basket and the reel blades (Fig. 23a). This prevents grass clippings from dropping on the ground.

4. Make sure the basket lips are the same distance from the reel blades at both ends of the reel. If the basket is too close to the reel, it is possible for the reel to contact the basket at the instant the cutting unit is raised off the ground.

5. Make sure each of the three (3) cutting units track straight with the traction unit:

   A. On a smooth, level surface, draw a straight line on the floor (Fig. 23b). Push traction unit forward (removing slack from pull arms) so center of each front wheel is on top of the line. Use a plumb bob or square to make sure each wheel is centered on the line.

   B. Measure from each end of cutting unit front roller to chalk line. Distance from each end of roller to line must be equal within 3/16 (0.187) in.

   C. Loosen jam nuts on pull arms and adjust ball sockets so distance from each end of roller to line is within 3/16 (0.187) in.

NOTE: If a cutting unit cannot be adjusted to track correctly with the traction unit, the pull frame, or lift arm is damaged and/or the lift arm and pull frame bushings are worn and must be replaced.

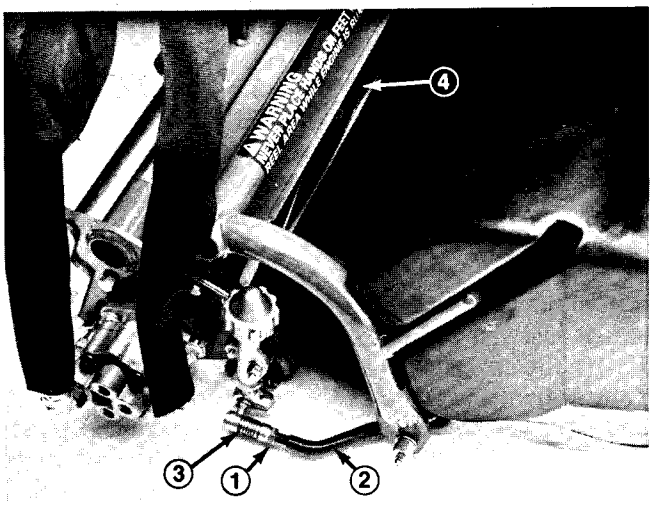


Figure 23a

1. Jam nut
2. Pull arm
3. Ball joint - adjust for clearance
4. 1/4 - 1/2 in. (6 - 13 mm) clearance

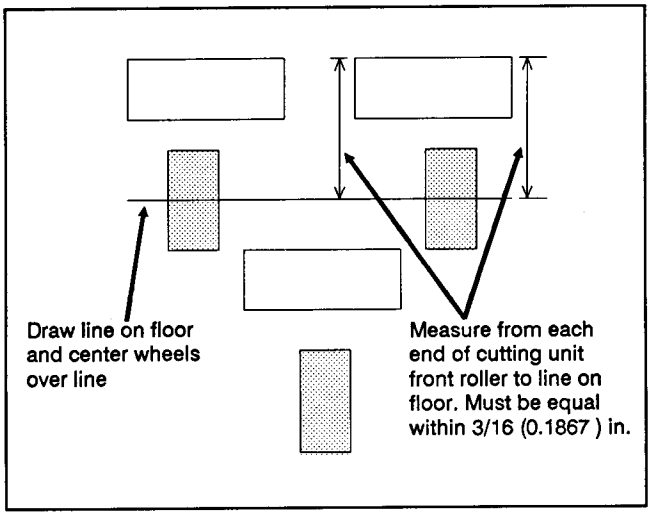


Figure 23b

1. Jam nut
2. Pull arm
3. Ball joint - adjust for clearance
4. 1/4 - 1/2 in. clearance

Cutting Unit Removal and Installation

Remove cutting unit from traction unit before doing adjustments or repairs.

1. Remove basket from pull frame.

2. Loosen reel motor mounting nuts (Fig. 24). Rotate the motor clockwise so motor flanges clear studs and pull motor off of cutting unit.

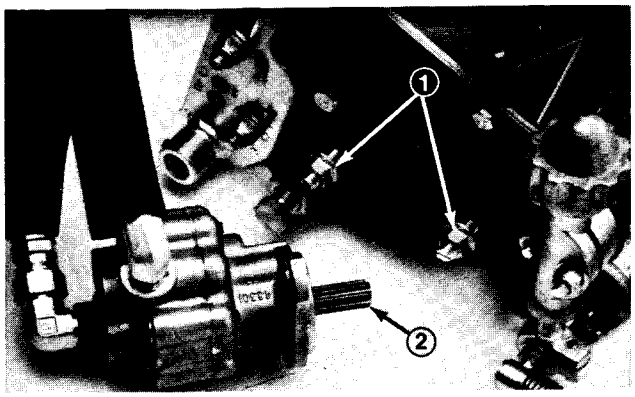


Figure 24

1. Motor mount nuts **2. Motor shaft**

3. Slide the sleeve back on the ball joint and disconnect the pull arm from each side of the cutting unit (Fig. 25).

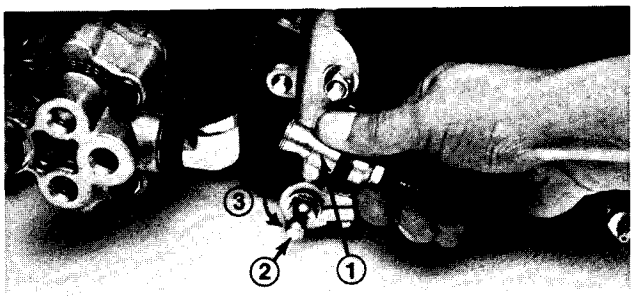


Figure 25

1. Slide back to mount
2. Ball stud
3. Swing up to remove, down to install

4. Slide cutting unit out from under pull frame, disengaging the lift arm from the lift bail (Fig. 26).

5. Reverse steps 1 - 4 to install the cutting unit.

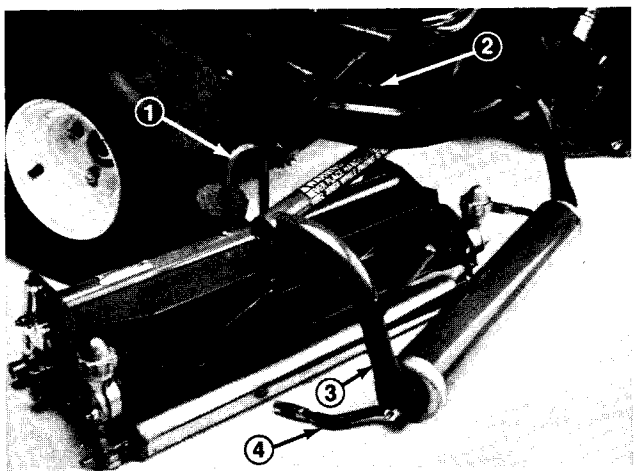


Figure 26

1. Lift bail **3. Pull frame**
2. Lift arm **4. Pull arm**

Reel Lapping

Check reel bearing adjustment and correct if necessary before backlapping. Make sure bedknife is parallel to reel. On groomer equipped cutting units, backlap by using a length of 3/8 in. square stock inserted into the center hole in the reel shaft on the reel drive motor end of the cutting unit. Attach a socket, extension and backlapping machine. Backlap according to procedures in the Toro publication "Sharpening Reel & Rotary Mowers" Form No. 80-300-PT.

NOTE: For a better cutting edge, run a file across front face of bedknife when lapping operation is completed. This will remove any burrs or rough edges that may have built up on the cutting edge.

CAUTION

Be careful when lapping the reel because contact with the reel or other moving parts can result in personal injury.

Bedbar Removal and Installation

1. Loosen pivot screws securing bedknife pivot assembly to reel frame supports (Fig. 27).

2. Rotate adjustment knob and pivot assembly clockwise (left hand thread) until it is unthreaded from bedbar pivot (Fig. 27).

3. Loosen jam nuts retaining right and left bedbar pivot bolts. Remove pivot bolts (Fig. 27).

IMPORTANT: Note position of plastic washer and steel washer on right end of bedbar, and plastic washer on left end of bedbar for reinstallation.

4. Slide bedbar down and out from under cutting unit. Do not misplace washers.

5. Replace and/or grind bedknife to renew cutting edges.

NOTE: For proper grinding of bedknife, follow procedures in the Toro publication, "Sharpening Reel and Rotary Mowers", Form No. 80-300-PT.

