Part No. 92801SL, Rev. I

Service Manual

Groundsmaster® 300 Series

Preface

Groundsmaster 328-D

Use this book along with the Toro Operator's Manual and Parts Catalog for the specific model and serial number of the machine, and the Kubota 05 Series Workshop Manual.

This publication will provide the service technician with information for troubleshooting, testing, and repair of major systems and components on the Groundsmaster 345, 322-D and 325-D (Model 30788 and 30795).

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

Table Of Contents

Chapter 1 - Safety

Safety Instructions . . . . 1 - 1

Chapter 2 - Product Records and Manuals

Product Records. . . . . 2 - 1
Equivalents and Conversions. . . . . 2 - 2
Torque Specifications . . . . 2 - 3
Maintenance Interval Charts. . . . . 2 - 4
Equipment Operational and
Service Historical Report Record

Chapter 3 - Ford VSG-411 Gasoline Engine

Specifications . . . . 3 - 1
General Information . . . . 3 - 2
Adjustments . . . . 3 - 3
Repairs . . . . 3 - 6
FORD VSG-411/413 ENGINE SERVICE MANUAL

Chapter 4 - Mitsubishi K3D Diesel Engine

Introduction. . . . . 4 - 2
Specificationis. . . . . 4 - 3
Special Tools . . . . 4 - 11
Adjustments . . . . 4 - 13
Troubleshooting . . . . 4 - 15
Testing . . . . 4 - 18
Preparation for Engine Repair . . . . 4 - 25
External Engine Component Repair. . . . . 4 - 26
Fuel System Repairs . . . . 4 - 34
Removing and Installing the Engine. . . . . 4 - 46
Cylinder Head Overhaul. . . . . 4 - 47
Cylinder Block Overhaul. . . . . 4 - 53

Chapter 4A - Kubota Diesel Engine

General Information . . . . 4 - 2
Specificationis. . . . . 4 - 3

Chapter 5 - Hydraulic System

Specifications . . . . 5 - 2
General Information . . . . 5 - 3
Hydraulic Schematics. . . . . 5 - 6
Hydraulic Flow Diagrams . . . . 5 - 7
Special Tools . . . . 5 - 10
Troubleshooting . . . . 5 - 12
Testing . . . . 5 - 18
Adjustments . . . . 5 - 22
Repairs . . . . 5 - 26

Chapter 6 - Electrical System

Wiring Schematics . . . . 6 - 2
Special Tools. . . . . 6 - 3
Troubleshooting (Groundsmaster 345) . . . . 6 - 6
Troubleshooting (Groundsmaster 322-D/325-D) . . . . . 6 - 12
Testing . . . . 6 - 18
Repairs . . . . 6 - 30

Chapter 6A - Electrical System (S/N 21000000 & Up)

Wiring Schematics . . . . 6 - 1
Special Tools. . . . . 6 - 2
Electrical System Quick ChecksT. . . . . 6 - 3
Component Identification and Testing. . . . . 6 - 4
Service and Repairs . . . . 6 - 12

Chapter 7 - Differential Axle

Introduction. . . . . 7 - 1
Specifications . . . . 7 - 2
Repairs . . . . 7 - 3

Chapter 8 - Steering and Brakes

Introduction. . . . . 8 - 1
Schematics. . . . . 8 - 3
Specifications . . . . 8 - 4
Special Tools. . . . . 8 - 4
Troubleshooting . . . . 8 - 5
Testing . . . . 8 - 7
Adjustments . . . . 8 - 9
Repairs . . . . 8 - 11

Chapter 9 - Transmission Coupler and PTO

Introduction. . . . . 9 - 2
Troubleshooting . . . . 9 - 3
Adjustments . . . . 9 - 4
Repairs . . . . 9 - 7

Chapter 10 - 4WD Rear Axle
(GM322-D or GM325-D with Inasaka axle)

Specifications . . . . 10 - 2
General Information . . . . 10 - 3
Adjustments . . . . 10 - 4
Repairs . . . . 10 - 5

Chapter 10.1 - 4WD Rear Axle
(GM325-D or GM328-D with Dae Dong axle)

Specifications . . . . 10 - 2
Adjustments . . . . 10 - 3
Repairs . . . . 10 - 4

Chapter 11 - 72″ Cutting Units

Specifications . . . . 11 - 2
General Information. . . . . 11 - 3
Troubleshooting . . . . 11 - 4
Adjustments. . . . . 11 - 5
Repairs . . . . 11 - 8

Chapter 12 - Triflex® 88″ Cutting Unit

Specifications . . . . 12 - 2
General Information. . . . . 12 - 3
Troubleshooting . . . . 12 - 4
Adjustments. . . . . 12 - 5
Repairs . . . . 12 - 13

Chapter 13 - Guardian® 72″ Recycler® Cutting Unit

Specifications . . . . 13 - 2
Troubleshooting . . . . 13 - 3
Adjustments. . . . . 13 - 4
Repairs . . . . 13 - 7

Chapter 1

Safety

SAFETY INSTRUCTIONS 1
Before Operating 1
While Operating. 2
While Doing Maintenance, Troubleshooting, Testing, Adjustments or Repairs 3

Safety Instructions

The Groundsmaster 300 Series was tested and certified by TORO for compliance with the B71.4 1984 specifications of the American National Standards Institute. Although hazard control and accident prevention partially are dependent upon the design and configuration of the machine, these factors are also dependent upon the awareness, concern, and proper training of the personnel involved in the operation, transport, maintenance, and storage of the machine.

CAUTION

Improper operation, maintenance, troubleshooting, testing, adjustments or repairs of the machine can result in injury or death. To reduce the potential for injury or death, comply with the following safety instructions.

Before Operating

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

   The Toro Company
   8111 Lyndale Avenue South
   Minneapolis, Minnesota 55420

2. Never allow children to operate the machine. Do not allow adults to operate the machine without proper instruction. Only trained operators, skilled in slope operation and who have read the Operator's Manual should operate this machine.

3. Never operate machine when under the influence of drugs or alcohol.

4. Remove all debris or other objects that might be picked up and thrown by cutter blades or fast moving components from other attached implements. Keep all bystanders away from the operating area.

5. Keep all shields and safety devices in place. If a shield, safety device, or decal is defective or damaged, repair or replace it before operating the machine. Also, tighten any loose nuts, bolts, and screws to make sure machine is in safe operating condition.

6. Do not wear loose fitting clothing because it could get caught in moving parts. Always wear long pants and substantial shoes. Wearing safety glasses, safety shoes, and a helmet is advisable and required by some local ordinances and insurance regulations.

7. Be sure interlock switches are adjusted correctly so engine cannot be started unless traction pedal is released to neutral position and PTO lever is in OFF position.

8. Grass deflectors must be installed in lowest position on side discharge cutting units and properly attached to Triflex® cutting unit wings.

9. Fill fuel tank with the proper fuel before starting the engine. Avoid spilling any fuel. Since fuel is very flammable, handle it carefully.

   A. Use an approved fuel container.

   B. Do not fill fuel tank when engine is hot or running.

   C. Do not smoke while handling fuel.

   D. Fill fuel tank outdoors and up to about one inch (25 mm) from the top of the tank, not the filler neck.

   E. Wipe up any spilled fuel.

10. Sit on the seat when starting the engine and operating the machine.

11. On machines equipped with roll-over protection (ROPS), always use seat belt and ROPS together. Make sure seat pivot retaining pin is installed.

12. Before starting the engine:

A. Engage parking brake,

B. Make sure traction pedal is in neutral and PTO is in OFF (disengage) position.

C. After engine is started, release parking brake and keep foot off traction pedal. Machine must not move. If movement is evident, the neutral return mechanism is adjusted incorrectly. Shut engine off and adjust until machine does not move when traction pedal is released.

13. Do not run the engine in a confined area without adequate ventilation. Exhaust fumes are hazardous and could possibly be deadly.

14. Maximum seating capacity is one person. Therefore, never carry passengers.

15. Check carefully for overhead clearances before driving under any objects.

While Operating

16. Using the machine demands the operator's complete attention. To prevent loss of control:

A. Operate only in daylight or when there is good artificial light.

B. Drive slowly.

C. Avoid sudden stops and starts.

D. Look behind machine before backing up.

E. Watch for holes or other hidden hazards.

F. Do not drive close to a sand trap, ditch, creek, or hazard.

G. Reduce speed when making sharp turns and when turning on a hillside

H. The cutting deck must be lowered when going down slopes for steering control.

17. To maintain machine control, 35 lb. of weight must be mounted on rear of traction unit before using the Triflex 88" cutting unit. More weight may be required in some steeper slope conditions.

18. Operator must be skilled and trained in how to drive on hillsides. Failure to use caution on slopes or hills may cause loss of control and vehicle to tip or roll possibly resulting in personal injury or death.

19. Traverse slopes carefully. Do not start or stop suddenly when traversing slopes or when traveling uphill or downhill.

20. If engine stalls or machine loses headway and cannot make it to the top of a slope, do not turn machine around. Always back slowly straight down the slope.

21. The grass deflector(s) must always be installed and in lowest position on the cutting unit. This product is designed to drive objects into the ground where they lose energy quickly in grassy areas. However, don't take an injury risk!! When a person or pet appears unexpectedly in or near the mowing area, STOP MOWING. Careless operation, combined with terrain angles, ricochets, or improperly positioned guards, can lead to thrown object injuries. Do not resume mowing until area is cleared.

22. Never raise the cutting unit or other attached implement while the blades or other parts are rotating.

23. If cutting blades or other implement components strike a solid object or the machine vibrates abnormally, disengage PTO, move throttle to SLOW, set parking brake, and shut engine off. Remove key from switch to prevent possibility of accidental starting. Check cutting unit or other implement and traction unit for damage and defective parts. Repair any damage before restarting the engine and operating the implement or cutting unit. Assure cutting unit blades are in good condition and blade bolts are torqued to proper specifications (See Cutting Unit Operator's Manual).

24. To stop machine, remove foot from traction pedal and use brakes. Gradually reversing the traction pedal can provide additional braking.

25. Do not touch engine, muffler, or radiator while engine is running or soon after it has stopped. These areas could be hot enough to cause a burn.

26. Lower the cutting unit or other attached implement to the ground and remove key from switch whenever machine is left unattended.

27. Before getting off the seat:

A. Move traction pedal to neutral position and remove foot from pedal.

B. Set the parking brake and disengage the PTO.

C. Shut the engine off and remove key from ignition switch. Wait for all movement to stop before getting off the seat.

While Doing Maintenance, Troubleshooting, Testing, Adjustments or Repairs

28. Remove key from ignition switch to prevent accidental starting of the engine when servicing, adjusting, or storing the machine.

29. Make 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 an Authorized TORO Distributor.

30. To reduce potential fire hazard, keep the engine free of excessive grease, grass, leaves, and accumulations of dirt. Clean protective screen on front of engine frequently. When cleaning parts, do not use flammable solvents, such as diesel fuel, kerosene or gasoline.

31. THE ASBESTOS BRAKE LININGS CONTAIN ASBESTOS FIBERS. BREATHING ASBESTOS DUST MAY BE HAZARDOUS TO YOUR HEALTH AND MAY CAUSE SERIOUS RESPIRATORY OR OTHER BODILY HARM. For your protection:

A. AVOID CREATING DUST.

B. Do not remove brake drum without proper equipment.

C. Do not work on brake linings without proper protective equipment.

D. Do not replace brake linings without proper protective equipment.

E. Do not attempt to sand, grind, chisel, file, hammer, or alter brake linings in any manner without proper protective equipment.

F. Follow O.S.H.A standards for proper protective devices to be used when working with asbestos materials.

32. If the cutting unit discharge area ever plugs, disengage PTO and shut engine off before removing the obstruction.

33. Make sure machine is in safe operating condition by keeping nuts, bolts, and screws tight. Check all cutting unit blade mounting bolts frequently to assure they are torqued to proper specifications (See Cutting Unit Operator’s Manual).

34. If machine is equipped with roll-over protection (ROPS), periodically inspect the roll bar and roll bar mounting. Repair as necessary. Do not weld, cut, drill, or modify roll bar in any manner.

35. Make sure all hydraulic line connectors are tight, and all hydraulic hoses and lines are in good condition before applying pressure to the system.

36. 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 ejected into the skin, it must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.

37. Before disconnecting or performing any work on the hydraulic system, all pressure in system must be relieved by stopping engine and lowering implement to the ground.

38. If the engine must be running to perform maintenance or an adjustment, keep clear of PTO shaft, cutting unit blades, and other moving parts.

39. Do not over-speed the engine by changing the governor settings. To ensure safety and accuracy, have an Authorized TORO Distributor check maximum engine speed with a tachometer.

40. Engine must be shut off before checking oil or adding oil to the crankcase.

41. Disconnect the cables from the battery before servicing the machine. If battery voltage is required for troubleshooting or test procedures, temporarily connect the battery.

42. 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 gasses 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.

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

44. 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.

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

46. At the time of manufacture, the machine conformed to safety standards in effect for riding mowers. To ensure optimum performance and continued safety certification of the machine, use genuine TORO replacement parts and accessories. Replacement parts and accessories made by other manufacturers may result in non conformance with the safety standards, and the warranty may be voided.

Chapter 2

Product Records and Manuals

Table of Contents

PRODUCT RECORD FORM 1
EQUIVALENTS AND CONVERSIONS 2
Decimal and Millimeter Equivalents 2
U.S. to Metric Conversions 2
TORQUE SPECIFICATIONS 3
Capscrew Markings and Torque Values - U.S. . . 3
Capscrew Markings and Torque Values - Metric . 3
EQUIPMENT OPERATION
AND SERVICE HISTORY REPORT FORM

Product Records

Record information about your Groundsmaster 345, 322-D or 325-D on the Equipment Operation and Service History Report Form. Use this information when referring to your machine.

Insert Operator's Manuals and Parts Manuals for your Groundsmaster 345, 322-D or 325-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**

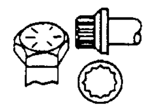
U.S to Metric Conversions

	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
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^o 2. Multiply by 5/9

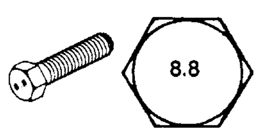
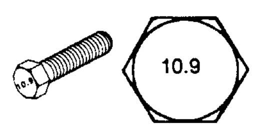
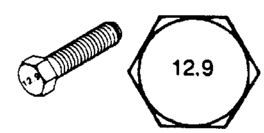
Torque Specifications

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								
	Capsc Grade 5				Caps rque - Grade 8			
	Cast Iron		Aluminum		Cast Iron		Aluminum	
Capscrew Body Size	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 M												
Thread Diameter	Capsc								Capsc rque			
	Cast Iron		Aluminum		Cast Iron		Aluminum		Cast Iron		Aluminum	
mm	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
GROUNDSMASTER® 345

Unit Model and Serial Number: __________-__________

Deck Model and Serial Number: __________-__________

Engine Numbers: ____________________

Transmission Numbers: ____________________

Drive Axle(s) Numbers: ____________________

Date Purchased: ____________________ Warranty Expires__________

Purchased From: ____________________

____

____

Contacts: Parts ____________________ Phone__________________

Service ____________________ Phone__________________

Sales ____________________ Phone__________________

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

GROUNDSMASTER® 345 Maintenance Schedule

Minimum Recommended Maintenance Intervals:

	Maintenance Procedure	Maintenance Interval & Service
	Check Battery Fluid Level	Every 50hrs / A Level Service
	Check Battery Cable Connections	Every 50hrs / A Level Service
	Lubricate All Grease Fittings	Every 50hrs / A Level Service
	Lubricate Brake Cables	Every 50hrs / A Level Service
	Check Cutting Unit Gear Box Oil Level	Every 50hrs / A Level Service
	Clean Under Cutting Unit Belt Covers	Every 50hrs / A Level Service
	Check Cutting Unit Drive Belt Adjustment	Every 50hrs / A Level Service
	Check PTO Belt Adjustment	Every 50hrs / A Level Service
	Inspect Air Filter, Dust Cup, and Baffle	Every 50hrs / A Level Service
‡	Change Engine Oil and Filter	Every 100hrs / B Level Service
†	Check Fan and Alternator Belt Tension	Every 100hrs / B Level Service
	Inspect Cooling System Hoses	Every 100hrs / B Level Service
†	Replace Transmission Oil Filter	Every 200hrs / C Level Service
	Service Air Filter	Every 200hrs / C Level Service
	Check Governor Oil Level	Every 200hrs / C Level Service
	Decarbon Spark Arrestor Muffler	Every 200hrs / C Level Service
	Check Rear Wheel Toe-In and Steering Linkage	Every 200hrs / C Level Service
†	Torque Wheel Lug Nuts	Every 200hrs / C Level Service
	Replace Fuel Filter	Every 400hrs / D Level Service
	Change Transmission Oil	Every 400hrs / D Level Service
	Change Cutting Unit Gear Box Oil	Every 400hrs / D Level Service
	Replace Spark Plugs	Every 400hrs / D Level Service
	Pack Rear Wheel Bearings	Every 400hrs / D Level Service
	Torque Head, Adjust Valves,Check Engine RPM	Every 400hrs / D Level Service

† Initial break in at 10 hours

‡ Initial break in at 50 hours

Annual Recommendations	
Replace Moving Hoses	**Annual Recommendations:** *Items listed are recommended every 1500 hours or 2 years whichever occurs first.*
Replace Safety Switches	
Coolant System - Flush/Replace Fluid	

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

GROUNDSMASTER® 345 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 _____HRS	TUES _____HRS	WED _____HRS	THURS _____HRS	FRI _____HRS	SAT _____HRS	SUN _____HRS
✓ Safety Interlock Operation							
✓ Grass Deflector in Down Position							
✓ Brake Operation							
✓ Fuel Level							
✓ Engine Oil Level							
✓ Cooling System Fluid Level							
✓ Dust Cup and Baffle (Air Filter)							
✓ Radiator & Screen for Debris							
✓ Unusual Engine Noises							
✓ Unusual Operating Noises							
✓ Transmission Oil Level							
✓ Hydraulic Hoses for Damage							
✓ Fluid Leaks							
✓ Tire Pressure							
✓ Instrument Operation							
✓ Condition of Blades							
Lubricate All Grease Fittings[1]							
Touch-up damaged paint							

[1] = Immediately after every washing, regardless of the intervals specified.

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)

GROUNDSMASTER® 345 Supervisor Maintenance Work Order

Date:_______________

(duplicate this page for routine use)

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

A - Service (every 50 hours)

- ☐ Check Battery Fluid Level
- ☐ Check Battery Cable Connections
- ☐ Lubricate All Grease Fittings
- ☐ Lubricate Brake Cables
- ☐ Check Cutting Unit Gear Box Oil Level
- ☐ Clean Under Cutting Unit Belt Covers
- ☐ Check Cutting Unit Drive Belt Adjustment
- ☐ Check PTO Belt Adjustment
- ☐ Inspect Air Filter, Dust Cup, and Baffle

B - Service (every 100 hours)

- ☐ Change Engine Oil and Filter
- ☐ Check Fan and Alternator Belt Tension
- ☐ Inspect Cooling System Hoses
- ☐ **A-Service** required
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________

C - Service (every 200 hours)

- ☐ Replace Transmission Oil Filter
- ☐ Service Air Filter
- ☐ Check Governor Oil Level
- ☐ Decarbon Spark Arrestor Muffler
- ☐ Check Rear Wheel Toe-In and Steering
- ☐ Torque Wheel Lug Nuts
- ☐ **A** and **B Service** required
- ☐ ____________________
- ☐ ____________________

D - Service (every 400 hours)

- ☐ Replace Fuel Filter
- ☐ Change Transmission Oil
- ☐ Change Cutting Unit Gear Box Oil
- ☐ Replace Spark Plugs
- ☐ Pack Rear Wheel Bearings
- ☐ Torque Head, Adjust Valves, ✓ Engine RPM
- ☐ **A, B,** and **C Service** required
- ☐ ____________________
- ☐ ____________________

Annual Service

- ☐ Replace Moving Hoses
- ☐ Replace Safety Switches
- ☐ Coolant System - Flush/Replace Fluid
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________

Additional Servicing Items

- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________

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

Form No. 95-844-SL

EQUIPMENT OPERATION AND SERVICE HISTORY REPORT
for
GROUNDSMASTER® 322-D and 325-D

Unit Model and Serial Number: __________-__________

Deck Model and Serial Number: __________-__________

Engine Numbers: ____________________

Transmission Numbers: ____________________

Drive Axle(s) Numbers: ____________________

Date Purchased: ____________________ Warranty Expires__________

Purchased From: ____________________

____

____

Contacts:	Parts	____________________	Phone__________________
	Service	____________________	Phone__________________
	Sales	____________________	Phone__________________

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

GROUNDSMASTER® 322-D and 325-D Maintenance Schedule

Minimum Recommended Maintenance Intervals:

	Maintenance Procedure	Maintenance Interval & Service
	Check Battery Fluid and Cable Connections	Every 50hrs
	Lubricate Grease Fittings	
	Lubricate Brake Cables	
	Check Cutting Unit Gear Box Oil Level	
	Clean Under Cutting Unit Belt Covers	
	Check Cutting Unit Drive Belt Adjustment	
	Change Engine Oil	
	Check PTO Belt Tension	*A Level Service*
	Inspect Air Filter, Dust Cup and Baffle	
‡	Replace Engine Oil Filter	Every 100hrs
†	Check Fan and Alternator Belt Tension	*B Level Service*
	Inspect Cooling System Hoses	
†	Replace Transmission Oil Filter	Every 200hrs
	Service Air Filter	
	Decarbon Spark Arrestor Muffler	
	Check Rear Wheel Toe-In and Steering Linkage	*C Level Service*
†	Torque Wheel Lug Nuts	
	Replace Diesel/Water Separator Filter	Every 400hrs
	Replace Electric Fuel Pump Filter	
	Check Fuel Lines and Connections	
	Change Cutting Unit Gear Box Oil	
	Pack rear wheel bearings (2WD)	
	Change Rear Axle Lubricant (4WD)	
	Change Transmission Oil	*D Level Service*
‡	Torque Head, Adjust Valves, and Check RPM	

† Initial break in at 10 hours

‡ Initial break in at 50 hours

Replace Moving Hoses	**Annual Recommendations:**
Replace Safety Switches	*Items listed are recommended every 1500 hours or 2 years whichever occurs first.*
Coolant System - Flush/Replace Fluid	
Fuel Tank - Drain/Flush	

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

GROUNDSMASTER® 322-D and 325-D Daily Maintenance Check List

Unit Designation:__________
TORO ID#:_______-_______

Daily Maintenance: (duplicate this page for routine use)

Maintenance Check Item	Daily Maintenance Check For Week Of ______________						
	MON ______HRS	TUES ______HRS	WED ______HRS	THURS ______HRS	FRI ______HRS	SAT ______HRS	SUN ______HRS
✓ Safety Interlock Operation							
✓ Grass Deflector in Down Position							
✓ Brake Operation							
✓ Fuel Level							
✓ Engine Oil Level							
✓ Cooling System Fluid Level							
Drain Water/Fuel Separator							
✓ Dust Cup and Baffle (Air Filter)							
✓ Radiator & Screen for Debris							
✓ Unusual Engine Noises[1]							
✓ Unusual Operating Noises							
✓ Transmission Oil Level							
✓ Hydraulic Hoses for Damage							
✓ Fluid Leaks							
✓ Tire Pressure							
✓ Instrument Operation							
✓ Condition of Blades							
Lubricate All Grease Fittings[2]							
Touch-up damaged paint							

[1] = Check diesel glow plug and injector nozzles, if hard starting, excess smoke, or rough running is noted.
[2] = Immediately after every washing, regardless of the intervals specified.

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)

GROUNDSMASTER® 322-D and 325-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 and Cable Connections
- ☐ Lubricate Grease Fittings
- ☐ Lubricate Brake Cables
- ☐ Check Cutting Unit Gear Box Oil Level
- ☐ Clean Under Cutting Unit Belt Covers
- ☐ Check Cutting Unit Drive Belt Adjustment
- ☐ Change Engine Oil
- ☐ Check PTO Belt Tension
- ☐ Inspect Air Filter, Dust Cup and Baffle

B - Service (every 100 hours)

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

C - Service (every 200 hours)

- ☐ Change Transmission Oil
- ☐ Replace Transmission Oil Filter
- ☐ Service Air Filter
- ☐ Decarbon Spark Arrestor Muffler
- ☐ Check Rear Wheel Toe-In and Steering
- ☐ Torque Wheel Lug Nuts
- ☐ **A** and **B Service** required
- ☐ ______________________
- ☐ ______________________

D - Service (every 400 hours)

- ☐ Replace Diesel/Water Separator Filter
- ☐ Replace Electric Fuel Pump Filter
- ☐ Check Fuel Lines and Connections
- ☐ Change Cutting Unit Gear Box Oil
- ☐ Pack rear wheel bearings (2WD)
- ☐ Change Rear Axle Lubricant (4WD)
- ☐ Change Transmission Oil
- ☐ Torque Head, Adjust Valves, & Check RPM
- ☐ **A, B,** and **C Service** required

Annual Service

- ☐ Replace Moving Hoses
- ☐ Replace Safety Switches
- ☐ Coolant System - Flush/Replace Fluid
- ☐ Fuel Tank - Drain/Flush
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________

Additional Servicing Items

- ☐ ______________________
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________

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

Form No. 95-855-SL

Chapter 3

(For Groundsmaster 345 only)

Ford VSG-411 Engine

Table of Contents

SPECIFICATIONS 1
GENERAL INFORMATION 2
Spark Plug Inspection and Replacement 2
ADJUSTMENTS 3
Alternator Belt Adjustment 3
Coolant Fan Belt Adjustment 3
Governor Adjustment 4
REPAIRS 6
Crankshaft Pulley Installation 6
Engine Removal and Installation 7
Engine Repair Information 8
FORD VSG-411/413 ENGINE SERVICE MANUAL

Specifications

Item	Specification
Make / Designation	Ford Model VSG-411
Firing order	1-2-4-3
Ignition timing	Distributorless Ignition System (DIS) Timing controlled by Universal Electronic Spark Control (UESC)
Spark plug	Motorcraft AGSF22C or AGRF22 or equivalent
Spark plug gap	0.040 in. (1.0 mm)
Crankcase oil capacity	3.5 U.S. qt. (3.25 liter) including filter
Oil service classification	API SG, SG/CC, SG/CD
Oil viscosity	**Ambient temperature (single viscosity oil)** –10° to +60°F SAE 10 +10° to +90°F SAE 20 Above +32°F SAE 30 Above +50°F SAE 40 **Ambient temperature (multi-viscosity oil)** Below +60°F SAE 5W-30 –10° to +90°F SAE 10W-30 Above –10°F SAE 10W-40 or 10W50 Above +10°F SAE 20W40 or 20W50
Fuel	Unleaded gasoline 87 octane or higher
Coolant	50 / 50 ethylene glocol anti-freeze and water
Cooling system capacity	6 U.S. qt. (5.7 liter)
Carburetor idle speed setting (throttle arm against stop)	1350 ± 50 RPM
Governor idle speed setting	1500 ± 50 RPM
Governor high speed setting	3200 ± 100 RPM

Spark Plug Inspection and Replacement

Since air gap between center and side electrodes increases gradually during normal engine operation, check condition of electrodes at 100 hour intervals.

The correct spark plugs to use in the engine are Motorcraft AGSF22C or AGRF22 or equivalent. Set air gap at 0.040 in. (1.0 mm).

1. Clean area around spark plugs so dirt does not fall into cylinder when plugs are removed.

2. Pull wire off spark plugs and remove plugs from cylinder head.

3. Check condition of center and side electrodes to determine operating temperature of engine.

A. Light brown insulator tip indicates correct spark plug and heat range.

B. Black or oily insulator tip indicates an excessively rich fuel mixture, possibly caused by a dirty air cleaner element or a carburetor that is set too rich.

C. Light gray or blistered-white insulator indicates overheating caused by a lean carburetor setting or incorrect spark plug (heat range too high).

IMPORTANT: A cracked, fouled or dirty spark plug must be replaced. Do not sandblast, scrape or clean electrodes by using a wire brush because grit may release from the plug and enter combustion chamber resulting in engine damage.

4. After setting air gap at 0.040 in. (1.0 mm), install spark plug in cylinder head. Tighten the plug to 11 - 15 ft-lb. Push wire onto spark plug.

Adjustments

Alternator Belt Adjustment (Fig. 1)

A new alternator belt is to be tensioned to 65 lbs. A used belt is to be re-tensioned to 40 lbs.

1. To adjustable tension, loosen bolt securing brace to engine, bolt securing alternator to brace and alternator mounting bolts.

2. Insert pry bar between alternator and engine and pry out on alternator.

3. Hold alternator in position after proper tension is achieved and tighten alternator and brace bolts to secure adjustment.

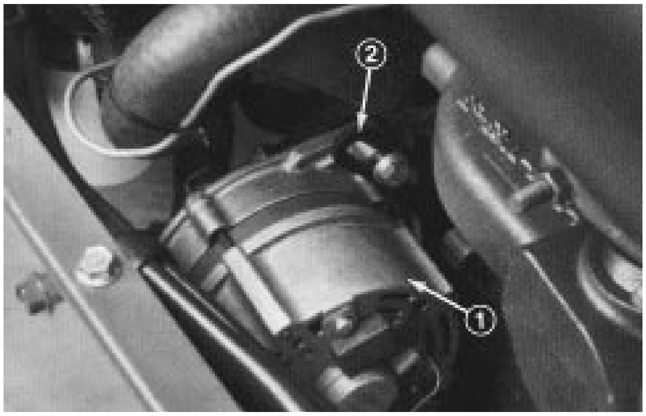


Figure 1

1. Alternator
2. Brace

Coolant Fan Belt Adjustment (Fig. 2)

A new fan belt is to be tensioned to 45 lbs. A used belt is to be re-tensioned to 28 lbs.

1. To adjust belt tension, loosen upper and lower nuts securing idler arm to front engine mount.

2. Pull out on idler arm until desired belt tension is achieved.

3. Tighten mounting nuts to secure adjustment.

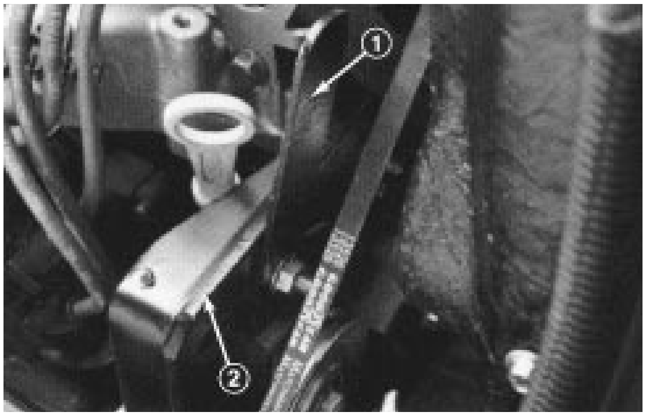


Figure 2

1. Edler arm
2. Engine mount

Governor Adjustment (Fig. 3, 4)

1. With engine shut off, move throttle control to FAST position and open hood. Check between throttle arm and stop on carburetor base to make sure there is a 1/32 in. (0.8 mm) gap. If gap is not correct, adjust throttle rod by turning ball joint ends until gap is 1/32 in. (0.8 mm). If gap is correct, to to step 2.

> **WARNING**
>
> **Engine must be running so final adjustment of governor can be performed. To guard against possible personal injury, engage parking brake and keep hands, feet, face, and other parts of body away from fan and other moving parts.**

2. Start engine and move throttle to SLOW position. Allow engine to warm up to normal operating temperature.

3. Rotate throttle arm closed until it contacts stop.

4. Check idle speed and adjust carburetor idle speed screw if necessary to attain 1350 ± 50 rpm.

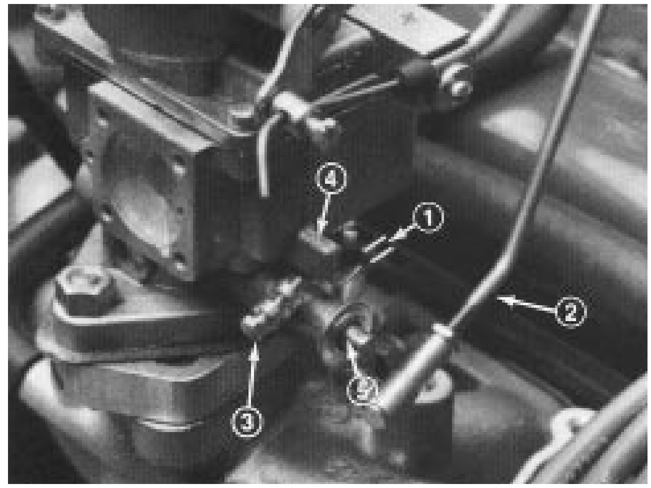


Figure 3

1. 1/32" (0.8 mm)
2. Throttle rod
3. Carbruetor idle speed screw
4. Stop
5. Throttle arm

5. Release throttle arm, loosen jam nut on governor low idle stop screw and adjust it to get 1500 ± 100 rpm. Tighten jam nut.

6. Slowly move throttle to FAST position until engine speed reaches 3200 ± 100 rpm. Shut off engine. Adjust high idle stop screw until it contacts speed control lever.

IMPORTANT: Do not over-speed the engine because the transmission could be damaged.

7. Move throttle rapidly from SLOW to FAST. The engine should not surge. If engine surges, go to step 8.

8. Check V-belts from engine to governor pulley and make sure they are tight. If belts are loose, engine will surge. If belts are tensioned properly, loosen jam nut that retains anti-surge screw. Rotate screw clockwise 1/8 turn at a time until surging stops. Should governor continue to surge, check the following:

A. Carburetor too rich or too lean.
B. Binding in throttle linkage.
C. Governor worn internally.

IMPORTANT: Never rotate anti-surge screw in too far so that speed of engine increases.

9. Bump throttle lever with your hand so engine speeds up momentarily. If governor is working properly, engine speed should return to normal within one or two surges of governor. More than two surges of governor usually indicates that the anti-surge screw must be turned in slightly more than it is. When adjustment is correct, lock jam nut against governor body.

10. Check low and high idle speed to be sure there is no change from initial setting. If high idle speed has increased, anti-surge screw has been turned into governor too far and it must be backed out. Then, repeat the entire adjustment procedure.

NOTE: If the throttle control on instrument panel will not stay in FAST position during operation, remove panel cover and tighten nut and capscrew at base of throttle lever assembly.

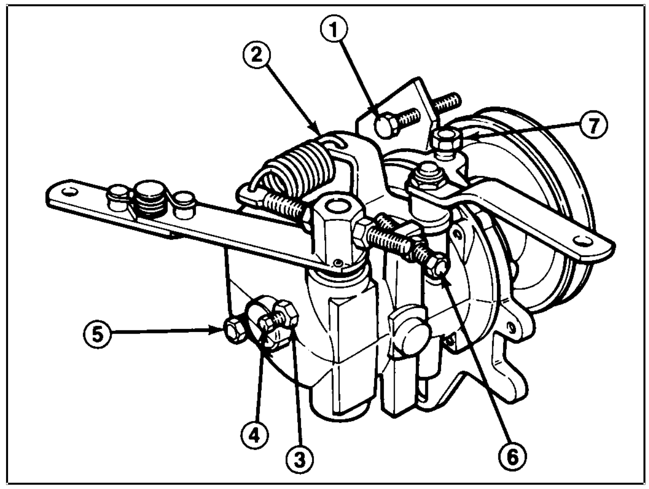


Figure 4

1. High idle stop screw
2. Speed control lever
3. Jam nut
4. Anti-surge screw
5. Oil check plug
6. Low idle stop screw
7. Oil fill plug

Crankshaft Pulley Installation

1. Insert three of four locking rings into crankshaft pulley.

NOTE: Outside locking rings have tapered I.D. and flat O.D. Inside locking rings have flat I.D. and tapered O.D.

A. Install first outside ring seated against small internal shoulder of pulley, flat edge of ring touching small pulley shoulder.

B. Install second inside ring, mating taper to taper with first ring.

C. Install third outside ring with flat edge against previous inside ring.

D. Align ring end gaps with key slot in pulley.

2. Align pulley key slot with crankshaft key. Install pulley approximately 1/4" onto crankshaft.

3. Insert fourth locking ring, taper to taper, with third ring.

4. Insert bolt through special washer. Shoulder on washer contacts shoulder of fourth locking ring.

5. Draw pulley onto crankshaft by tightening crankshaft bolt. Resistance will be felt as crankshaft passes through locking rings.

6. Tighten crankshaft bolt to a torque of 40-44 ft-lb. Check pulley alignment between crankshaft and water pump.

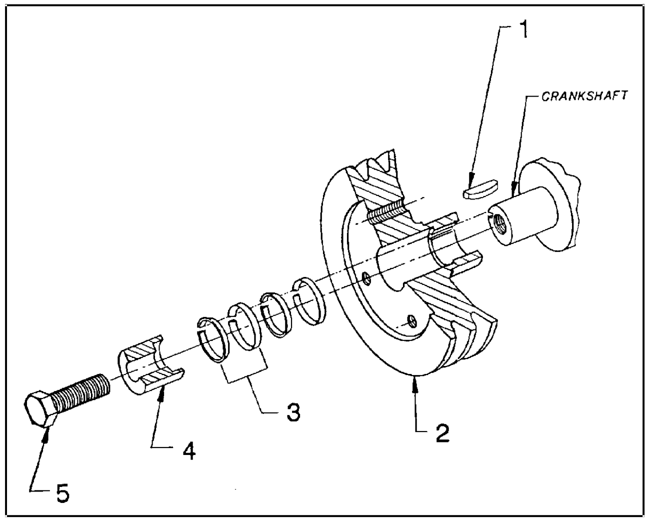


Figure 5

1. Woodruff key
2. Pulley
3. Locking rings
4. Special washer
5. Metric bolt

Engine Removal and Installation

Removing the Engine

1. Put machine on a level surface, stop engine, remove key from ignition switch and engage parking brake.

2. Remove intake hose from air cleaner and carburetor.

3. Remove transmission drive coupling (see Chapter 10 - Transmission Coupler and PTO).

4. Remove PTO belt (see Chapter 10 - Transmission Coupler and PTO).

5. Disconnect battery cables from battery terminals.

6. Disconnect and tag all wires connected to engine and engine accessories.

7. Put a drain pan under radiator, loosen radiator cap, loosen radiator petcock and allow radiator to drain completely.

8. Move drain pan under lower radiator hose. Disconnect hose from radiator and allow coolant to drain into pan. Remove lower and upper radiator hoses.

9. Move drain pan under rear of engine and remove cylinder block plug (located above starter) to drain coolant from cylinder block. Install cylinder block plug.

10. Remove cable tie securing control cables and vacuum sensor hose near caburetor.

11. Disconnect vacuum sensor hose from fuel trap on carbruetor.

12. Disconnect choke control cable from carburetor.

13. Disconnect throttle control cable from governor.

14. Remove fuel line from inlet side of fuel pump.

NOTE: Be prepared to insert a plug into fuel line to prevent fuel spill.

15. Remove capscrews securing fan shroud to radiator so fan shroud can be move during engine removal for cooling fan clearance.

16. Attach a short section of chain between the two lifting shakles on the engine. Attach block and tackle or hoist chain to this short section of chain, approximately midway between the two shakles.

17. Remove four bolts securing rear engine mount to frame.

18. Remove slack from lifting chain and carefully remove two capscrews which pass through the two rubber front engine mounts.

19. Lift and guide engine from engine compartment. Be careful not to damage the radiator cooling fan or other components during removal.

Installing the Engine

1. Do steps 2 - 19 of “Removing the Engine” in reverse order.

2. Fill cooling system with new coolant. Install a new oil filter and fill engine with correct oil.

3. Inspect for oil and coolant leaks.

4. Check engine idle speed and maximum governed speed settings.

Engine Repair Information

Ford VSG-411 Component Changes

Ford VSG-411 engines with a date code of 2D21 or later have five (5) main bearings, which is the same design used on the VSG-413 engine. VSG-411 engines produced before this date have four (4) main bearings (see Page 1-01, under IDENTIFICATION in the Ford VSG-411/413 Engine Service Manual for an explanation of Ford corporate date system).

Listed below is a summary of changes from the four (4) main bearing design to the five (5) main bearing design of the VSG-411 engine:

Cylinder block – New, five main bearing design.

Crankshaft – Same as VSG-413.

Crankshaft lower main bearing – No change.

Crankshaft upper main bearing – No change.

Crankshaft rear oil seal retainer – Same as VSG-413.

Crankshaft rear bearing oil seal gasket – Same as VSG-413

Chapter 4

(For Groundsmaster 322-D/325-D only)

Mitsubishi K3D Diesel Engine

Table of Contents

For Groundsmaster 328-D, use the Toro Operator's Manual and Parts Catalog along with the Kubota 05 Series Workshop Manual (Toro Part No. 01090SL).

INTRODUCTION 2
SPECIFICATIONS 3
General 4
Engine 5
Lubrication System 7
Fuel System 8
Governor System 8
Cooling System 8
Electrical System 9
Tightening Torque 10
SPECIAL TOOLS 11
ADJUSTMENTS 13
Valve Clearance 13
Engine Speed Adjustments 14
Throttle Linkage Adjustment 15
TROUBLESHOOTING 15
TESTING 18
Glow Plug Test 18
Compression Test 19
Nozzle Tests 20
Injection Pump Test 22
Injection Timing Test 23
Fuel Pump Test 24
Thermostat Test 24
PREPARATION FOR ENGINE REPAIR 25
Cylinder and Cylinder Block Overhaul 25
EXTERNAL ENGINE COMPONENT REPAIR 26
Crankcase Breather System 26
Alternator Belt Service 27
Fan Belt Service 27
Fan, Fan Pulley and Fan Shaft Service 28
Glow Plug Replacement 29
Oil Pressure Switch Replacement 29
Oil Pump Servicing 30
Stop Solenoid Replacement 32
Water Pump Servicing 33
FUEL SYSTEM REPAIRS 34
Bleeding the Fuel System 34
Bleeding Air From the Injectors 35
Fuel Pump Service 35
Governor Mechanism Operation 37
Governor Inspection 37
Injection Pump Servicing 38
Nozzle Servicing 45
REMOVING AND INSTALLING THE ENGINE 46
Removing the Engine 46
Installing the Engine 46
CYLINDER HEAD OVERHAUL 47
Cylinder Head Removal 47
Cylinder Head Servicing 48
Valve Guides 49
Valves 49
Valve Seats 50
Valve Springs 51
Rocker Arm and Rocker Shaft Service 51
Cylinder Head Reassembly and Installation . . . 52
CYLINDER BLOCK OVERHAUL 53
Cylinder Block Disassembly 53
Camshaft and Bearing 55
Fuel Injection Pump Camshaft 55
Crankshaft Bearings 56
Timing Gears 56
Connecting Rod and Connecting Rod Bearings 57
Cylinders 57
Oversized Pistons, Cylinder Bore and Rings. . . 58
Piston and Pin Replacement 59
Engine Reassembly 59

Introduction

This chapter gives information about specifications, maintenance, troubleshooting, testing and repair of the diesel engine used in the Groundsmaster® 322-D and 325-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 Groundsmaster® 322-D/325-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 embossed on the pump mounting side of the crankcase. The serial number is stamped on the injection pump mounting surface of the crankcase (Fig. 1).

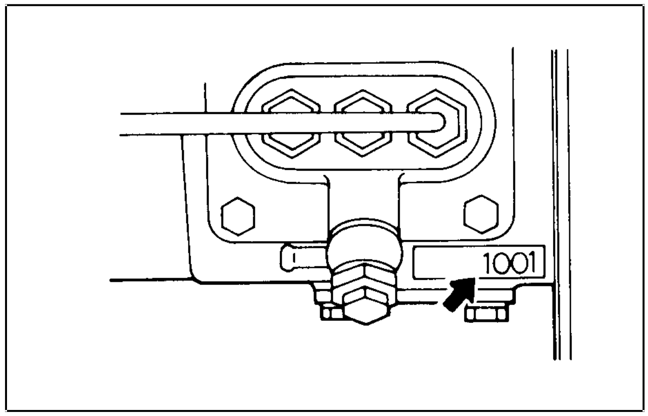


Figure 1

Specifications

The illustrations (Figs. 2a and 2b) 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.

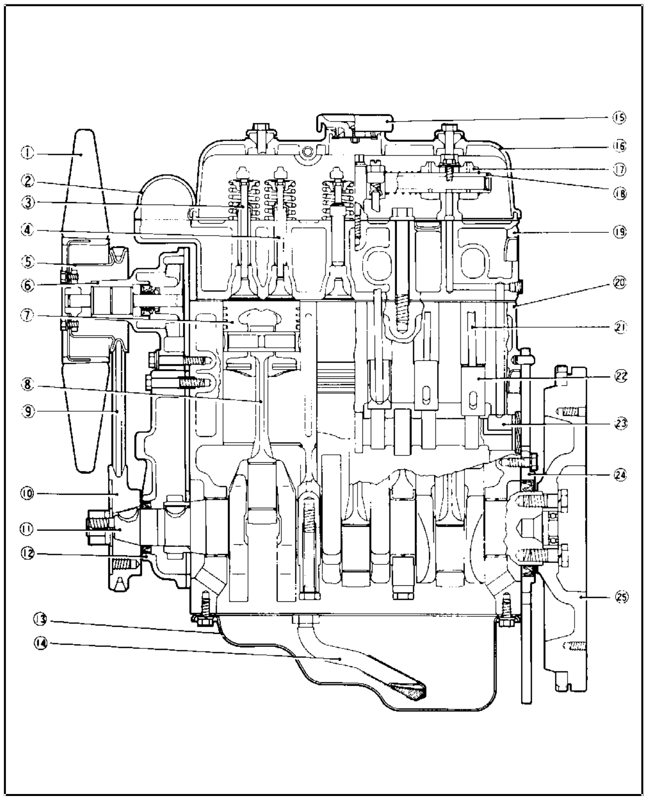


Figure 2a

1. Cooling fan
2. Water oulet fitting
3. Intake valve
4. Exhaust valve
5. Water pump pulley
6. Water pump
7. Piston
8. Connecting rod
9. Fan belt
10. Crank pulley
11. Crankshaft
12. Gear case
13. Oil pan
14. Oil screen
15. Oil filler cap
16. Rocker cover
17. Rocker arm
18. Rocker shaft
19. Cylinder head
20. Cylinder block
21. Push rod
22. Tappet
23. Camshaft
24. Rear oil seal case
25. Flywheel

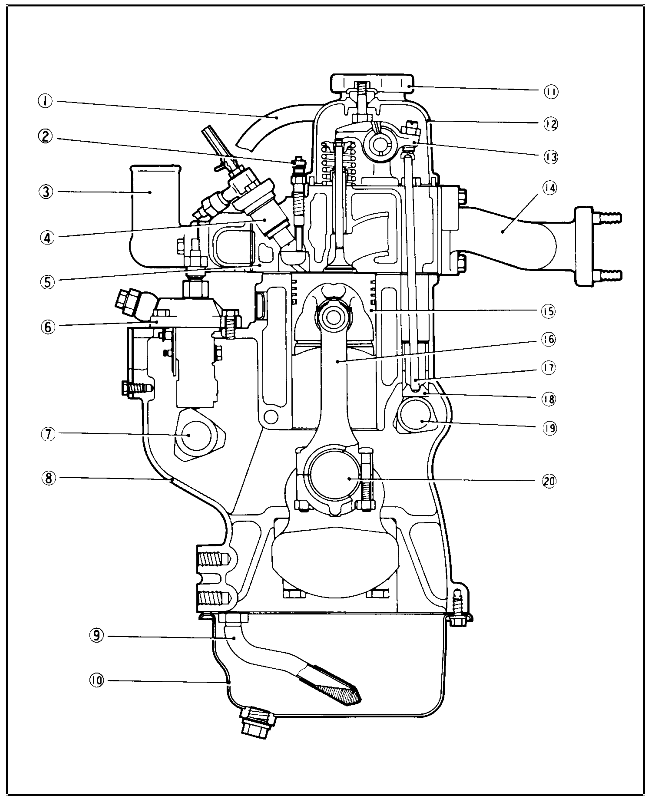


Figure 2b

1. Air breather pipe
2. Glow plug
3. Intake manifold
4. Nozzle holder
5. Cylinder head
6. Injection pump
7. Pump camshaft
8. Cylinder block
9. Oil screen
10. Oil pan
11. Oil filler cap
12. Rocker cover
13. Rocker arm
14. Exhaust manifold
15. Piston
16. Connecting rod
17. Push rod
18. Tappet
19. Camshaft
20. Crankshaft

General

Item	Specification
Make/Designation	Mitsubishi K3D-61TG, overhead valve, vertical in-line, 4 cycle diesel
Rotation	Counterclockwise at flywheel side
Combustion Chamber	Swirl chamber type
Number of Cylinders	3
Bore x Stroke	73 x 78 mm (2.9 x 3.1 in.)
Total Displacement	0.979 liter (59.7 in.^{3})
Compression Ratio	23:1
Firing Order	1 - 3 - 2
Dry Weight (approximate)	124 kg (273 lb.)
Fuel	Diesel ASTM No. 2-D (ASTM No. 1-D in very cold weather)
Fuel Injection Pump	Bosch M type
Governor	Centrifugal fly weight type
Fuel Injector Nozzle	Throttle type
Fuel Injection Pressure	(120 - 130 kg/cm^2) 1700 - 1850 psi
Lubrication System	Forced lubrication
Oil Pump	Gear type
Oil Filter	Paper element filter (full flow type)
Crankcase Oil Capacity	3.5 liter (3.7 U.S. qt.) including filter
Cooling System	Forced circulation, water cooling
Water Pump	Centrifugal type
Cooling System Capacity	5.7 liter (6 U.S. qt.)
Starter	Solenoid shift type 2.0 kW (12 volt)
Alternator	AC type 12 volt 35A
Glow Plug	Sheathed type

Engine

Item	Standard Specification	Repair Limit	Service Limit
Governor	Mechanical/Centrifugal		
Operating Speed (no load)	3200 rpm		± 50 rpm
Idle Speed (no load)	1500 rpm		± 50 rpm
Compression	32 kg/cm^2 (455 psi) at 280 rpm	26 kg/cm^2 (370 psi)	22 kg/cm^2 (313 psi)
Pressure Difference Between Cylinders	2.5 kg/cm^2 (36 psi) max.		
Cylinder Injection Order	1 - 3 - 2		
Injection Timing	23^o B.T.D.C. (at smoke set position		± 2^o
Cylinder Head			
Bottom Surface Flatness (distortion)	0.05 mm (0.002 in.) max.	0.1 mm (0.004 in.)	
Valve Guide I.D.	6.6 mm (0.26 in.)		
Valve Seat Angle	45^o		
Valve Seat Width	1.3 - 1.8 mm (0.051 - 0.071 in.)	2.5 mm (0.1 .in.)	
Valve Seat Sinkage			–1 mm (– 0.039 in.)
Valve Clearance (cold) (both intake and exhaust)	0.25 mm (0.01 in.)		
Valves			
Valve Head Dia. (IN)	27.2 mm (1.079 in.)		
Valve Head Dia. (EX)	25.2 mm (0.992 in.)		
Overall Length	114.5 (4.508 in.)		
Valve Stem O.D.	6.6 mm (0.260 in.)		
Stem to Guide Clearance (IN)			0.10 mm (0.004 in.)
Stem to Guide Clearance (EX)			0.15 mm (0.006 in.)
Valve Seat Face Angle	45^o		
Valve Head Thickness (margin width)	1 mm (0.039 in.)		0.5 mm (0.020 in.)
Valve Head Sinkage (from cyl. head bottom face)	0.5 mm (0.020 in.)		1.5 mm (0.06 in.)
Valve Spring			
Free Length	43 mm (1.693 in.)		– 1 mm (– 0.039 in.)
Installed Load/Height	14 ± 0.7kg/36 mm (30.9 ± 1.5 lb./1.417 in.)		–15%
	29.75 ± 1.5 kg/28 mm (65.6 ± 3.3 lb./1.102 in.)		–10%
Squareness	2^o		3^o
Rocker Arm I.D.	18.9 mm (0.744 in.)		
Rocker Arm to Shaft Clearance			–0.2 mm (0.008 in.)
Cylinder Block			
Camshoft hole I.D.			
Front (Bush)	45 mm (1.772 in.)		
Oil Clearance	0.15 mm (0.006 in.)		
Center	44 mm (1.732 in.)		
Rear	34 mm (1.339 in.)		
Cylinder Bore	73 mm (2.874 in.)	+0.2 mm (0.008 in.)	+ 0.95 mm (0.037 in.)
Oversize finish tolerance	0 to 0.03 mm (0 to 0.001 in.)		
Cylindricity of cylinder bore	0.01 mm (0.0004 in.) max.		
Warpage of head gasket mating surface	0.05 mm (0.0020 in.) max.	0.1 mm (0.004 in.)	

Engine (cont.)

Item	Standard Specification	Repair Limit	Service Limit
Piston			
Type	Solid		
Material	Aluminum alloy		
Piston Outside Diameter (skirt end)	73 mm (2.874 in.)		
Piston to Cylinder Wall Clearance			0.3 mm (0.012 in.)
Oversize	0.25, 0.50, 0.75 mm (0.01, 0.02, 0.03 in.)		
Piston Pin			
Type	Semi-floating		
Outside Diameter	19 mm (0.748 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			
3 Compression	No. 1: Chrome plated, semi-keystone type No. 2 and No. 3: 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. 1	0.06 - 0.12 mm (0.0024 - 0.005 in.)		0.3 mm (0.012 in.)
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	0.05 mm (0.002 in.) max.		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, 0.75 mm (0.01, 0.02, 0.03 in.)		
Crankshaft			
Type	Fully counterbalanced		
Bend	Within 0.03 mm (0.001 in.)		0.05 mm (0.002 in.)
End Play	0.05 - 0.205 mm (0.002 - 0.008 in.)		
Journal O.D.	52 mm (2.047 in.)	– 0.15 mm (– 0.006 in.)	– 0.95 mm (– 0.037 in.)
Pin O.D.	42 mm (1.654 in.)	– 0.15 mm (– 0.006 in.)	– 0.95 mm (– 0.037 in.)
Finish Undersize			
Journal U.S. 0.25 mm (0.01 in.)	51.735 - 51.750 mm (2.0368 - 2.0374in.)		
Journal U.S. 0.50 mm (0.02 in.)	51.485 - 51.500 mm (2.0270 - 2.0276 in.)		
Journal U.S. 0.75 mm (0.03 in.)	51.235 - 51.250 mm (2.0171 - 2.0177 in.)		
Pin U.S. 0.25 mm (0.01 in.)	41.700 to 41.715 mm (1.6417 - 1.6423 in.)		
Pin U.S. 0.50 mm (0.02 in.)	41.450 - 41.465 mm (1.6319 - 1.6325 in.)		
Pin U.S. 0.75 mm (0.03 in.)	41.200 - 41.215 mm (1.6220 - 1.6226 in.)		

Engine (cont.)

Item	Standard Specification	Repair Limit	Service Limit
Main Bearings Oil Clearance Undersize	 0.25, 0.50, 0.75 mm (0.01, 0.02, 0.03 in.)		 0.10 mm (0.004 in.)
Camshaft Drive System Journal to Cylinder Block Hole Clearance Cam Lobe Height (both intake and exhaust)	 Gear 35.76 mm (1.401 in.)		 0.15 mm (0.006 in.) – 1.0 mm (– 0.039 in.)
Pump Camshaft Drive System Bearing Front Rear Cam Lobe Height	 Gear Ball bearing Cylinder block hole 44 mm (1.732 in.)		 – 1.0 mm (– 0.039 in.)
Tappets Outside Diameter Tappet to Cylinder Block Hole Clearance	 23 mm (0.906 in.)		 – 0.15 mm (– 0.006 in.)
Push Rod Bend	0.3 mm (0.012 in.) max.		

Lubrication System

Item	Standard Specification	Repair Limit	Service Limit
Oil Capacity	3.5 liter (3.7 qt.) including oil filter		
API Service Class	CD		
Viscosity Above 68°F (20°C) 41°F to 68°F (5° to 20°C) Below 41°F (5°C)	 SAE 30 or 10W-30 SAE 20 or 10W-30 SAE 10W-30		
Oil Pump Type Check Valve Opening Pressure Outer Rotor to Housing Clearance Outer Roto to Inner Rotor Clearance Rotor to Cover Clearance	 Gear type 4 kg/cm^2 (56.9 psi) at 1000 rpm 0.15 - 0.20 mm (0.006 - 0.008 in.) 0.05 - 0.12 mm (0.002 - 0.005 in.) 0.03 - 0.07 mm (0.001 - 0.003 in.)	 0.3 mm (0.012 in.) 0.25 mm (0.01 in.) 0.2 mm (0.008 in.)	
Oil Pressure Switch Indicator Lamp Lighting Pressure	 0.5 kg/cm^2 (7.1 psi)		

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.)	 MD-PER3M 23^o B.T.D.C. (at smoke set position		 $\pm 2^o$
Nozzles Type Model Injection Start Pressure	 Throttle type ND-DN4SD24 120 kg/cm^2 (1707 psi)		 120 ± 10 kg/cm^2 (1707 ± 142 psi)

Cooling System

Item	Standard Specification	Repair Limit	Service Limit
Coolant Capacity	5.7 liter (6 U.S. qt.)		
Thermostat Type Valve Cracking Temperature Full Opening Valve Temperature Valve Lift	 Wax type 76.5° ± 1.5°C (177° ± 3°F $90^o \pm 1.5^oC$ ($194^o \pm 3^oF$) 8 mm (0.314 in.)		

Electrical System

Item	Standard Specification	Repair Limit	Service Limit
Starter			
Type	Solenoid shift type		
Nominal Output	2.0 kW - 12V		
Direction of Rotation	Clockwise as viewed from pinion side		
No-load Characteristics (Cold)			
Terminal Voltage/Current	11V/130A max. at 20°C (68°F)		
Speed	3850 rpm min.		
Height of Brush	11.5 mm (0.45 in.)		1.7 mm (0.07 in.)
Spring Pressure	3 kg (6.6 lb.)		1.8 kg (4 lb.)
Commutator O.D.	38.7 mm (1.52 in.)		– 1.0 mm (– 0.4 in.)
Depth of Commutator Undercut	0.5 -0.8 mm (0.02 - 0.03 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.) max.		
Alternator			
Nominal Output	12V - 35A		
Direction of Rotation	Clockwise as viewed from pulley side		
No Load Output Characteristics (Cold)			
Terminal Voltage/Current	14V/0A at 20°C (68°F)		
Speed	1300 rpm or less		
Load Output Characteristics (Cold)			
Terminal Voltage/Current	14V/30A or more at 20°C (68°F)		
Speed	2500 rpm		
Regulator (separate type)			
Regulated Voltage	14.8 ± 0.3V		
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	Description	Tightening Torque
Cylinder head bolt Cylinder head bolt	M12 (qty. 8) M10 (qty. 3)	11.5 - 12.5 kgm (wet) (83 - 90 ft-lb) 6.5 - 8.0 kgm (wet) (47 - 58 ft-lb)
Crankshaft pulley nut	M18	15 - 16 kgm (109 - 116 ft-lb)
Main bearing cap bolt		5 - 5.5 kgm (36 - 40 ft-lb)
Connecting rod cap nut		3.2 - 3.5 kgm (23 - 25 ft-lb)
Flywheel mounting bolts	(8T) flanged bolts (8T) bolts with washers	13 - 14 kgm (94 - 101 ft-lb) 11.5 - 12.5 kgm (83 - 90 ft-lb)
Oil drain plug		5 - 6 kgm (36 - 43 ft-lb)
Oil filter		1.1 - 1.3 kgm (8 - 9 ft-lb)
Fuel injection pump Delivery valve holder		 4 - 5 kgm (29 - 36 ft-lb)
Nozzle holder Holder mounting bolt Holder body and retaining nut		 1.5 - 2 kgm (11 - 15 ft-lb) 6 - 8 kgm (43 - 58 ft-lb)
Glow plug		1.5 - 2 kgm (11 - 15 ft-lb)

Special Tools

Order special tools from *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (Commercial Products)*. Some tools may be available from a local supplier.

Filter Cleaner (Fig. 3)

Filter cleaner. Mix with water and use solution to wash the Donaldson air cleaner element.

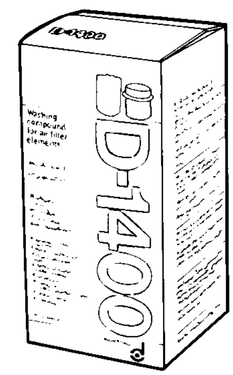


Figure 3

Diesel Engine Compression Test Kit (Fig. 5)

Diesel engine compression test kit. 0-1000 PSI Gauge allows testing of diesel engines to check general operating condition of engine. Includes case, guage with hose, glow plug hole adapters and instructions.

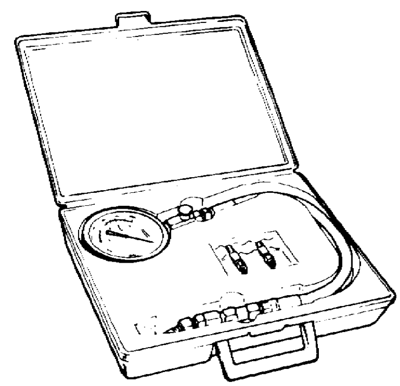


Figure 5

Piston Pin Tool (Fig. 6)

Piston pin tool is used to remove and install the wrist pin without distorting the piston. Inludes an adapter for use with Mitsubishi and most other engines.

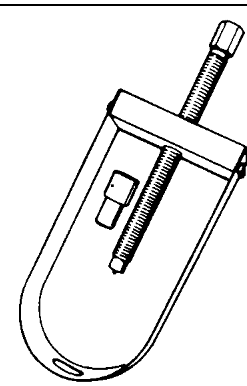


Figure 6

Nozzle Tester (Fig. 7)

Nozzle tester tests condition and opening pressure of fuel injector nozzles.

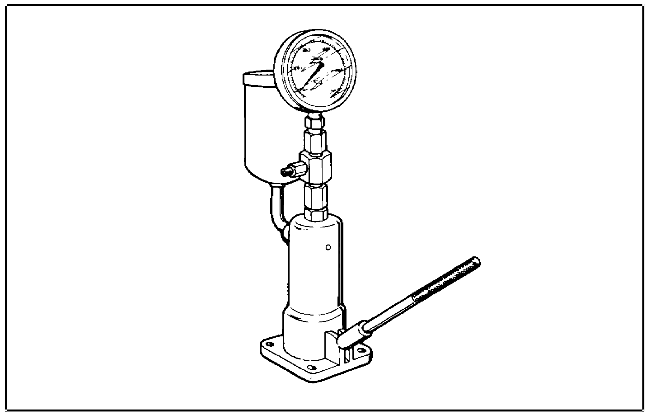


Figure 7

Nozzle Tester Adapter (Fig. 8)

Nozzle tester adapter is required to test the fuel injection nozzles.

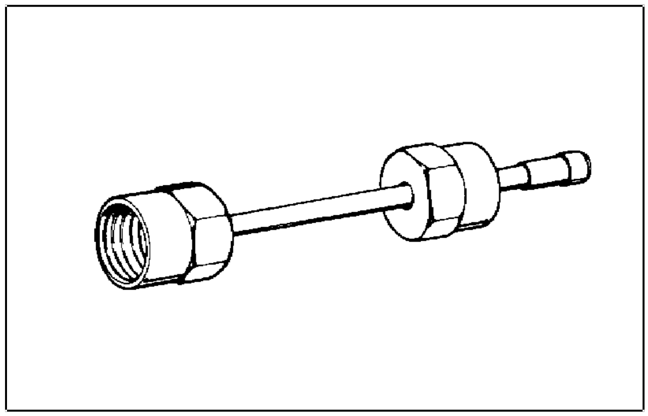


Figure 8

Camshaft Bushing Tool (Fig. 9)

The camshaft bushing removal and installation tool is used in conjunction with a soft metal hammer to remove or install the camshaft bushing in the Mitsubishi K3D engine.

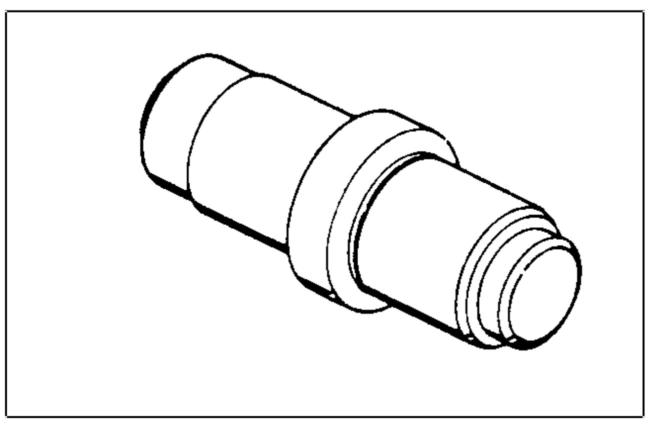


Figure 9

Adjustments

Valve Clearance (Fig. 10, 11, 12)

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.

M12 bolt torque (wet): 1.5 - 12.5 kgm (83 - 90 ft-lb)
M10 bolt torque (wet): 6.5 - 8.0 kgm (47-58 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. 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. 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^{o} clockwise to get No. 3 cylinder TDC. Turn the crankshaft an additional 240^{o} 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.

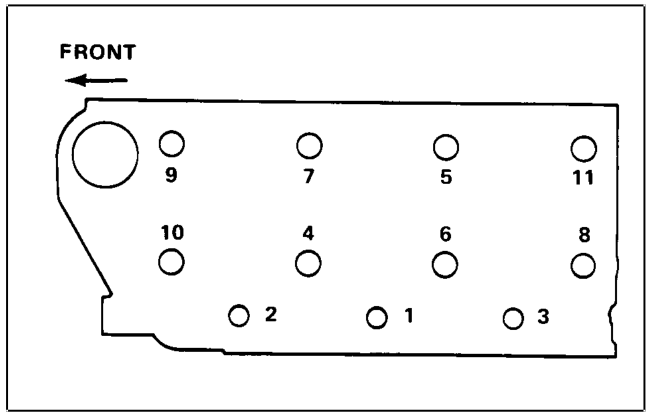


Figure 10

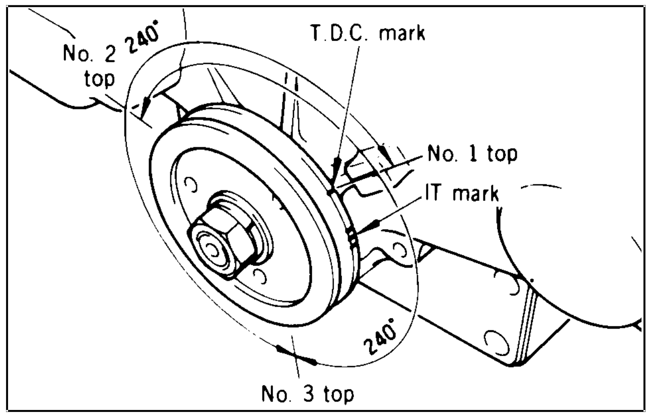


Figure 11

Figure 12

Engine Speed Adjustments (Fig. 13, 14)

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.

NOTE: This engine is equipped with a special damper spring (Fig. 14) which is designed to prevent engine stalling when the throttle decelerated quickly. Adjustment of this spring is required when adjusting the engine rpm.

High Speed Adjustment

NOTE: Specified rpm is with no load on engine.

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

Idle rpm	1500 ± 50 rpm
No load governed rpm	Setting “A” 3120 - 3160 rpm Setting “B” 3145 - 3200 rpm

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

2. Open and support the hood.

3. Remove sealing cap from damper spring adjusting bolt (Fig. 14) and loosen adjusting bolt to remove damper spring tension. NOTE: If tie rod cover was removed, make sure governor tie rod has been pushed to the high speed position before cover is installed.

4. Loosen the lock nut on the high speed set bolt (Fig. 13) and adjust maximum engine speed to setting “A” by rotating the high speed set bolt. Tighten lock nut after adjusting.

5. Tighten damper spring adjusting bolt to adjust maximum engine speed to setting “B”, then tighten locknut to secure adjusting bolt (apply Loctite 242 or equivalent to threads of adjusting bolt).

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

Idle Speed Adjustment

NOTE: Specified engine rpm is with no load on engine.

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. Make sure throttle cable is mounted correctly to allow complete travel of throttle control.

4. Loosen the lock nut on the low speed set bolt (Fig. 13) and adjust idle speed to 1500 ± rpm by rotating the low speed set bolt. Tighten the lock nut.

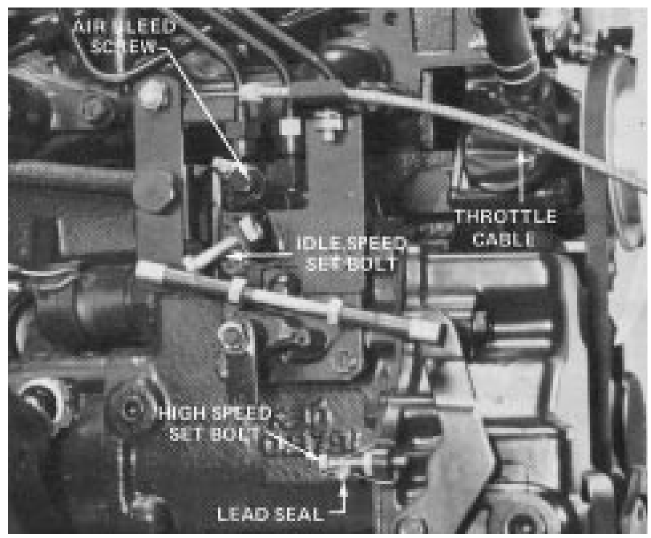


Figure 13

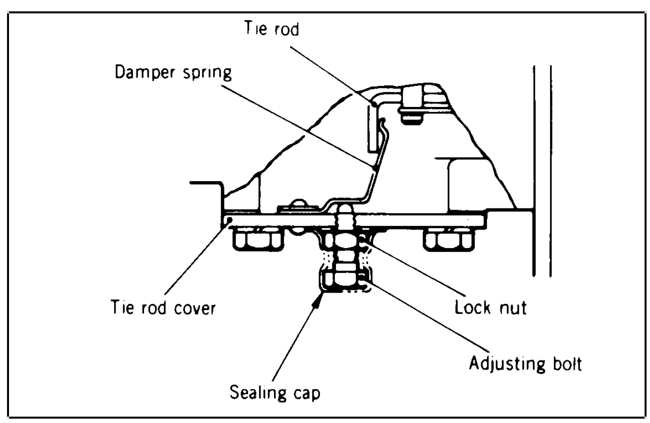


Figure 14

Throttle Linkage Adjustment (Fig. 15)

1. Loosen the capscrew and nut securing the throttle cable to throttle lever.

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

3. Move the throttle lever 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.

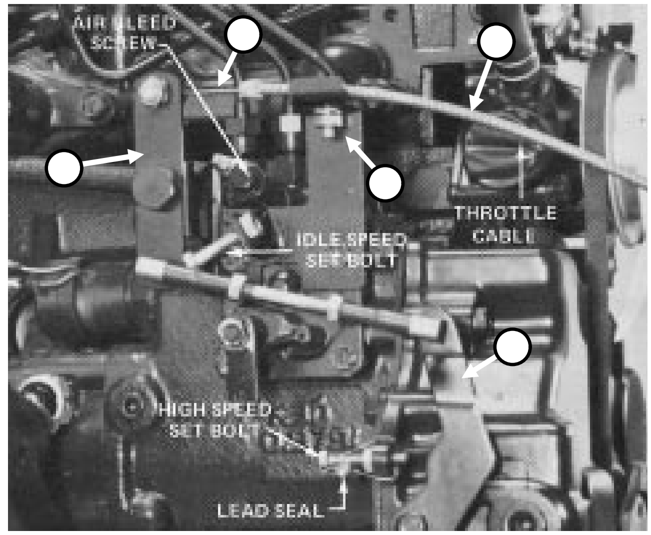


Figure 15

1. Governor lever
2. Cap screw and nut
3. Throttle lever
4. Throttle cable
5. 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 (Fig. 16)

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. If the glow plug glows red-hot, the glow plug is operating correctly.

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

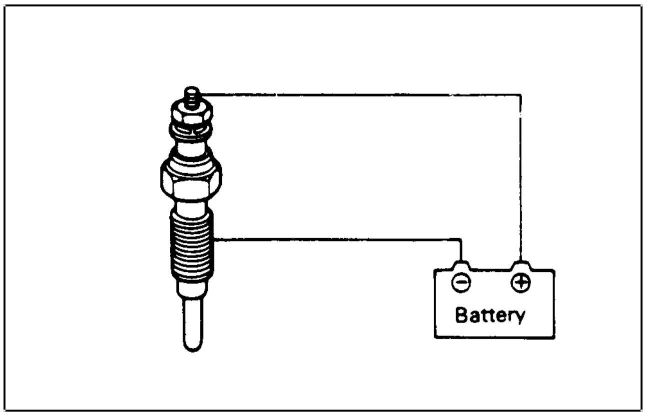


Figure 16

Compression Test (Fig. 17)

Normal cylinder compression is 32 kg/cm^2 (455 psi) at 280 rpm (normal cranking speed). The engine should be warm - coolant temperature of 50^o C (120^o 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.

4. Hold fuel shut off lever in closed position to prevent fuel delivery during compression test. This will prevent wash-down of cylinders and inaccurate readings.

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

6. If the pressure is less than 26 kg/cm^2 (370 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).

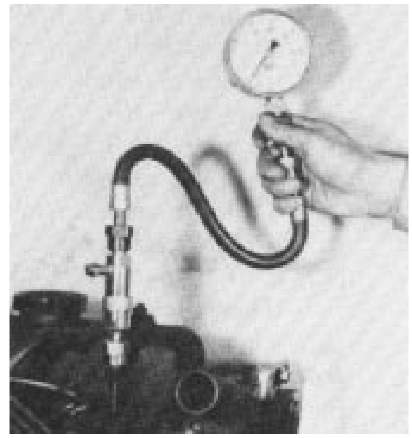


Figure 17

Nozzle Tests (Fig. 18, 19)

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.)

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.

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	120 kg/cm^2 (1700 psi)
Maximum starting pressure	130 kg/cm^2 (1850 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.

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.

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.)

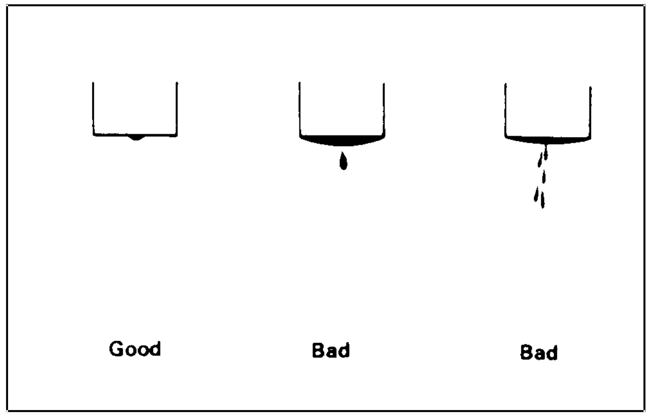


Figure 18

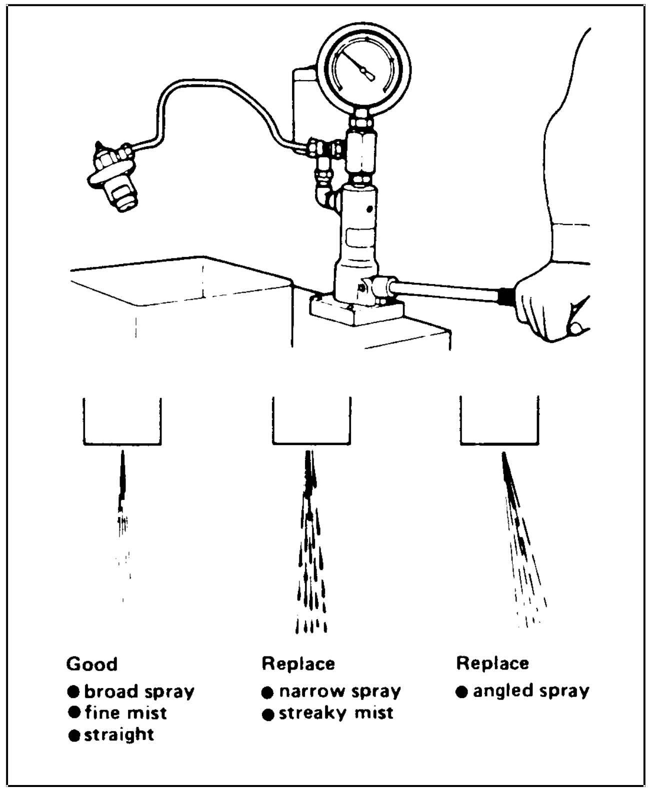


Figure 19

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.

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 (Fig. 20, 21)

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 1 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 assembly and spring.

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

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 1 cylinder compression stroke is approaching by checking the push rods. Both push rods on the number 1 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 electric fuel pump will supply fuel through the injection pump and out the number 1 delivery valve holder.

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 large screwdriver inserted between the transmission drive hub and rubber coupler will provide control and leverage to slowly rotate the engine crankshaft.)

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 23^{o} BTDC; standard fuel injection timing. The outside marks represent 25^{o} BTDC and 21^{o} 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^{o}. 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.)

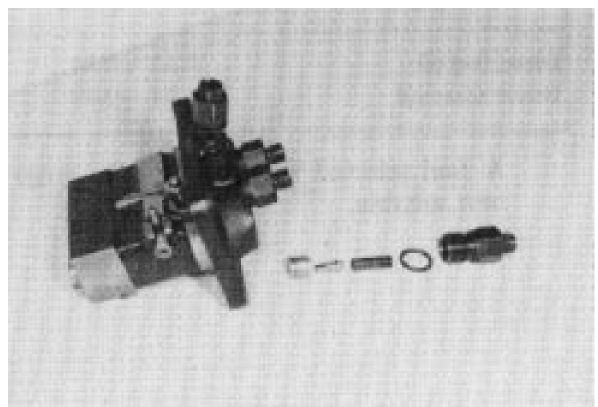


Figure 20

Removing the delivery valve

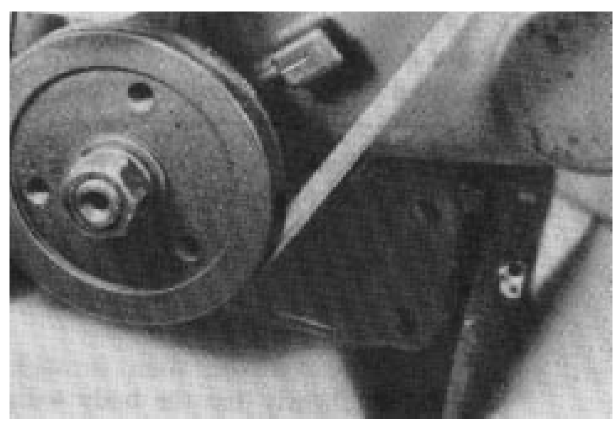


Figure 21

Fuel Pump Test (Fig. 22)

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.)

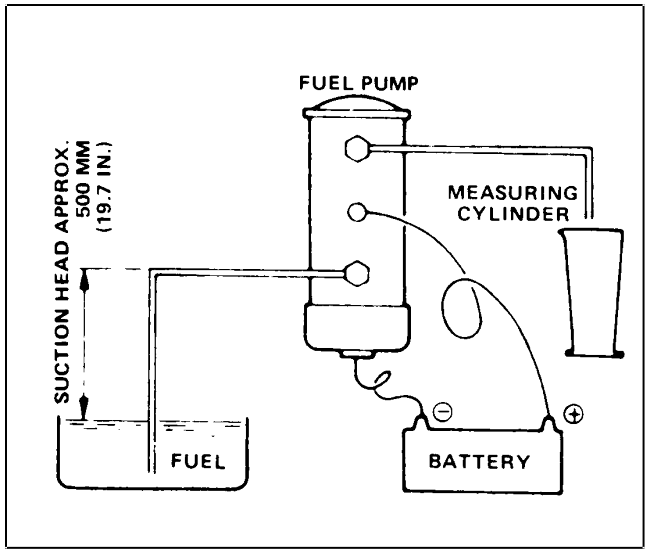


Figure 22

Thermostat Test (Fig. 23)

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^{o} C (177^{o} F).
Full-open temperature: 90^{o} C (194^{o} F)
Valve lift: 8 mm (0.314 in.)

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

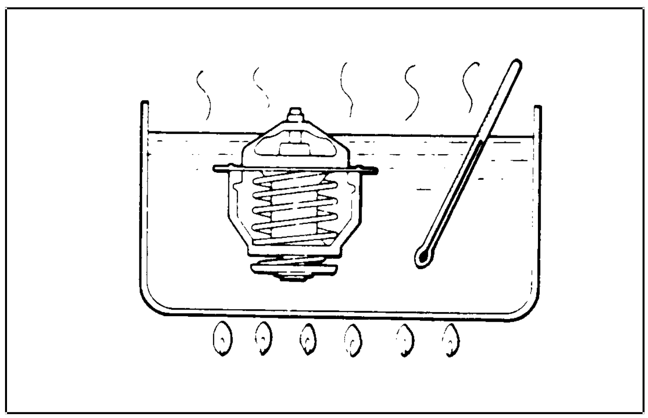


Figure 23

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.

External Engine Component Repair

In this section, repairs to the external engine components will be outlined. These are repairs which can be accomplished without removing the engine from the mower frame. They are:

Crankcase Breather
Fan, Pulley, Bearing and Shaft Repair or Replacement
Oil Pressure Switch Replacement
Oil Pump
Stop Solenoid Replacement
Water Pump Replacement

Crankcase Breather System (Fig. 24)

The crankcase breather system is shown in the illustration. Blow-by fumes are recirculated for recombustion without being discharged into the atmosphere. The fumes within the cylinder block flow into the rocker cover through holes in the valve tappets and the push rod clearance holes. They are carried through a rubber air breather pipe from the rocker cover to the inlet pipe, and then to the combustion chamber. The air breather pipe (rubber hose) should be replaced if it is damaged or shows any sign of deterioration.

Failure to periodically inspect this hose, or to replace a faulty hose, will allow dirt to enter directly into the engine cylinder, and can cause premature engine wear or damage.

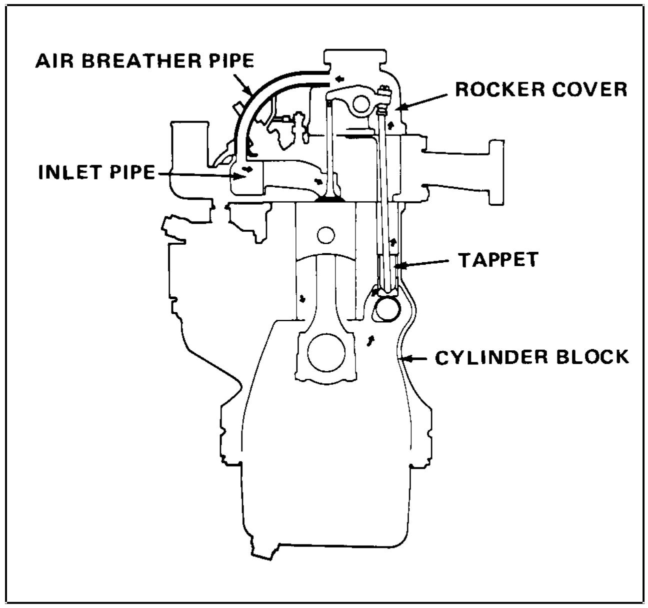


Figure 24

Crankcase breather system

Alternator Belt Service (Fig. 25)

1. Unlatch and open hood.

2. Check tension by depressing belt midway between alternator and crankshaft pulleys. Belt should deflect 7/16 in. (11 mm). If deflection is incorrect, proceed to step 3. If correct, continue operation.

3. Loosen bolt securing brace to engine and bolt securing alternator to brace.

4. Insert pry bar between alternator and engine and pry out alternator.

5. Hold alternator in position after proper belt tension setting is achieved and tighten alternator and brace bolts to secure adjustment.

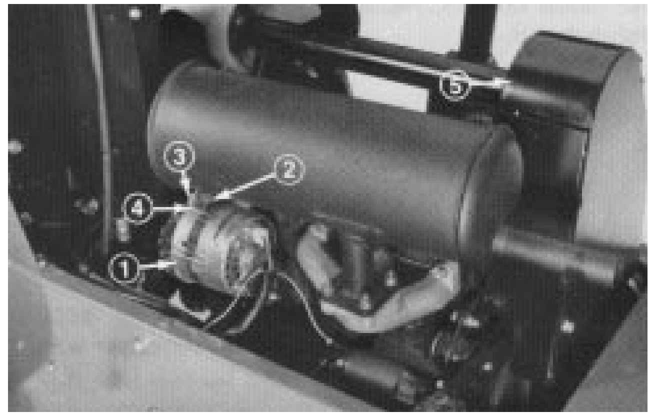


Figure 25

1. Alternator
2. Engine brace bolt
3. Alternator brace bolt
4. Brace
5. Fan belt guard

Fan Belt Service (Fig. 25, 26)

1. Unlatch and open hood.

2. Remove capscrews (5) securing fan belt guard and remove guard.

3. Belt should deflect 1/4 in. (6 mm) midway between pulleys with 5 lbf (22 N) of force applied. If deflection is incorrect, proceed to step 4. If correct proceed to step 5.

4. Loosen locknut securing idler pulley. Push idler pulley against belt until proper deflection is achieved and tighten idler pulley locknut.

5. Install fan belt guard and secure with capscrews. Close and latch hood.

To replace belt:

1. Do steps 1 and 2 above.

2. Loosen locknut securing idler pulley, slide pulley away from belt and remove belt from top and bottom pulleys.

3. Install new belt and adjust for proper tension. Push idler pulley against belt until belt deflects 1/4 in. (6 mm) with 5 lbf (22 N) of force applied midway between top and bottom pulleys. Tighten idler pulley locknut to secure adjustment.

4. Install fan belt guard and secure with capscrews. Close and latch hood.

NOTE: Check fan belt tension after first days of operation. Readjust tension, if necessary.

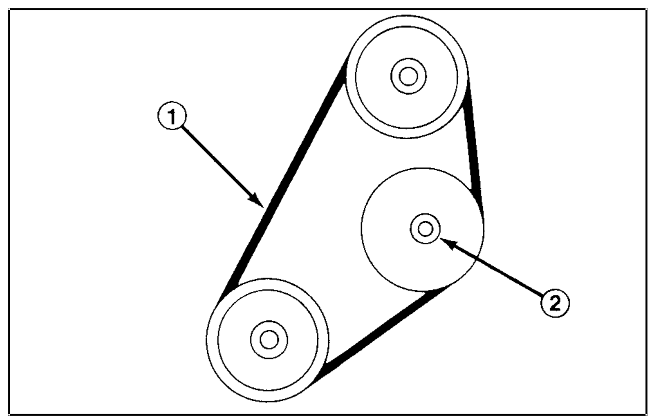


Figure 26

1. 1/4 in. (6 mm) deflection
2. Idler pulley locknut

Fan, Fan Pulley and Fan Shaft Service (Fig. 27)

Fan Assembly Removal

1. Park the machine on a level surface, turn engine off, remove key from switch, and apply the parking brake.

2. Remove five capscrews which secure fan belt guard and remove guard.

3. Loosen locknut securing idler pulley. Slide pulley to right to remove tension from fan V-belt and slip belt off of flywheel and fan pulleys.

4. Use a hoist connected to the two engine hangers to support the rear of the engine.

IMPORTANT: Position lift chain underneath fan shaft tube to prevent damage to tube.

NOTE: An alternate method is to put a sturdy board beneath oil pan and use a floor jack to support engine.

5. Remove two cap screws which pass through rubber engine mounts. If shims are used between rubber mounts and metal engine mount (bar), be sure to note their locations and reinstall them correctly.

6. Remove two cap screws which fasten fan mount to the rear of engine block. These are located just above edge of flywheel.

7. Remove four cap screws which secure fan mount to front of cylinder head, cylinder block and muffler bracket.

8. Remove fan assembly from machine.

9. Remove cotter pins, slotted nuts, woodruff keys and washers from ends of the fan shaft. Note number and placement of washers.

10. Remove pulley from end of shaft (it may be necessary to use a puller).

11. Remove cap screws and lock washers which retain fan to fan hub. Remove fan hub and woodruff key from shaft.

NOTE: If bearings or mating tube and shaft surfaces are not worn or damaged do not disassemble.

12. Press shaft and fan-side bearing from tube by pressing on belt pulley end of shaft. Inner races of bearings are pressed onto shaft and fit against shoulders on shaft; both bearings are also pressed into tube ends.

13. Press remaining bearing from tube by applying pressure to bearing outer race.

Fan Assembly Inspection

1. Inspect fan for cracks; replace fan if damaged.

2. Inspect shaft and tube for signs of wear in bearing areas; replace if bearings are loose and a press-fit is not possible.

3. Rotate bearings; replace them if they do not rotate smoothly, or if there is noticeable play in them.

Fan Assembly Installation

1. Clean inside of pulley end of tube and outside diameter of pulley end bearing. Apply Loctite #609 (or equivalent) to outside diameter of bearing and press bearing into pulley end of tube.

2. Insert shaft through tube and into installed bearing. Support inner race of bearing as shaft is being installed into bearing.

3. Position second bearing (no Loctite on this bearing) onto fan end of shaft. Press bearing into tube.

4. Position woodruff key in fan shaft and slide pulley onto shaft. Fit flat washer and shim washer(s) to shaft and install slotted hex nut. Torque nut from 50 to 70 ft–lb (68 to 94 N–m).

5. Position woodruff key in fan shaft and slide fan hub onto shaft. Install fan to fan hub with cap screws and lock washers. Fit flat washer and shim washer(s) to shaft and install slotted hex nut. Torque nut from 50 to 70 ft–lb (68 to 94 N–m).

IMPORTANT: If hex nut slot and cotter pin shaft hole do not align after applying correct torque to slotted hex nut, remove nut and add shim washers until alignment is correct. DO NOT loosen nut to align the slot and hole.

6. Install new cotter pins through slotted nut and fan shaft to retain both pulley and fan hub.

7. Reinstall fan assembly onto engine by performing removal steps 1 through 8 in reverse order.

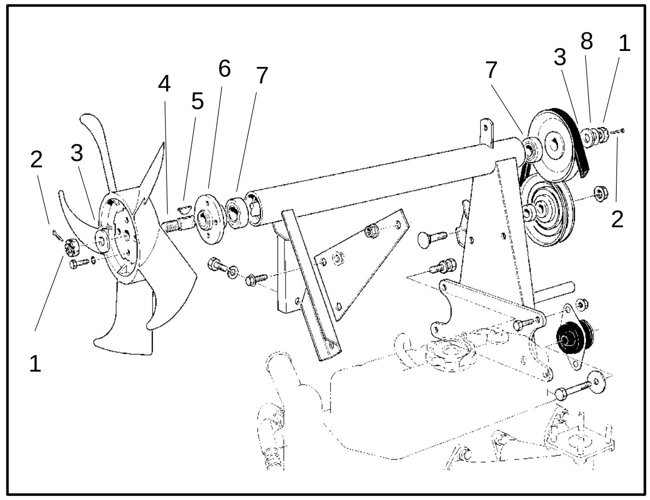


Figure 1

1. **Slotted hex nut**
2. **Cotter pin**
3. **Flat washer**
4. **Fan shaft**
5. **Woodruff key**
6. **Fan hub**
7. **Bearing**
8. **Shim washer**

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Glow Plug Replacement

If a glow plug has been determined to be defective by failing the glow plug test, it should be replaced.

1. Remove the nut and lead wire.

2. Clean the area around the glow plug to prevent dirt or grit from falling into the glow plug hole and the cylinder during replacement.

3. Remove the defective glow plug from its mounting hole.

4. Install the replacement glow plug. Torque the glow plug to 11 - 14.5 ft-lb (1.5 - 2 KgM).

5. Reinstall the lead wires and nuts.

Oil Pressure Switch Replacement (Fig. 28)

The engine is equipped with an oil pressure switch which activates a lamp and buzzer on the control panel if the oil pressure drops below safe levels during operation. The switch is located on the oil pump at the rear of the right-hand side of the cylinder block.

The switch and lamp circuit can be tested with a 12 VDC battery. With the switch removed the warning

lamp should light and buzzer sound when it is connected in series with the switch and battery. Removing the switch from the circuit will test the lamp and buzzer only.

If the switch is defective it should be replaced. Use a small amount of LOCTITE #567 Thread Sealant (or equivalent) on the switch threads. Be careful to install the switch carefully so that the sealant will not block the oil hole in the switch.

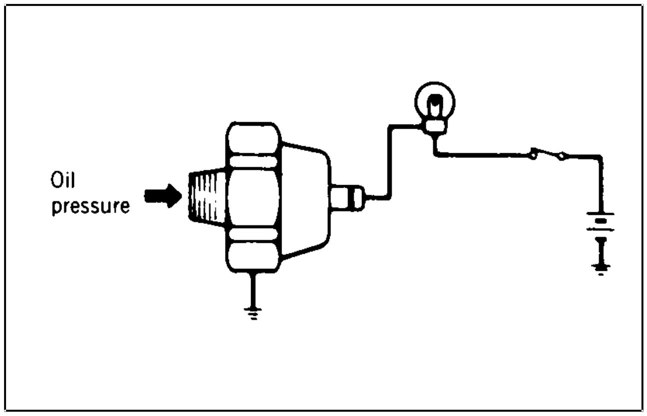


Figure 28

Oil Pump Servicing

The oil pump is a trochoid gear type pump, mounted to the rear of the fuel injection pump, and driven by the fuel injection pump camshaft. The pump houses a check valve which opens to the oil pan when the pump delivery pressure exceeds 57 psi (393 kPa), thereby preventing excessive oil pressure.

Disassembly of Oil Pump (Fig. 29)

1. Drain the engine oil.

2. Remove the oil filter. The use of a filter wrench may be necessary.

3. Remove the four bolts which hold the pump cover in place and attach the pump to the cylinder block.

4. Remove the pump cover, body and rotors and gasket.

Oil Pump Inspection (Fig. 30, 31, 32)

The oil pump, or its worn components, should be replaced when internal pump clearances exceed those shown in the table above.

1. Outer Rotor to body clearance should be checked with a feeler gauge. If clearance exceeds the service limit, replace the rotor assembly.

2. Outer rotor to Inner Rotor clearance should be checked with a feeler gauge. If clearance exceeds the service limit, replace the rotor assembly. Check the coupling end of the Inner Rotor shaft for cracks or damage.

3. Rotor to cover clearance should be check with a feeler gauge by placing the rotor assembly in the pump body and using the cover as a straight edge.

In case of excessive clearance, replace either the Rotor Assembly or the Oil Pump Body.

4. Inspect the Pump Body 0-ring for cuts, cracks or other damage.

5. The Pump Relief Valve can be disassembled by removing the plug, gasket, spring and plunger. Ensure that the Relief Plunger travels freely, and that the drain holes in the Plunger are not blocked.

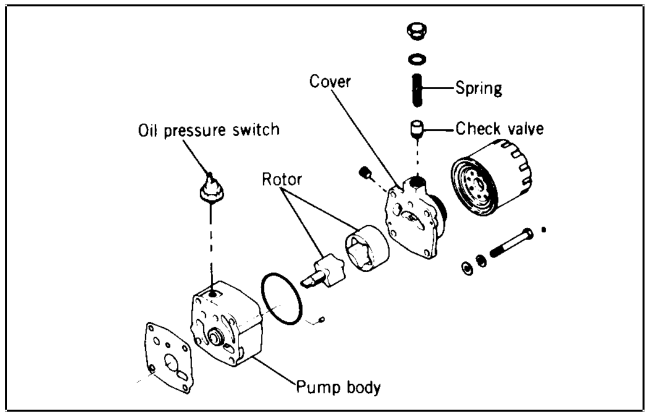


Figure 29

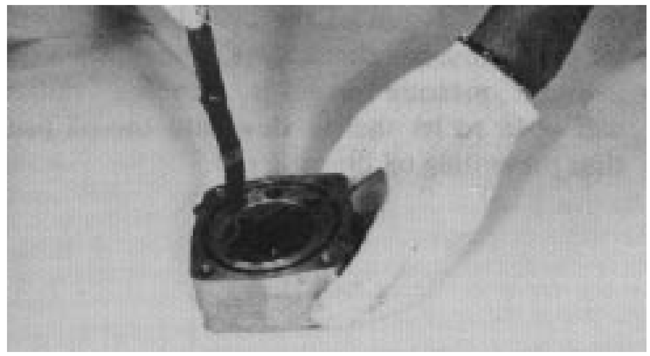


Figure 30

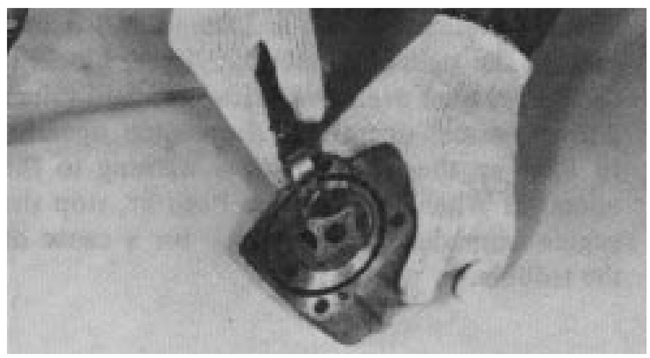


Figure 31

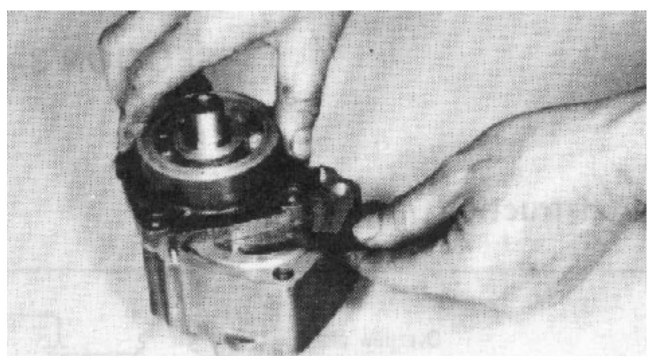


Figure 32

Oil Pump Reassembly (Fig. 33)

1. Install the Plunger, Spring, Gasket and Plug of the Oil Relief Valve into the Pump Cover.

2. Verify that the dowel pins are in place, and install the 0-ring in the pump body (if replaced or removed).

3. Place the Rotor Assembly into the Pump Body. Apply oil to the rotating parts.

NOTE: The Inner and Outer Rotors have a dimple which faces outward from the Pump Body.

4. Place the Pump Body, along with a new oil Pump Body Gasket, in position, and rotate the rotor assembly until the inner rotor shaft couples with the slot in the injector pump cam shaft.

5. Position the Pump Cover on the dowel pins and secure the pump into positions with the four bolts, washers, and lock washers. Torque the bolts to 12 - 13 ft-lb (1.7 KgM).

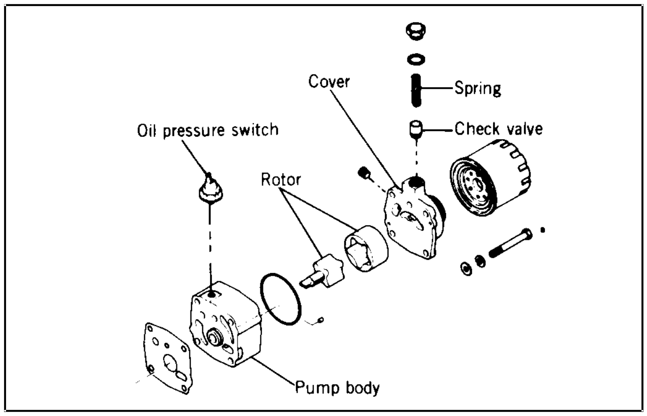


Figure 33

Stop Solenoid Replacement (Fig. 34)

The Mitsubishi engine uses an electrical solenoid to shut off the fuel supply and stop the engine. An emergency stop lever is provided in case the stop solenoid fails. If a solenoid failure is suspected, it can be checked by attaching 12 VDC battery leads to the solenoid terminals. If the solenoid operates when battery contact is make the stopping failure is elsewhere in the electrical system (refer to Chapter 6).

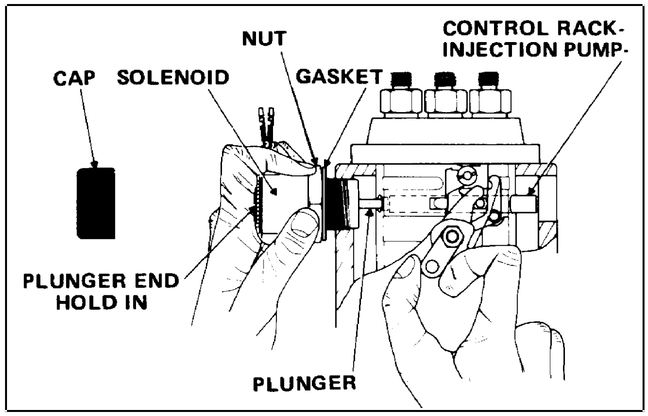


Figure 34

1. Turn the engine off (with emergency stop lever if necessary), and remove the key from the ignition switch.

2. Disconnect the solenoid wires from the main wire harness.

3. Loosen the nut securing the solenoid to the engine and unscrew the solenoid. (Use a 36 mm wrench.)

4. Remove the gasket and the nut and install them on the new solenoid. Thread the nut fully onto the solenoid. Remove the cap from the old solenoid.

5. Start to thread the solenoid into the cylinder block.

6. Push the plunger on the solenoid fully in and hold it in this position.

7. Rotate the emergency engine stop lever to the STOP position (counterclockwise).

8. Continue to hold the solenoid plunger in and thread the solenoid into the cylinder block until the inner end of the plunger contacts the control rack of injector pump. Contact will be indicated when the outside end of the plunger is pushed away from the solenoid body.

9. When contact is indicated, discontinue threading the solenoid into the cylinder block. Turn the solenoid slowly outward until the plunger again contacts the solenoid body, then rotate the solenoid body one eighth turn further out.

10. Hold the solenoid body to prevent it from turning and tighten the nut against the cylinder block to secure the adjustment. DO NOT over tighten the nut or the solenoid may become distorted causing it to malfunction.

11. Connect the solenoid wires, install the cover.

Water Pump Servicing

The water pump is a centrifugal impeller type pump which is mounted on the front upper part of the cylinder block. The pump bearings and seals are not serviceable.

Water Pump Removal

1. Drain the coolant from the radiator and cylinder block (drain plug on the left-hand side of the block).

2. Disconnect the water hoses.

3. Remove the V-belt which drives the water pump.

4. Disconnect the water bypass hose.

5. Remove the six bolts fastening the water pump to the cylinder block.

Water Pump Inspection

1. Inspect all hoses for cracks or leaks.

2. Rotate the water pump impeller and shaft. If the bearings do not rotate smoothly, or are noisy, the water pump must be replaced; the water pump has no replaceable components.

Water Pump Reassembly

Reassemble in reverse order of disassembly. Use a new water pump gasket to avoid leaks.

now move freely when operated by hand. If it does not, difficulty with the injection pump should be suspected.

Fuel System Service

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 (Fig. 35, 36)

1. Stop the engine and engage the parking brake. Unlatch and raise hood.

2. Loosen the air bleed screw on the fuel filter / water separator.

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 bleed screw on the fuel injection pump.

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.)

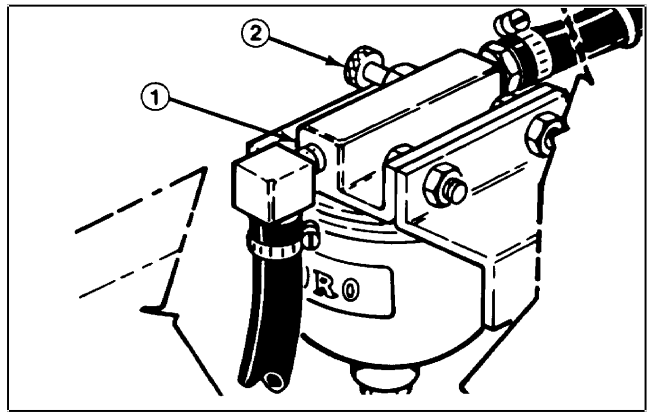


Figure 35

1. Fuel filter/water separator 2. Air bleed screw

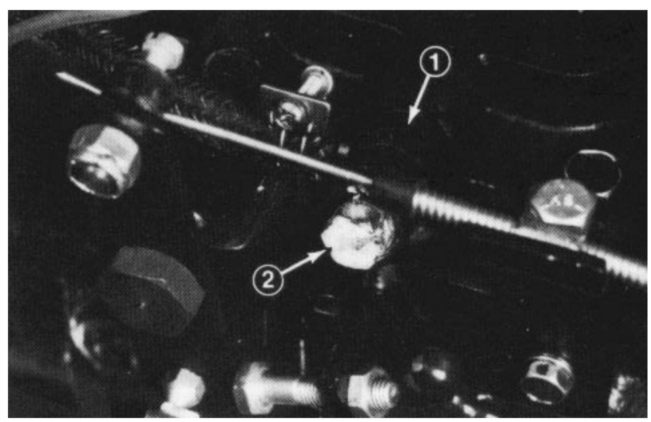


Figure 36

1. Fuel injection pump 2. Air bleed screw

Bleeding Air From the Injectors (Fig. 37)

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 1 nozzle and holder assembly on the cylinder head .

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 37

Fuel Pump Service (Fig. 38)

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. Remove the gasket, magnet and filter element.

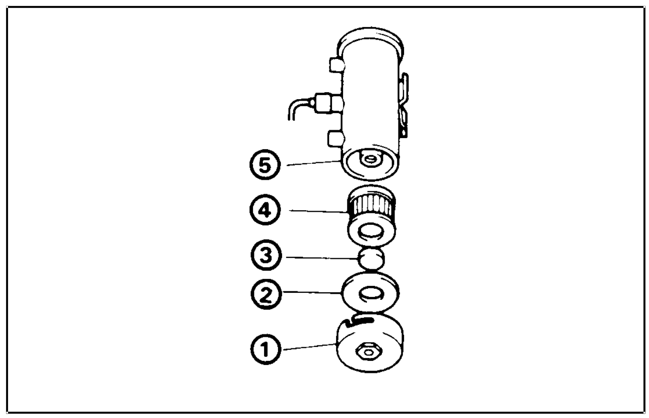


Figure 38

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

5. Carefully remove the spring retainer from the end of the plunger tube. 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.)

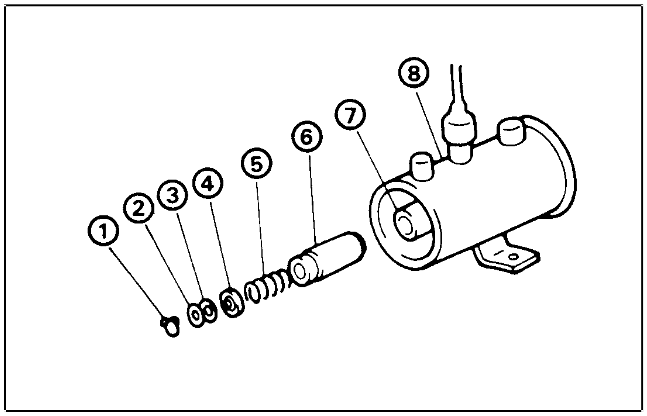


Figure 39

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

Governor Mechanism Operation

Operation of the governor keeps the engine speed constant as the centrifugal force acting on the governor weights balances with the tension of the governor spring.

As the engine speed increases the governor weights will open, forcing the end of the sliding shaft against the governor lever. The governor lever then moves against the governor spring tension and moves the control rack, through the tie rod, in the direction that decreases the amount of fuel delivered by the injection pump. A leaf spring on the tie rod cover is used to prevent stalling during rapid deceleration by limiting the travel of the tie rod.

Servicing the governor requires removal of the gear case on the front of the engine, and there for engine removal.

Governor Inspection (Engine Not Removed) (Fig. 40)

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

1. Remove the tie rod cover and operate the speed control lever. The injection pump control rack should move as the lever is operated.

2. If the control rack does not move, remove the tie rod retaining spring and tie rod from the control rack. The control rack should now move freely when operated by hand. If it does not, difficulty with the injection pump should be suspected.

3. With the tie rod removed from the control rack, operate the speed control lever and watch for tie rod travel. Failure of the tie rod to move would indicate difficulty with the governor spring, governor lever or other internal parts. Refer to “Removing and Replacing the Engine” for engine removal instructions.

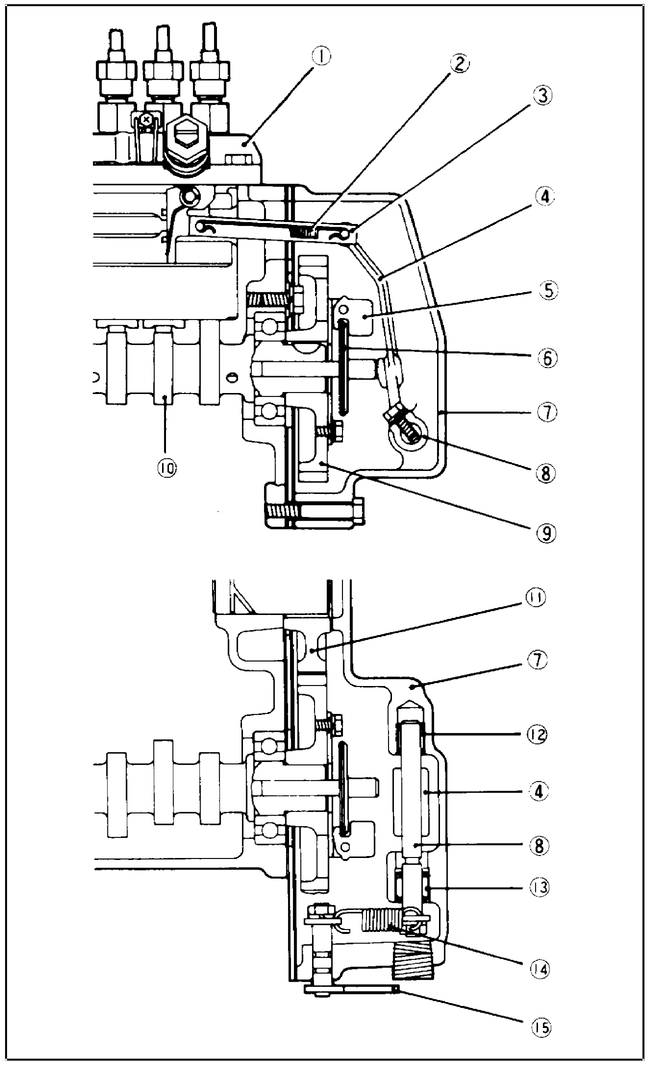


Figure 40

1. Injection pump
2. Stopper spring
3. Tie rod
4. Governor lever
5. Governor weight
6. Sliding shaft
7. Gear case
8. Governor shaft
9. Pump gear
10. Pump camshaft
11. Idle gear
12. Needle bearing
13. Needle bearing
14. Governor spring
15. Speed control lever

Injection Pump Servicing (Fig. 41)

A built-in three-cylinder injection pump is mounted

on the right-hand side of the cylinder block. It

consists of a pump element (plunger and barrel assembly), a delivery valve, a tappet and a smoke set unit. As the pump cam rotates, the plunger is moved up and down through a prescribed stroke, delivering fuel to the engine cylinders. A key operated stop system is provided.

Fuel Injection Control

The fuel injection rate is controlled by changing the effective stroke of the plunger within the barrel. The plunger is rotated by the control pinion which meshes with the plunger lower collar to directly turn the plunger.

As the engine turns, the injection pump camshaft rotates to move the control rack by way of the governor weights, governor sleeve, and lever. The control rack slides to turn the control pinions. Movement of the control rack to the right decreases the fuel injection rate and movement to the left increases the rate.

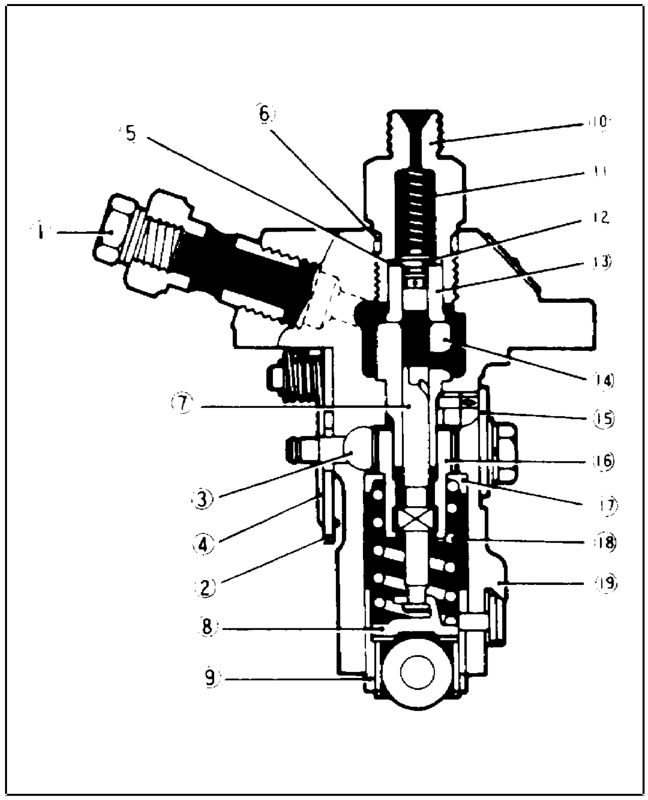


Figure 41

1. Air vent screw
2. Stopper
3. Control rack
4. Return spring
5. Gasket
6. O-ring
7. Plunger
8. Lower seat
9. Tappet
10. Valve holder
11. Spring
12. Delivery valve
13. Valve seat
14. Plunger barrel
15. Adjusting plate
16. Control pinion
17. Upper seat
18. Plunger spring
19. Pump housing

Control Rack Smoke Set and Ungleich Device (Fig. 42, 43, 44)

The injection pump on the is equipped with a mechanism that allows for over injection of fuel during starting, and thereafter limits the amount of fuel delivered during operation to reduce excessive exhaust smoke. These devices, the smoke set plate and Ungleich set plate, are located on the side of the injection pump and operate by limiting the travel of the control rack.

The Ungleich device requires that the engine be OFF, either with the key switch or emergency stop lever, in order for the control rack to travel completely to the left (over-injection). Once started, the action of the governor causes the control rack to move to the right (less fuel) until the corner of the smoke set plate engages the shoulder of the Ungleich set plate. The amount of control rack movement is now restricted by the locations of the smoke set plate and the Ungleich set plate.

During extreme loading the control rack will overcome the tension on the smoke set spring and slightly increase the amount of fuel delivered to the cylinders. This fuel increase is determined by the Ungleich set plate and is referred to as Ungleich Effect “L” (length).

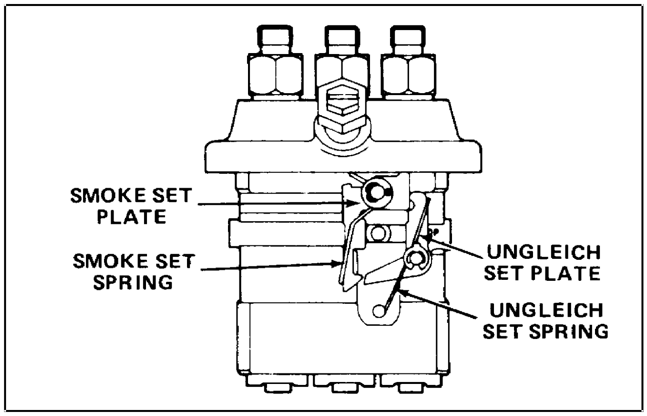


Figure 42

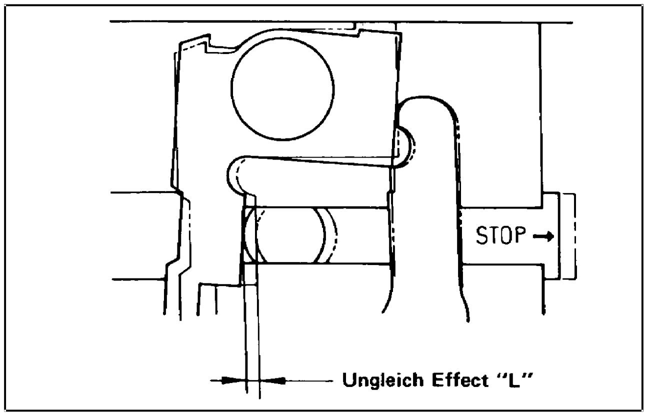


Figure 43

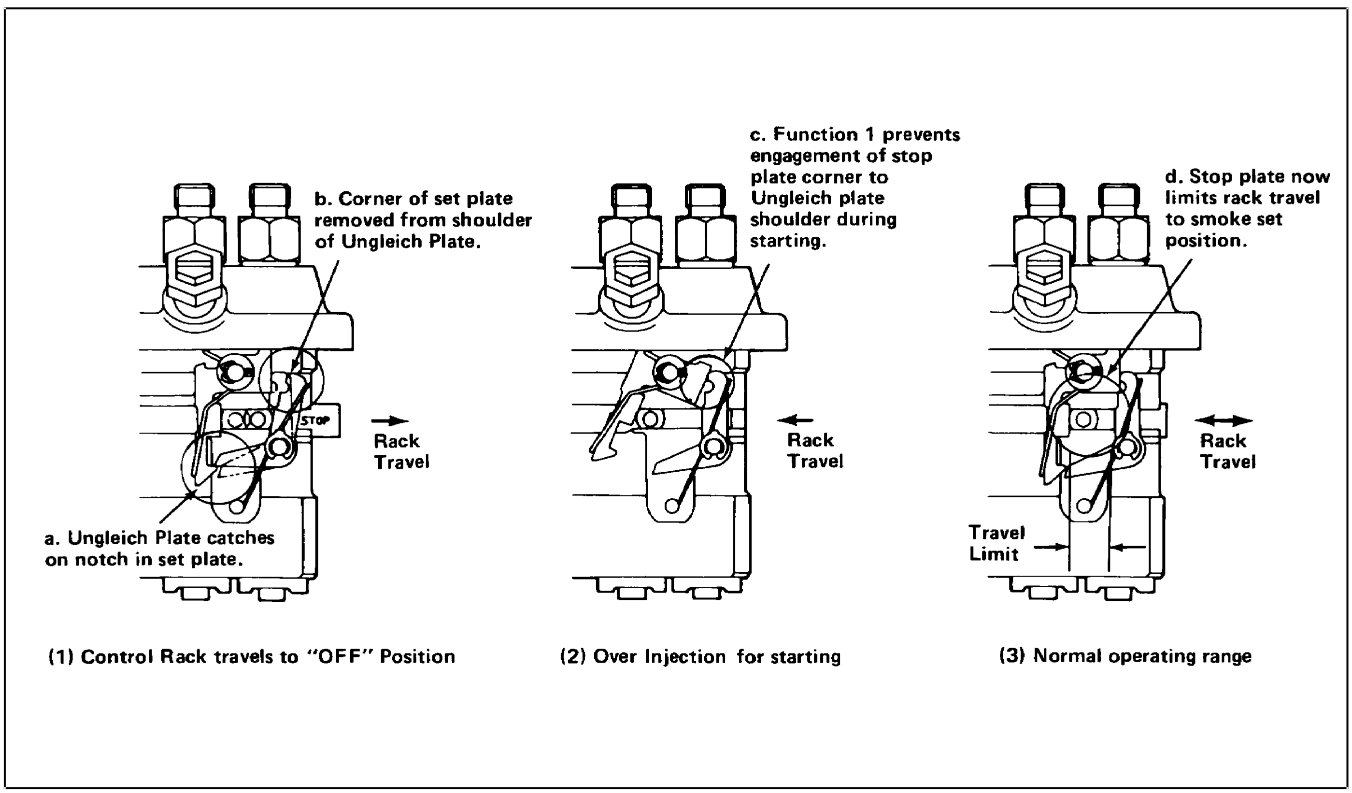


Figure 44

Delivery Valve Operation (Fig. 45)

The delivery valve serves two functions. First, the valve opens to deliver fuel to the delivery pipe when the pressure generated by the stroke of the plunger within the barrel is sufficiently high. The pressure must be high enough to cause the injector nozzle to open. Second, after injection into the cylinder the Delivery Valve closes, reducing the pressure within the delivery pipe to nearly zero while preventing fuel from flowing from the tube.

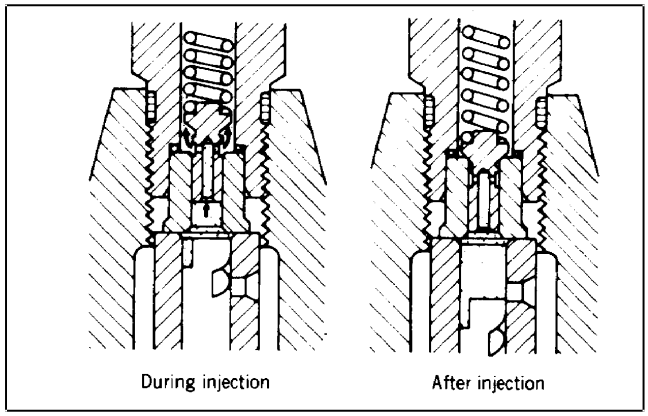


Figure 45

Inter-Cylinder Injection Control (Fig. 46)

The amount of fuel delivered to each of the three cylinders is adjusted by means of adjusting plates. These plates function as a cam to position the plunger barrel within the pump housing.

IMPORTANT: Do not remove the Adjusting Plates from the pump housing. If removed, re-calibration by a diesel shop will be necessary.

If it is necessary to remove the plates, carefully scribe the plate and pump body to allow for exact, correct reassembly.

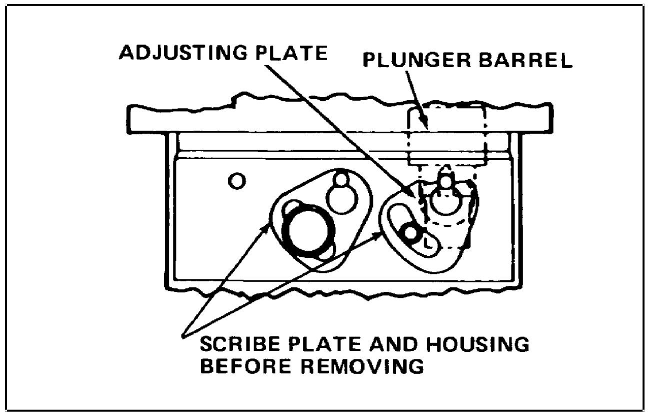


Figure 46

Injection Pump Disassembly (Fig. 47)

The injection pump may be disassembled to replace worn, damaged or defective components according to the following procedures:

IMPORTANT: Clean external engine area near injection pump before disassembly. Do not spray water on a hot injection pump. Do not remove Inter-cylinder adjusting plates unless necessary. If necessary, scribe plates and housing carefully to ensure exact repositioning upon reinstallation. Do not mix delivery valves, delivery valve seats, plungers or plunger barrels from one cylinder to another. Handle these parts carefully. Place these parts in clean diesel fuel to prevent rust.

1. Remove the fuel pipes from the injection pump to the injector nozzles.

2. Remove the fuel return hose by disconnecting the collar from the pump, or by removing the hose clamp.

3. Remove the tie rod cover. Disconnect the Tie Rod retaining spring and Tie Rod from the Control Rack.

4. Remove the four injection pump mounting bolts.

5. Remove the injection pump from the cylinder block. Make note of the number and thickness of the adjusting shims under the pump. The shims determine the injection timing.

6. Straighten the locking tabs on the plate which retains the Tappet Guide Pin). Rotate the pin 180", push in on the Tappet slightly and remove the Guide Pin and Tappet.

7. Remove the Lower Seat, Plunger Spring, Upper Seat, Control Pinion and Plunger.

8. Remove the Delivery Valve Holder, Gasket, 0-ring, Valve Spring and Delivery Valve. Push the barrel assembly out from below.

9. Remove the components of the other two injector pumps using the same procedure.

10. To remove the Control Rod, remove the E-rings, Ungleich set spring, and Ungleich set plate. Slide the rack from the pump body.

11. To remove the smoke set plate, remove the cotter pin, washer and return spring.

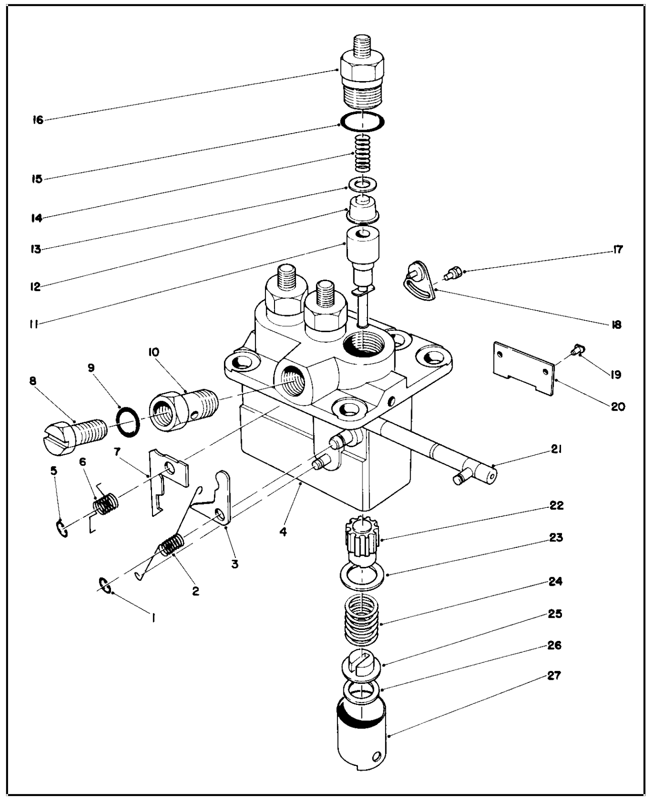


Figure 47

1. E-ring
2. Ungleich set spring
3. Ungleich set plate
4. Pump housing
5. E-ring
6. Return spring
7. Smoke set plate
8. Air breather screw
9. Washer
10. Hollow screw
11. Pump element ass'y
12. Delivery valve ass'y
13. Gasket
14. Delivery valve spring
15. O-ring
16. Delivery valve holder
17. Bolt/washer
18. Adjusting plate
19. Tappet guide pin
20. Plate
21. Control rack
22. Plunger control sleeve
23. Upper spring seat
24. Pump plunger spring
25. Lower spring seat
26. Shim plate
27. Tappet

Injection Pump Inspection (Fig. 48)

1. Inspect the contact surfaces of the delivery valve seat. Replace the Delivery Valve Assembly if defective.

2. Inspect the plunger and barrel for wear, damage or rust. Check to see that the plunger slides smoothly in the barrel. Replace the Pump Element Sub-Assembly if defective.

3. Inspect the Control Rack and Pinions for worn or damaged teeth. Replace worn or damaged components.

4. Inspect the Tappet outside diameters, rollers and shafts for wear or damage. Replace damaged or worn components.

Figure 48

Injection Pump Reassembly (Fig. 49, 50)

NOTE: Wash each part thoroughly in clean diesel fuel as it is reassembled.

1. Install the Control Rack, Smoke Set and Ungleich plates, retainer springs and fasteners.

2. If the adjusting plate assemblies have been removed, reinstall them, paying careful attention to install them according to the marks scribed on the pump housing and plates.

3. Install the Plunger Barrel into the bore in the top of the Pump Housing. Make sure that the groove in the barrel aligns with the pin in the side of the bore.

4. Install the delivery valve and seat, gasket, spring, 0-ring and Valve Holder and hand tighten the assembly. Be careful not to damage the 0-ring when installing it onto the valve holder.

5. Install the control pinion by positioning it so that the deeply cut tooth is aligned with the grooves in the Control Rack.

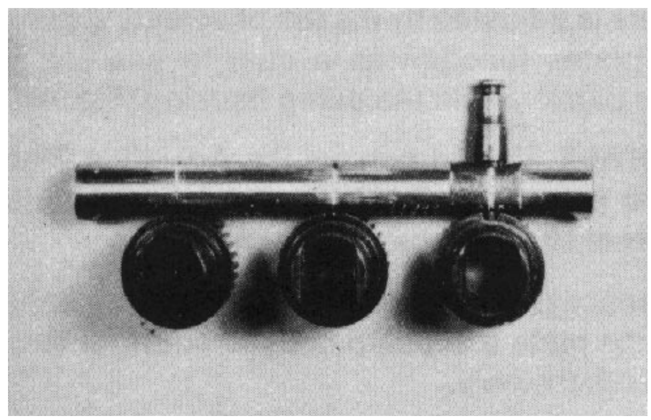


Figure 49

Alignment of pinions and control rack

6. Install the upper spring seat and spring.

7. Assemble the lower spring seat to the plunger. Insert the plunger into the barrel with the side of the plunger collar marked “L” towards the control rack.

NOTE: the collar and pinion are designed to prevent incorrect installation.

8. Insert the tappet carefully to avoid dropping the shim. Align the tappet guide hole with the hole for the tappet guide pin. Install the guide pin locking plate and guide pin. Rotate the guide pin to lock its edge under the lip on the pump housing and lock the pin by bending the plate tab.

9. Torque the Delivery Valve Holder to 28.9 - 36.2 ft-lb (4 - 5 KgM). Ensure that the control rack slides smoothly, with little resistance. Sliding force should be 1.75 oz. (50 g) or less. If the rack binds, it is assembled incorrectly or parts are dirty, and it must be reassembled or cleaned.

10. Repeat the procedure for the other remaining cylinders.

11. Install the injection pump to the cylinder block. Make certain that the same number and size shims that were under the pump when removed are replaced correctly.

12. Connect the Tie Rod and Tie Rod Retaining Spring to the Control Rack.

13. Push the control rack to the high speed position (left) and reinstall the tie rod cover using a new cover gasket.

14. Reassemble the fuel return line and delivery pipes.

15. Bleed the air from the fuel system. Refer to “Bleeding Air From Fuel System,”.

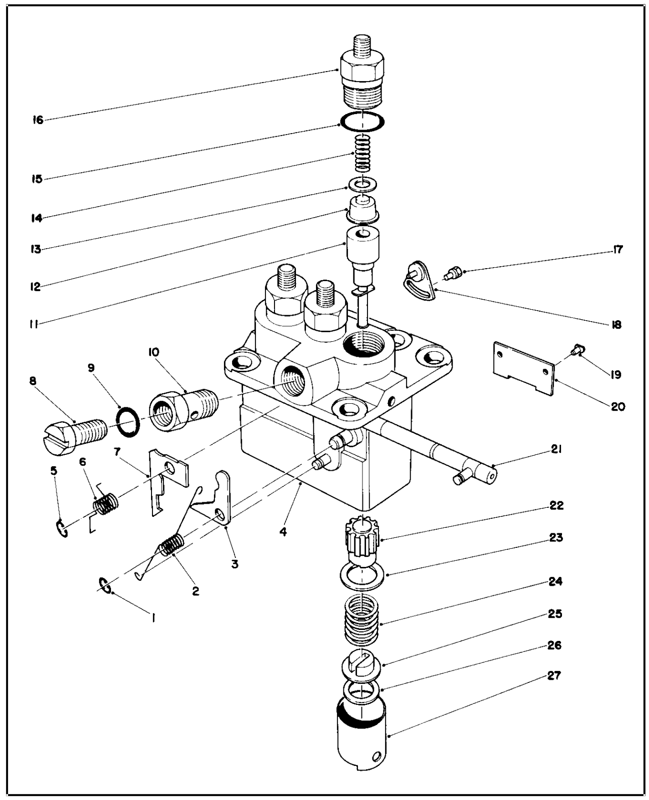


Figure 50

1. **E-ring**
2. **Ungleich set spring**
3. **Ungleich set plate**
4. **Pump housing**
5. **E-ring**
6. **Return spring**
7. **Smoke set plate**
8. **Air breather screw**
9. **Washer**
10. **Hollow screw**
11. **Pump element ass’y**
12. **Delivery valve ass’y**
13. **Gasket**
14. **Delivery valve spring**
15. **O-ring**
16. **Delivery valve holder**
17. **Bolt/washer**
18. **Adjusting plate**
19. **Tappet guide pin**
20. **Plate**
21. **Control rack**
22. **Plunger control sleeve**
23. **Upper spring seat**
24. **Pump plunger spring**
25. **Lower spring seat**
26. **Shim plate**
27. **Tappet**

Injection Pump Pressure and Delivery Rate

Injection pump pressure and the delivery rate of the pump, as well as inter-cylinder delivery rates must be determined by the use of specialized equipment. If difficulties with the injection pump are suspected the help of a competent diesel engine service shop should be sought.

Injection Pump Timing and Adjustment

Adjusting the shim thicknesses as explained on, “Injection Timing Test,” will adjust the injection timing.

NOTE: If timing requires adjustment, and the engine has not been worked on, or the shim thickness changed, the injection pump components and camshaft should be inspected for wear or damage.

Nozzle Servicing (Fig. 51)

The fuel from the injection pump flows through the injection pipes to the nozzle. During the injection stroke of the pump, pressurized fuel builds up in the nozzle. When the pressure becomes sufficiently high, the nozzle valve opens and a spray of fuel is injected into the combustion chamber where it is ignited due to the heat produced by the cylinder compression. If the nozzle does not function properly, starting failure, low power output, or engine knocking can occur.

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

Nozzle Testing

Refer to “Nozzle Tests” for complete instructions.

Nozzle Removal and Disassembly

1. Remove the fuel overflow line from the

nipple on the nozzle body.

2. Disconnect the fuel injection pipe from the nozzle body.

3. Remove the two bolts which pass through the nozzle flange and remove the nozzle assembly from the cylinder head. Remove the copper nozzle holder gasket.

NOTE: Further disassembly of the nozzle is not required for testing purposes.

4. Secure the retaining nut in a vise which is equipped with aluminum or brass jawplates and loosen the nozzle body with a wrench.

5. Remove the nozzle body, shim, pressure spring, flange, pressure pin and distance piece.

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

Inspection and Cleaning

1. Clean the inside and outside of the retaining nut in clean diesel fuel 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. Stubborn deposits may be removed with brass wired brush.

IMPORTANT: Do not use a steel brush, steel wool, etc. or the nozzle hole or pin tip may become damaged and need to be replaced.

3. Clean the flange, body, shim, spring, pin and distance piece in clean diesel fuel. Replace any worn or damaged parts.

Reassembly and Test

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

2. Install the shim, pressure spring and flange in the body. Assemble the body to the retaining nut. Torque the body and nut to 43 - 58 ft-lb (6 - 8 KgM).

3. Test the reassembled nozzle for proper operation. Refer to “Nozzle Tests.”

Installation

1. Install a new nozzle holder gasket onto the nozzle.

2. Position the nozzle assembly on the head and install the bolts through the flange. Alternate tightening the bolts to ensure even pressure on both sides of the flange. Torque the bolts to 11 - 15 ft-lb (1.5 - 2 KgM).

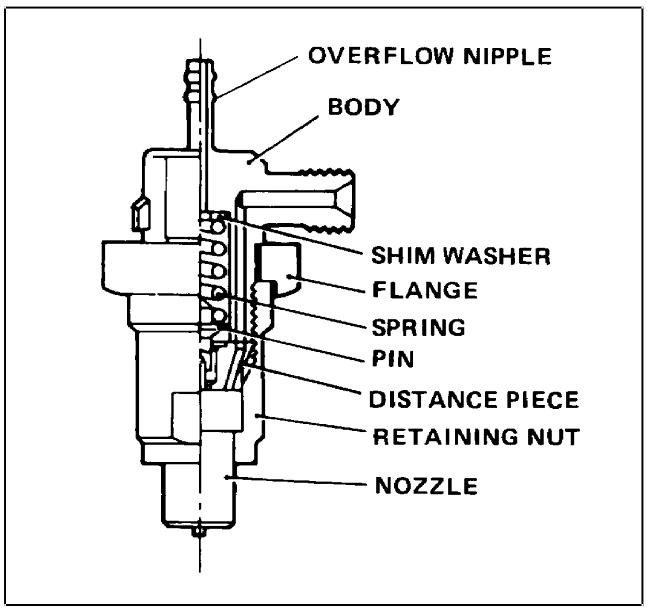


Figure 51

Removing and Installing the Engine

Removing the Engine

1. Put machine on a level surface, stop engine, remove key from ignition switch and engage parking brake.

2. Remove intake hose from air cleaner and carburetor.

3. Remove transmission drive coupling (see Chapter 10 - Transmission Coupler and PTO).

4. Remove PTO belt (see Chapter 10 - Transmission Coupler and PTO).

5. Disconnect battery cables from battery terminals.

6. Disconnect and tag all wires connected to engine and engine accessories.

7. Put a drain pan under radiator, loosen radiator cap, loosen radiator petcock and allow radiator to drain completely.

8. Move drain pan under lower radiator hose. Disconnect hose from radiator and allow coolant to drain into pan. Remove lower and upper radiator hoses.

9. Move drain pan under rear of engine and remove cylinder block plug (located above starter) to drain coolant from cylinder block. Install cylinder block plug.

10. Disconnect throttle control cable from throttle bracket.

11. Remove fuel line from outlet side of fuel filter/water separator.

NOTE: Be prepared to insert a plug into fuel line to prevent fuel spill.

12. Remove main fuel return hose at injector nozzle connection.

13. Remove capscrews attaching fan belt guard and remove fan belt guard.

14. Remove capscrews securing fan shroud to radiator so fan shroud can be move during engine removal for cooling fan clearance.

15. Attach a short section of chain between the two lifting shakles on the engine. Attach block and tackle or hoist chain to this short section of chain, approximately midway between the two shakles.

NOTE: Do not attach hoist chain or chains directly to shackles on engine as this may cause damage to fan shaft tube or muffler when the engine weight is supported by chains.

16. Remove four bolts securing rear engine mount to frame.

17. Remove slack from lifting chain and carefully remove two capscrews which pass through the two rubber front engine mounts.

18. Lift and guide engine from engine compartment. Be careful not to damage the radiator cooling fan or other components during removal.

Installing the Engine

1. Do steps 2 - 18 of “Removing the Engine” in reverse order.

2. Fill cooling system with new coolant. Install a new oil filter and fill engine with correct oil.

3. Inspect for oil and coolant leaks.

4. Check engine idle speed and maximum governed speed settings.

Cylinder Head Overhaul

This section explains disassembly, inspection, repair, and reassembly of the cylinder head and its components as outlined below:

- Cylinder Head Removal
- Cylinder Head Servicing
- Valve Guides
- Valves
- Valve Seats
- Valve Springs
- Rocker Arms, Bearings, Shaft
- Cylinder Head Reassembly and Installation

IMPORTANT: When overhauling the cylinder head and cylinder block it is important that many of the components be reinstalled in the exact location from where they were removed. These items are noted in the text. It is useful to construct a rack where these components can be stored, in order, until reassembly.

Cylinder Head Removal (Engine Removed) (Fig. 52, 53)

1. Remove the fan shaft bracket, muffler, and rear motor mount.

2. Disconnect the water bypass hose from the cylinder head.

3. Remove the injection pipes (injection pump) to nozzles.

4. Remove the rocker cover and breather tube.

5. Loosen the two bolts and the cap screw which retain the rocker shaft assembly, and remove the rocker shaft.

6. Remove the push rods. Place each push rod into a marked holder so that it can be replaced in the original position.

7. Loosen and remove the cylinder head bolts in the sequence shown. Lift the cylinder head from the cylinder block. It may be necessary to tap the cylinder head with a wooden mallet to break the seal of the head gasket. Place the cylinder head on a flat, clean surface.

9. Remove the thermostat housing and the thermostat.

10. Remove the glow plug lead wires and glow plugs.

11. Remove the nozzle holder bolts and nozzles.

12. Remove the used cylinder head gasket. Use a scraper to remove all traces of gasket material. Pay particular attention not to damage or scratch the cylinder head or cylinder block surface.

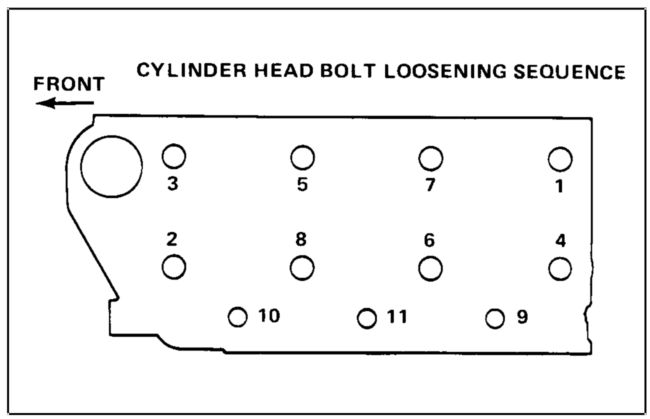


Figure 52

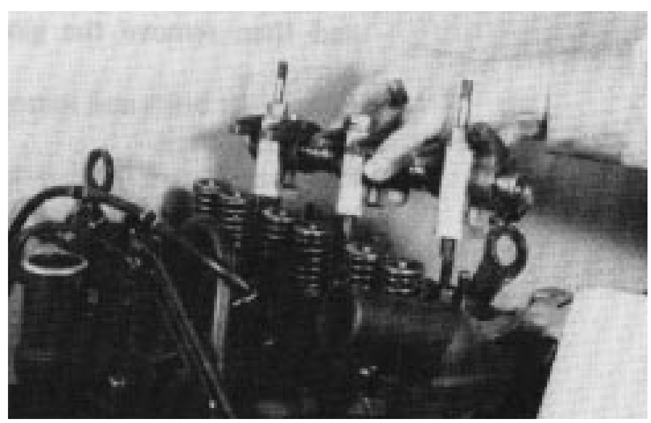


Figure 53

Cylinder Head Servicing (Fig. 54)

1. Use a spring compressor to compress the valve springs. Remove the retainer locks (keepers), retainers, and valve springs. Place each part in a holder or rack so that they can be replaced in their original position.

2. Remove the valves and place them in position in the rack. Examine each valve for indications of burning, pitting, heavy carbon deposits or wear. The condition of the valves can give important clues to other components which may require service (example: improper valve clearance, worn valve guides, damaged seals, etc.). Remove the valve seals.

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

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

5. 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 materials.

6. Use compressed air to ensure that the oil passage way through the head is not clogged.

Wear eye protection during use of compressed air. Limit air pressure to 40 psi (280 kPa).

7. Check the flatness of the cylinder head lower surface using a straight edge and feeler gauge. Be sure to check the surface variation crosswise, lengthwise, and diagonally. If a surface flatness variation greater than 0.002 inch (0.05 mm) exists, the cylinder head or cylinder block must be replaced or resurfaced.

8. 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:

Intake Valve . . . . 0.0039 inch (0.10 mm)
Exhaust Valve . . . . 0.0059 inch (0.15 mm)

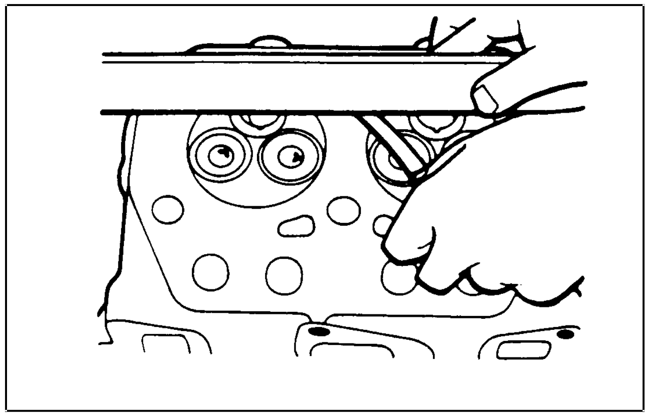


Figure 54

Checking cylinder head distortion

Valve Guides (Fig. 55)

If the valve guide clearance, after cleaning, exceeds the specifications in step 6 above, they must be replaced.

1. Remove the existing valve guide by pressing it upward using a valve guide removing mandrel with a pilot section.

2. To install the new guide press it in from the top of the cylinder head using the valve guide mandrel. Valve guides should be installed so that their installed height is as shown.

NOTE: Placing the valve guide in a refrigerator or freezer for several minutes before installation will aid in assembly.

3. After installing the valve guide, again check the guide to stem clearance. If the clearance is smaller than the standard size it will be necessary to ream the valve guide bore to obtain the proper clearance.

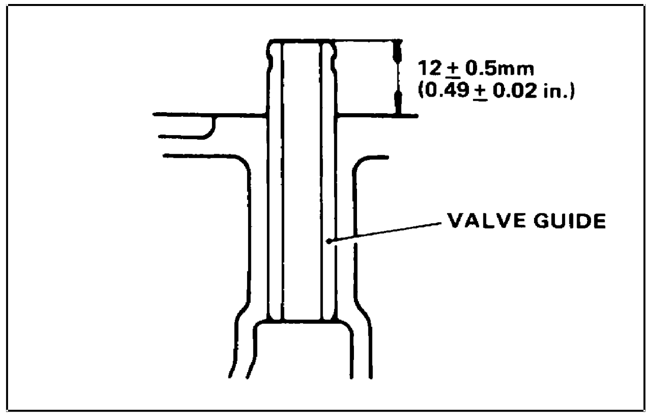


Figure 55

Installing valve guide

Valves (Fig. 56)

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

2. Check the valve face and the 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 as long as the margin or valve lip thickness is not less than the surface limit.

3. Check the tip of the valve stem for wear or pitting. If pitted or worn the valve stem tip may be resurfaced by placing the valve stem in a V-block and dressing the tip against a grinding wheel.

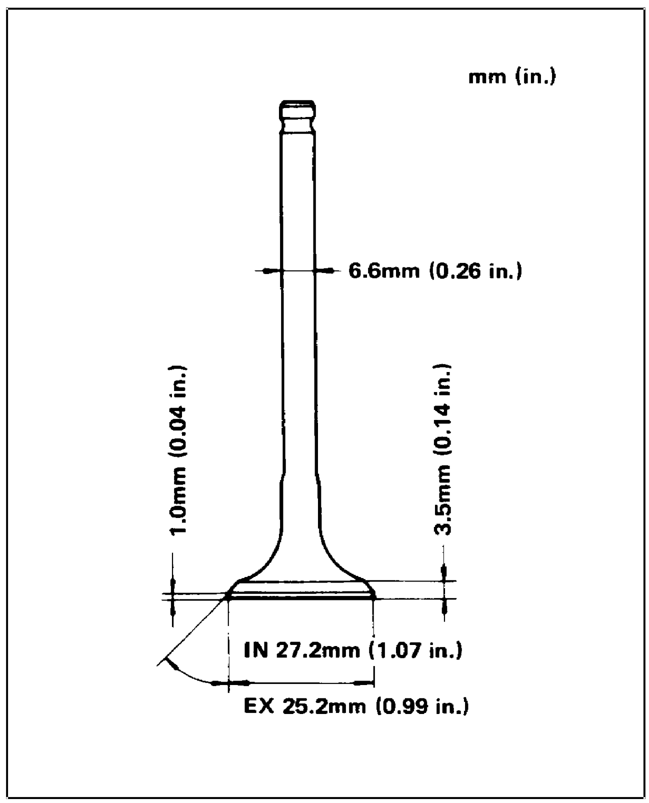


Figure 56

Dimensions of valve

Valve Seats (Fig. 57, 58)

1. Check the valve seat for damage and signs of incorrect contact.

2. If the valve seat is defective, the seat can be re-cut to the dimensions shown.

3. After cutting new valve seats, lap the valve to the seat using the lapping compound. After lapping, thoroughly clean the valve seat and valve areas to remove any traces of lapping compound. To verify that the valve face is making proper contact to the valve seat, lightly coat the valve seat area with Prussion blue, install the valve, rotate the valve 1/4 turn while holding it down and then bring it 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.

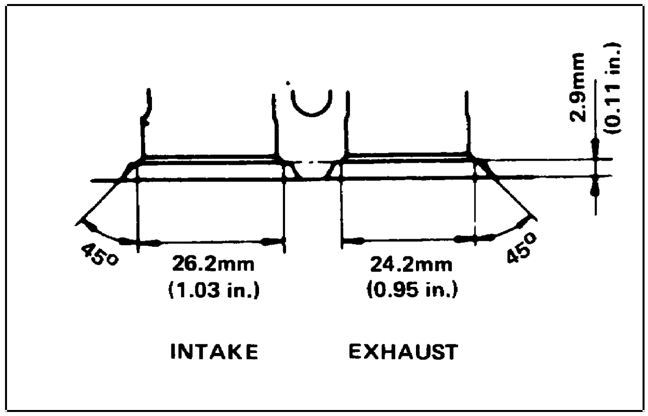


Figure 57

Dimension of valve seat

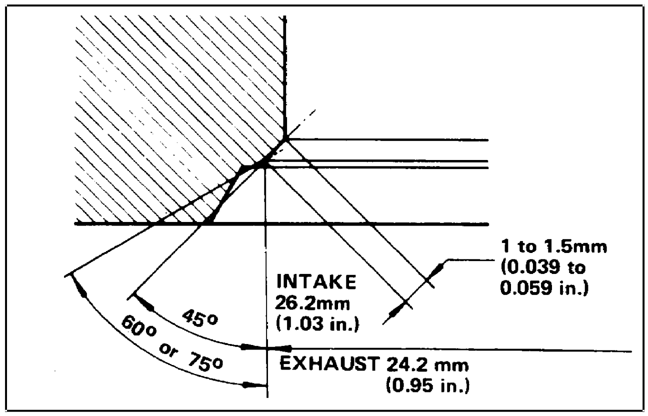


Figure 58

Correction of valve seat

Valve Springs (Fig. 59)

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

2. Check the squareness of the valve spring by placing it upright on a level surface. Springs may be out of square by 1.5 degrees. Springs that are out of square by 3 degrees or more must be replaced.

3. Measure the spring free length. The standard dimension is 1.69 inches (43 mm). Springs which measure 1.64 inches (41.7 mm) or shorter must be replaced.

4. Over time, valve springs can lose some of their tension. Test the springs to make sure that the spring pressure is within the following limits: 23.5 - 28.5 lbs. (11.2 - 12.4 Kg) with the installed length of 1.46 inches (37.1 mm). When the spring pressure at the length given is 20 lbs. (9.5 Kg) or less, the spring must be replaced.

NOTE: Valve springs are inexpensive compared to the cost of repairing engine damage due to weak valve springs.

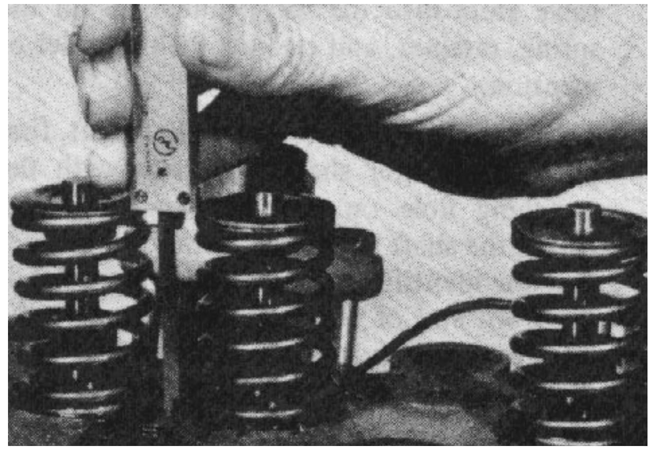


Figure 59

Checking valve spring length

Rocker Arm and Rocker Shaft Service (Fig. 60)

1. Disassemble the rocker shaft by removing the outside retaining rings on each end and by removing the two rocker arms stay bolts and seats from the rocker shaft.

2. Inspect each rocker arm for signs of wear where they contact the valve tip and push rod contact surfaces. Rocker arms which are worn should be replaced.

3. Examine the rocker shaft for excessive wear or damage. Replace it if it is defective.

4. Measure the rocker arm inside diameter and the shaft outside diameter. The maximum clearance between the rocker arm and the rocker arm shaft should be .0079 inches (0.2 mm). Replace the shaft if clearance is in excess of this dimension.

5. Inspect the oil passages in the rocker shaft and rocker arms to make sure that they are clear of obstruction. Clean if necessary.

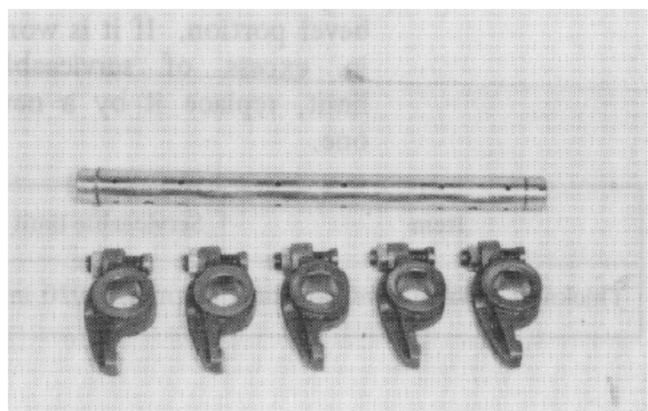


Figure 60

Rocker arm and shaft

Cylinder Head Reassembly and Installation (Fig. 61, 62, 63)

1. Ensure that the valve guides are properly installed.

2. Install the valve stem seal onto the valve guide securely.

3. Apply a coating of oil to the valve stems and insert them in proper order, into the valve guides. Install the valve springs, valve retainers and retainer locks.

4. Assemble the rocker arms to the rocker shaft in the following order. First, attach the front rocker arm stay to the cylinder head with the bolt hole toward the right (valve side) of the cylinder head. Next, install the rocker shaft so that the identification mark (small drilled hole near the end of the shaft) is located near the front (water pump), and to the right side of the engine. Install the cap screw and washer through the stay and into the shaft. Install the front rocker arm and retaining ring. Next, install the remaining rocker arms, springs and rocker shaft stays, and bolt them to the cylinder head.

5. Install the glow plugs and glow plug lead wires. The glow plugs should be torqued to 10.8 - 14.5 ft-lbs (1.5 - 2.0 KgM).

6. Install the nozzle holder and tighten the bolts evenly to 10.8 - 14.5 ft-lbs (1.5 - 2.0 KgM).

7. Ensure that the cylinder head and cylinder block surfaces are clean. Position a new head gasket on the head and insert some dowel pins into two cylinder head bolt holes in the cylinder to assist with mounting the cylinder head. Carefully position the cylinder head over the dowels onto the cylinder block and remove the dowel pins. Insert the head bolts.

IMPORTANT: Do not coat the cylinder head gasket with any sealant.

8. Tighten the cylinder head bolts to their specified torque as in the order shown. A good practice is to tighten the head bolts in proper order, first to one-third of their specified torque, then to two-thirds of their torque and finally to the specified torque.

9. Adjust the valve clearance.

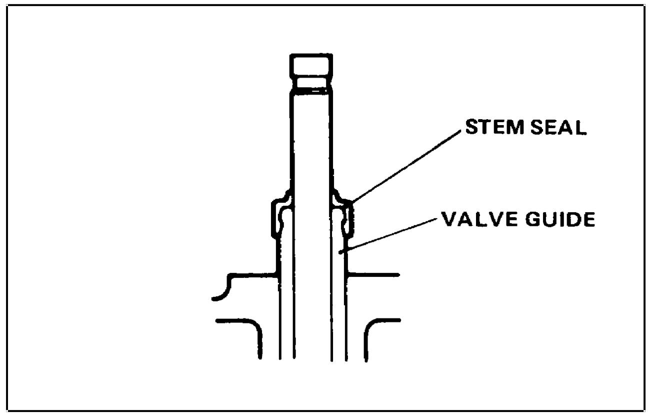


Figure 61

Valve stem seal

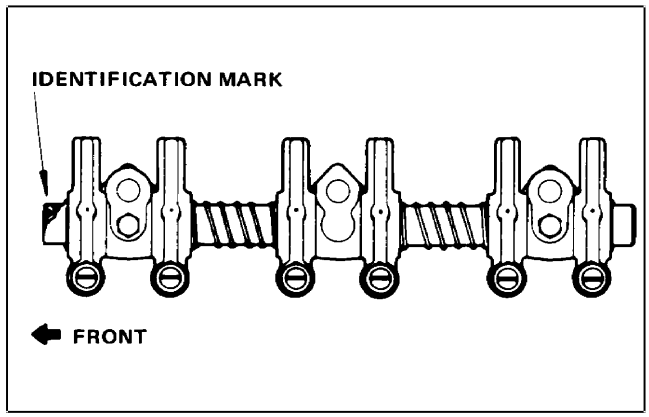


Figure 62

Rocker arm and shaft assembly

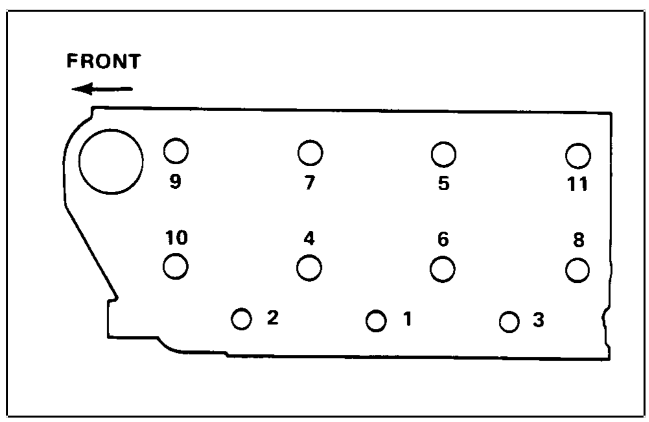


Figure 63

Cylinder head bolt tightening sequence

Cylinder Block Overhaul

This section outlines procedures for disassembly, inspection, repair and reassembly of the cylinder block and its components, as outlined below:

Cylinder Block Disassembly
Camshaft Service
Injection Pump Camshaft Service
Crankshaft Bearings
Timing Gears
Connecting Rods and Bearings
Cylinders
Oversized Pistons, Cylinder Bore and Rings
Piston and Pin Replacement

Cylinder Block Disassembly

NOTE: It is assumed that the engine has been removed from the mower, placed on an engine stand, and the cylinder head removed.

1. Place a drain pan under the engine. Remove the oil pan drain plug and drain the oil from the engine. Remove the oil filter from the oil pump body. Discard the oil filter. Dispose of the oil in the proper manner.

2. Remove the water pump.

3. Remove the fuel injection pump from the cylinder block body and the fuel filter.

NOTE: It is necessary to remove the tie rod cover, the control rod, and retaining spring from the control rack before removing the injection pump.

4. Lift the push rods out of the cylinder block.

5. Remove the valve lifters from their positions in the cylinder block.

6. Remove the speedometer drive assembly from the left hand side of the engine by removing the cap screw and clamp and pulling the gear out.

7. Turn the engine upside down on the stand and remove the oil drain pan and filter screen (spring-like screen).

8. Remove the crankshaft pulley, nut, washer, lock washer and key.

9. Remove the gear case from the front of the motor.

NOTE: The front plate is retained to the cylinder block by bolts that are underneath the cover. Do not attempt to remove the plate without first removing the gear case cover and the bolts underneath.

10. Remove the camshaft and gear by carefully backing them out from the cylinder block.

NOTE:The speedometer drive and valve lifters must be removed to remove the camshaft.

11. To remove the injection pump camshaft, first remove the governor sliding shaft and governor flyweight assembly. Align the hole in the injection pump camshaft gear with the retaining bolt and washer. Remove the washer and carefully pull the camshaft gear and bearing from its location in the cylinder block.

12. Remove the idler gear from its shaft.

13. Remove the flywheel bolts and washers and remove the flywheel from the crankshaft.

14. Remove the ring ridge from each cylinder using a ridge removing tool. This will prevent damage to the rings and pistons. Remove the connecting rod cap nuts and then remove the bearing caps. Place these parts in cylinder number order. Remove the pistons and connecting rods by pushing them up from the bottom of the block. Use a wooden block to push the pistons and rods to avoid damage to the connecting rod.

NOTE: Before removing the pistons scribe the number of the cylinder onto the top of the piston. When the piston and rod assembly is removed, use care to prevent damage to the piston or bearing surfaces.

15. Remove the main bearing caps. Arrange the removed caps and bearings according to cylinder order so they may be replaced in the same position upon reassembly.

NOTE: Before removing the main bearing caps, measure the crankshaft end play.

16. Remove the crankshaft after removing the main bearing caps.

17. Remove the crankshaft oil seal and gasket.

18. Check the cylinder block for cracks or damage. Replace the cylinder block if it is unserviceable.

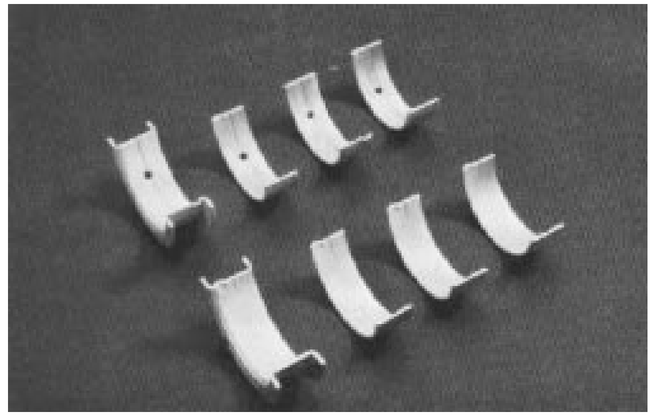


Figure 64

Main bearing caps

Camshaft and Bearing (Fig. 65, 66)

1. Inspect the camshaft for evidence of severe wear.

2. Using a micrometer and a hole gauge, measure the clearance between the camshaft journals and the cylinder block. If the clearance is greater than 0.0059 inch (0.15 mm) the camshaft or the camshaft bushing must be replaced.

3. To remove the camshaft bushing in the cylinder block, carefully drive the bushing from its location using the camshaft bushing tool (refer to “Special Tools”).

NOTE: You must drive the bushing into the cylinder block and then crush it to remove it. Be careful not to damage the valve lifter hole when removing the camshaft bushing.

4. To install a new camshaft bushing use the camshaft bushing tool and drive the bushing in from the outside of the cylinder block being careful to align the oil delivery hole in the cylinder block with the oil hole in the bushing.

5. If the cam surface is damaged or the cam lobe is badly worn it must be replaced. Cam lobe height should be measured using a micrometer. The standard cam lobe height for both intake and exhaust valves is 1.4079 inches (35.75 mm). The maximum allowable wear on cam surface is 0.0394 inch (1.0 mm). Replace the camshaft if wear exceeds this amount.

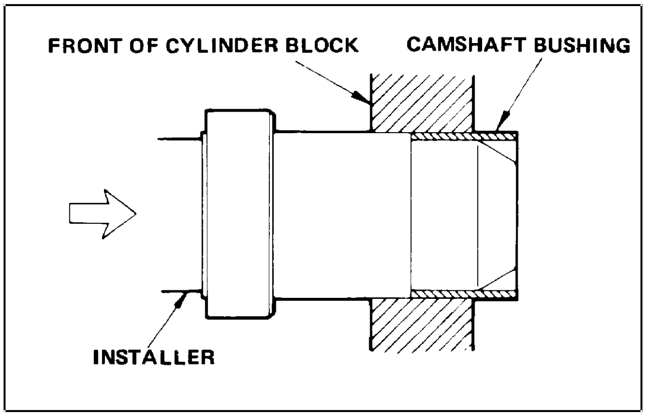


Figure 65

Removing camshaft bushing

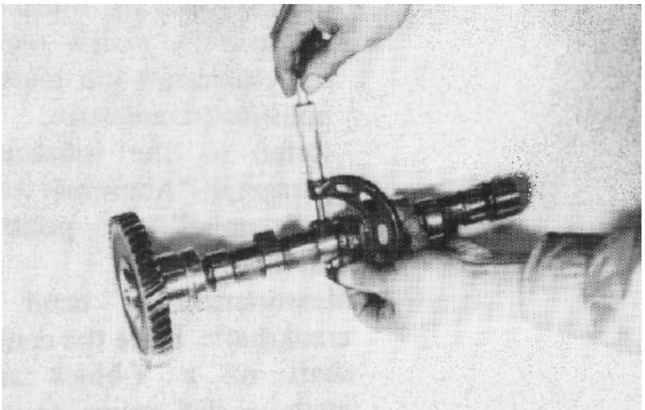


Figure 66

Measuring camshaft cam lobe height

Fuel Injection Pump Camshaft (Fig. 67)

1. Inspect the camshaft bearing, replace if defective.

2. Examine the oil pump coupling. The camshaft must be replaced if this coupling is worn.

3. Examine the cam lobe surfaces. Replace the cam if they are damaged.

4. Measure the cam lobe height in the same manner as measuring the valve camshaft lobe height. The standard lobe height for each cylinder of the injection pump is 1.7323 inches (44 mm). The camshaft must be replaced if the cam lobe has been worn by 0.0394 inch (1 mm) or more.

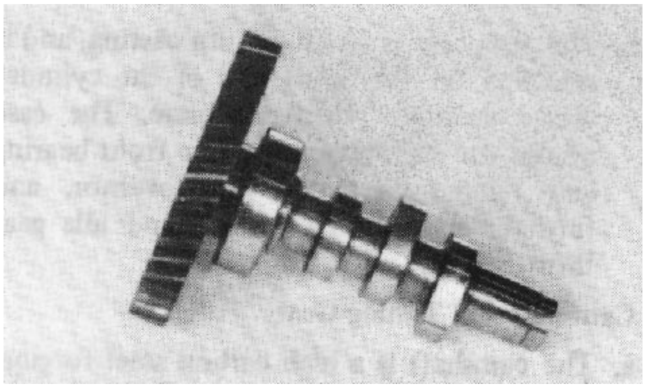


Figure 67

Fuel injection pump camshaft

Crankshaft Bearings (Fig. 68, 69)

1. 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. The maximum allowable crankshaft run-out is .0012 inch (0.03 mm).

2. Check the crank journals and crank pins for damage such as galling, seizure, etc. If journals or pins are seriously damaged they may be reground and oversized bearings installed. The main bearing and connecting rod bearing oil clearances may be measured with a micrometer or Plastigauge. Crankshaft oil clearances are: Journal, 0.0039 inch (0.10 mm); Crank pin, 0.0059 inch (0.15 mm).

NOTE: When using Plastigauge to measure the clearance between the crankshaft and its bearings, install the crankshaft into the cylinder block, place a piece of Plastigauge onto the crank pin or journal, and torque the bearing cap (with bearing) in place. DO NOT TURN THE CRANKSHAFT WHEN PLASTIGAUGE IS IN PLACE SINCE THE PLASTIGAUGE WOULD BE DESTROYED. Remove the bearing cap and measure the width of the Plastigauge to determine the clearance. If the oil clearances exceed these amounts attempt to install a new bearing to reduce the clearance. If installing a replacement bearing does not reduce the clearance to within tolerance the crankshaft must be reground and an oversized bearing installed.

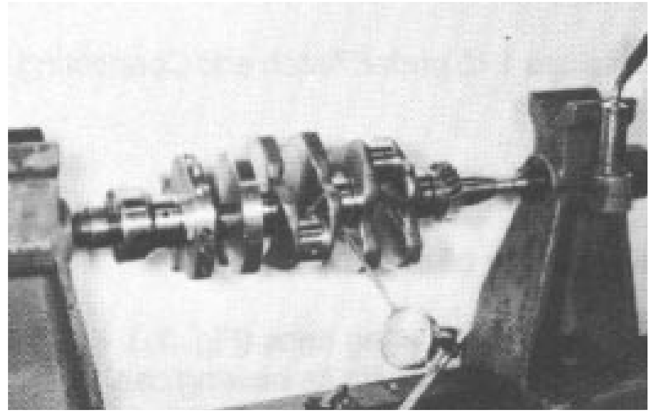


Figure 68

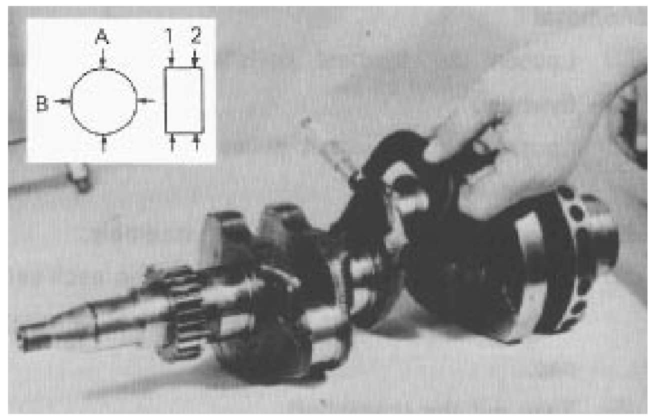


Figure 69

Timing Gears (Fig. 70)

1. Inspect the idler gear, fuel injection pump gear, camshaft gear and crankshaft gear for wear or damage. Replace these gears if defective.

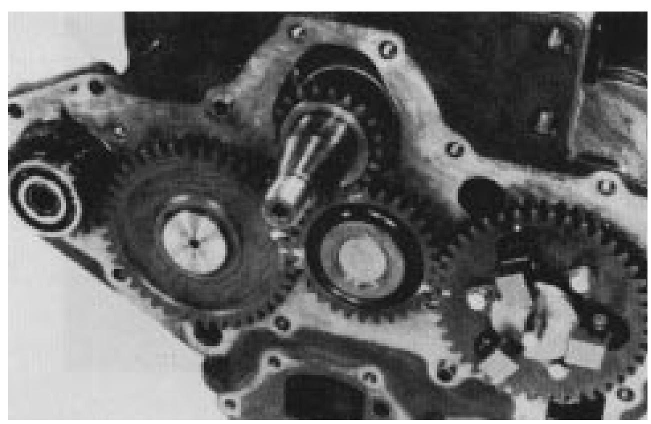


Figure 70

Connecting Rod and Connecting Rod Bearings (Fig. 71)

1. Check for bending or distortion of the connecting rod. If excessive, replace the rod (0.002 inch or 0.05 mm max.).

2. Assemble each connecting rod to the crankshaft in their proper order. Use a feeler gauge to measure the connecting rod thrust clearance between the connecting rod and crankshaft. The proper clearance is .0039 -.0138 inch (.1 -.35 mm). If the clearance exceeds this amount replace the connecting rod assembly.

3. The connecting rod journal to crank pin oil clearance can be measured using a micrometer or Plastigauge. Refer to “Crankshaft Bearings,” for tolerances.

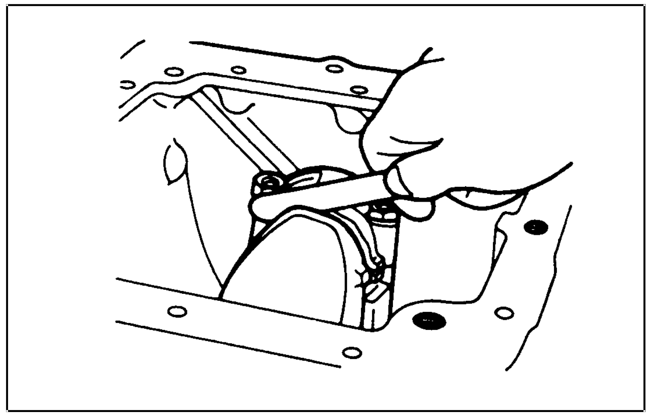


Figure 71

Measuring connecting rod thrust clearance

Cylinders (Fig. 72)

1. Measure the cylinder bore size in six locations as shown. The standard bore diameter is 2.8740 inches (73 mm). The cylinder must be rebored and oversized piston and rings installed if the diameter exceeds the standard by .0079 inch (.2 mm). Examine the cylinder bore diameter readings to determine the amount of taper of the cylinder. If the taper exceeds .0004 inch (.01 mm) the cylinder must be rebored and oversized piston and rings installed.

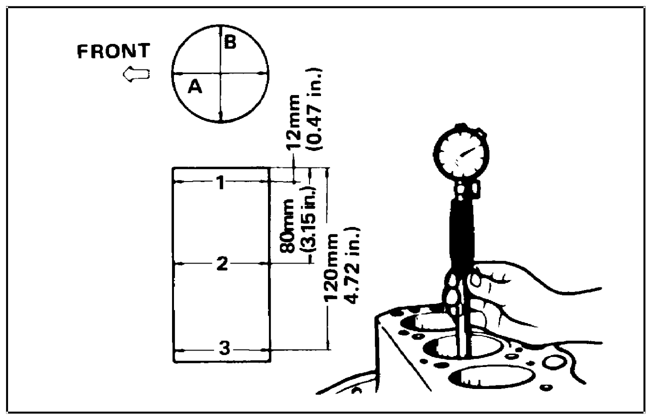


Figure 72

Checking cylinder bore size

Oversized Pistons, Cylinder Bore and Rings (Fig. 73, 74, 75)

1. Check the piston for wear, signs of seizure or nicks. Replace it if it is defective.

2. Measure the piston outside diameter. If the clearance between the piston and the cylinder exceeds 0.01 18 in. (.3 mm), replace the piston.

NOTE: The piston O.D. should be measured at the lower end of the skirt across the thrust faces, or on access points perpendicular to the piston pin direction.

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

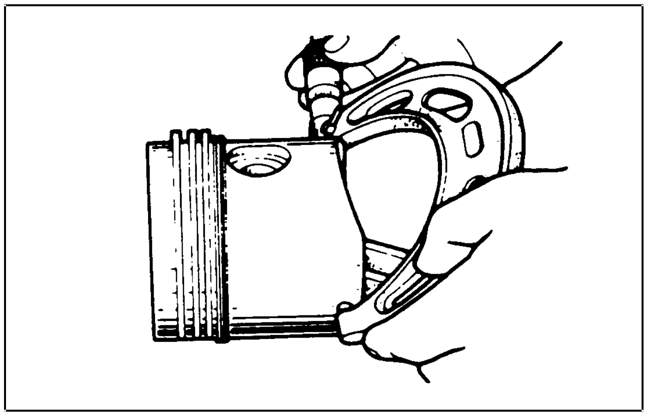


Figure 73

Measuring piston outside diameter

4. Measure the piston ring side clearances using a thickness gauge.

If the piston ring side clearance exceeds the service limit in the chart below, the ring must be replaced.

NOTE: In the case of a tapered ring (No. 1), measure the clearance on the bottom, or widest area of the ring.

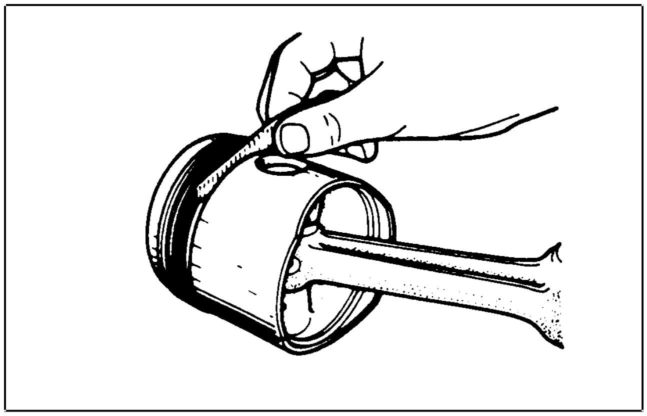


Figure 74

Measuring piston ring side clearance

5. Measure the piston ring gap clearance. Insert the ring into the least worn area of the cylinder by pushing it into place with the piston. The standard gap is 0.0059 - 0.0157 inch (0.15 - 0.4 mm). If the gap exceeds 0.0590 inch (1.5 mm) the ring must be replaced.

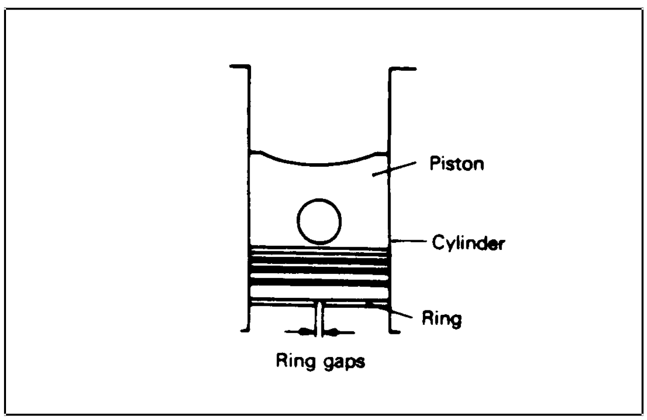


Figure 75

Measuring piston ring gap clearance

Piston and Pin Replacement (Fig. 76)

To remove a piston from its connecting rod, use the piston pin tool (see Special Tools section) to press the pin from the connecting rod.

IMPORTANT: Do not attempt to remove the piston pins by driving them out with a hammer. A stuck piston pin, requiring excessive pressure to remove, should be replaced. 1100 - 3300 lbs (500 - 1500 Kg) pressure is standard force needed to remove the piston pin.

1. Press the piston pin from the connecting rod as described above.

2. Use a micrometer and bore gauge to measure the clearance between the piston and pin. If the clearance exceeds 0.0031 inch (0.08 mm) the piston and/or pin must be replaced.