6. Adjust the reel bearings. (See Reel Bearing Service and Adjustment in the Adjustments section of this chapter.)

7. Grind the reel to remove any taper and renew cutting edges. (See Preparing Cutting Unit for Reel Grinding in this section of the book.)

8. Check size of hole in bedbar end bushings every time bedbar is removed. Insert flange bushing into rubber bushing (Fig. 28). Insert clean shoulder bolt into flange bushing/rubber bushing assembly. If bolt slides easily into bushing, replace all four bedbar bushings. (See Bedbar Bushing Replacement in this section of the book.)

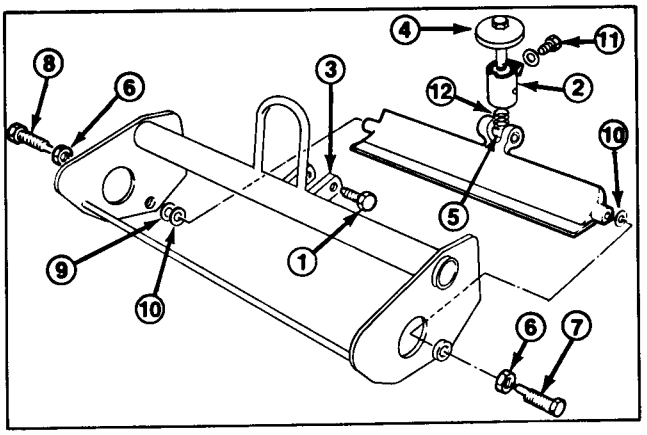


Figure 27

1. Pivot screw
2. Bedknife pivot ass'y
3. Frame supports
4. Adjustment knob
5. Bedbar pivot
6. Jam nuts
7. Left bedbar pivot bolt
8. Right bedbar pivot bolt
9. Steel washer
10. Plastic washer
11. Spring arm retaining capscrew
12. Compression spring

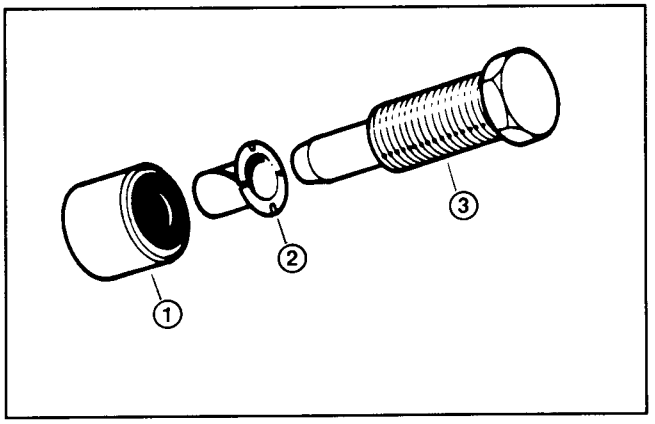


Figure 28

1. Rubber bushing
2. Flange bushing
3. Shoulder (pivot) bolt

9. With frame on level surface and pivot set screws installed, measure from flat surface up to end of each setscrew (Fig. 29). If not within 1/16 in. of each other, carefully bend frame supports to line up screws. Remove pivot set screws. Measure distance between frame pivot supports (Fig. 29). If dimension is not between 1-9/16 in. and 1-5/8 in., carefully bend supports until correct.

10. To install bedbar, slide it into position between side plates, making sure each end of bedbar is under shield (Fig. 30).

IMPORTANT: Always use McLUBE (Toro Part No. 505-35) on bedbar pivot and pivot bolts.

11. Install jam nut on eccentric pivot bolt. Put plastic washer between left side of bedbar and side plate. Thread pivot bolt into side frame until distance from top of pivot bolt to side plate is 1-5/16 in. with identification dot toward the rear (Fig. 31). Do not tighten jam nut.

12. Install jam nut on straight pivot bolt. Put plastic washer and steel washer between right side of bedbar and side plate with plastic washer closest to bedbar. Thread pivot bolt into side plate. Adjust right-hand pivot bolt until left end of bedbar firmly seats against the plastic washer and side plate, clamping the plastic washer snugly. This removes end-play from bedbar. Bedbar must pivot without binding. Hold right-hand pivot bolt to keep it from moving and tighten jam nut.

IMPORTANT: Apply NEVER-SEEZ or equivalent to the threads of the handle assembly.

13. Thread adjustment knob and pivot assembly into flat side of bedbar pivot (left-hand thread). Make sure there is an equal gap between each side of pivot assembly housing and frame supports (Fig. 32). Adjust (before installing pivot screws) by sliding bedbar pivot sideways.

IMPORTANT: On hand-adjustable knobs, check to make sure die spring is compressed to 13/16 in. by tightening locknut (left-hand thread).

14. If equipped with hex head type pivot screws, tighten pivot screws to 60 ft-lb. If equipped with hex socket head set screws and jam nuts, tighten set screws finger tight, then tighten an additional 1/2 turn (total - not each). Tighten jam nuts.

15. Secure spring arm to pivot assembly. If spring arm is adjustable, adjust upward until a solid clicking sound is achieved when adjusting knob is turned.

16. Level bedknife to reel. Level rear roller to reel. Set height of cut. If necessary, backlap to get desired fit between reel and bedknife.

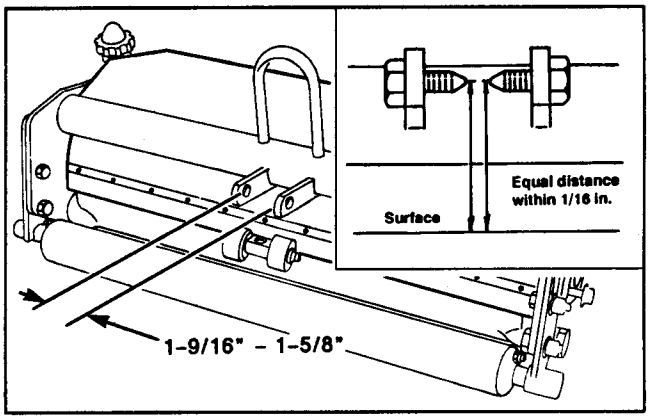


Figure 29

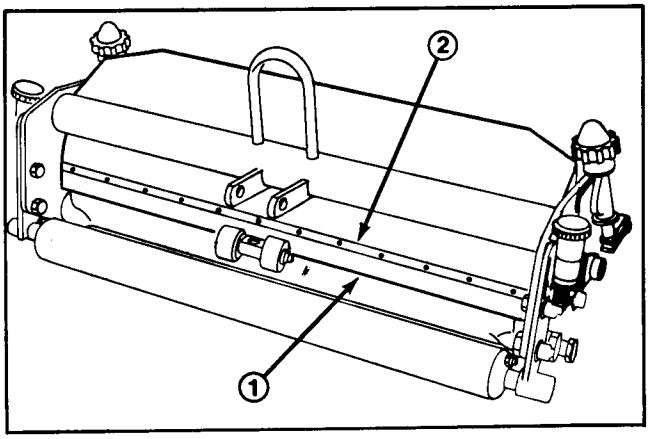


Figure 30

1. Bedbar **2. Shield**

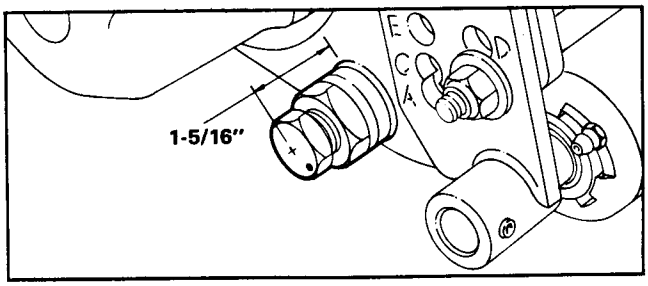


Figure 31

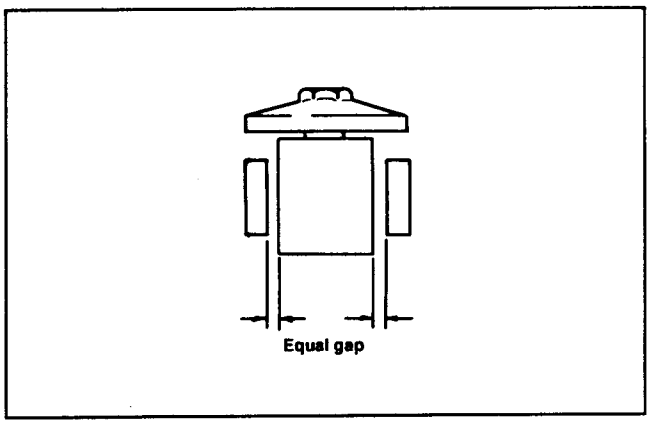


Figure 32

Bedbar Bushing Replacement

NOTE: Only after making sure that all normal cutting unit adjustments are correct, should the bushings be suspected as causing quality of cut problems.