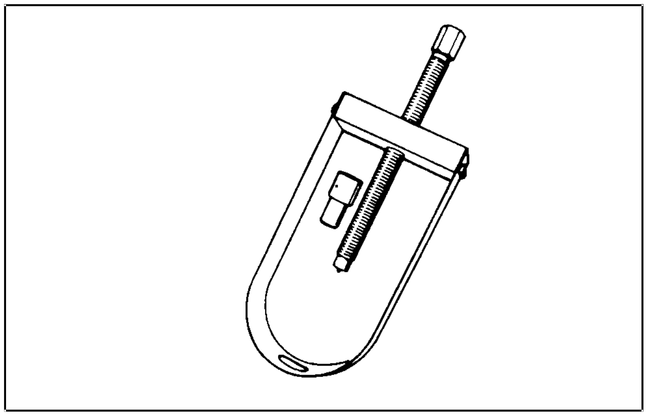


Figure 76

Piston pin removal tool

Engine Reassembly

The engine should be reassembled in the order given in this section. The following general precautions should be observed when reassembling the engine.

1. Clean each part carefully. Pay particular attention to oil holes, bearing surfaces and rotating parts.

2. Before assembly apply engine oil to all sliding and rotating parts such as bearings and cylinder inner walls.

3. Replace all gaskets, packings, and oil seals with new ones. Reuse of these parts is not acceptable.

4. Apply sealant to gaskets and threads.

5. Tighten all fasteners to the proper torque as outlined in the torque specifications.

6. Check clearances and end plays when installing.

Engine Reassembly Procedures

Follow the procedures listed below in reassembling the engine.

1. Install the camshaft bushing.

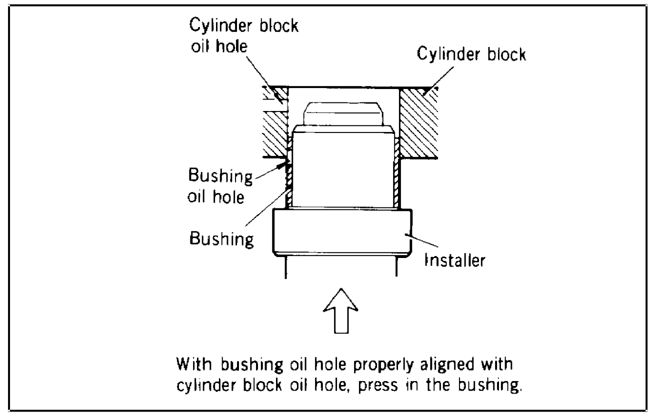


Figure 77

Installing camshaft bushing

2. Install the main bearings to the cylinder block and main bearing cap. Ensure that these are in proper position.

3. Install the crankshaft.

4. Install the main bearing caps then tighten the cap bolts to the specified torque. Each cap carries an embossed arrow mark and letter or numeral to indicate its position in the cylinder block. When installing the no. 1 and no. 4 bearing caps, apply sealant to the upper surface (that meets with the cylinder block).

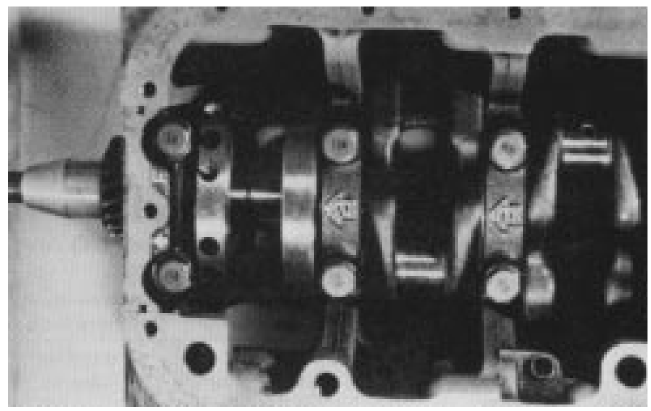


Figure 78

Installed direction of main bearing caps

5. With the bolts torqued use a dial indicator on the end of the crankshaft to measure the crankshaft end play. If the end play exceeds .0197 inch (0.5 mm) replace the No. 3 main bearing.

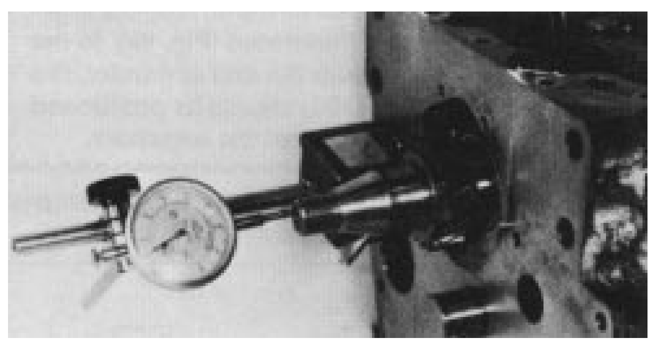


Figure 79

Measuring crankshaft end play

6. Apply sealant to the outside surface of the front and rear side seals. The side seals are installed with the radius towards the outside of the engine.

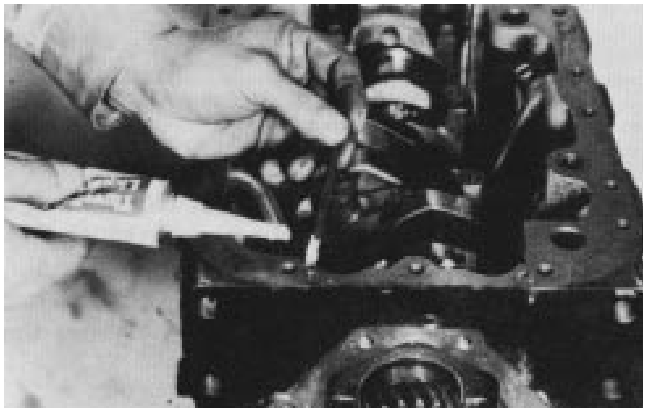


Figure 80

Installing bearing side cap seals

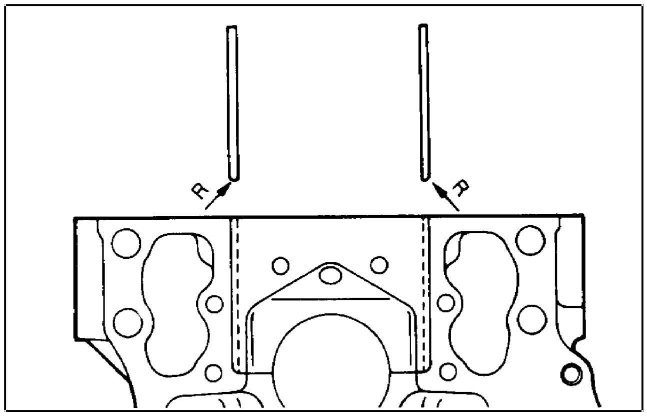


Figure 81

Direction of side seal installation

7. Insert the oil seal into the crankshaft rear oil seal case.Apply a light coat of oil to the oil seal lip and install the seal case to the cylinder block.

NOTE: Use a new gasket.

8. Install the rear engine plate if it has been removed.

9. Install the flywheel onto the crankshaft using the bolts and special washers. Torque the flywheel bolts to 83 - 90 ft-lbs (11.5 - 12.5 KgM).

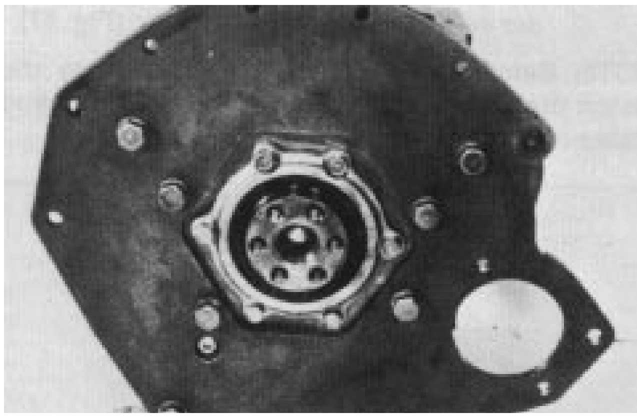


Figure 82

Installing oil seal case

NOTE: Before insertion apply engine oil to the piston pin O.D. and the connecting rod small end inside diameter.

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

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

NOTE: The piston and piston pin are matched parts and should not be mixed.

After assembling the piston and connecting rod make certain that the connecting rod small end is properly positioned at the center of the piston pin.

11. Install the piston rings.

IMPORTANT: The piston rings differ in shape from one another. Be careful to install them in proper position and with the ring gaps in the directions as illustrated. In the case of the oil ring with the coil expander, the gap clearance of the ring should be positioned 180° away from the joint of the expander.

NOTE: Install the piston rings with the stamped manufacturer mark facing up.

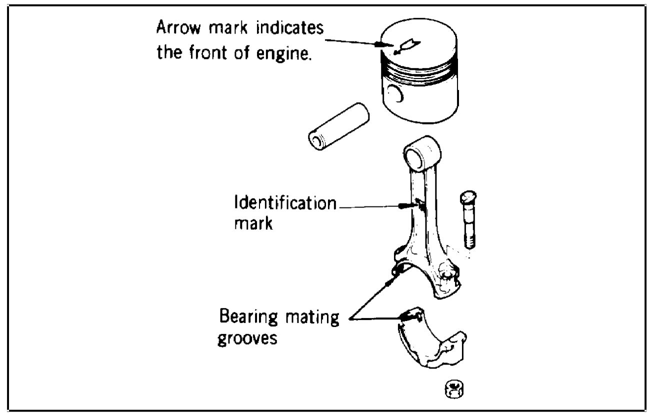


Figure 83

Installing piston rod

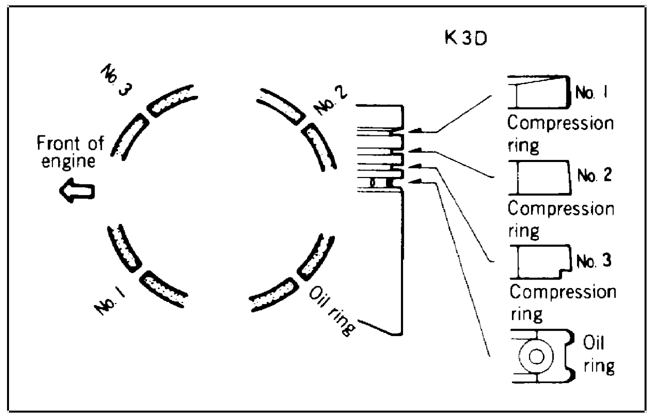


Figure 84

Ring gap positions **Piston ring shapes**

12. Insert the piston and connecting rod assembly into the cylinder block using a ring compressor and a wooden block. After insertion into the cylinder, properly install the connecting rod bearings and rod caps and tighten the bolts to the specified torque.

NOTE: The bearing assembly grooves in the connecting rod cap should be on the same side when assembled.

13. Install the front plate. Remember to use a new gasket.

14. Turn the crankshaft until the No. 1 piston is a top dead center (TDC).

15. Drive the key into the crankshaft and install the crankshaft gear onto the shaft if it has been disassembled.

16. With the idler gear mating mark “1" properly aligned with the crankshaft mating mark ”1",install the idler gear on to the idler shaft.

17. Insert the camshaft and gear assembly into the cylinder block and align the idler gear mark “2" with the camshaft gear mating mark ”2".

18. Install the injection pump camshaft assembly into the cylinder block and align the idler gear mating mark “3" with the pump gear mark ”3". Remember to install the bolt and washer which retain the injection pump camshaft bearing.

19. Install the governor weight assembly and sliding shaft to the injection pump cam gear.

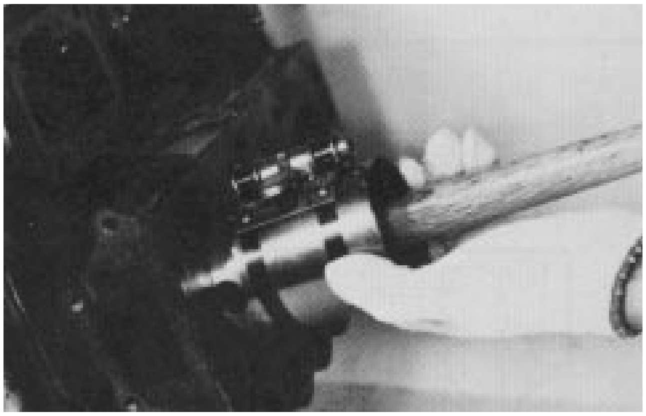


Figure 85

Installing piston and rod assembly

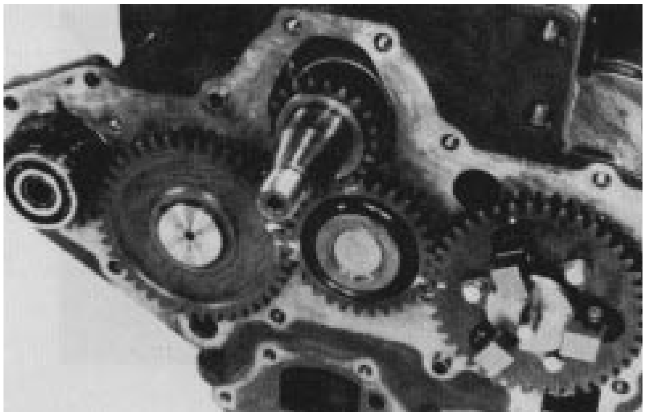


Figure 86

Mating marks of gears

29. Install the front gear case and gasket, using PERMATEX No. 2 on gasket surfaces. When installing the gear case insert the tie rod and tie rod stopper spring into the hole in the cylinder block under injection pump. Install the crankshaft pulley and key. Torque the retaining nut to 144 - 180 ft-lbs. (20 - 25 KgM).

30. Install the oil screen and the oil pan using a new gasket.

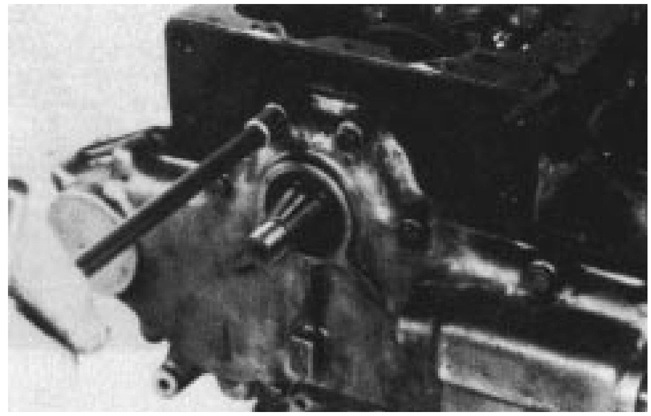


Figure 87

Installing gear case

31. Reinstall the speedometer unit while rotating the speedometer shaft. Make sure that the O-ring is properly installed. Apply oil to the outside surface of valve lifters and insert the lifters into the cylinder block in the order of which they were removed. Install the push rods into the lifters in the order in which they were removed.

32. Install the cylinder head assembly.

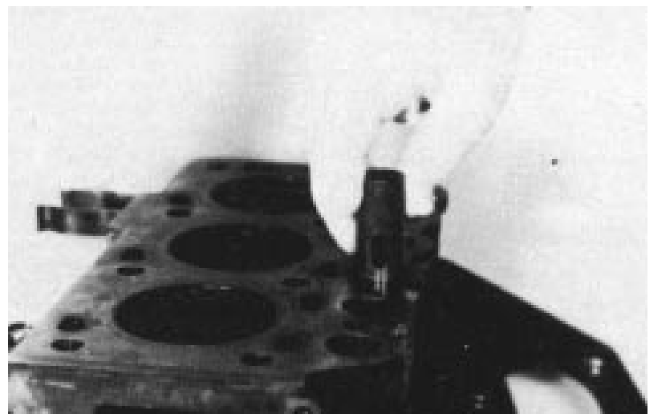


Figure 88

Inserting tappet

33. Install the fuel injection pump.

34. Install the oil pump and oil filter if they have been removed.

35. Install the water pump.

36. Install the starter if it has been removed.

37. Install the overhauled engine onto the machine following the reverse procedure for removing the engine from the machine.

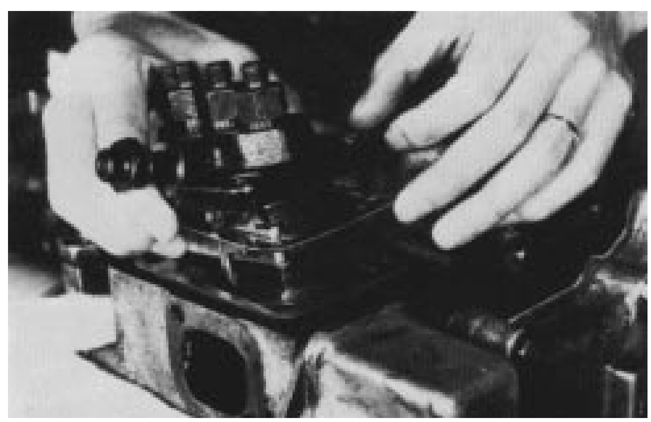


Figure 89

Installing injection pump

Chapter 4A

(For Groundsmaster 328–D only)

Kubota Diesel Engine

Table of Contents

General Information 1
Specifications 2

General Information

The engine used in the Groundsmaster 328–D is manufactured by Kubota. Service and repair parts for this engine are supplied through TORO Distributors. Repair parts may be ordered by TORO part number. If no parts list is available be sure to provide your Distributor with the TORO model number and serial number.

General maintenance procedures are described in your Operator's Manual. Information regarding engine troubleshooting, testing, disassembly and assembly is identified in the Kubota 05 Series Service Manual (Toro part 01090SL).

Note: Refer to Chapter 4 – Mitsubishi K3D Diesel Engine for Groundsmaster 328–D engine removal and installation procedure.

Specifications

Item	Description
Make / Designation	Kubota Model 1105 4 Cycle, 3 Cylinder Diesel Engine
Number of Cylinders	3
Bore	3.07 in (78.0 mm)
Stroke	3.09 in (78.4 mm)
Total Displacement	68.53 cu in (1123 cc)
Firing Order	1–2–3
Combustion Chamber	Spherical Type
Fuel	No. 2 Diesel Fuel (ASTM D975)
Fuel Capacity	6.5 U.S. gallon (24.6 liter)
Fuel Injection Pump	Bosch MD Type Mini Pump
Injection Nozzles	Mini Nozzle (DNOPD)
Governor	Centrifugal Mechanical
Idle Speed (no load)	1500 – 1650 RPM
High Idle (no load)	3100 – 3250 RPM
Coolant Capacity	6 U.S. quart (5.7 liter)
Engine Oil	See Operator's Manual
Oil Capacity	4 U.S. quart (3.8 liter) with filter
Starter	12 VDC, 1.4 KW
Alternator/Regulator	12 VDC, 40 AMP
Dry Weight	205.0 lbs (93.0 kg)

Chapter 5

Hydraulic System

Table of Contents

SPECIFICATIONS 2
Hydraulic Oil 2
GENERAL INFORMATION 3
Hydraulic Hoses 3
Hydraulic Fitting Installation 3
Towing 5
HYDRAULIC SCHEMATICS 6
HYDRAULIC FLOW DIAGRAMS 7
Forward Traction Operation 7
Raising the Cutting Unit 8
Turning Steering Wheel to Right 9
SPECIAL TOOLS 10
TROUBLESHOOTING 12
TESTING 18
Test No. 1: Charge Pressure 19
Test No. 2: Implement Relief Pressure 20
Test No. 3: Traction Pressure 21
Test No. 4: Charge Pump Flow and
Implement Relief Pressure 22
ADJUSTMENTS 23
Traction Control Rod Adjustment 23
Traction Pedal Friction Wheel Adjustment 23
Traction Control Neutral Adjustment 24
Lift Lever Latch Adjustment 25
REPAIRS 26
Transmission Trunnion Seal Replacement 26
Transmission By-Pass Valve 27
Transmission Acceleration Valves 28
Transmission Implement Relief Valve 29
Transmission Charge Relief Valve 30
Transmission Charge Pump 31
Transmission Removal and Installation 33
Transmission Overhaul 34
Separating Transmission Into Sections 34
Transmission Pump Section 35
Transmission Center Section 37
Transmission Motor Section 38
Assembling Transmission Sections 39
Priming After Transmission Overhaul
or Replacement 40
Lift Cylinder Removal and Installation 41
Lift Cylinder Repair 42
Lift Valve Removal and Installation 43
Lift Valve Repair 44

Specifications

Item	Description	Standard
Transmission	Sauer-Sundstrand 15 Series In-line Operating Pressure Charge pressure Implement relief pressure Forward traction relief pressure (4WD only)	 500 to 5200 PSI 70 - 150 PSI 700 to 900 PSI 5200 PSI
Oil filter	25 micron rated, screw-on type	
Hydraulic oil (Fig. 1)	Extreme (over 90°F) Normal (40 - 100°F) Cool - Spring/Fall (30 - 50°F) Winter (Below 30°F)	SAE 30 SF/CC or CD SAE 10W30 or 10W40 SF/CC or CD SAE 5W30 SF/CC or CD Type “F” or “FA” ATF Automatic Transmission Fluid
Hydraulic resevoir	Front axle differential housing	5 U.S. qt. (4.7 liter) approx. capacity
Lift control valve	Four-way, three position, open center	

Hydraulic Oil

The hydraulic system is designed to operate on any high-quality detergent oil having the American Petroleum Institute (API) service classification SF/CC or CD. Oil viscosity (weight) must be selected according to anticipated ambient temperature. (See Hydraulic oil specifications in above chart).

IMPORTANT: DO NOT mix engine oil and automatic transmission fluid or hydraulic system component damage may result. When changing fluids, also change transmission filter. DO NOT USE DEXRON II ATF.

NOTE: Fluid to operate the power steering is supplied by the hydraulic system transmission charge pump. Cold weather start-up may result in “stiff” operation of the steering until the hydraulic system has warmed up. Using proper weight hydraulic oil in system minimizes this condition.

To check oil level:

1. Put machine on a level surface, raise the implement and stop the engine.

2. Unscrew dipstick cap from filler neck and wipe it with a clean rag. Screw dipstick cap finger tight onto filler neck. Unscrew dipstick and check level of oil. If level is not within 1/2 inch (13 mm) from groove in dipstick, add enough oil to raise level to groove mark. DO NOT OVERFILL by more than 1/2 inch (13 mm) above groove.

IMPORTANT: When adding oil to hydraulic system, use a funnel with a fine wire screen (200 mesh). Make sure funnel and oil are very clean to prevent accidental contamination of hydraulic system.

3. Screw dipstick filler cap finger-tight onto filler neck. It is not necessary to tighten cap with a wrench.

4. Lower the implement.

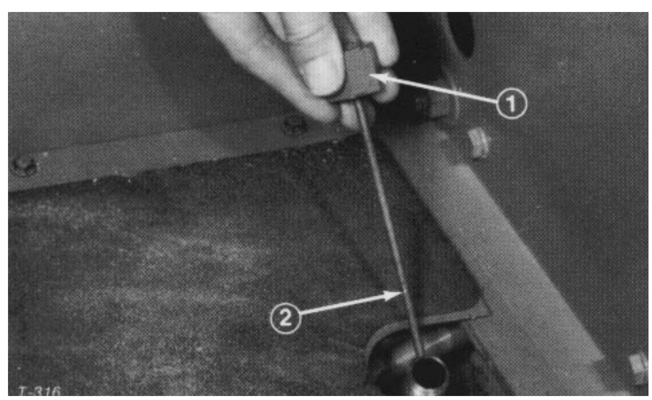


Figure 1

1. Dipstick cap **2. Groove**

General Information

Hydraulic Hoses

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

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

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved by lowering the cutting unit to the ground and stopping the engine.

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

Hydraulic Fitting Installation

O-Ring Face Seal

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches, or any foreign material (Fig. 3).

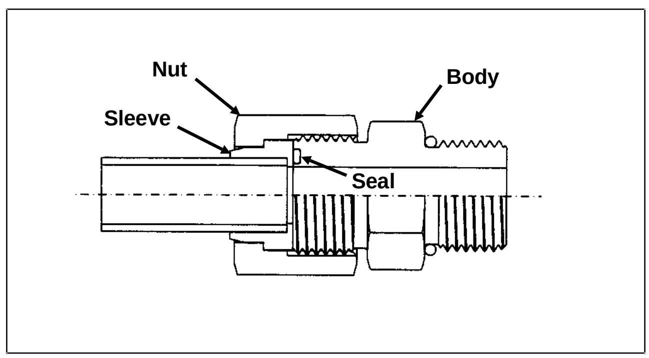
2. Make sure the O-ring is installed and properly seated in the groove. It is recommended that the O-ring be replaced any time the connection is opened.

3. Lubricate the O-ring with a light coating of oil.

4. Put the tube and nut squarely into position on the face seal end of the fitting and tighten the nut until finger tight.

5. Mark the nut and fitting body. Hold the body with a wrench. Use another wrench to tighten the nut to the correct flats from finger tight (F.F.F.T.). The markings on the nut and fitting body will verify that the connection has been tightened.

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



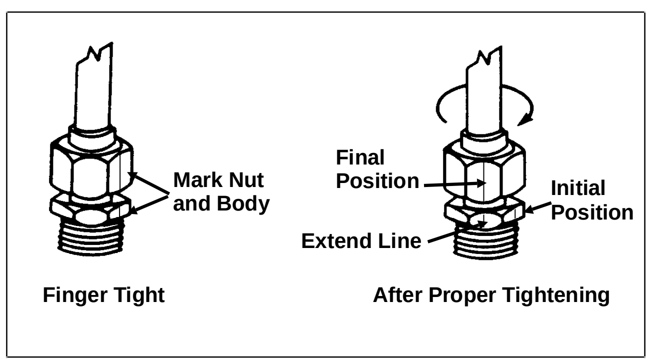


Figure 3

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. 4).

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

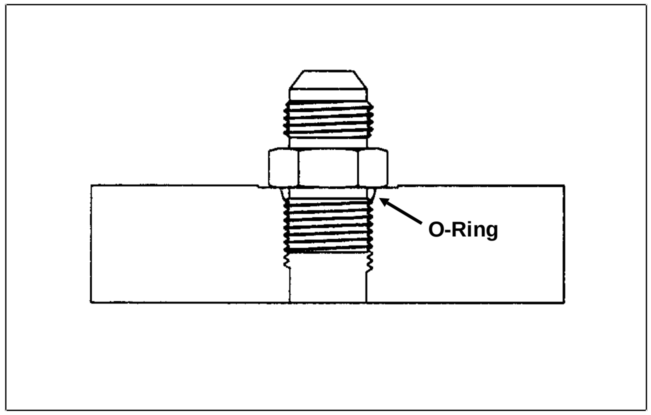


Figure 4

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. 5).

2. Always replace the O-ring seal when this type of fitting shows signs of leakage.

3. Lubricate the O-ring with a light coating of oil.

4. Turn back the jam nut as far as possible. Make sure the back up washer is not loose and is pushed up as far as possible (Step 1).

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

6. To put the fitting in the desired position, unscrew it by the required amount, but no more than one full turn (Step 3).

7. Hold the fitting in the desired position with a wrench and turn the jam nut with another wrench to the correct flats from finger tight (F.F.F.T.) (Step 4)

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

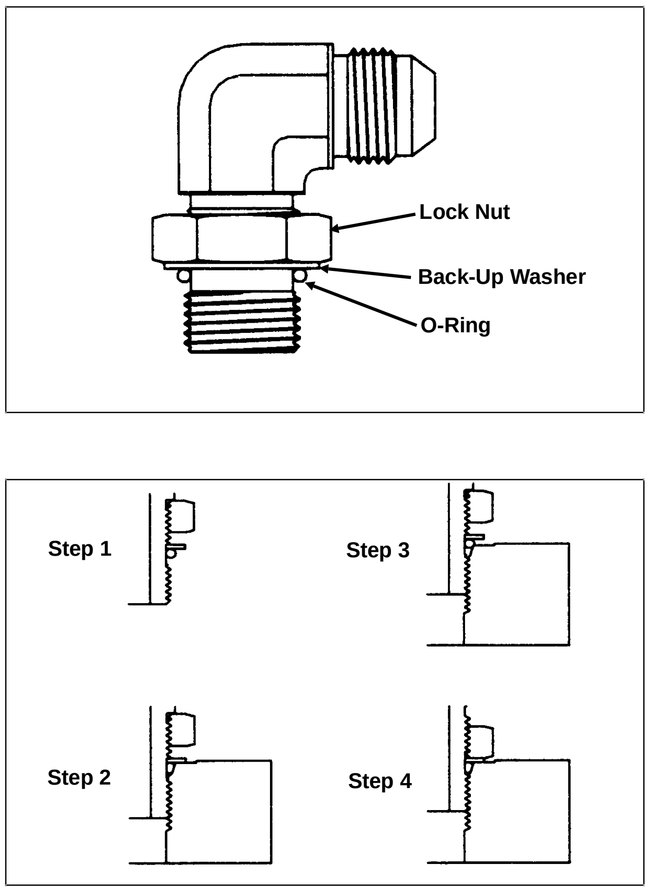


Figure 5

Pushing or Towing (Fig. 6)

In an emergency, the traction unit can be pushed or towed for a very short distance. However, Toro does not recommend this as a standard procedure.

IMPORTANT: Do not push to tow the traction unit faster than 2 to 3 mph because the transmission may be damaged. If traction unit must be moved a long distance, transport it on a truck or trailer. When ever traction unit is pushed or towed, the by-pass valve must be open.

1. Raise and support seat to get access to by-pass valve.

2. Rotate by-pass valve on transmission counterclockwise 1/2 to 1 turn. Opening the valve opens an internal passage in the pump to by-pass transmission oil. Because fluid is by-passed, the machine can be pushed slowly without damaging the transmission.

3. Close by-pass valve by rotating it clockwise until it is securely seated. Do not exceed 5 to 8 ft-lb of torque when tightening.

IMPORTANT: Do not start engine when valve is open. Running the machine with the by-pass valve open will cause the transmission to overheat.

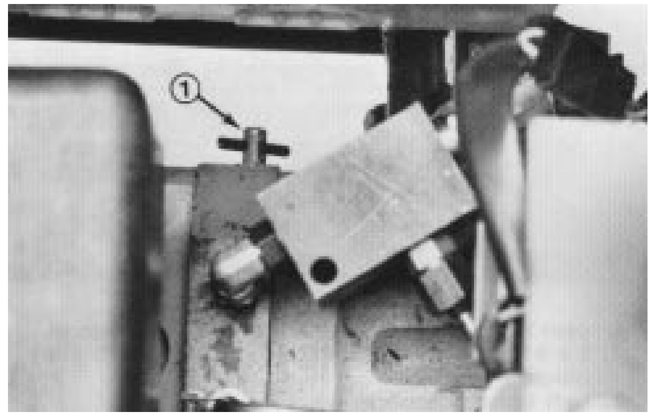
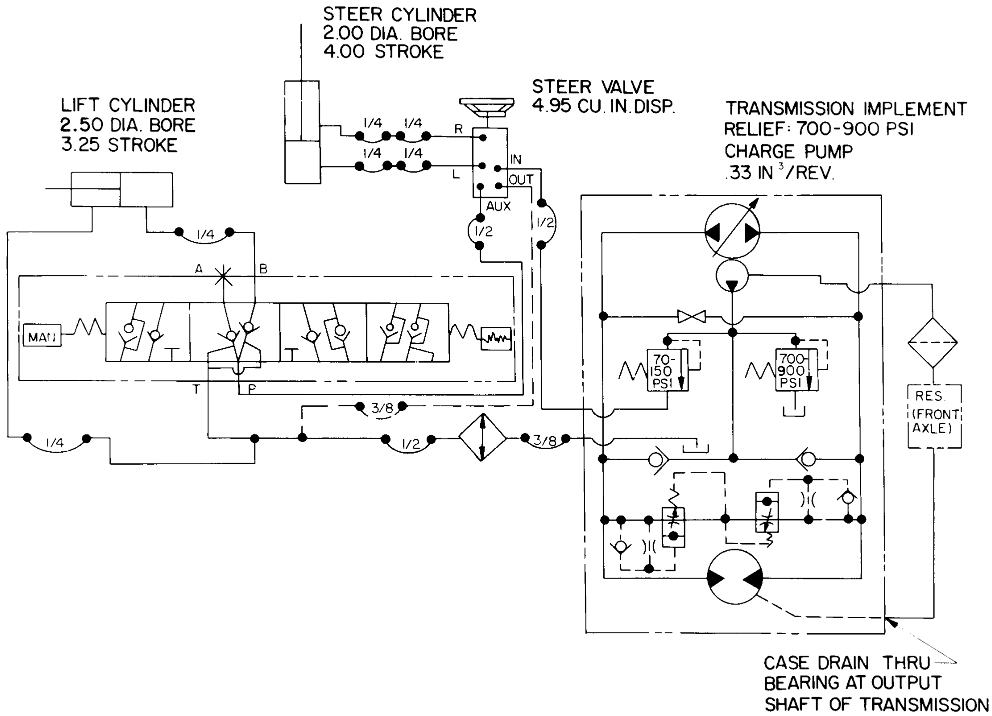


Figure 6
(4WD unit shown)

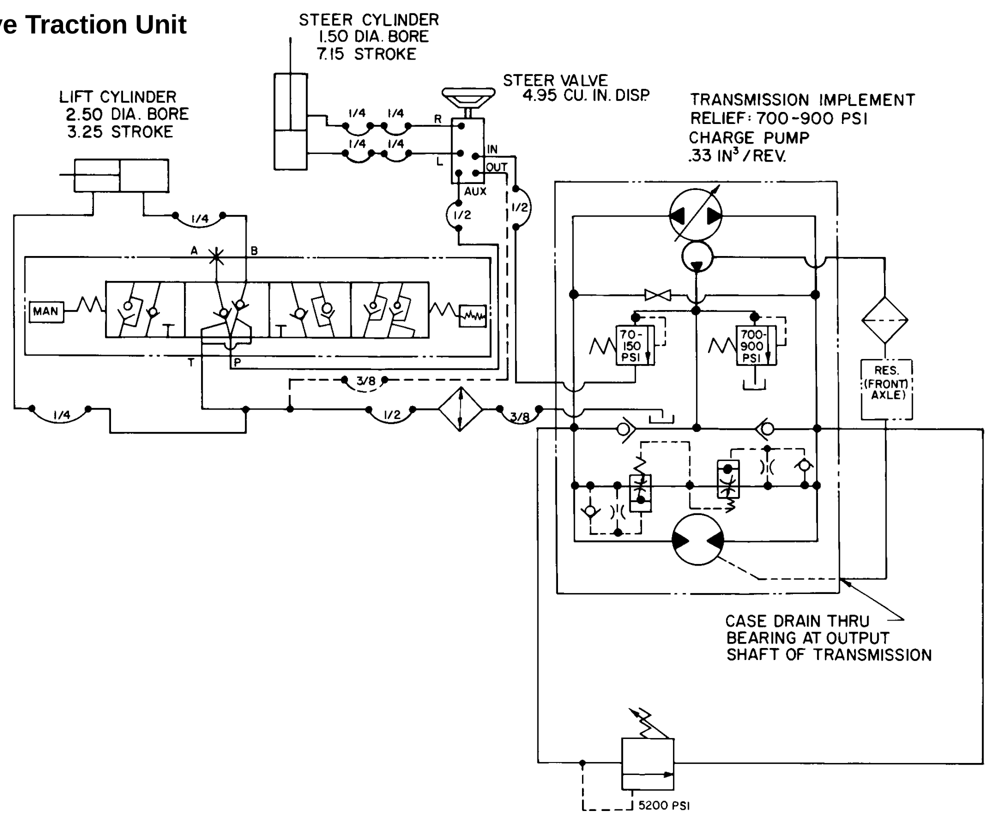
1. Bypass valve

Hydraulic Schematics

2 Wheel Drive Traction Unit

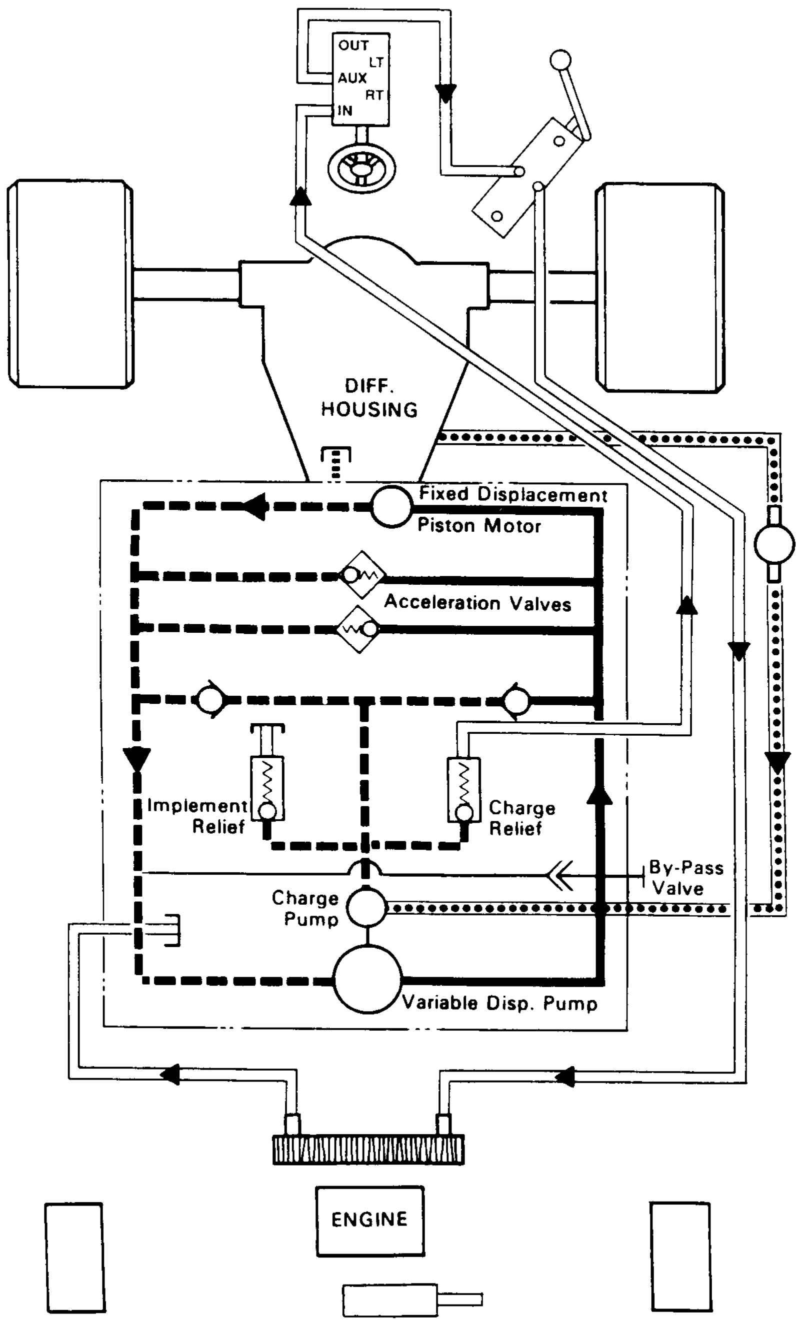


4 Wheel Drive Traction Unit



Forward Traction Operation

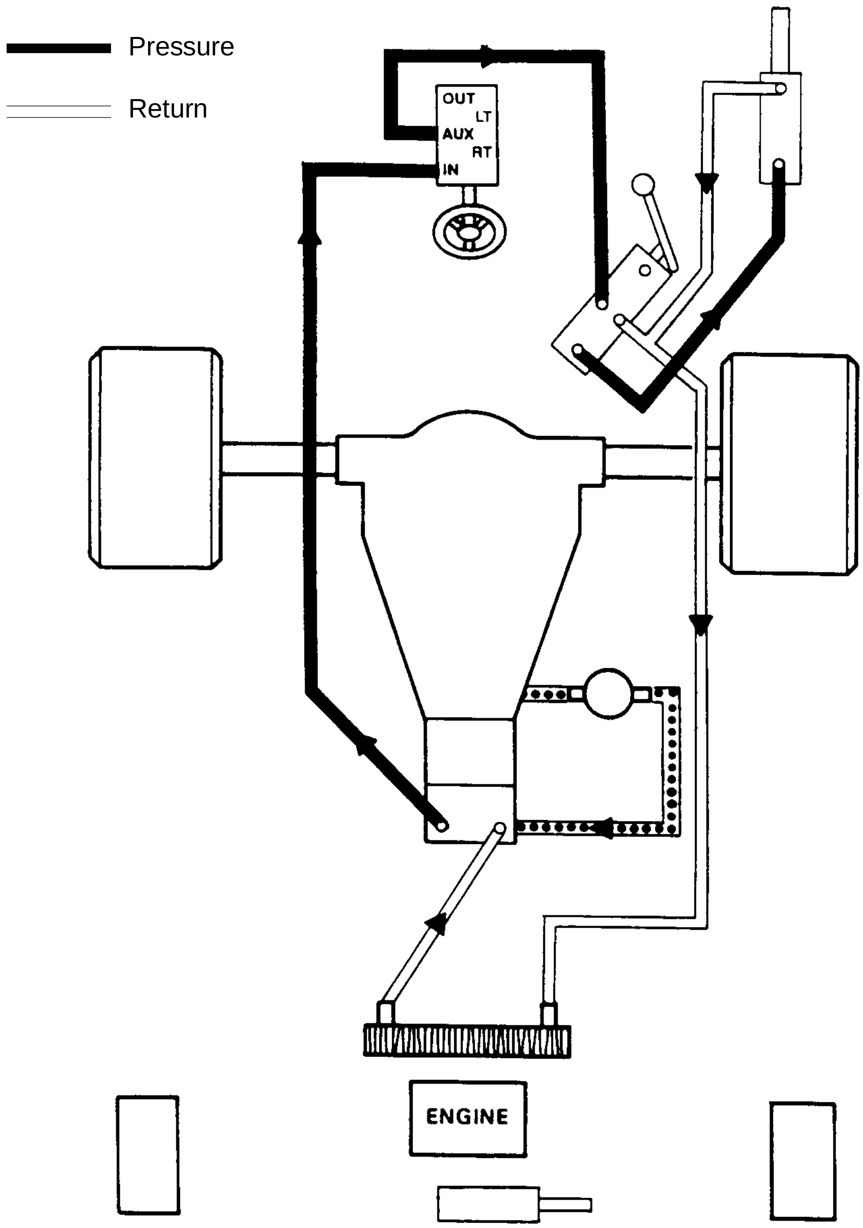
The hydrostatic transmission consists of a charge pump, variable displacement pump and a fixed displacement motor. The diagram shows flow of the hydraulic oil during forward operation.



Raising the Cutting Unit

The charge pump supplies oil through the "AUX" port of the steering valve to the lift valve. When the lift lever is actuated to raise the cutting unit, oil supplied by the charge pump is directed out the work port of the lift valve to the barrel end of the lift cylinder. Oil displaced from the rod end of the cylinders goes through the oil cooler and back to reservoir.

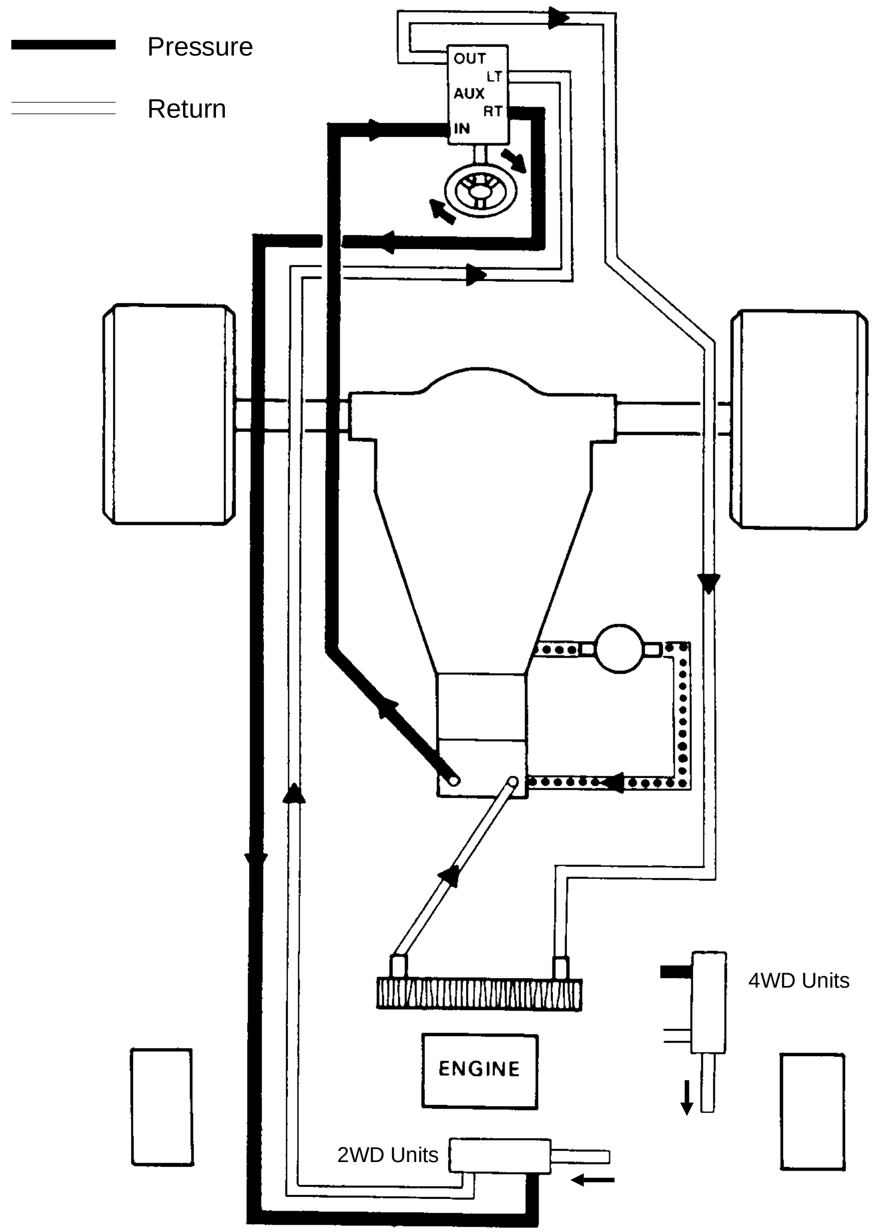
NOTE: The steering valve will not allow oil to flow through it to the lift valve when the steering wheel is being turned. Whenever the steering wheel is not moving, the steering valve allows oil to flow through it. Oil in the rest of the steering circuit is then trapped.



Turning Steering Wheel to Right

When the steering wheel is turned to the right the control valve within the steering valve shifts to close the “AUX” port. This directs oil supplied by the charge pump to the metering section of the steering valve. As the steering wheel turns, oil is metered out port “RT” to the steering cylinder. Oil displaced by the other end of the steering cylinder returns to the steering valve through port “LT” which directs it through the “OUT” port back to reservoir.

When the steering wheel stops turning the control valve within the steering valve shifts back to neutral allowing oil to flow through the steering valve out the “AUX” port to the lift control valve. Oil in the rest of the steering circuit is then trapped.



Special Tools

NOTE: Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*. Some tools may be listed in the Parts Catalog for your Toro equipment. Some tools may also be available from a local supplier.

Hydraulic Pressure Gauges (Fig. 7)

Used to take various hydraulic pressure readings for diagnostic tests.

Low pressure gauge 0 - 1000 psi, high pressure gauge 0 - 5000 psi, and associated hoses and fittings.

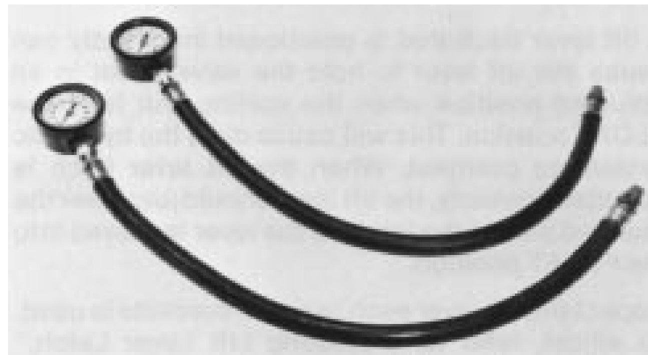


Figure 7

Hydraulic Tester (With Pressure and Flow Capabilities) (Fig. 8)

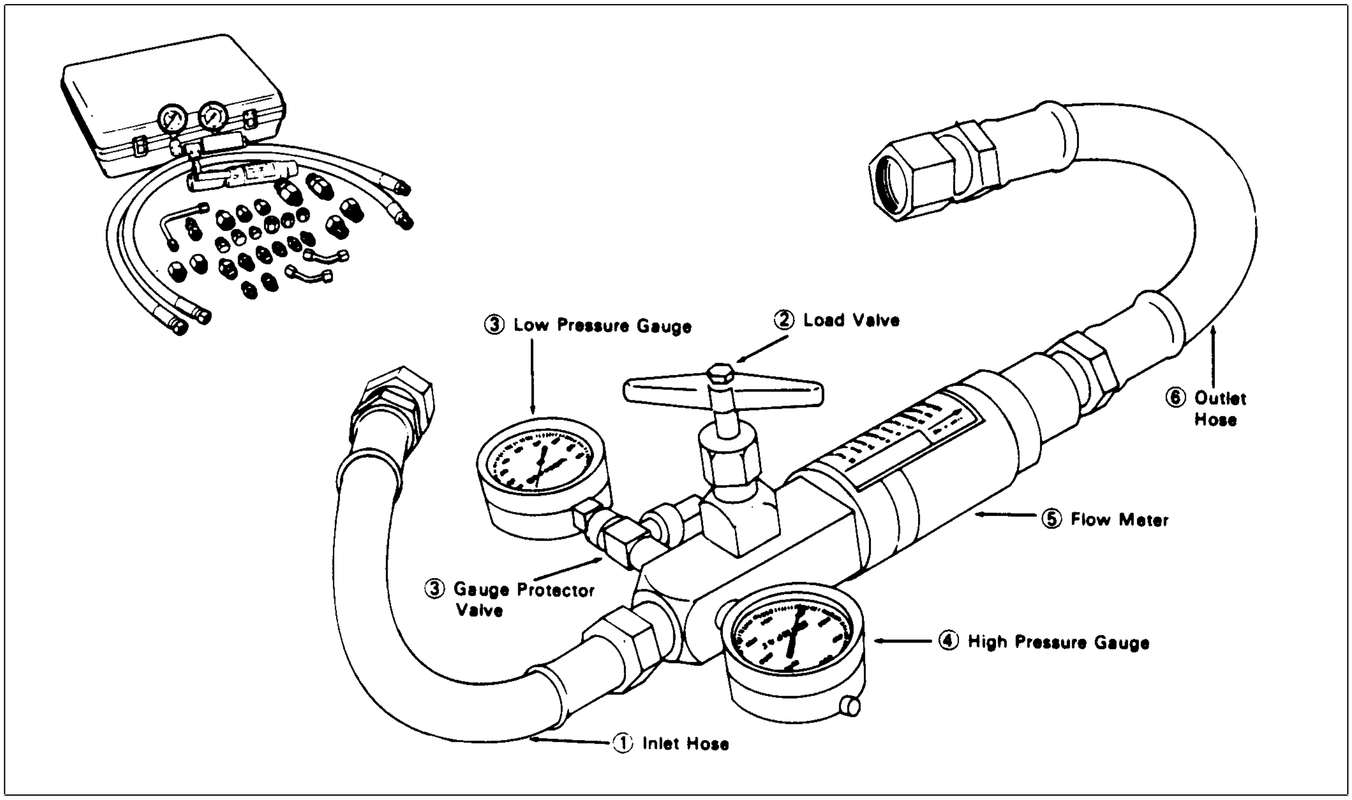


Figure 8

You must have o-ring face seal (ORFS) adapter fittings for this tester to use it on current models of the Groundsmaster 300 Series.

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.

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.

5. FLOW METER: This meter measures actual oil flow in the operation circuit, with a gauge rated at 15 GPM.

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

Troubleshooting

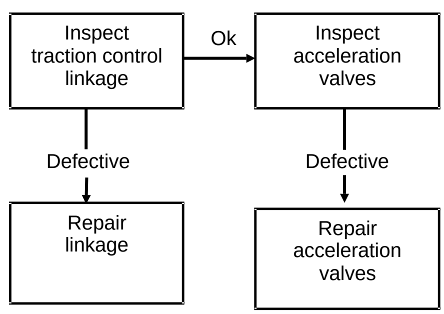
The cause of an improperly functioning hydraulic system is best diagnosed with the use of proper testing equipment and a thorough understanding of the complete hydraulic system.

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

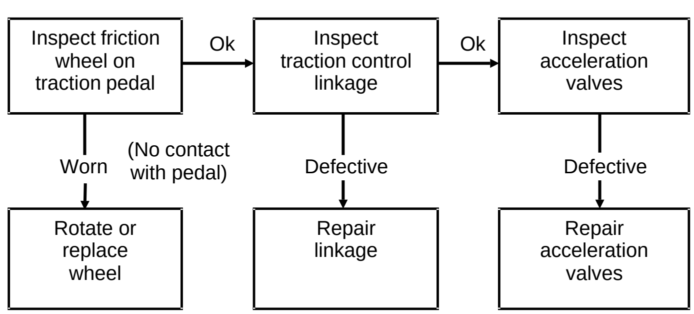
The charts that follow contain detailed information to assist in troubleshooting. There may possibly be more than one cause for a machine malfunction. All causes should be checked in the order in which they are listed on the charts.

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

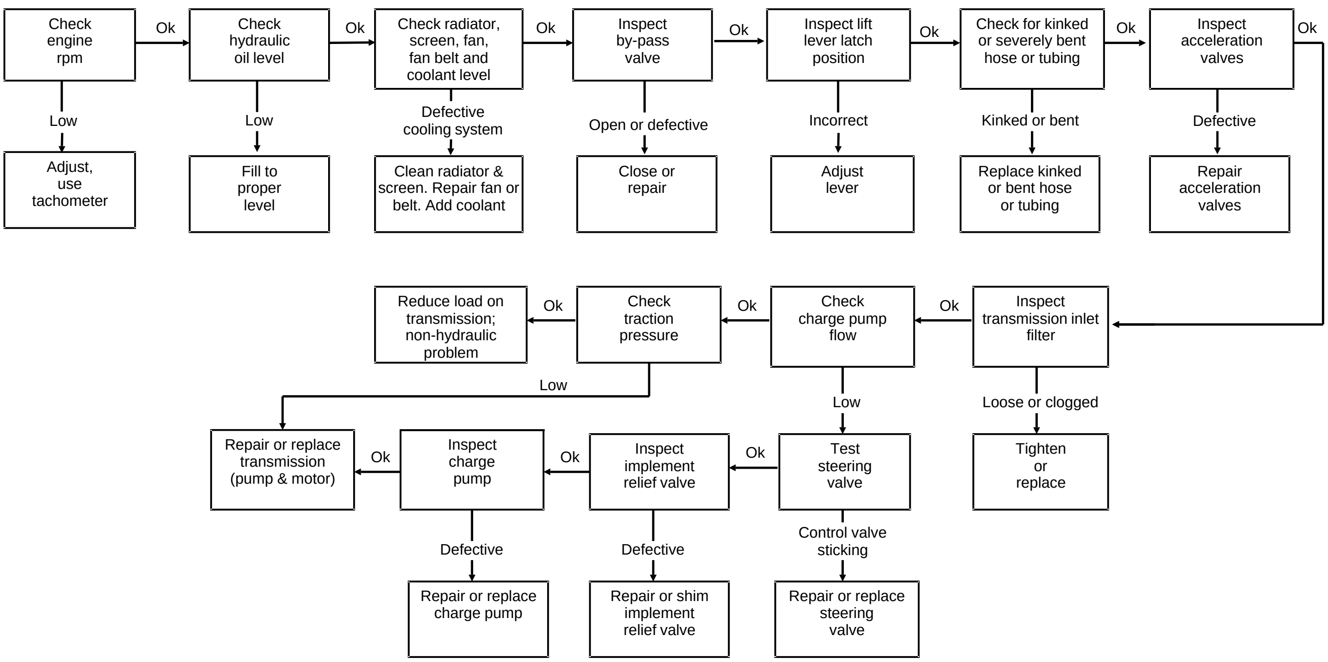
System Operates in Only One Direction



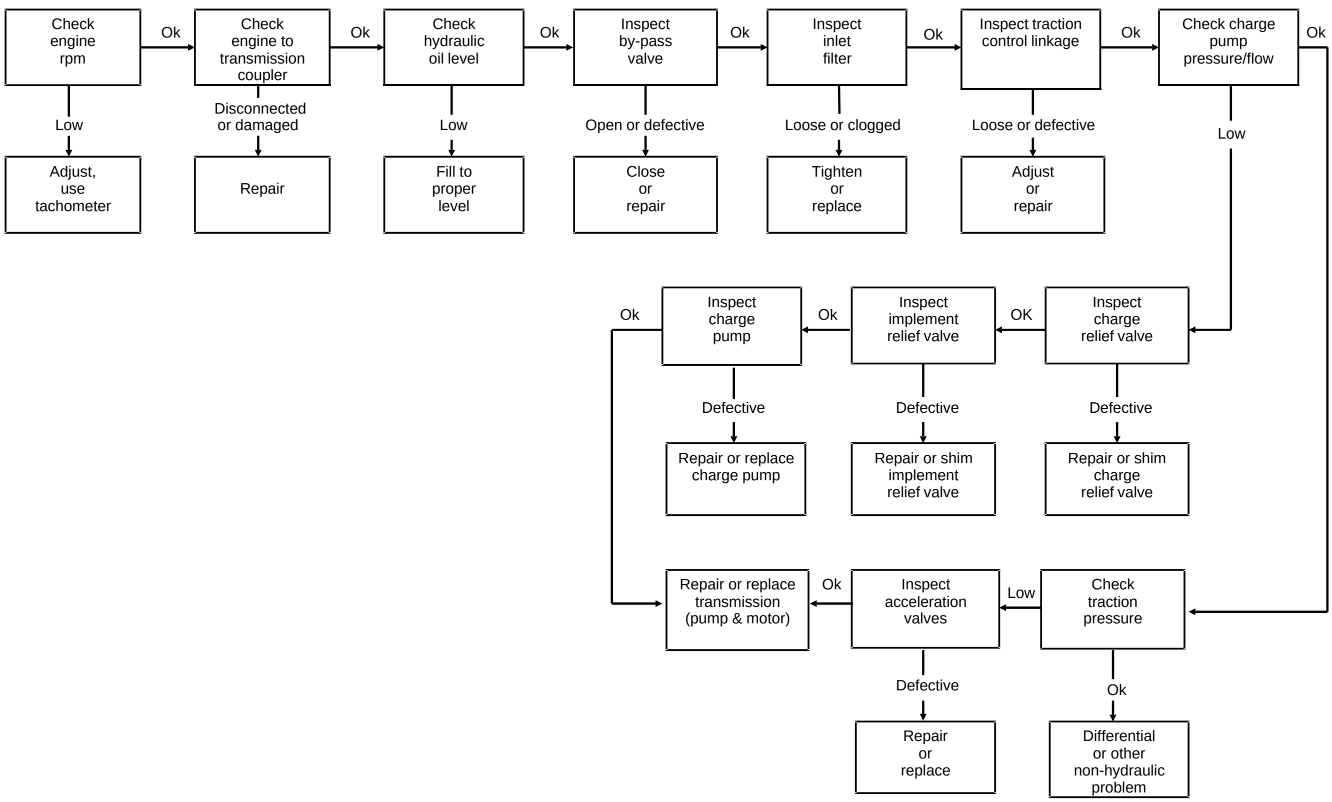
System Jerky When Starting

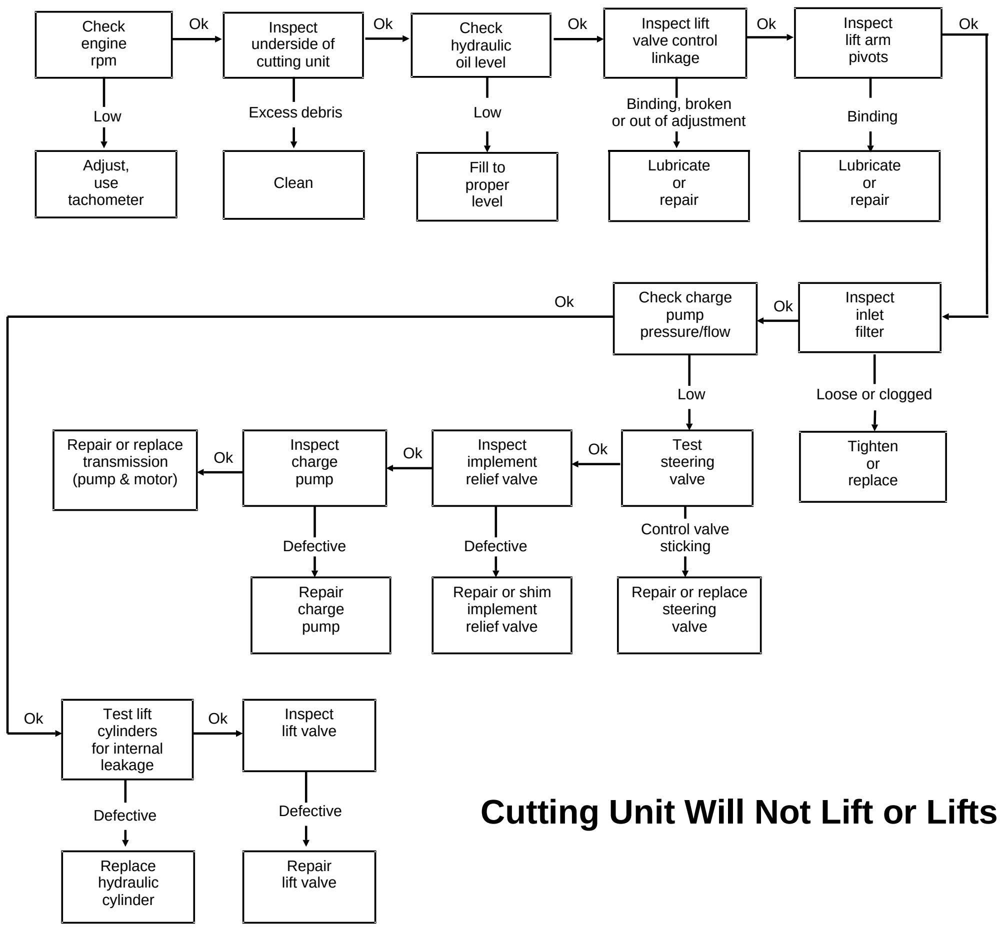


System Operates Hot



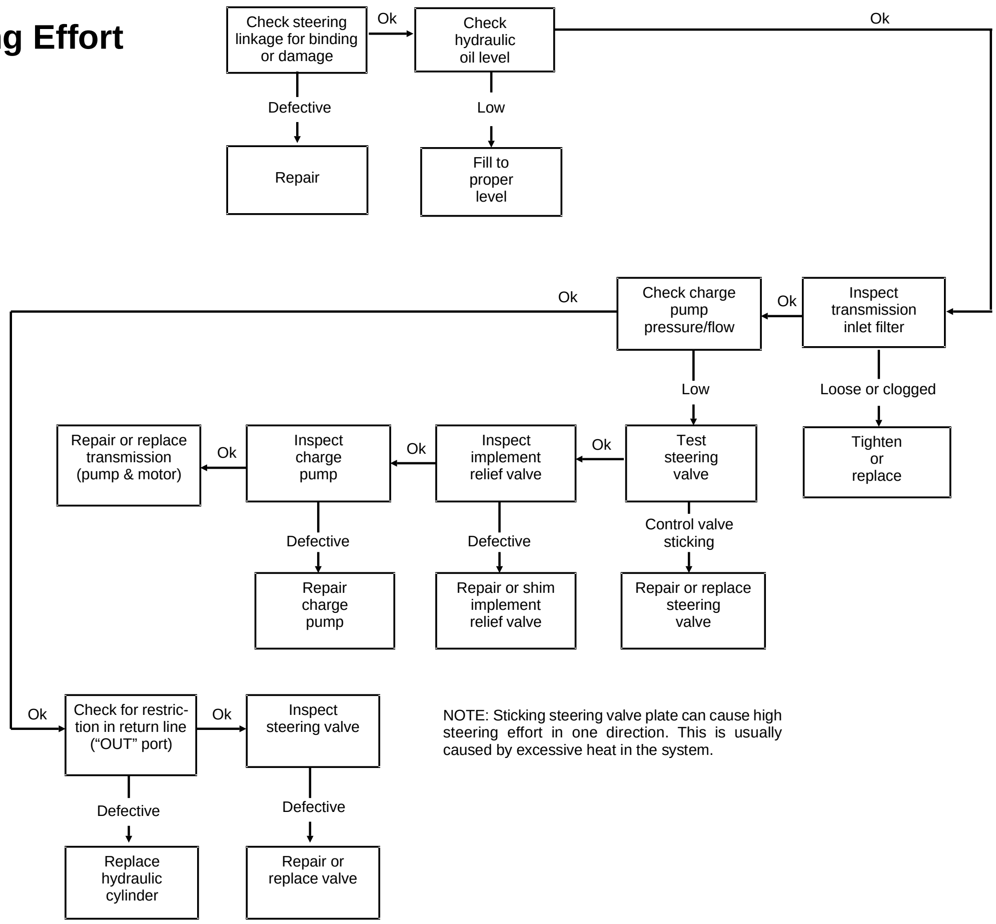
Loss Of Power Or Unit Will Not Operate In Either Direction





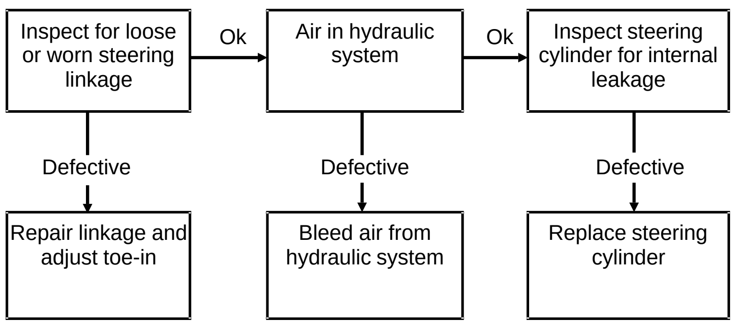
Cutting Unit Will Not Lift or Lifts Slowly

High Steering Effort



NOTE: Sticking steering valve plate can cause high steering effort in one direction. This is usually caused by excessive heat in the system.

Steering Wander or Shimmy



Testing

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

CAUTION

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

Before Performing Hydraulic Tests

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

Do electrical diagnostics before performaing hydraulic tests to make sure the electrical system is operating properly. If the electrical system is not operating properly the hydraulic system may appear to malfunction.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved by lowering the cutting unit to the ground and shutting the engine OFF.

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

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

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

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

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

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

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

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

8. Check the oil level in the reservoir.

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

10. All hydraulic tests should be made with the hydraulic oil at normal operating temperature.

TEST NO. 1: Charge Pressure (Fig. 9)

Using a low pressure gauge: 0 - 1000 psi

1. Engage the parking brake, and block the front wheels to prevent movement of the machine. Lower the cutting unit or implement to the floor and turn the engine OFF.

2. Raise and support the seat.

3. Place a drain pan under the transmission. Use a 3/16 inch Allen wrench to remove the 1/8 inch pipe plug located next the implement pressure port on top of the transmission.

4. Connect the 0 - 1000 psi hydraulic gauge hose into the 1/8 inch pipe opening.

5. Start the engine and move the throttle to SLOW so that the engine idles. Use a tachometer to verify that the engine is running at 1500 ± 50 rpm. The engine must idle at this speed to provide sufficent charge pump flow and pressure to lubricate the internal parts of the transmission.

6. Allow the engine to run for approximately 5 minutes so that the hydraulic oil reaches normal operating temperature.

7. Increase the engine speed to the FULL throttle setting and use a tachometer to verify that the engine is running at 3200 ± 50 rpm.

8. Observe the pressure measurement on the low pressure gauge. The reading should be 70 - 150 psi.

NOTE: A higher reading may be obtained due to the back pressure in the system. This is acceptable.

9. If the pressure is below 70 psi, adjust the charge relief valve by adding the required amount of shims from the shim pack.

NOTE: If adding shims to the relief valve does not increase the pressure, inspect the condition of the charge pump gerotor and internal housing.

If the charge pump is in good condition (no scoring, scratches, or excessive wear), the general condition of the transmission's piston pump and piston motor might be suspected of wear and inefficiency.

A lack of minimum charge pressure or low flow could be due to the fact that the charge pump is having to direct all of its flow to the main traction circuit (piston pump and piston motor). When this occurs, oil pressure may not increase to the 70 - 150 psi pressure necessary to open the charge relief valve; therefore, no oil can flow into the steering and implement circuit.

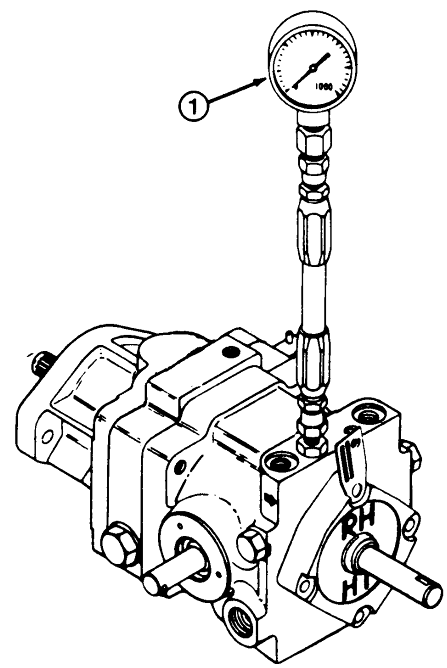


Figure 9

1. Low pressure gauge (0 - 1000 psi)

TEST NO. 2: Implement Relief Pressure (Fig. 9)

Using a low pressure gauge: 0 - 1000 psi

1. Perform steps 1 - 7 under Charge Pressure Test.

2. While observing the gauge, move the lift control lever to the RAISE position. While holding the lever in the RAISE position, look at the pressure reading on the gauge. The gauge should show 700 - 800 psi. Stop the engine and move the lift control lever to the LOWER position to lower the implement to the ground.

3. If the pressure is below 700 psi, adjust the implement relief valve by adding the required amount of shims from the shim pack.

CAUTION

The implement relief pressure must not exceed 800 psi.

NOTE: When testing the implement relief valve pressure, it may be found that the pressure is already set to the 800 psi maximum. If this is so, a slow or no lift condition is most likely caused by an added force being applied to the lift system and not a fault within the hydraulic circuit. This is can be caused by parts that are binding or build up of debris under the cutting unit. This adds to the amount of force that the hydraulic cylinder must overcome. Repair such items before continuing with the hydraulic tests.

If adding shims to the relief valve does not increase the pressure, inspect the condition of the charge pump gerotor and internal housing.

If the charge pump is in good condition (no scoring, scratches, or excessive wear), the general condition of the transmission's piston pump and piston motor might be suspected of wear and inefficiency.

A lack of sufficient implement pressure could be due to the fact that the charge pump is having to direct most of its flow to the main traction circuit (piston pump and piston motor). When this occurs, oil pressure may not increase to the 700 - 800 psi pressure necessary to raise the heavy implement.

At this point, a traction pressure test could be used to determine whether the hydrostatic transmission has excessive piston group leakage and needs to be repaired. (See Traction Pressure Test.)

TEST NO. 3: Traction Pressure (Fig. 10)

Using a high pressure gauge: 0 - 5000 psi

CAUTION

Failure to use a high pressure gauge 0 - 5000 psi during this traction pressure test could result in damage to the gauge and possible personal injury due to leaking, hot oil.

1. Before beginning the traction test, drive the machine to an open area, lower the cutting unit, turn the engine OFF and engage the parking brake. Connect a chain to the rear axle. Connect the other end of the chain to an immovable object and remove all slack from the chain.

2. Place a drain pan on the floor beneath the transmission. Remove the hex head plug from the transmission.

3. Connect the high pressure hydraulic gauge hose to the gauge port.

4. Start the engine and allow it to run for approximately 5 minutes so that the hydraulic oil reaches normal operating temperature.

5. Increase the engine speed to the FULL throttle setting and use a tachometer to achieve 3200 ± 50 rpm.

CAUTION

To prevent damage to gauge and possible personal injury due to leaking, hot oil, do not exceed 5000 psi during traction pressure test.

6. Sit on the seat, and with the brakes locked, slowly depress the top of the traction pedal. While pushing the top of the traction pedal down, look at the pressure reading on the gauge. The gauge should show 4000 - 4500 psi. DO NOT exceed 5000 psi.

7. If the traction pressure is lower than 4000 psi, check the acceleration valves. If the acceleration valves are in good condition and there is no foreign material in the ports of the transmission, inspect the charge check valves. If the charge check valves are in good condition, overhaul the transmission because either the pump, motor, or both piston groups are at fault.

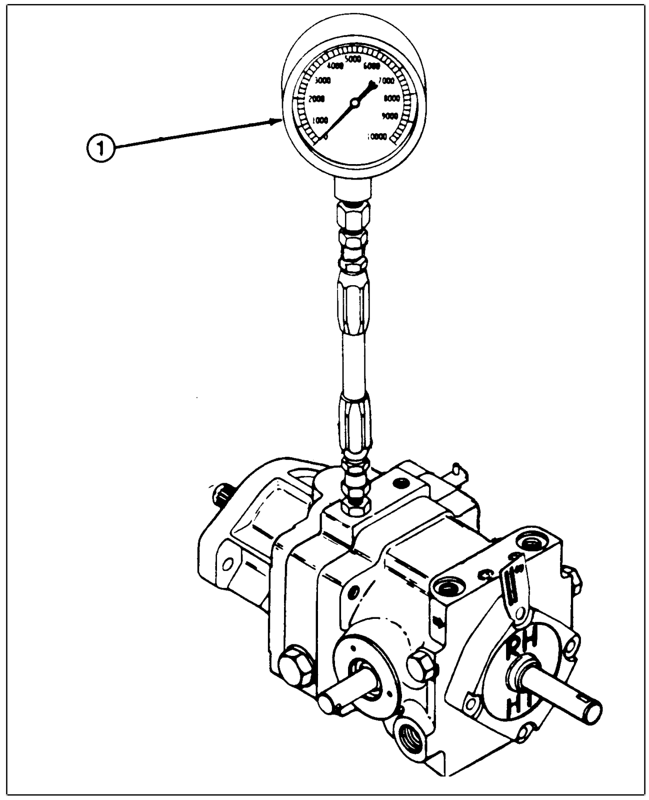


Figure 10

1. High pressure gauge (0 - 5000 psi)

TEST NO. 4: Charge Pump Flow and Implement Relief Pressure (Fig. 11)

Using a hydraulic tester with flow meter

1. Engage the parking brake and block the front wheels to prevent movement of the machine. Lower the cutting unit or implement to the floor and turn the engine OFF.

2. Raise and support the seat or remove the seat and seat mounting plate.

3. Put a drain pan below the transmission. Disconnect the hydraulic hose from the charge pump outlet (pressure) fitting on the transmission.

4. Connect the inlet hose of the tester to the fitting on the transmission. Connect the tester outlet hose to the hose that was disconnected in step 3.

IMPORTANT: Make sure that the oil flow indicator arrow on the flow gauge is showing that the oil will flow through the tester from the pump to the steering valve.

5. Make sure that the tester load valve is fully open (counterclockwise). Start the engine and allow it to run for approximately 5 minutes so that the hydraulic oil reaches normal operating temperature.

6. Increase the engine speed to the FULL throttle setting and use a tachometer to verify that the engine is running at 3200 ± 50 rpm.

7. While watching the flow and pressure gauges, slowly close the flow control valve (load valve) until the flow gauge reads 1.0 GPM.

8. If the pressure is below 700 psi or 1.0 GPM could not be achieved, adjust the implement relief valve by adding the required amount of shims from the shim pack.

CAUTION

The implement relief pressure must not exceed 800 psi.

If adding shims to the relief valve does not increase the pressure, inspect the condition of the charge pump gerotor and internal housing.

If the charge pump is in good condition (no scoring, scratches, or excessive wear), the general condition of the transmission's piston pump and piston motor might be suspected of wear and inefficiency.

A lack of sufficient implement pressure could be due to the fact that the charge pump is having to direct most of its flow to the main traction circuit (piston pump and piston motor). When this occurs, oil pressure may not increase to the 700 - 800 psi pressure necessary to raise the heavy implement.

At this point, a traction pressure test could be used to determine whether the hydrostatic transmission has excessive piston group leakage and needs to be repaired. (See Traction Pressure Test.)

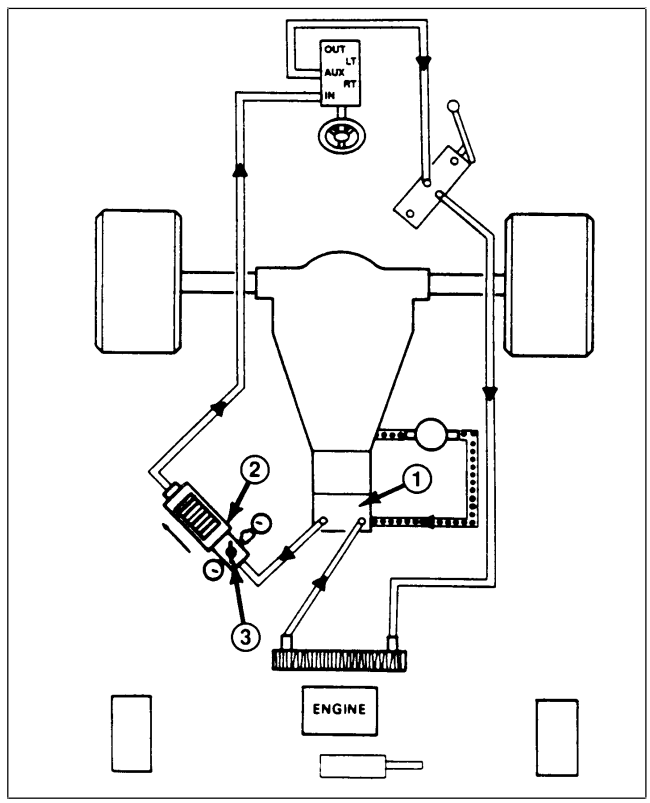


Figure 11

1. Transmission
2. Tester
3. Load valve

Adjustments

Traction Control Rod Adjustment (Serial Numbers Below 50000) (Fig. 12)

1. Check traction drive neutral position to assure front wheels do not creep; refer to “Traction Drive Neutral Adjustment”.

2. Depress traction pedal fully. There must be 1/16 inch (1.6 mm) between inside front edge of pedal and triangular support brace. If distance is as specified, the control rod is adjusted correctly. If distance is not as specified, proceed to step 3 for an adjustment.

3. Loosen jam nut away from front of control rod. Remove cotter pin and slotted nut retaining tapered socket in pivot mount on bottom of traction pedal.

4. Adjust tapered socket as required. Slide end of tapered socket through traction pedal pivot mount. Then depress pedal and check for 1/16 inch (1.6 mm) clearance between front edge of pedal and top of support brace. Adjust tapered socket until correct adjustment results.

5. After control rod is adjusted correctly, secure tapered socket and traction pedal together with slotted nut and cotter pin. Also tighten jam nut against front of control rod.

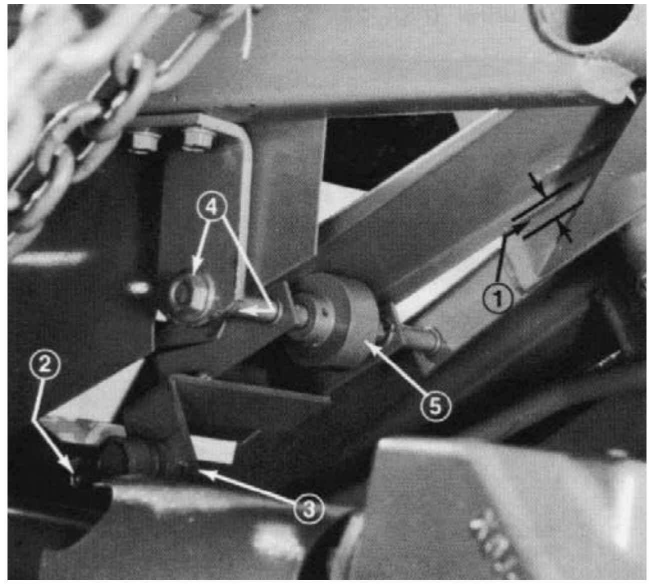


Figure 12

1. **1/16 in. (1.6 mm)**
2. **Jam nut**
3. **Cotter pin & slotted nut**
4. **Nuts**
5. **Friction wheel**

Traction Control Rod Adjustment (Serial Numbers Above 50000) (Fig. 12A)

1. Check traction drive neutral position to assure front wheels do not creep; refer to “Traction Drive Neutral Adjustment”.

2. Loosen lock nuts and adjust traction pedal stop screw to a length of 3” (76.2 mm).

3. Rotate traction pump lever on transmission to full forward speed location.

4. Adjust traction control rod end until there is a .120” (3.05 mm) gap between top of traction pedal stop screw and pedal.

5. Make sure that all nuts are properly secured after adjustment.

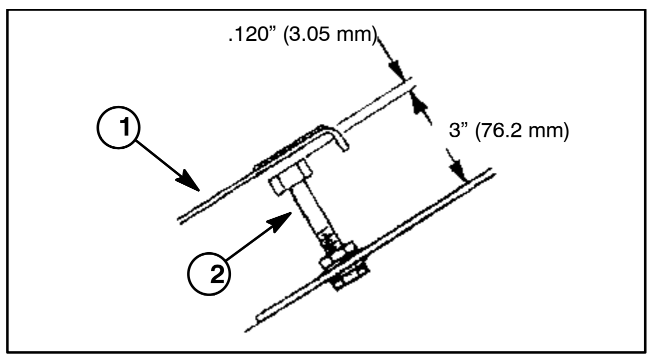


Figure 12A

1. **Traction pedal**
2. **Stop screw**

Traction Pedal Friction Wheel Adjustment (Fig. 12)

1. Loosen two nuts securing traction pedal shaft on right side of pedal.

2. Rotate shaft to relocate worn surface of friction wheel away from underside of traction pedal.

3. Tighten nuts to secure shaft and wheel in position.

Traction Control Neutral Adjustment (Fig. 13)

1. Park vehicle on a level surface and turn engine off. Apply the parking brake, tip seat forward, and actuate pump lever (Fig. 13) to ensure assembly is properly seated and operating freely. Correct any discrepancy.

2. Jack up frame so left front wheel is off the ground. On four wheel drive machines, jack up frame so at least one rear wheel is also off the ground. Use jack stands to support the raised machine.

3. Block wheels that are on the ground so vehicle cannot roll forward or backward.

4. Start engine and allow it to idle for 5 minutes to heat oil in transmission to operating temperatures.

5. Release parking brake; then check that wheel(s) that are off the ground are NOT rotating. Check for wheel rotation with throttle in both SLOW and FAST position. If wheel(s) that are off the ground are NOT rotating, proceed to step 8 as no adjustment is necessary.

6. If the wheel(s) that are off the ground ARE rotating, the pump plate must be adjusted as follows:

A. Move throttle to SLOW.

B. Loosen three (3) capscrews that secure pump plate to transmission.

C. If wheel is rotating forward, lightly tap bottom of pump plate counterclockwise. By contrast, tap pump plate clockwise if wheel is rotating backward. When wheel stops rotating, tighten capscrews to secure pump plate.

D. Check that wheel(s) that are off the ground are NOT rotating with throttle in both SLOW and FAST position. If necessary, repeat pump plate adjustment until wheels do not rotate.

7. Should wheel(s) that are off the ground continue to rotate after adjustment procedure, check for the following:

A. Ball bearing is loose or worn.

B. Plunger on interlock switch is sticking.

C. Fasteners on pump control assembly are loose or missing.

D. Weak or damaged leaf springs.

E. Pump lever loose on transmission control shaft. Make sure that fasteners are tight (bolts or spring pin). If necessary, remove pump lever from control shaft, apply Loctite #680 (or equivalent) to shaft and reattach pump lever.

F. Internal transmission component malfunction (see Repairs section of this chapter).

8. Shut engine off.

9. Adjust traction control rod; refer to Traction Control Rod Adjustment in this section.

10. Check operation of neutral switch and adjust if necessary.

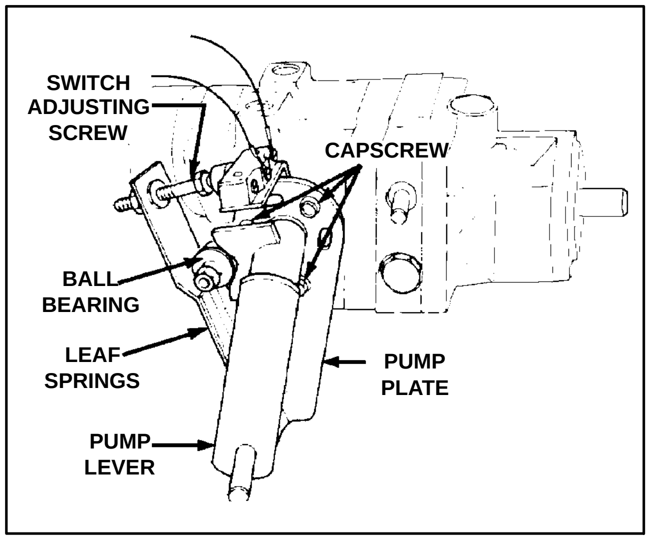


Figure 13

Lift Lever Latch Adjustment (Fig. 14)

A lift lever latch that is positioned incorrectly can cause the lift lever to hold the spool in an actuated position when the implement is in the FLOAT position. This causes oil in the hydraulic system to overheat. When lift lever latch is adjusted correctly, the lift lever should just clear the rounded part of the latch as lever is moved into FLOAT position.

1. Unscrew ball from lift lever.

2. Remove self tapping screws and lift cover off

lift lever to expose the latch.

3. Loosen two capscrews on top of the lift lever latch. Place lever on rounded tip of latch, and slide latch w/lever forward until stopping resistance is felt. Then tighten capscrews to lock the latch in place. Check for free operation of the lift lever by moving lever from RAISE or TRANSPORT to FLOAT position. Lift lever should just clear rounded position of latch as lever is moved into FLOAT position.

4. Slide cover into place and install it with self tapping screws. Screw ball onto lift lever.

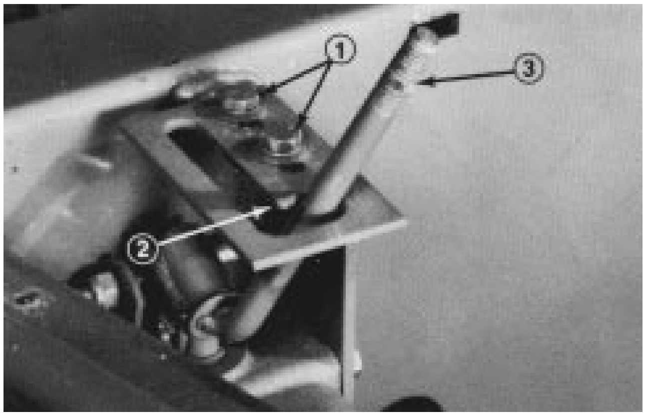


Figure 14

1. Capscrews
2. Rounded tab
3. Lift lever

Transmission Trunnion Seal Replacement (Fig. 15)

1. Remove the control lever and the interlock switch assembly from the trunnion shaft on the right side of the transmission.

2. Remove the snap ring from the end of trunnion shaft and slide the flat washer off of the shaft. Using a seal puller; pull the seal out of the housing. Do not scratch the shaft.

NOTE: Since oil drains out of the transmission when the seal is removed, use a drain pan to catch the oil; however, do not use this oil again.

3. Examine the trunnion shaft and remove all burrs, sharp edges and residue.

4. Using a seal protector, press a new seal into the transmission housing and assure that it is seated properly.

NOTE: In place of a seal protector, use plastic wrap or a similar material to wrap the shaft. This protects the lip of the seal from possible damage when sliding it onto the shaft and pressing it onto the housing.

5. Slide the flat washer onto the shaft and install the snap ring into the groove at the end of the shaft. Do not use a flat washer that is bent.

6. Install the control lever and the interlock switch assembly on the right side of the transmission. Adjust the traction pedal control rod and linkage for neutral, refer to "Traction Control Neutral Adjustment".

7. Since some oil drained out of the transmission when the seals were replaced, check the oil level in the axle housing. Start the engine and let it run for about one or two minutes. Then turn the engine off and check the oil level in the axle housing again. Also check the seals in the transmission for oil leaks.

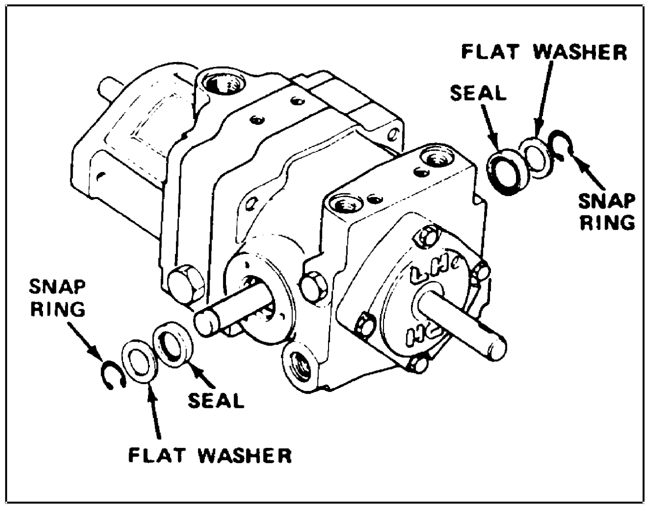


Figure 15

Transmission By-Pass Valve (Fig. 16)

1. Place a drain pan below the by-pass valve.

2. Remove the by-pass valve assembly from the center section by turning it counterclockwise. Some oil may flow into the drain pan.

3. Inspect the threads on the by-pass valve. Replace the valve if the threads are damaged.

4. Check the O-ring and back-up ring for damage. If the parts are damaged, replace them.

5. If the O-ring or back up ring was removed because of damage, slide the new back up ring into the groove at the center of the valve, then install the O-ring into the same groove.

6. To install the by-pass valve, screw it into the center section. Tighten the valve to 5 - 8 ft-lb.

7. Since some oil drained out of the transmission when the by-pass valve was removed, check the oil level in the axle housing. Start the engine and let it run for about one or two minutes. Then turn the engine off and check the oil level in the axle housing again. Also, inspect the by-pass valve area for oil leaks.

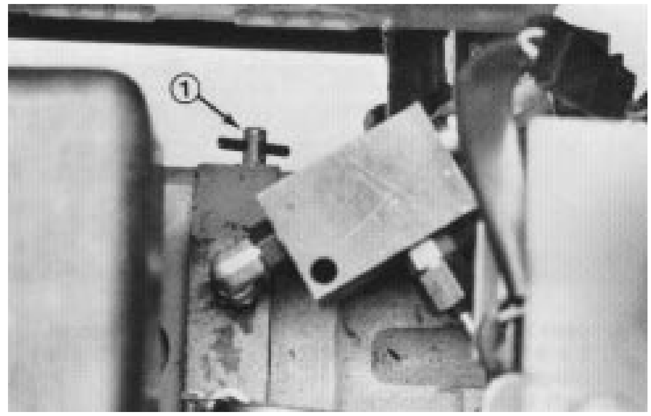


Figure 16

1. Transmission by-pass valve

Transmission Acceleration Valves (Fig. 17)

1 . Place a drain pan below the acceleration valves.

2. Remove both acceleration valve plugs and O-rings from the sides of the center section. Some oil may flow into the drain pan.

3. Slide the acceleration valve and spring out of the center section. Also slide the other acceleration valve out of the opposite side of the center section.

NOTE: There are two acceleration valves in the center section, but only one spring.

4. Remove the O-rings from the plugs.

5. Inspect the plugs, valves and center section for damage or stripped threads. Replace any damaged part.

6. Inspect the bore of the acceleration valve for damage and foreign material. If the valve is damaged, replace it; however, clean the valve with cleaning fluid and use it again if foreign material is in its bore.

7. Check the spring for damage and correct specifications. Replace the spring if its condition is doubtful. Spring specifications are listed in the table below.

Acceleration Valve Spring Specifications

Free Length	2.25 in.
Number of Coils	23-1/2
Outside Diameter	0.297-0.303 in.
Pounds per Inch	17

8. To install acceleration valves, place a new O-ring onto both acceleration valve plugs.

9. Slide one acceleration valve into the center section, then install plug. Then, slide the spring and remaining acceleration valve into the opposite side of the center section. Install the remaining plug to retain the parts in place.

10. Since some oil has drained out of transmission when the acceleration valves were removed, check the oil level in the axle housing. Start the engine and let it run for about one or two minutes. Then turn the engine off and check the oil level in the axle housing again. Also inspect the acceleration valve areas for oil leaks.

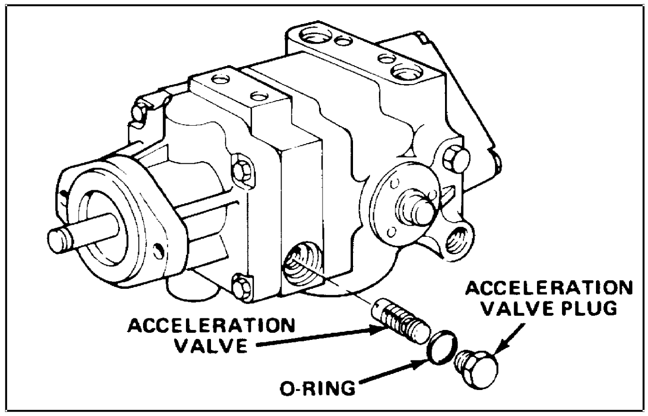


Figure 17

Transmission Implement Relief Valve (Fig. 18)

1. Place a drain pan below the implement relief valve.

2. Remove the implement relief plug and O-ring from the side of the pump housing. Slide the shim pack, spring and cone out of the pump housing. Some oil may flow out of the transmission.

NOTE:Count the shims when they are removed. The same number of shims must be installed when assembling the parts. Do not interchange implement relief shims with charge relief shims.

3. Remove the O-ring from the plug.

4. Inspect the plug and the pump housing for stripped threads. Replace any part that is damaged. Also, check the seat inside the pump housing for damage and foreign material.

5. Inspect the relief valve cone for noticeable damage. If cone is damaged, replace it.

6. Check the spring for damage and correct specifications. Replace the spring if its condition is doubtful. Spring specifications are listed in the table below.

Implement Relief Spring Specifications

Free Length	0.804 in.
Number of Coils	10
Outside Diameter	0.260 - 0.262 in.
Pounds per Inch	339

7. To install the implement relief valve, slide the new O-ring onto the implement relief plug.

8. In sequence, install the cone, spring, and shim pack into the pump housing. Install the plug to retain the parts in place.

9. Since some oil drained out of the transmission when the implement relief valve was removed, check the oil level in the axle housing. Start the engine and let it run for about one or two minutes.Then turn the engine off and check the oil level in the axle housing again. Also, inspect implement relief plug area for oil leaks.

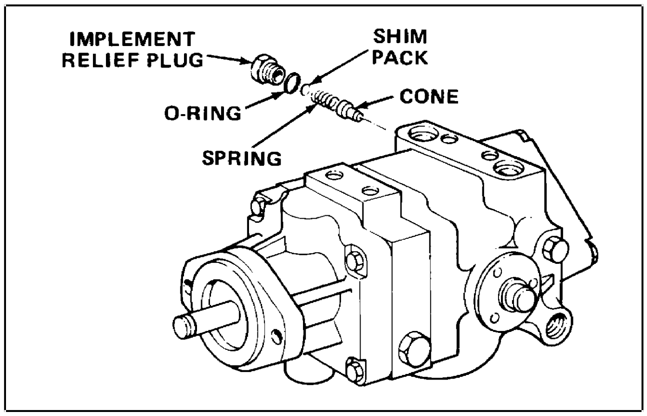


Figure 18

Transmission Charge Relief Valve (Fig. 19)

1 . Place a drain pan below the charge relief valve.

2. Remove the charge relief plug and O-ring from the side of the pump housing. Slide the shim pack, spring and ball or cone out of the housing. Some oil may flow out of the transmission.

NOTE: Count the shims when they are removed. The same number of shims must be installed when assembling the parts. Do not interchange charge relief shims with implement relief shims.

3. Remove the O-ring from the plug.

4. Inspect the plug and pump housing for stripped threads. Replace any part that is damaged. Also check the seat inside the pump housing for damage and foreign material.

5. Check the spring for damage and correct specifications. Replace the spring if is condition is doubtful. Spring specifications are listed in the table below.

Charge Relief Spring Specifications

Free Length	1.051 in.
Number of Coils	14
Outside Diameter	0.249 - 0.251 in.
Pounds per Inch	13.8

6. To install the charge relief valve, slide a new O-ring onto the charge relief plug.

7. In sequence, insert the check ball or cone, spring, and shim pack into the pump housing. Install the plug to retain the parts in place.

8. Since some oil drained out of the transmission when the charge relief valve was removed,check the oil level in the axle housing. Start the engine and let it run for about one or two minutes. Then turn the engine off and check the oil level in axle housing again. Also inspect the charge relief plug area for oil leaks.

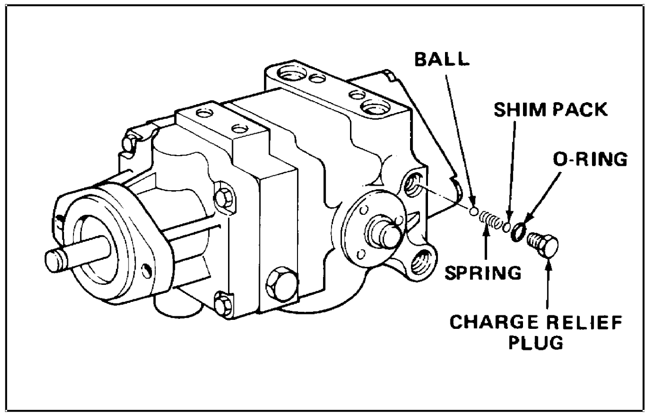


Figure 19

Transmission Charge Pump (Fig. 20, 21)

1. Remove the drive coupling from between the engine pulley and the transmission hub; refer to "Removing Drive Coupling" in Chapter 10.

2. Remove the taper lock (if applicable) and the hub from the transmission shaft.

3. Examine the transmission pump shaft and remove all burrs, sharp edges and residue to prevent possible damage to the lip seal.

NOTE: Disassembly of the charge pump is not necessary when the seal is the only part that must be replaced (see step four). Servicing any other part of the charge pump requires disassembly (see step 5).

4. If the charge pump seal is the only part being serviced, pull the seal out of the charge pump housing using the oil seal puller or similar tool. Do not scratch the pump shaft. Since oil flows out of the transmission when the seal is removed, use a drain pan to catch the oil; however, do not use this oil again.

5. If the charge pump must be disassembled, scribe a mark on charge pump housing and adjacent pump housing to assure correct installation when parts are assembled.

NOTE: Charge pump housings that have the letters LH and RH on the external surface must be installed with the letters LH positioned closest to the top of the transmission.

6. Remove the cap screws holding the charge pump housing against the adjacent pump housing. Using a seal protector, slide the charge pump housing and gerotor wheel off of the pump shaft. The O-ring will probably stay in the groove on the inside of the pump housing.

NOTE: If a seal protector is not used, wrap the pump shaft with plastic wrap to protect the seal. When sliding the housing and gerotor wheel off of the pump shaft, the drive pin may drop out of the pump shaft. Do not lose the pin because it is the only part that drives the gerotor wheel. Without the pin, the gerotor wheel will not rotate; thus, no "charge pressure" and no hydraulic functions.

7. Examine the gerotor wheel and the inside of the charge pump housing for excessive wear patterns, scratches or score marks. If a part is damaged beyond repair, replace it.

IMPORTANT: If either the gerotor wheel or the charge pump housing is damaged, replace both parts. Never replace only one part because the charge pump housing and gerotor wheel have a definite wear-in characteristic.

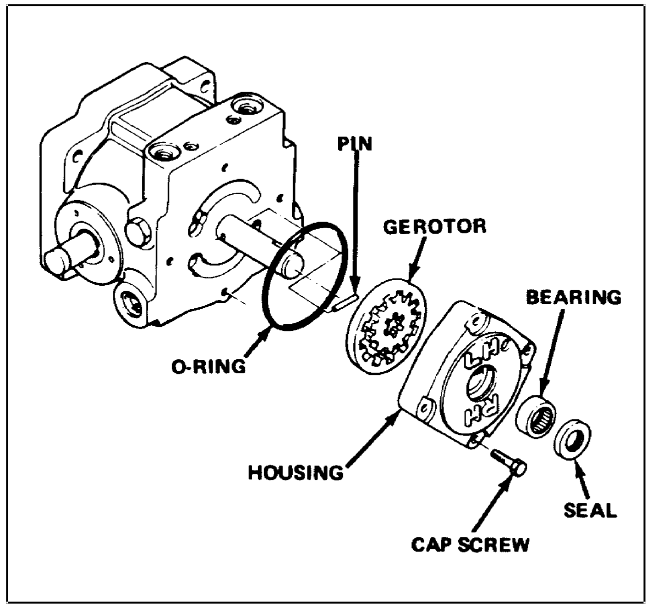


Figure 20

8. Examine the bearing in the charge pump housing for damage and free rotation. If the bearing is damaged, replace the bearing and seal.

9. To assemble the charge pump, install a new O-ring into the groove in charge pump housing.

10. Apply transmission oil on the gerotor wheel and the inside of the charge pump housing. Slide the drive pin through the hole in the pump shaft. (It is helpful to have this hole positioned horizontally, as shown, to keep the pin in place during reassembly.) Then slide the gerotor wheel onto the pump shaft and drive pin so positive engagement results.

11. Using a seal protector for the lip seal, slide the charge pump housing onto the pump shaft and against the side of the adjacent pump housing. Align the scribe marks in both housings to assure proper assembly and to prevent damage to the transmission.

Most Sundstrand charge pump housings are marked with the letters RH and LH. These are used to denote which side of the charge pump is mounted towards the top of the transmission for a given direction of engine rotation (i.e. clockwise). The GROUNDSMASTER mower application requires that the "LH" markings be toward the top of the transmission. Having "LH" toward the bottom of the transmission will result in a complete loss of hydraulic functions.

NOTE: In place of a seal protector, use plastic wrap or a similar material to wrap the pump shaft. This protects the seal from possible damage when sliding it onto the pump shaft. Apply transmission oil on the plastic wrap to make the seal slide freely.

12. Secure the charge pump housing against the adjacent housing with four cap screws. Tighten the cap screws to 12 - 15 ftlb.

IMPORTANT: Excessive pressure on the pump shaft will shear the pin that propels the gerotor wheel. If the pin should shear, the transmission will not operate.

13. Install the drive coupling and transmission hub to the engine pulley; refer to "Installing Drive Couplings" in Chapter 10.

14. Since some oil has drained out of the transmission when the charge pump was serviced, check the oil level in axle housing. Start the engine and let it run for about one or two minutes. Then turn the engine off and check oil level in the axle housing again. Also check the seal in the charge pump for oil leaks.

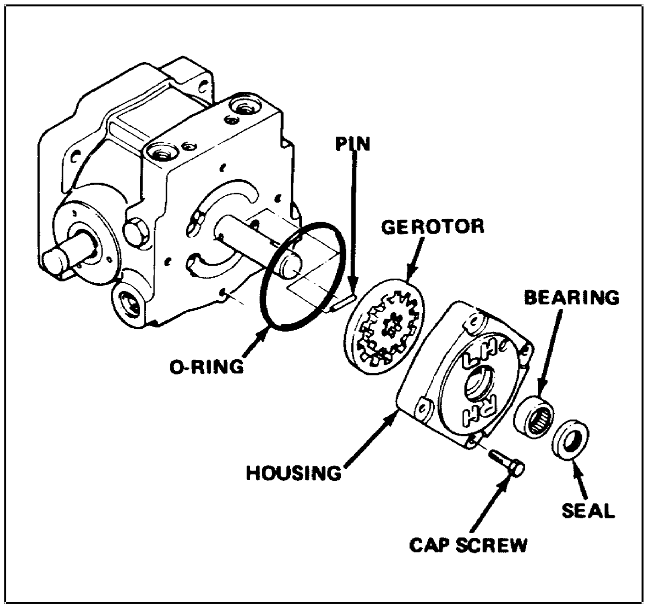


Figure 21

Transmission Removal and Installation

1. Position the machine on a level surface in a clean area of the workshop.Block all four wheels of the unit to prevent it from moving.

2. Lower the cutting unit or implement to the shop floor. Turn the engine off and remove the key from the ignition switch.

3. Disconnect the positive battery terminal from the battery. Place the cable out of the way and in such a position that it cannot spring back and make contact with the positive battery terminal.

4. Raise the seat of the machine and secure it in that position.

5. Place a drain pan underneath the differential. Remove any loose sand, grass, or debris from the top of the transmission. Place a drain pan underneath the differential and hydrostat. Remove the oil line that connects the differential to the transmission or hydraulic filter. Allow oil to drain. Cap or plug the lines and fittings.

6. Remove the hydraulic lines that connect to the transmission. Cap or plug all hoses and fittings to prevent contamination. NOTE: To ease reassembly, tag all lines as to their proper location.

7. Loosen and remove the engine to transmission coupler; refer to "Removing Drive Coupling" of Chapter 10.

8. Disconnect and remove the traction pedal rod where it fastens to the transmission.

9. Support the transmission to prevent it from failing while removing the two cap screws that secure the transmission to the differential.

10. Carefully pull the transmission out of the differential and guide it down and out from under the machine.

11. Remove the gasket that fits between the transmission and differential.

12. Thoroughly clean the area of the differential. where the new or rebuilt transmission will be installed.

13. Reverse steps 1 - 10 to reinstall the transmission and use Loctite 271 on the two cap screws that hold the hydrostat to the differential.

14. Replace the hydraulic oil filter and fill the system with oil.

Transmission Overhaul

As the transmission components are removed for service and inspection, it should be noted that nominal wear to the components is acceptable. Critical contact surfaces (i.e. charge pump gerotor, piston slippers, etc.) must be in good condition or the system will be inefficient.

When components have circumferential scratches or grooves noted on the running surfaces, it is an indication of foreign material in the hydraulic oil.

If upon inspection of the critical contact surfaces you notice circumferential scratches that might be removed by a minimum amount of polishing or touch lapping; rework and use them again.

When scratches or grooves can be detected by "feel" with a fingernail or lead pencil, the part should be replaced. Polishing or touch lapping can be accomplished using 4/0 grit sandpaper on a flat lapping table (table must be kept flat). Polish parts using polishing solvent or equivalent. Do not polish parts dry.

IMPORTANT: Lapping plate must be flat within 0.00005 inch.

Separating Transmission Into Sections (Fig. 23)

The transmission must be separated into three main sections to perform major overhaul. The three sections are: pump section, center section, and motor section.

NOTE: The following procedures are for major overhaul of the in-line transmission. Servicing the charge pump, seals and valves is covered on previous pages.

1. Before separating the transmission, scribe or paint an alignment mark on each housing to assure correct reassembly of the sections.

2. Remove the four cap screws in small increments so the three main sections separate evenly. As the cap screws are loosened, oil will drain from the housings.

NOTE: When the cap screws are first loosened, an internal spring load causes the sections to separate slightly.

3. When the four cap screws are removed, pull the motor housing away from the center section. Do not let the internal parts fall out of the housing because damage may result.

NOTE: The motor valve plate will probably adhere to the side of the center section. Do not let it fall when separating the motor housing from the center section.

4. Remove the motor valve plate and gasket.

5. Set the motor housing and motor valve plate aside. Keep the motor valve plate separate from the pump valve plate because these parts are not interchangeable.

6. Pull the pump housing away from the center section. Do not let the internal parts fall out of the housing because damage may result.

NOTE: The pump valve plate will probably adhere to the side of the center section. Do not let it fall when separating the pump housing from the center section.

7. Remove the pump valve plate and gasket.

8. Set the pump housing and pump valve plate aside. Keep the pump valve plate separate from the motor valve plate because these parts are not interchangeable.

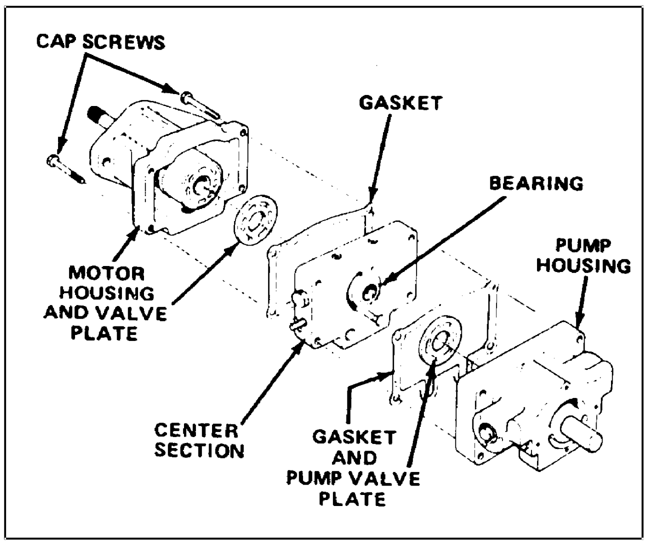


Figure 23

Transmission Pump Section (Fig. 24, 25, 26, 27)

1. Separate the pump housing from the center section; refer to "Separating Transmission Into Sections,".

2. Lift the cylinder block assembly out of the pump housing. Do not be concerned if the pistons come out of the cylinder block because they do not have a special order in the cylinder block

NOTE: Since the entire cylinder block assembly must be replaced if it is defective, do not disassemble the spring and other parts from the center bore of the cylinder block. Cylinder block components are not interchangeable.

3. Remove the thrust plate from the counterbore in the variable position swash plate.

4. Wrap the port side of the pump housing with a clean rag to protect the face of the housing. Set the pump housing on to a clean work bench.

5. Drive the spring pins through the swash plate and out of the trunnion and control shafts.

NOTE: There are two spring pins on the control shaft side of the pump housing and one pin on the trunnion shaft side. The control shaft must have two pins because of the continuous "applied force" from the traction pedal during operation.

6. Mark the control shaft and housing so the shaft can be installed correctly when the parts are reassembled. Slide a long punch through the hole at the end of the control shaft and pull the shaft out of the bore in the swash plate and pump housing.

7. Slide a 3/8 x 7 inch wooden dowel into the bore at the control shaft side of the housing. Place the dowel against the end of the trunnion shaft and drive it out of the housing.

8. Lift the swash plate out of the pump housing and off of the pump shaft.

9. If the pump shaft or bearing must be serviced, use the following steps to remove the parts:

A. Remove the snap ring from the housing.

B. Slide the pump shaft and bearing out of the housing, toward the large open end.

C. Remove the snap ring from the shaft.

D. Press the bearing off of the pump shaft, toward the keyed end.

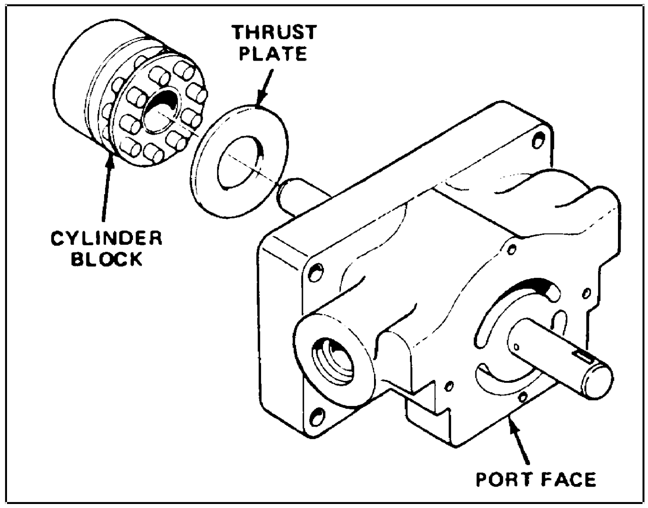


Figure 24

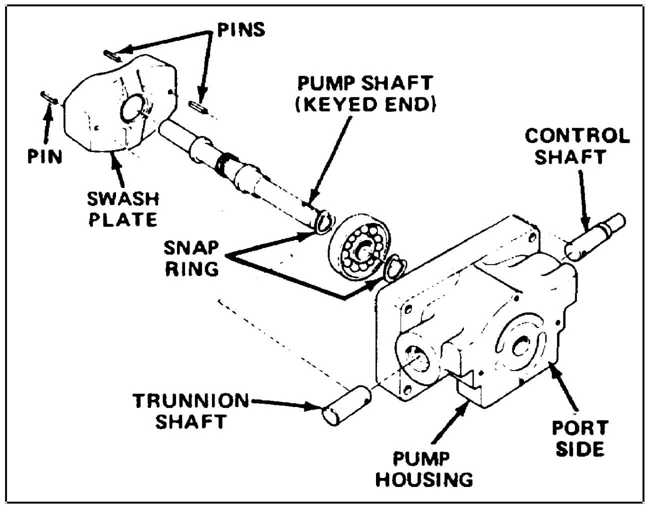


Figure 25

10. Clean and inspect the following parts:

A. Thrust Plate - Check both sides for damage and flatness.

B. Cylinder Block Assembly - Check surfaces for wear, scratches and scoring. Also, check the slippers for damage and make sure the pistons are free in the bores.

C. Ball Bearing - Check for free rotation and noticeable damage.

D. Pump Shaft - Check for scratches, scoring, damaged splines and burrs near keyway.

E. Control and Trunnion Shafts - Check for wear, scratches and burrs.

F. Needle Bearings - Check needle bearings in the pump housing for free rotation and any noticeable damage.

G. Swash Plate - Inspect the swash plate for damage and any noticeable imperfections.

NOTE: Replace any defective part. Remember that the cylinder block assemblies must be replaced as a complete component, not individual parts. Interchanging parts between the pump cylinder block assembly and the motor cylinder block assembly will cause the transmission to malfunction.

11. Lubricate the bearing with transmission oil and press the bearing onto the shaft. Install the snap ring onto the shaft. Then slide the shaft and bearing into the pump housing from the large open side. Install the large snap ring into the pump housing.

12. Slide the swash plate onto the pump shaft and into the pump housing. The counterbore side of the swash plate must face up.

13. Align the holes on both sides of the swash plate with the holes on both sides of the pump housing. Next, slide the control and trunnion shafts into the housing and swash plate. Make sure the control shaft is on the implement relief side of the housing - see alignment marks on the shaft and housing. Secure the shafts and swash plate together with the spring pins.

IMPORTANT: Use only new spring pins when assembling the swash plate and shafts - two pins through the control shaft and one pin through the trunnion shaft. When installing two pins through the swash plate and control shaft, drive the first pin flush with the swash plate and install the other pin onto the top of the first pin. Drive both pins in until the top pin is 1/4 inch below the surface of the swash plate. The pin holding the trunnion shaft must also be 1/4 inch below the surface of the swash plate. Make sure the swash plate swings freely; 15 degrees to each side of center.

14. Lubricate the thrust plate with transmission oil. Slide the thrust plate onto the pump shaft and into the counterbore of the swash plate.

15. Lubricate the pump cylinder block parts with oil. Assemble the cylinder block parts and slide the cylinder block assembly onto the pump shaft. The cylinder block must slide onto the splines near center of the shaft. Assure that the thrust plate remains seated in the counterbore and that the piston slippers contact the face of the thrust plate.

16. Push against the back of the cylinder block. A slight spring pressure assures correct installation of the parts.

17. Assemble the transmission sections if no other service work is required, refer to "Assembling Transmission Section".

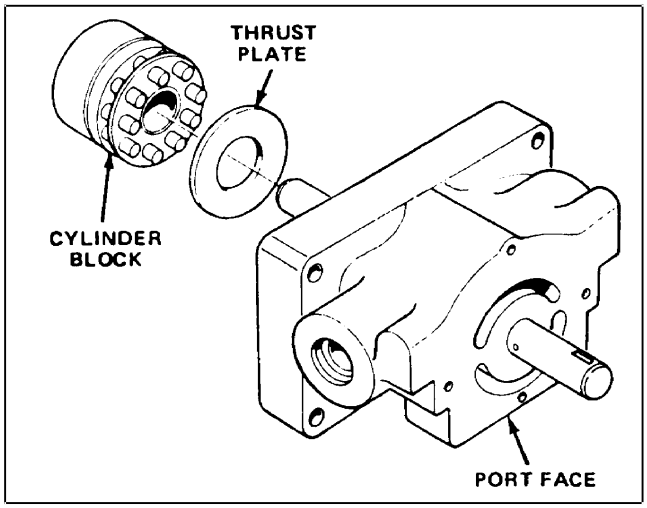


Figure 26

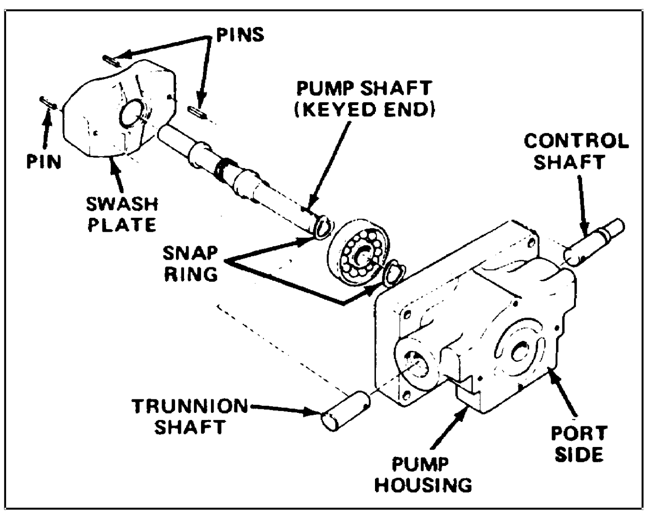


Figure 27

Transmission Center Section (Fig. 28)

1 . Separate the center section from the motor and pump housings; refer to "Separating Transmission Into Sections".

2. Wrap the pump side of the center section with a clean rag to protect its face. Set the center section on a clean work bench so that the motor side faces up. The rag will protect the pump side of the center section from direct contact with the top of the work bench.

3. Remove the two slotted directional charge check plugs from the motor side of the center section. Invert the center section and allow the two valve springs and check balls to fall into your cupped hand. Also remove the two O-rings from the pump side of the center section.

4. If the needle bearings must be serviced, press them out of the center section.

5. Clean and inspect the following parts:

A. Slotted plugs and O-rings - Check the slotted plugs for damaged threads and burrs. Also check the O-ring for tears. It is a good practice to install new O-rings whenever the slotted plugs are removed.

B. Valve Springs and Check Balls - Check the valve springs and check balls for damage. Spring specifications are listed in the table below.

Check Valve Spring Specifications

Free Length	0.550 in
Number of Coils	10
Outside Diameter	0.217 - 0.219 in.
Pounds Per Inch	3.67

C. Needle Bearings - Check for free rotation and any noticeable damage.

D. Dowel Pins - Check the dowel pin on the motor side and the pump side of the center section for wear and damage.

NOTE: Replace any defective parts. The slotted plugs, valve springs, and check balls are interchangeable.

6. If the needle bearings were removed, press new bearings into the center section. Allow 3/32 - 1/8 inch of the bearing to extend beyond the face of the center section because the motor valve plate and pump valve plate pilot on the two bearings.

7. Press the locating pins into the holes in the motor side and pump side of the center section.

8. Insert the check balls and valve springs into the two holes in the motor side of the center section. Slide the O-rings onto the slotted plugs and install the plugs into the two holes in the motor side of center section. Insert the two new O-rings into the holes in the pump side of the center section.

9. Assemble the transmission sections if no other service work is required; refer to "Assembling Transmission Sections".

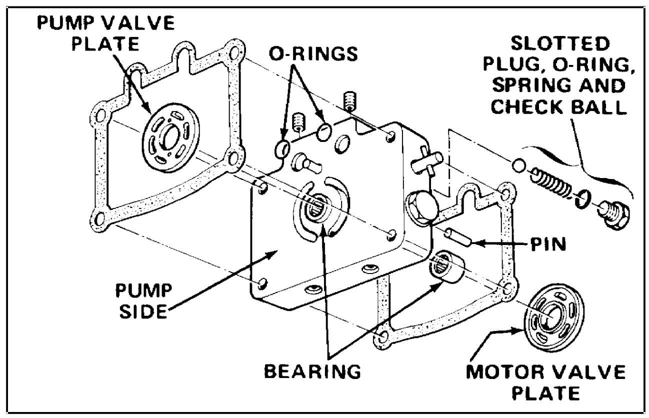


Figure 28

Transmission Motor Section (Fig. 29, 30)

1. Separate the motor housing from the center section; refer to "Separating Transmission Into Sections".

2. Lift the cylinder block assembly out of the motor housing. The pistons may come out of the cylinder block, but do not be concerned; they do not have a special order in the cylinder block.

NOTE: Since the entire cylinder block assembly must be replaced if it is defective, do not disassemble the spring and other parts from center bore of the cylinder block. Cylinder block components are not interchangeable.

3. Remove the thrust plate from the counterbore in the motor housing.

4. If the motor shaft or bearing must be serviced, remove the snap ring from the motor housing. Slide the motor shaft and bearing out of the housing toward the

flange end. If the shaft sticks in the housing, tap it lightly with a rubber hammer to remove it.

5. Clean and inspect the following parts:

A. Motor Valve Plate - Check for wear, scratches and scoring.

B. Thrust Plate - Check both sides for damage and flatness.

C. Cylinder Block Assembly-Check the surfaces for wear, scratches and scoring. Also, check the slippers for damage and make sure the pistons are free in the bores of the cylinder block.

D. Ball Bearing - Check for free rotation and any noticeable damage.

E. Motor Shaft - Check for scratches, scoring or damaged splines.

NOTE: Replace any defective part. Remember that the cylinder block assemblies must be replaced as a complete component, not individual parts. Do not interchange parts between the motor cylinder block assembly and the pump cylinder block assembly because the transmission will not operate at its optimum capacity.

6. Lubricate the bearing with transmission oil. Press the bearing onto the motor shaft. Slide the motor shaft and bearing into the motor housing from the flange side. Install the snap ring into the groove at the flange end of the motor housing.

NOTE: Make sure the splines at the end of the motor shaft are toward the flange side of the motor housing.

7. Lubricate the thrust plate with transmission oil. Slide the thrust plate onto the motor shaft and into the counterbore of the motor housing.

8. Lubricate the motor cylinder block parts with transmission oil. Assemble the cylinder block parts and slide the cylinder block assembly onto the motor shaft. The cylinder block must slide onto the splines near the center of the shaft.

NOTE: Assure that the thrust plate remains seated in the counterbore and that the piston slippers contact the face of the thrust plate.

9. Push against the back of the cylinder block. A slight spring pressure assures the correct installation of parts.

10. Assemble the transmission sections if no other service work is required; refer to "Assembling Transmission Sections" which follows.

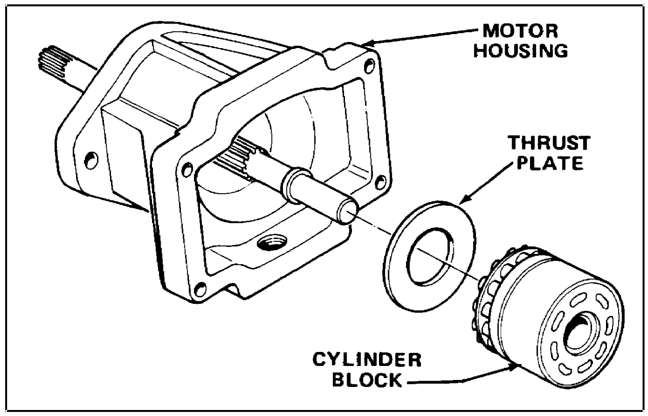


Figure 29

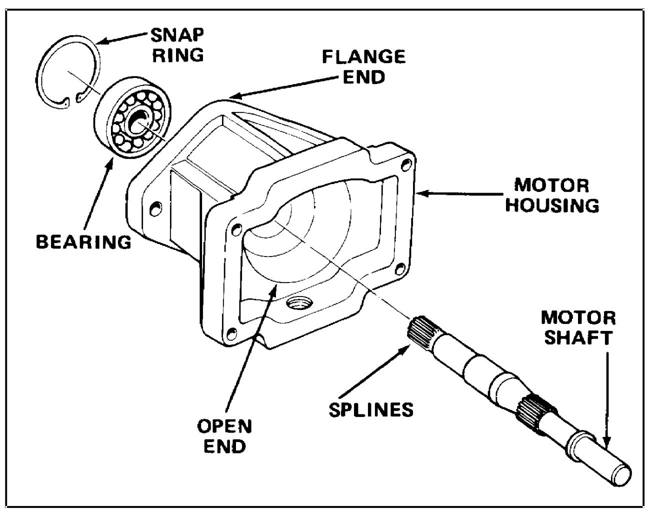


Figure 30

Assembling Transmission Sections (Fig. 31, 32)

1. Apply transmission oil on both sides of the center section. Place the gaskets in position against the pump and motor sides of the center section.

NOTE: The transmission oil should hold the gaskets against the sides of the center section.

2. Identify the motor side of the center section by locating the two slotted directional charge check plugs. Apply transmission oil on the surfaces of the motor valve plate and install the recessed groove side of the motor valve plate against the side of the center section. The slot in the valve plate must fit over the locating pin. Make sure that the center of the valve plate pilots on the needle bearing extending out of the center section.

IMPORTANT: The motor valve plate and the pump valve plate are not interchangeable. Identify the motor valve plate by the four V-notches in the kidney shaped grooves. The pump valve plate has two V-notches in the grooves.

3. Apply transmission oil on the surfaces of the pump valve plate and install the recessed-groove side of the pump valve plate against the pump side of center section. The slot in the valve plate must fit over the locating pin. Assure that the center of the valve plate pilots on the needle bearing extending out of the center section.

4. Assemble the center section between the motor housing and the pump housing. The line scribed or painted on the motor housing, center section, and pump housing must line up to assure the correct assembly of the parts.

NOTE: When assembling the three main sections, make sure the gaskets, valve plates, and cylinder block assemblies remain in place.

5. Use new capscrews and special flat washer when assembling the transmission sections. Lubricate the four cap screws with oil and secure the three main sections together. Alternately, and in gradual increments, tighten the cap screws to 34 - 37 ft-lb.

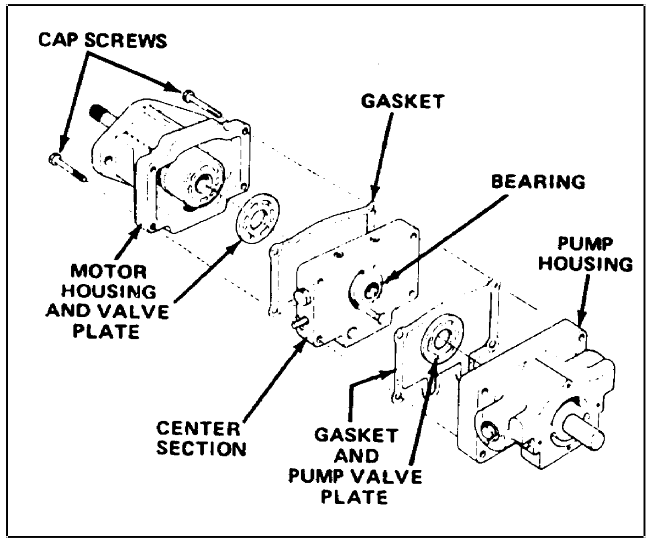


Figure 31

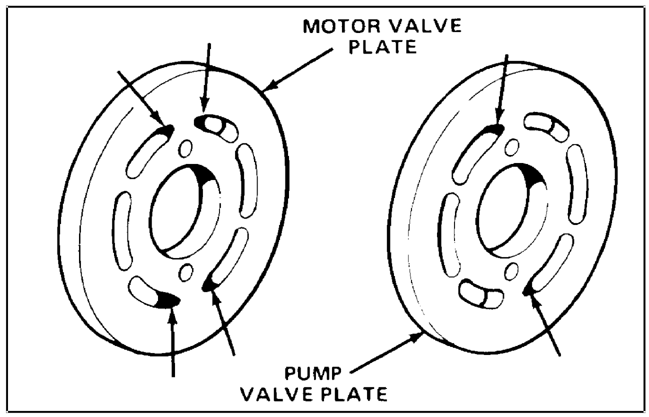


Figure 32

Priming After Transmission Overhaul Or Replacement

Use the following procedures to prime the hydraulic system whenever the Sundstrand Transmission is overhauled or replaced:

1. Pour a quantity of transmission oil into the transmission before mounting it to the machine.

2. Fill a new filter with fresh, clean oil and install it onto the transmission.

3. Remove the dipstick from the pipe nipple in the differential assembly and add oil to the proper level.

4. Start the engine and operate the traction and lift system controls for approximately five minutes. Then turn the engine off.

5. Allow the machine to stand idle for approximately two minutes, remove the dipstick and check the oil level. If the oil level is too high, drain the system until it is at the correct level. Add oil if the fluid level is too low.

Lift Cylinder Removal and Installation (Fig. 33)

1. Lower the cutting unit to the shop floor and turn the engine off. Jack up the right front side of the traction unit and support it with a jack stank. Remove the wheel nuts and slide the wheel off of the mounting studs.

2. Remove the hoses from the lift cylinder and cap the hoses to prevent contamination.

3. Remove the hair pin cotters and spring from the cotter pin. Remove the mounting pins and slide the cylinder from between the lift arm and the stationary mounting bracket.

4. Install the new or rebuilt cylinder with the pins and assure the cotter pin which secures the moveable end of the cylinder is to the outside. Hook the chain tension spring through the eye of the cotter pin.

5. Connect the hydraulic hoses from the control valve to the cylinder.

6. Install the wheel and tighten the nuts to 45 - 55 ft-lb. Remove the jack stank and lower the deck to the shop floor.

7. Check the level of the hydraulic oil to be sure it is up to the proper level. Start the engine and operate the lift cylinder to remove air from the lines. Turn the engine off.

8. Check the level of the hydraulic oil again to be sure it is up to the proper level.

9. NOTE: The hydraulic fitting elbow located at the back of the lift cylinder has a special orifice size to determine the actuation speed of the cylinder. Always use the proper Toro replacement part for this fitting to prevent damage to the hydraulic system.

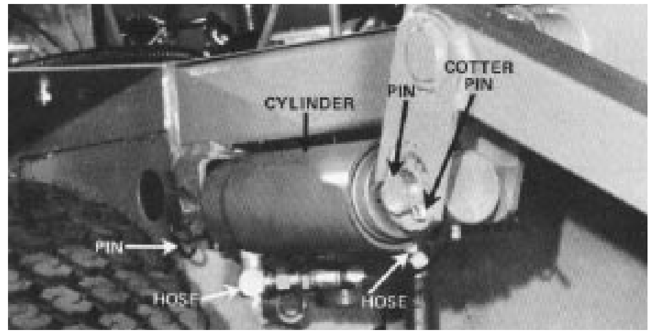


Figure 33

Lift Cylinder Repair (Fig. 34)

Pump the oil out of the cylinder into a drain pan by moving the piston back and forth.

1. Wash the lift cylinder in solvent and dry it thoroughly.

2. Mount the lift cylinder vertically in a vise so the shaft end of the cylinder is facing up.

3. Push the head (Item 5) into the barrel (Item 13) approximately 3/4 inch. Remove the retaining ring (Item 4).

4. Grasp the large end of the shaft and use a twisting and pulling motion to carefully extract the piston (Item 11), shaft (Item 2) and head (Item 5) from the cylinder bore.

5. Remove the cylinder from the vise.

6. Securely mount the piston, shaft and head assembly into the vise so that the large nut (Item 12) is easily assessable for removal.

7. Remove the large nut from the end of the shaft.

8. Remove the piston and head from the shaft.

9. Inspect the head, shaft and piston for excessive scoring, pitting or wear. Replace any defective parts.

10. Use a new seal kit (Items 3, 6 - 10) to replace all O-rings, seals and back-up rings.

IMPORTANT: The dust seal lips must point outward; the seal must have the O-ring portion facing towards the inside of the cylinder.

11. The rod end is retained with 75 - 90 ft-lbs torque and with Loctite Retaining Compound (very strong).

12. Tighten the piston head locknut to 75 - 90 ft-lb. Remove the piston, head and shaft assembly from the vise.

NOTE: Coat all O-rings, seals, wiper rings and the interior bore of the cylinder with a light coating of hydraulic oil to ease assembly.

13. Install the barrel into the vise in the vertical position described in step 3.

14. Slide the shaft, piston and head assembly into the barrel, aligning the ports for the hydaulic lines as needed.

15. Install the retaining ring to secure the head in the barrel. Pull up on the piston to make sure the retaining ring is in place.

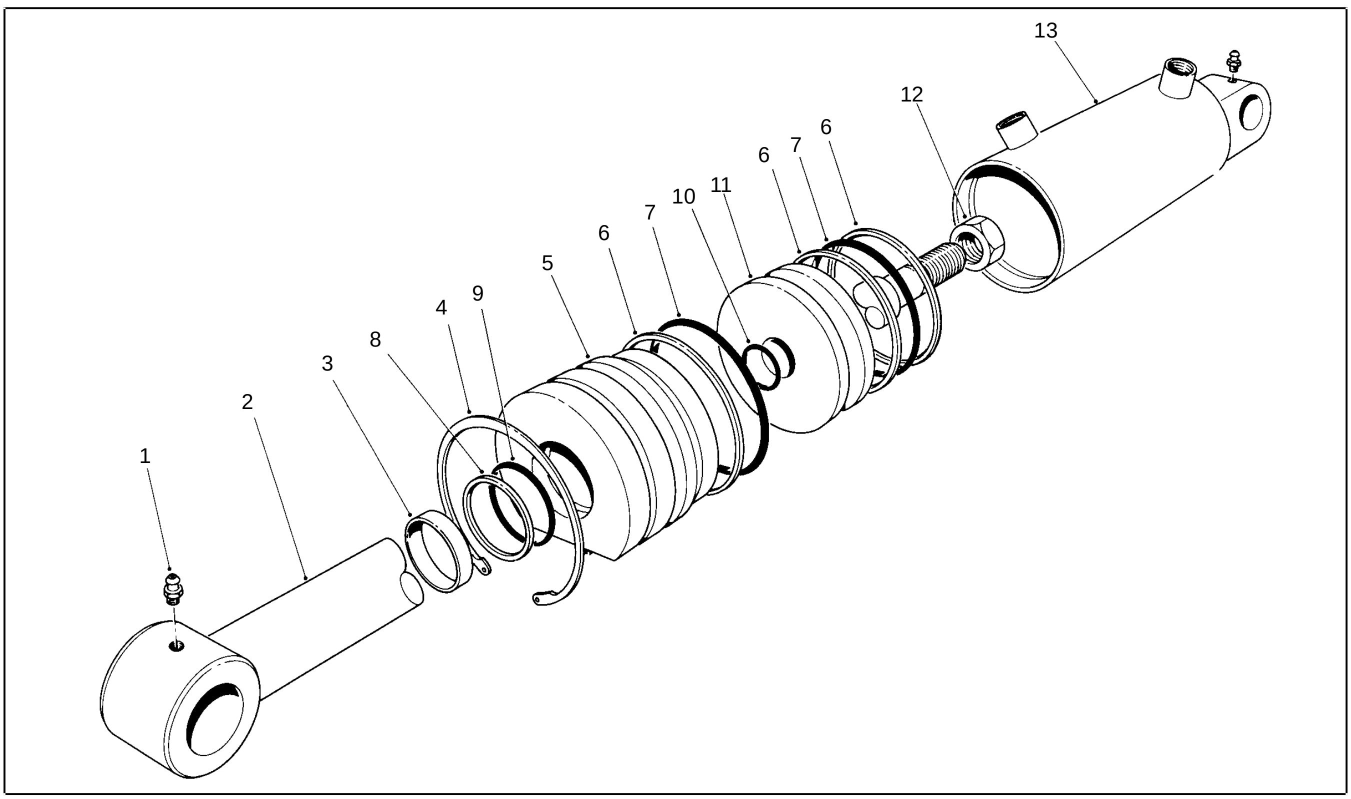


Figure 34

Lift Valve Removal and Installation (Fig. 35)

1. Unscrew the ball from the lift lever.

2. Remove the self-tapping screws and lift the cover off of the lift lever to expose the valve.

3. Loosen and remove the hydraulic lines that are attached to the valve. Cap or plug all of the fittings and hoses to prevent contamination.

4. Remove the five cap screws and locknuts that secure the valve and lever to the main frame.

5. Lift out the control valve.

6. Reverse order to install a new or reconditioned control valve.

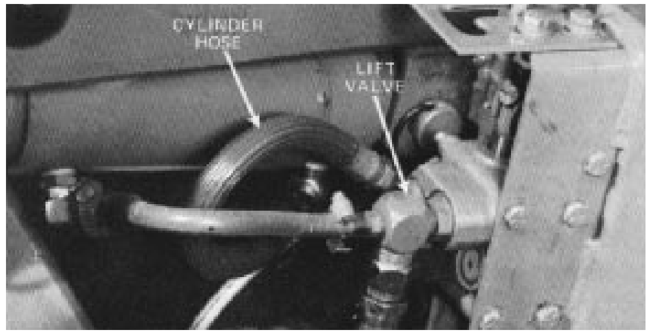


Figure 35

Lift Valve Repair (Fig. 36)

1. After removing the control valve assembly, wash the valve in solvent and dry it thoroughly.

2. Carefully mount the control valve into a vise so that the control valve mounting pads are against the jaws of the vise. The control valve spool snap ring (Item 15) should be facing up.

3. Remove the hex cap plug (Item 1) from the side of the valve body. Within the valve body, beneath each hex cap plug, there is a spring (Item 3), ball (Item 4) and cam pin (Item 6); withdraw these parts.

4. Remove the snap ring (Item 15) from the spool (Item 8). Carefully push and twist the spool to remove the spool from the valve body.

5. Use a hooked scribe or thin screwdriver to remove the O-rings from the inside bore of the valve body (be careful not to scratch valve bore finish). These O-rings are the seals for the spool itself. Inspect all components for wear, paying special attention to the spool itself. Signs of wear on one side of the spool may indicate a bent spool. Inspect the spool for flatness and replace if necessary.

6. After completing reassembly by reversing these procedures and after having installed new O-rings and seals.

7. Prior to reassembly coat all the O-rings with oil to ease assembly. Install the spool into the valve body before inserting the cam pins, balls, springs and hex plugs.

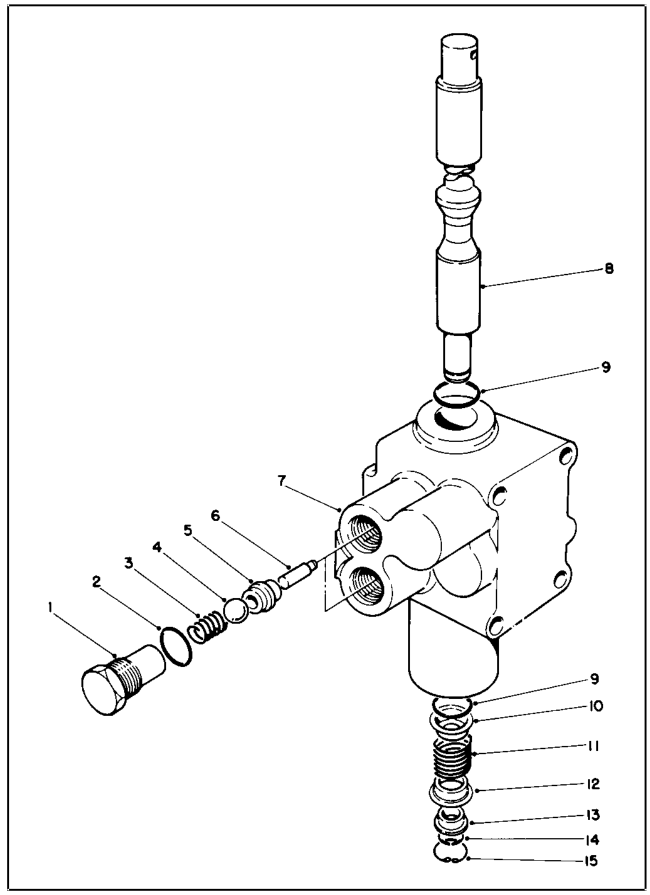


Figure 36

Chapter 6

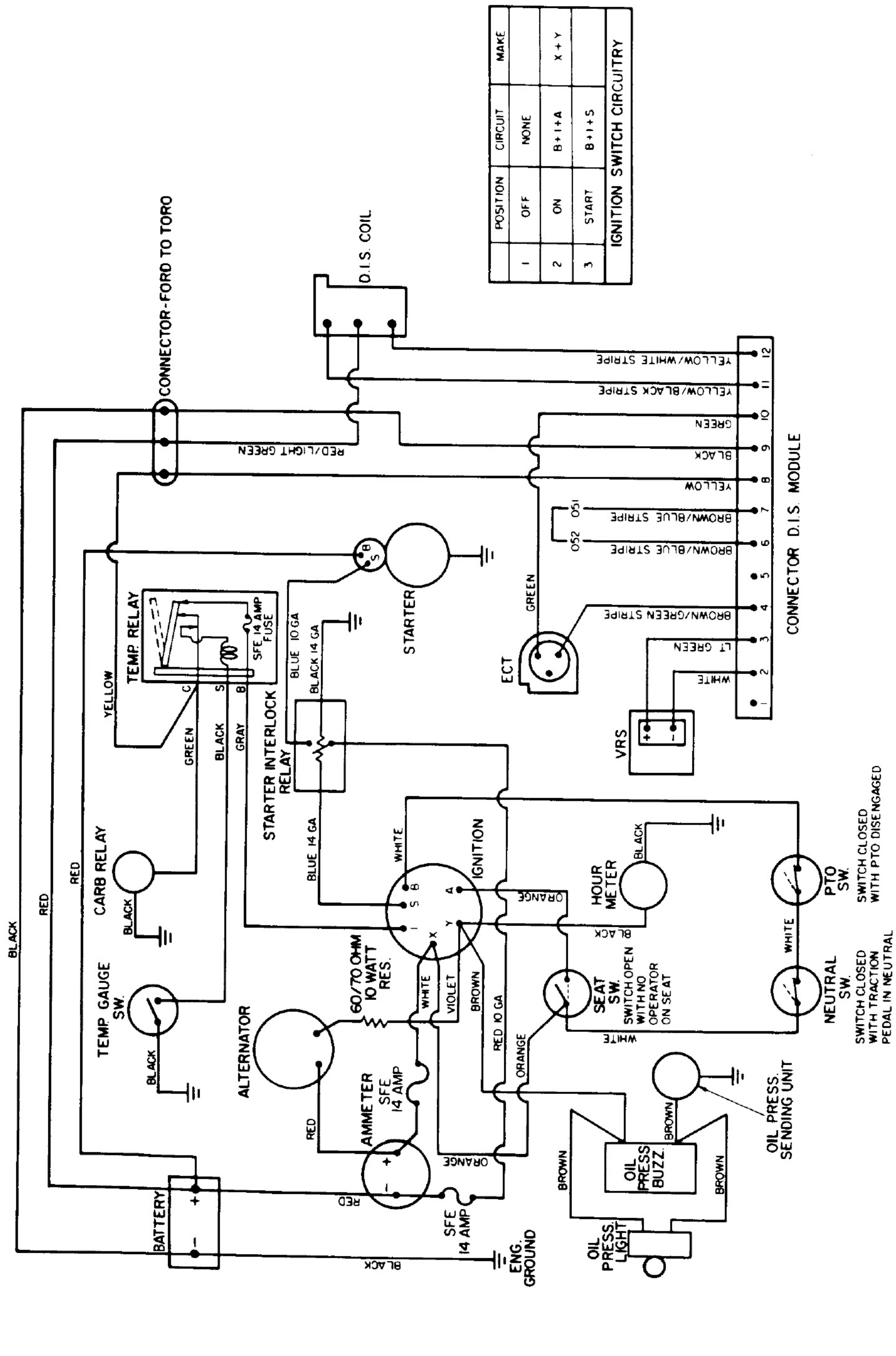
Electrical System

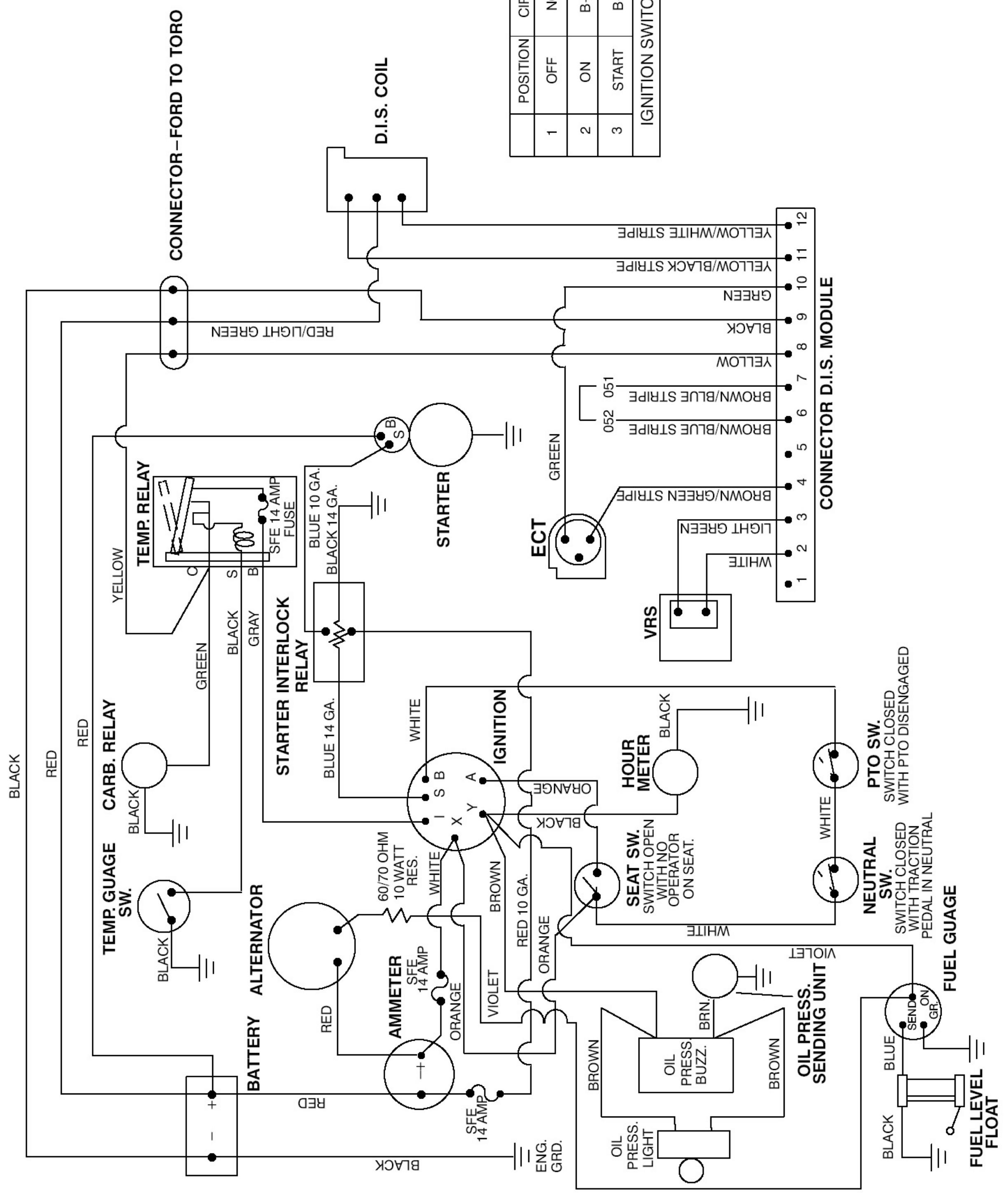
Table of Contents

WIRING SCHEMATICS 2
Groundsmaster 345. 2
Groundsmaster 322-D/325-D 3
SPECIAL TOOLS 4
TROUBLESHOOTING (Groundsmaster 345) 6
Starting Problems 6
Operation Problems 9
Verify Interlock Operation 11
TROUBLESHOOTING (Groundsmaster 322-D/325-D) . . 12
Starting Problems 12
Operation Problems 15
Verify Interlock Operation 17
TESTING 18
Ignition Key Switch 18
Seat Switch 19
Traction (Neutral) Switch. 20
PTO Switch 20
Starter Interlock Relay. 21
Glow Plugs (Groundsmaster 322-D/325-D only) 22
Battery 22
Fuel Stop Solenoid (Groundsmaster 322-D/325-D only) 23
Fuel Stop Control Unit (Groundsmaster 322-D/325-D only) 24
Indicator Lights, Buzzers and Gauges. 26
Temperature Relay 27
Temperature Gauge Sender 27
Engine Oil Pressure Switch. 28
Fuel Gauge Sending Unit 29
REPAIRS 30
Battery Service 30
Fuses. 31
Traction (Neutral) Switch Replacement. 32
PTO Interlock Switch Replacement. 33
Seat Switch Replacement 35

Groundmaster 345

(Serial Number less than 40000)



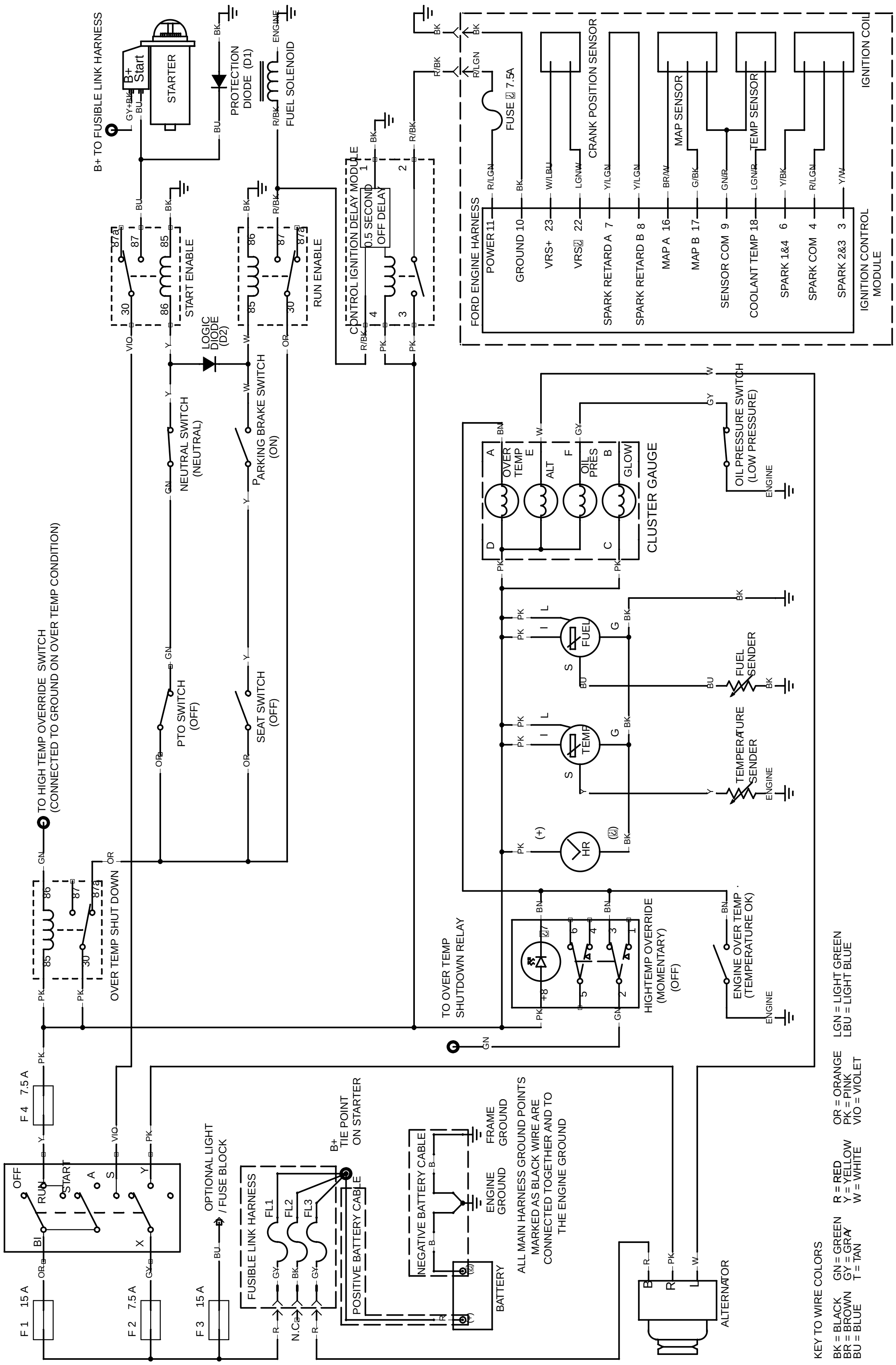


	POSITION	CIRCUIT	MAKE
1	OFF	NONE	
2	ON	B+I+A	X+Y
3	START	B+I+S	

IGNITION SWITCH CIRCUITRY

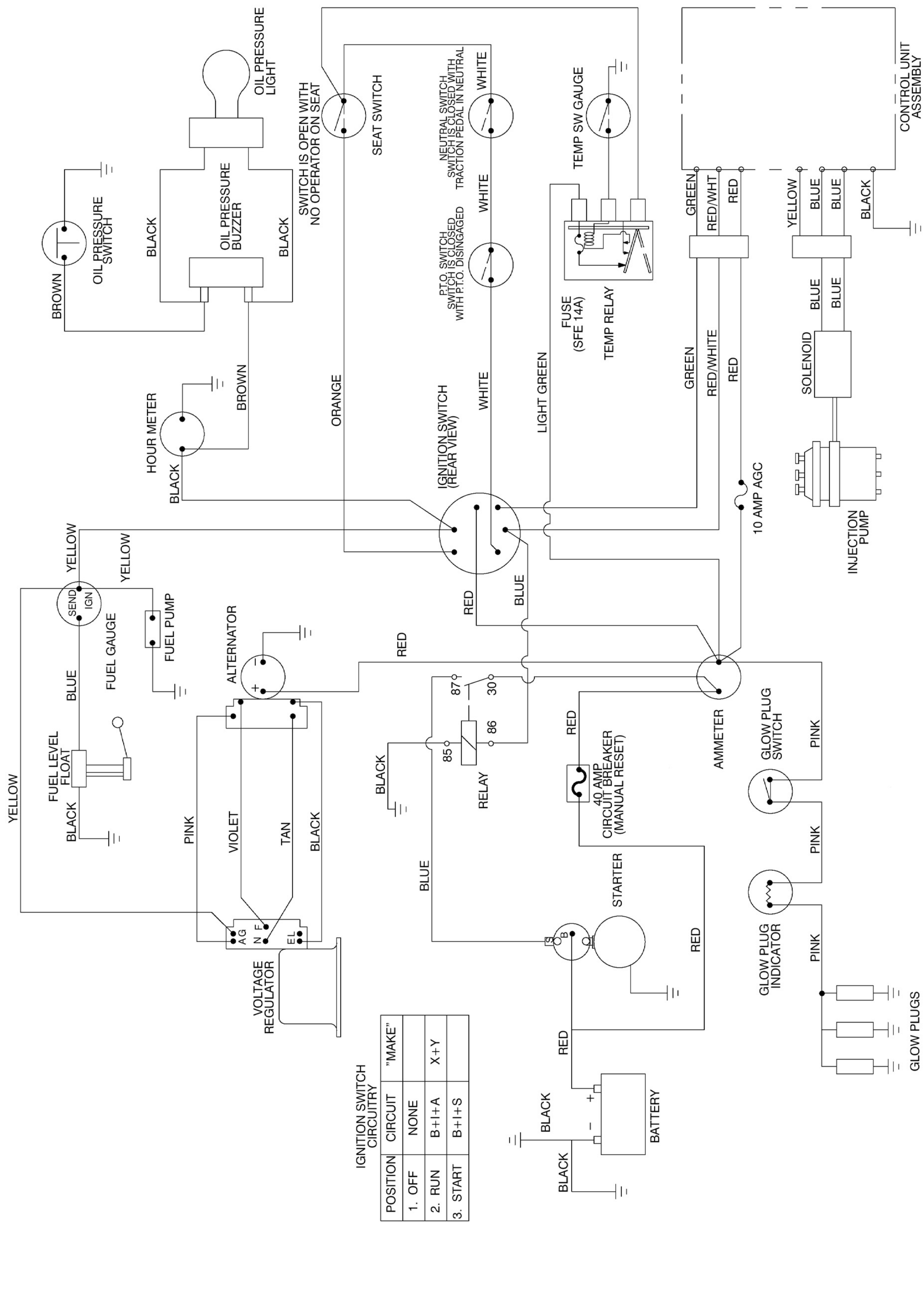
Groundmaster 345

(Serial Number higher than 21000000)



Groundmaster 322−D/325−D

(Serial Number less than 20000000)

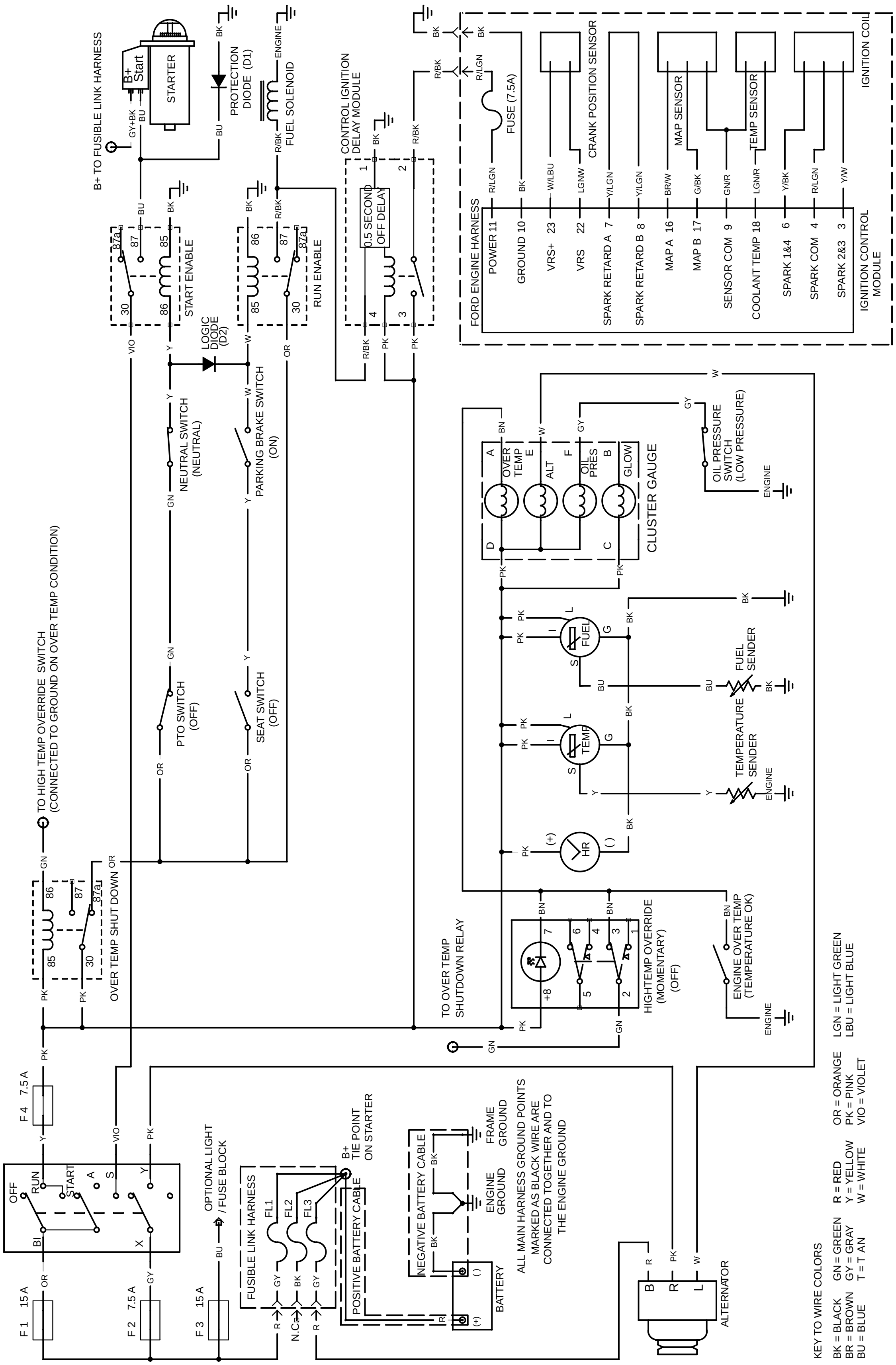


IGNITION SWITCH CIRCUITRY

POSITION	CIRCUIT	"MAKE"
1. OFF	NONE	
2. RUN	B+I+A	X+Y
3. START	B+I+S	

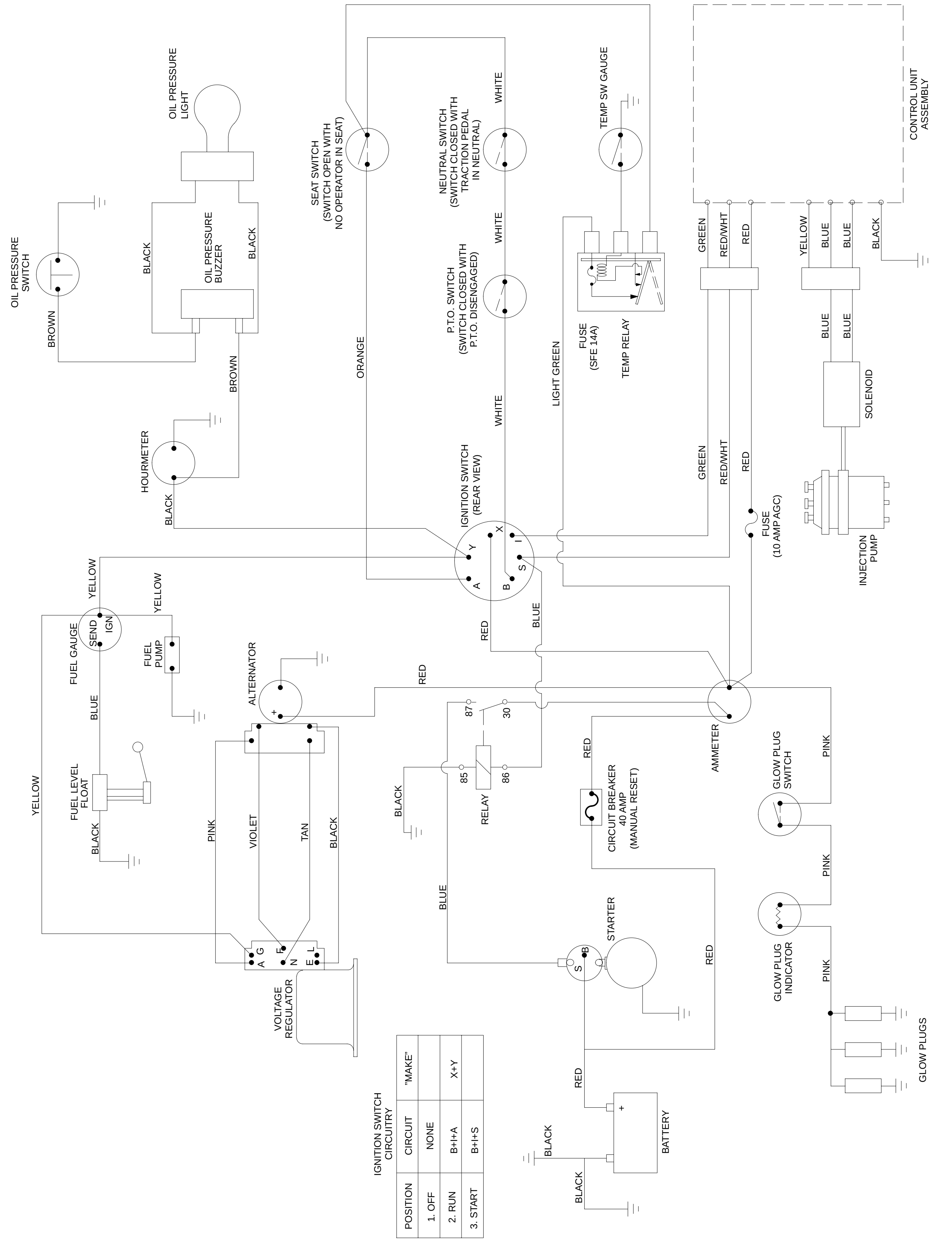
Groundmaster 345

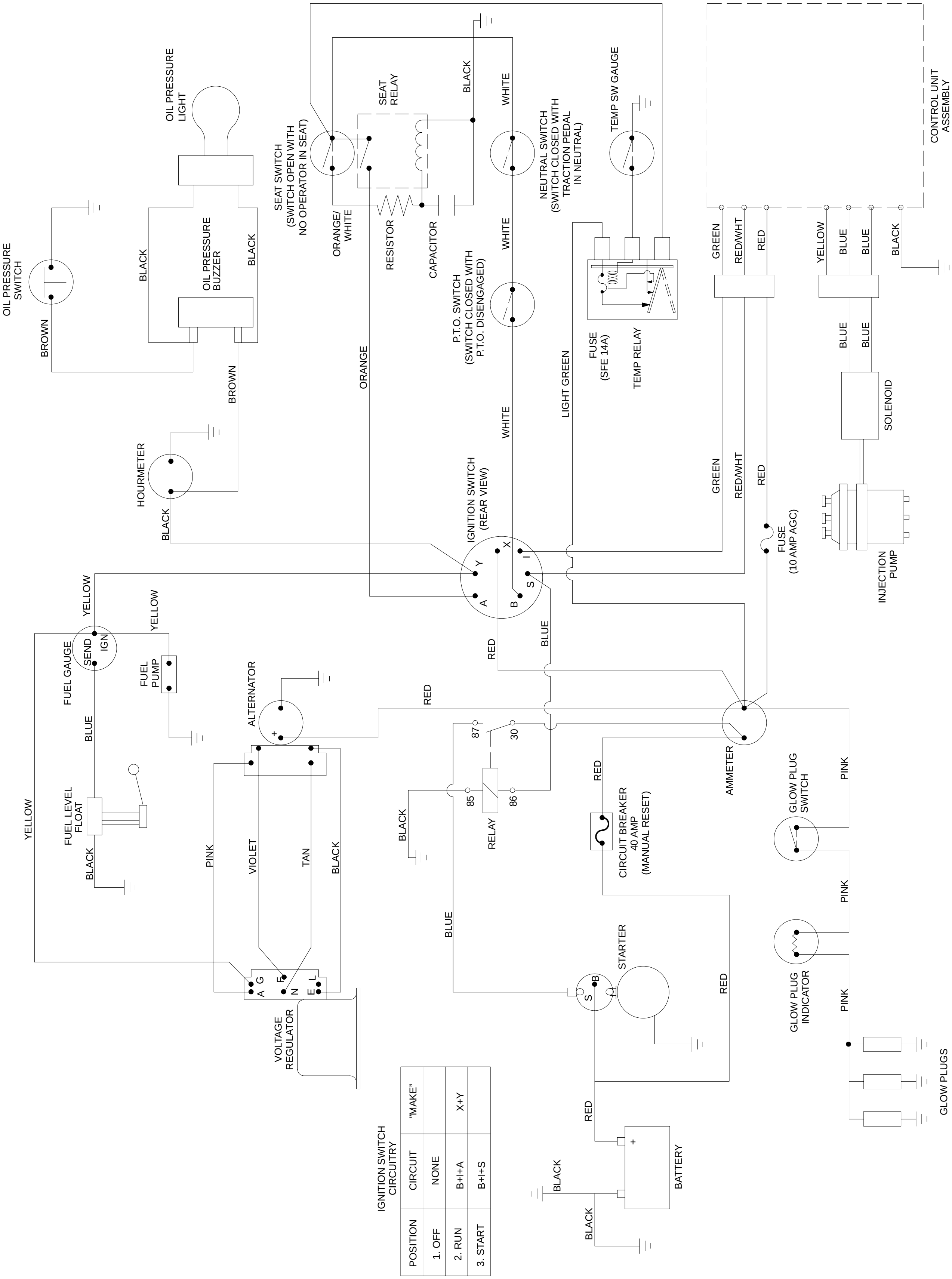
(Serial Number higher than 21000000)



Groundmaster 322–D/325–D

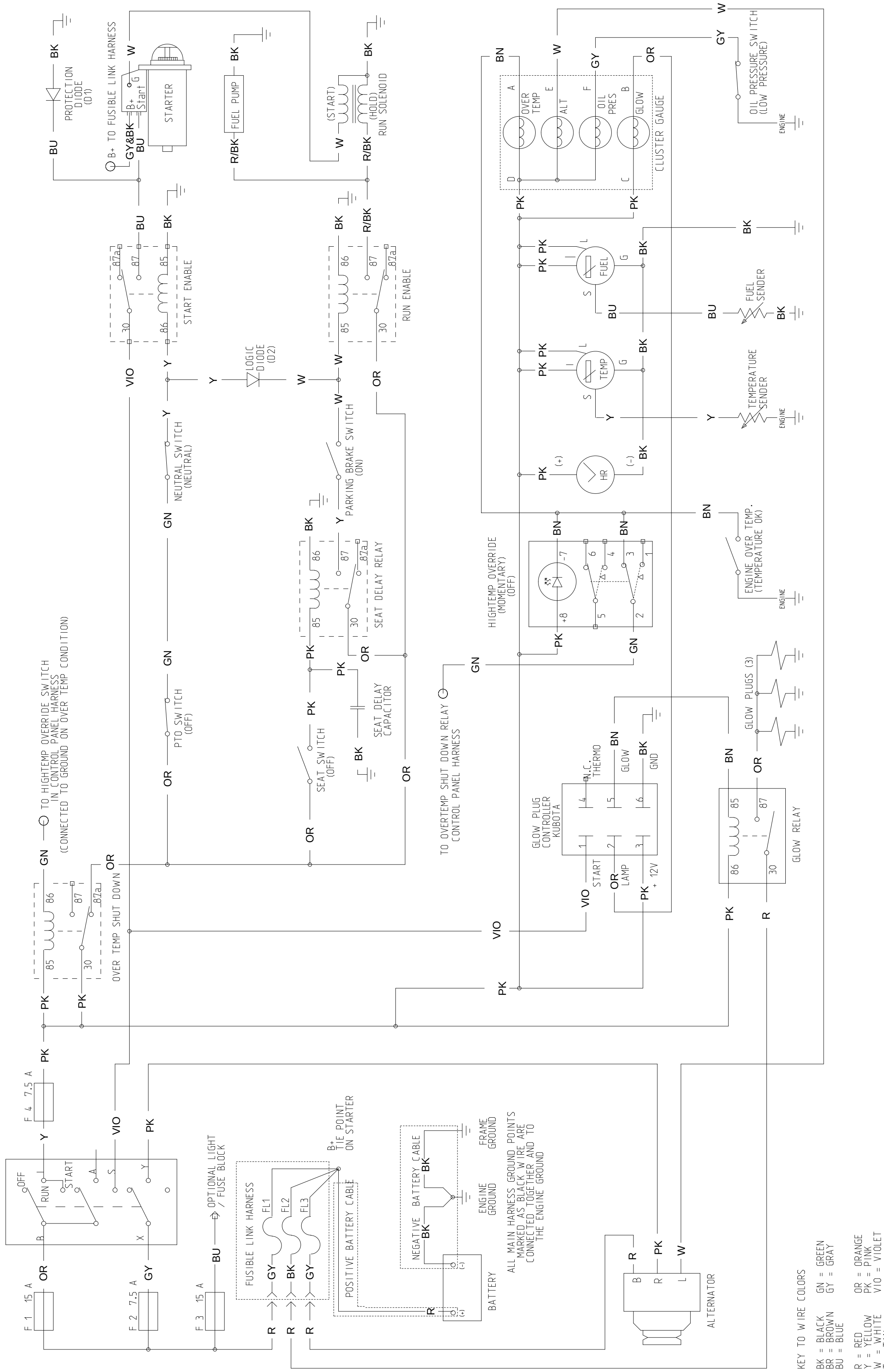
(Serial Number less than 20000000)





IGNITION SWITCH CIRCUITRY

POSITION	CIRCUIT	"MAKE"
1. OFF	NONE	
2. RUN	B+I+A	X+Y
3. START	B+I+S	



PROTECTION DIODE (D1)
B+ TO FUSIBLE LINK HARNESS
STARTER
FUEL PUMP
(START)
(HOLD)
RUN SOLENOID
START ENABLE
RUN ENABLE
LOGIC DIODE (D2)
NEUTRAL SWITCH (NEUTRAL)
PARKING BRAKE SWITCH (ON)
SEAT DELAY RELAY
SEAT DELAY CAPACITOR
SEAT SWITCH (OFF)
PTO SWITCH (OFF)
TO HIGHTEMP OVERRIDE SWITCH IN CONTROL PANEL HARNESS (CONNECTED TO GROUND ON OVER TEMP CONDITION)
OVER TEMP SHUT DOWN
TO OVERTEMP SHUT DOWN RELAY CONTROL PANEL HARNESS
CLUSTER GAUGE
OVER TEMP
ALT
OIL PRES
GLOW
FUEL
TEMP
HR
OIL PRESSURE SWITCH (LOW PRESSURE)
FUEL SENDER
TEMPERATURE SENDER
ENGINE OVER TEMP. (TEMPERATURE OK)
HIGHTEMP OVERRIDE (MOMENTARY) (OFF)
GLOW PLUGS (3)
GLOW RELAY
GLOW PLUG CONTROLLER KUBOTA
F 1 15 A
F 2 7.5 A
F 3 15 A
F 4 7.5 A
OFF
RUN
START
OPTIONAL LIGHT / FUSE BLOCK
FUSIBLE LINK HARNESS
B+ TIE POINT ON STARTER
POSITIVE BATTERY CABLE
NEGATIVE BATTERY CABLE
BATTERY
ENGINE GROUND
FRAME GROUND
ALL MAIN HARNESS GROUND POINTS MARKED AS BLACK WIRE ARE CONNECTED TOGETHER AND TO THE ENGINE GROUND
ALTERNATOR
KEY TO WIRE COLORS
BK = BLACK
BR = BROWN
BU = BLUE
GN = GREEN
GY = GRAY
R = RED
Y = YELLOW
W = WHITE
T = TAN
OR = ORANGE
PK = PINK
VIO = VIOLET

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 (Fig. 1)

Battery powered test lamp which is helpful in testing for continuity of circuits and electrical components when the current is off.

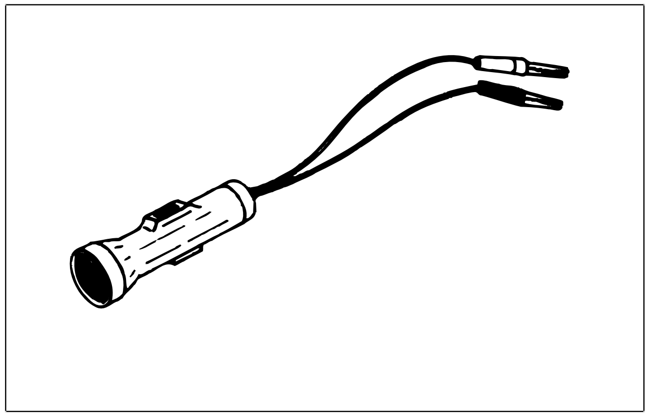


Figure 1

Volt - Ohm - Amp Meter (Fig. 2)

The meter can test electrical components and circuits for current, resistance, or voltage draw.

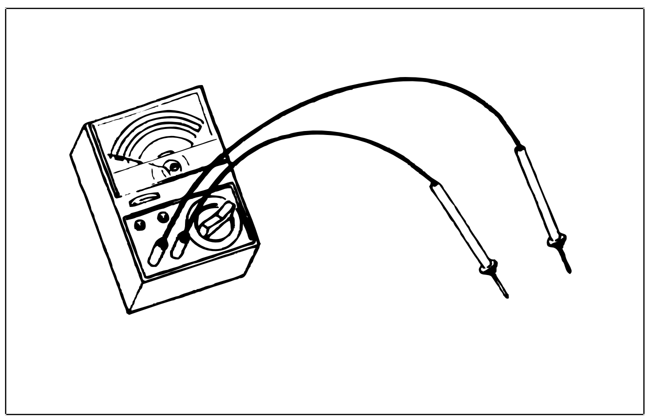


Figure 2

Skin-Over Grease (Fig. 3)

Special non-conductive grease which forms a light protective skin to help waterproof electrical switches and contacts.

Figure 3

Troubleshooting (Groundsmaster 345)

CAUTION

Remove all jewelry, especially rings and watches, before doing any electrical troubleshooting or testing. Disconnect the battery cables unless the test requires battery voltage.