The bedbar end bushings and pivot bushings (Fig. 33) contain rubber and are exposed to severe conditions. It is recommended to replace these bushings and the plastic flange bushings every two years.

1. Do steps 1 - 4 under Bedbar Removal and Installation in this section of the book.

2. Remove bedbar end bushings with a punch and hammer (Fig. 34). Alternate from one side to other on bushing (there are two slots in bedbar bushing boss).

IMPORTANT: Apply "Never-Seez" or equivalent to outside surface of bedbar end bushings and pivot bushings before installing in bedbar.

3. Press end bushings into bedbar far enough so plastic sleeve collar is below bedbar end face (Fig. 35).

NOTE: Bedbar end bushings have less rubber and more steel which is visible than bedbar pivot bushings. Do not use bedbar end bushings in the pivot area as they are too rigid.

4. Use an arbor press to remove bedbar pivot bushings (Fig. 36). DO NOT hammer on pivot boss of bedbar without support. You will break the casting.

5. Press center pivot bushings into place (Fig. 36). DO NOT hammer on pivot boss of bedbar without support. You will break the casting.

6. Do steps 5 - 16 under Bedbar Removal and Installation in this section of the book.

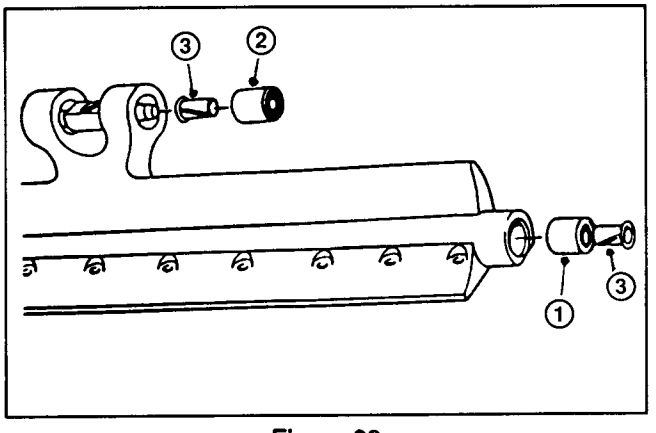


Figure 33

1. Bedbar end bushing (2)
2. Bedbar pivot bushing (2)
3. Flange bushing (4)

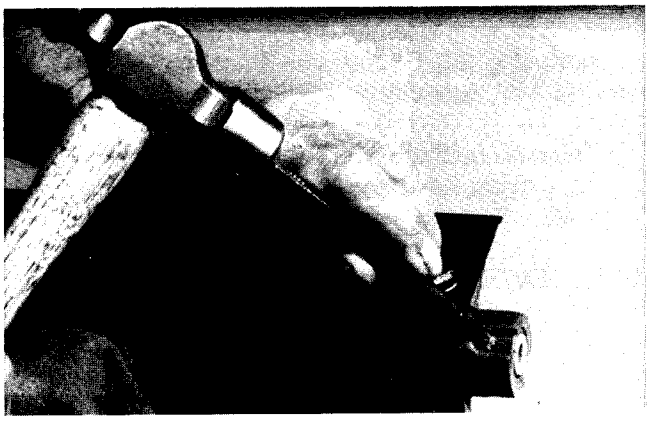


Figure 34

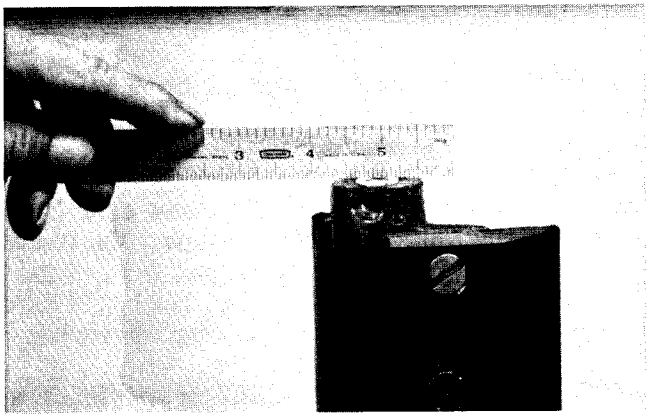


Figure 35

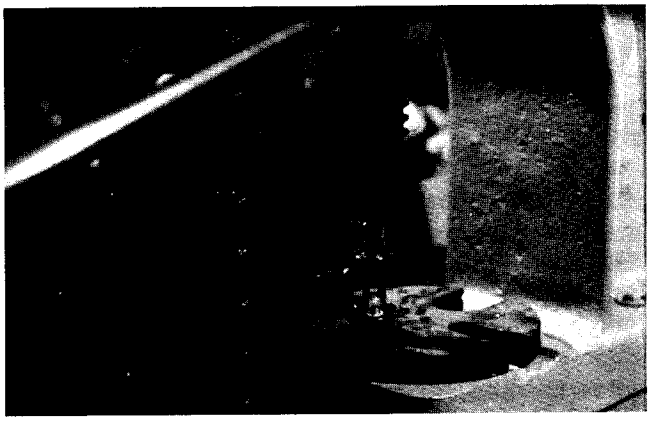


Figure 36

Bedknife Replacement

1. Do steps 1 - 4 under Bedbar Removal and Installation in this section of the book.

2. Remove bedknife screws and remove bedknife.

3. Remove all rust, scale and corrosion from bedbar surface before installing new bedknife.

4. Install new bedknife with the proper bedknife screws (57-4910). Bedknife screws must bottom out on bedknife, not bedbar. Tighten screws to a torque of 200 in-lb, working from the center toward each end of the bedbar (Fig. 37).

5. Grind new bedknife to match it to bedbar.

NOTE: For proper grinding of bedknife, follow procedures in the Toro publication "Sharpening Reel and Rotary Mowers", Form No. 80-300-PT..

6. Do steps 6 - 16 under Bedbar Removal and Installation in this section of the book.

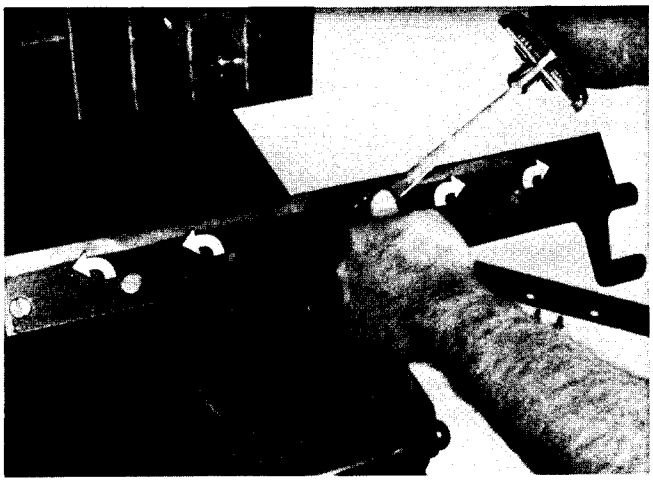


Figure 37

Preparing Cutting Unit for Reel Grinding

IMPORTANT: Adjust reel bearings before grinding reel. (See Reel Bearing Service and Adjustment in the Adjustments section of this chapter

1. Do steps 1 - 6 under Bedbar Removal and Installation in this section of the book.

NOTE: Some reel grinders require rear roller assembly be mounted to cutting unit for proper support in reel grinder. Rear roller must be parallel to reel shaft to remove taper when grinding.

2. Raise or remove front roller assembly.

   A. Loosen locknuts securing height of cut adjusting rods at both ends of cutting unit and roller shaft clamp bolts (Fig. 38).

   B. Turn height of cut adjustment knobs to raise rollerr out of the way or remove roller if necessary.

For proper grinding of reel, follow procedures in the Toro publication "Sharpening Reel and Rotary Mowers Form No. 80-300-PT.

3. Do steps 8 - 16 under Bedbar Removal and Installation in this section of the book. After grinding, assemble cutting unit, check bearing adjustment and adjust top shield and bar. Back lap if necessary to get desired fit between reel and bedknife.

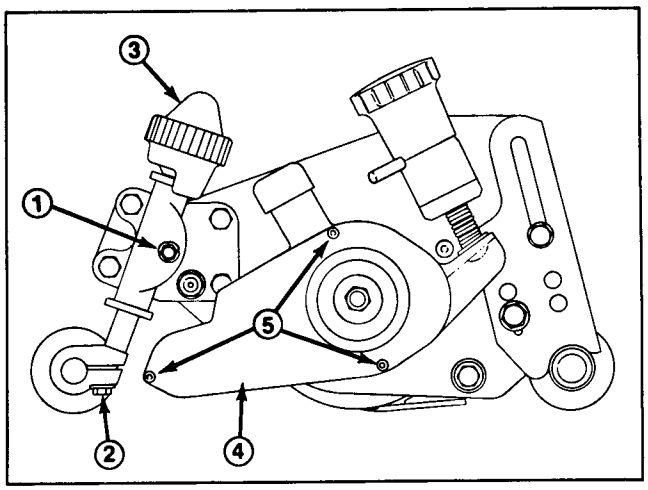


Figure 38

1. Height of cut locknut
2. Roller shaft clamp bolt
3. Height of cut knob
4. Grooming reel cover
5. Cover screws and washers

Reel Removal and Bearing Replacement

1. Do steps 1 - 4 under Bedbar Removal and Installation in this section of the book.

2. Loosen two (2) set screws and remove clutch knob. Remove groomer reel housing cover from left side of cutting unit (Fig. 39).

3. Remove grooming reel adjustment knob assembly from groomer housing (Fig. 40).

CAUTION

Adjustment knob assembly is spring loaded.

4. Loosen idler pulley (Fig. 40). Remove nut and washer from clutch adapter shaft. Pull clutch assembly off adapter shaft and slide belt off driven pulley. Remove clutch adapter from reel shaft (Fig. 49).

5. Remove driven pulley from groomer shaft (left-hand thread) (Fig. 40).

6. Remove two (2) locknuts and flat head socket screws to remove bearing adapter and left side groomer housing (Fig. 41).

7. Remove locknut from the right end of groomer reel shaft to remove groomer reel. Remove grooming reel adjustment knob assembly from right side groomer plate assembly (Fig. 42).

8. Remove two (2) flange locknuts (reel motor mounting nuts). Remove two (2) inside locknuts. Use a stud removal tool or double nuts to remove special studs. Remove groomer bearing adapter and right side groomer plate (Fig. 42).

9. Remove bearing adjustment locknut from left end of reel shaft. Remove spline nut from right end of reel shaft.

IMPORTANT: Remove grease fittings from bearing housing at each end of cutting unit. Note that the straight fitting is on the right end, and 90° fitting at the left end (when viewed in the direction of travel).

10. Use a soft face hammer to rotate each bearing housing slightly. Install bolts from outside of housings and turn bolts alternately against side plate to remove bearing housings (Fig. 43). Bearing housings will slip out of side plates. Reel can be removed as soon as bearing housings are disassembled from side plates.

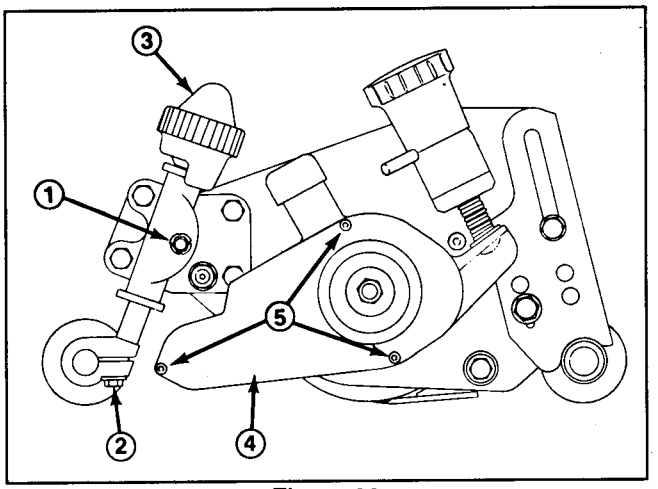


Figure 39

1. Height of cut locknut
2. Roller shaft clamp bolt
3. Height of cut knob
4. Grooming reel cover
5. Cover screws & washers

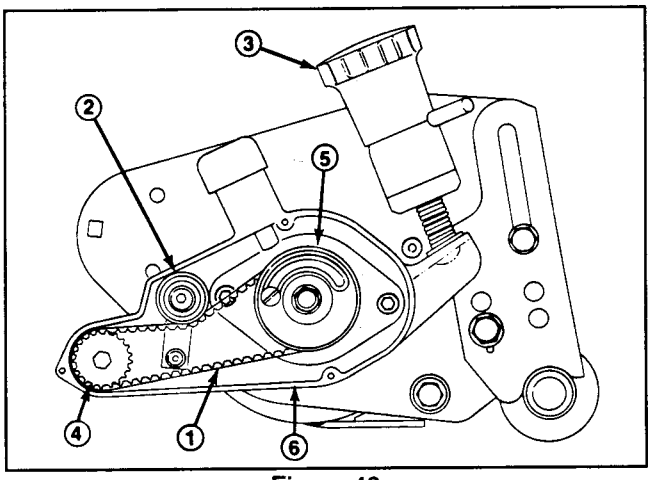


Figure 40

1. Drive belt
2. Drive belt idler pulley
3. Grooming reel adjustment knob assembly
4. Groomer driven pulley
5. Clutch assembly
6. Groomer reel housing

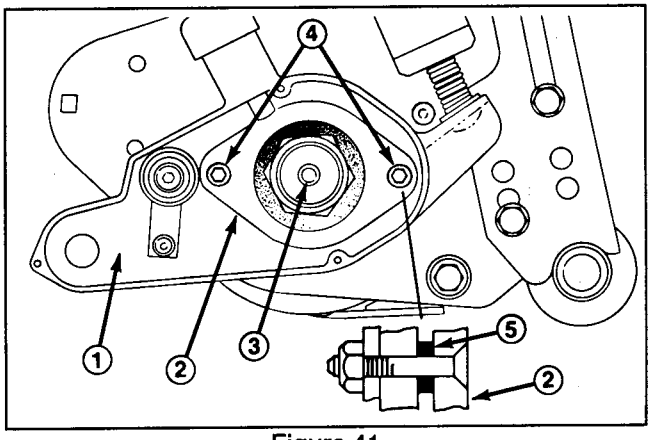


Figure 41

1. Left side groomer housing
2. Bearing adapter
3. Reel bearing adjustment nut
4. Flat head screws
5. Spacer

11. If necessary, install new bearings and seals:

A. Remove bearing cup, bearing cone and inner seal.

B. Bearing housing must be completely free of paint and foreign material before installing bearing cup. If necessary remove any "flash" from bearing housing that may interfere with accurate seating of bearing. Install inner seal. Install bearing cup.

C. Install bearing housing to frame. Pack bearing cone with grease and install over reel shaft into bearing cup.

12. After installing reel, tighten spline nut to 40 - 60 ft-lb, then adjust bearings (See Reel Bearing Service and Adjustment in the Adjustments section of this chapter.)

Use Loctite 271 on spline nut threads.

13. Install right side groomer plate assembly and bearing adapter. Use a stud installation tool or double nuts to tighten two (2) special studs to 17 - 21 ft-lb. Make sure a spacer is installed over each stud between groomer bearing adapter and reel bearing housing. Tighten two (2) inside locknuts to 23 - 27 ft-lb. Install two (2) flange locknuts (reel motor mounting nuts). (Fig. 42).

14. Install grooming reel adjustment knob assembly to right side groomer plate assembly (Fig. 42). Install groomer reel shaft to right side groomer plate assembly and install locknut on right end of groomer shaft.