For effective troubleshooting and repairs, you MUST have a good understanding of the electrical circuits and components used on this machine. (See Electrical Schematics and Diagrams section of this chapter.)

Study the operating characteristics preceding the electrical failure to help identify the area of difficulty. Try to isolate the failure to a specific functional system; then check that area, repairing one component at a time. Attempting to repair more than one system at one time will lead to confusion.

Possible Causes and Corrections in the troubleshooting charts should be checked in the order in which they are listed.

If the machine being repaired has any interlock switches by-passed, they must be reconnected for proper troubleshooting and safety.

Engine Starting Problems

Condition	Possible Cause	Correction
Starter solenoid clicks, but engine will not crank. (If solenoid clicks, problem is not in interlock system.)	Low battery charge	Charge battery. Replace battery if it will not hold a charge.
	Loose or corroded battery cables. Loose or corroded ground.	Clean and tighten, or repair as necessary.
	Faulty wiring at starter.	Repair wiring.
	Loose starter mounting bolts.	Clean mounting surface and tighten bolts.
	Faulty starter.	Repair or replace starter.
	Faulty starter solenoid.	Replace starter solenoid.
	Engine seized.	Repair engine.

Starting Problems (continued)

Condition	Possible Cause	Correction
Nothing happens when start attempt is made.	Battery is dead.	Charge battery. Replace battery if it will not hold a charge.
	Loose or corroded battery cables. Loose or corroded ground.	Clean and tighten or repair as necessary.
	Fuse open.	Check fuse and replace if fuse is open. If fuse burns out often, find and correct cause.
	Ammeter faulty.	Test ammeter and replace if faulty.
	Ammeter wiring loose, corroded or damaged.	Repair wiring.
	Ignition switch faulty.	Test ignition switch. Replace if faulty.
	Ignition switch wiring loose, corroded or damaged.	Repair wiring.
	Traction neutral switch out of adjustment or faulty.	Test switch and replace if faulty. Make sure wires are connected to “COMMON” and “NORMALLY OPEN” (N.O.) terminals.
	Traction neutral switch wiring loose, corroded or damaged.	Repair wiring.
	PTO switch out of adjustment or faulty.	Test switch and adjust or replace if faulty.
	PTO switch wiring loose, corroded or damaged.	Repair wiring.
	Starter interlock relay wiring loose corroded or damaged.	Repair wiring.
	Starter interlock relay faulty.	Test relay and replaced if faulty.
	Starter solenoid wires loose, corroded or damaged.	Clean and tighten or repair as necessary.
	Starter solenoid faulty.	Test starter solenoid. Replace if faulty.

Starting Problems (continued)

Condition	Possible Cause	Correction
Engine cranks, but does not start.	Engine wiring connector or wires loose, corroded or damaged.	Repair wiring.
	Temp. gauge switch faulty.	Test temp. gauge switch and replace if faulty.
	Temp. relay faulty.	Test temp. relay and replace if faulty.
	Temp. relay wiring faulty.	Repair wiring.
	Engine, engine ignition, or fuel system problem.	See Ford VSG-411/413 Engine Service Manual.
Engine cranks (but should not) with traction pedal out of neutral.	Traction neutral switch out of adjustment or faulty.	Test switch and replace if faulty. Make sure wires are connected to "COMMON" and "NORMALLY OPEN" (N.O.) terminals.
Engine cranks (but should not) with PTO ON.	PTO switch out of adjustment or faulty.	Test switch and adjust or replace if faulty.

Operation Problems

Condition	Possible Cause	Correction
Engine continues to run (but should not) when traction pedal is depressed with no operator on seat.	Seat switch plunger depressed with no operator on seat.	Check for seat support spring that is broken, missing or stuck in down position. Check for binding seat pivot hinge. Check for waterlogged seat.
	Seat switch faulty or out of adjustment.	Test seat switch. Adjust or replace if faulty.
	Traction neutral switch faulty or out of adjustment.	Test switch, Adjust or replace if faulty. Check for correct terminal connections.
Engine kills when traction pedal is depressed or PTO is engaged.	Operator sitting too far forward on seat (seat switch not depressed).	Instruct operator.
	Seat hinge, support pin or spring binding, preventing seat switch from closing.	Repair seat pivot and support.
	Seat switch is faulty or out of adjustment.	Test seat switch. Adjust or replace if faulty.
	Seat switch wiring loose, corroded or damaged.	Repair wiring.
Battery does not charge.	Loose, corroded or broken wire(s).	Repair wiring.
	Faulty alternator.	Test alternator and replace if faulty.
	Dead battery.	Charge battery. Replace battery if it will not hold a charge.
Battery continuously charges at high rate.	Regulator / rectifier faulty.	Replace regulator / rectifier.

Operation Problems (continued)

Condition	Possible Cause	Correction
Engine continues to run (but should not) when PTO is ON with no operator on the seat.	Seat switch plunger depressed with no operator on seat.	Check for seat support spring that is broken, missing or stuck in down position. Check for binding seat pivot hinge. Check for waterlogged seat.
	Seat switch faulty or out of adjustment.	Test seat switch. Adjust or replace if faulty.

Verify Interlock System Operation

The machine has interlock switches in the electrical system. These switches are designed to stop the engine when operator gets off the seat while either the PTO lever is engaged or traction pedal is depressed. However, operator may get off the seat while engine is running. Although engine will continue to run if PTO lever is disengaged and traction pedal is released, it is strongly recommended that the engine be stopped before dismounting from the seat.

CAUTION

Do not disconnect the interlock switches. Check operation of switches daily to assure interlock system is operating correctly. If a switch is malfunctioning, replace it before operating the machine. To ensure maximum safety, replace all switches after every two years or 1000 hours, whichever comes first.

To check operation of interlock switches:

1. Drive the machine slowly to a large, relatively open area. Lower cutting unit, stop the engine and apply parking brake.

2. Sit on seat. Move PTO lever to ON position. With the traction pedal in neutral position, try to start the engine. The engine should not crank. If the engine cranks, there is a malfunction in the interlock system that should be corrected before beginning operation.

3. Sit on seat. Move PTO lever to OFF and depress the traction pedal. Try to start the engine. The engine should not crank. If the engine cranks, there is a malfunction in the interlock system that should be corrected before beginning operation.

CAUTION

Do not operate machine without implement unless the PTO drive shaft is also removed.

4. Sit on seat and start the engine. Raise off the seat and move the PTO lever to ON. The engine should stop within 2 - 3 seconds. If the engine does not stop, there is a malfunction in the interlock system that should be corrected before beginning operation.

Troubleshooting (Groundsmaster 322-D/325-D)

CAUTION

Remove all jewelry, especially rings and watches, before doing any electrical troubleshooting or testing. Disconnect the battery cables unless the test requires battery voltage.

For effective troubleshooting and repairs, you MUST have a good understanding of the electrical circuits and components used on this machine. (See Electrical Schematics and Diagrams section of this chapter.)

Study the operating characteristics preceding the electrical failure to help identify the area of difficulty. Try to isolate the failure to a specific functional system; then check that area, repairing one component at a time. Attempting to repair more than one system at one time will lead to confusion.

Possible Causes and Corrections in the troubleshooting charts should be checked in the order in which they are listed.

If the machine being repaired has any interlock switches by-passed, they must be reconnected for proper troubleshooting and safety.

Starting Problems

Condition	Possible Cause	Correction
Starter solenoid clicks, but starter will not crank. (If solenoid clicks, problem is not in interlock system.)	Low battery charge	Charge battery. Replace battery if it will not hold a charge.
	Loose or corroded battery cables. Loose or corroded ground.	Clean and tighten, or repair as necessary.
	Faulty wiring at starter.	Repair wiring.
	Loose starter mounting bolts.	Clean mounting surface and tighten bolts.
	Faulty starter.	Repair or replace starter.
	Faulty starter solenoid.	Replace starter solenoid.
	Engine seized.	Repair engine.

Starting Problems (continued)

Condition	Possible Cause	Correction
Nothing happens when start attempt is made.	Battery is dead.	Charge battery. Replace battery if it will not hold a charge.
	Loose or corroded battery cables. Loose or corroded ground.	Clean and tighten or repair as necessary.
	Circuit breaker open.	Reset circuit breaker. Correct cause of open circuit breaker.
	Ammeter faulty.	Test ammeter and replace if faulty.
	Ammeter wiring Loose, corroded or damaged.	Repair wiring.
	Ignition switch faulty.	Test ignition switch. Replace if faulty.
	Ignition switch wiring loose, corroded or damaged.	Repair wiring.
	Traction neutral switch out of adjustment or faulty.	Test switch and replace if faulty. Make sure wires are connected to “COMMON” and “NORMALLY OPEN” (N.O.) terminals.
	Traction neutral switch wiring loose, corroded or damaged.	Repair wiring.
	PTO switch out of adjustment or faulty.	Test switch and adjust or replace if faulty.
	PTO switch wiring loose, corroded or damaged.	Repair wiring.
	Temp. gauge switch faulty.	Test temp. gauge switch and replace if faulty.
	Temp. relay faulty.	Test temp. relay and replace if faulty.
	Temp. relay wiring loose, corroded or damaged.	Repair wiring.
	Starter interlock relay wiring loose corroded or damaged.	Repair wiring.
	Starter interlock relay faulty.	Test relay and replaced if faulty.
	Starter solenoid wires loose, corroded or damaged.	Clean and tighten or repair as necessary.
	Starter solenoid faulty.	Test starter solenoid. Replace if faulty.

Starting Problems (continued)

Condition	Possible Cause	Correction
Engine cranks, but does not start (if engine cranks, cause of problem is not in interlock system).	Glow plugs not used properly before starting.	Use glow plugs to pre-heat engine cylinders before and during cold starting. Hold glow plug switch in ON position until indicator glows red, or as specified in Operator's Manual for ambient temperature. DO NOT exceed 2 minutes of continuous use.
	Glow plug circuit malfunctioning.	Test glow switch, glow plug indicator and glow plugs and replace if faulty. Check glow plug circuit wiring and repair if loose, corroded or damaged.
	Fuel shut-off solenoid is IN (should be OUT).	Check for voltage at solenoid connector while cranking. If no voltage, but solenoid is IN, solenoid is faulty. If there is voltage, control unit is faulty.
	Engine or fuel system problem.	See Troubleshooting section of Chapter 4 - Mitsubishi Diesel Engine.
Engine cranks (but should not) with traction pedal out of neutral.	Traction neutral switch out of adjustment or faulty.	Test switch and replace if faulty. Make sure wires are connected to "COMMON" and "NORMALLY OPEN" (N.O.) terminals.
Engine cranks (but should not) with PTO ON.	PTO switch out of adjustment or faulty.	Test PTO switch and adjust or replace if faulty.

Operation Problems

Condition	Possible Cause	Correction
Engine continues to run (but should not) when traction pedal is depressed with no operator on seat.	Seat switch plunger depressed with no operator on seat.	Check for seat support spring that is broken, missing or stuck in down position.
		Check for binding seat pivot hinge.
		Check for waterlogged seat.
	Seat switch faulty or out of adjustment.	Test seat switch. Adjust or replace if faulty.
Engine kills when traction pedal is depressed or PTO is engaged.	Operator sitting too far forward on seat (seat switch not depressed).	Instruct operator.
	Seat hinge, support pin or spring binding, preventing seat switch from closing.	Repair seat pivot and support.
	Seat switch is faulty or out of adjustment.	Test seat switch. Adjust or replace if faulty.
	Seat switch wiring loose, corroded or damaged.	Repair wiring.
Battery does not charge.	Loose, corroded or damaged wire(s).	Repair wiring.
	Faulty alternator.	Check alternator belt tension. Test alternator and replace if faulty.
	Dead battery.	Charge battery. Replace battery if it will not hold a charge.

Operation Problems (continued)

Condition	Possible Cause	Correction
Engine continues to run (but should not) when PTO is ON with no operator on the seat.	Seat switch plunger depressed with no operator on seat.	Check for seat support spring that is broken, missing or stuck in down position. Check for binding seat pivot hinge. Check for waterlogged seat.
	Seat switch faulty or out of adjustment.	Test seat switch. Adjust or replace if faulty.
Engine continues to run (but should not) when ignition switch is turned off.	Engine will not restart after manual shut-down.	See listings under Starting Problems.
	10 AMP fuse open.	Replace fuse. Correct cause of blown fuse.
	Faulty wiring between ammeter and control unit.	Repair wiring.
	Ignition switch faulty.	Test ignition switch and replace if faulty.
	Faulty wiring between ignition switch and control unit.	Repair wiring.
	Fuel shut-off solenoid faulty.	Test fuel shut-ff solenoid. Adjust or replace fuel shut-off solenoid if faulty.
	Fuel shut-off solenoid wiring faulty.	Repair wiring.
	Control unit faulty.	Test control unit and replace if faulty.

Verify Interlock System Operation

The machine has interlock switches in the electrical system. These switches are designed to stop the engine when operator gets off the seat while either the PTO lever is engaged or traction pedal is depressed. However, operator may get off the seat while engine is running. Although engine will continue to run if PTO lever is disengaged and traction pedal is released, it is strongly recommended that the engine be stopped before dismounting from the seat.

CAUTION

Do not disconnect the interlock switches. Check operation of switches daily to assure interlock system is operating correctly. If a switch is malfunctioning, replace it before operating the machine. To ensure maximum safety, replace all switches after every two years or 1000 hours, whichever comes first.

To check operation of interlock switches:

1. Drive the machine slowly to a large, relatively open area. Lower cutting unit, stop the engine and apply parking brake.

2. Sit on seat. Move PTO lever to ON position. With the traction pedal in neutral position, try to start the engine. The engine should not crank. If the engine cranks, there is a malfunction in the interlock system that should be corrected before beginning operation.

3. Sit on seat. Move PTO lever to OFF and depress the traction pedal. Try to start the engine. The engine should not crank. If the engine cranks, there is a malfunction in the interlock system that should be corrected before beginning operation.

CAUTION

Do not operate machine without implement unless the PTO drive shaft is also removed.

4. Sit on seat and start the engine. Raise off the seat and move the PTO lever to ON. The engine should stop within 2 - 3 seconds. If the engine does not stop, there is a malfunction in the interlock system that should be corrected before beginning operation.

Testing

This section will define components, and the tests that can be performed on those components, when those parts are disconnected from the electrical system.

For accurate resistance and/or continuity checks, electrically disconnect the component being tested from the circuit (e.g. unplug the seat switch connector before doing a continuity check).

NOTE: Electrical troubleshooting of any 12 Volt power connection can also be performed through voltage drop tests without disconnection of the component.

CAUTION

When testing electrical components for continuity with a volt-ohm meter or continuity tester, make sure that power to the circuit has been disconnected.

Ignition Key Switch (Fig. 5)

The circuitry of the ignition switch is shown in the charts. 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.

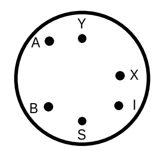
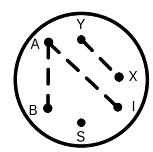
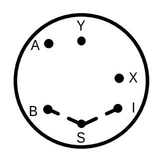
POSITION	CONTINUITY AMONG TERMINALS	
1. OFF		NONE
2. ON		B + I + A X + Y
3. START		B + I + S

Figure 5

Seat Switch (Fig. 6, 7)

The seat switch is a normally open (N.O.) switch that closes when the operator is on the seat. If the PTO switch or traction switch is open and the operator raises off the seat, the engine will stop.

1. Raise the seat to get access to the seat switch wiring connector.

2. Disconnect the seat switch wiring connector and install a continuity tester or ohm meter between the two leads of the seat switch.

3. Lower the seat. The continuity tester should show no continuity.

NOTE: Make sure the compression spring and pin holds the seat up off the seat switch when there is no operator on the seat.

4. Have the operator sit on the seat, slowly depressing the seat switch. The continuity tester should show continuity as the seat approaches the bottom of its travel. (See Replacing Seat Switch in Repairs section of this chapter for replacement and adjustment procedures.)

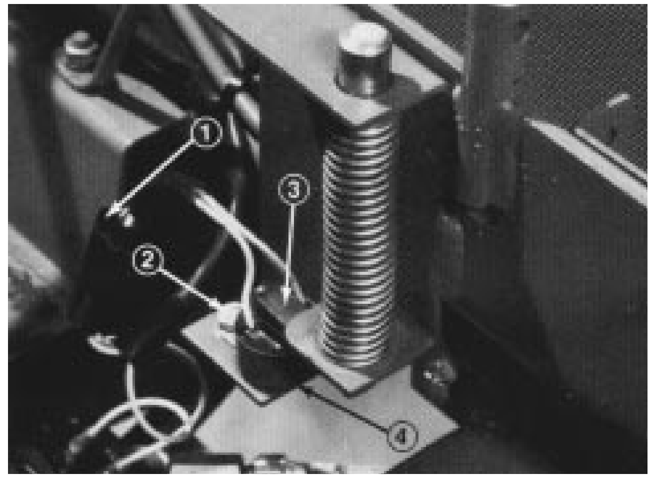


Figure 6
(S/N Below 30001)

1. Connectors
2. Capscrew & locknut
3. Switch
4. Mounting bracket

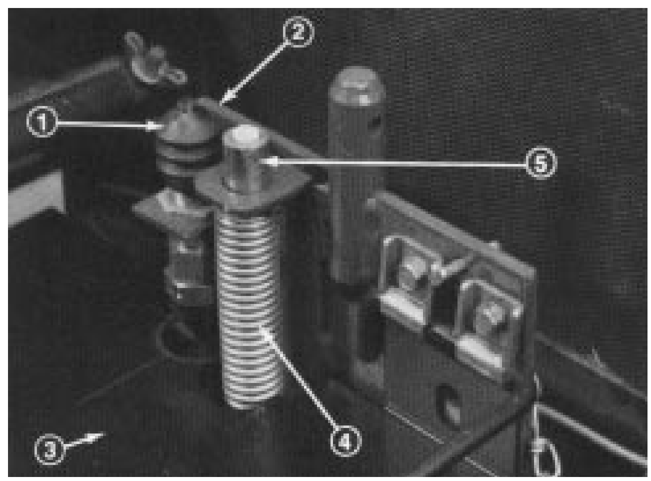


Figure 7
(S/N 30001 and UP)

1. Seat switch
2. Seat support bracket
3. Connector
4. Spring
5. Pin

Traction (Neutral) Switch (Fig. 8)

The traction switch is normally open and closes when traction pedal is in neutral.

IMPORTANT: The traction switch has three (3) terminals. Make sure the wires are connected to the “COMMON” and “N.O.” terminals.

Test switch by disconnecting wires from switch terminals and connecting a continuity tester across COMMON and N.O. terminals. With engine off, slowly push traction pedal in forward and reverse direction while watching continuity tester. There should be indications that traction switch is opening and closing. Allow traction pedal to return to neutral. There should be continuity across the terminals. (See Replacing Traction Switch in Repairs section of this chapter for replacement and adjustment procedures.)

NOTE: Apply “Loctite 271” or equivalent to threads of switch screws before installing.

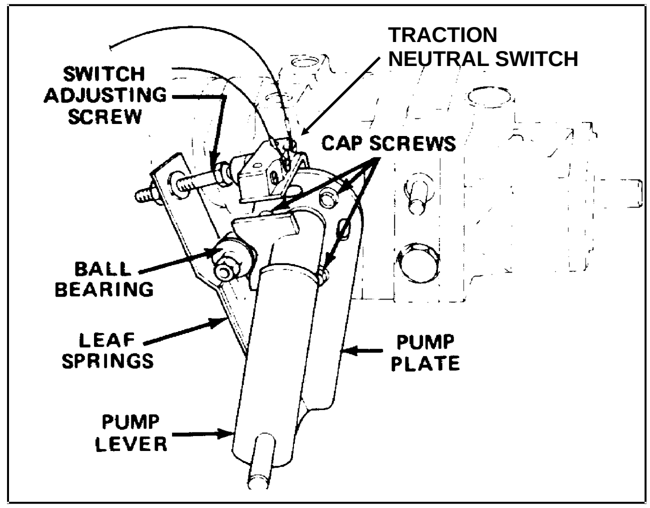


Figure 8

PTO Switch (Fig. 9, 10)

The PTO switch is normally open and closes when the PTO lever is pushed forward to ON position.

Test the switch by disconnecting the wires from the switch terminals and connecting a continuity tester across the terminals. With the PTO lever pushed forward (ON), there should be continuity across the terminals. With the PTO lever pulled back (OFF) there should be no continuity across the terminals. (See Replacing the PTO Switch in the Repairs section of this chapter for replacement procedures).

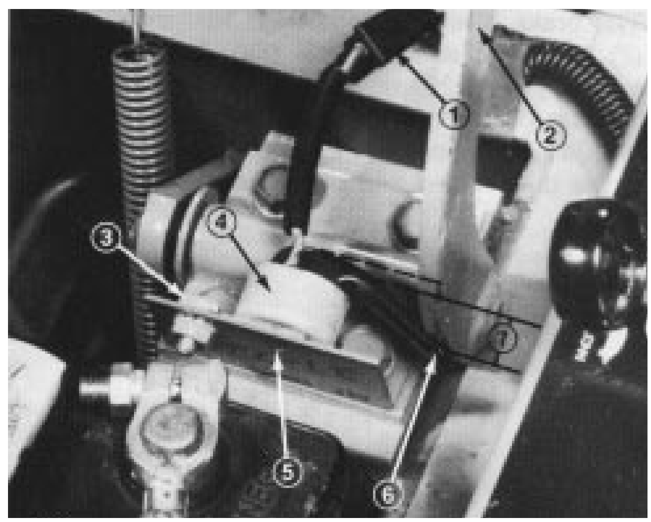


Figure 9
(S/N Below 30001)

1. Connectors
2. PTO lever
3. Capscrew & locknut
4. Switch
5. Mounting bracket
6. Switch arm
7. 1/2 inch (13 mm)

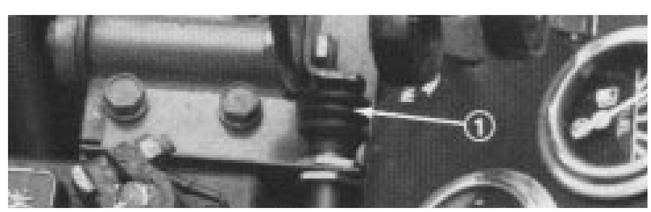


Figure 10
(S/N 30001 and UP)

1. PTO switch

Starter Interlock Relay (Fig. 11, 12, 13)

To test the relay (Fig. 11, Item 22 or Fig. 12, Item 42), disconnect the relay wire connector and install a continuity tester between the relay terminals (terminals 30 and 87). The relay should make and break continuity at terminals 30 and 87 as 12 V.D.C. is connected and disconnected to terminal 85 with terminal 86 connected to ground.

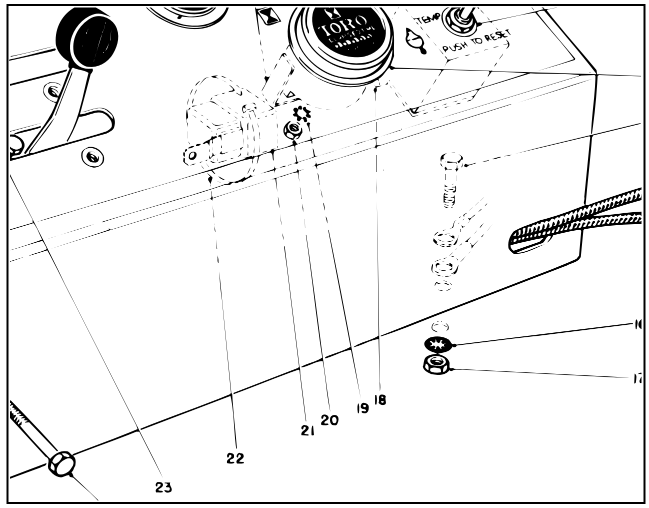


Figure 11
(Groundsmaster 345)

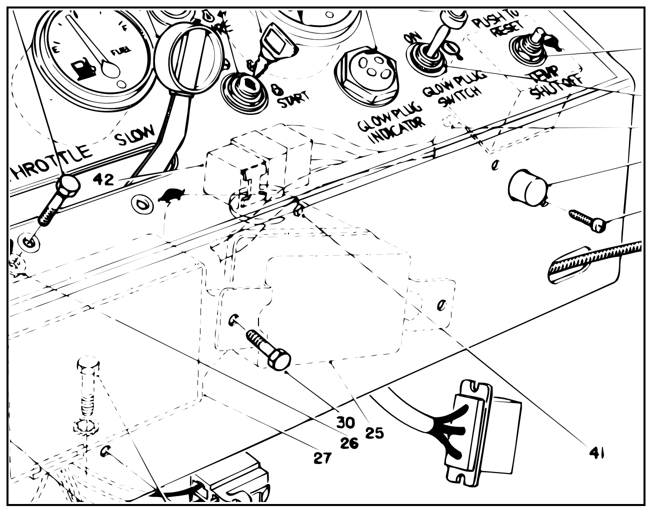


Figure 12
(Groundsmaster 322-D/325-D)

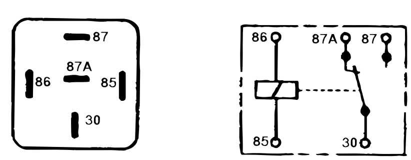


Figure 13

Glow Plugs (Groundsmaster 322-D/325-D only)

See Chapter 4 - Diesel Engine.

Battery (Fig. 14, 15)

Use a hydrometer to test the battery. Charge the battery if necessary (see Battery Service).

Electrolyte specific gravity

Fully charged: 1.250 - 1.280
Discharged: less than 1.240

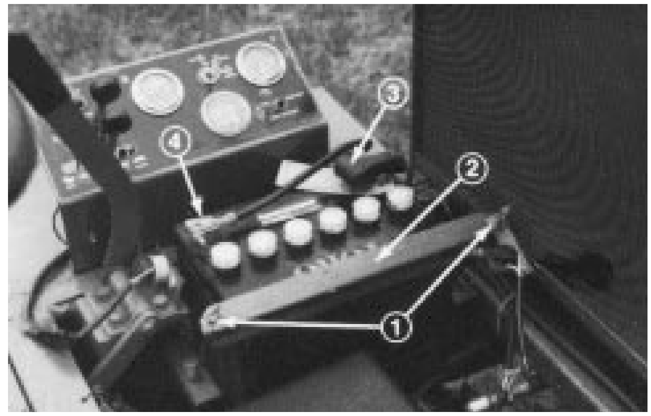


Figure 14
(Groundsmaster 345)

1. Wing nuts
2. Hold down strap
3. Positive (+) terminal
4. Negative (–) terminal

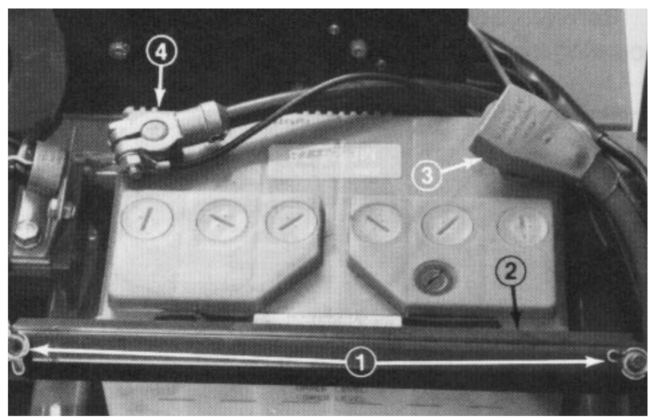


Figure 15
(Groundsmaster 322-D/325-D)

1. Wing nuts
2. Hold down strap
3. Positive (+) terminal
4. Negative (–) terminal

Fuel Stop Solenoid (Groundsmaster 322-D/325-D only) (Fig. 16)

Test the fuel stop solenoid by connecting the two solenoid lead wires to a 12 volt battery (fused at 10 AMPS). When the battery is connected, the plunger of the solenoid should be activated (for replacement instructions see Chapter 4 - Diesel Engine).

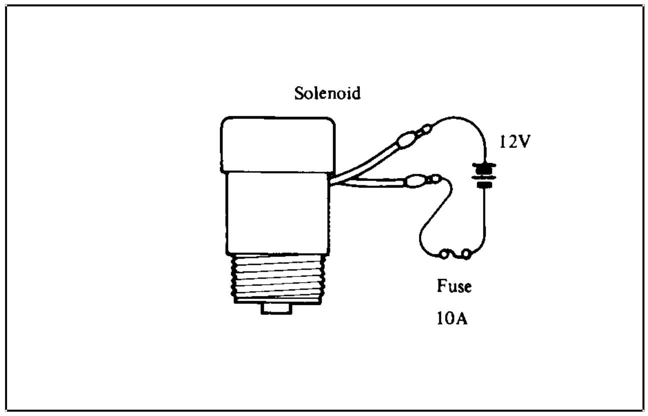


Figure 16

Fuel Stop Control Unit (Groundsmaster 322-D/325-D only) (Fig. 17)

The control unit (Fig. 17, Item 27) is a solid-state timing device that controls a fuel stop solenoid for shutting the engine off with the ignition key switch.

To check operation of the control unit and fuel stop solenoid, listen for an audible “click” when the key is turned to the OFF position (after having been in the RUN position), and then once again approximately 7 to 15 seconds after the key switch has been turned off. The “clicking” should is made by the solenoid (on back of injection pump). These sounds signify that the system is functioning properly *electrically*.

Detailed testing of the control unit, alone, is provided in the chart that follows. These tests must be performed with the control unit installed in the machine and connected to the electrical system.

IMPORTANT: Testing the control unit by any other method, especially when using a battery powered meter or tester, may cause damage to the solid state circuitry in the control unit.

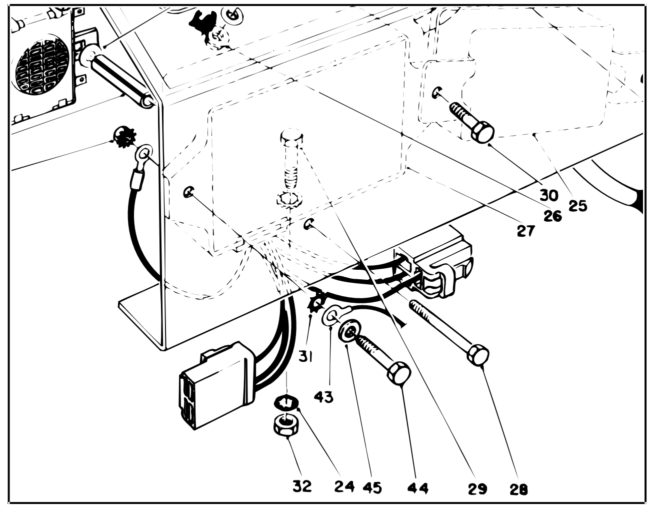
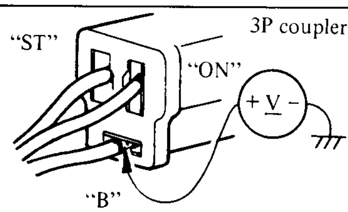
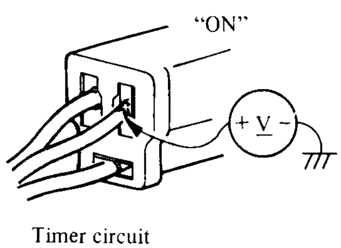
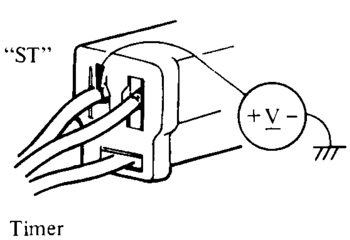
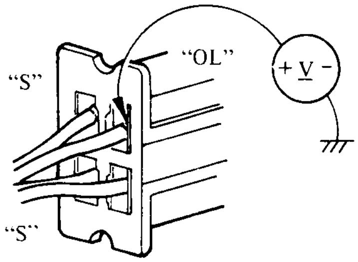
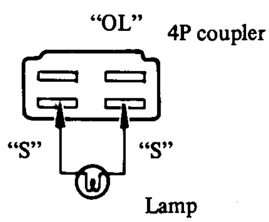
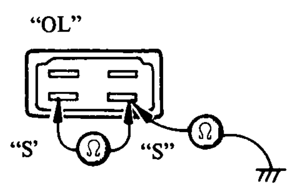


Figure 17

Test	Sketch of Connector	Testing Procedure
1		Connect a voltmeter to the “B” terminal (red wire) of the 3P coupler. Voltmeter reading should be approximately 12 volts D.C. If no voltage is present, check the 40 amp circuit breaker (manual reset), the 10 amp fuse (in-line holder), or the battery for fault.
2		Connect a voltmeter to the “ON” terminal (green wire) of the 3P coupler. Read the voltmeter each time the key switch is turned to ON (RUN) and OFF. When ON, voltage should be 12 volts; when OFF, voltage should be 0 volts. If voltage is not present when the key switch is turned to the ON position, test the key switch for fault, the fuse in the temperature relay box, or the safety interlock switches for proper operation.
3		Connect a voltmeter to the “ST” terminal (red/white wire) of the 3P coupler. Read the voltmeter each time the key switch is turned to START and ON (RUN). When switch is turned to START, voltage should be 12 volts; when turned to ON (RUN), voltage should be 0 volts. If voltage is not present when the key switch is turned to the START position, test the key switch for fault.

Test	Sketch of Connector	Testing Procedure
4	4P coupler 	Connect a voltmeter to the "OL" terminal (yellow wire) of the 4P coupler. Read the voltmeter each time the engine is stopped and operated. When the engine is started, the voltage at terminal "OL" should be 12 volts; when stopped, 0 volts. If voltage is not present when the engine is started, either the control unit's ground lead is not allowing current flow, or the control unit assembly is at fault and must be replaced.
5		Disconnect the 4P coupler from the main wire harness and connect a lamp (3 watt or lower, 12 VDC) between terminals "S" and "S" (2 blue wires). Keep terminal "OL" free of any connections. Turn the key switch to ON (RUN) and after waiting for a few seconds, turn the switch to OFF. The lamp will go on and stay lit for 7 to 15 seconds. If the lamp does not light, or will not go out, either the control unit's ground lead is not allowing current flow, or the control unit is at fault and must be replaced.
6		Disconnect the 4P coupler from the main wire harness and connect an ohmmeter across terminals "S" and "S" (2 blue wires) to read the resistance between the terminals. **IMPORTANT: Be sure to disconnect the coupler or the control unit may be damaged.** Then measure the resistance between ground (black wire) and each terminal ("S" and "S") with the ohmmeter. The ohmmeter readings between the two "S" terminals should be approximately 1.7 ohms of resistance. The ohmmeter readings between each "S" terminal and the ground lead should be infinity ohms. If these tests are failed, replace the control unit assembly.

Indicator Lights, Buzzers and Gauges

Oil Pressure Light and Buzzer

Oil pressure lamp and buzzer 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 light and buzzer by disconnecting the wire from oil pressure switch and grounding it against the engine. The light and buzzer should come on when the wire is grounded with the ignition switch in the ON position.

Ammeter

Check the ammeter by comparing it to another ammeter. Replace it if it registers incorrectly.

Glow Indicator (Groundsmaster 322-D/325-D only)

The glow indicator should glow red after holding the glow plug switch on for approximately 20 seconds.

Test the indicator by disconnecting the wires and checking for continuity across the terminals.

Hourmeter

Test the hourmeter by connecting a 12 volt battery so the positive (+) battery terminal is connected to the positive terminal on the hourmeter. Connect the negative (–) battery terminal to the negative (–) terminal on the alternator. The hourmeter should operate as 12 V.D.C. is applied between the terminals.

Engine Temperature Gauge and Fuel Level Gauge

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.

Temperature Relay (Fig. 18)

The temperature relay (Fig. 18, Item 18) works with the temperature gauge to disconnect battery voltage to the ignition system (gas engine) or fuel shut stop control unit (diesel engine) if the engine temperature gets too hot.

The B & C terminals of the temperature relay have a normally closed connection between them. If there is no continuity between terminals B & C check the SFE-14 fuse inside the relay box.

A coil resistance may be read on the ohmmeter between terminals B & S. No resistance, indicates an open coil. If the coil is open, replace the temperature relay device.

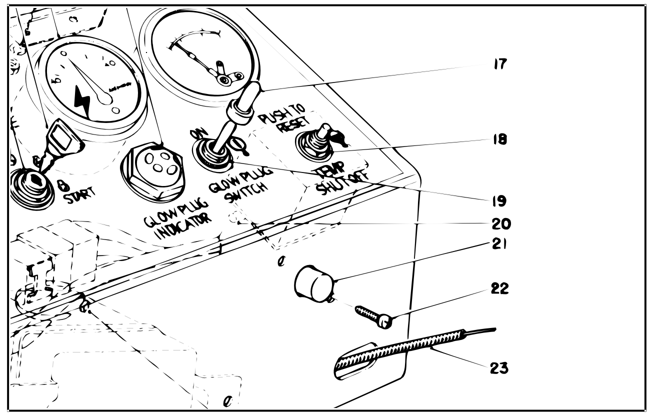


Figure 18

Temperature Gauge Sending Unit (Fig. 19)

The temperature gauge sending unit is located on the top of the cylinder head, near the thermostat .

1. Lower the coolant level in the engine and remove the temperature gauge sending unit located near engine thermostat.

2. Put the sending unit in a container of oil with a thermometer and heat the oil.

3. With an Ohm meter connected as shown, the resistance readings should changed as the temperature increases (resistance should get lower as temperature gets higher).

CAUTION

Handle hot oil with special care to prevent personal injury or fire.

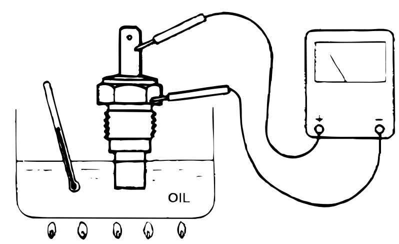


Figure 19

Engine Oil Pressure Switch (Fig. 20)

The oil pressure switch is located on the cylinder block and has a brown wire attached. The switch is normally closed (NC) and opens with pressure.

Turn ignition key switch ON. Oil pressure lamp and buzzer should be on.

If lamp and buzzer are not on:

1. Disconnect wire from oil pressure switch and touch wire to a good ground, such as the engine block.

2. If lamp and buzzer come on, replace switch.

3. If lamp and buzzer do not come on check wiring between switch, lamp and buzzer for continuity.

If lamp and buzzer are on with engine running:

1. Shut off engine immediately.

2. Check switch by disconnecting wire with ignition switch in ON position. Light should go out.

3. If light is still on, check for short circuit in wiring.

4. Install test gauge in engine oil pressure switch port. Start engine and check oil pressure. If engine oil pressure is good, replace switch. If engine pressure is low, DO NOT operate the engine.

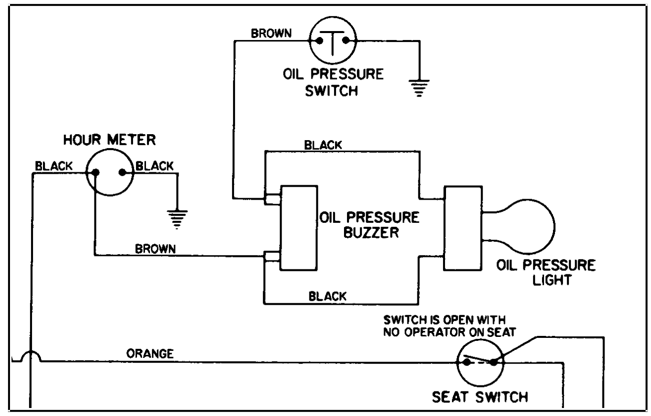


Figure 20

Fuel Gauge Sending Unit (Fig. 21)

1. Remove the two wires from top of sending unity.

2. Loosen and remove screws securing sending unit to fuel tank.

DANGER

Because fuel is flammable, caution must be used when the sending unit is removed. Vapors may build up and be ignited by a spark or flame source many feet away. Prevent sparks and DO NOT smoke while working on the fuel system, to avoid the possibility of an explosion and personal injury.

3. Carefully remove sending unit from fuel tank.

4. Connect an ohmmeter (set on the R x 1 scale) across the two terminals of the sending unit. As the float is moved up and down, the resistance (in Ohms) will be registered on the meter. The resistance should vary between 90 and 0 Ohms.

5. If not change in the resistance is measured as the float is moved up and down, the sending unit is faulty and must be replaced.

6. Reverse steps 1 - 4 to install the sending unit.

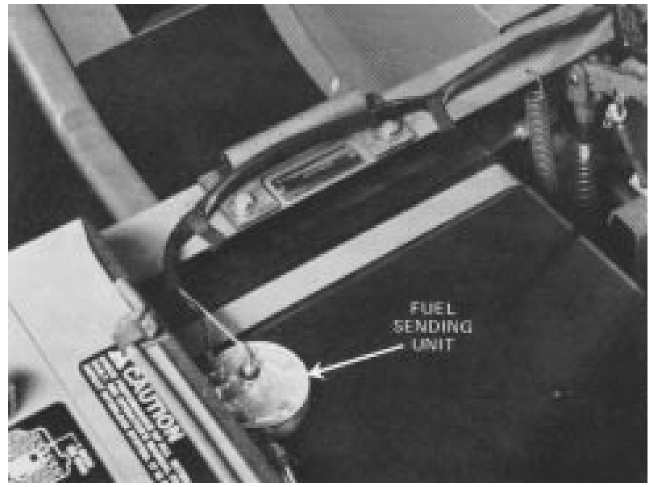


Figure 21

Repairs

IMPORTANT: Before welding on the machine, disconnect both battery cables from the battery and disconnect the terminal connector from the alternator to prevent damage to the electrical system.

Battery Service (Fig. 22)

IMPORTANT: To prevent damage to 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. 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

CAUTION

Do not charge a frozen battery because it can explode and cause injury. Let the battery warm to 60^{O} F (16^{O} 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.

Reelmaster 345
Battery Specifications

BCI Group 24 Battery
370 Amp Cranking Performance at 0^{o} F (17 ^{o} C)
45 min. Reserve Capacity at 80^{o} F (27 ^{o} C)

Reelmaster 322-D/325-D
Battery Specifications

BCI Group 24 Battery
550 Amp Cranking Performance at 0^{o} F (–17 ^{o} C)
140 min. Reserve Capacity at 80^{o} F (27 ^{o} C)

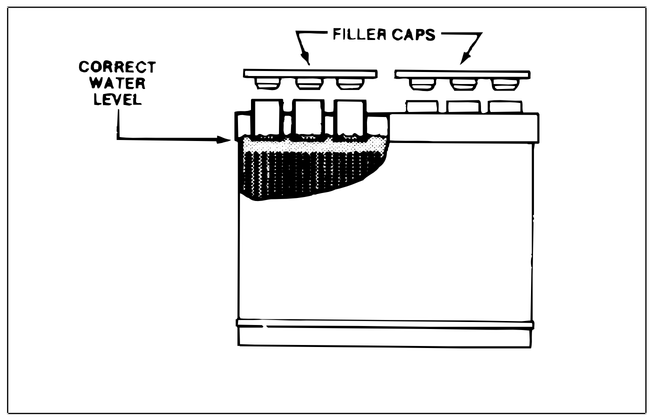


Figure 22

Fuses and Circuit Breaker (Fig. Figure 23, 24)

Groundsmaster 345

An engine temperature reset relay fuse – SFE 14 AMP – is located behind the reset relay. An inline fuse – SFE 14 AMP – protects the entire electrical system. Get access to the fuses by removing the instrument panel cover.

Groundsmaster 322-D/325-D

An engine temperature reset relay fuse – SFE 14 AMP – is located behind reset relay. An inline fuse – AGC 10 AMP – protects the engine control module. Access to the fuses can be gained by removing the instrument panel cover.

A 40 AMP circuit breaker protects the entire electrical system. A reset button is located on the lower side of the instrument panel which can be reached after removal of the battery cover. The button should be depressed if a total loss of all electrical functions should occur.

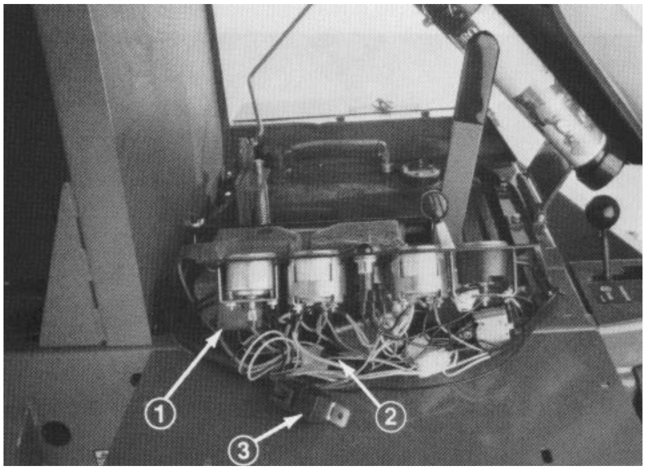


Figure 23
(Groundsmaster 322-D shown)

1. SFE 14 AMP fuse – engine temp. reset relay
2. In-line fuse
3. Starter interlock relay

Figure 24

1. Circuit breaker reset button

Traction (Neutral) Switch Replacement (Fig. 25)

1. Remove the two wires that are connected to the traction switch.

2. Loosen two (2) screws and remove the switch.

3. Install new switch. DO NOT over-tighten screws as the switch case could break.

NOTE: Apply “Loctite 271” or equivalent to threads of switch screws before installing.

4. Reconnect the two wires to the new switch. Make sure that one wire is connected to the “COMMON” terminal, and one wire is connected to the “NORMALLY OPEN” (N.O.) terminal.

IMPORTANT: The traction switch has three (3) terminals. If the two (2) wires are not connected to the “COMMON” and “NORMALLY OPEN” (N.O.) terminals, the engine will be unable to start and the safety interlock circuit will not function properly.

CAUTION

If the wires are not correctly installed to the switch, the engine could start with the traction pedal in forward or reverse.

5. Coat the switch terminals and wires with skin-over grease.

6. Check traction control neutral adjustment. (See Traction Control Neutral Adjustment in the Adjustments section of Chapter 4 - HYDRAULIC SYSTEM.

7. Actuate the pump lever to insure all parts are operating freely and seated properly.

8. Loosen jam nut. Rotate switch adjusting screw until there is a gap between head of screw and switch button.

9. Rotate adjusting screw until it contacts the switch button. Continue to rotate the screw until the circuit is completed (switch “clicks”). After the switch clicks, rotate the adjusting screw an additional 1/2 turn. Tighten jam nut.

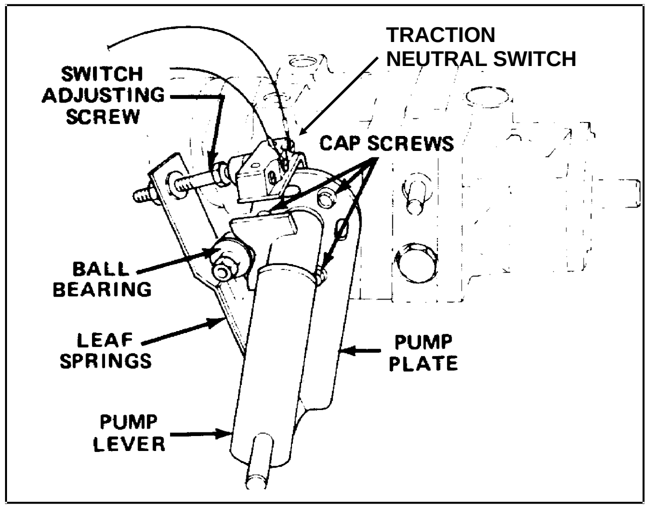


Figure 25

PTO Switch Replacement (Fig. 26, 27)

Lever Type Switch (S/N Below 30001) (Fig. 26)

1. Disengage latches and remove instrument cover.

2. Disconnect negative battery cable from battery and separate wire harness connectors.

3. Move PTO lever to the ON position and remove capscrew and locknut holding switch against mounting bracket.

4. Install new switch with capscrew and locknut. Move PTO lever to OFF position. When lever is in its normal, released position, the switch arm must bend about 1/2 inch (13 mm). If switch arm does not bend 1/2 inch (13 mm), bend the mounting bracket to get the correct adjustment.

5. Connect a continuity tester or ohm meter to switch connector. With PTO lever in forward (ON) position, the switch circuit should have no continuity. If there is continuity, check switch installation. If there is no continuity, go to next step.

6. Move PTO lever to OFF position. When PTO lever is in its normal, released position, the PTO switch should have continuity. If there is no continuity, check switch installation. If there is continuity, go to next step.

7. Liberally coat inside of wiring connectors with skin-over grease. Push wire harness connectors together. Connect negative battery cable to battery.

8. Install instrument cover and lock the latches.

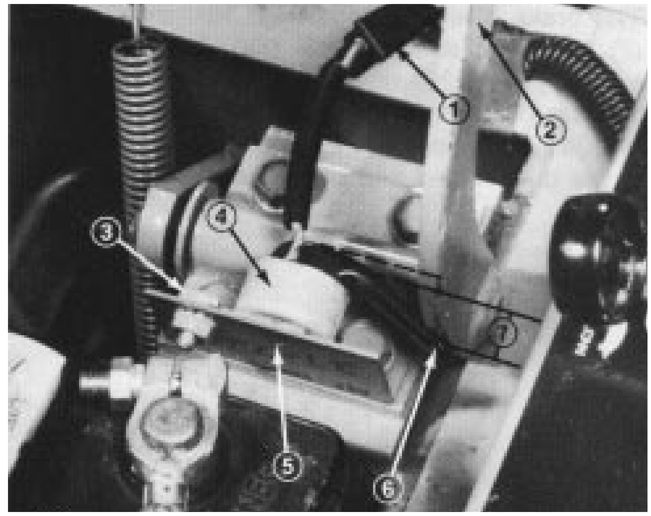


Figure 26
(S/N Below 30001)

1. Connectors
2. PTO lever
3. Capscrew & locknut
4. Switch
5. Mounting bracket
6. Switch arm
7. 1/2 inch (13 mm)

Plunger Type Switch (S/N 30001 and UP) (Fig. 27)

1. Disengage latches and remove instrument cover.

2. Disconnect negative battery cable from battery.

3. Move PTO lever forward to ON position.

4. Disconnect PTO switch electrical connector.

5. Remove boot from button end of switch. Keep boot for installation later.

6. Remove front jam nut securing switch to mounting bracket and remove switch.

7. Install new switch to mounting bracket. Adjust switch so it is depressed 1/2" (13 mm) when PTO lever is moved to OFF position. Tighten jam nuts to 75 in-lb. Install rubber boot on switch.

IMPORTANT: Threads on PTO switch will be damaged if jam nuts are over-tightened.

8. Connect a continuity tester or ohm meter to switch connector. With PTO lever in forward (ON) position, the switch circuit should have no continuity. If there is continuity, check switch installation. If there is no continuity, go to next step.

9. Move PTO lever to OFF position. When PTO lever is in its normal, released position, the PTO switch should have continuity. If there is no continuity, check switch installation. If there is continuity, go to next step.

10. Push switch connectors together.

11. Install instrument cover and lock the latches.

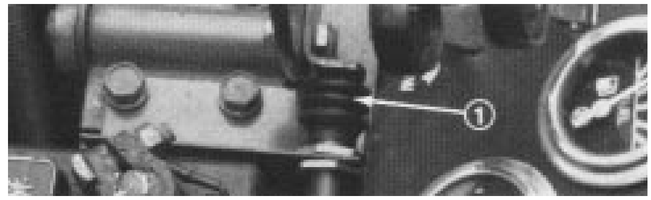


Figure 27
(S/N 30001 and UP)

1. PTO switch

Seat Switch Replacement (Fig. 28, 29)

Lever Type Switch (S/N Below 30001) (Fig. 28)

1. Remove instrument cover and disconnect negative (–) battery cable from battery.

2. Pivot seat forward and secure with support rod to prevent it from falling.

3. (4WD units only) Remove (4) flange screws and (2) locknuts securing sealing plate to frame above fuel tank. Remove sealing plate.

4. Disconnect electrical connectors for seat switch. Remove capscrew and locknut securing switch to mounting bracket.

5. To install new seat switch, set it on mounting bracket and make sure locating pin on bottom of switch fits hole in bracket. Secure switch in place with capscrew and locknut.

6. Carefully lower seat, but do not sit on, or apply pressure to the seat. There should be a slight gap between the switch and seat plate.

7. Connect a continuity tester or ohm meter to switch connector. With seat in down position and no one on seat, the switch circuit should have no continuity. If there is continuity, check switch installation. If there is no continuity, go to next step.

8. Set on the seat. The seat switch should have continuity. If there is no continuity, check switch installation. If there is continuity, go to next step.

9. Liberally coat inside of wiring connectors with skin-over grease and push wire harness connectors together.

10. (4WD units only) Install sealing plate to frame above fuel tank.

11. Disengage support rod lower the seat. Install lynch pin through rod to hold seat in place. Connect negative battery cable to battery.

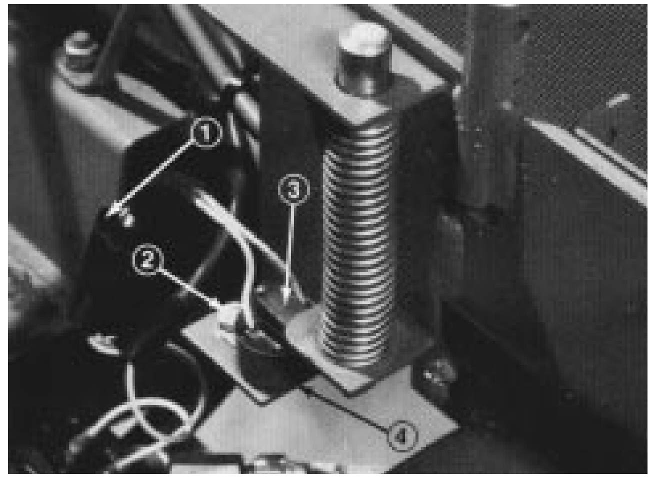


Figure 28
(S/N Below 30001)

1. Connectors **3. Switch**
2. Capscrew & locknut **4. Mounting bracket**

Plunger Type Switch (S/N 30001 and UP) (Fig. 29)

1. Remove instrument cover and disconnect negative (–) battery cable from battery.

2. Pivot seat forward and secure with support rod to prevent it from falling.

3. (4WD units only) Remove (4) flange screws and (2) locknuts securing sealing plate to frame above fuel tank. Remove sealing plate.

4. Remove boot from button end of seat switch. Keep boot for installation later. Disconnect seat switch wiring connector.

5. Remove top jam nut securing seat switch to mounting bracket and remove switch.

6. Install new seat switch to support bracket. Adjust switch height so it is 3/32" (2.4 mm) below top of spring pin. Tighten jam nuts to 75 in-lb. Install rubber boot.

IMPORTANT: Threads on seat switch will be damaged if jam nuts are over-tightened.

7. Carefully lower seat, but do not sit on, or apply pressure to the seat. There should be a slight gap between the switch and seat plate.

8. Connect a continuity tester or ohm meter to switch connector. With seat in down position and no one on seat, the switch circuit should have no continuity. If there is continuity, check switch installation. If there is no continuity, go to next step.

9. Set on the seat. The seat switch should have continuity. If there is no continuity, check switch installation. If there is continuity, go to next step.

10. Push switch connectors together.

11. (4WD units only) Install sealing plate to frame above fuel tank.

12. Connect battery cable and install instrument cover.

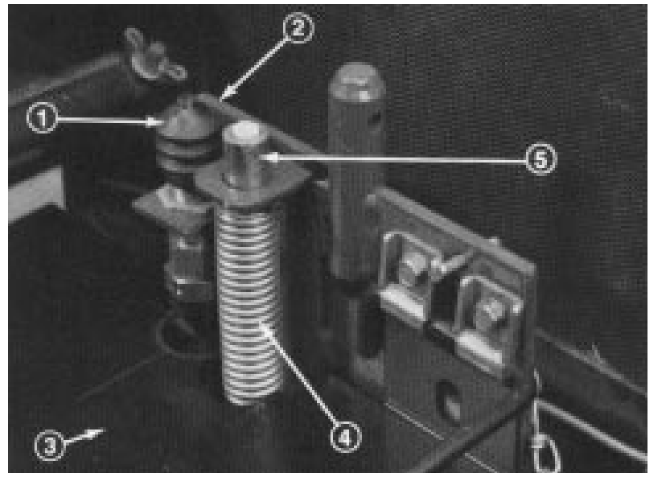


Figure 29
(S/N 30001 and UP)

1. Seat switch
2. Seat support bracket
3. Connector
4. Spring
5. Pin

Chapter 6A

For GM 345 (Serial Number above 21000000) and GM 328–D

Electrical System

Table of Contents

ELECTRICAL SCHEMATICS 1
SPECIAL TOOLS 2
ELECTRICAL SYSTEM QUICK CHECKS 3
Battery Test (Open Circuit Test) 3
Charging System Test 3
Glow Plug System Test (Groundsmaster 328–D) . 3
COMPONENT IDENTIFICATION AND TESTING . . 4
Seat Switch 4
High Temperature Override Switch 4
Start Enable, Run Enable, Over Temperature and Seat Delay (GM 328–D) Relays 5
Fuel Sender 6
Fusible Link Harness 7
Diode Assembly 7
Control Ignition Delay Module (Groundsmaster 345) 8
Glow Relay (Groundsmaster 328–D) 8
Glow Controller (Groundsmaster 328–D) 9
Run Solenoid (Groundsmaster 328–D) (Solenoid with 3 Wire Connector) 10
Run Solenoid (Groundsmaster 328–D) (Solenoid with 2 Wire Connector) 11
SERVICE AND REPAIRS 12
Battery Service 12

Note: Only new information for Groundsmaster 345 machines with serial numbers above 21000000 and Groundsmaster 328–D machines is provided in this Chapter. See Chapter 6 – Electrical System for additional component identification and testing information.

Electrical Schematics

The electrical schematics for all Groundsmaster 300 models are provided in Chapter 6 – Electrical System.

Special Tools

Digital Multimeter

The Digital Multimeter can test electrical components and circuits for current, resistance, or voltage drop. Obtain Digital Multimeter from a local supplier.

Note: Toro recommends the use of a DIGITAL multimeter when testing electrical circuits. The high impedance (internal resistance) of a digital meter will ensure that excess current is not allowed through the meter. Excess current can cause damage to a circuit that is not designed to carry it.

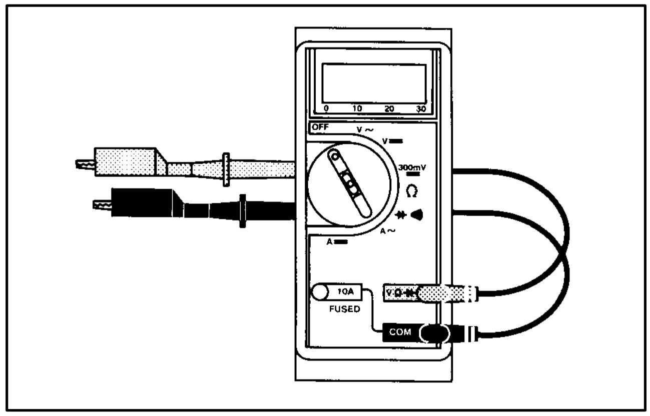


Figure 1

Skin–Over Grease

Special non–conductive grease which forms a light protective skin to help waterproof electrical switches and contacts.

Toro P/N **505–47** 8 oz. (.24 L) can

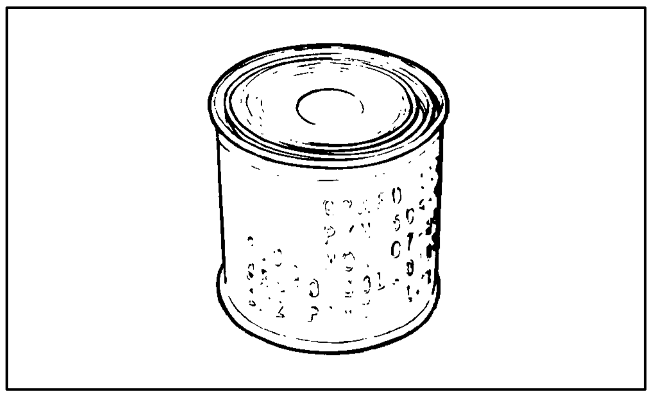


Figure 2

Inductive Ammeter (AC/DC Current Transducer – Hall Effect)

Use this tool, connected to a Digital multimeter for doing current draw tests. This tool can be useful when checking glow plug and starter circuits. Obtain the Inductive Ammeter from a local supplier.

Electrical System Quick Checks

Battery Test (Open Circuit Test)

Use a multimeter to measure the voltage between the battery terminals.

Set the multimeter to the DC volts setting. The battery should be at a temperature of 60º to 100º F (16º to 38º C). The ignition key should be in the OFF position and all accessories turned off. Connect the positive (+) meter lead to the positive battery post and the negative (–) meter lead to the negative battery post. Use the table to the right to determine charge level of the battery.

Note: This test provides a relative condition of the battery. Load testing of the battery will provide additional and more accurate information.

Voltage Measured	Battery Charge Level
12.68 v (or higher)	Fully charged (100%)
12.45 v	75% charged
12.24 v	50% charged
12.06 v	25% charged
11.89 v	0% charged

Charging System Test

This is a simple test used to determine if the charging system is functioning. It will tell you if the charging system has an output, but not its capacity.

Use a multimeter set to the DC volts position. Connect the positive (+) meter lead to the positive battery post and the negative (–) meter lead to the negative battery post. Leave the multimeter test leads connected to the battery and record the battery voltage.

Note: Upon starting the engine, the battery voltage will drop and then should increase once the engine is running.

Note: Depending upon the condition of the battery charge and battery temperature, the charging system voltage will increase at different rates as the battery charges.

Start the engine and run at high idle speed. Allow the battery to charge for at least three (3) minutes. Record the battery voltage.

After allowing the engine to run for at least three (3) minutes, battery voltage should be at least 0.5 volts higher than initial battery voltage (see example in table to the right).

Note: While engine is running, if battery voltage exceeds 16 volts, the regulator in the charging system should be inspected.

After allowing the engine to run for at least three (3) minutes, if battery voltage does not increase at least 0.5 volts, additional testing of the battery and/or charging system should be performed.

Acceptable voltage increase:	
Initial Battery Voltage	= 12.25 v
Battery Voltage after 3 Minute Charge	= 12.80 v
Difference	= +0.55 v

Glow Plug System Test (Groundsmaster 328–D)

This is a fast, simple test that can help to determine the integrity and operation of the Groundsmaster 328–D glow plug system. The test should be run anytime hard starting (cold engine) is encountered on a diesel engine equipped with a glow plug system.

Use a digital multimeter and/or inductive Ammeter (AC/DC Current Transducer) set to the correct scale. With the ignition switch in the OFF position, place the ammeter pickup around the main glow plug power supply wire. Adjust the meter to read zero (if applicable). Cycle the glow plug system at least two times (per instructions in Traction Unit Operator's Manual) and record the final results.

The Groundsmaster 328–D glow plug system should have a reading of approximately 27 Amps. If low current reading is observed, one (or more) glow plugs is faulty.

Component Testing

Note: See Chapter 6 – Electrical System for additional component identification and testing information. Only new information for Groundsmaster 345 machines with serial numbers above 21000000 and Groundsmaster 328–D machines is provided in this Chapter.

Seat Switch

The seat switch is normally open and closes when the operator is on the seat. The switch is located directly under the seat (Fig. 3).

1. Make sure the engine and ignition switch are Off. Remove key from ignition switch.

2. Tilt operator seat up. Disconnect machine wire harness connector from seat switch.

3. Check the continuity of the switch by connecting a multimeter (ohms setting) across the switch connector terminals.

4. With no pressure on the seat cushion, there should be no continuity between the switch terminals.

5. Press directly onto the seat switch through the seat cushion. There should be continuity as the seat cushion approaches the bottom of its travel.

6. Connect machine wire harness connector to seat switch.

If switch removal is necessary, remove seat with sliders from seat plate. Remove switch from bottom of seat.

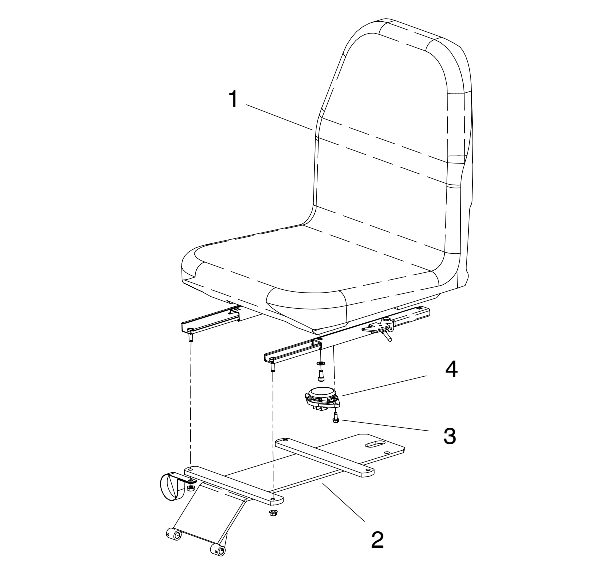


Figure 3

1. **Seat**
2. **Seat plate**
3. **Screw (2 used)**
4. **Seat switch**
5. **Switch harness**

High Temperature Override Switch

The high temperature override switch is located on the control console.

The switch terminals are marked as shown in Figure 4. The circuitry of the switch is shown in the chart below. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. Verify continuity between switch terminals.

SWITCH POSITION	NORMAL CIRCUITS	OTHER CIRCUITS
ON	2 + 3	5 + 6
OFF	1 + 2	4 + 5

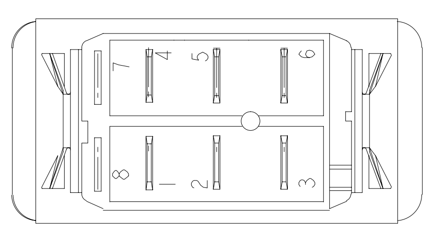


Figure 4

Start Enable, Run Enable, Over Temperature and Seat Delay (GM 328–D) Relays

Three (3) relays (start enable, run enable and over temperature) are used on the Groundsmaster 328–D and Groundsmaster 345 to control engine operation. The Groundsmaster 328–D uses an additional relay (seat delay) to allow the engine to continue to run when the operator lifts from the seat momentarily. The relays are attached to a bracket under the instrument panel next to the battery. These relays are identical. Refer to electrical schematics in Chapter 6 – Electrical System for relay identification.

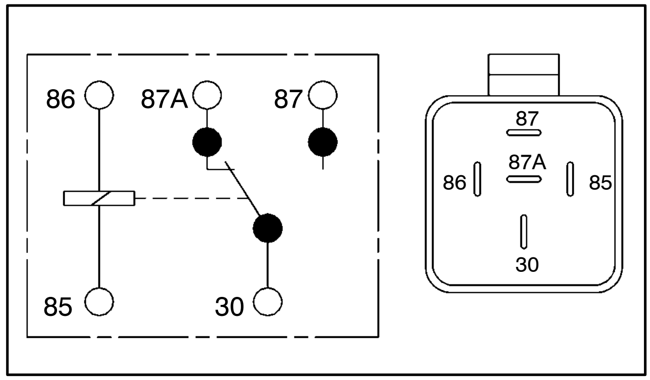


Figure 5

Testing

Note: Prior to taking small resistance readings with a digital multimeter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from the measured value of the component you are testing.

1. Locate relay to be tested. Disconnect the machine wire harness connector from the relay.

2. Using a multimeter (ohms setting), measure coil resistance between terminals 85 and 86 (Fig. 5). Resistance should be between 70 and 90 ohms.

3. Connect multimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87 as +12 VDC is applied and removed from terminal 85.

4. Disconnect voltage from terminal 85 and multimeter lead from terminal 87.

5. Connect multimeter (ohms setting) leads to relay terminals 30 and 87A. Apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87A as +12 VDC is applied and removed from terminal 85.

6. Disconnect voltage and multimeter leads from the relay terminals. Reconnect relay to machine wire harness.

Fuel Sender

The fuel sender is located on top of the fuel tank.

Testing

1. Remove blue wire and black ground wire from the sender.

CAUTION

If testing circuit wiring and fuel gauge, make sure wire connections are secure before turning ignition switch ON to prevent an explosion or fire from sparks.

2. To test the circuit wiring and fuel gauge, connect blue and black wires and turn ignition switch to ON. Fuel gauge needle should point to the right edge of the green area (full). Turn ignition switch OFF and continue testing fuel sender if circuit wiring and gauge are acceptable.

3. Remove five (5) screws that secure the sender to the fuel tank.

4. Remove sender and gasket from the fuel tank. Clean any fuel from the sender.

Note: Before taking small resistance readings with a digital multimeter, short meter test leads together. The meter will display a small resistance value. This internal resistance of the meter and test leads should be subtracted from the measured value of the component.

CAUTION

Make sure sending unit is completely dry (no fuel on it) before testing. Perform test away from the tank to prevent an explosion or fire from sparks.

5. Check resistance of the sender with a multimeter (Fig. 6).

   A. Resistance with the float in the full position should be 27.5 to 39.5 ohms.

   B. Resistance with the float in the empty position should be 240 to 260 ohms.

6. Replace sender as necessary. Reinstall sender into fuel tank.

7. Reconnect wires to fuel sender. Apply skin–over grease (Toro Part No. 505–47) to sender terminals.

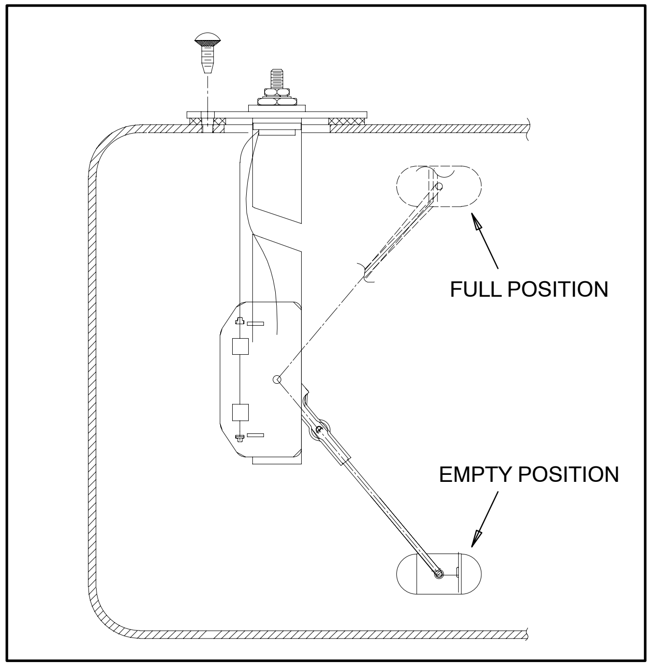


Figure 6

Fusible Link Harness

The Groundsmaster 328–D and Groundsmaster 345 use three (3) fusible links for circuit protection. These fusible links are located in a harness that connects the starter B+ terminal to the main wire harness. If any of these links should fail, current to the protected circuit will cease. Refer to wire harness drawings in Chapter 6 – Electrical System for additional fusible link information.

Use a multimeter to make sure that continuity exists between each terminal pin in connector P1 and connector J1 at the starter (Fig. 7). If any of the fusible links are open, replace the complete harness.

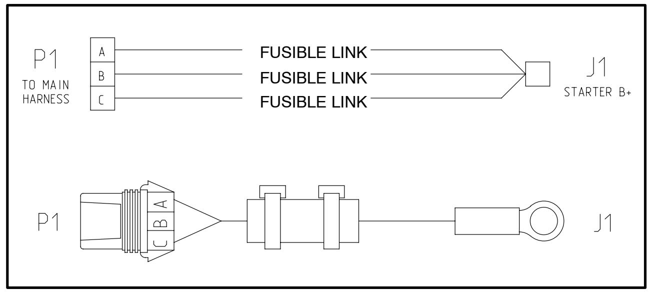


Figure 7

Diode Assembly

Two (2) diode assemblies (Fig. 8) are used in the machine wire harness. Diode D1 is used for circuit protection from inductive voltage spikes that occur when the starter motor is shut off. Diode D2 provides logic for the interlock switches to allow the engine to run when the traction pedal is in neutral and the PTO switch is off. The diodes plug directly into the wiring harness.

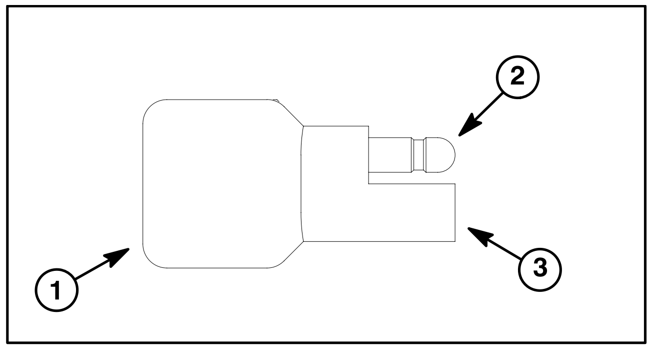


Figure 8

1. **Diode**
2. **Male terminal**
3. **Female terminal**

Testing

The diodes can be individually tested using a digital multimeter (diode test or ohms setting) and the table **below**.

Multimeter Red Lead (+) on Terminal	Multimeter Black Lead (–) on Terminal	Continuity
Female	Male	YES
Male	Female	NO

Control Ignition Delay Module (Groundsmaster 345)

The control ignition delay module on the Groundsmaster 345 is one of the components in the interlock system. Whenever the run enable relay is energized, the control ignition delay module is energized and allows current to the engine ignition control module. If the run enable relay is de–energized (e.g. operator gets off the seat), the control ignition delay module will de–energize after .5 second and will cause the engine to stop running as power to the engine ignition control module is shut off. The module is attached to a bracket under the instrument panel next to the battery.

Testing

1. Locate control ignition delay module. Unplug wire harness connectors from module.

2. Connect multimeter (DC volts setting) leads to module terminals P1–2 (meter + lead) and P1–1 (meter – lead) (Fig. 9).

3. Connect a jumper lead from module terminal P1–4 to module wire connector J1.

4. Using a 12 VDC power source, apply +12 VDC to terminal P1–3 and ground terminal P1–1.

5. Connect a second jumper lead to module terminal P1–3 and touch terminal P1–4. The multimeter display should show 12 VDC as long as the jumper is connected to P1–4.

6. Disconnect the jumper wire from module wire connector J1 while watching the multimeter display. The meter should show 0 VDC after .5 seconds.

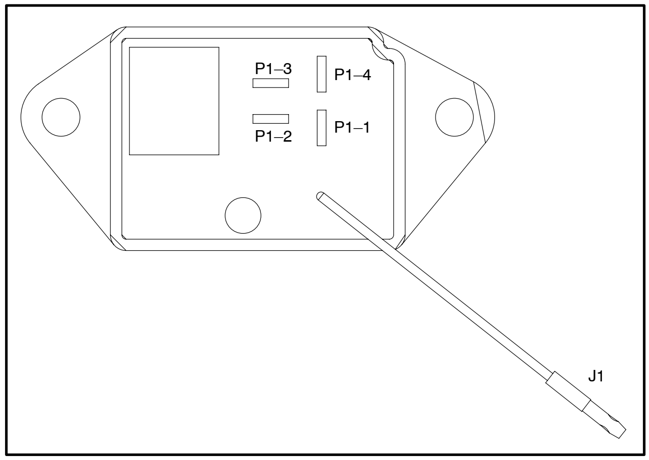


Figure 9

Glow Relay (Groundsmaster 328–D)

The Groundsmaster 328–D (diesel engine) uses a relay to energize the engine glow plugs. This glow relay is attached to the frame below the radiator assembly.

Testing

1. Verify coil resistance between terminals 86 and 85 with a multimeter (ohms setting) (Fig. 10). Resistance should be from 41 to 51 ohms.

2. Connect multimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87 as +12 VDC is applied and removed from terminal 85.

3. Disconnect voltage and leads from the terminals.

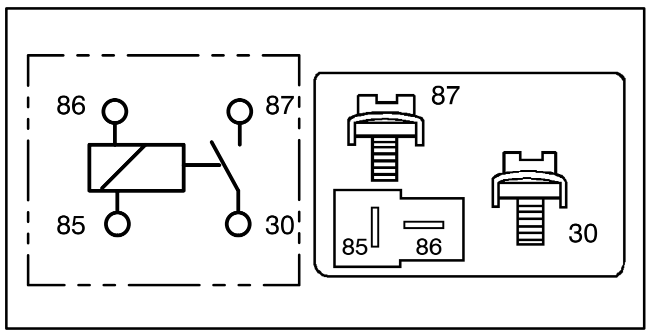


Figure 10

Glow Controller (Groundsmaster 328–D)

The glow controller used on the Groundsmaster 328–D (diesel engine) is located under the instrument panel.

Note: Refer to Groundsmaster 328–D electrical schematic in Chapter 6 – Electrical System when troubleshooting the glow controller circuit.

Controller Operation

1. When the ignition switch is placed in the RUN position, the controller energizes the glow plugs and lights up the glow lamp for approximately 6 seconds.

2. When the ignition switch is held in the START position, the glow plugs will energize while the switch is held in START and the glow lamp will **not** light.

3. When the ignition switch is released from START to RUN, the glow plugs will de–energize and the glow lamp will remain off.

Controller Checks

1. Make sure there is power from the battery.

2. Disconnect electrical connector to the fuel stop solenoid to prevent the engine from starting.

3. Place ignition switch in the RUN position. Verify the following while in the RUN position:

    A. Glow indicator lamp is on.

    B. Glow relay is energized.

    C. Glow plugs are energized.

    D. Glow indicator lamp goes out and glow plugs de–energize after approximately 6 seconds.

4. Place ignition switch in the START position. Verify the following while in the START position:

    A. Glow indicator lamp is out.

    B. Glow relay is energized.

    C. Glow plugs are energized.

    D. Power exists at terminal 1 of the glow controller.

Note: If there is no power to terminal 1 of the glow controller, verify continuity of the circuitry from the ignition switch to the glow controller and perform Step 4 again (see Groundsmaster 328–D electrical schematic in Chapter 6 – Electrical System).

5. If any of the conditions in Step 3 are not met or power to terminal 1 exists and any of the other conditions in Step 4 are not met:

    A. Verify continuity of the circuitry from the battery to the glow relay and glow plugs (see Groundsmaster 328–D electrical schematic in Chapter 6 – Electrical System).

    B. Verify continuity of the circuitry from the battery to ignition switch, glow controller, glow lamp, glow relay and ground (see Groundsmaster 328–D electrical schematic in Chapter 6 – Electrical System).

    C. Replace parts as necessary.

6. Connect electrical connector to the fuel stop solenoid.

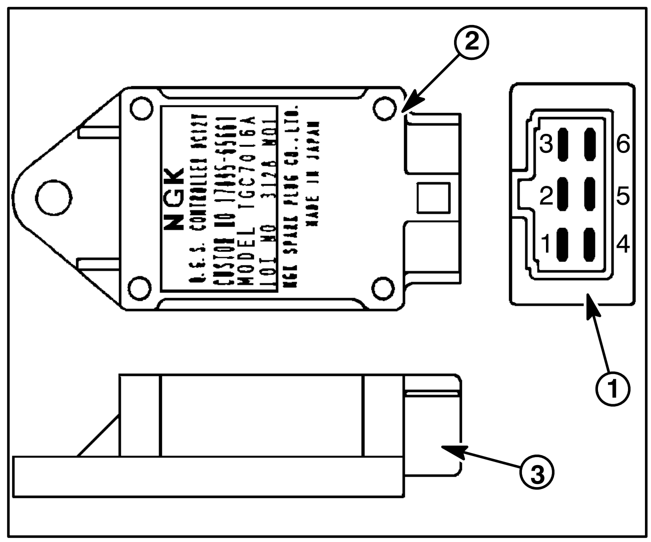


Figure 11

1. **Glow controller end view**
2. **Top view**
3. **Side view**

Run Solenoid (Groundsmaster 328–D) (Solenoid With 3 Wire Connector)

The run (ETR) solenoid must be energized for the engine to run. The solenoid is mounted on the engine block near the injection pump.

In Place Testing

Note: Prior to taking small resistance readings with a digital multimeter, short the test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from from the measured value of the component you are testing.

1. Disconnect the wire harness connector from the solenoid.

2. Using a digital multimeter, touch one lead to the pin of the **black** wire and the other lead to the pin of the **white** wire. The resistance of the **pull coil** should be about 0.33 ohms.

3. Using a digital multimeter, touch one lead to the pin of the **black** wire and the other lead to the pin of the **red/ black** wire. The resistance of the **hold coil** should be about 12.2 ohms.

4. Connect solenoid to the wiring harness.

Live testing

1. Disconnect the wire harness connector from the solenoid.

Note: The solenoid may be removed from the engine or tested in place.

2. If the solenoid is removed from the engine, make sure that the solenoid plunger moves freely and is free of dirt, debris and corrosion.

3. Connect a positive (+) test lead from a 12 VDC source to the pins of the **red/black** and **white** wires.

4. Touch a negative (-) test lead from the 12 VDC source to the pin of the **black** wire. The solenoid should engage making an audible "click".

5. Remove positive (+) voltage from the pin of the **white** wire. The solenoid should stay engaged.

6. Remove positive (+) voltage from the pin of the **red/ black** wire. The solenoid should release.

7. Reconnect the wires to the solenoid.

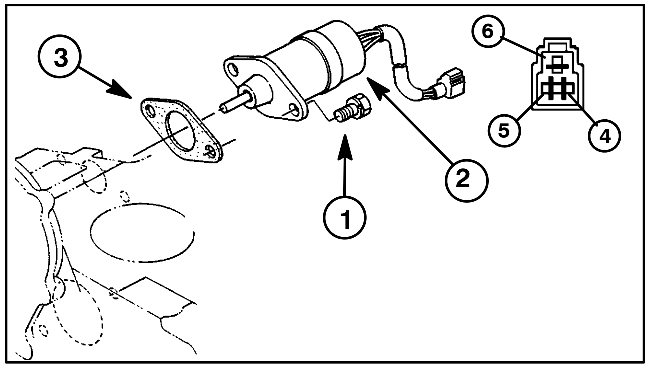


Figure 12

1. **Cap screw**
2. **Fuel stop solenoid**
3. **Gasket**
4. **Common (black wire)**
5. **Hold coil (red/black wire)**
6. **Pull coil (white wire)**

Run Solenoid (Groundsmaster 328–D) (Solenoid With 2 Wire Connector)

The run (ETR) solenoid must be energized for the engine to run. The solenoid is mounted on the engine block near the injection pump.

In Place Testing

Note: Prior to taking small resistance readings with a digital multimeter, short the test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from from the measured value of the component you are testing.

1. Disconnect machine wire harness connector from solenoid.

2. Using a digital multimeter, touch one test lead to the pull coil terminal and the other test lead to the fuel stop solenoid frame (ground) (Fig. 13). The resistance of the pull coil should be less than 1 ohm (but not zero).

3. Using a digital multimeter, touch one test lead to the hold coil terminal and the other test lead to the fuel stop solenoid frame (ground) (Fig. 13). The resistance of the hold coil should be approximately 15 ohms.

4. Connect solenoid to the machine wire harness.

Live testing

1. Disconnect wire harness connector from run solenoid.

Note: The solenoid may be removed from the engine or tested in place.

2. If the solenoid is removed from the engine, make sure that the solenoid plunger moves freely and is free of dirt, debris and corrosion.

Note: When testing run solenoid, use test leads with at least 14 gauge wire.

3. Connect a positive (+) test lead from a 12 VDC source to the pull coil and hold coil terminals.

4. Touch a negative (–) test lead from the 12 VDC source to the fuel stop solenoid frame (ground) (Fig. 13). The solenoid should engage, making an audible “click,” and the plunger should retract.

5. Remove positive (+) voltage from the pull coil terminal. The solenoid should stay engaged.

6. Remove positive (+) voltage from the hold coil terminal. The solenoid should release.

7. Connect the wire harness connector to the run solenoid.

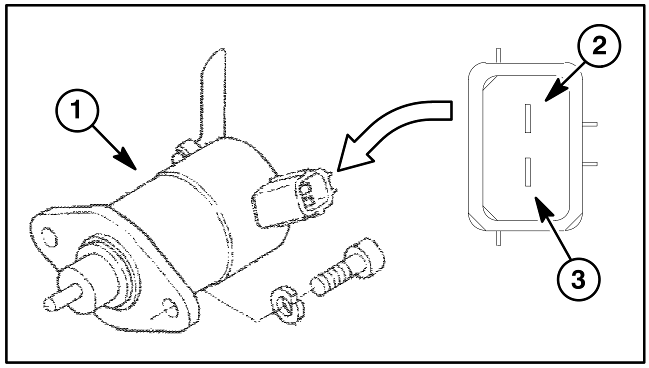


Figure 13

1. **Fuel stop solenoid**
2. **Pull coil terminal**
3. **Hold coil terminal**

Service and Repairs

Battery Service

The battery is the heart of the electrical system. With regular and proper service, battery life can be extended. Additionally, battery and electrical component failure can be prevented.

Note: Battery information for all Groundsmaster 322/325 machines and Groundsmaster 345 machines with serial number below 21000000 is included in Chapter 6.

Electrolyte Specific Gravity

Fully charged: 1.265 corrected to 80° F (26.7° C)
Discharged: less than 1.240

Battery Specifications Groundsmaster 328–D

BCI Group 24
660 Amp Cranking Performance at 0° F (–17.8° C)
110 Minute Reserve Capacity at 80° F (26.7° C)

Battery Specifications Groundsmaster 345

BCI Group 24
420 Amp Cranking Performance at 0° F (–17.8° C)
67 Minute Reserve Capacity at 80° F (26.7° C)

CAUTION

Wear safety goggles and rubber gloves when working with electrolyte. Charge the battery in a well ventilated so gases produced while charging can dissipate. Since the gases are explosive, keep open flame and electrical spark away from the battery; do not smoke. Nausea may result if the gases are inhaled. Unplug charger from electrical outlet before connecting to, or disconnecting charger leads from battery posts.

Inspection, Maintenance and Testing

1. Perform the following inspection and maintenance tasks:

A. Check for cracks caused by overly tight or loose hold–down clamp. Replace battery if cracked and leaking.

B. Check battery terminal posts for corrosion. Use a terminal brush to clean corrosion from the battery terminal posts.

IMPORTANT: Before cleaning the battery, tape or block the vent holes to the filler caps and make sure the caps are on tightly.

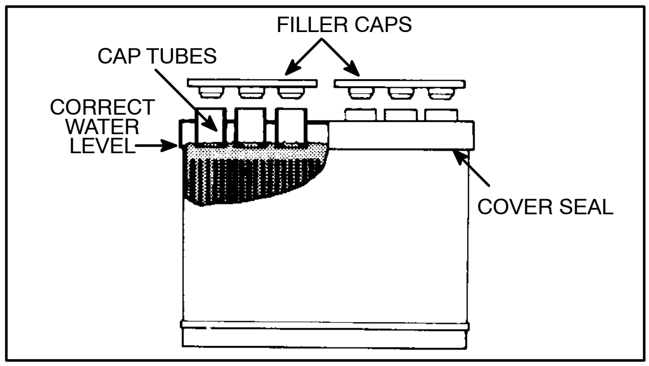


Figure 14

C. Check for signs of wetness or leakage on the top of the battery which might indicate a loose or missing filler cap, overcharging, loose terminal post or overfilling. Also, check the battery case for dirt and oil. Clean the battery with a solution of baking soda and water, then rinse it with clean water.

D. Check that the cover seal is not broken away. Replace the battery if the seal is broken or leaking.

E. Check the electrolyte level in each cell. If the level is below the tops of the plates in any cell, fill all cells with **distilled** water to the bottom of the cap tubes. Charge at 15 to 25 amps for 15 minutes to allow sufficient mixing of the electrolyte.

2. Conduct a hydrometer test of the battery electrolyte.

IMPORTANT: Make sure the area around the cells is clean before opening the battery caps.

A. Measure the specific gravity of each cell with a hydrometer. Draw electrolyte in and out of the hydrometer barrel prior to taking a reading to warm–up the hydrometer. At the same time take the temperature of the cell.

B. Temperature correct each cell reading. For each 10º F (5.5º C) above 80 F (26.7º C) add 0.004 to the specific gravity reading. For each 10º F (5.5º C) below 80º F (26.7º C) subtract 0.004 from the specific gravity reading.