15. Install left side groomer housing and bearing adapter (Fig. 41). Install two (2) flat head socket screws and tighten to 17 - 21 ft-lb. Make sure a spacer is installed over each flat head socket screw between groomer bearing adapter and reel bearing housing. Install two (2) locknuts and tighten to 23 - 27 ft-lb.

16. Install groomer reel driven pulley to groomer reel shaft (left-hand thread) and tighten to 29 - 35 ft-lb (Fig. 40).

17. Install clutch adapter on reel shaft and tighten to 170 - 210 in-lb (Fig. 49). Hold belt on drive pulley and slide clutch assembly on clutch adapter while sliding belt onto driven pulley (Fig. 40). Install washer and nut (removed in step 4) on clutch adapter shaft. Use a block of wood to keep reel from rotating and tighten nut to a torque of 7 - 10 ft-lb.

18. Install grooming reel adjustment knob assembly to left side groomer housing (Fig. 40).

19. Adjust belt tension. (See Groomer Reel Drive Belt Adjustment in the Adjustments section of this book.) Install groomer reel housing cover (Fig. 39). Install clutch knob and tighten two (2) set screws against flats of clutch release disk.

20. Do steps 5 - 16 under Bedbar Removal and Installation in this section of the book.

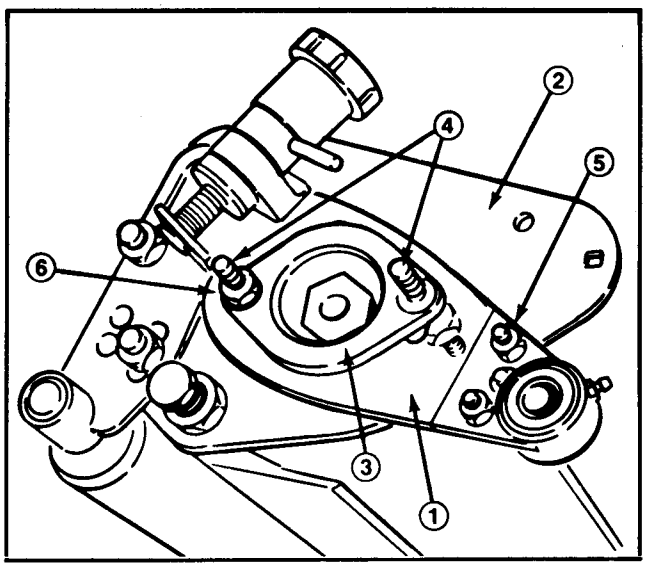


Figure 42

1. Right side groomer plate ass'y
2. Right reel frame plate
3. Groomer bearing adapter
4. Special stud (2)
5. Inside locknut (2)
6. Flange locknut (2)

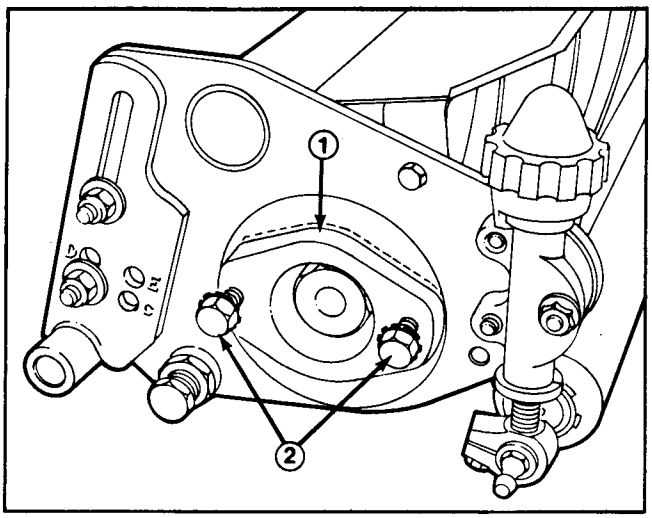


Figure 43

1. Bearing housing
2. Bolt

Groomer Reel Blade Service

Inspect grooming reel blades frequently for damage and wear. Straighten bent blades with a pliers. Either replace worn blades or reverse the grooming reel shaft to put the sharpest blade edge forward (Fig. 44). (See Groomer Reel Removal and Installation in this section of the book.). During blade inspection procedures, check to make sure the right and left blade shaft end nuts are tight.

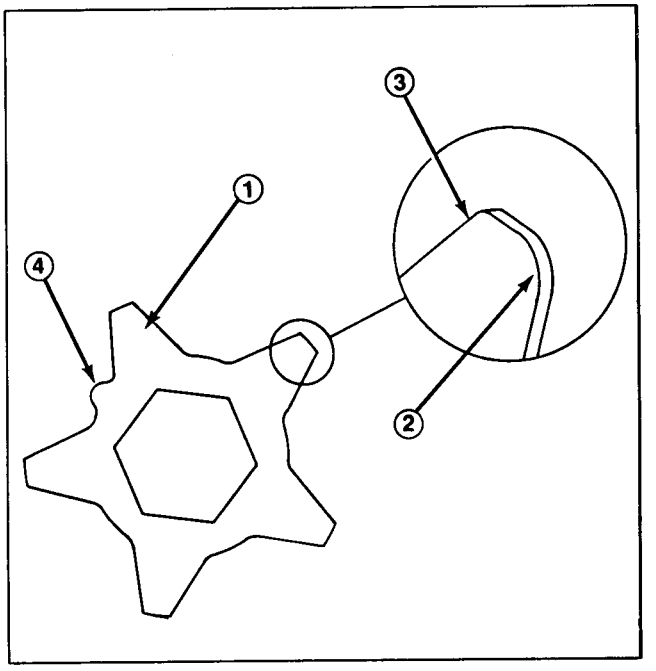


Figure 44

1. Grooming blade
2. Dull rounded edge
3. Sharp edge
4. Location mark

Groomer Reel Drive Belt Replacement

1. Loosen two (2) set screws and remove clutch knob (Fig. 6). Remove groomer reel housing cover from left side of cutting unit (Fig. 39).

2. Loosen the backside idler pulley pivot screw (Fig. 45). Pivot idler to loosen and remove belt.

3. Install the belt. The belt should have a deflection of 1/4 in. when 5 - 10 lb. of force is applied midway between the pulleys. Pivot the idler to get proper tension and tighten the allen head screw to a torque of 7 - 10 ft-lb.

4. Install groomer reel housing cover. Install clutch knob and tighten two (2) set screws against flats on release disk.

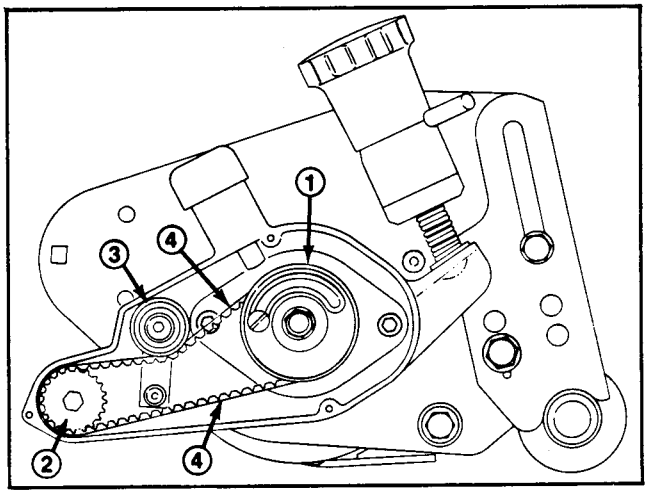


Figure 45

1. Drive pulley and clutch assembly
2. Driven pulley
3. Drive belt (backside) idler pulley
4. Drive belt

Groomer Reel Removal and Bearing Service

1. Loosen two (2) set screws and remove clutch knob (Fig. 6). Remove groomer reel housing cover from left side of cutting unit (Fig. 39).

2. Loosen the backside idler pulley pivot screw (Fig. 45). Pivot idler to loosen and remove belt.

3. Remove groomer driven pulley from groomer reel shaft (left-hand thread) (Fig. 45).

4. Remove locknut from right end of groomer reel shaft (Fig. 46a).

5. Remove three (3) screws and nuts securing bearing housing to right side groomer plate (Fig. 46a). Remove right side bearing bracket from groomer reel shaft. Remove groomer reel shaft from bearing support in left side groomer housing (Fig. 46b).

6. Check condition of groomer shaft bearings and replace if necessary (Fig. 47). Bearings must be installed with seal facing out on each side of bearing housing. For each groomer housing (R.H. and L.H.), install outer bearing and spacer first. Install inner bearing so it is flush with the housing (Fig. 47)

7. To replace groomer reel blades, remove locknut on each end of groomer reel shaft. Remove blades and spacers. Install new blades and previously removed spacers. Install locknut on each end of groomer shaft to secure blades and spacers.

NOTE: Spacers are available for 1/4 in. (76 blades) or 3/4 in. (26 blades) blade spacing.

8. Reverse steps 1 - 5 to install groomer reel. Check drive belt tension before installing cover. (See Groomer Reel Drive Belt Replacement in this section of the book.)

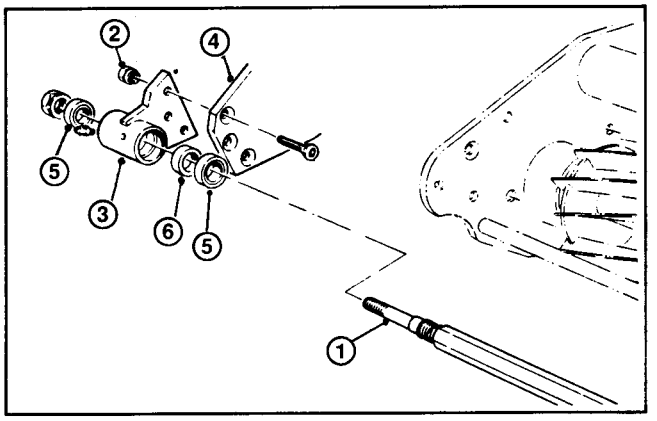


Figure 46a

1. Groomer reel shaft
2. Locknut
3. R.H. groomer housing
4. R.H. groomer plate
5. Bearing
6. Bearing spacer

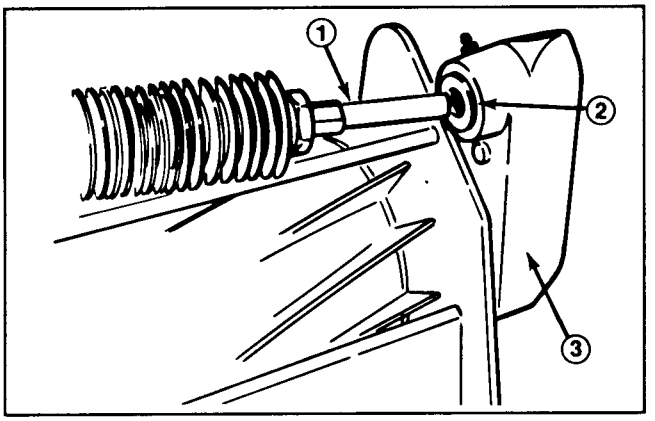


Figure 46b

1. Groomer reel shaft
2. Bearing
3. L.H. groomer housing

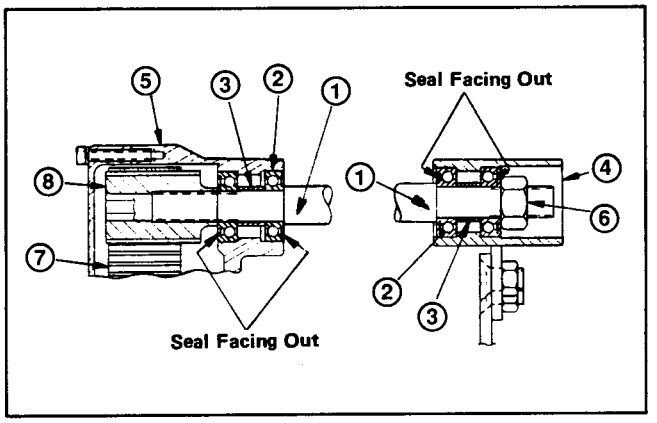


Figure 47

1. Groomer reel shaft
2. Bearing (4)
3. Bearing spacer (2)
4. R.H. groomer housing
5. L.H. groomer housing
6. Locknut
7. Belt
8. Driven gear

Groomer Reel Clutch Service

CAUTION

Do not use your hand to prevent reel from turning while servicing; this can result in personal injury. Use a 1/2 in. thick x 3 in. wide x 8 in. long piece of hardwood inserted into front of cutting unit between reel blades.

Removal and Disassembly

1. Loosen two (2) set screws and remove clutch knob (Fig. 51). Remove groomer reel housing cover from left side of cutting unit (Fig. 39).

2. Loosen idler pulley pivot screw (Fig. 45). Pivot idler to loosen belt.

3. Remove nut and washer from clutch adapter shaft (Fig. 51). Pull clutch assembly off adapter shaft and slide belt off driven pulley.

5. Remove clutch adapter from reel shaft if necessary (Fig. 49).

6. To disassemble clutch, remove special screw and clutch pin (Fig. 51).

IMPORTANT: The special screw and clutch pin were assembled using "Loctite 271". It will be necessary to apply heat to these parts before disassembly.

7. Check condition of roller bearing and needle bearing (Fig. 51). Replace bearings if worn or damaged.

Installation and Assembly (New Clutch Assembly)

1. Loosen two (2) set screws and remove clutch knob from new clutch assembly (Fig. 48). Use a block of wood to keep the reel from rotating and remove nut and washer from clutch adapter shaft (Fig. 48)

2. Pull clutch adapter out of new clutch assembly and install on reel shaft. Tighten clutch adapter to a torque of 170 - 210 in-lb.

3. Hold belt on drive pulley of clutch and slide clutch on clutch adapter while sliding belt on driven pulley.

IMPORTANT: If clutch has come apart since nut and washer were removed in step 1, make sure belleville washers are installed as shown in Figure 50.

4. Install washer and nut (removed in step 1) on clutch adapter shaft and tighten nut to a torque of 7 - 10 ft-lb.

5. Adjust belt tension. (See Groomer Reel Drive Belt Adjustment in the Adjustments section of this book.) Install groomer reel housing cover (Fig. 39). Install clutch knob and tighten two (2) set screws against flats of clutch release disk.

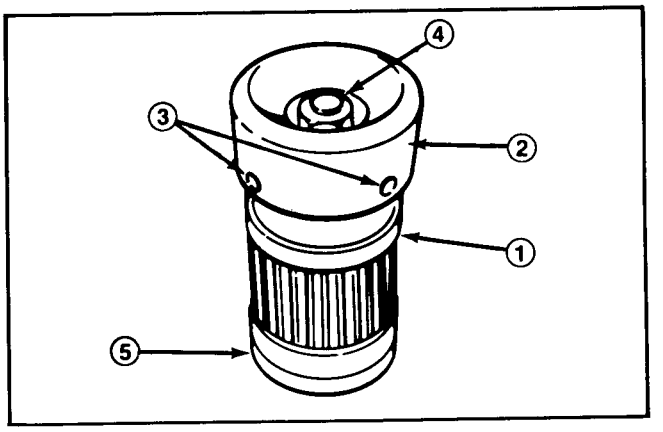


Figure 48

1. **Belt drive clutch assembly**
2. **Clutch engage / disengage knob**
3. **Allen head set screw (2)**
4. **Nut and washer**
5. **Clutch adapter shaft**

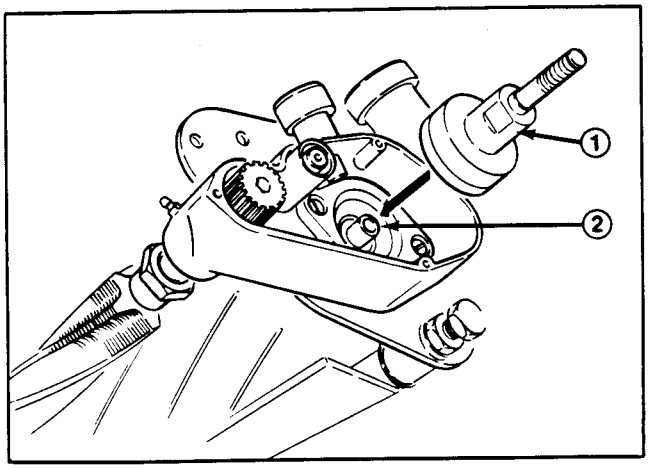


Figure 49

1. **Clutch adapter shaft**
2. **Reel shaft**

Installation and Assembly (Disassembled Clutch)

1. Pack bearings and area inside clutch body with No. 2 multi-purpose lithium base grease.

IMPORTANT: When assembling clutch, make sure belleville washers are installed correctly (Fig. 50).