Example:	Cell Temperature 100º F	
	Cell Gravity	1.245
	ADD (20º above 80º F)	0.008
	Correction to 80º F	1.253

C. If the difference between the highest and lowest cell specific gravity is 0.050 or greater or the lowest cell specific gravity is less than 1.225, charge the battery. Charge at the recommended rate and time given in **Charging** or until specific gravity of all cells is 1.225 or greater with the difference in specific gravity between the highest and lowest cell less than 0.050. If these charging conditions can not be met, replace the battery.

3. Perform a high–discharge test with an adjustable load tester.

This is one of the most reliable means of testing a battery as it simulates the cold–cranking test. A commercial battery load tester is **required** to perform this test.

CAUTION

Follow the manufacturer's instructions when using a battery load tester.

A. Check the voltage across the battery terminals prior to testing the battery. If the voltage is less than 12.0 VDC, recharge the battery.

B. If the battery has been charged, apply a 150 amp load for 15 seconds to remove the surface charge. Use a battery load tester following the manufacturer's instructions.

C. Make sure the battery terminals are free of corrosion.

D. Measure the temperature of the center cell.

E. Connect a battery load tester to the battery terminals **following the manufacturer's instructions**. Connect a digital multimeter to the battery terminals.

F. Apply a test load of one half the Cranking Performance rating of the battery for 15 seconds.

G. Take a voltage reading at 15 seconds, then remove the load.

H. Using the table below, determine the minimum voltage for the cell temperature reading.

Minimum Voltage	Battery Electrolyte Temperature	
9.6	70º F (and up)	21.1º C (and up)
9.5	60º F	15.6º C
9.4	50º F	10.0º C
9.3	40º F	4.4º C
9.1	30º F	–1.1º C
8.9	20º F	–6.7º C
8.7	10º F	–12.2º C
8.5	0º F	–17.8º C

I. If the test voltage is below the minimum, replace the battery. If the test voltage is at or above the minimum, return the battery to service.

Charging

To minimize possible damage to the battery and allow the battery to be fully charged, the slow charging method is presented here. This charging method can be accomplished with a constant current battery charger which is available in most shops.

CAUTION

Follow the manufacturer's instructions when using a battery charger.

1. Determine the battery charge level from either its open circuit voltage or specific gravity.

Battery Charge Level	Open Circuit Voltage	Specific Gravity
100%	12.68	1.265
75%	12.45	1.225
50%	12.24	1.190
25%	12.06	1.155
0%	11.89	1.120

2. Determine the charging time and rate **using the manufacturer's battery charger instructions** or the following table.

Reserve Capacity (Minutes)	Battery Charge Level (Percent of Fully Charged)			
	75%	50%	25%	0%
80 or less	3.8 hrs at 3 amps	7.5 hrs at 3 amps	11.3 hrs at 3 amps	15 hrs at 3 amps
81 to 125	5.3 hrs at 4 amps	10.5 hrs at 4 amps	15.8 hrs at 4 amps	21 hrs at 4 amps
126 to 170	5.5 hrs at 5 amps	11 hrs at 5 amps	16.5 hrs at 5 amps	22 hrs at 5 amps
171 to 250	5.8 hrs at 6 amps	11.5 hrs at 6 amps	17.3 hrs at 6 amps	23 hrs at 6 amps
above 250	6 hrs at 10 amps	12 hrs at 10 amps	18 hrs at 10 amps	24 hrs at 10 amps

CAUTION

Do not charge a frozen battery because it can explode and cause injury. Let the battery warm to 60º F (15.5º C) before connecting to a charger.

Charge the battery in a well–ventilated place to dissipate gases produced from charging. These gases are explosive; keep open flame and electrical spark away from the battery. Do not smoke. Nausea may result if the gases are inhaled. Unplug the charger from the electrical outlet before connecting or disconnecting the charger leads from the battery posts.

3. **Following the manufacturer's battery charger instructions**, connect the charger cables to the battery. Make sure a good connection is made.

4. Charge the battery **following the manufacturer's battery charger instructions**.

5. Occasionally check the temperature of the battery electrolyte. If the temperature exceeds 125º F (51.6º C) or the electrolyte is violently gassing or spewing, the charging rate must be lowered or temporarily stopped.

6. Three hours prior to the end of the charging, measure the specific gravity of a battery cell once per hour. The battery is fully charged when the cells are gassing freely at a low charging rate and there is less than a 0.003 change in specific gravity for three consecutive readings.

Chapter 7

Differential Axle

Table of Contents

INTRODUCTION 1
TORQUE SPECIFICATIONS 2
REPAIRS 3
Axle Removal and Installation 3
Axle Shaft Disassembly
and Wheel Bearing Service 4
Differential and Housing Disassembly 8
Differential and Housing Reassembly 14

Introduction

Groundsmaster® 300 Series traction units are equipped with a Dana Hydrostatic Axle, model GT-20. The differential and axle form the final drive of the power train (Fig. 1A).

The differential has a heavy duty case with automotive type, cut gears that rotate on tapered roller bearings. Single-row, pre-set, tapered roller bearings are used on the outside ends of the axle shafts.

The entire drive line of the axle assembly is made of alloy steel. The axle has a die-cast aluminum housing that also serves as the hydraulic oil reservoir.

Power is transmitted from the transmission output gear to the pinion spur gear. The pinion spur gear transmits power directly to the differential drive gears, to turn the axles and the wheels.

The differential axle has a one-piece axle shaft with the flange being part of the axle stem (Fig. 1B).

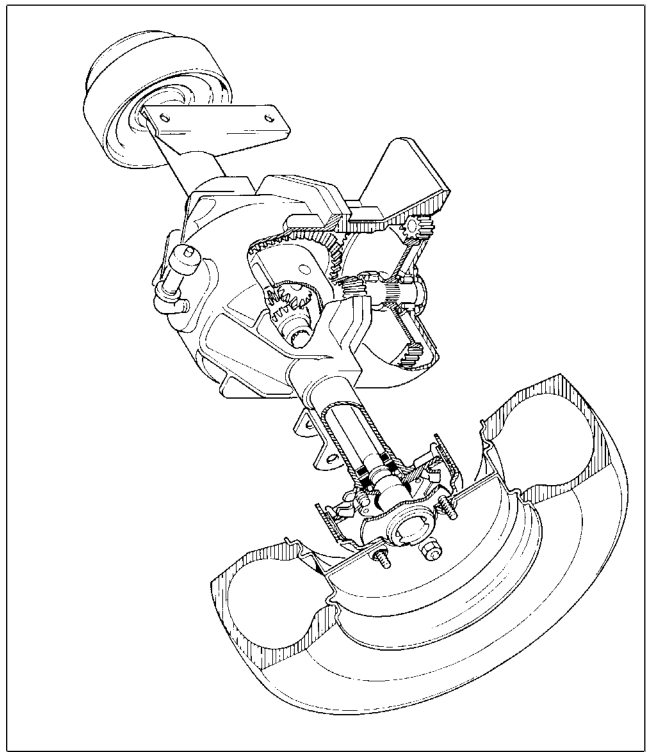


Figure 1A

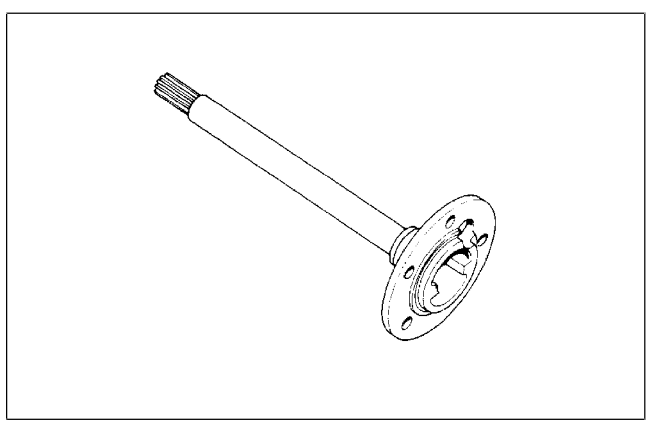


Figure 1B

Specifications

Item	Specification
Front wheel lug nut torque	45 to 55 ft-lb
Front to rear housing torque	18 to 28 ft-lb
Transmission to axle torque	25 to 30 ft-lb
Differential bearing caps torque	30 to 45 ft-lb
Ring gear to differential case torque	45 to 65 ft-lb
Fill pipe torque	20 to 30 ft-lb
Side plate (gear cover) torque	25 to 40 in-lb
Axle shaft bearing retainer (nut) torque With hex head screw With socket head screw (newer models)	 37 to 45 ft-lb 16 to 20 ft-lb
Ring gear to pinion gear backlash	0.003 to 0.007 in.
Pinion gear end play	0.00 to 0.005 in.

Special Tools

NOTE: Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*. Some tools may be listed in the Parts Catalog for your Toro equipment. Some tools may also be available from a local supplier.

Differential Gear Holder

Remove gear cover from right hand side of differential and bolt this tool in place to lock spur gear in position when removing nut that secures drive shaft flange for 4WD drive shaft.

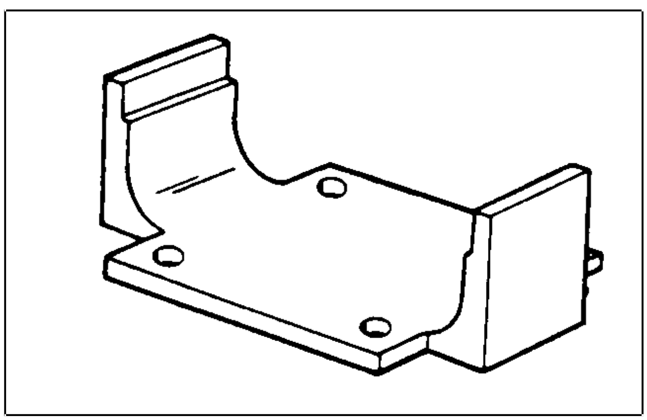


Figure 2

Repairs

Axle Removal and Installation

1. Put machine on a level surface, lower cutting unit, stop the engine and remove key from ignition switch. Block rear wheels to prevent machine from moving.

2. Remove the cutting unit. (See the Repairs section of Chapter 11 - Cutting Units.)

3. If unit is equipped with 4WD, remove rear axle drive shaft (see Chapter 9 - 4WD Rear Axle).

4. Remove hydrostatic transmission. (See Repairs section of Chapter 5 - Hydraulic System.)

5. Slightly loosen all front wheel lug nuts. Jack both front wheels off the ground and install jackstands or blocks under traction unit frame (not axle tubes) to prevent machine from falling. Remove both front wheels.

6. Remove extension spring and clevis pin to disconnect brake cable from brake actuating lever on each brake.

7. Remove capscrew securing axle support bracket to top of differential. Loosen nuts securing axle support bracket to frame (Fig. 3A).

8. Put a jack or blocking under differential to hold it in place. Remove capscrews and locknuts securing axle mounting pads to frame. Note number of shims between frame and axle mounting pad, which are used to get correct engine to transmission alignment (Fig. 3B). Carefully lower axle and pull it out from under traction unit.

9. If unit is equipped with 4WD, remove nut (Fig. 3C, Item 20), washer (Item 21) and flange (Item 22) from differential axle pinion (Item 8). Use Differential Gear Holder tool to gears when removing nut.

NOTE: Before installing flange (for 4WD drive shaft), apply Permatex No. 2 to external splines of pinion and internal splines of flange. Tighten lock nut to secure pinion coupler 75 - 90 ft-lb (102 - 122 N-m).

10. To install axle, reverse steps 1 - 9. Leave axle mounting pad nuts loose. Install shims (P/N 42-6080) between axle mounting pads and frame to get correct engine to transmission alignment, then tighten axle mounting nuts.

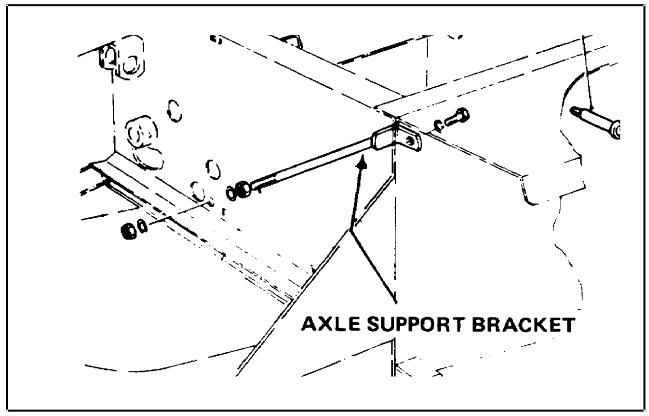


Figure 3A

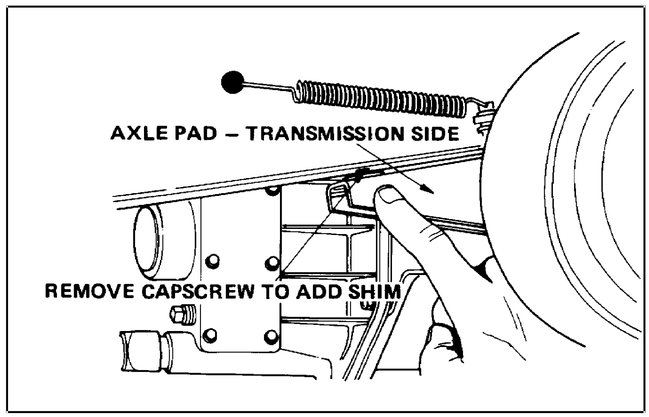


Figure 3B

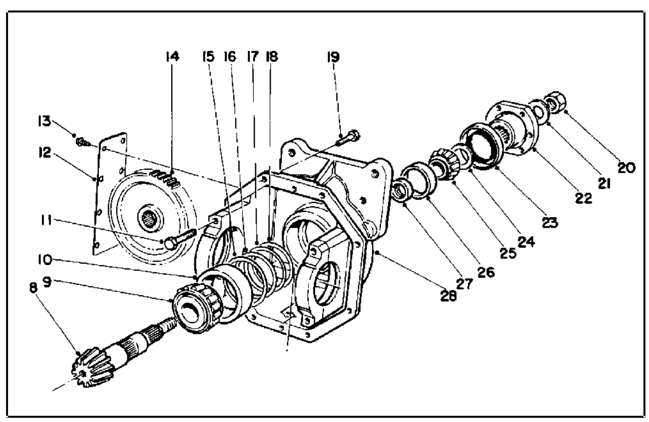


Figure 3C

Axle Shaft Disassembly and Wheel Bearing Service

NOTE: When servicing the bearing and seal area of the axle shaft, it is recommended that you replace hex head screws and flange nuts with socket head screws (94-6934), washers (94-6936) and nuts (94-6935). See Figure 18.

1. After the wheel has been removed, slide the brake drum off of the axle flange (Fig. 5).

NOTE: It may be necessary to loosen the brake shoes by turning the star wheel inside the brake drum assembly. (See Chapter 7 - Steering and Brakes.)

Figure 5

2. Line up the hole in the axle shaft flange and remove the backing plate nuts which hold the axle shaft assembly to the axle housing. Use a 1/2 inch socket wrench (Fig. 6).

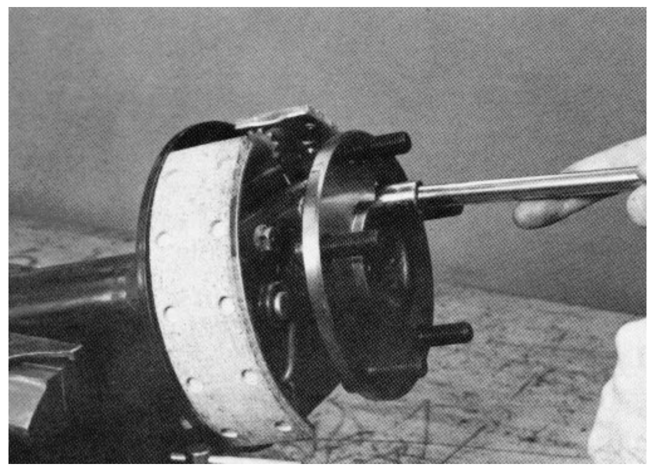


Figure 6

3. Pull out the axle shaft and brake assembly (Fig. 7).

NOTE: Bearing races and retainer ring are cemented together with an epoxy adhesive. If the bearing and race come apart, remove the bearing cup from the housing with a puller.

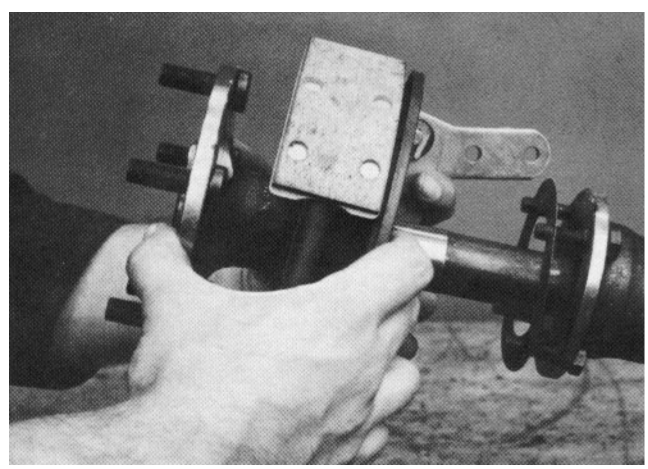


Figure 7

4. Remove the inner axle shaft seal (Fig. 8). Discard the seal and replace with a new one at the time of assembly.

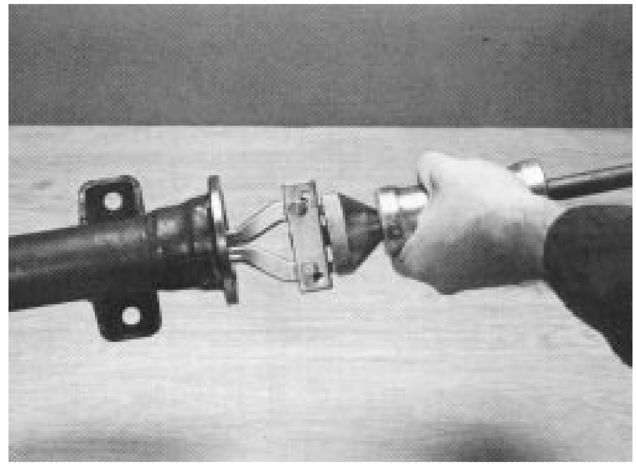


Figure 8

5. Center punch the outside of the retaining ring (Fig. 9).

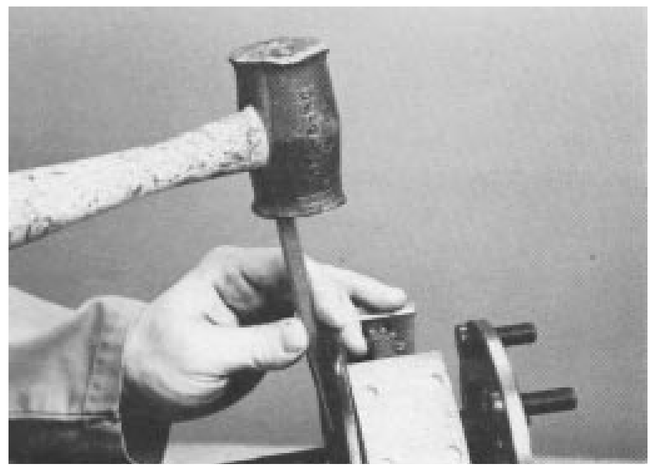


Figure 9

6. Drill a 1/4 inch hole (approximate) into the outside of the retainer ring to a depth of about 3/4 the thickness of the ring (Fig. 10).

IMPORTANT: Drilling completely through the retainer ring could damage the shaft.

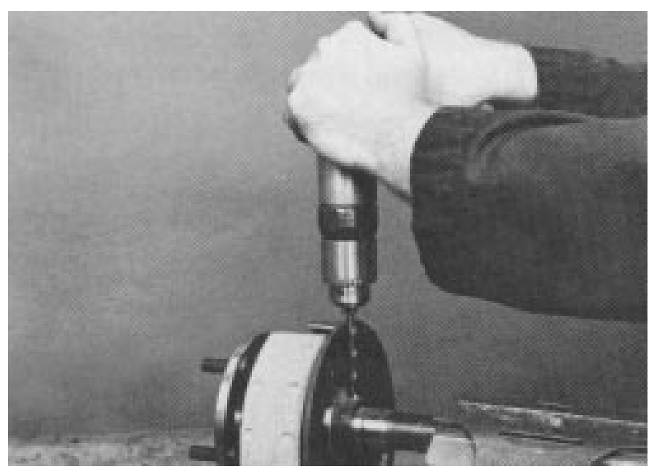


Figure 10

7. After drilling, put a chisel in position across the hole and strike sharply to break the ring. Replace with a new ring at time of reassembly (Fig. 11).

WARNING

Wear protective safety goggles when breaking the retaining ring. Personal injury could result from flying metal particles. Keep all personnel away during this procedure.

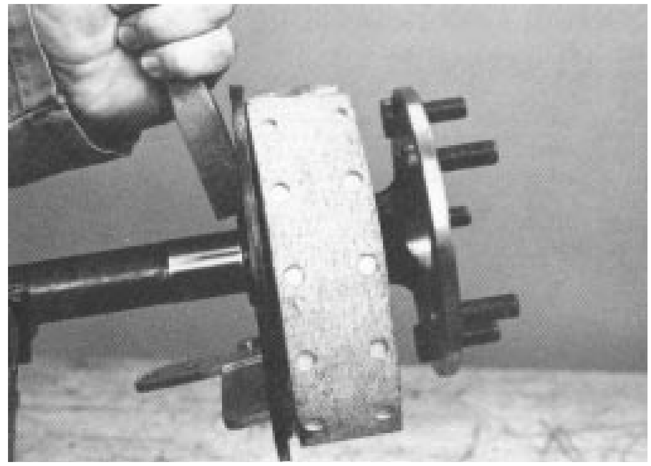


Figure 11

8. Inspect the shaft for possible damage (Fig. 12). Inspect the sealing surface of the hub and shaft. Replace it if the seal has grooved the surface more that 1/64 inch (0.4 mm).

9. Put a new grease seal, brake assembly, and a new grease packed bearing (in that order) onto the axle shaft.

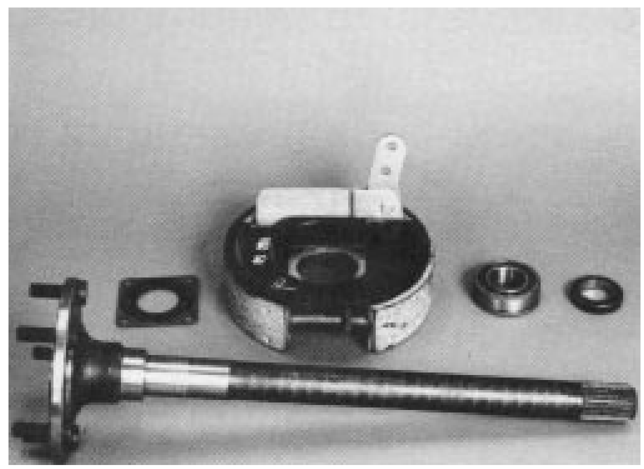


Figure 12

10. Press the assembly until the bearing is firmly seated against the axle shaft shoulder (Fig. 13).

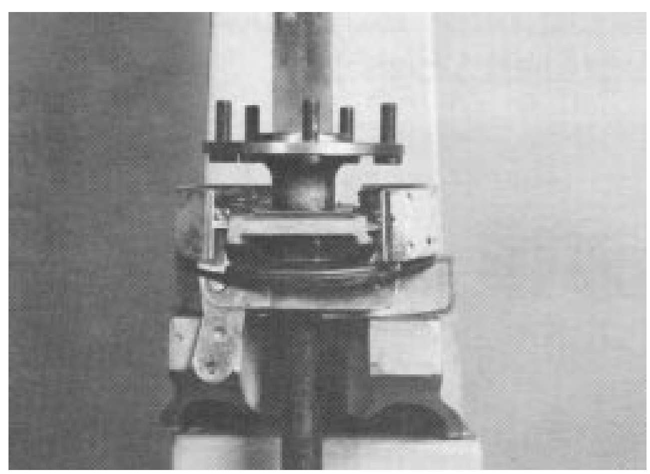


Figure 13

11. Slide a new retaining ring on the axle shaft and support the shaft and ring in a suitable press (Fig. 14). Press the retaining ring firmly against the bearing.

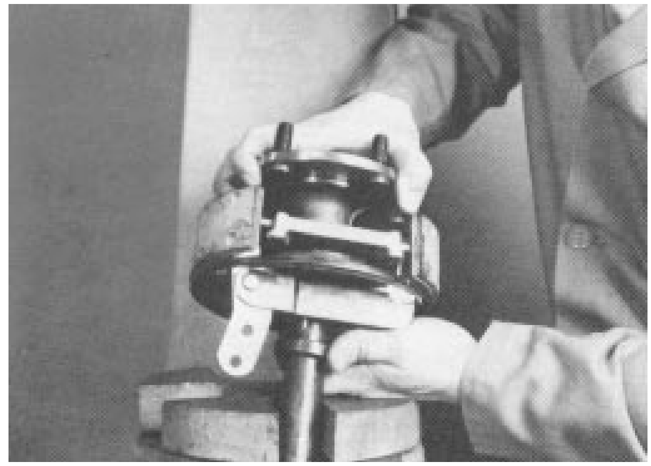


Figure 14

12. Put a light coating of No. 1 Permatex on the outside diameter of a new grease seal (surface that contacts the axle housing). Install the new seal to a depth of 1.218 in. into the housing (Fig. 15, 16). After the seal has been assembled, put grease on the lip of the seal.

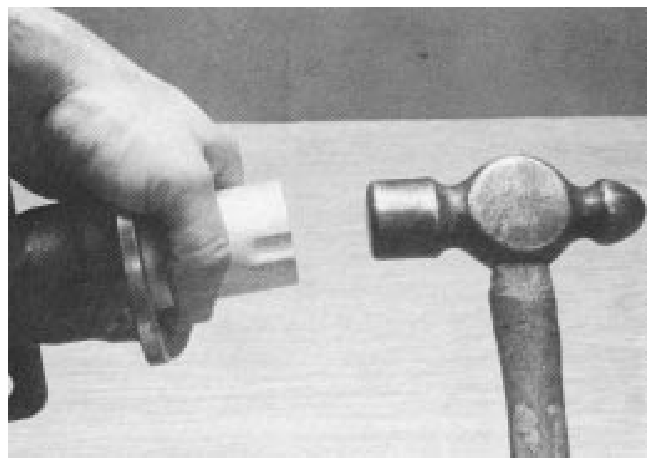


Figure 15

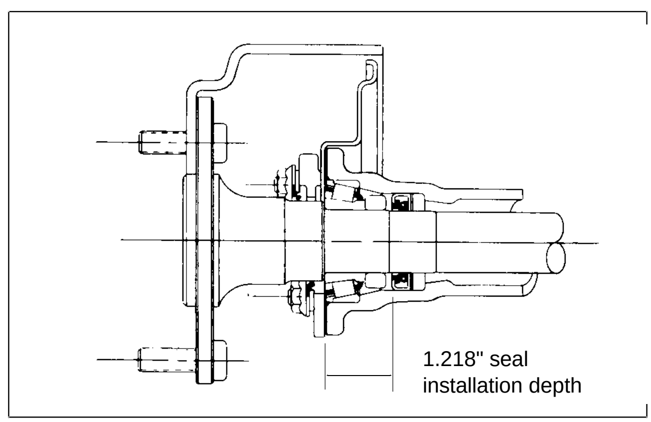


Figure 16

13. Assemble the bearing retainer bolts to the axle housing. Apply a 0.625 in. (16 mm) bead of gasket material to flange on end of axle housing, then install the axle shaft assembly into the axle housing. Be careful not to damage the oil seal and bearing. Line up the holes of the brake assembly and oil seal. Push the axle shaft as far as possible into the axle housing (Fig. 17).

Wheel end gasket material: P/N 92-8775 Liquid Gasket Kit (Kit contains Loctite Ultra-Gray gasket eliminator and instructions.

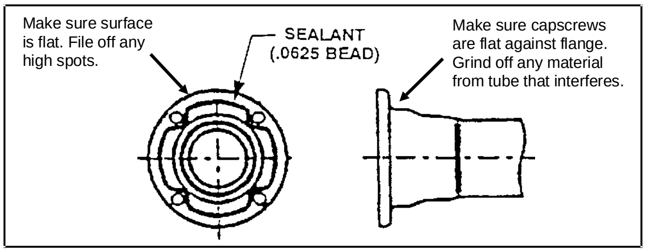


Figure 17

14. Start the nuts by hand. Tighten the nuts so the bearing assembly is drawn evenly into the axle housing (Fig. 18). **NOTE:** It is recommended that you replace hex head screws and flange nuts with socket head screws, washers and nuts (Fig. 18). If installing socket head screws, tighten the nuts to a torque of 16 - 20 ft.-lb. (2 - 3 Kgm). If reinstalling hex head screws, tighten the nuts to a torque of 37 - 45 ft.-lb. (5 - 6 Kgm).

IMPORTANT: Hold the socket head screw or hex head screw when tightening the nut to prevent the head from turning into the tube radius.

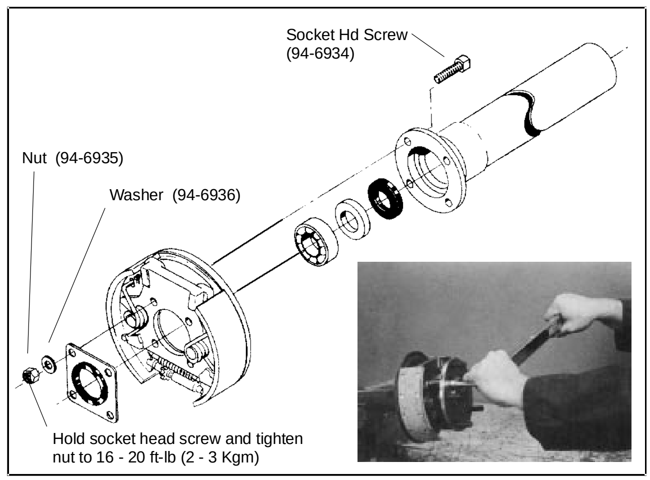


Figure 18

Differential and Housing Disassembly

1. Remove the right and left-hand axle assemblies. (See Axle Shaft Disassembly and Wheel Bearing Service in this section of the book.)

Remove the eight (8) housing cap screws and separate the upper and lower axle housings (Fig. 19). Clean the gasket material from the mating surfaces before reassembly.

NOTE: A complete Upper Housing Assembly for Differential repairs is available. Using this assembly eliminates the need for “trial and error” shimming procedures to establish the correct contact pattern between ring and pinion gears.

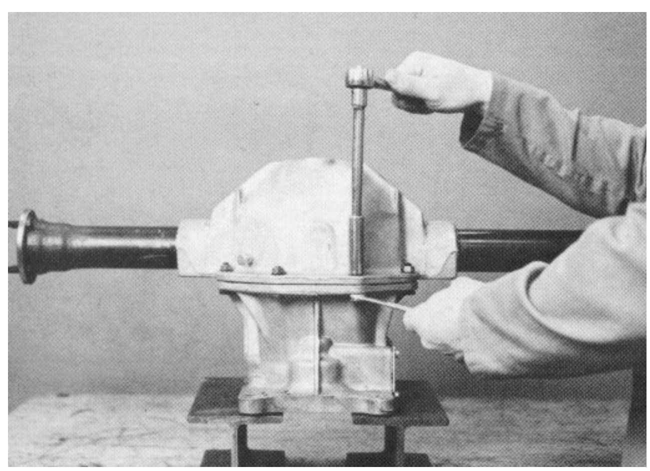


Figure 19

2. Remove the four bearing cap screws and remove the caps. Place the caps in a safe place to avoid damaging their machined surfaces (Fig. 20).

The bearing caps are marked for identification. The letters or numbers are in horizontal and vertical positions. When reassembling, place them back in the same position.

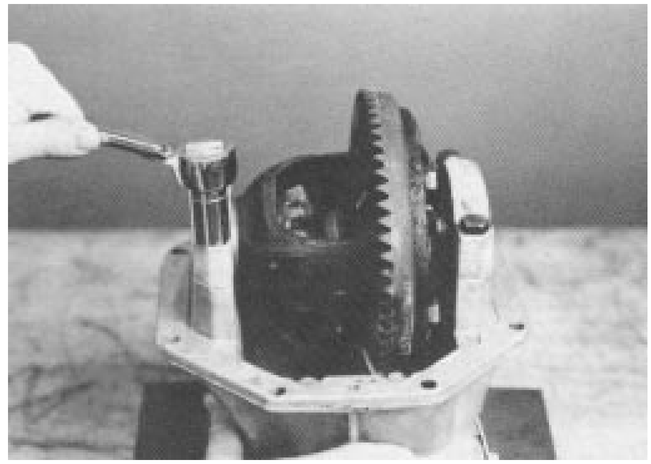


Figure 20

3. To remove the differential assembly, place two wooden devices (i.e. hammer handles) under the differential case and pry firmly upward. The bearing cups must be kept with their mating cones (Fig. 21).

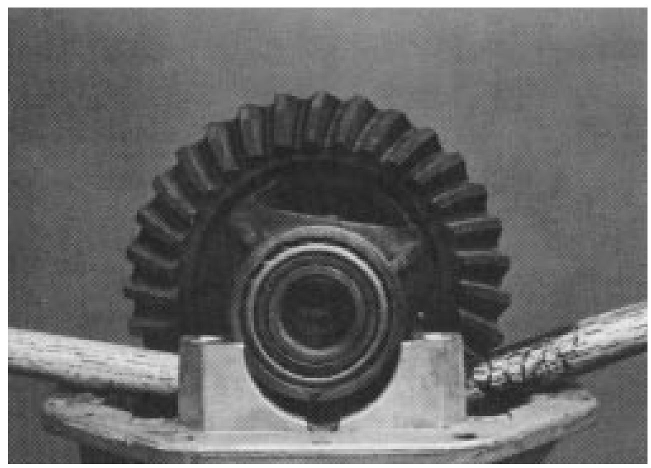


Figure 21

4. Remove the ring gear cap screws. Using a hard wooden block and a hammer, drive the ring gear off of the differential case. Be prepared to protect the ring gear when removing it from the differential case; this will avoid damage of the ring gear teeth (Fig. 22).

NOTE: It is recommended that whenever the ring gear screws are removed, they are to be replaced with new screws.

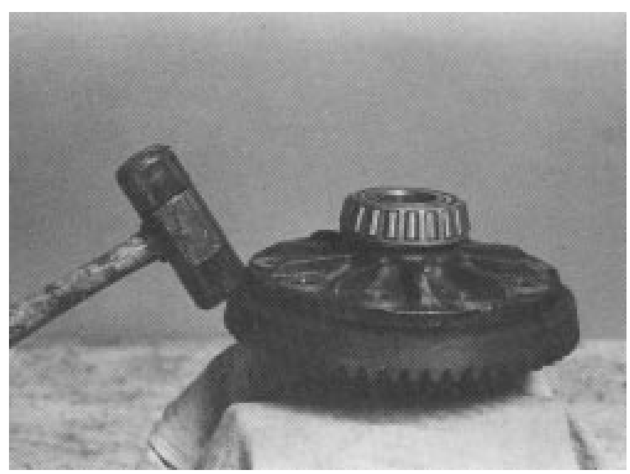


Figure 22

5. Do not remove the bearings from the differential case unless bearing failure is evident. It is recommended that whenever bearings are removed (regardless of usage) they must be replaced with new ones. Remove the case side bearing with a puller as shown (Fig. 23).

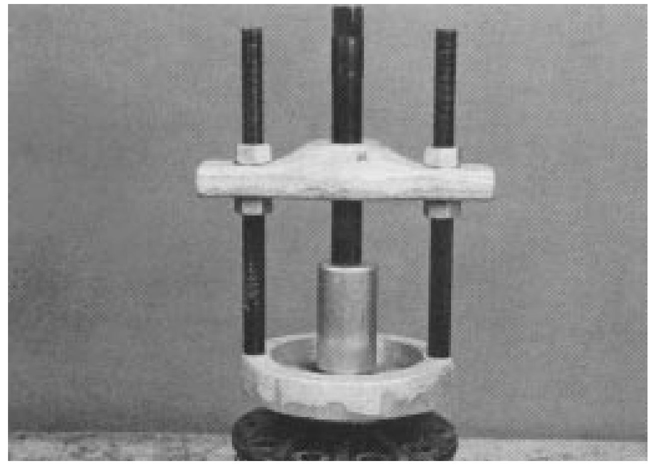


Figure 23

6. Put the case in a vise. Drive the lock pin out of the pinion shaft (Fig. 24). Use a small drift punch as shown.

WARNING

To prevent personal injury, always wear a face shield or safety goggles when striking a drift punch with a hammer.

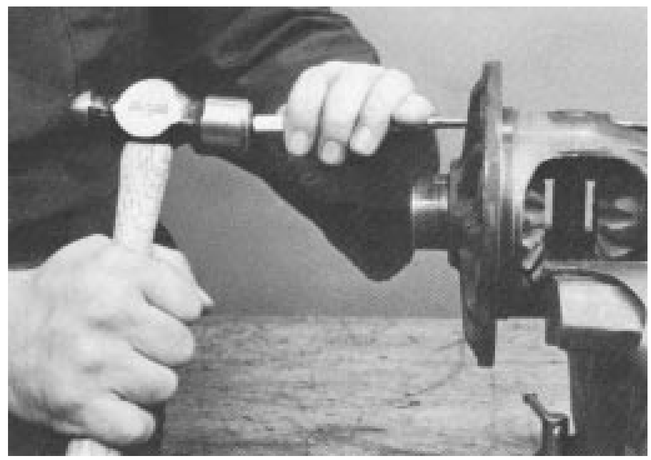


Figure 24

7. While supporting the differential in a vise, drive the pinion mate shaft from the differential with a long drift punch (Fig. 25).

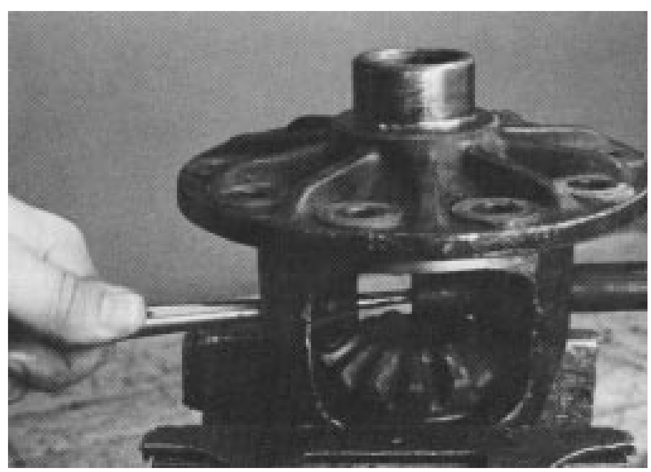


Figure 25

8. To remove the side gears and pinion mate gears, rotate the side gears. This will allow the pinion mate gears to turn to the opening of the case (Fig. 26). Remove the pinion mate gears and the spherical washers behind the gears.

Figure 26

9. Remove the eight side cover capscrews. Remove the the side cover from the carrier assembly (Fig. 27). Clean the gasket material from the mating surfaces before reassembly.

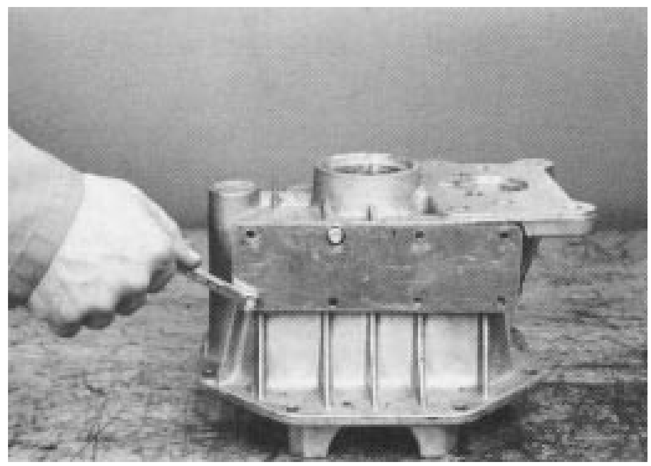


Figure 27

10. If unit has an expansion plug, remove it by driving a pointed punch through the plug about 3/8 inch (10 mm) from the outer edge. When the hole is large enough, insert a large screwdriver through it and pry the plug outward (Fig. 28).

Figure 28

11. Before pressing pinion out of housing:

If unit was equipped with an expansion plug (removed in step 10), remove the snap ring and shim from the end of the pinion (Fig. 29).

If unit is equipped with a flange for 4WD (no expansion plug), nut, washer and flange (Fig. 3C) must be removed before pressing pinion out of housing.

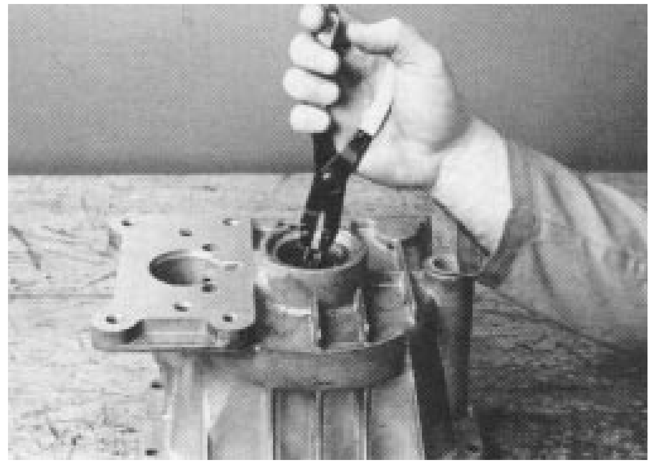


Figure 29

12. Position the housing assembly on a suitable press. Place a 1/8 inch (3 mm) piece of steel or a screwdriver blade under the edge of the spur gear. This will prevent the spur gear from cocking and possibly cracking the housing (Fig. 30).

When the pinion is close to being pressed completely out of the bearing, reach under the housing and catch the pinion in your hand to prevent any damage to the pinion.

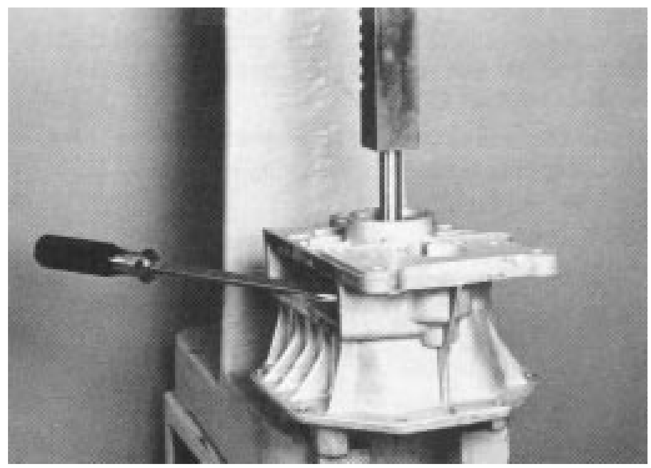


Figure 30

Removing the drive pinion releases the spur gear, spacer, and outer pinion bearing for removal (Fig. 31).

If unit was equipped with a flange for 4WD (no expansion plug), remove oil seal from housing (Fig. 3C).

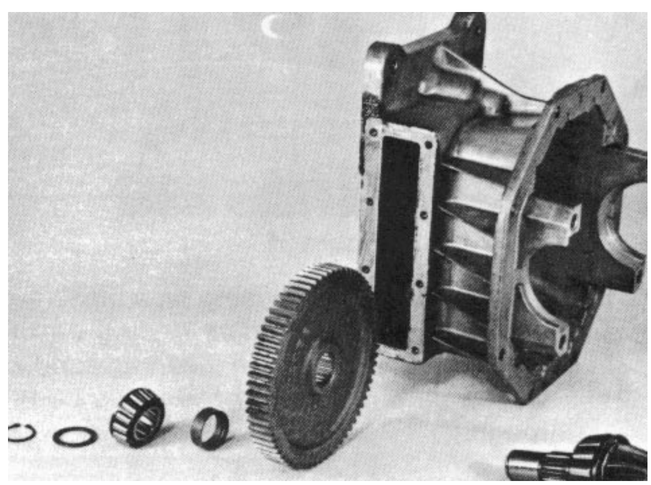


Figure 31

13. Clamp the inner pinion bearing with a universal bearing remover (Fig. 32). Position the unit in a press and carefully push the drive pinion out of the bearing.

DO NOT allow the pinion to drop on the floor - damage will result.

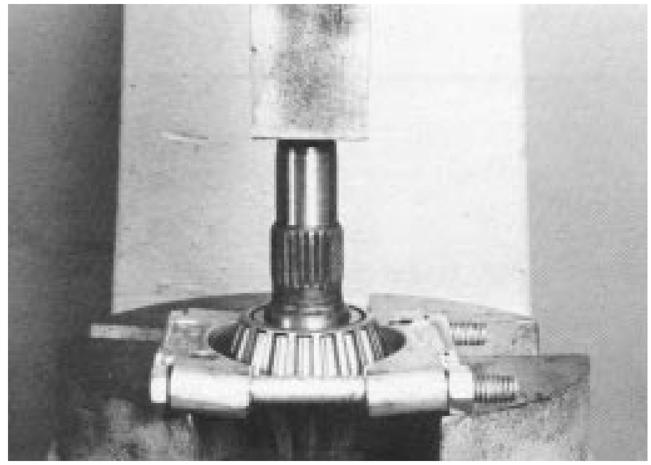


Figure 32

14. To remove the outer pinion bearing cup, position the housing in a press. Place a press plate of the proper size against the cup. Press the cup out of the housing (Fig. 33).

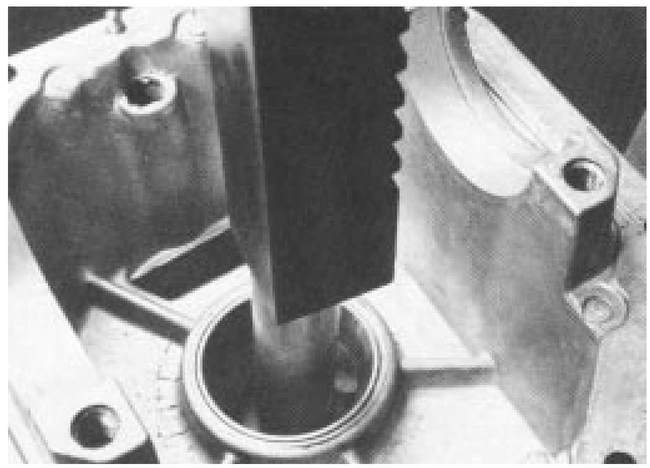


Figure 33

15. Position the front housing on a press bed with the bearing saddles resting on the press bed. Protect the bearing saddles with a strip of wood if the press bed is rough.

Insert a press plate of the proper size and press the bearing cup toward the inside of the housing. Retain the shims located under the bearing cup (Fig. 34). If the shims are damaged, replace with new shims of the same thickness.

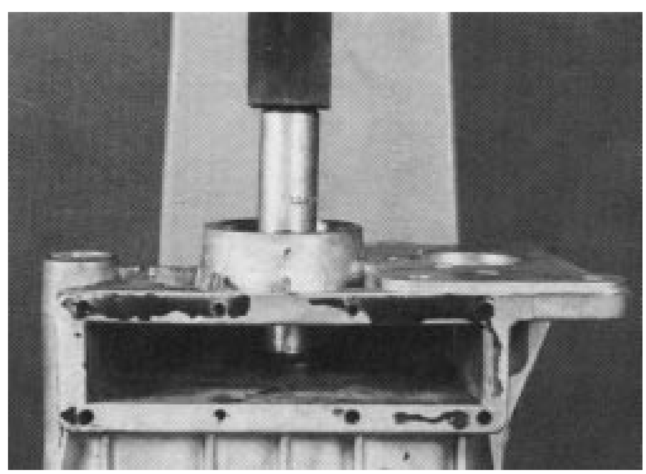


Figure 34

Differential and Housing Reassembly

1. Inspect the differential parts for damage before assembling.

A. If any bearings are damaged they must be replaced with new ones.

B. Check the ring, pinion, and spur gear for abnormal wear and damage; replace worn components.

C. Inspect the housings for cracks and external damage that could affect the operation of the axle assembly.

D. Inspect the differential case for wear in the side gear and pinion mate area. Replace the case if its machined areas are scored or if the pinion mate shaft fits loosely in the bore.

2. Press the inner pinion bearing onto the pinion drive gear. Support the bearing on the inner cup of the bearing ONLY WHEN INSTALLING (Fig. 35).

3. Put the front housing on a press. Using a press plate, push the outer pinion bearing cup into the housing until it bottoms in the housing (Fig. 36).

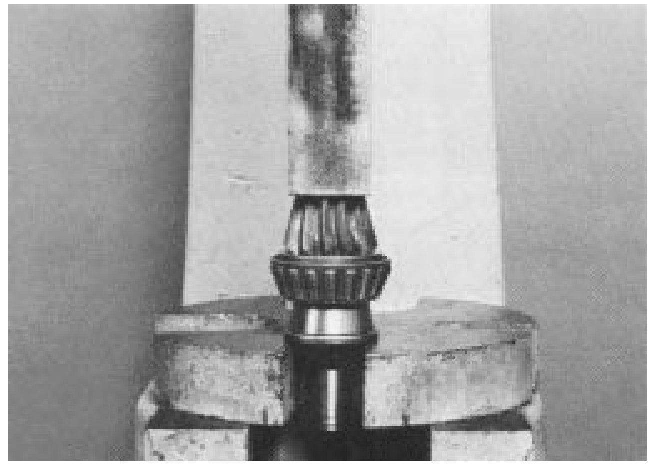


Figure 35

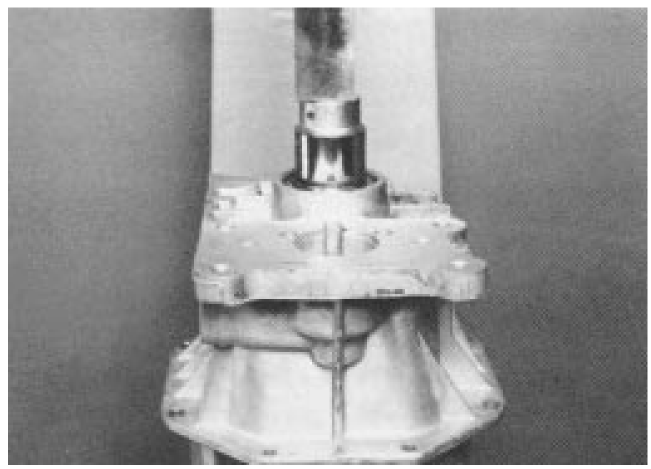


Figure 36

Ring and Pinion Set

Rings gears and pinions are supplied in matched sets only. Matching numbers are etched on both the pinion and ring gear (Fig. 37).

The mounting distance from the bottom of the differential bearing bores to the button end of the pinion is 1.210 in.

On the button end of each pinion there is a plus (+) or minus (–) number, or a (0) number. This number indicates the best running position for each particular gear set. This dimension is controlled by the shimming behind the inner bearing cup.

For example, if a pinion is etched +3, this pinion would require 0.003 in. less than a pinion etched “0". This means that by removing shims, the mounting distance of the pinion is increased to 1.213 in., which is just what +3 indicates. Or if a pinion is etched –3, we would want to add 0.003 in. shims, the mounting distance of the the pinion was decreased to 1.207 in., which is just what a –3 etching indicates.

If a new gear set is being used, notice the (+) or (–) etching on both the old and new pinion and adjust the thickness of the new shim pack to compensate for the difference of these two numbers.

For example: If the old pinion reads +2 and the new pinion is –2, add .004 in. shims to the original shim pack.

Figure 37

4. Install a new inner bearing cup using a press plate of proper diameter. Reuse the original shims or use new shims of the same thickness. Push the bearing cup into the housing until it bottoms against the housing (Fig. 38).

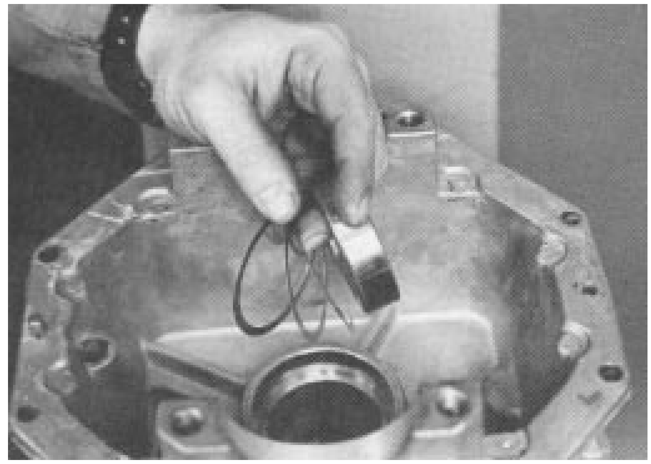


Figure 38

5. Insert the pinion into the housing.

NOTE: A number marked on the new ring and pinion set is used to establish the proper amount of shims required prior to installing the pinion gear (see page 15). The final pinion position will be verified by using the gear contact pattern method as described on page 21of this chapter.

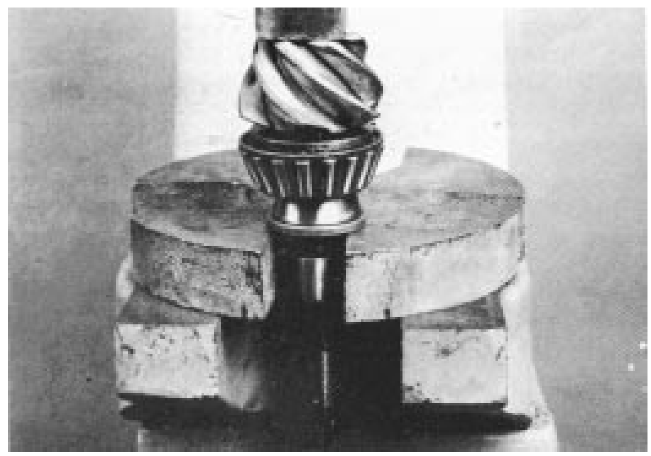


Figure 39

6. Insert the spur gear into the front housing with the chamfered area of the center spline toward the drive pinion. Install the drive pinion with a soft mallet to engage the splines in the spur gear (Fig. 40).

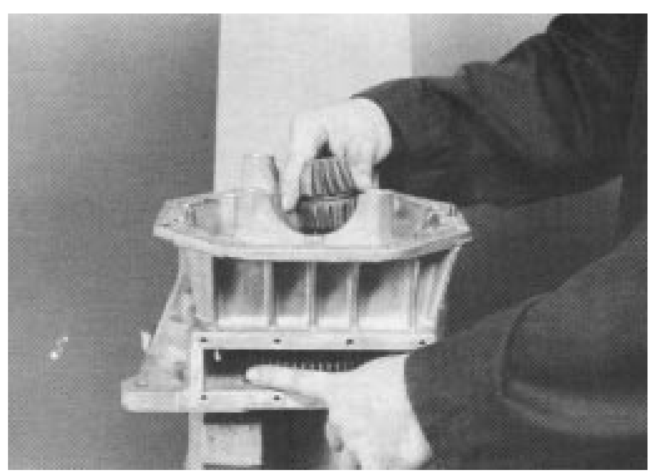


Figure 40

7. Support the drive pinion in a suitable press (Fig. 41).

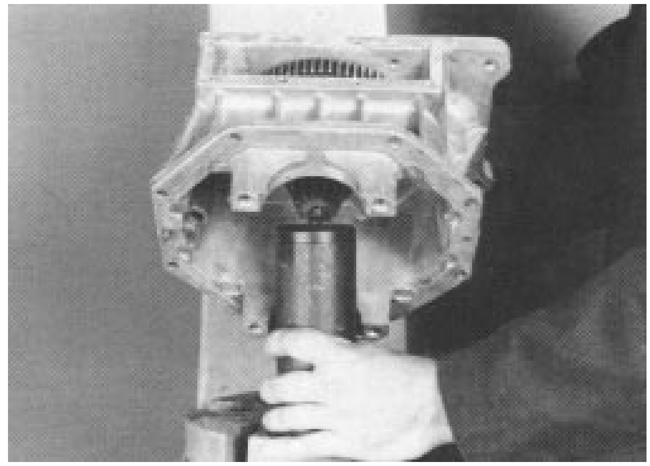


Figure 41

8. Install the outer pinion spacer with the chamfer towards the pinion splines and install the new outer pinion bearing cone (Fig. 42).

Figure 42

9. With a hollow press sleeve of proper diameter, press on the outer bearing cone race until the drive pinion seats in the carrier and a slight drag is noticed when the gear is rotated by hand (2-13 in.-lb. torque to rotate) (Fig. 43). If the drag is to severe, tap the pinion shaft with a soft mallet until the drag is reduced.

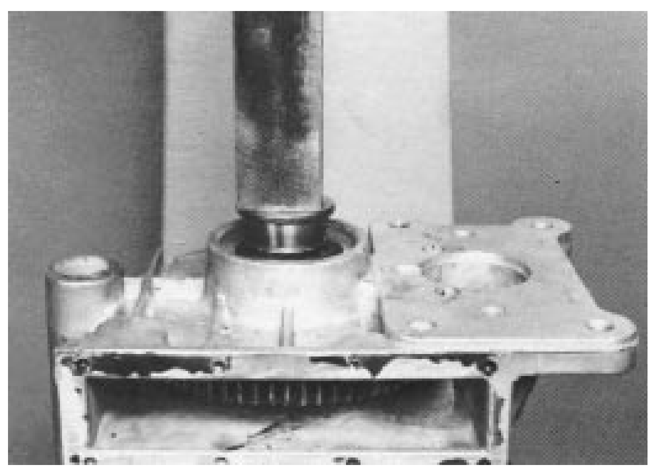


Figure 43

10. Install the shim and snap ring onto the end of the pinion shaft. Use the thickest shim possible which will permit installation of the snap ring (Fig. 44). Limit the end play to 0.000 - 0.005 inch (0.000 - 0.127 mm).

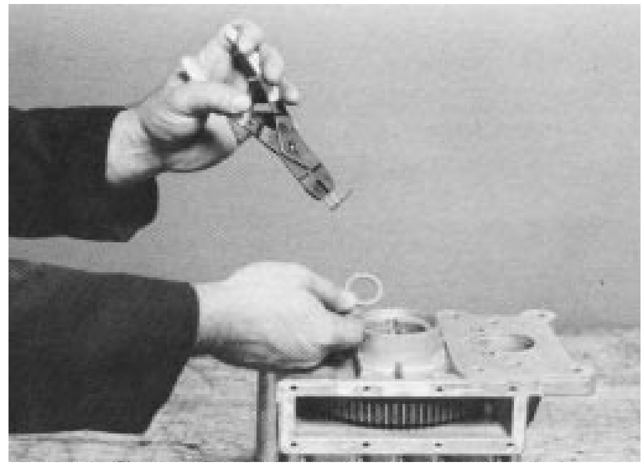


Figure 44

11. Apply a small bead of Permatex No. 2 or silicone sealant to the outer edge of the carrier bore. Install the expansion plug (or seal if equipped with flange for 4WD) into carrier until plug or seal seats firmly in carrier bore (Fig. 45).

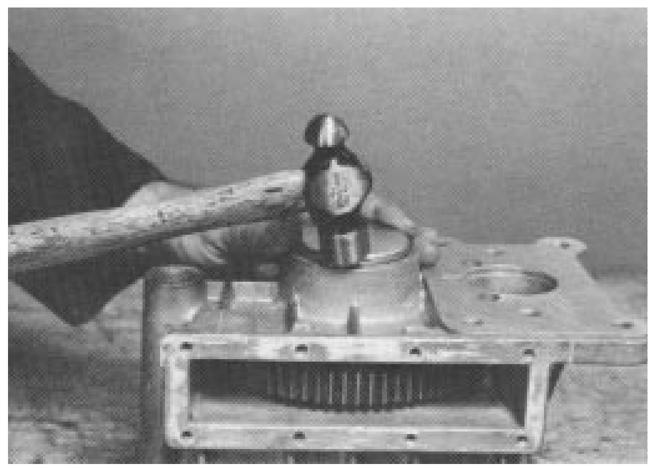


Figure 45

12. Install the spur gear cover. Use Permatex No. 2 or silicone sealant when installing the cover. Tighten the capscrews to a torque of 25 - 40 in.-lb. (Fig. 46).

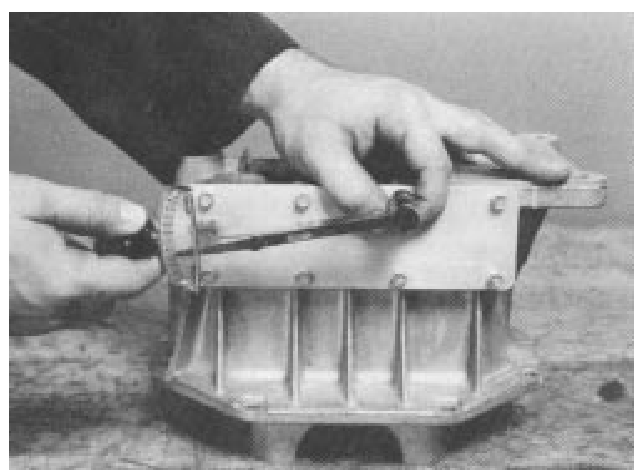


Figure 46

13. Place the differential case in a vise as shown (Fig. 47). Apply grease to new side gear thrust washers and hubs of the side gears. Apply grease to new pinion mate spherical washers and pinion mate gears. Place the side gears and thrust washers in the case. Install the pinion gears while holding the side gears in place.

Rotate the side gears until the holes of the washers and pinion gears line up with the holes of the case. If the gears cannot be rotated by hand, install one of the axle shafts into the side gear spline and use a pipe wrench to turn the shafts.

Figure 47

14. Install the pinion shaft. Grease the shaft to aid assembly. Be sure the hole in the pinion shaft lines up with the hole in the differential case (Fig. 48).

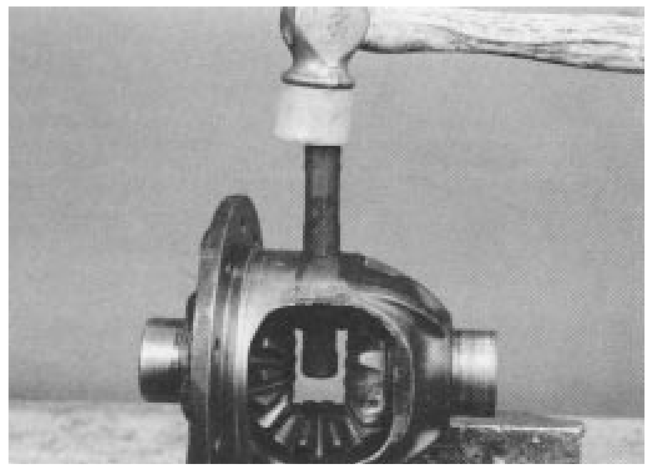


Figure 48

15. Assemble the lock pin. Drive the pin to the approximate center location of the pinion mate shaft. Peen the metal of the case to lock the pin in place (Fig. 49).

Figure 49

16. Put the ring gear onto the differential case and start the new capscrews into the gear with your fingers. Tighten the screws, alternating back and forth across the gear to allow the gear to be pulled evenly into place. Tighten the cap screws to a torque of 45 - 65 ft-lb (6.2 - 9.0 KgM) (Fig. 50).

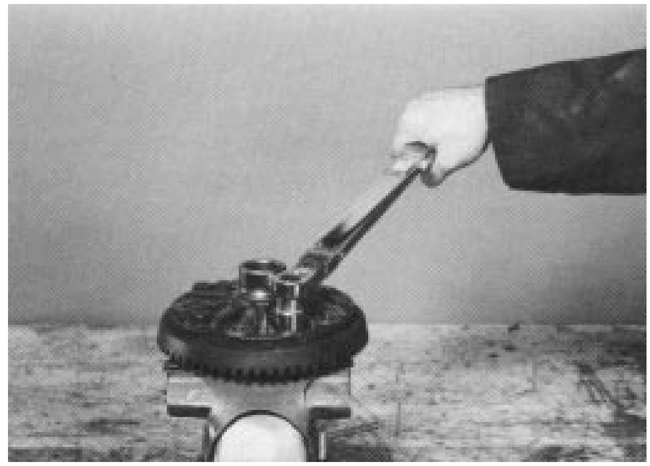


Figure 50

17. When installing new differential bearings, reuse the original shims or use new shims of the same thickness. Press the bearing onto the differential case. If a new differential case is being installed, start with a .020 inch pack of shims under each differential bearing. Shims are available in .003, .005, .010, and .030 inch sizes (Fig. 51).

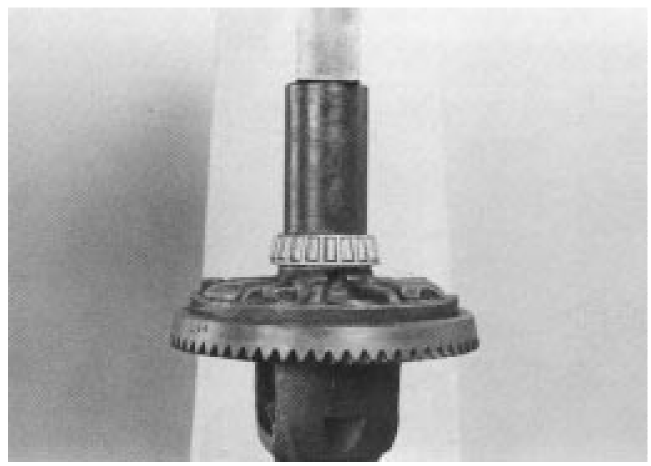


Figure 51

18. Assemble new differential bearing cups to differential bearing cones. Seat differential assembly with drive gear on proper side of carrier into carrier bearing cradles.

NOTE: Groundsmaster 300 Series (S/N 90001 & up) require that the ring gear teeth face toward the spur gear cover.

The bearing cradles are designed to apply a slight preload to the bearings. It is important to push both of the bearing assemblies simultaneously into their saddles.

Bearing caps must be installed with indexing marks “P” adjacent to indexing marks “P” in case. Install the bearing caps into their original position as previously marked. Tighten the cap screws to a torque of 30 - 45 ft-lb (4.1-6.2 KgM) (Fig. 52).

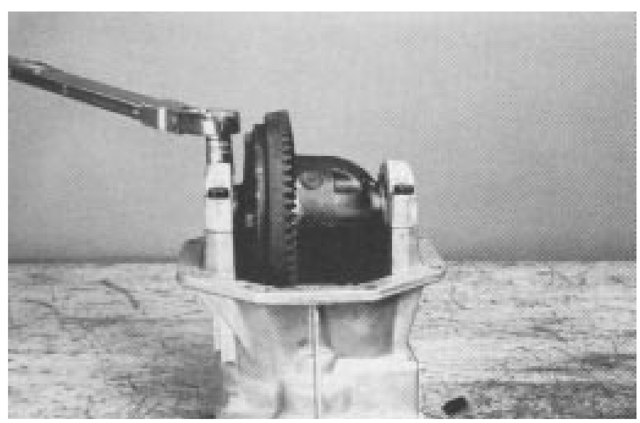


Figure 52

19. Using a dial indicator, check the ring gear backlash in three equally spaced points. Ring gear backlash should be .003 - .007 inch (.076 - .178 mm) and must not vary more than .002 in. between points checked (Fig. 53).

If the backlash is not in this range, move the shims which are located beneath the differential bearings, from one side to the other until the correct backlash is attained.

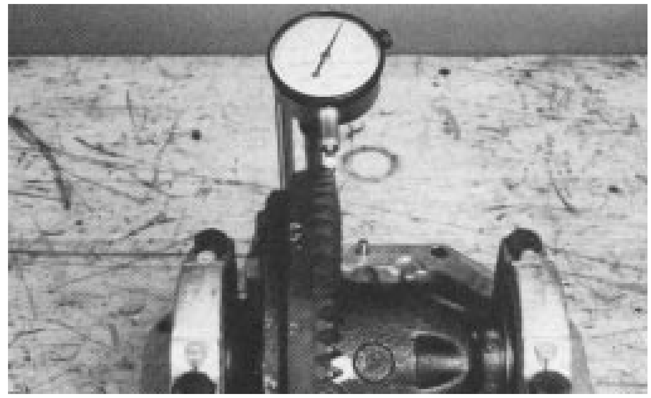


Figure 53

Checking Ring Gear Pattern

Final position of pinion is verified by using the gear contact pattern method as described in the following procedure.

Gear tooth **Toe** - the portion of the tooth surface at the end towards the center.
Gear tooth **Heel** - the portion of the gear tooth at the outer end.
Gear tooth **Top Land** - top surface of tooth.

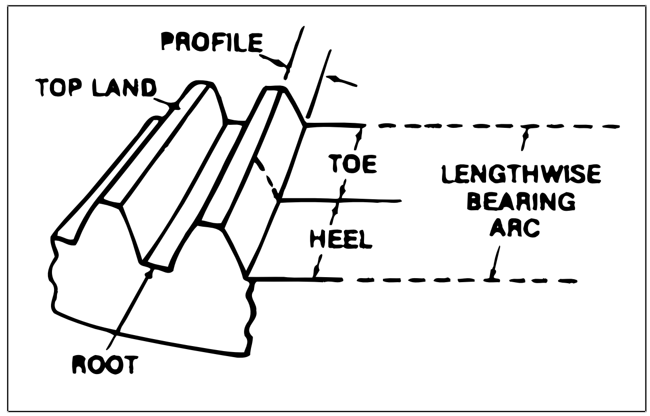


Figure 54

Every gear has a characterisitc pattern. The illustrations show typical patterns only and explaing how patterns shift as gear location is changed. When making pinion position changes, shims should be changed in the range of .002 inch to .004 inch until a correct pattern has been obtained.

When a change in backlash is required, backlash shims should be changed in the range of 1-1/2 times the amount of backlash required to bring the gears into specification. For example, if the backlash needed to be changed by .004 inch, the shim pack should be changed by .006 inch as a starting point.

High backlash is corrected by moving the ring gear closer to the pinion. Low backlash is corrected by moving the ring gear away from the pinion. These corrections are made by switching shims from one side of the differential case to the other.

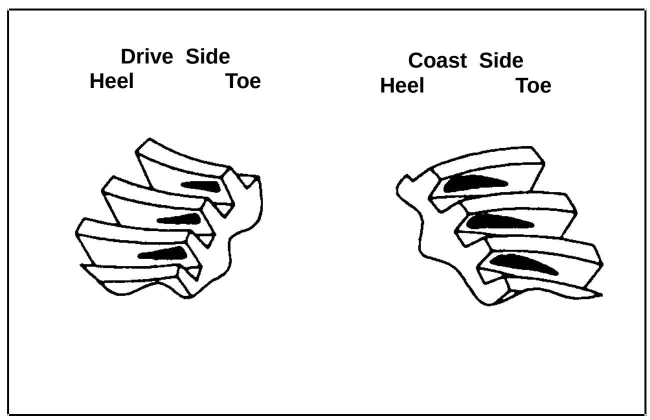


Figure 54A

To check the ring gear and pinion pattern:

1. Paint the teeth of the ring gear, both drive and coast side, with a gear marking compound, such as DyKem Steel Blue.

2. While applying a light load to the ring gear, rotate the pinion gear until the ring gear has made one complete revolution. Study the patterns in the following illustrations and correct as necessary.

The preferred pattern is shown in Figure 54A. The drive side pattern should be located at the toe portion of the tooth. The coast pattern should also be at the toe portion of the tooth.

NOTE: When making changes, note that two variables are involved. Example: If you have the backlash set correctly to specifications and you change the pinion position shim, you may have to readjust backlash to the correct specification before checking the pattern.

Backlash correct. Thicker pinion position shims required.

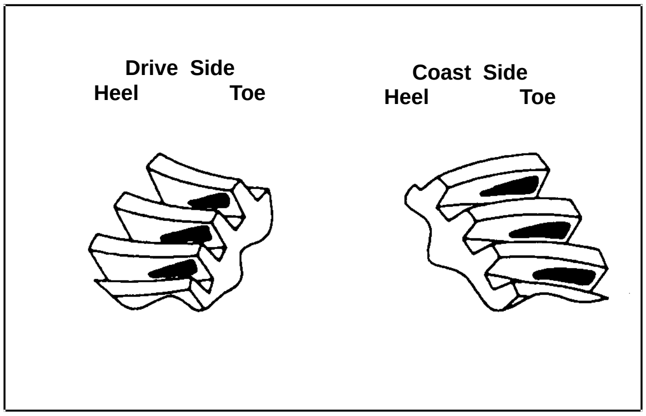


Figure 55

Backlash correct. Thinner pinion position shims required.

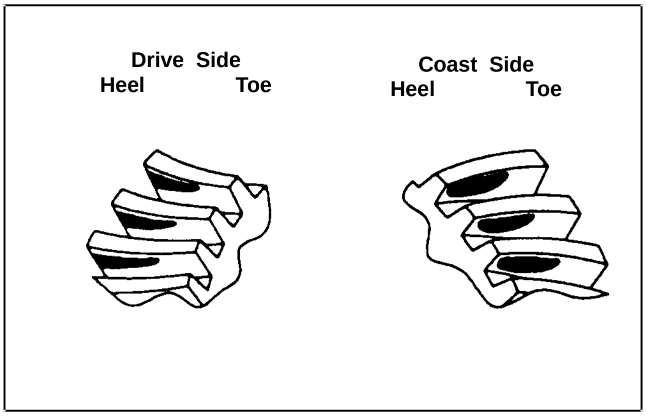


Figure 56

Backlash incorrect. Thinner pinion position shim required. Adjust backlash to match.

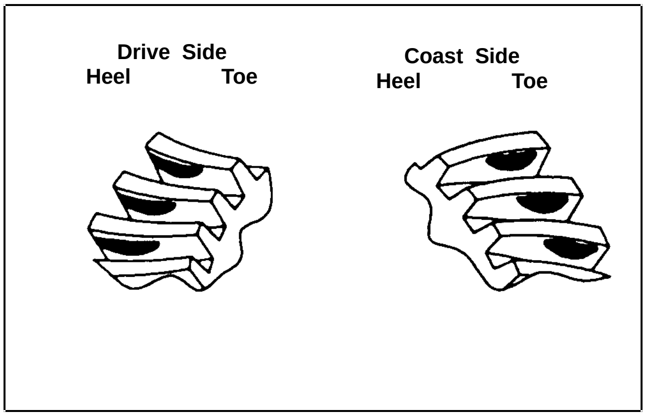


Figure 57

Gear Pattern Movements Summary

1. Decreasing backlash moves the ring gear closer to the pinion.

Drive pattern (convex side of gear) moves lower and toward the toe.

Coast pattern (concave side of gear) moves slightly higher and toward the heel.

2. Increasing backlash moves the ring gear away from the pinion.

Drive pattern moves higher and toward the heel.

Coast pattern moves slightely lower and toward the toe.

3. Thicker pinion position shim with the backlash constant moves the pinion closer to the ring gear.

Drive pattern moves deeper on the tooth (flank contact) and slightly toward the toe.

Coast pattern moves deeper on the tooth and toward the heel.

4. Thinner pinion position shim with backlash constant moves the pinion further from the ring gear.

Drive pattern moves toward the top of the tooth (face contact) and toward the heel.

Coast pattern moves toward the top of the tooth (face contact) and toward the heel.

Apply silicone sealant between the front and rear axle housings and install the eight housing cap screws. Tighten the cap screws to a torque of 18 - 23 ft-lb (2.5 - 3.2 KgM) (Fig. 58).

Figure 58

Chapter 8

Steering and Brakes

Table of Contents

INTRODUCTION 2
SCHEMATICS 3
SPECIFICATIONS 4
SPECIAL TOOLS 4
TROUBLESHOOTING 5
TESTING 7
  Steering Valve and Pump Tests 7
  Steering Cylinder Internal Leakage Test 8
ADJUSTMENTS 9
  Rear Wheel Toe-In Adjustment 9
  Brake Adjustment 10
REPAIRS 11
  Steering Wheel Removal and Installation 11
  Rear Axle Bushing Service 12
  Steering Pivot Bushing Service 12
  Rear Wheel Spindle Bushing Service 14
  Front Wheel Bearing Service. 15
  Rear Wheel Bearing Service 16
  Steering Cylinder Removal and Installation. . . . 18
  Steering Cylinder Service 19
  Brake Shoe Replacement 20
  Steering Valve Removal and Installation 21
  Steering Valve Service 22

Introduction

Power Steering

The Groundsmaster® 300 Series traction units are equipped with power steering. The power steering valve is enclosed in the steering tower at the front of the traction unit. As the steering wheel is turned, the steering valve meters hydraulic fluid to the double-acting steering cylinder on the rear axle and turns the wheels. Hydraulic fluid flow for power steering is supplied by the charge pump on the hydrostatic transmission. The implement/steering hydraulic circuit is designed so priority flow is provided for steering.

The Model HGF Hydraguide™ steering valve (Fig. 1) is manufactured by TRW, Ross Gear Division.

NOTE: Because the steering cylinder has different displacements when extended and retracted, the steering wheel will not return to its original position after making a turn.

NOTE: The steering system will operate with the engine off if necessary (with increased effort).

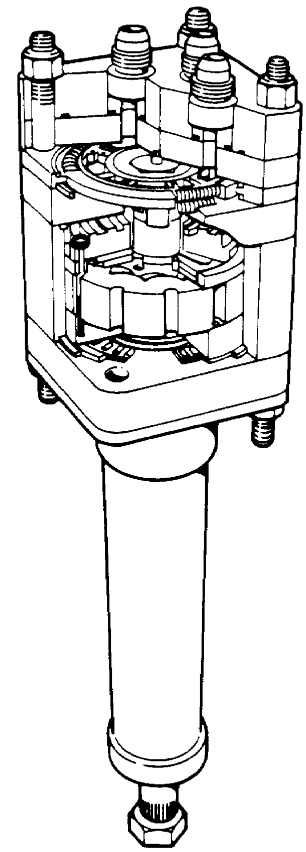


Figure 1

Brakes

The Groundsmaster® 300 Series traction units are equipped with 7 inch diameter x 1-3/4 inch wide mechanical drum brakes on the front wheels.

Two pedals are used to control the brakes. When used separately, the pedals can control each wheel brake to assist steering or traction on side hills. The two pedals may be locked together with the brake lock arm. When the lock arm is engaged both wheels will brake equally and act as a service brake or parking brake.

The brake pedals operate the brakes through a cable system to a strut and lever on the brake shoes.

Power Steering Schematics

When the steering wheel is turned to the right (Fig. 3), the control valve within the steering valve shifts to close the "AUX" port. This directs oil supplied by the steering pump to the metering section of the steering valve. As the steering wheel is turned, system oil is metered out port "RT" to the steering cylinder. Oil displaced by the other end of the steering cylinder returns to the steering valve through port "LT" and is directed out port "OUT" back to reservoir.

NOTE: On 2WD units right turn pressure is supplied to the rod end of the steering cylinder and left turn pressure to the barrel end as shown. On 4WD units these hydraulic lines are reversed (right turn pressure to barrel end and left turn pressure to rod end).

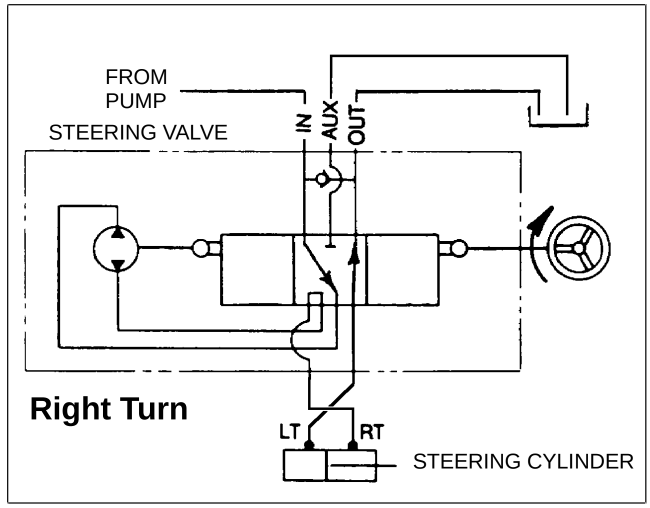


Figure 3

When the steering wheel is stationary, the control valve within the steering valve shifts back to neutral (Fig. 4), allowing system oil to flow through the steering valve and out the "AUX" port back to reservoir. Oil in the rest of the steering circuit is then trapped.

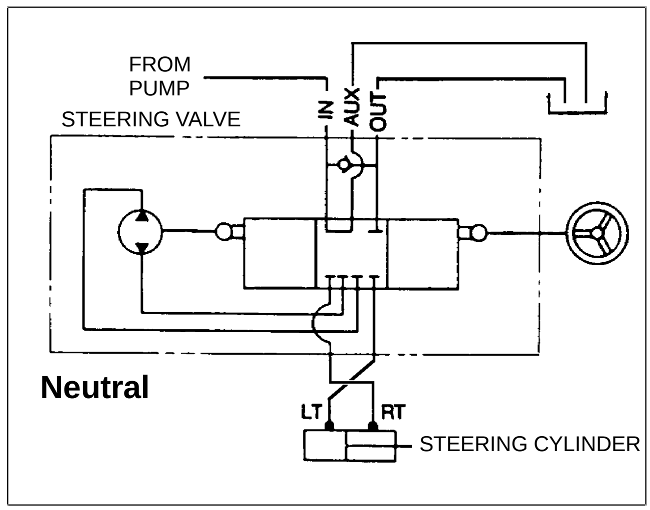


Figure 4

When the steering valve is turned to the left (Fig. 5) oil is metered out port "LT" to the steering cylinder. Oil displaced by the other end of the cylinder returns to the steering valve through port "RT" and is directed out port "OUT" back to reservoir.

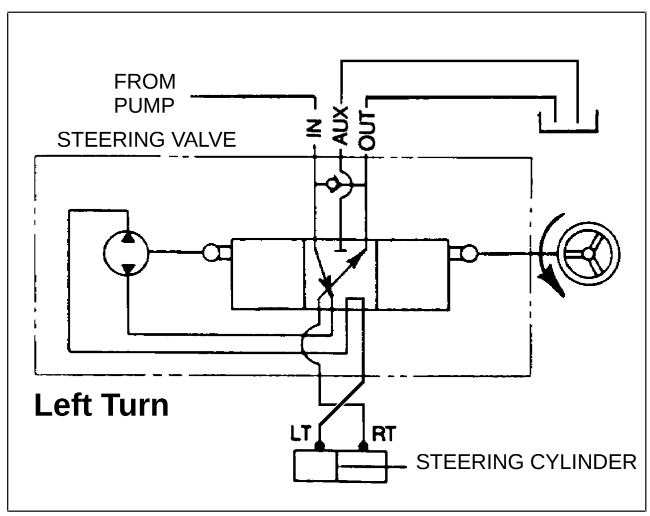


Figure 5

Specifications

Item	Specification
Front wheel lug nut torque	45 to 55 ft-lb
Rear wheel lug nut torque	30 to 35 ft-lb
Steering cylinder bolt torque	130 to 150 ft-lb
Rear wheel toe-in	0 to 1/8 in.
Tire pressure	10 to 15 psi, front and rear
Brake pedal free travel	1/2 to 1 in.

Special Tools

Steering Valve Service Fixture

To avoid distorting or damaging the steering valve when repairing, do not clamp it directly into a vise. Fabricate a service fixture (Fig. 6) and use it as instructed (See Steering Valve Service in the Repairs section of this chapter).

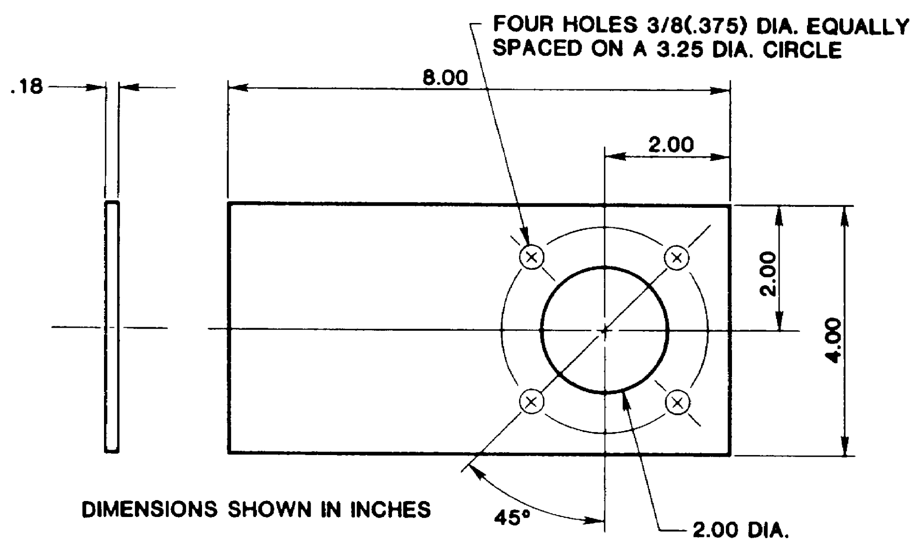


Figure 6

Troubleshooting

Problem	Possible Causes
Steering Wander	Tire pressure incorrect or unequal left to right. Loose or worn steering linkage. Improperly adjusted or worn rear wheel bearings. Rear wheels out of alignment; toe-in / toe-out. Internal leakage of steering cylinder.
Poor or No Returnability (Recovery)	Improper rear wheel alignment; toe-in. Steering linkage binding. Low tire pressure. Steering column binding or out of alignment.
Shimmy	Steering linkage loose, worn or out of adjustment. Wheel bearings out of adjustment. Air in hydraulic system. Internal leakage of steering cylinder.
High Steering Effort in One Direction	Low hydraulic system pressure. Excessive heat causing steering valve plate valve to stick (See Excessive Heat in this section).
High Steering Effort in Both Directions	Cold hydraulic oil or oil viscosity not correct for ambient temperature. Low hydraulic fluid level. Low flow or pressure from hydraulic pump. Steering linkage binding. Restriction in hydraulic return line.

Problem	Possible Causes
Steering Wheel Lash (Free Movement)	Steering wheel loose on column. Steering linkage loose or worn. Steering valve loose at mounting. Air in hydraulic system. Internal leakage in hydraulic cylinder.
Excessive Heat in Hydraulic System	Undersized replacement hose or tube line. Kinked or severely bent hose or tube line. Restricted oil cooler. Restricted recentering of steering valve control valve plate.

Steering Valve Test (Control Valve Section)

Using Hydraulic Tester With Flow Meter

1. Engage the parking brake and block the front wheels to prevent movement of the machine. Lower the cutting unit or implement to the floor and turn the engine OFF.

2. Disconnect the hydraulic hose at the charge pump outlet (pressure) fitting.

3. Connect the inlet hose of the tester to the hydraulic fitting on the transmission and the outlet hose of the tester to hose that was disconnected in step 2.

IMPORTANT: Make sure that the oil flow indicator arrow on the flow gauge is showing that the oil will flow through the tester from the charge pump to the steering valve.

4. Make sure that the tester load valve is fully open (counterclockwise). Start the engine and allow it to run for approximately 5 minutes so that the hydraulic oil reaches normal operating temperature.

5. With the tester load valve fully open (counterclockwise) run the engine at full throttle.

6. Turn the steering wheel all the way to the right (clockwise) and hold it against the right stop. Look at the flow meter. There should be no flow as the steering wheel is held against the right stop. Flow should be approximately 3 gpm when the steering wheel is released. Repeat this procedure with the steering wheel all the way to the left (counterclockwise). If flow does not return to approximately 3 gpm when the steering wheel is released the control valve within the steering valve may be sticking.