2. Apply thick coating of grease to special screw (do not get on threads) and cam surface of clutch release disk. Apply "Loctite 271" or equivalent to threads of special screw before assembling to clutch pin. Assemble so clutch pin is 0.240 - 0.260 in. out from face of clutch body when pin is in fully extended position.

3. Install clutch adapter to reel shaft (Fig. 49). Tighten clutch adapter to a torque of 170 - 210 in-lb.

4. Hold belt on drive pulley of clutch and slide clutch on clutch adapter while sliding belt on driven pulley. Install washer and nut on clutch adapter shaft and tighten nut to a torque of 7 - 10 ft-lb.

5. Adjust belt tension. Install groomer reel housing cover (Fig. 39). Install clutch knob and tighten two (2) set screws against flats of clutch release disk.

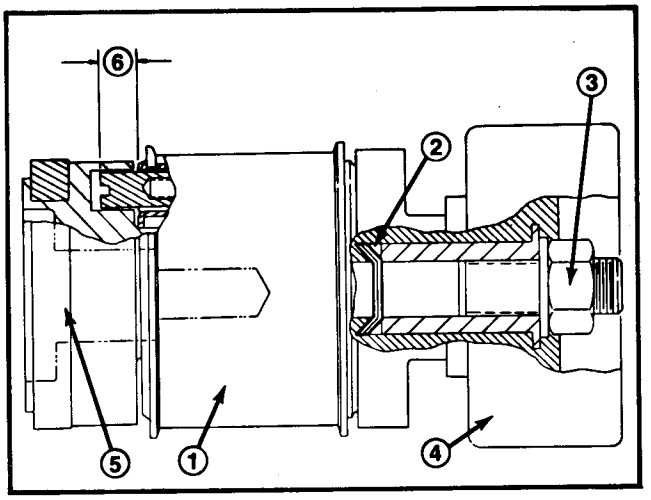


Figure 50

1. Clutch body/drive pulley
2. Belleville washer (2)
3. Nut and washer
4. Clutch engage/disengage knob
5. Clutch adapter
6. 0.250 in. ± 0.10 (pin extended)

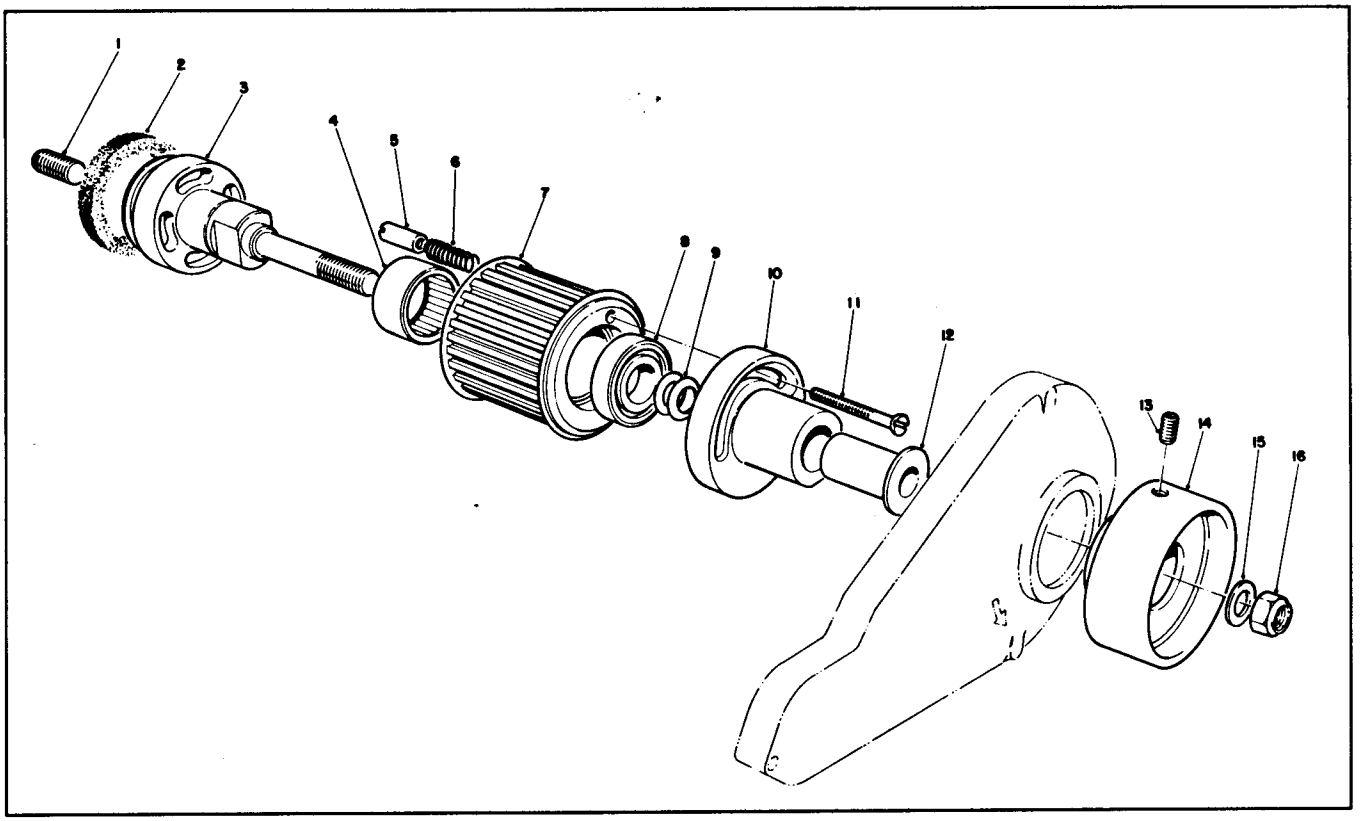


Figure 51

1. Set screw
2. Felt seal
3. Clutch adapter
4. Needle bearing
5. Clutch pin
6. Compression spring
7. Clutch body/drive pulley
8. Roller bearing
9. Belleville washer (2)
10. Clutch release disk
11. Special screw
12. Flange bushing
13. Set screw
14. Clutch knob
15. Flat washer
16. Lock nut

Bedknife to Reel Adjustment Knob Bearing Service

1. Turn bedknife adjustment knob counterclockwise to remove bedknife to reel contact.

2. Remove two (2) pivot screws (Fig. 38).

3. Rotate adjustment knob and pivot assembly clockwise (left-hand thread) until it is unthreaded from the bedbar pivot.

4. If necessary, remove locknut securing die spring to shaft (Fig. 6b). Slide pivot housing off adjustment knob threaded shaft (Fig. 38).

5. Pull inner races from pivot housing. Pull bearings from pivot housing. Check condition of inner races and bearings and replace if necessary.

6. Install new o-ring on each race if necessary.

7. Install bearings and races in pivot housing. Slide pivot housing onto shaft of knob.

8. Install spring over adjusting knob threaded shaft and thread adjustment knob and pivot assembly into flat side of bedbar pivot. Make sure there is an equal gap between each side of pivot assembly housing and frame supports (Fig. 29). Adjust (before installing pivot screws) by sliding bedbar pivot sideways.

IMPORTANT: On hand-adjustable type knobs, check to make sure die spring is compressed to a dimension of 13/16 in. by tightening locknut (left-hand thread) (Fig. 6b).

9. If equipped with hex head type pivot screws, tighten pivot screws to 60 ft-lb. If equipped with hex socket head set screws and jam nuts, tighten set screws finger tight then tighten 1/2 turn more (total - not each). Tighten jam nut.

10. Adjust bedknife to reel contact.

NOTE: If quality of cut has deteriorated or the reel and bedknife have become "rifled" , you must grind the reel and bedknife to remove rifle pattern.

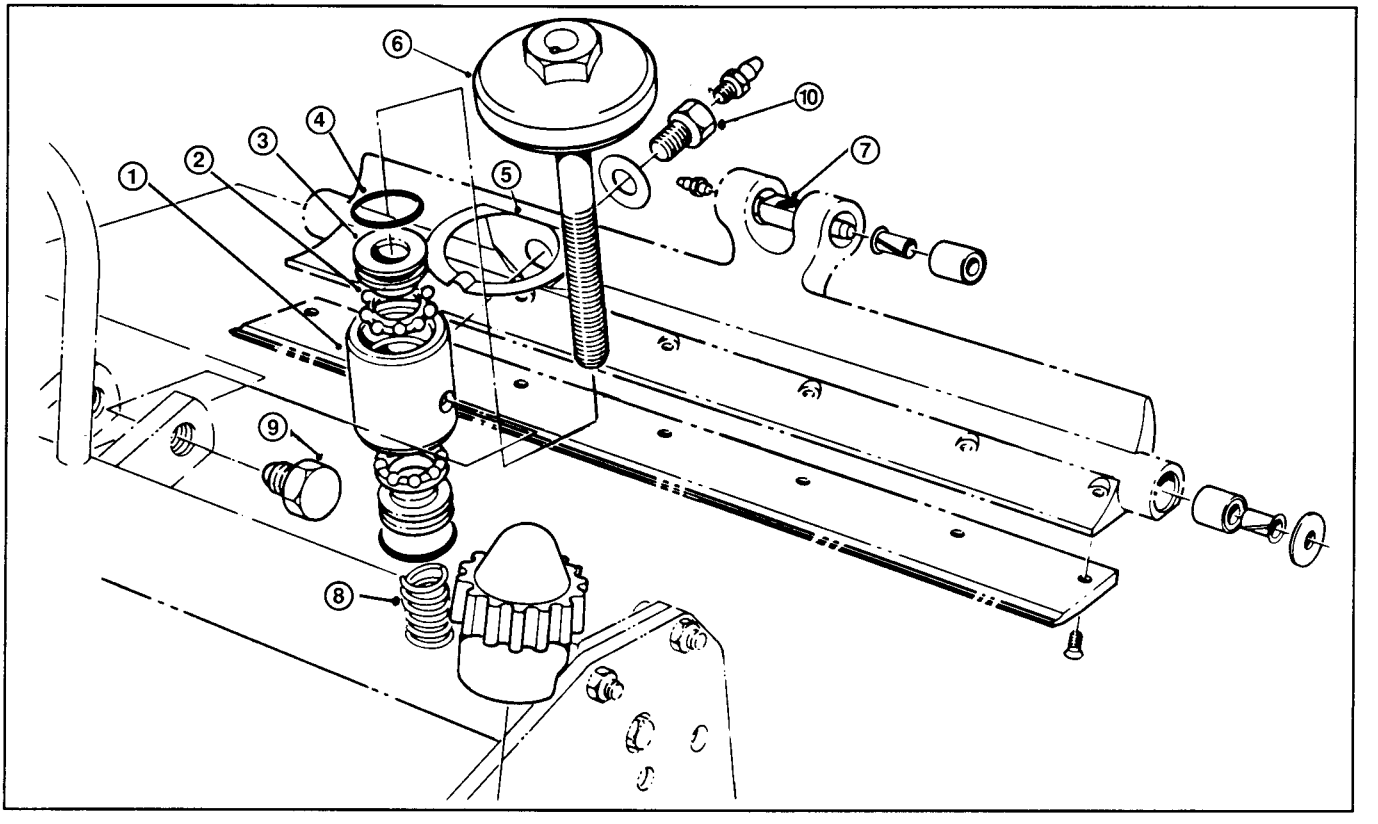


Figure 52

1. Pivot housing
2. Bearing (2)
3. Inner race (2)
4. O-ring (2)
5. Spring arm
6. Adjustment knob
7. Bedbar pivot
8. Spring
9. Pivot screw (2)
10. Spring arm retaining capscrew

Lift Bail Replacement

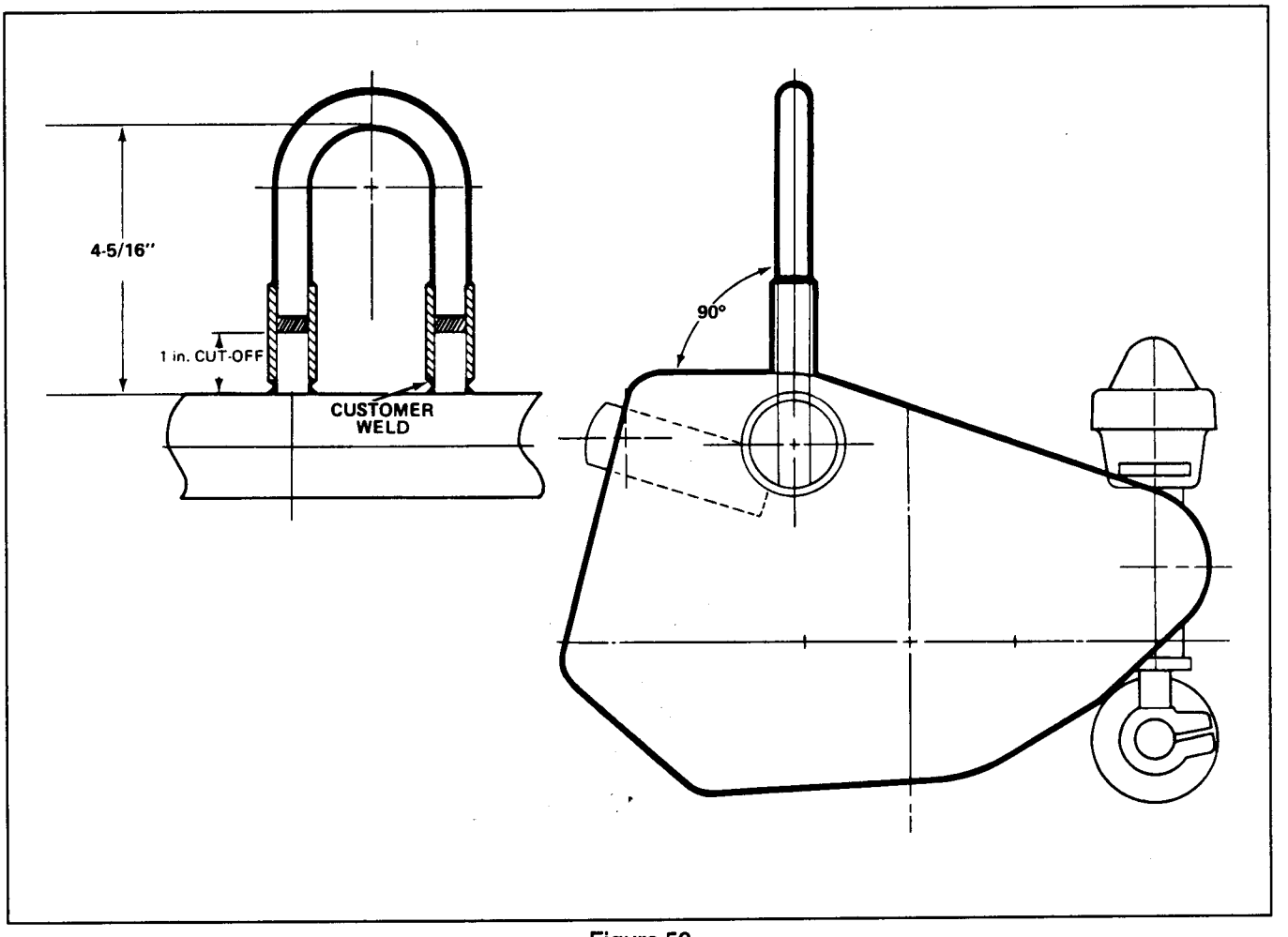


Figure 53

1. Use a saw to cut the lift bail off of the cutting unit. Make the cut 1 inch from the horizontal frame tube (Fig. 53).

2. Use a grinder to remove burrs from the stubs of the lift bail remaining on the cutting unit.

3. Install the repair lift bail (Part No. 71-1600).

4. Support the lift bail so the bottom radius is 4 5/16 inches from the top of the horizontal frame tube. Make sure the lift bail is square to the side frame.

5. Weld all around the bottom of the repair lift bail with mild steel rod, both sides.

Commercial Products Division

Form 89-740-ST

Printed in U.S.A.