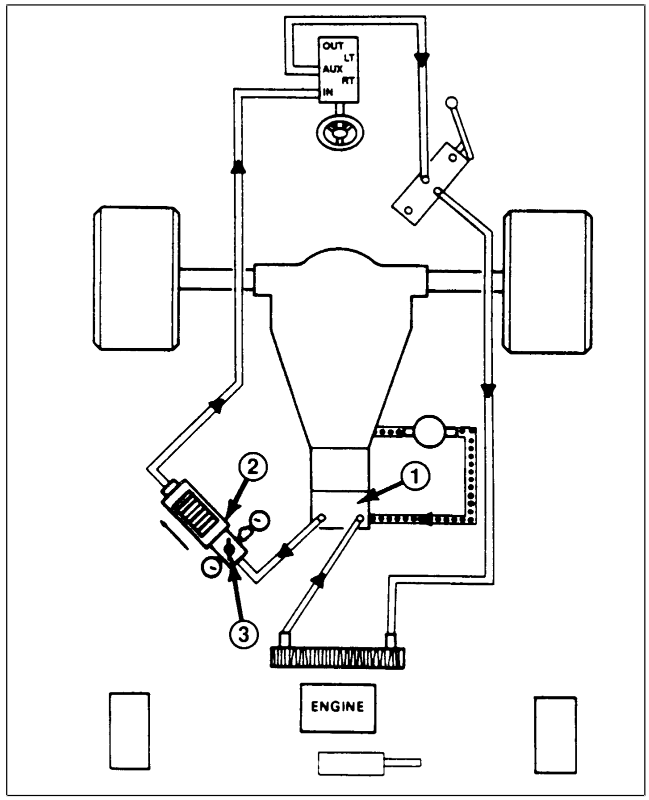


Figure 7

1. Transmission
2. Tester
3. Load valve

If a Hydraulic Tester is Not Available:

1. Engage the parking brake.

2. Run the engine at full throttle.

3. Turn the steering wheel all the way to the right (clockwise) and hold it against the stop. Pull the lift control lever back to raise the implement while holding the steering wheel against the stop. The implement should NOT raise until the steering wheel is released. Repeat this procedure with the steering wheel turned all the way to the left (counterclockwise). If the implement raises slowly, or not at all when the steering wheel is released, the control valve within the steering valve may by sticking. When turning the steering wheel, the wheels must move from stop to stop. The wheels must move smoothly in both directions.

Steering Cylinder Internal Leakage Test

1. Engage the parking brake, and lower the cutting unit to the floor.

2. Turn the steering wheel all the way to the left (counterclockwise) on a 2WD machine or to the right (clockwise) on a 4WD machine, so the steering cylinder rod is extended all the way.

3. Turn the engine OFF.

4. Disconnect the hydraulic hose from the fitting on the rod end of the cylinder. Put a plug in the end of the hose to prevent contamination.

5. With the engine OFF, continue turning the steering wheel to the left (counterclockwise) with the cylinder rod completely extended and observe the open fitting on the steering cylinder. If oil comes out of the fitting while turning the steering wheel to the left, the steering cylinder has internal leakage and must be repaired or replaced.

NOTE: DO NOT turn the steering wheel to the right (clockwise) or the steering valve will meter oil out the disconnected hydraulic hose.

Rear Wheel Toe-in Adjustment

The rear wheels should have 0 to 1/8 of an inch toe-in when they are pointed straight ahead. To check toe-in, measure the center-to-center distance, at axle height, in front and rear of steering tires. If toe-in is not within specifications, an adjustment is required.

1. Rotate the steering wheel so the rear wheels and steering plate are straight ahead.

2. Loosen the jam nuts on both tie rods. Adjust both tie rods until center-to-center distance at front of rear wheels is 0 - 1/8 of an inch less than at the rear of the wheels (Fig. 9).

3. When toe-in is correct, tighten jam nuts against tie rods.

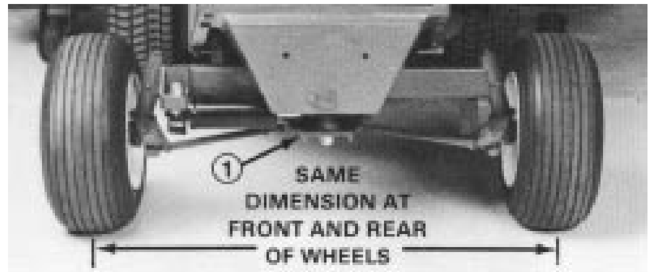


Figure 9

1. Steering plate

Brake Adjustment

Adjust the service brakes when there is more that one inch of “free travel” of the brake pedals. Free travel is the distance the brake pedal moves before braking resistance is felt.

Adjust where brake cables connect to brake pedal mount. When cable is no longer adjustable, star nut on inside of the brake drum must be adjusted to move brake shoes outward. Brake cables must be adjusted again after star nut is adjusted.

1. Disengage lock arm from left brake pedal so both pedals work independently of each other.

2. To reduce free travel of brake pedals:

    A. Loosen front nut on threaded end of brake cable (Fig. 12).

    B. Tighten rear nut to move cable toward the rear until brake pedals have 1/2 to 1 in. of free travel.

    C. Tighten front nut after adjusting.

3. When brake cables cannot be adjusted to get free travel within 1/2 to 1 in., star nut inside brake drum must be adjusted. Before adjusting the star nut, loosen brake cable nuts to prevent unnecessary strain on the cables.

4. Loosen (do not remove) the five (5) wheel lug nuts.

5. Jack up machine until front wheel is off the floor. Use jack stands or block machine to prevent it from falling accidentally.

6. Remove wheel nuts and slide wheel off the studs. Rotate the brake drum until adjusting slot is at the top and centered over star-nut (Fig. 13).

7. Use a brake adjusting tool or a screwdriver to rotate star nut until brake drum locks because of outward pressure of brake shoes (Fig. 14).

8. Loosen star nut approximately 12 to 15 notches or until brake drum rotates freely.

9. Install wheel onto studs with five (5) wheel nuts. Tighten the wheel lug nuts.

10. Remove jack stands or blocking and lower machine to floor. Tighten wheel lug nuts to a torque of 45 to 55 ft-lb.

11. Adjust brake cables (see step 2 of this procedure).

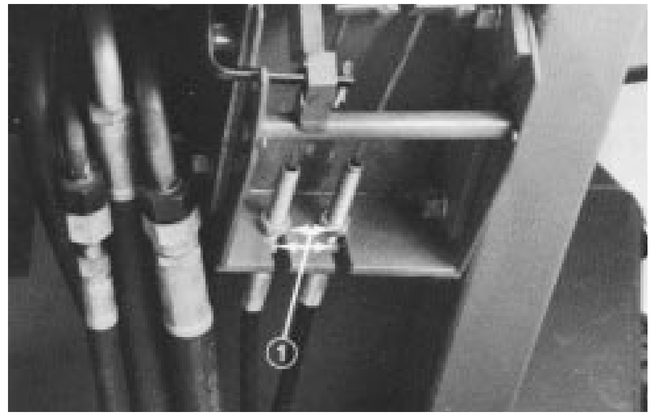


Figure 12

1. Jam nuts

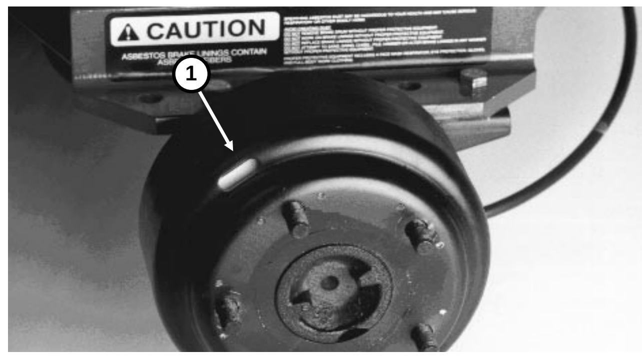


Figure 13

1. Brake adjusting slot

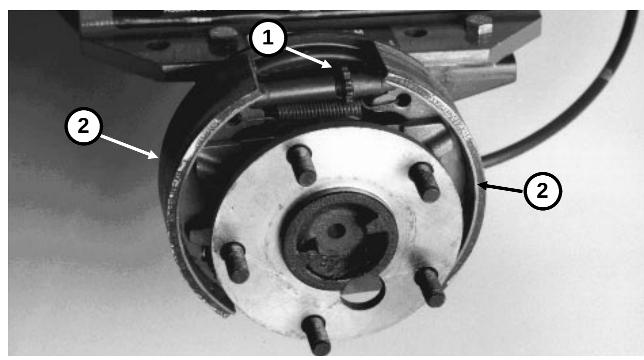


Figure 14

1. Star nut **2. Brake shoe**

Steering Wheel Removal and Installation

Removing the Steering Wheel

Remove the cover from the steering wheel hub. Remove the locknut that secures the steering wheel to the shaft (Fig. 15). 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.

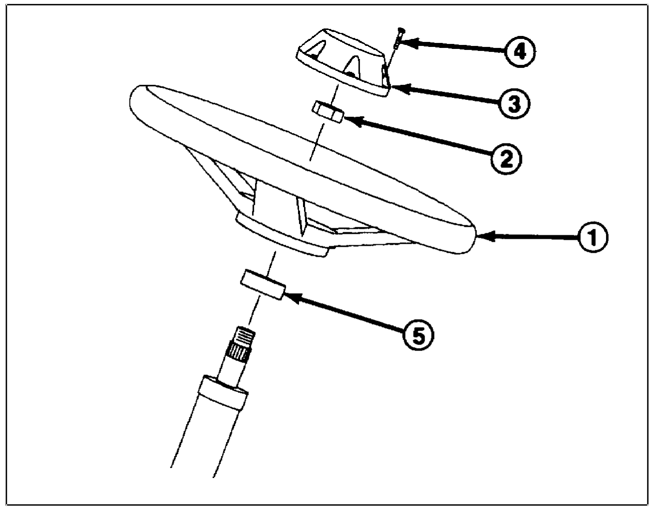


Figure 15

1. Steering wheel
2. Jam nut
3. Cap
4. Screw
5. Foam seal

Installing the Steering Wheel

1. Use the steering wheel to put the rear wheels in the straight ahead position.

2. Slide the steering wheel onto the steering shaft.

3. Secure the steering wheel in place with the jam nut (Fig. 10). Tighten the nut to 20 to 26 ft-lb.

4. Install cap to steering wheel with screw.

Rear Axle Bushing Service (2WD Units)

The rear axle must be held in place snugly by the axle pin. Excessive movement of the axle, which is characterized by erratic steering, usually indicates worn bushings. To correct the problem, replace the bushings.

1. Disconnect the hydraulic hoses from the steering cylinder. 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 the nut (Fig. 16, Item 9) from the end of the rear axle pin. Remove the two (2) cap screws (Item 2) securing the axle pin to the frame.

3. Jack up the frame (just ahead of the rear wheels) until pressure is taken off the axle pin. Support the machine with jack stands to prevent it from falling.

4. Pull the axle pin out. This will release the rear axle and washer(s) from the frame. Carefully pull the entire axle and wheel assembly out from under the machine.

NOTE: A varying number of washers (Item 45) may have been installed between the axle pivot tube and frame during manufacture. Make sure the same number of washers are installed during reassembly.

5. Use a drift punch and hammer to drive both bushings (Item 4) out of the axle pivot tube. Clean the inside of the axle pivot tube to remove dirt and foreign material.

6. Apply grease to the inside and outside of the new bushing. Use an arbor press to install the bushings into the top and bottom of the axle pivot tube. Bushings must be flush with the axle tube.

7. Wipe the rear axle pin with a rag to remove dirt and grease. Inspect the pin for wear or damage and replace as necessary.

8. Mount the axle to the frame with the axle pin. The washer(s) (Item 45) must be positioned between the front end of the pivot tube and the frame (see the NOTE after step 4). Secure the axle pin in place with the two (2) cap screws (Item 2). Install the washer (Item 8) and nut (Item 9).

9. Remove the jackstands and lower the machine to the floor.

10. Install the hydraulic hoses to the steering cylinder.

11. Lubricate the rear axle bushings through the grease fitting on the rear axle.

Steering Pivot Bushing Service (2WD Units)

The steering pivot (Fig. 16, Item 38) must fit snugly onto the mounting pin. Excessive movement of the steering pivot may indicate worn bushings or tie rod ball joints.

1. Remove the lock nut (Item 37) and cap screw (Item 11) securing the steering cylinder rod end to the steering pivot (Fig. 16).

2. Remove two (2) nuts (Item 43) to disconnect the tie rod end (Item 39) from the spindle arm (Item 1, 33). Inspect all tie rod end ball joints for wear or damage and replace as necessary.

3. Remove the retaining ring (Item 12), washer (Item 17) and thrust washer (Item 18). Slide the steering pivot off of the mounting pin on the bottom of the axle.

4. Use a drift punch and hammer to drive both bushings (Item 41) out of the steering pivot. Clean the inside of the steering pivot tube to remove dirt and foreign material. Also clean the mounting pin on the bottom of the rear axle.

5. Apply grease to the inside and outside of the new bushings. Use an arbor press to install the bushings into the top and bottom of the steering pivot tube. Bushings must be flush with the end of the tube.

6. Slide the steering pivot onto the mounting pin. Secure the plate in place with the thrust washer, washer and retaining ring.

7. Connect the tie rod end to the spindle bracket with one (1) nut. Tighten the nut to a torque of 25 - 33 ft-lb. Install the jam nut and tighten against the other nut to secure tie rod end.

8. Install the lock nut and cap screw to secure the steering cylinder rod end to the steering pivot. Tighten the nut to 130 to 150 ft-lb.

9. Lubricate the bushings through the grease fitting on the steering pivot.

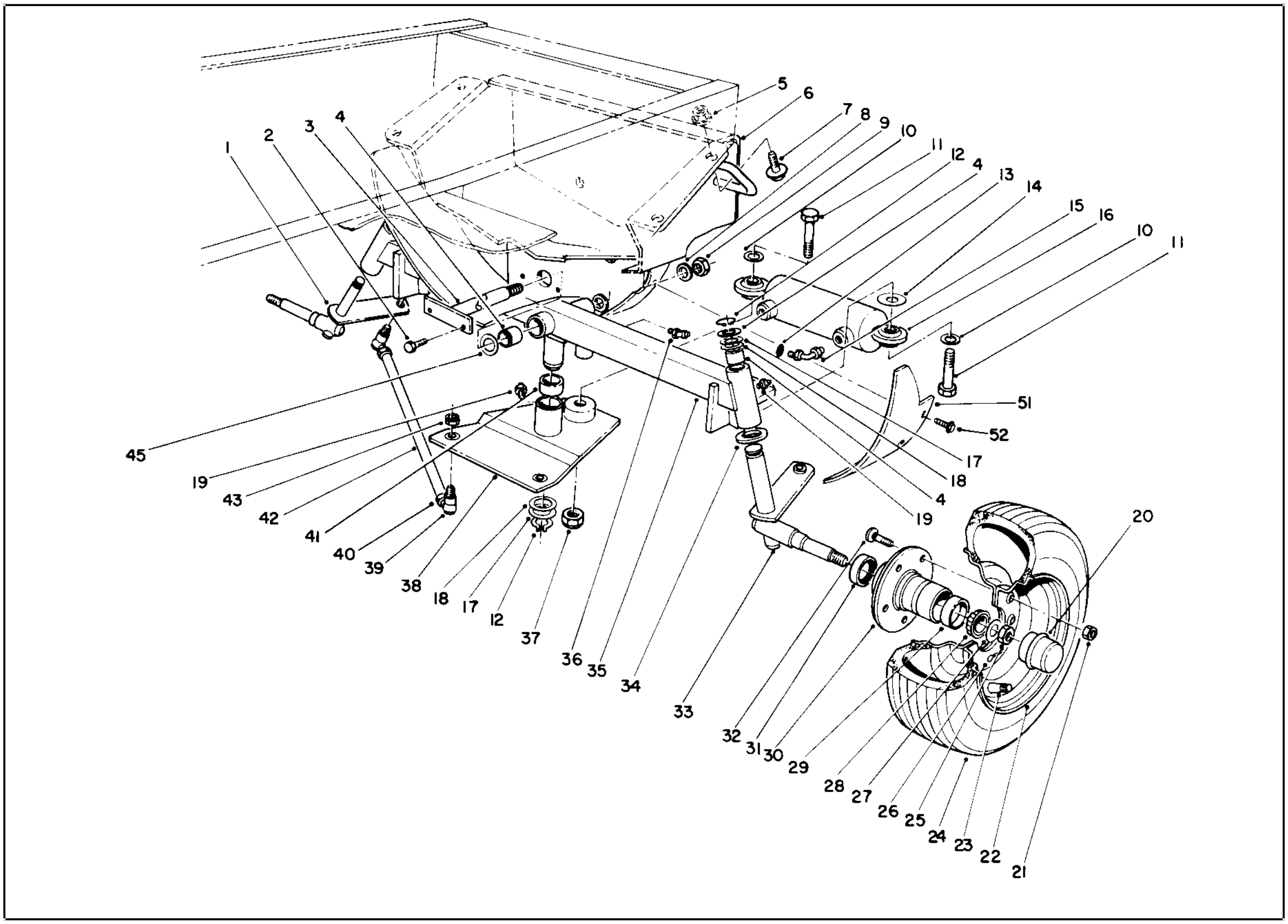


Figure 16

Rear Wheel Spindle Bushing Service (2WD Units)

The rear wheel spindles must fit snugly in the rear axle. Excessive movement of the spindle in the axle indicates that the bushings are probably worn and must be replaced.

1. Disconnect the hydraulic hoses from the steering cylinder. 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 nut (Fig. 16, Item 9) and washer (Item 8) from end of rear axle pin. Remove the two (2) cap screws (Item 2) securing the axle pin to the frame.

3. Jack up the frame (just ahead of the rear wheels) until pressure is taken off the axle pin. Support the machine with jack stands to prevent it from falling.

4. Pull the axle pin out. This will release the rear axle and washer(s) from the frame. Carefully pull the entire axle and wheel assembly out from under the machine.

NOTE: A varying number of washers (Item 45) may have been installed between the axle pivot tube and frame during manufacture. Make sure the same number of washers are installed during reassembly.

5. Remove the retaining ring (Item 12) and washers (Item 17, 18) that secure the wheel spindle (Item 1, 33) into the axle tube. Slide the spindle and wheel assembly out of the axle tube to expose the bushings.

6. Use a punch and hammer to drive both bushings (Item 4) out of the axle tube. Clean the inside of the axle tube to remove any dirt and foreign material.

7. Apply grease to the inside and outside of the new bushings. Use an arbor press to install the bushings into the top and bottom of the axle tube. The bushings must be flush with ends of the axle tube.

8. Wipe the spindle shaft with a rag to remove any dirt and grease. Inspect the spindles for wear and replace as necessary.

9. Install the thrust bushing (Item 34) onto the spindle shaft and push the shaft through the axle tube. Hold the wheel and spindle shaft assembly in place and install the thrust washer (Item 18), washer (Item 17) and retaining ring (Item 12) onto the end of the spindle shaft.

10. Connect the tie rod end to the spindle bracket with one (1) nut. Tighten the nut to a torque of 25 - 33 ft-lb. Install the jam nut and tighten against the other nut to secure tie rod end.

11. Mount the axle to the frame with the axle pin. The washer(s) (Item 45) must be positioned between the front end of the pivot tube and the frame (see the NOTE after step 4). Secure the axle pin in place with the two (2) cap screws (Item 2). Install the washer (Item 8) and nut (Item 9).

12. Remove the jackstands and lower the machine to the shop floor.

13. Install the hydraulic hoses to the steering cylinder.

14. Lubricate the steering spindle and rear axle pivot.

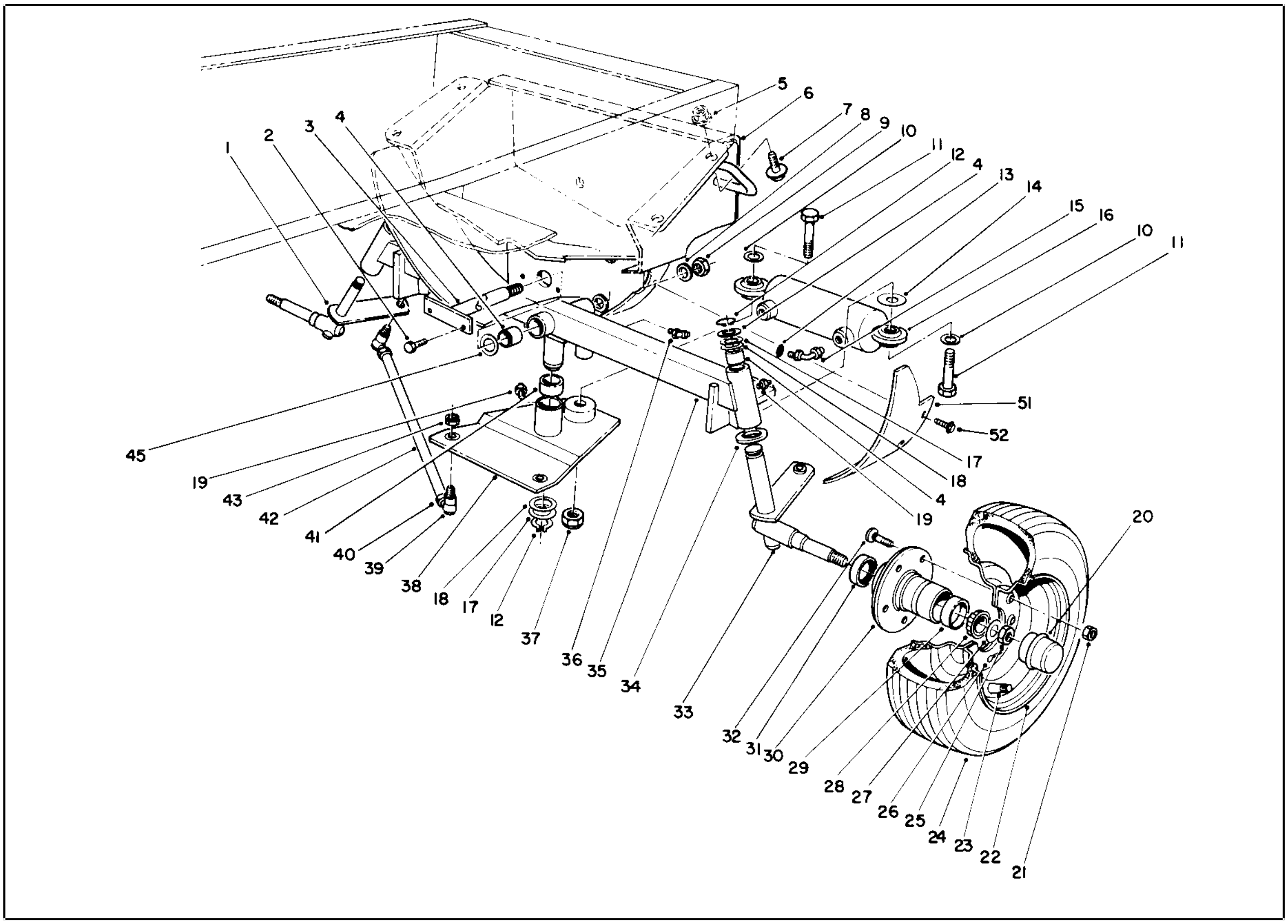


Figure 17

Front Wheel Bearing Service

See Axle Shaft Disassembly and Wheel Bearing Service in the Repairs section of Chapter 6 - Differential.

Rear Wheel Bearing Service (2WD Units)

Disassemble, clean, repack and adjust the rear wheel bearings after each 500 hours of operation or once a year. Use No. 2 general purpose lithium base grease containing E.P. additive. If operating conditions are extremely dusty and dirty, it may be necessary to perform this maintenance more often.

1. Jack up the rear of the machine until the tire is off the floor. Support the machine with jack stands or blocks to prevent it from falling.

2. Remove the dust cap from the end of the wheel spindle (Fig. 18).

3. Remove the cotter pin, slotted nut, and washer. Slide the wheel off spindle shaft.

4. Pull the seal out of the wheel hub.

5. Remove the bearings from both sides of the wheel hub. Clean the bearings in solvent. Make sure the bearings are in good operating condition. Clean the inside of the wheel hub. Check the bearing cups for wear, pitting or other noticeable damage. Replace worn or damaged parts.

6. If bearing cups were removed from the wheel hub, press them into the hub until they seat against the shoulder.

7. Pack both bearings with grease. Install one bearing into the cup on inboard side of the wheel hub. Lubricate the inside of the new lip seal and press it into the wheel hub.

IMPORTANT: The lip seal must be pressed in so it is flush with the end of the hub. The lip of the seal must be toward the bearing.

8. Pack inside of wheel hub with some grease (not full). Install remaining bearing into the bearing cup.

9. Slide the wheel onto the spindle shaft and secure it in place with the flat washer and slotted nut. DO NOT tighten the nut or install the cotter pin.

10. Adjust preload on the wheel bearings.

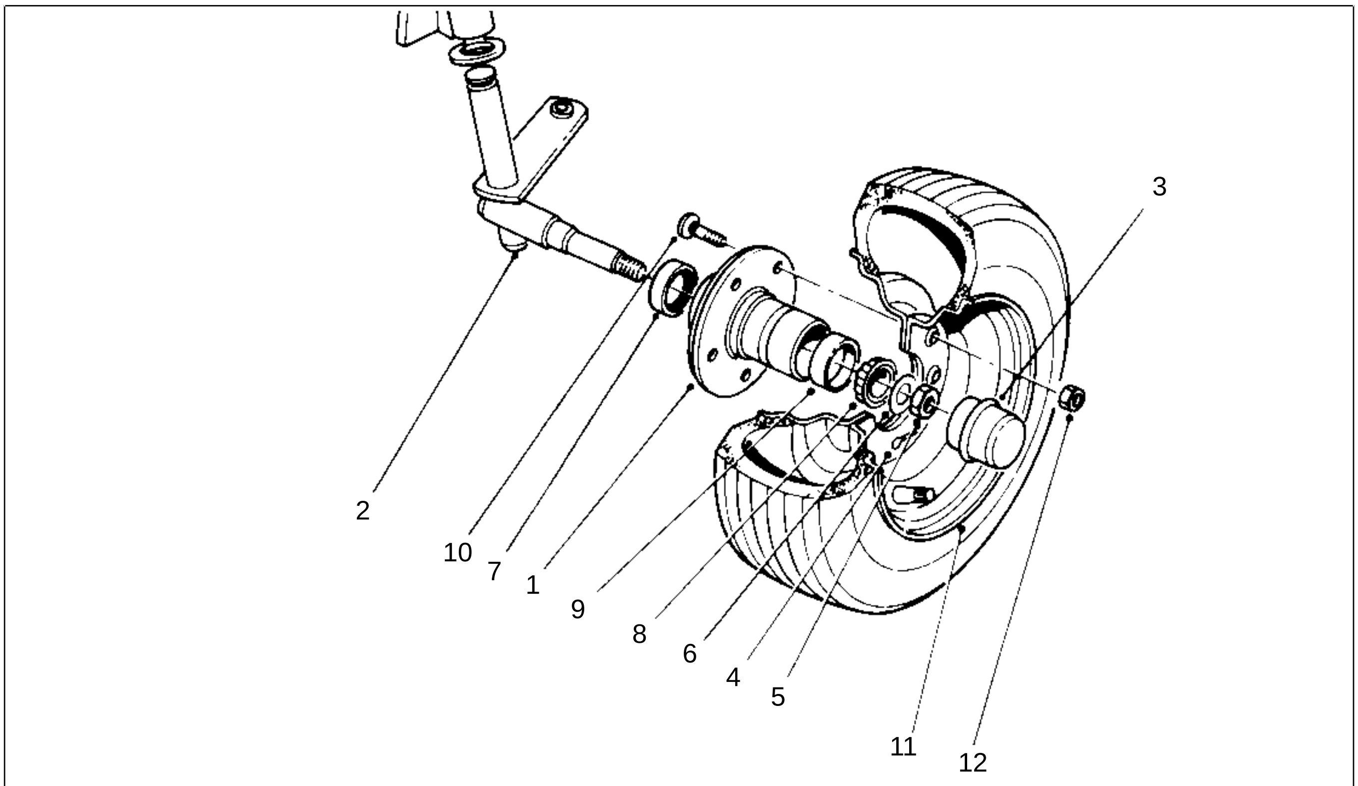


Figure 18

1. Wheel hub
2. Wheel spindle
3. Dust cap
4. Cotter pin
5. Slotted nut
6. Washer
7. Seal
8. Bearing cone
9. Bearing cup
10. Stud
11. Wheel
12. Wheel nut

Adjusting Rear Wheel Bearings

1. Remove dust cap from end of wheel spindle. Also remove cotter pin retaining slotted nut in place (Fig. 18).

2. Rotate the wheel by hand and tighten the slotted nut (Fig. 19) until the bearing binds SLIGHTLY. Then, loosen the nut until the nearest slot and hole in the spindle line up. Reinstall the cotter pin to retain the slotted nut in place. NOTE: The correct end play of the adjusted assembly is .002 -. 005 inches.

3. Remove jack stands or blocks and lower machine to floor.

4. Put a coating of grease on the inside of the dust cap. Install dust cap on the end of the wheel spindle (Fig. 18).

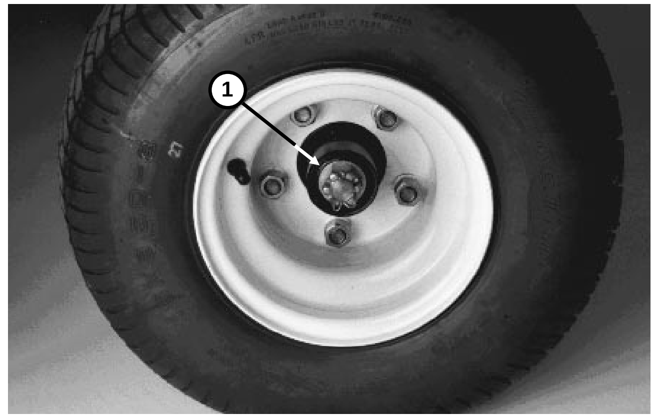


Figure 19

1. Cotter pin and slotted nut

Steering Cylinder Removal and Installation

1. Engage the parking brakes, lower the cutting units to the ground, turn the engine OFF and remove the key from the ignition switch.

2. Disconnect the hydraulic hoses from the steering cylinder. 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.

3. Remove the lock nut and cap screw securing the rod end of the cylinder to the steering pivot.

4. Remove the lock nut, cap screw and spacer securing the barrel end of the cylinder to the rear axle.

5. Remove the cylinder.

6. Reverse steps 2 - 5 to install the steering cylinder. Tighten the cap screw and nut securing the rod end of the cylinder to the steering pivot to 130 - 150 ft-lb.

7. After installing the cylinder, bleed the hydraulic system.

Steering Cylinder Service

IMPORTANT: To prevent damage to rod or barrel, clamp vise on pivot ends only. DO NOT clamp against smooth rod surface.

1. After removing the cylinder, pump oil out of cylinder into a drain pan by SLOWLY moving piston in and out of cylinder bore.

2. Plug the ports and clean the outside of the cylinder.

3. Mount cylinder in a vise so rod end of cylinder is tilted up slightly. Do not close the vise so firmly that the cylinder barrel could become distorted.

4. Use a spanner wrench to unscrew (counterclockwise) head (Fig. 21, Item 2) from barrel (Item 1).

5. Grasp large end of piston rod (Item 4) and use a twisting and pulling motion to carefully extract piston, rod, and head from cylinder tube.

6. Securely mount piston, rod, and head into vise so large nut (Item 6) is easily accessible for removal. Remove nut by turning it counterclockwise.

7. Remove piston (Item 5). Slide head off of piston rod.

8. Remove all seals and O-rings (Item 2).

9. Wash parts in a safe solvent. Dry parts with compressed air. DO NOT wipe them dry with a cloth or paper as lint and dirt may remain.

10. Carefully inspect internal surface of barrel for damage (deep scratches, out-of-round, etc.). Replace entire cylinder if barrel is damaged. Inspect head, rod, and piston for evidence of excessive scoring, pitting, or wear. Replace any damaged parts.

11. Put a light coating of oil on all new seals, and O-rings. Install new seals and O-rings.

12. Install head onto piston rod.

13. Install piston onto rod and tighten hex nut to 30 - 34 ft-lb.

14. Put a light coating of oil on all cylinder parts.

15. Slide piston rod assembly into cylinder tube.

16. Install head into tube and tighten by hand to properly engage threads. Tighten head with a spanner wrench.

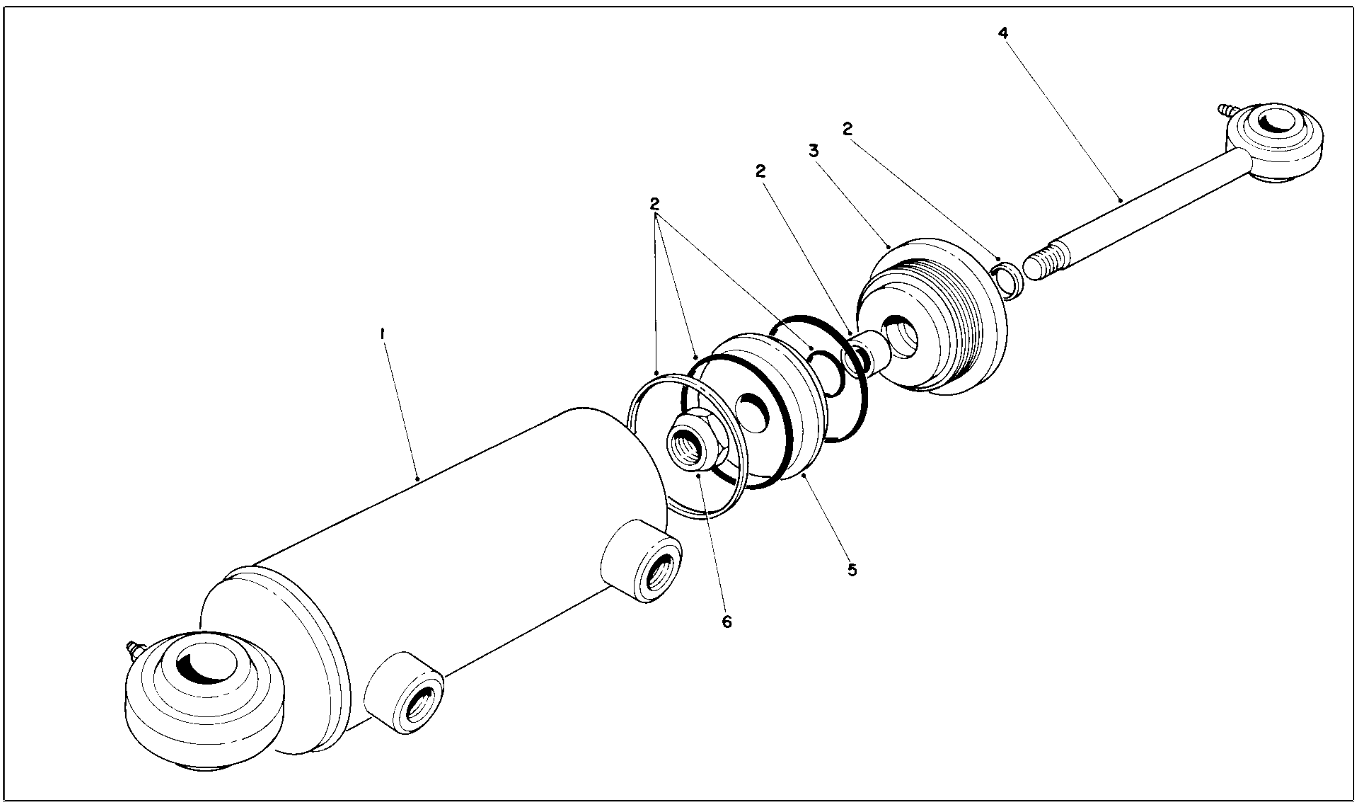


Figure 21

Brake Shoe Replacement

CAUTION

The 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.

1. Loosen wheel lug nuts. Jack up machine until front wheel is off of floor. Use jackstands to prevent machine from falling accidentally. Remove wheel lug nuts and slide wheel and tire assembly off of studs.

2. Remove brake drum. If drum will not come off easily, brake shoes may have to be retracted with star nut (see Brake Adjustment).

3. Remove brake shoe return spring (Fig. 22) by prying the end of the spring up and over its retaining boss. Use a brake spring pliers or flat blade screwdriver.

CAUTION

Wear a face shield when removing brake return spring (Fig. 22). The spring is under tension and could possibly slip during removal.

4. Remove brake lever retainers (cotter pins) with a slip joint pliers.

5. Pull strut and lever from brake shoes. Remove brake shoes by sliding them both on one motion straight down off cast-iron spider.

6. Remove adjusting screw spring and star wheel assembly.

7. Install new brake shoes (reverse steps 2 - 7) Install new brake drum if it is severely scored.

8. Install wheel and tire assembly on studs with five (5) wheel nuts. Tighten wheel lug nuts. Remove jack stands or blocking and lower machine to the floor. Tighten wheel lug nuts to a torque of 45 - 55 ft-lb.

9. Adjust brakes (see Brake Adjustment).

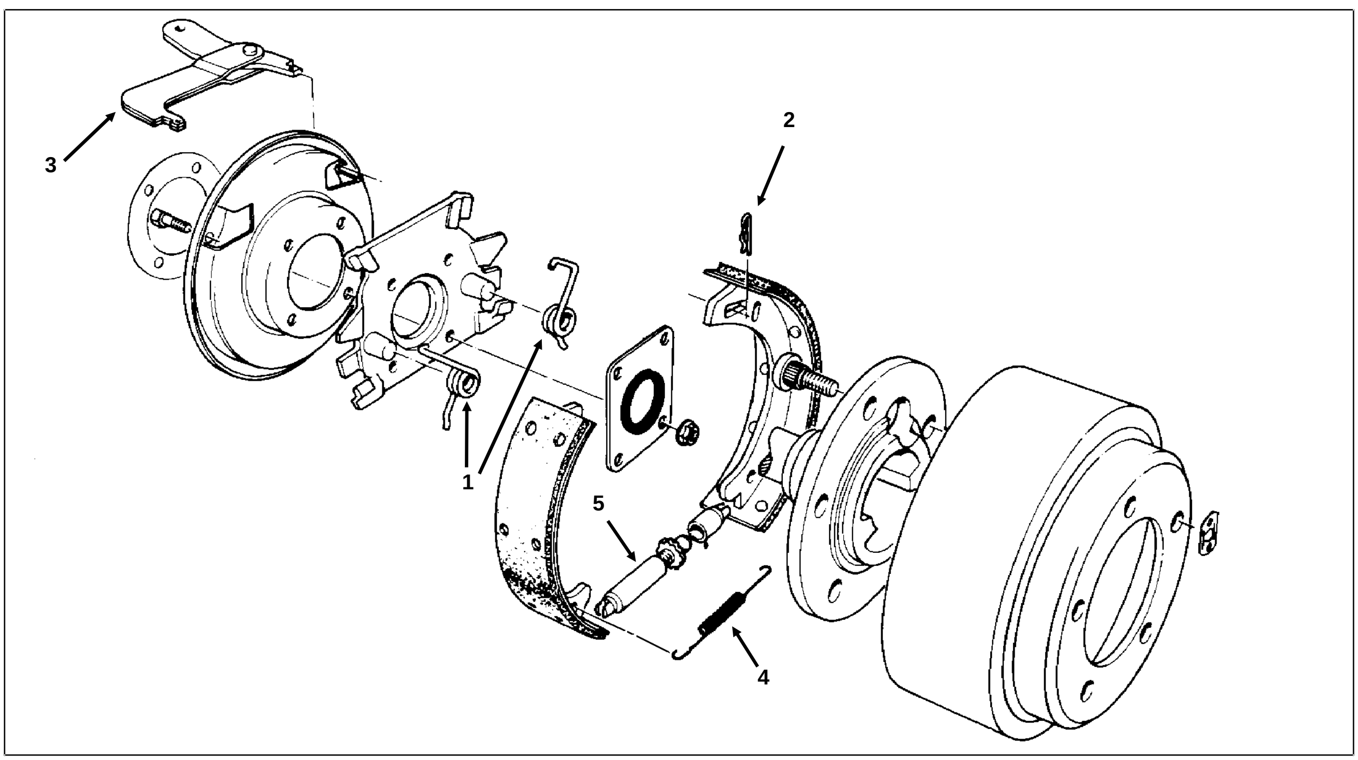


Figure 22

1. Return spring
2. Cotter pins
3. Strut and lever
4. Adjusting screw spring
5. Star wheel assembly

Steering Valve Removal and Installation

1. Engage the parking brakes, lower the cutting units to the ground, turn the engine OFF and remove the key from the ignition switch.

2. Remove the cutting unit or other implement.

3. Remove the steering wheel.

4. Remove the six (6) self-tapping screws securing the steering tower cover (Fig. 23A). Slide the steering tower cover off of steering column and parking brake rod.

5. Clean outside of the steering valve and the area around the hydraulic fittings. Disconnect hydraulic hoses from steering valve. Put caps or plugs on all fittings and hoses to prevent contamination.

NOTE: To ease reassembly, tag each hose and tube line to show their correct position on the steering valve.

6. Remove two (2) capscrews to remove clamp half securing steering column to column support (Fig. 23B).

7. Remove four (4) locknuts and flat washers securing steering valve to mounting bracket.

8. Carefully move hydraulic lines to the side and pull steering valve and column out through bottom of steering tower.

9. Reverse steps 2 - 8 to install the steering valve.

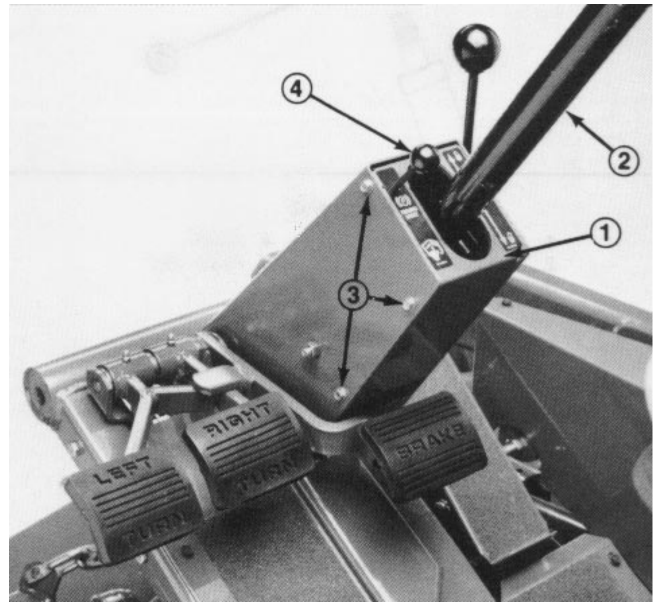


Figure 23A

1. Steering column cover
2. Steering column
3. Self tapping screws
4. Parking brake knob

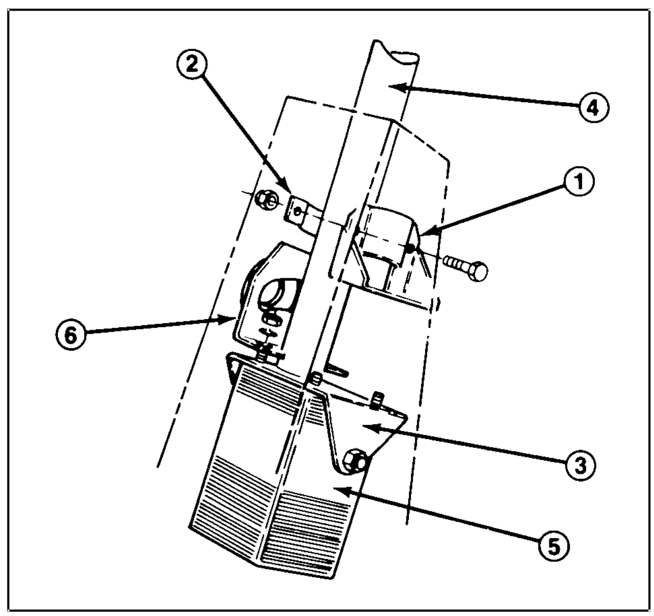


Figure 23B

1. Column support
2. Clamp half
3. Mounting bracket
4. Steering column
5. Valve
6. Pivot plate

Steering Valve Service

Before Disassembly

When disassembling any of the parts, use a clean work bench. Wash all parts in solvent and dry them with compressed air. DO NOT wipe them dry with a cloth of paper as lint and dirt may remain. Keep each part separate to prevent nicks and burrs.

Components of the steering valve are stacked on four bolts and held in alignment with alignment pins. The alignment pins are designed to be a slip fit into the components. Use the minimum force necessary and maximum care when separating or assembling the components.

The steering valve has several components that are of brazed laminate construction. These components have plates and parts bonded together permanently to form an integral component that cannot be disassembled. Disassemble the steering valve only to the extent shown in this book.

IMPORTANT: Do not force or abuse closely fitted parts, or you may damage them.

Components of the steering valve with alignment grooves, must be assembled so that their alignment grooves are positioned as illustrated for the valve to function correctly (Fig. 24).

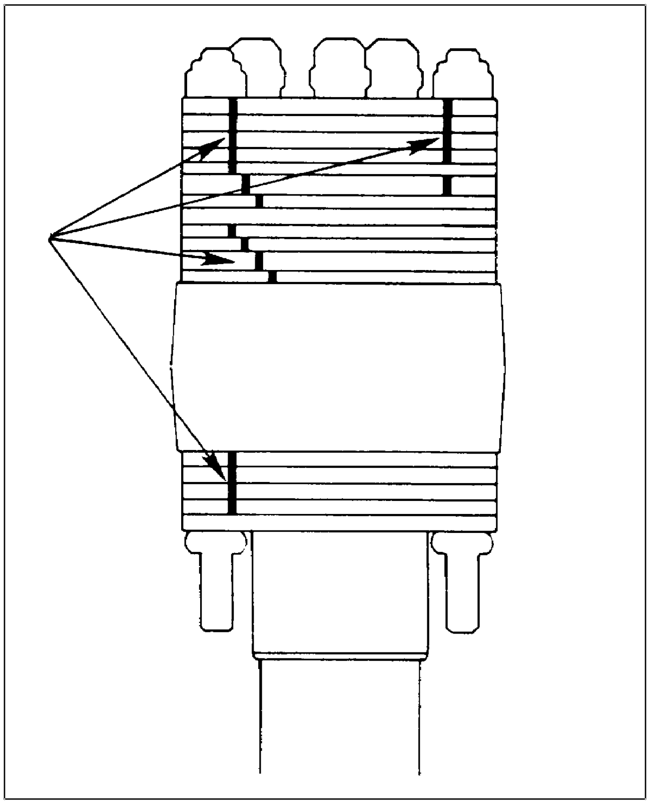


Figure 24

Disassembly of Steering Valve

1. To avoid distorting or damaging the steering valve, do not clamp it directly into a vise. Clamp a service assembly fixture securely in a vise (Fig. 25). Put the steering valve, input shaft first, into the service assembly fixture. Attache the steering valve to the fixture with four (4) 5/16-24 UNF nuts (Fig. 26).

NOTE: Before beginning the disassembly of the steering valve, study the relative positions of the alignment grooves on the side of the components in the assembly. The relative alignment groove positions on the components must be maintained at reassembly (Fig. 24).

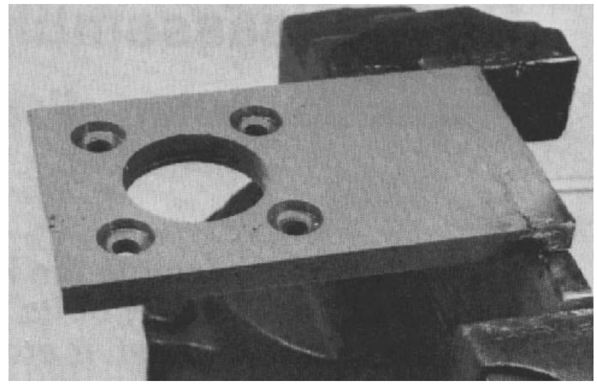


Figure 25

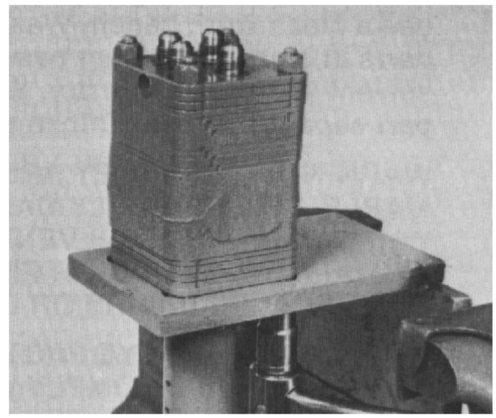


Figure 26

2. Use a slot type screwdriver or screwdriver socket to loosen the plug assembly one turn counterclockwise. (Fig. 27). Do not remove the plug assembly.

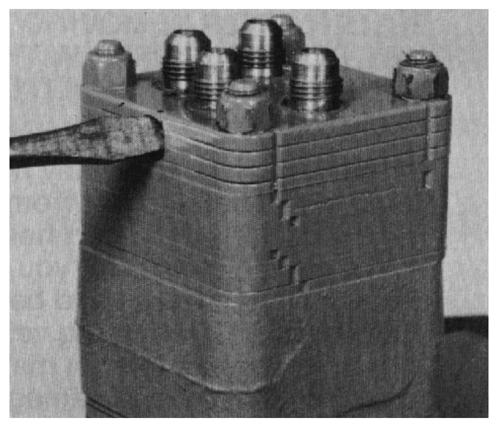


Figure 27

3. Remove the four nuts from the port cover assembly. Be careful not to damage the ports (Fig. 28).

IMPORTANT: The nuts are a special self-locking type. Do not substitute any other type.

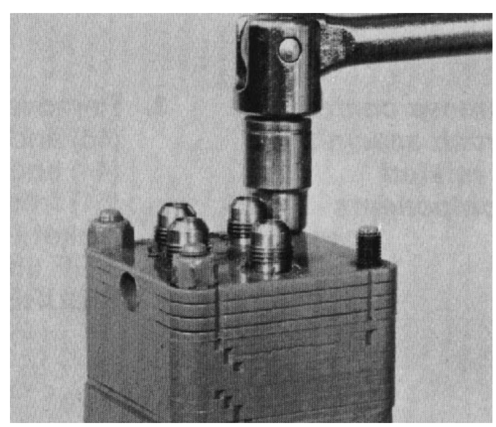


Figure 28

4. Grasp the port cover assembly (four plates bonded together) and lift it from the unit. Remove and discard the four o-rings and seal ring (Fig. 29).

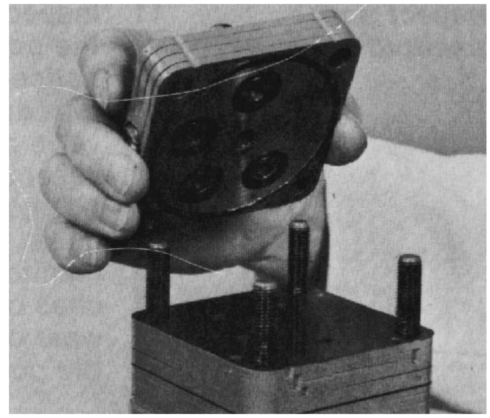


Figure 29

5. Remove the loosened plug and o-ring assembly from the port cover. Be ready to catch the steel check ball as it falls from its cavity (Fig. 30). Discard the o-ring.

6. Inspect the port cover for port fitting sealing surface scratches and thread damage. Replace the port cover if it is damaged.

NOTE: Be prepared to catch three springs which may become disengaged when removing the port manifold.

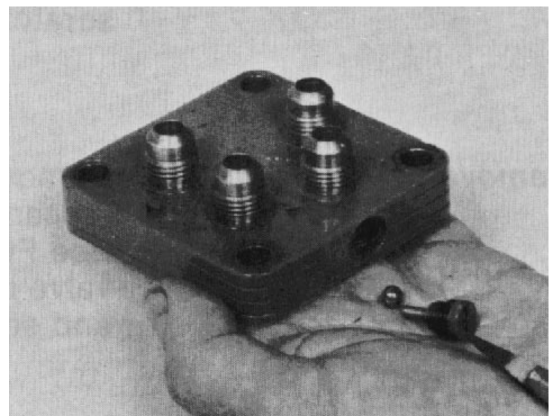


Figure 30

7. Carefully lift the port manifold (3 plates bonded together) from the unit (Fig. 31).

8. Remove the three springs from the port manifold.

NOTE: The unit has two different length spring sets. The set you have just removed from the port manifold are 3/4 in. (19 mm) long. Keep this set of three springs separate from the next set of three springs to be removed.

9. Inspect the springs for bent or distorted coils. If a spring is broken or deformed, all six springs in the unit should be replaced.

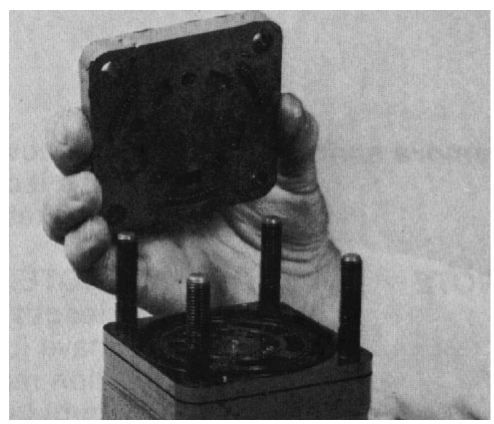


Figure 31

10. Inspect the ground surfaces of the port manifold. You should notice a “normal” polished pattern due to the rotation of the valve plate and hex drive assembly. All edges should be sharp and free of nicks and burrs. The surfaces of the port manifold should be free of scratches or scoring.

NOTE: Scoring is indicated by fine scratches or grooves. If these scratches can be detected by feel, finger nail, or lead pencil, the manifold should be replaced.

IMPORTANT: Many components in the unit have finely ground surfaces. Be careful not nick or scratch these surfaces.

11. Remove the valve ring (Fig. 32). Remove and discard the two seal rings (Fig. 33). The valve ring should be free of nicks and scoring.

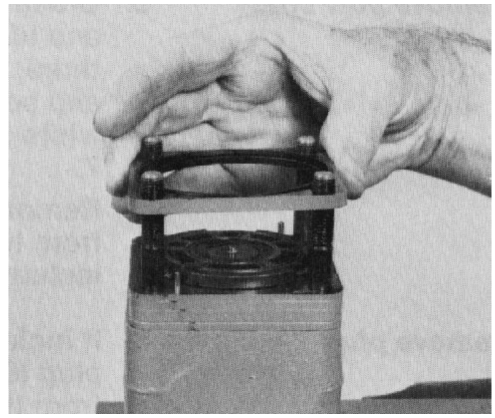


Figure 32

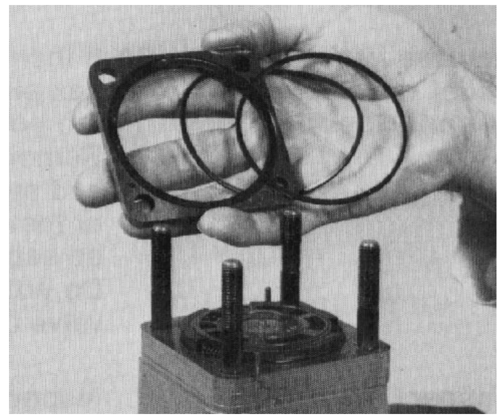


Figure 33

12. Remove the valve plate by lifting it from the isolation manifold (Fig. 34).

13. Inspect the slot edges and ground surfaces. If the valve plate shows nicks or scoring or the edges are not sharp, it must be replaced.

NOTE: The valve ring and valve plate are a matched set and must be replaced as a set.

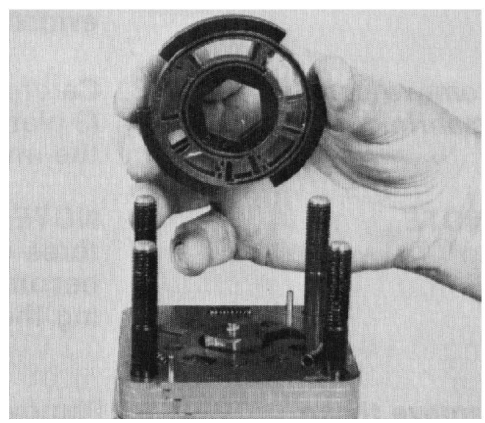


Figure 34

14. Remove three springs from the isolation manifold pockets (Fig. 35).

NOTE: The unit has two different length spring sets. the set you have just removed from the isolation manifold is 1/2 in. (13 mm) long. Keep this spring set separate from the set removed from the port manifold.

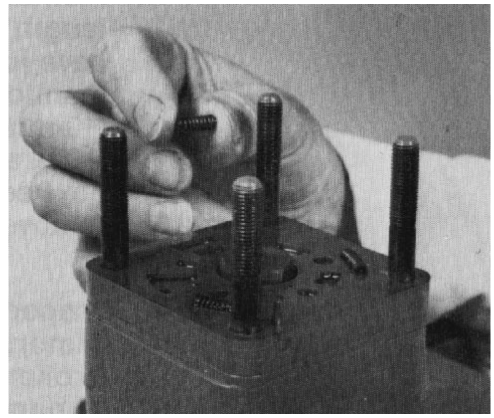


Figure 35

15. Inspect the springs for bent or distorted coils. If a spring is broken or deformed, all six springs in the unit must be replaced (Fig. 36).

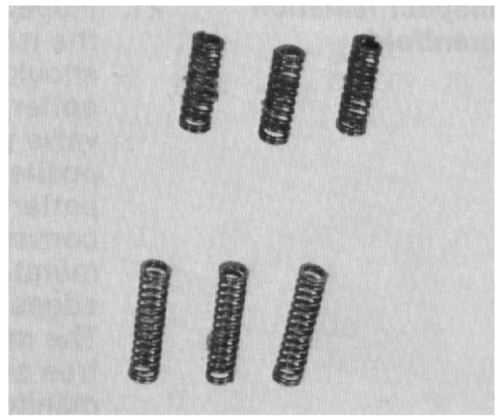


Figure 36

16. Remove the hex drive assembly from the drive link (Fig. 37).

17. The pin in the hex drive assembly should not show wear and must be firmly pressed in place. the sides of the hex and slot should not have grooves or scoring. if the hex drive assembly shows signs of this type of wear, it must be replaced.

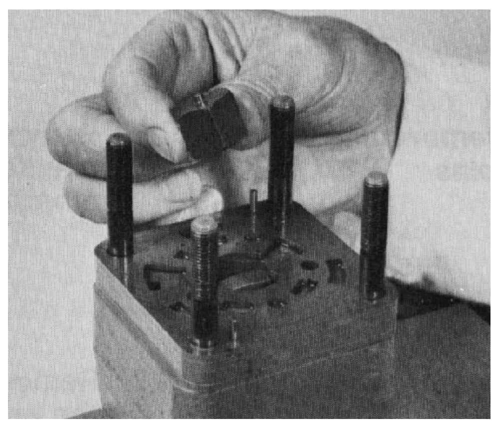


Figure 37

18. Remove the two alignment pins that align the port manifold, valve ring and isolation manifold (Fig. 38).

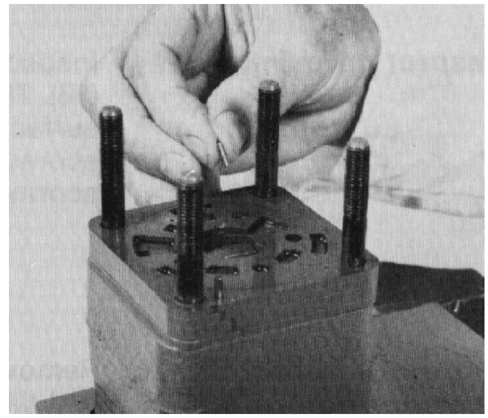


Figure 38

19. Remove the isolation manifold (four plates bonded together) (Fig. 39).

20. Inspect the ground surfaces of the isolation manifold. You should notice a “normal” polished pattern due to the rotation of the valve plate, and on the opposite side a “normal” polished pattern due to the action of the commutator cover and commutator seal. The holes and edges should be free of nicks. The manifold surfaces should be free of nicks or scoring. If the manifold has developed any of these conditions, it must be replaced.

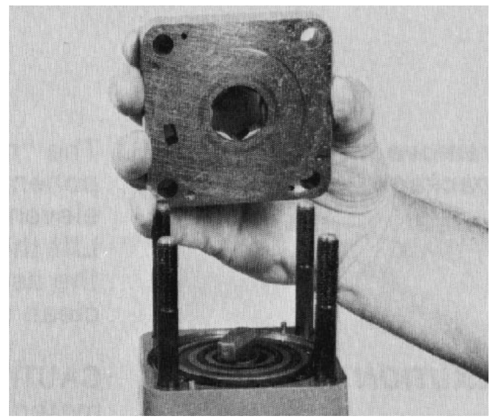


Figure 39

21. Remove the two isolation manifold-metering ring alignment pins (Fig. 40).

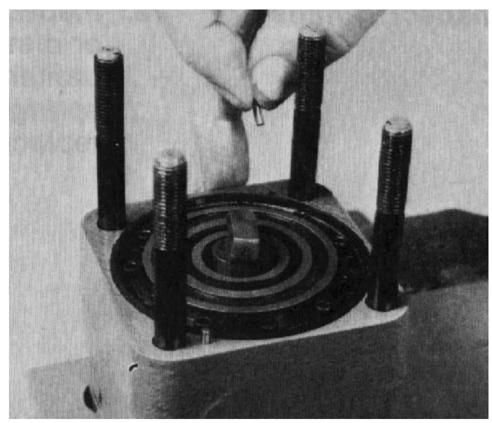


Figure 40

22. Remove the drive link from the unit (Fig. 41).

23. Inspect each end of the drive link. the four crowned contact surfaces should not be worn or scored. Replace if wear or scoring is evident.

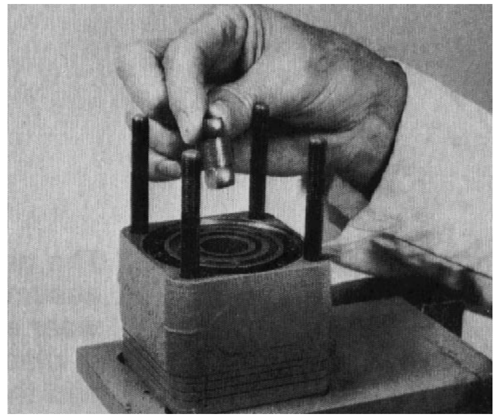


Figure 41

24. Remove the metering ring and discard the two seal rings (Fig. 42). If the metering ring bore is scored, it should be replaced.

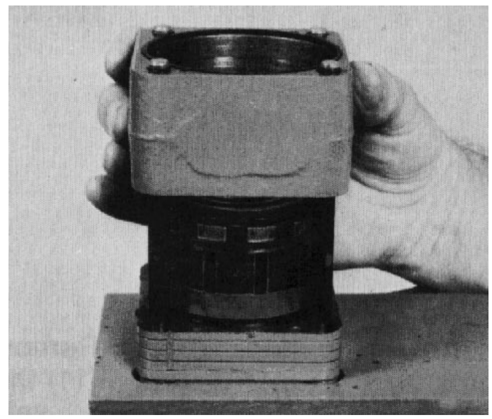


Figure 42

25. The “metering package” components are held together with eleven hex socket head screws. Lift the metering package from the assembly, and put it on a clean surface (Fig. 43).

IMPORTANT: Do not clamp the metering package in a vise, as this could damage the components.

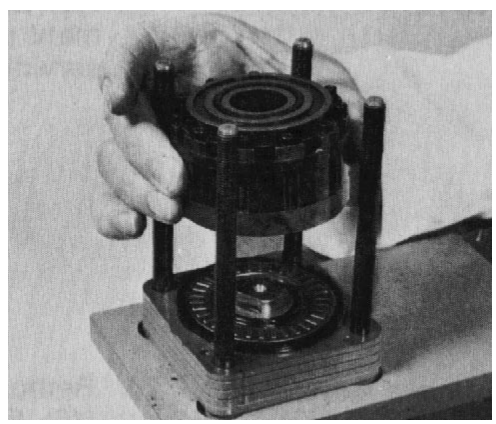


Figure 43

26. Remove and discard the commutator seal from the commutator cover (Fig. 44).

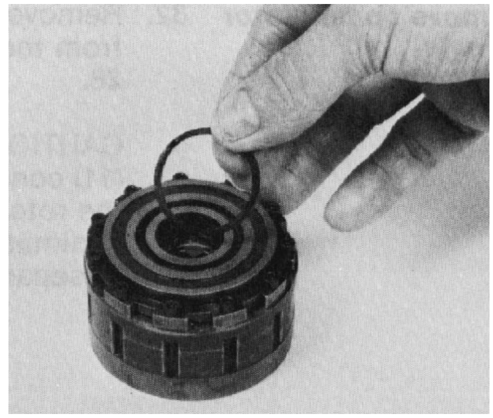


Figure 44

27. Remove the eleven hex socket head screws, that hold the metering package together (Fig. 45). Use a 3/32 in. allen wrench. Inspect the screws for thread and socket damage and replace as necessary.

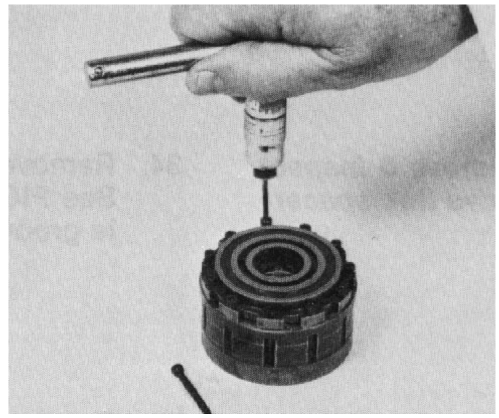


Figure 45

28. Lift the commutator cover from the metering package (Fig. 46).

29. Inspect the ground surfaces of the commutator cover. You should notice a "normal" polished pattern due to the rotation of the commutator. If the cover has nicks, burrs, or scoring, it must be replaced.

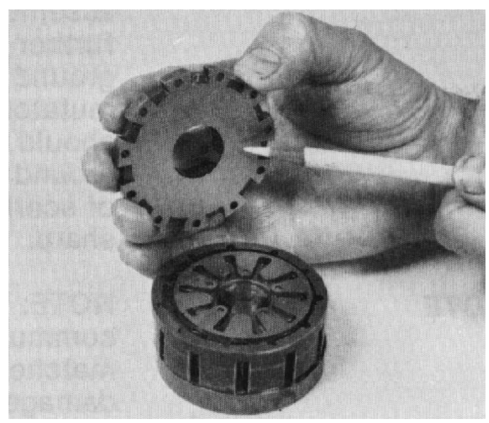


Figure 46

30. Remove the commutator ring (Fig. 47). Inspect for cracks, burrs and scoring.

IMPORTANT: Handle the commutator ring with care, as it is easily broken.

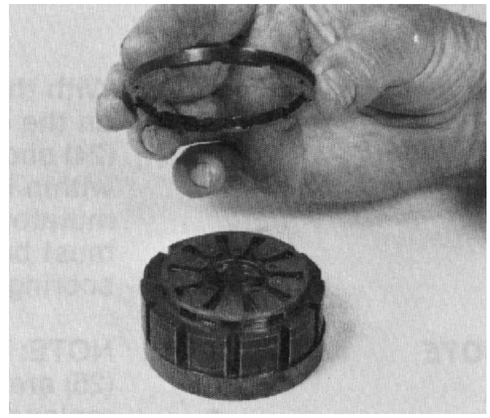


Figure 47

31. Remove the commutator from the rotor (Fig. 48).

IMPORTANT: To prevent damage, DO NOT use a screwdriver to remove the commutator. Use a wood dowel if necessary.

32. The commutator is made up of two round plates, pinned and bonded together as a permanent assembly that cannot be disassembled. Inspect the ground surfaces of the commutator. The holes and edges should be free of nicks. The ground surfaces should be free of scoring. The edges should be sharp.

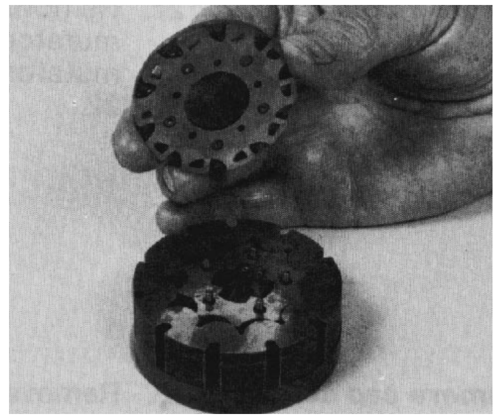


Figure 48

NOTE: The commutator and commutator ring are a matched set. If either is worn or damaged, the set must be replaced.

IMPORTANT: Five alignment pins connect the commutator to the rotor with a slip fit. Care and minimum force should be used to separate the two components.

33. Remove the five alignment pins (Fig. 49).

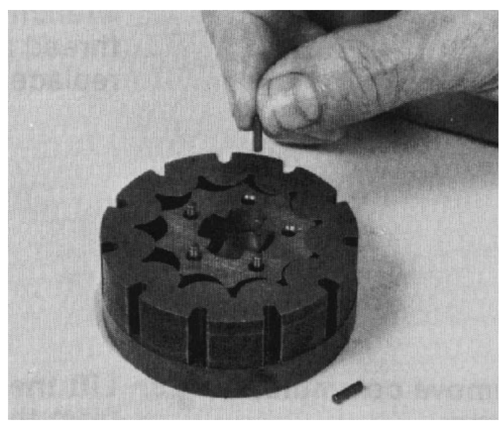


Figure 49

34. Remove the drive link spacer (Fig. 50). Replace it if it grooved or worn.

35. With the rotor set lying on the drive plate, the rotor should rotate and orbit freely within the stator. The commutator side of the stator face must be free of grooves or scoring.

NOTE: the rotor and stator are a matched set. You must replace them as a matched set, if either is worn or damaged.

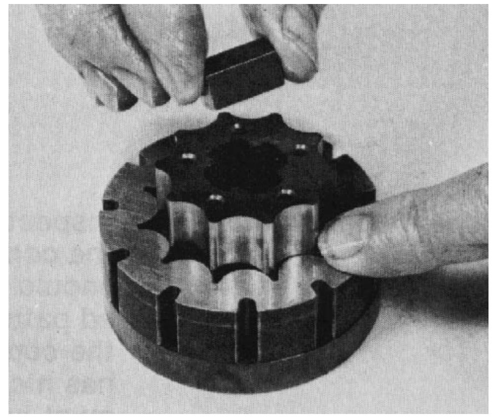


Figure 50

36. Check the rotor lobe “tip” to stator lobe “tip” clearance, with a feeler gauge (Fig. 51). The rotor lobe, directly across from the rotor lobe tip being measured (see pointer in Fig. 51) must be centered between stator lobes during the measurement. A rotor and stator that exceeds the maximum allowable “tip” clearance, must be replaced.

Max. rotor to stator “tip” clearance: 0.003 in. (0.08 mm)

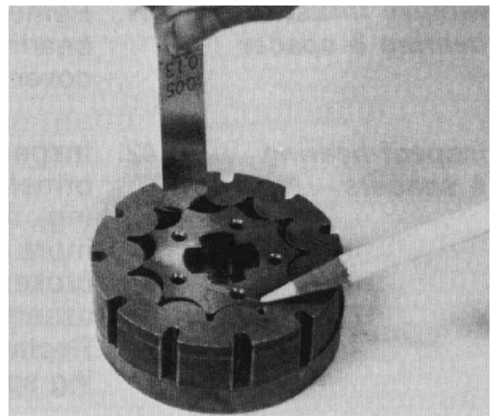


Figure 51

37. Remove the rotor set from the drive plate. The drive plate side of the rotor set also must be free of grooves or scoring.

NOTE: Handle the rotor set carefully to avoid nicks and scratches.

38. The rotor side of the drive plate (Fig. 52) should show the “normal” spiral pattern due to rotor movement.

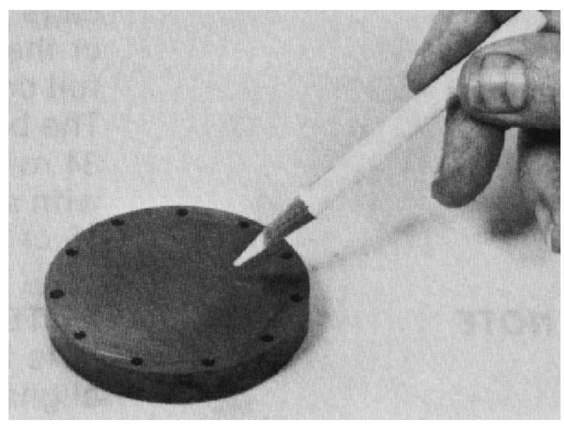


Figure 52

39. Inspect the thrust bearing side of the drive plate (Fig. 53) for brinelling (dents) or spalling (flaking). The flat sides of the input shaft engagement hole should not be grooved or worn. If any of these conditions in steps 38 and 39 are present, the drive plate must be replaced.

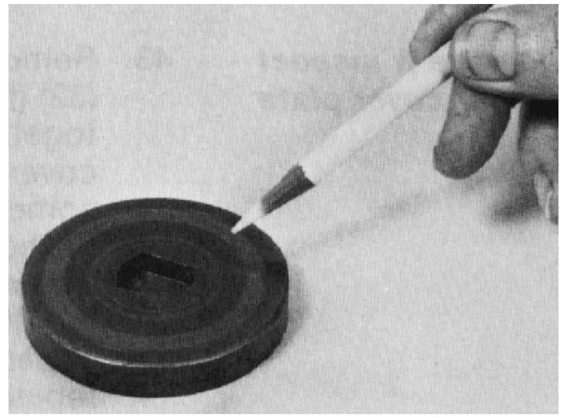


Figure 53

40.Remove the face seal, back-up ring, and face seal spacer from the upper cover plate (Fig. 54). Discard the face seal and back-up ring. Keep the metal spacer.

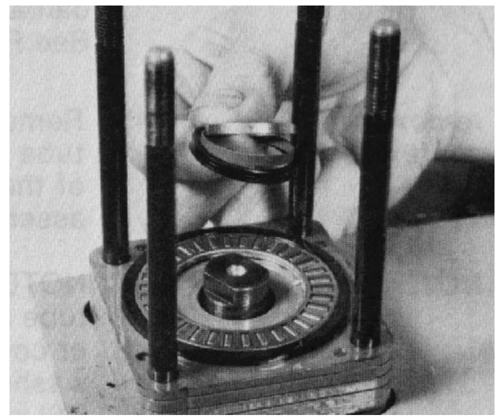


Figure 54

41. Remove the thrust bearing and bearing spacer from the upper cover plate (Fig. 55).

42. Inspect the thrust bearing for brinelling (dents) or spalling (flaking), if either exists, or if one or more of the rolls are lost or broken, replace the bearing assembly. Replace the seal spacer or bearing spacer if worn or broken.

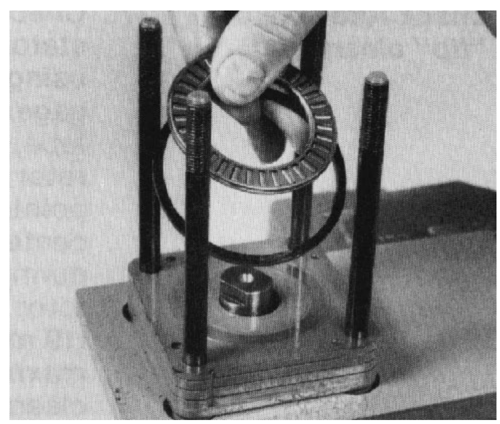


Figure 55

43. Remove the upper cover plate (four plates bonded together) (Fig. 56). Inspect the upper cover plate. You should notice some polishing due to the action of the seal. The plate should be free of brinelling (dents) or spalling (flaking). If it is damaged, the upper cover plate must be replaced.

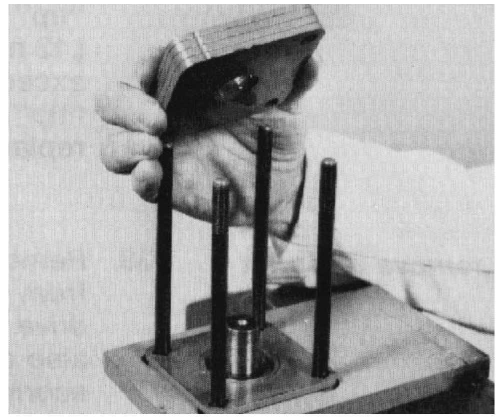


Figure 56

44. Slide the seal from the jacket tube (Fig. 57). If the seal is worn or damaged, it must be replaced.

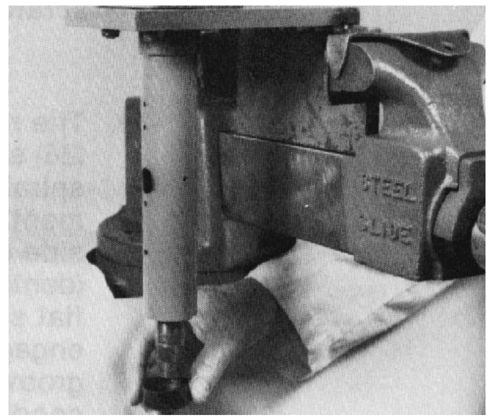


Figure 57

45. Remove the input shaft and snap ring, sliding it out of the upper cover end of the assembly (Fig. 58).

46. Inspect the input shaft serrations, threads and flats for grooves, wear, or damage.

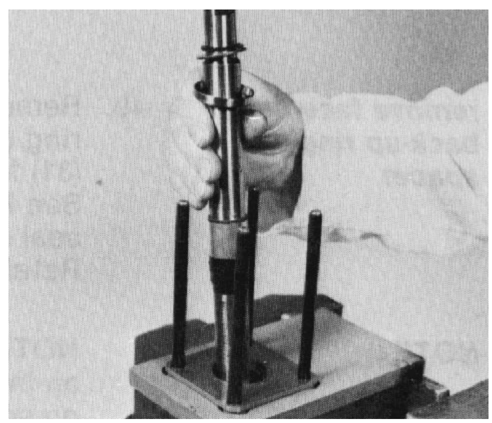


Figure 58

47. Remove the washer and upper cover & jacket (Fig. 59).

NOTE: The retaining plate and upper cover & jacket are a matched set. If either part is worn or damaged, both must be replaced.

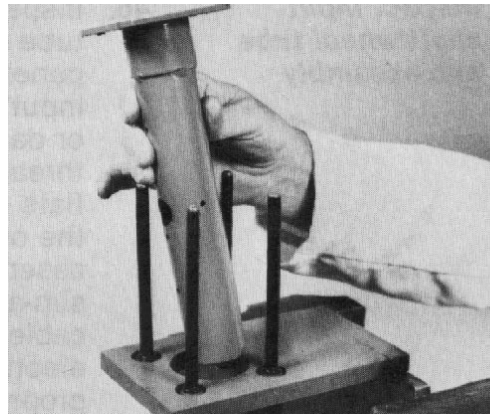


Figure 59

48. Inspect the bushing at the top of the cover & jacket for wear or damage. If bushing replacement is necessary. put the upper cover & jacket in a vise. Use a pliers or punch to straighten the crimped areas on the bushing end of the jacket tube (Fig. 60).

IMPORTANT: Hold the steering tube in a soft-jaw vise. Be careful not to damage the steering tube.

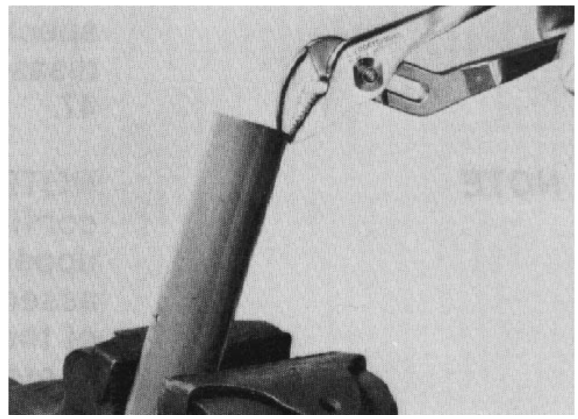


Figure 60

49. Use a bearing puller to remove the bushing (Fig. 61).

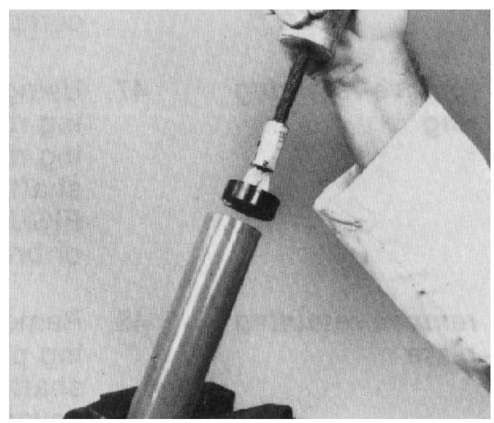


Figure 61

50. Remove the nuts holding the four bolts to the fixture, and remove the bolts (Fig. 62). Check the bolt threads for wear or damage.

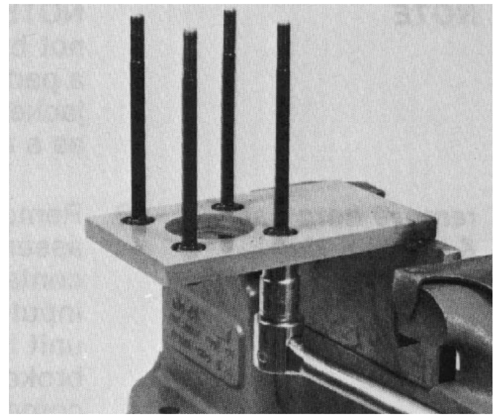


Figure 62

Assembly of Steering Valve

Replace all seals and o-rings with new ones. Make sure the seals and o-rings remain seated correctly when components are assembled.

Before assembling the steering valve, wash all parts in clean solvent. Dry the parts with compressed air. DO NOT wipe them dry with a cloth or paper as lint and dirt may remain.

1. Put the four bolts into the fixture with the shortest threaded end of the bolts through the fixture holes (Fig. 63). Secure the bolts to the fixture with four 5/16-24 UNF nuts. Tighten the nuts to secure the assembly to the fixture, but loose enough to turn the bolts and facilitate stacking of components.

2. If the bushing was removed from the upper cover and jacket for replacement, press a new bushing into the upper end of the jacket tube with the recessed end of the bushing toward the jacket tube. Use an arbor press or the wood handle end of a hammer (Fig. 64). Push the bushing down until it is 0.1 in. (2.5 mm) below the top of the jacket tube. Use a pliers or punch to “crimp” the end of the jacket tube over the bushing in two places approximately 90^{o} away from the original crimped areas (Fig. 65). Put clean multi-purpose grease on the inside of the bushing.

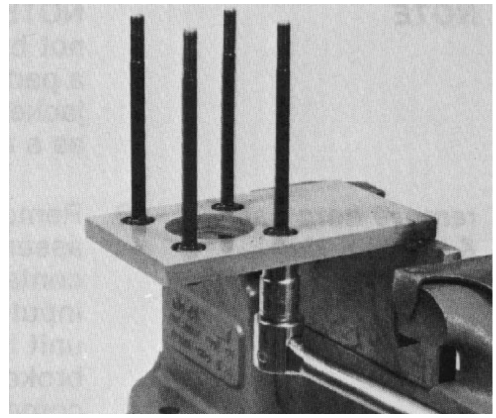


Figure 63

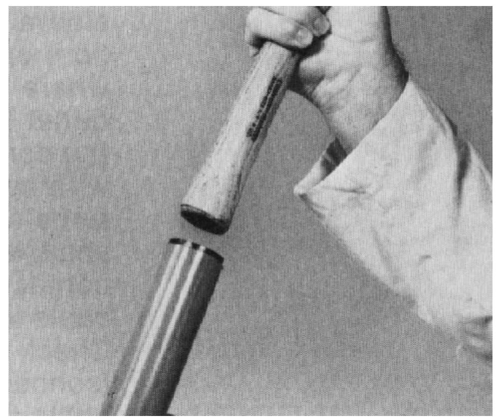


Figure 64

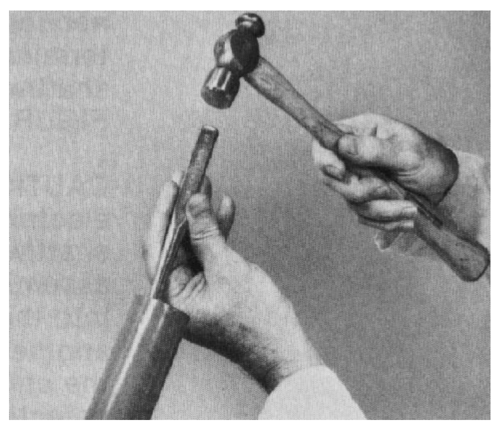


Figure 65

3. Put the upper cover and jacket on the four bolts with the jacket tube pointing down through the hole in fixture (Fig. 66). Make sure the square shoulder of the bolts engage the square holes in the upper cover.

4. Apply a small amount of multi-purpose grease to the recessed face of the retainer plate and washer. Put the retainer plate into the upper cover & jacket with the recessed retainer face out. Put the washer against the recessed face of the retainer plate.

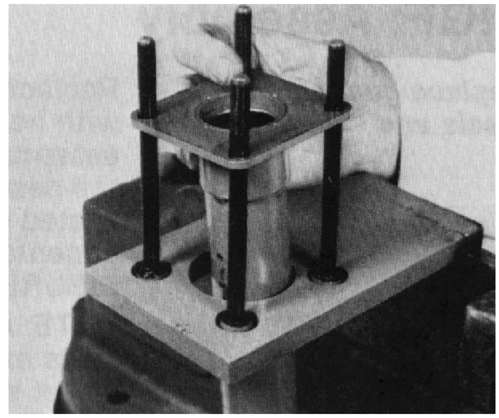


Figure 66

5. Install the snap ring onto the input shaft if it was removed (Fig. 67).

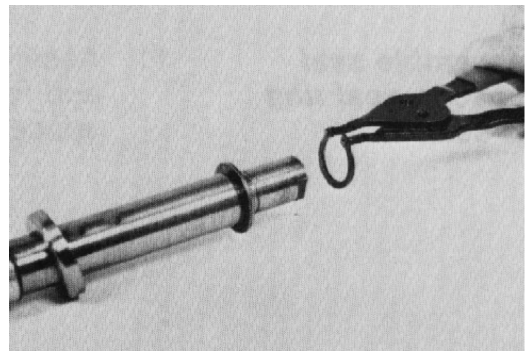


Figure 67

6. Slide the input shaft into the upper cover end of the upper cover & jacket and through the bushing until the retaining ring bottoms against the washer. Make sure the washer bottoms against the retainer plate recessed face and the retainer plate seats against the end of the jacket tube (Fig. 68).

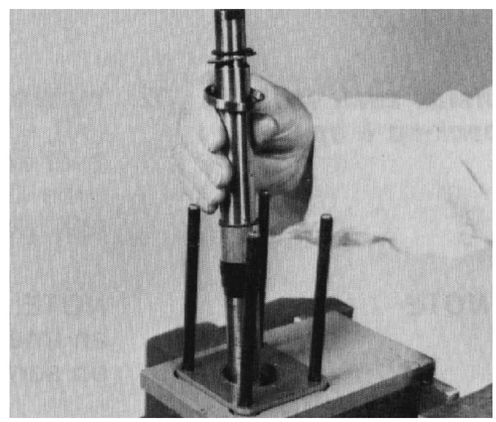


Figure 68

7. Install the upper cover plate over the four bolts with the highly polished surface up (Fig. 69).

IMPORTANT: The alignment grooves must be all on one side of the steering valve for proper operation.

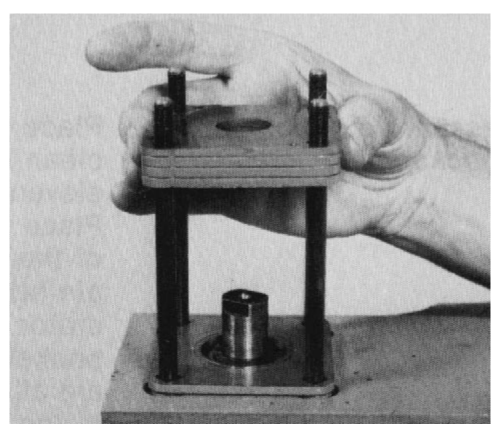


Figure 69

8. Apply clean multi-purpose grease to the face of the upper cover plate, input shaft and face seal (Fig. 70).

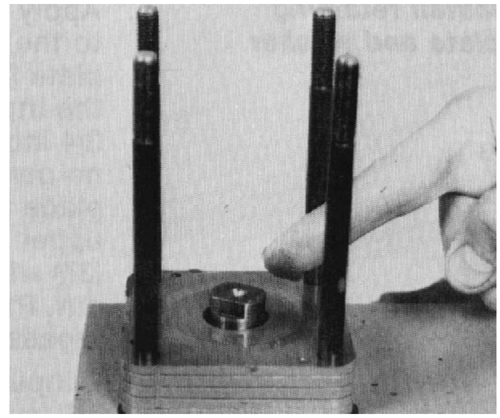


Figure 70

9. Assemble the seal back-up ring and face seal onto the seal spacer (Fig. 71).

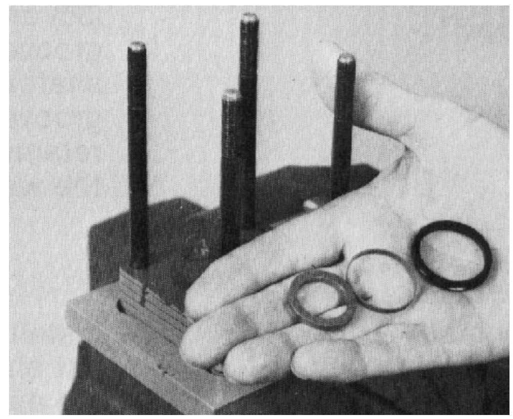


Figure 71

10. Install the face seal, back-up ring and spacer assembly over the end of the input shaft and onto the upper cover plate (Fig. 72).

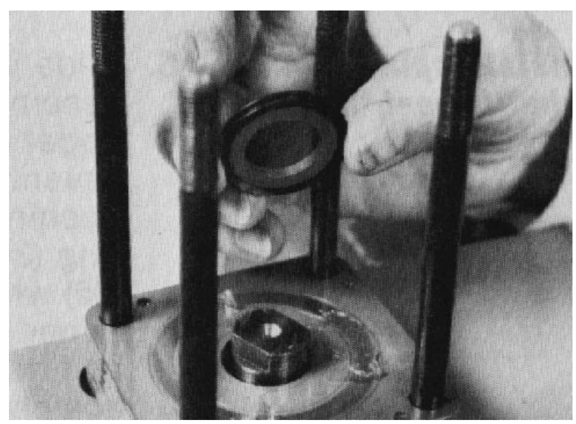


Figure 72

11. Put the drive plate on a clean lint-free surface with the eleven tapped holes facing up. Put the rotor set on top of the drive plate with the five pin holes facing up. Rotate the stator until the eleven hex socket head screw relief slots are aligned with the tapped holes in the drive plate (Fig. 73).

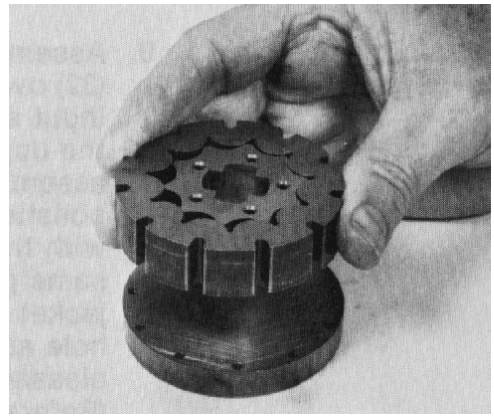


Figure 73

12. Apply a small amount of clean multi-purpose grease to the spacer and insert it into the drive slot in the rotor (Fig. 74). The grease will aid in retaining the spacer during other assembly procedures.

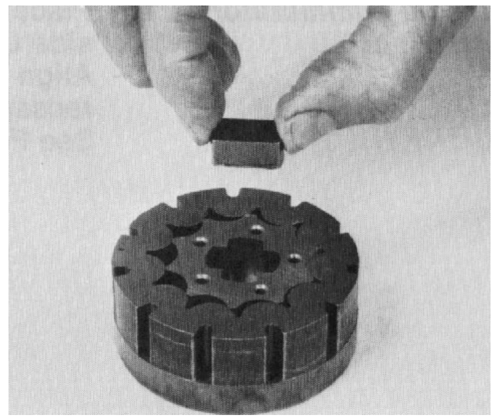


Figure 74

13. Put the commutator on top of the rotor. Be sure the correct surface (Fig. 75) is towards the rotor.

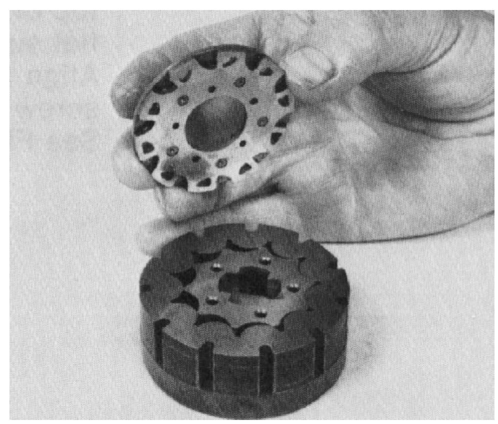


Figure 75

14. Align the five holes and press the five alignment pins in place (Fig. 76).

IMPORTANT: Make sure the five alignment pins are pressed below the surface of the commutator.

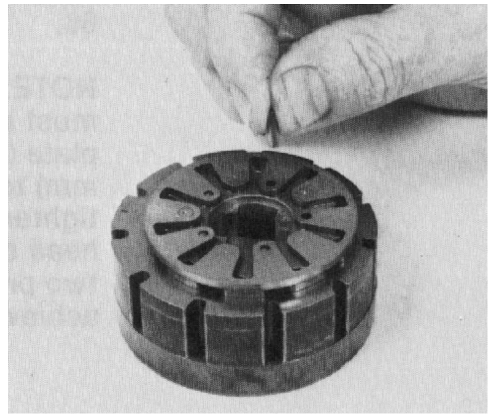


Figure 76

15. Put a few drops of oil into each recess in the commutator (Fig. 77).

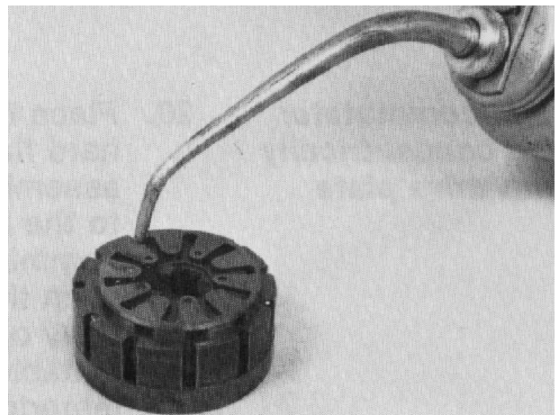


Figure 77

16. Put the commutator ring (either side up) on top of the stator (Fig. 78). Align the commutator ring screw recesses with the stator screw slots.

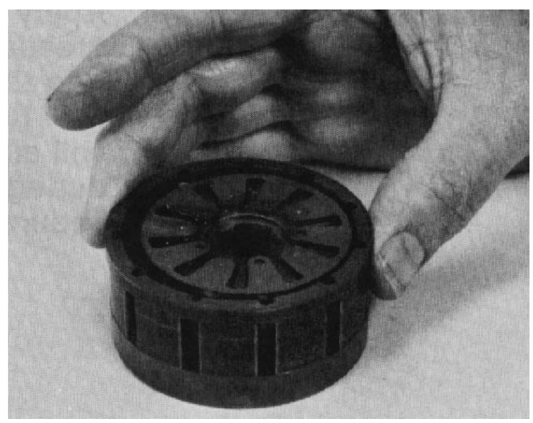


Figure 78

17. Put the commutator cover on top of the commutator ring with the flat surface towards the commutator (Fig. 79). Align the screw holes in the cover, with the screw holes in the drive plate.

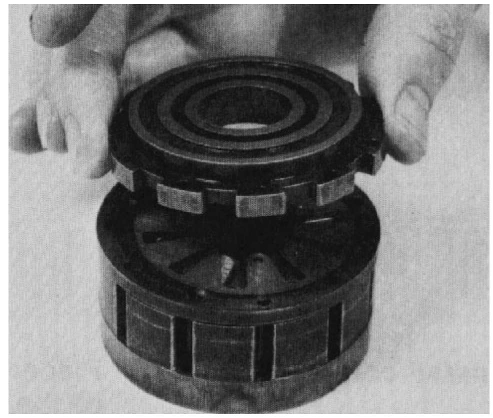


Figure 79

18. Screw the eleven hex socket head cap screws loosely into the metering package (Fig. 80).

NOTE: The commutator ring must be concentric with the drive plate within 0.005 in. (0.127 mm) total indicator reading AFTER tightening the eleven hex socket head cap screws. The next two procedures are a method of achieving the concentricity.

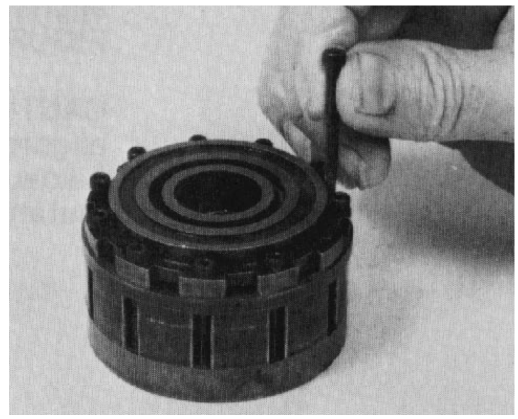


Figure 80

19. Put the metering ring on a hard flat surface. Put the assembled metering package into the metering ring with the commutator cover down, so the drive plate is partially out of the metering ring (Fig. 81). (A suitable wood block under the metering package will hold it in this position.) Put one piece of 0.007 in. (0.18 mm) shim stock approximately 0.5 in. (12 mm) wide and 1.5 in. (38 mm) long between the metering ring and drive plate in three places approximately equal distance around the outside diameter of the drive plate.

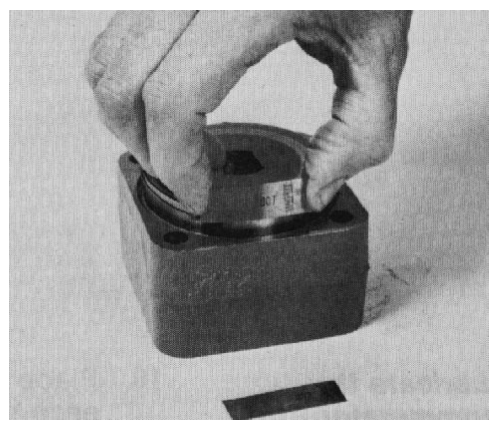


Figure 81

20. Put another piece of the 0.007 in. (0.18 mm) shim stock between the drive plate and each of the three pieces of shim stock already in place. Lift the metering ring and metering package and remove the wood block. Push the metering package and shims into the metering ring until the drive plate and shims are at least flush with the metering ring (Fig. 82).

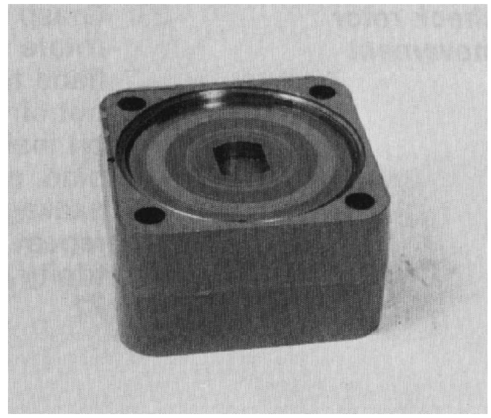


Figure 82

21. Reverse the metering ring and metering package as a unit on a flat surface. Push down on the metering package until the drive plate is on the flat surface. Be sure the cap screws are loose enough to allow the commutator ring and drive plate to align themselves concentrically in the metering ring bore. Gradually tighten the eleven cap screws, following the sequence shown in Figure 83 at least twice until a final torque of 11 - 13 in-lb (1.24 - 1.47 Nm) is reached (Fig. 83 and 84). Remove the metering package and shims from the metering ring. Discard the shims.

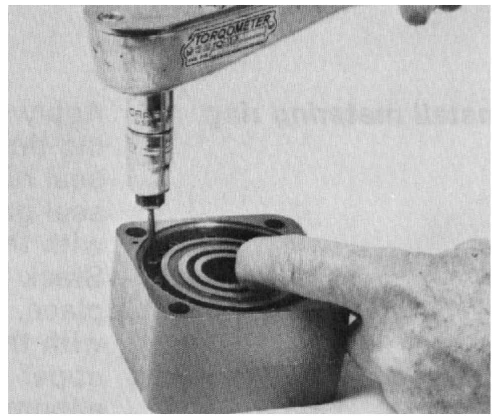


Figure 83

CAUTION

Use care and eye protection when adding and removing shims from the metering ring as the shims will be under spring tension and could fly into the air and cause injury.

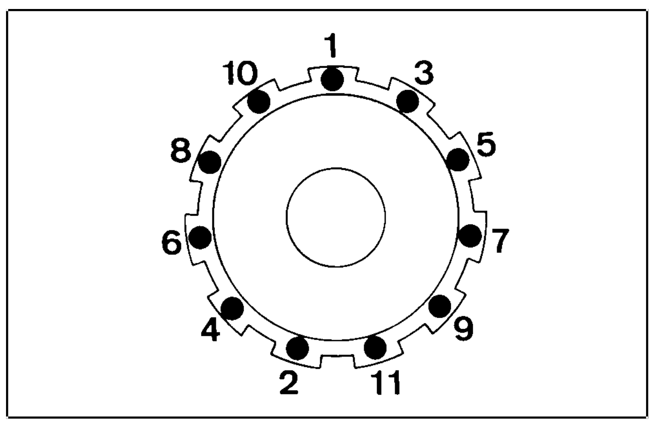


Figure 84

22. Insert the LARGE tang of the drive link into the slot in the rotor (Fig. 85).

IMPORTANT: An incorrect (reversed) assembly of the drive link will prevent the assembly of the hex drive.

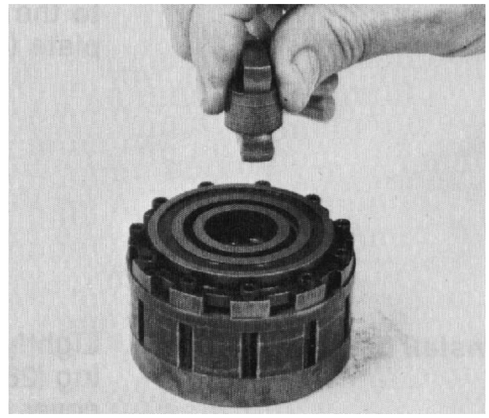


Figure 85

23. Grasp the drive link and rotate the metering package by hand to make sure the parts do not bind (Fig. 86). The rotor should orbit inside the stator. If they bind, disassemble the metering package, correct the cause and repeat the assembly and concentricity procedures.

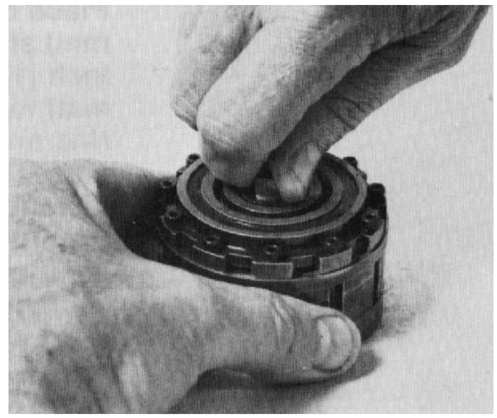


Figure 86

24. Apply clean multi-purpose grease to the metering ring seal ring. Put the seal ring into position in the metering ring seal groove opposite to the end with the alignment pin holes. Stack the metering ring into place, over the four bolts, with the seal ring towards the upper cover plate. Make sure an alignment pin hole on the metering ring is in line with and on the same side as the alignment groove on the side of the upper cover plate (Fig. 87). This is required so the other components can be aligned correctly.

IMPORTANT: Make sure the seal ring does not slip from position.

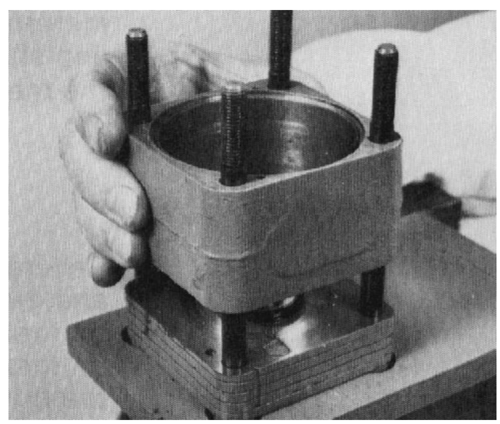


Figure 87

25. Put the bearing spacer onto the face of the upper cover plate (Fig. 88).

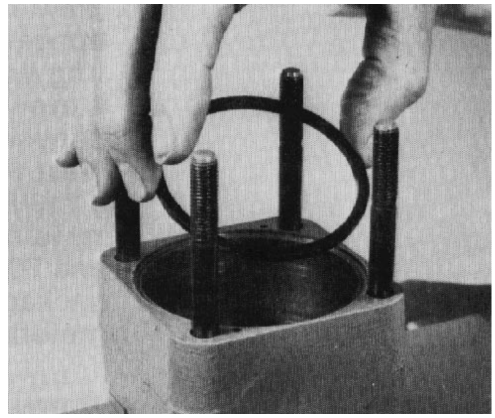


Figure 88

26. Lightly grease the roller thrust bearing and put it on the upper cover plate, inside the bearing spacer (Fig. 89).

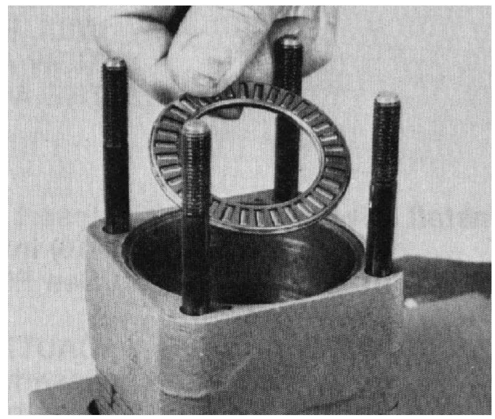


Figure 89

27. Inspect the exposed face of the drive plate making sure it is clean and lint free. Apply a small amount of clean multi-purpose grease on the drive plate (Fig. 90).

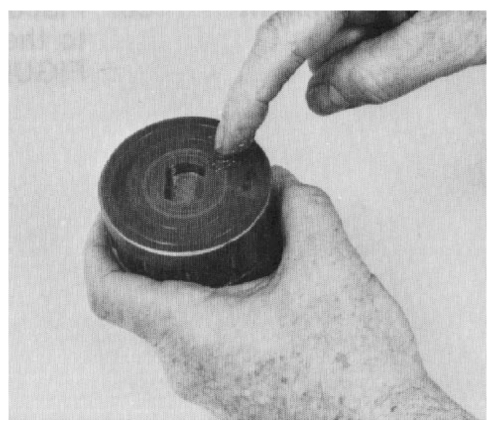


Figure 90

28. Put the metering package, drive plate side first, into the metering ring (Fig. 91). Revolve the input shaft or metering package until the hole in the drive plate engages the end of the input shaft and the drive plate is seated on the thrust bearing. When properly seated, the metering package will be below the surface of the metering ring.

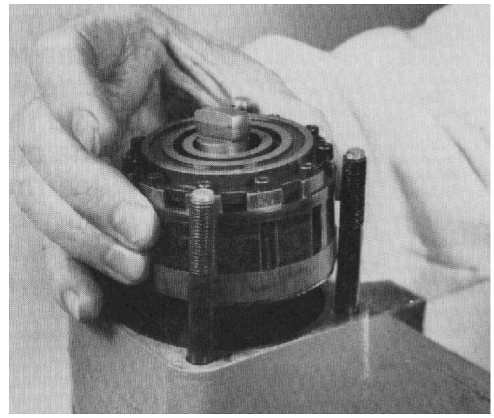


Figure 91

29. Apply clean multi-purpose grease on the new commutator seal and put it into the commutator cover seal groove (Fig. 92). The rubber portion (the softer side) of the seal with the yellow mark must be put into the seal groove.

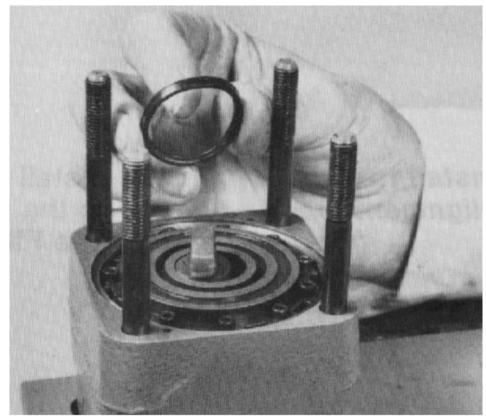


Figure 92

30. Apply clean multi-purpose grease to the metering ring seal ring. Put the seal ring into the metering ring seal ring groove (Fig. 93).

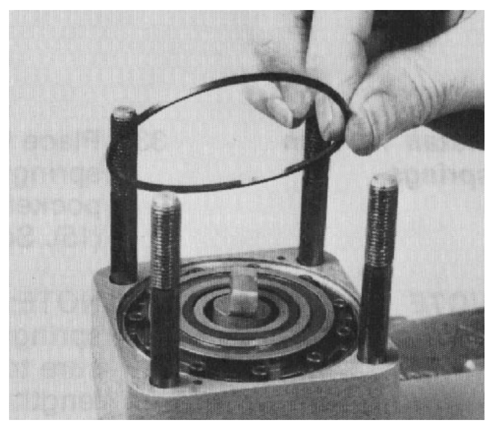


Figure 93

31. Put two alignment pins into the metering ring (Fig. 94).

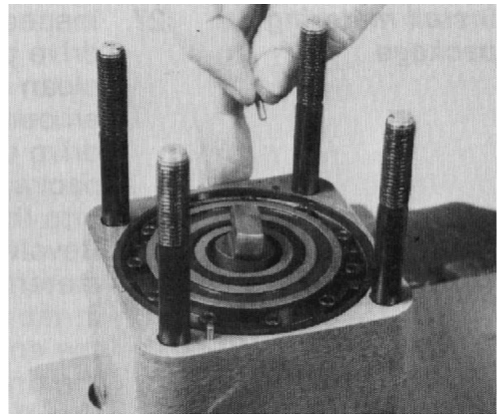


Figure 94

32. Stack the isolation manifold (4 plates bonded together) onto the metering ring, aligning the grooves on the side of the manifold with the grooves on the side of the upper cover plate (Fig. 95). Align the alignment pin holes with the alignment pins in the metering ring. The isolation manifold surface without the recessed slots must be toward the metering ring.

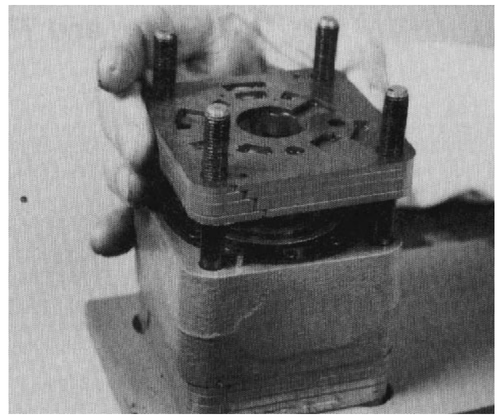


Figure 95

33. Install two alignment pins into the isolation manifold (Fig. 96).

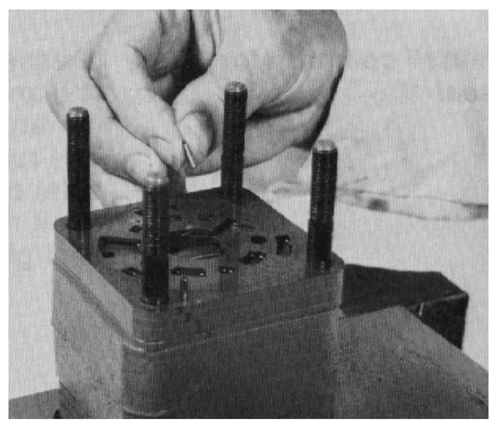


Figure 96

34. Put the three 1/2 in. (13 mm) springs into the spring pockets of the isolation manifold (Fig. 97).

NOTE: Two different length springs are used in the unit. Be sure to use the 1/2 in. (13 mm) length springs during this part of the assembly.

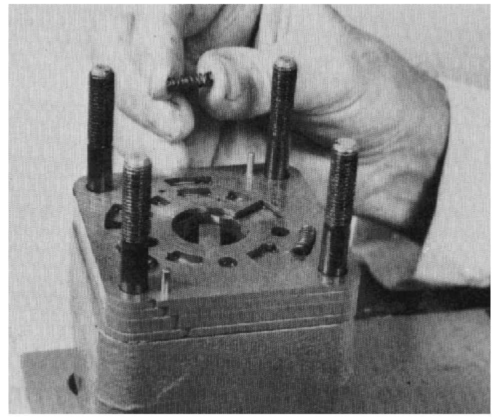


Figure 97

35. Apply clean grease to a seal ring and put it in the valve ring recess that will face down when installed. Install the valve ring over the bolts and alignment pins with the seal ring facing the isolation manifold (Fig. 98).

IMPORTANT: Be sure the seal ring is seated correctly after the valve ring is assembled.

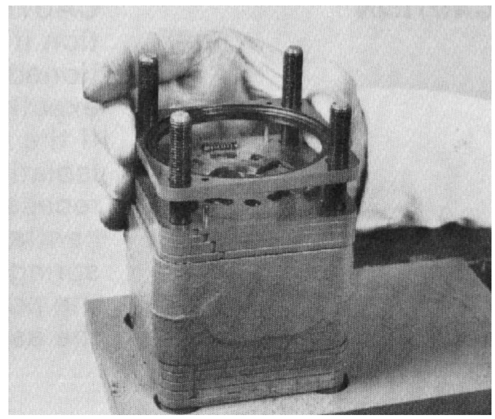


Figure 98

36. Put the hex drive assembly, pin side up, through the hole in the isolation manifold (Fig. 99). the slot in the hex drive must be engaged with the SMALL tang of the drive link. Turn the input shaft to assist the engagement.

NOTE: If the hex drive does not readily assemble on the drive link, the drive link was assembled incorrectly (See step 22 of this procedure.)

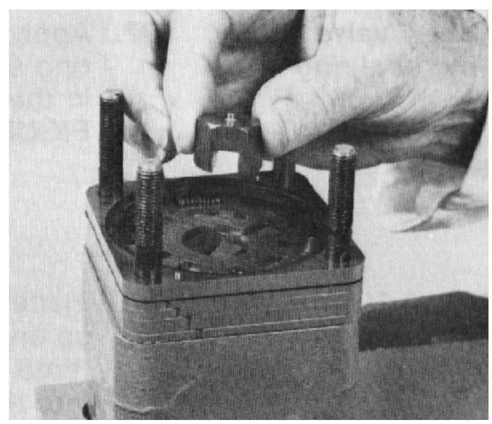


Figure 99

37. To install the valve plate correctly, first carefully study Figures 93 and 94 for positioning of the valve plate spring slots and other cavities in relation to the spring and spring recesses on the isolation manifold. Be sure to use the alignment grooves on the side of the isolation manifold for orientation.

Put the valve plate with the surface that reads “shaft side” down over the hex drive assembly. Align the three spring slots centrally over the three springs installed in the spring recesses of the isolation manifold. The valve plate spring slot with the small cavity and the words “port side” centrally below it (Fig. 100), must be placed over the spring and spring recess in the isolation manifold at the top (12 o’clock position) as shown (Fig. 100 and 101). Adjust the valve plate position radially to centralize the spring slots over the springs and the spring recesses in the isolation manifold.

IMPORTANT: The unit will not function if the valve plate is not positioned on the isolation manifold exactly as shown in Figure 101. If the valve plate spring slots, isolation manifold spring recesses and springs are not centrally aligned in this step, the springs could be damaged when the port manifold is installed onto the assembly.

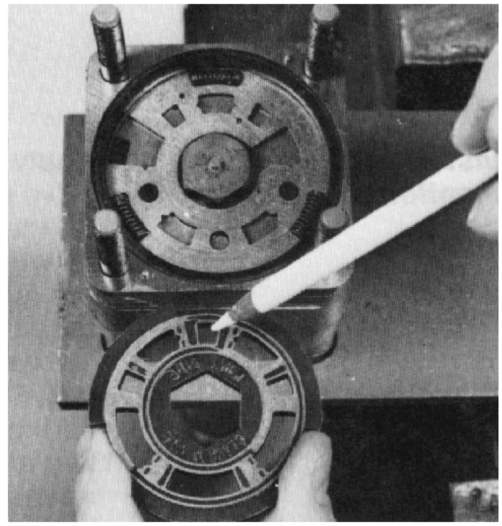


Figure 100

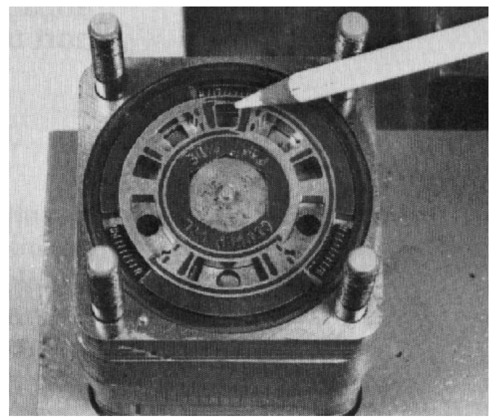


Figure 101

38. Apply clean multi-purpose grease to the valve ring seal ring. Install the seal ring in the valve ring (Fig. 102).

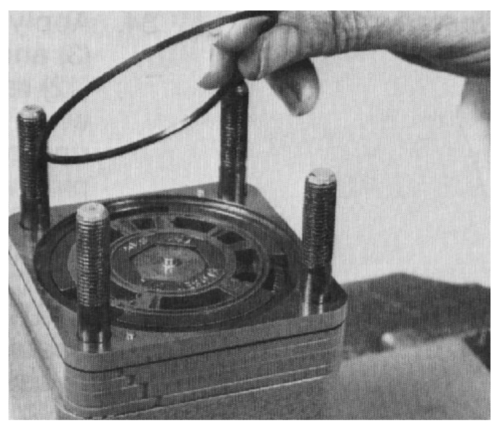


Figure 102

39. Put the port manifold (three plates bonded together), valve side up, in a clean surface. Install three 3/4 in. springs into the spring pockets (Fig. 103).

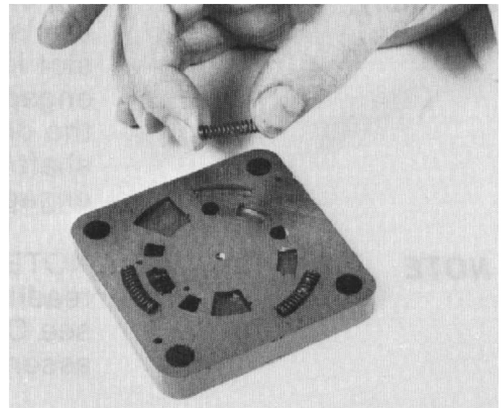


Figure 103

40. Apply a few drops of oil to the valve plate. Align the grooves on the side of the port manifold with the grooves on the side of the isolation manifold and assemble the port manifold with the springs toward the valve plate (Fig. 104). Be careful not to pinch a spring during installation. The two alignment pins in the valve plate will engage the holes in the port manifold. The pin on the hex drive assembly must engage the center hole in the port manifold.

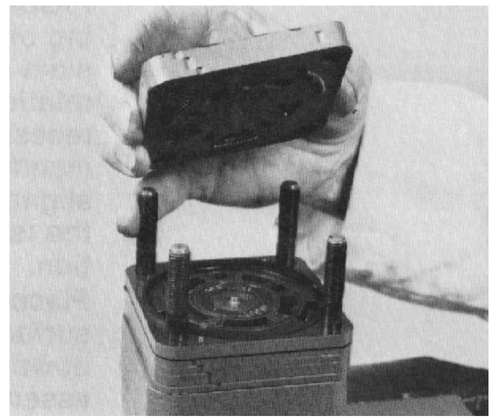


Figure 104

41. Install a new o-ring on the plug. Insert the check ball hole in the port cover. Be sure the ball is seated in the bottom of the check ball hole. Turn the plug assembly into the port cover until the ball is retained (Fig. 105).

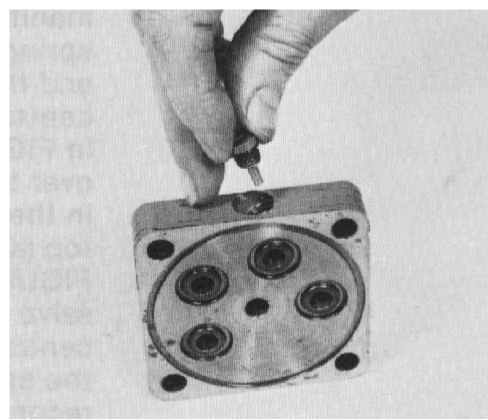


Figure 105

42. Apply clean multi-purpose grease to the four o-rings and seal ring. Put the new o-rings and seal ring into their proper location in the port cover (Fig. 106).

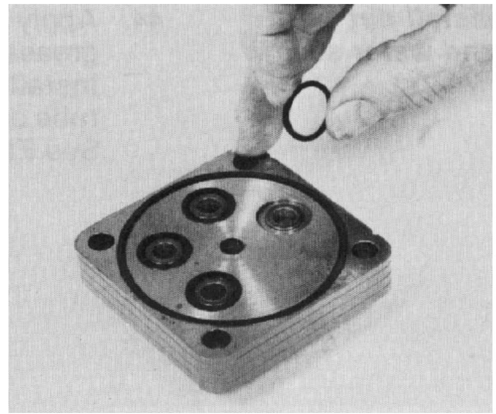


Figure 106

43. Align a groove on the side of the port cover with the grooves on the side of the port manifold and put the port cover into position (Fig. 107).

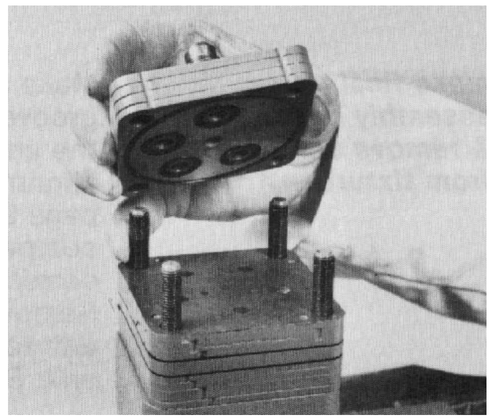


Figure 107

44. Install the lock nuts onto the bolts. Tighten each nut gradually until resistance is felt (Fig. 108). Tighten to a torque of 20 - 24 ft-lb (27 - 33 Nm) in the sequence shown (Fig. 109).

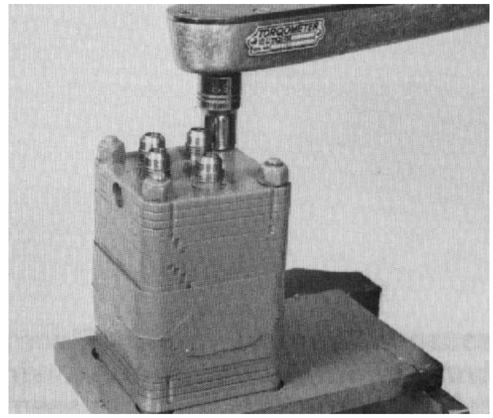


Figure 108

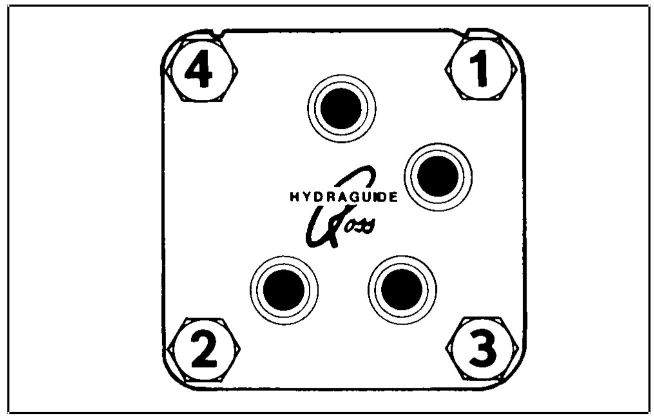


Figure 109

45. Tighten the plug to a torque of 8 - 12 ft-lb (11 - 16 Nm) (Fig. 110).

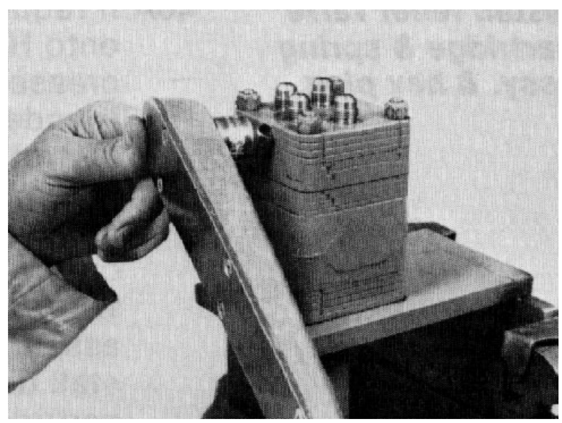


Figure 110

46. Apply a small amount of clean multi-purpose grease on the lip of the seal. Install the seal onto the jacket tube and input shaft (Fig. 111).

47. Make a final inspection of the relative groove positions on the side of the unit (Fig. 24). Components of the steering valve with alignment grooves, must be assembled so that their alignment grooves are positioned as illustrated for the valve to function correctly (Fig. 24). Disassemble and correct the assembly if necessary.

48. Remove the four nuts holding the unit to the fixture and remove the unit (Fig. 112).

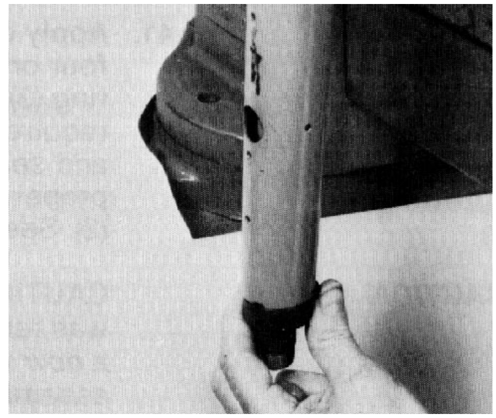


Figure 111

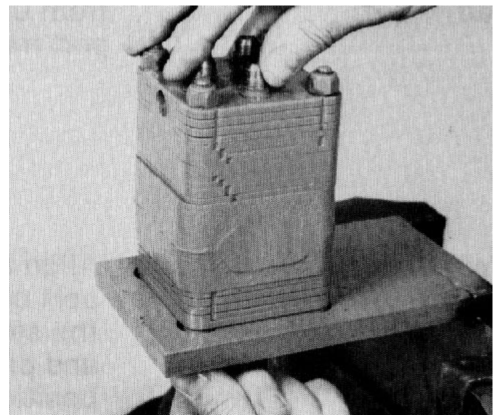


Figure 112

Chapter 9

Transmission Coupler and PTO

Table of Contents

INTRODUCTION 2
TROUBLESHOOTING 3
  Engine to Transmission Coupler 3
  PTO System 3
ADJUSTMENTS 4
  Checking Drive Coupling Alignment 4
  Adjusting Drive Coupling Alignment 4
  Correcting PTO Belt Slippage 5
  PTO Pulley and Engine Pulley Alignment 5
  PTO Brake Adjustment 6
REPAIRS 7
  Drive Coupling Removal and Installation. 7
  Engine Pulley Yoke Bearing Replacement 8
  PTO Brake Replacement. 8
  PTO Belt Replacement 9
  Removing PTO Control Lever and Linkage. . . . 10
  PTO Shaft and Bearing Service 11
  PTO Drive Shaft Removal and Installation 12
  PTO Drive Shaft Universal Joint Replacement . 13
  Installing the PTO Drive Shaft 14

Introduction

Engine to Transmission Coupler (Fig. 1)

Engine power is transmitted from the engine through a flexible coupling and drive link to the hydrostatic transmission. With this Toro design, there is no clutch used between the engine and the transmission.

The drive coupling consists of three main components: a metal drive coupling (shaft), a rubber coupling bolted to each end of the shaft, and the pump hub.

PTO System (Fig. 1)

The power take-off (PTO) system transmits power from the engine to the cutting deck or other implement attached to the from of the machine.

The PTO lever has two positions: ON (engage) and OFF (disengage). To engage the PTO shaft, slowly push the PTO lever fully forward to the ON position; this will start the implement or cutting unit blades. Slowly pull the lever backward to the OFF position to stop the implement's operation. The only time the PTO lever should be in the ON position is when the implement or cutting unit is down in the operating position and the operator is in the seat.

DANGER

Do not start the engine and engage the P.T.O. lever when the P.T.O. shaft is not connected to the gearbox on the cutting unit or other implement. If the engine is started and the P.T.O. shaft Is allowed to rotate, serious Injury could result.

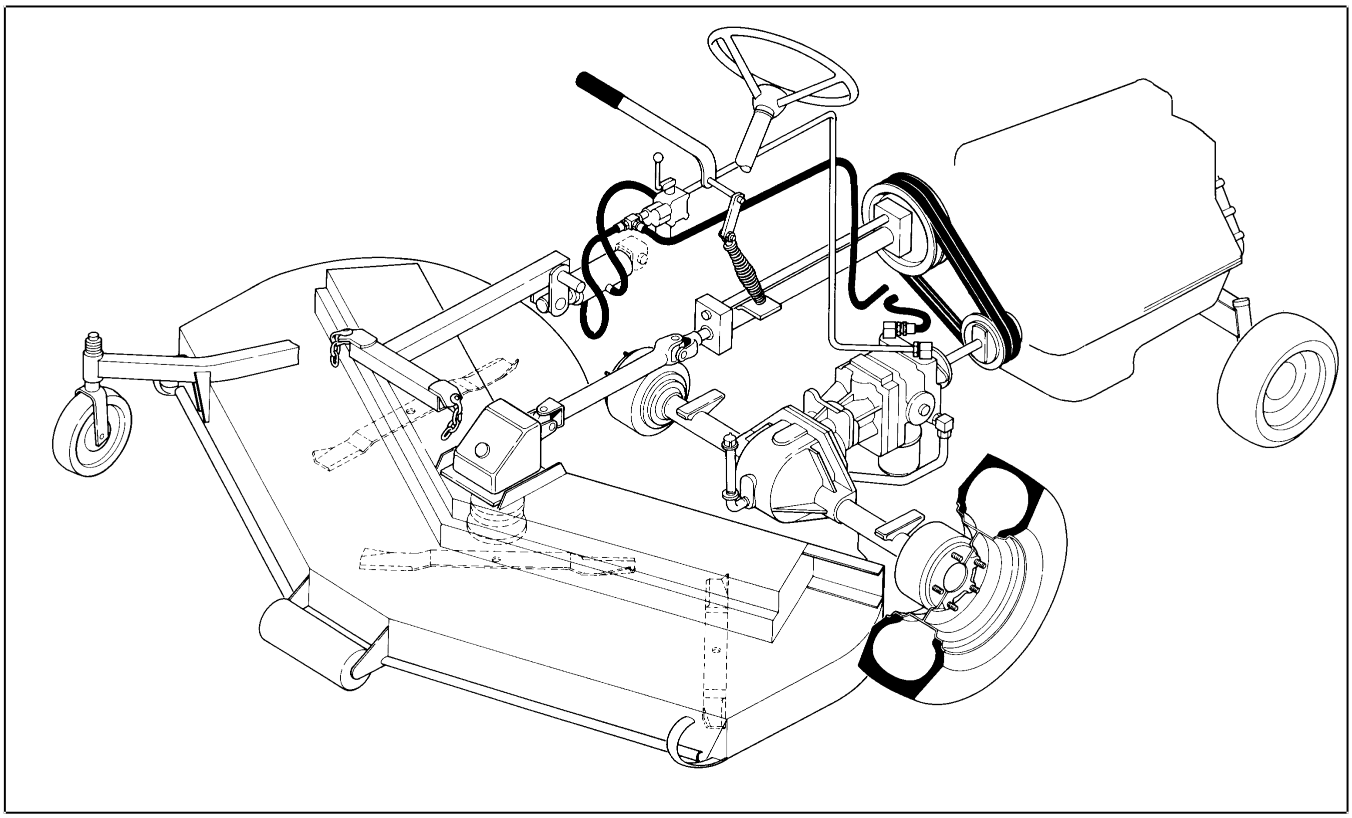


Figure 1

Troubleshooting

Engine to Transmission Coupler

Problem	Possible Cause
Output shaft bearing failure.	Lack of lubrication. Output shaft out of alignment.
Excessive vibration of drive coupling.	Drive coupling bent or deformed. Loose fasteners. Drive coupling out of alignment.
Flexible (rubber) couplings wear prematurely.	Drive coupling bent or deformed. Loose fasteners. Drive coupling out of alignment.
Pump hub damaged.	Drive coupling bent or deformed. Loose fasteners. Drive coupling out of alignment.

PTO System

Problem	Possible Cause
Machine vibrates excessively.	PTO shaft not properly aligned.
PTO drive shaft does not telescope.	Worn bearings or U-joints. Lack of lubrication to splines and tube.
Galling of U-joint journal cross-ends.	Drive shaft RPM to high. Lack of lubrication.
Abrasive corosion on PTO drive shaft.	Extreme low angle operation.
Broken U-joint journal.	Excessive shock loading to PTO shaft.

Checking Drive Coupling Alignment (Fig. 2)

When either the hydrostatic axle or the engine is removed and after all parts are reinstalled, the alignment of the drive coupling must be checked. In addition, any excess vibration usually indicates misalignment of the drive coupling. The drive coupling will be damaged when misalignment is more than 1/8 inch (3 mm).

To check the alignment of the drive couplings, place the square end of a ruler or scale against the face of the drive pulley and the bottom of the coupling retainer).If there is more than 1/8 inch (3 mm) between the ruler or scale and the opposite coupling retainer, or the scale is more than 1/8 inch (3 mm) higher than the bottom of the coupling, an adjustment is required. To correct for a misaligned drive coupling, proceed to “Adjusting Drive Coupling Alignment” which follows.

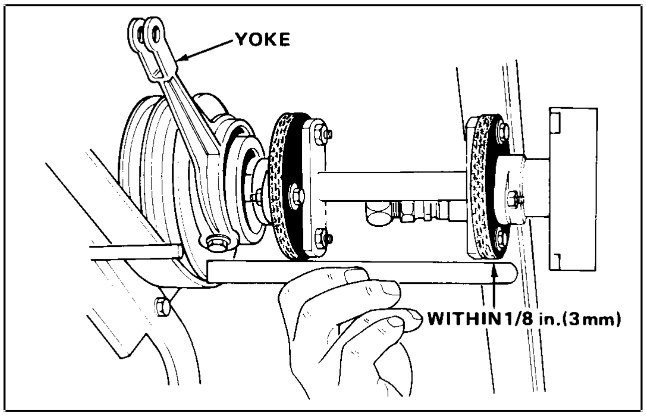


Figure 2

Adjusting Drive Coupling Alignment (Fig. 3, 4)

To correct drive coupling misalignment, first loosen the axle support nuts at the rear of the floor plate).

A transmission that is too high at the drive coupling end may be lowered by installing a 1/16 inch (1.6 mm) spacer between the rear of the mounting pad and the bottom of the frame. A transmission that is too low is corrected by installing a 1/16 inch (1.6 mm) spacer between the front of the mounting pad and the bottom of the frame.

To install the spacers, remove the appropriate two cap screws and loosen the other two. If the spacers must be added to the front of the mounting pad, remove the front cap screws and loosen the back ones. Do just the opposite to add spacers at the rear of the mounting pads.

After adding the spacers, install the two cap screws and tighten all of the cap screws to secure the axle in place. Check the alignment again. Continue to check the alignment and add shims as required. When the alignment is correct, tighten the axle support nuts. Tighten the rear nut with the fingers until it contacts the frame; then tighten the front nut securely. Secure the rear nut last.

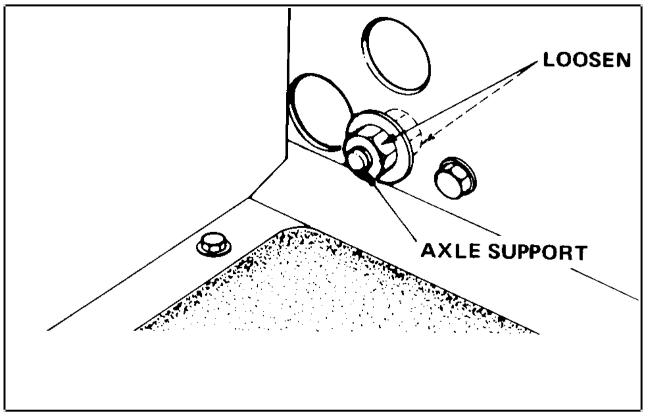


Figure 3

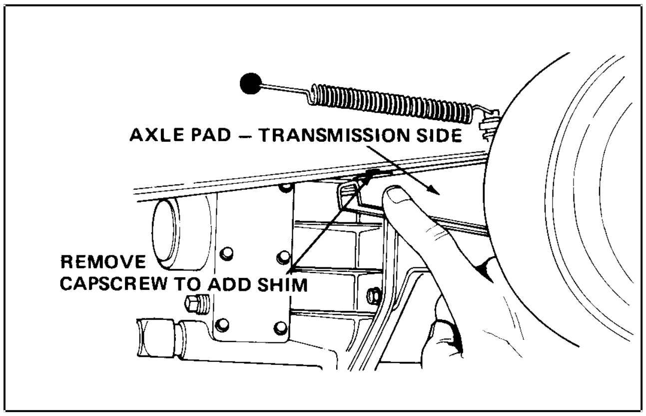


Figure 4

Correcting PTO Drive Belt Slippage (Fig. 5)

If belt begins to slip because it has stretched or because of worn linkage:

1. Unlatch and remove instrument cover.

2. Move PTO control lever to ON position.

3. Measure length of PTO spring between flat washers. There should be a spring length of 3-3/16 inches (81 mm).

4. To adjust, hold head of adjusting screw with wrench (under PTO actuating arm) and turn locknut.

5. Move PTO lever to OFF position and install instrument cover.

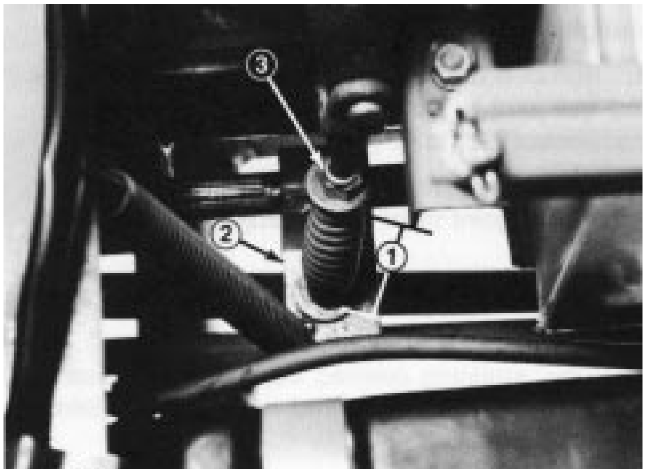


Figure 5

1. 3-3/16 in. (81 mm)
2. PTO actuating arm
3. Locknut

PTO Pulley and Engine Pulley Alignment (Fig. 6, 7)

1. Lower the implement to the shop floor, turn the engine off, remove the key from the ignition switch and engage the parking brake.

2. Move the P.T.O. lever to the ON position to move the pulley away from the brake. Remove the locknut holding the brake onto the mounting pin, and slide the spacer, brake and spring off of the pins.

3. Loosen the setscrews in the lock collars at the front and back of the P.T.O. shaft. Using a punch and hammer, loosen the collars by driving them in the opposite direction of the normal shaft rotation. The P.T.O. shaft and P.T.O. pulley assembly should now be free to slide.

4. Using a straight edge, line up the top of the engine pulley, with the top of the P.T.O. pulley. When the top of the pulleys are aligned, the bottom of the pulleys are misaligned by three degrees. Move the P.T.O. pulley until its top is in line with the top of the engine pulley. Then lock the pivot shaft and pulley in place by tightening the lock collars in the normal direction of shaft rotation. Check the alignment of the pulleys again to assure that the alignment did not change when the collars were tightened. If alignment is still correct, tighten the lock collar setscrews.

5. Slide the spring onto the large brake mounting pin. Then slide the brake onto the mounting pin and the small locating pin.

6. Move P.T.O. lever to OFF and position brake in grooves of pulley. Slide spacer onto mounting pin and secure all parts in place with the locknut. Tighten locknut until spacer contacts the brake.

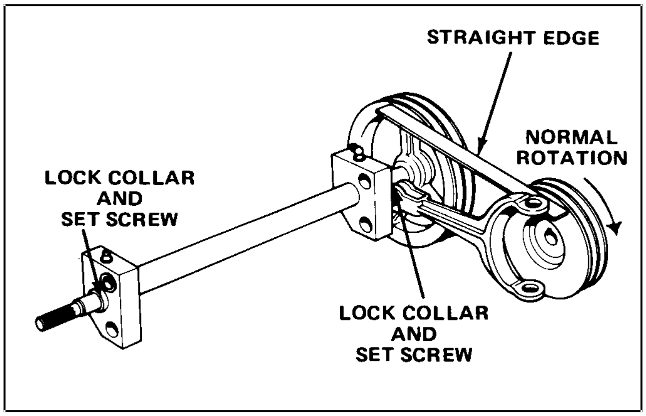


Figure 6

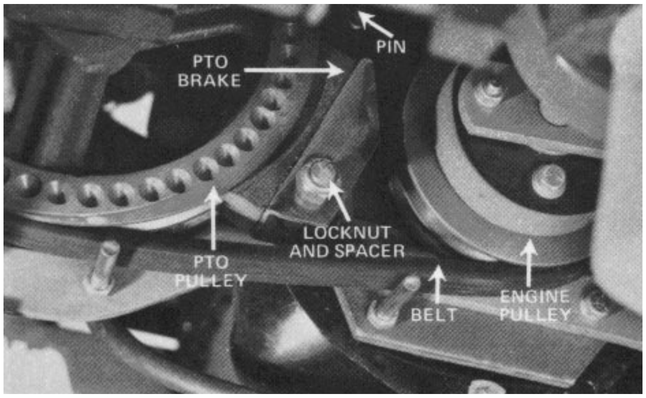


Figure 7

PTO Brake Adjustment (Fig. 8)

1 . Lower the implement to the shop floor, turn the engine off, remove the key from the ignition switch, and engage the parking brake.

2. Move the P.T.O. lever to the ENGAGE position. Loosen the adjusting locknut so that the brake is free to move. Then move the P.T.O. lever to OFF and position the brake in the grooves of the pulley.

3. Tighten the locknut until the spacer contacts the side of the brake bracket.

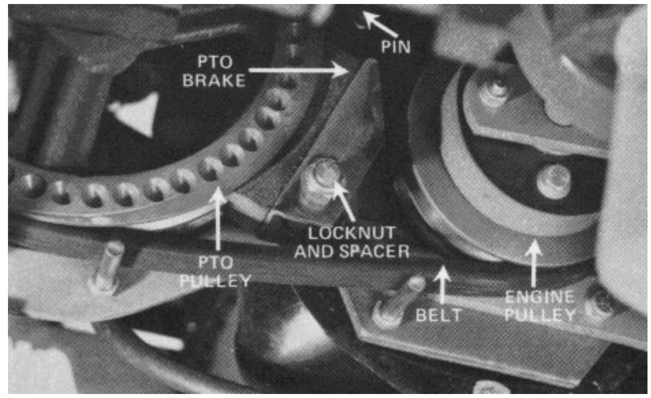


Figure 8

Drive Coupling Removal and Installation (Fig. 9)

Removing Drive Couplings

1. Lower the cutting unit to the shop floor, turn the engine off, remove the key from the ignition switch and engage the parking brake.

2. Raise the seat and secure it in that position.

3. Jack up the back end of the machine and support it with jackstands to prevent it from falling accidentally.

4. Block the front and back of the traction unit's drive wheels to prevent the machine from rolling.

5. Remove the two cap screws, lock washers, flat washers and spacers securing the drive coupling assembly to the engine hub. Remove the two cap screws, flat washers and locknuts securing the coupler to the transmission hub. Slide the assembly out after the cap screws have been removed.

6. If the drive coupling assembly must be disassembled, separate the rubber couplings (Item 17) from the drive coupling (Item 18) by removing the nuts, flatwashers and cap screws.

Installing Drive Couplings

1. Assemble the rubber couplings and drive coupling with the cap screws, flat washers and nuts.

2. Position the drive coupling assembly between the engine hub and transmission hub; align the holes. Secure the drive coupling to the hubs with cap screws, lock washers, flat washers, and nuts. Tighten the cap screws alternately and evenly to prevent distortion of the rubber couplings.

NOTE: After installing the drive coupling assembly, the rubber coupling must not be deformed more than .125 in. (3 mm) in either direction. If the rubber coupling is deformed, correct by loosening the transmission hub hub setscrews and changing the position of the hub. The end of the pump hub must be positioned 0.60 - .250 in. (1.5 - 6 mm) away from the transmission face. Tighten the setscrews on the hub(s) to a torque of 12 ft-lb (1.7 Kgm)

3. Remove the wheel blocks and jackstands. Lower the machine to the shop floor.

4. Lower the seat and start the engine to test for proper operation of the coupling components.

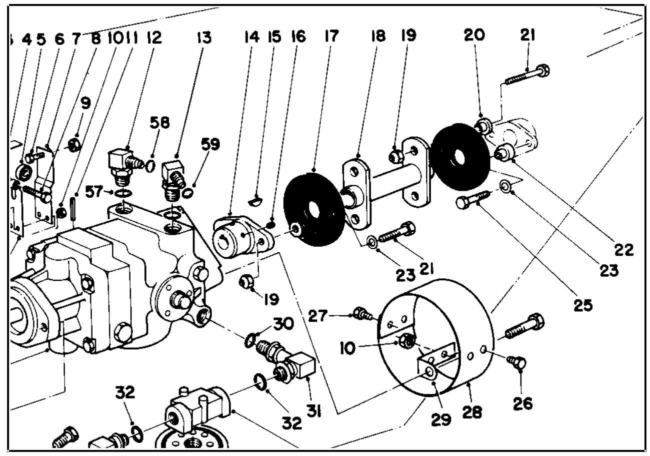


Figure 9

Engine Pulley Yoke Bearing Replacement (Fig. 10)

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

2. Remove the drive coupling as described in “Removing Drive Couplings”.

3. Remove the engine hub from the crankshaft pulley after loosening the two setscrews that secure it in place. Remove the woodruff key.

4. Use a thin screwdriver to remove the external retaining ring that secures the bearing onto the crankshaft pulley shaft.

5. Remove the two cap screws and spacers that secure the large yoke to the bearing collar.

6. Use a pry bar to carefully remove the bearing and bearing collar from the crankshaft pulley shaft.

7. Remove the bearing from the bearing collar after removing the large internal snap ring from the bearing collar. An arbor press should be used to press the bearing out of the collar.

8. After bearing service, reinstall the components in reverse order.

9. Lubricate the bearing with No. 2 general purpose lithium base grease.

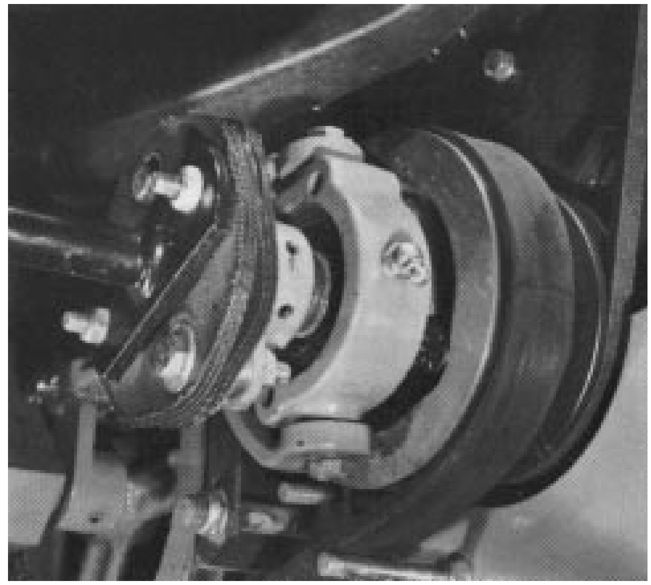


Figure 10

PTO Brake Replacement (Fig. 11)

1. Lower the implement to the shop floor, turn the engine off, remove the key from the ignition switch, and engage the parking brake.

2. Move the P.T.O. lever to the ENGAGE position to move the pulley away from the brake.

3. Remove the locknut holding the brake onto the mounting pin. Slide the spacer, brake and spring off of the pins.

4. Reverse procedures to install the brake.

5. Adjust the brake as described in “Adjusting the P.T.O. Brake”.

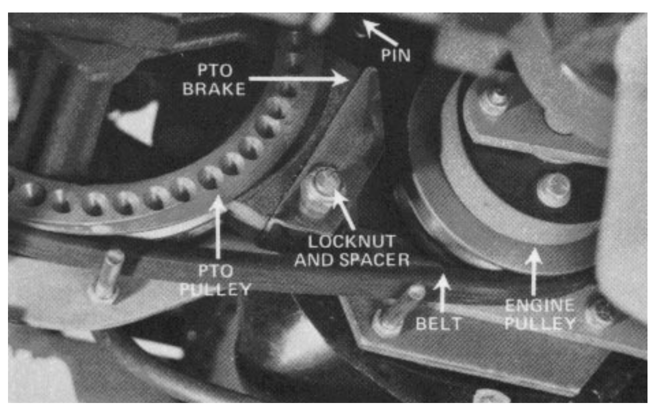


Figure 11

PTO Belt Replacement (Fig. 12)

The PTO belt is a special double belt referred to as a “torque team belt.”

1. To replace the belt, lower the implement to the shop floor, turn the engine off, remove the key from the ignition switch, and engage the parking brake.

2. Remove the drive coupling from between the engine pulley and transmission hub; refer to “Removing Drive Couplings”.

3. Move the P.T.O. lever to the ON position and remove the P.T.O. brake; refer to “Replacing The P.T.O. Brake”.

4. Move the P.T.O. lever to the OFF position to release the tension on the belt.

5. Remove the cotter pin and clevis pin from the P.T.O. fork and pivot the P.T.O. fork forward, off of the P.T.O. arm.

6. Roll the old belt off of the engine pulley and P.T.O. pulley by carefully turning the P.T.O. pulley (by hand) and moving the belt across the pulley grooves.

7. To install the new belt, roll the belt onto the P.T.O. pulley and engine pulley, making sure the belt is to the inside of the three belt guides.

8. Install the P.T.O. fork onto the P.T.O. arm and secure it with the clevis pin and a new cotter pin.

9. Install the P.T.O. brake between the pulleys and adjust it; refer to “Adjusting The P.T.O. Brake”.

10. Install the drive coupling between the engine pulley and transmission hub; refer to “Installing Drive Couplings”.

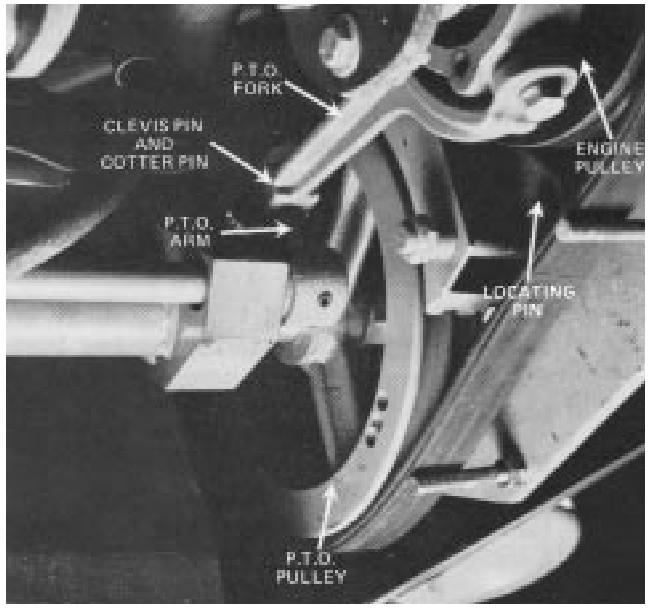


Figure 12

Removing PTO Control Lever and Linkage (Fig. 13, 14)

1. Lower the implement to the shop floor and turn the engine off. Engage the parking brake.

2. Unlatch and remove the instrument panel cover.

3. With the control lever in the OFF position, the P.T.O. compression spring tension is released and the linkage can be removed or repaired.

4. Remove the long cap screw (Fig. 14, Item 35) that passes through the P.T.O. compression spring (Item 48). Have a helper hold the nuts (Item 33, 34) on the top of the compression spring using the appropriate wrench. Then remove the spring, washers and cap screw.

5. Remove the cotter pin (Item 8) from the clevis pin (Item 7) that secures the P.T.O. lever to the P.T.O. compression spring yoke (Item 51). Remove the clevis pin and yoke.

6. Use locking pliers to grasp the tension spring (Item 50) which is attached to the frame just forward and left of the P.T.O. lever. Unhook and remove the tension spring from the P.T.O. assembly.

NOTE: There is an additional spring hook (Fig. 13) used in conjunction with the tension spring. Be certain that this hook is replaced as during reassembly or the spring itself will soon break due to excessive tension.

7. Remove the four cap screws from the P.T.O. lever clamp (Item 54). Lift the P.T.O. interlock switch bracket (Item 6) off and set aside. Remove the clamp and P.T.O. lever assembly.

8. Reverse steps 2 - 7 to reinstall the assembly.

9. Adjust the compression spring refer to “Correcting P.T.O. Drive Belt Slippage”.

10. See Chapter 6, Electrical System, for P.T.O. interlock switch repair and replacement.

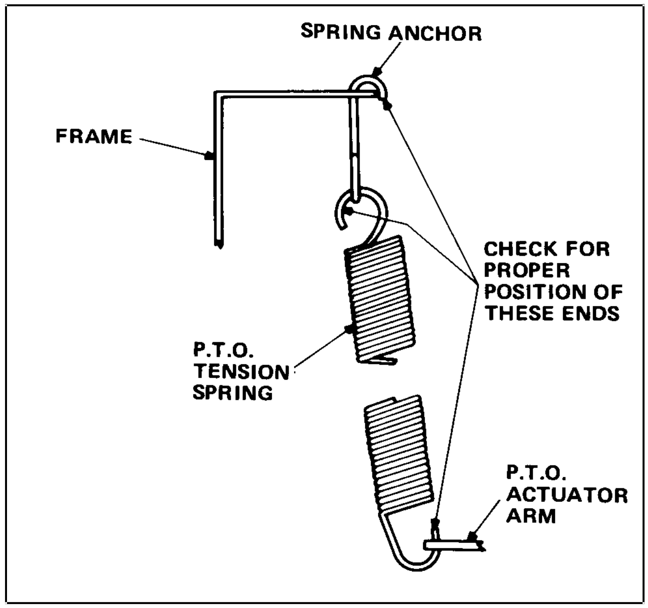


Figure 13

PTO Shaft and Bearing Service (Fig. 14)

1. Remove the P.T.O. belt; refer to “Replacing the P.T.O. Belt”.

2. Remove the clevis pin (Item 7) from the P.T.O. lever and compression spring yoke.

3. Remove the tension spring (Item 50) using a locking pliers; refer to instructions and note of step 6 in “Removing Control Lever and Linkage”.

4. Remove the roll pins (Item 49) from the pivot shaft (Item 9).

5. Remove the pivot shaft and lower the P.T.O. pivot assembly down and out of the traction frame.

6. Loosen the setscrews (Item 46) on the P.T.O. shaft bearing collars (Item 41). Use a punch and hammer to rotate the collars in the opposite direction of shaft rotation. Remove the shaft (Item 43) and bearings (Item 40).

7. Replace any worn bushings, bearings and shafts.

8. Reassemble in reverse order and check the alignment of the P.T.O. pulley. Adjust P.T.O. brake as necessary; refer to “Aligning the P.T.O. Pulley and Engine Pulley”.

9. Adjust the compression spring; refer to “Correcting P.T.O. Drive Belt Slippage”.

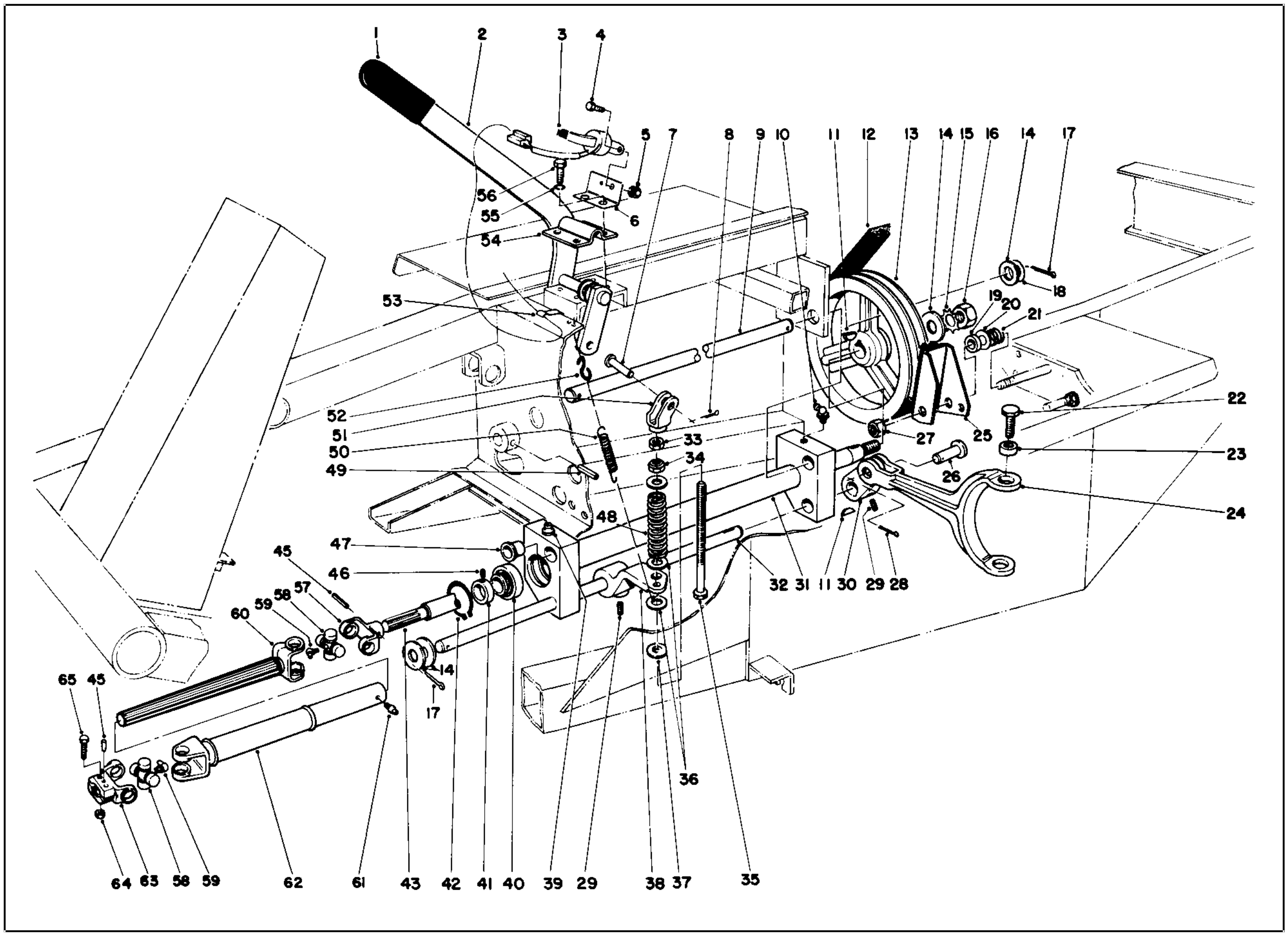


Figure 14

PTO Drive Shaft Removal (Fig. 15)

DANGER

Do not start the engine and engage the P.T.O. lever when the P.T.O. shaft is not connected to the gearbox on the cutting unit. If the engine is started and the P.T.O. shaft Is allowed to rotate, serious Injury could result.

1. Position the machine on a level surface, lower the cutting unit to the shop floor, turn the engine off, remove the key from the ignition switch, and engage the parking brake.

2. Remove the self-tapping screws securing the shield behind the cutting unit gear box and set the shield aside.

3. Drive the roll pin out of the yoke and the input shaft of the gearbox. Slide the yoke off of the input shaft. If the traction unit will be used without the cutting unit, drive the roll pin out of the yoke at the P.T.O. pivot shaft and remove the entire universal shaft from the traction unit.

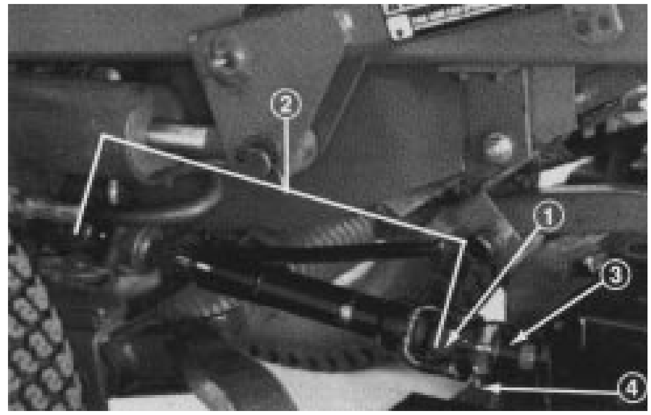


Figure 15

1. PTO yoke
2. Yokes in phase
3. Roll pin
4. Capscrews & locknuts

PTO Drive Shaft Universal Joint Replacement (Fig. 16, 17)

1 Remove the P.T.O. drive shaft.

2. Separate the two sections of the P.T.O. shaft.

3. Mount the section to be repaired in a vise so that the U-joint is pointing upward.

NOTE: If the splined portion is to be repaired, protect the splines from vise damage with wooden blocks, vise jaw cushions, etc.

4. Use two thin screwdrivers to remove the “C” shaped snap ring from each of the U-joint rollers (located inside of each yoke). Remove the shaft from the vise.

5. The vise may now be used as a press by placing a small socket against one roller and a large socket against the yoke on the opposite side. As the vise is closed, the small socket will force the cross to push the opposite roller partway into the large socket.

6. When the roller is forced partway out, grasp the roller and strike the yoke to complete removal. Do not spill the needle bearings.

7. Follow steps 5 and 6 to complete the removal of the U-joint from the P.T.O. shaft.

8. When replacing the U-joint, pack the roller bearings with the recommended lubricant (multi-purpose grease). Pack carefully to eliminate trapped air. Install seals.

9. Start one of the rollers in the yoke. Insert from the bottom with the open side of the roller up to prevent loss of the needles. Make sure that each roller contains all of the needles.

10. Insert one of the cross trunnions into the roller. Start the other roller making certain it slips over the trunnion.

11. When partially seated, place the two rollers between the vise jaws. Squeeze until FLUSH with the yoke. Stop when flush; do not over-tighten.

12. Tap one of the rollers (use a brass punch the full width of the roller) through the yoke until the snap ring can be inserted. Insert the snap ring. Use new snap rings. Make certain the snap ring is seated to full depth.

13. Support the cross and strike the yoke to force the snap ring against the inner face of the yoke. Always seat the roller in this fashion to prevent improper centering of the cross.

14. Install the other snap ring or rings and seat the rollers against the rings.

15. Grease the fitting SLOWLY until grease starts to show at the seals. Use a low pressure hand grease gun or a power gun equipped with a pressure relief valve. Never use a high pressure gun without this adapter as it is possible to blow the rollers out of the yokes with the tremendous pressure; seals may also be damaged.

16. Test the action of the assembled joint. It should move throughout its range without binding. If a slight bind exists, rap the yoke lugs with a soft hammer. This will usually free the joint. If it does not, disassemble and check for the source of the bind.

IMPORTANT: When clamping in the vise, clamp the solid portion of the U-joint. If the yoke must be clamped, clamp lightly. Use jaw covers. Avoid clamping the tube portion of the propeller shaft as it is thin and easily crushed. Never clamp the tube portion, even lightly, when it is necessary to hammer on the yoke. Support the free end of the propeller shaft to remove some of the strain from the clamped end.

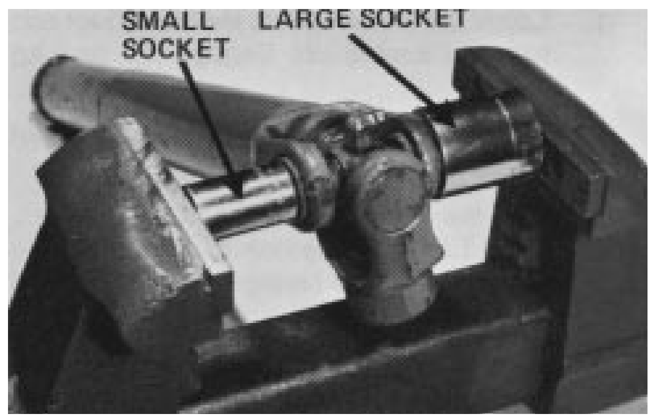


Figure 16

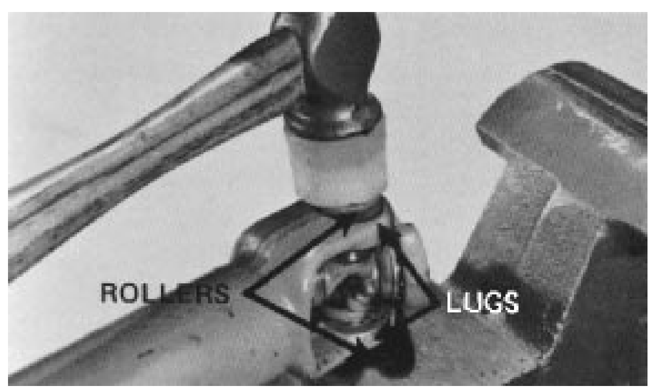


Figure 17

Installing the PTO Drive Shaft (Fig. 18, 19)

DANGER

Do not start the engine and engage the P.T.O. lever when the P.T.O. shaft is not connected to the gearbox on the cutting unit. If the engine is started and the P.T.O. shaft Is allowed to rotate, serious Injury could result.

The P.T.O. Drive Shaft has two major components. When replacing it on the machine, the spline shaft portion attaches to the traction unit and the tube portion attaches to the cutting unit gearbox.

IMPORTANT: The P.T.O. shaft yokes must be exactly in line with each other when the outer P.T.O. sleeve is installed on the splined shaft. Remove the sleeve and change the yoke position if alignment is not correct. Misalignment of the yokes will shorten the life of the P.T.O. Drive Shaft assembly and cause unnecessary vibration when the cutting unit is operated.

1. Line up the holes in the yoke and the input shaft of the gearbox. Slide the yoke onto the shaft and secure the parts together with the roll pin.

2. Mount the P.T.O. shield over the input shaft and onto the gearbox mounting plate with the two self-tapping screws.

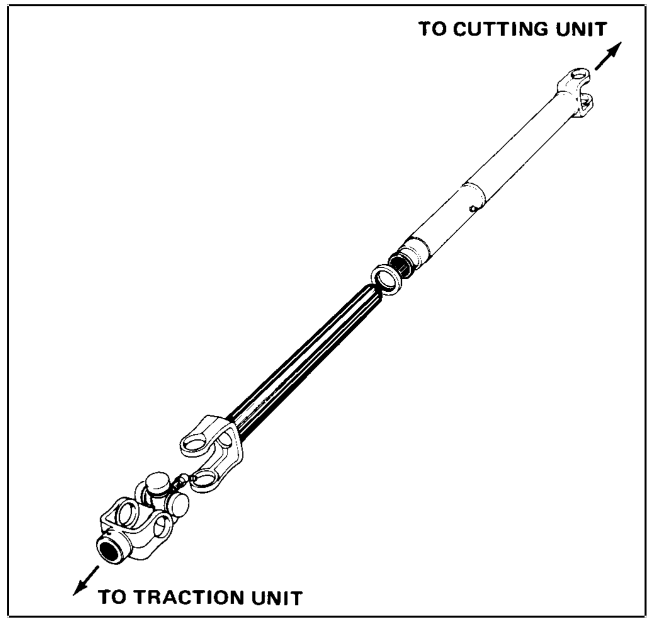


Figure 18

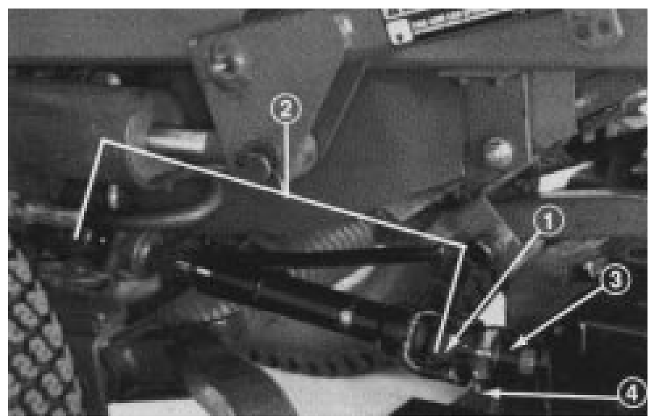


Figure 19

1. PTO yoke
2. Yokes in phase
3. Roll pin
4. Capscrews & locknuts

Chapter 10

GM322-D or GM325-D with Inasaka axle

4WD Rear Axle

Table of Contents

SPECIFICATIONS 2
GENERAL INFORMATION 3
    Over-Running Clutch Operation 3
ADJUSTMENTS 4
    Rear Wheel Toe-in. 4
REPAIRS 5
    Drive Shaft Service 5
    Rear Axle Removal and Installation. 7
    Axle Repair 8

Specifications

Item	Specification
Lubricant (Fig. 1, 2)	SAE 80W90 gear lube
Rear wheel toe-in	1/8 inch
Rear wheel bolt torque	45 - 55 ft-lb

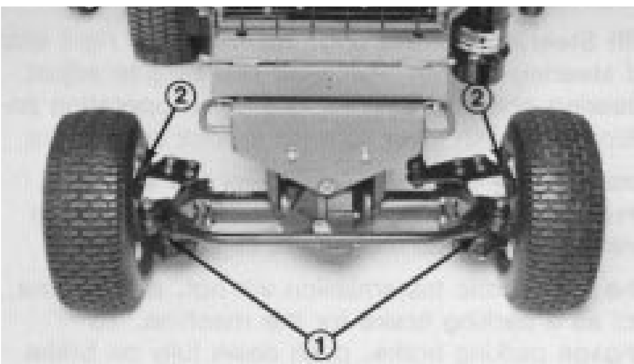


Figure 1

1. Check plugs (2) **2. Mounting bolts**

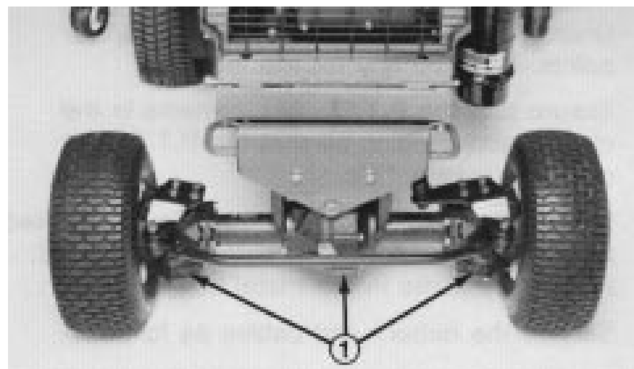


Figure 2

1. Drain plugs

Over-Running Clutch Operation

A drive shaft connected to the front axle provides power for the rear 4WD drive axle. The drive shaft tor the rear axle incorporates an OVER-RUNNING (ROLLER) CLUTCH THAT TRANSMITS POWER ONLY IN THE FORWARD DIRECTION (Fig. 4).

Front and rear axle gear ratios and tire sizes were carefully selected so that during normal operation, the REAR AXLE PINION SHAFT TURNS SLIGHTLY FASTER THAN THE REAR AXLE DRIVE SHAFT.

Any time the front wheels begin to slip (such as when climbing a steep hill), the forward movement of the traction unit slows. This causes the rear axle pinion speed to slow down. As soon as the rear axle pinion is turning the same speed as the drive shaft, the roller clutch will engage and power will be transmitted from the drive shaft to the rear wheels – four wheel drive (Fig. 4).

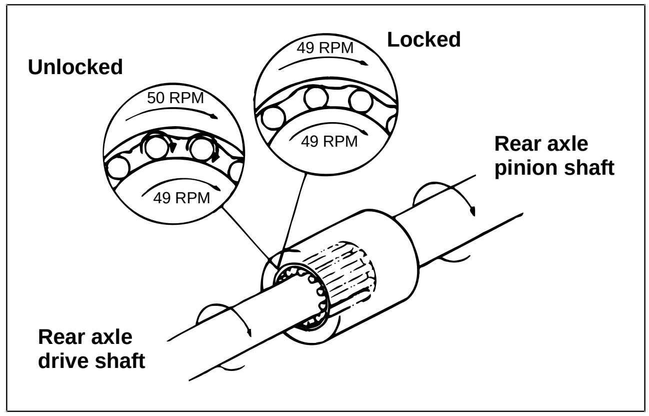


Figure 4

When the traction unit is turning, the rear wheels swing out in a larger arc and must travel faster than the front wheels. In this condition, the rear wheels and axle pinion shaft are turning faster than the drive shaft and the roller clutch is disengaged (Fig. 5).

NOTE: The four wheel drive system may not operate properly if the tires are replaced by different size tires, or if proper tire pressure is not maintained.

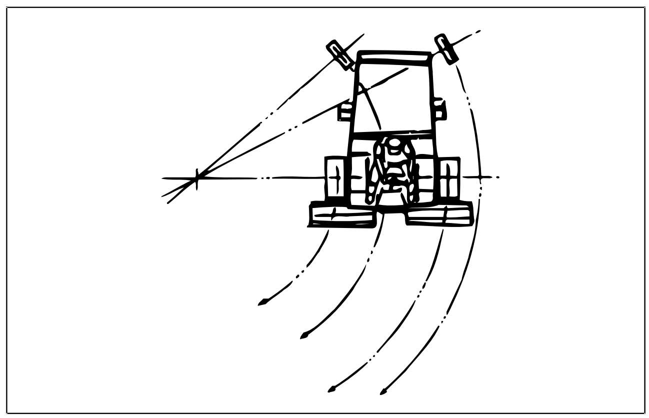


Figure 5

Adjustments

Rear Wheel Toe-in (Fig. 6)

1. Measure center–to–center distance (at axle height) at front and rear of steering tires. Front measurement must be 0 to 1/8 in. less than rear measurement.

2. Remove cotter pin and nut securing one tie rod ball joint to mounting bracket on axle and disconnect ball joint from axle (Fig. 7).

3. Loosen screw on tie rod clamp. Rotate ball joint in or out to adjust length of tie rod.

4. Reinstall ball joint ot mounting bracket and check wheel toe-in.

5. After getting correct adjustment, tighten screw on tie rod clamp and connect ball joint to mounting bracket with nut and cotter pin.

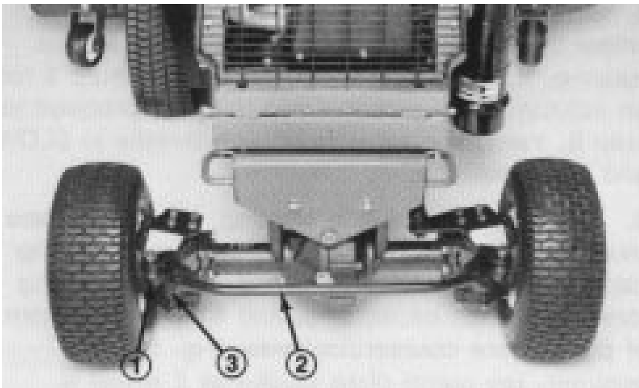


Figure 6

1. Ball joint
2. Tie rod
3. Tie rod clamp

Steering Stop Adjustment (Fig. 7)

The rear axle steering stops help prevent over travel of the steering cylinder in case of impact on rear wheels. The stops should be adjusted so there is 0.090 in. clearance between bolt head and knuckle on axle when steering wheel is completely turned left or right.

1. Thread bolt in out out unitl 0.090 in. clearance is attained (Fig. 7)

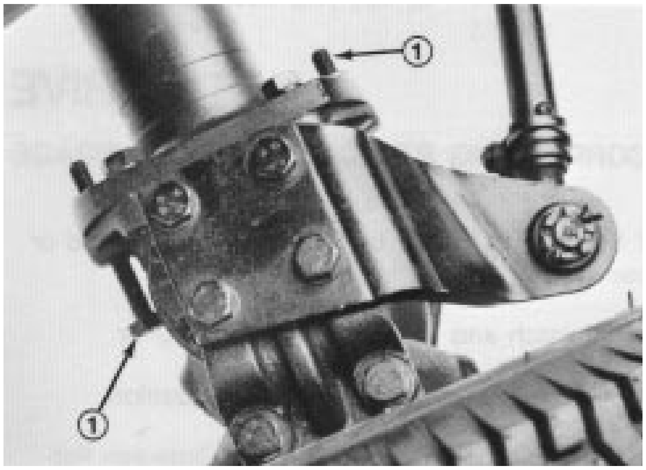


Figure 7

1. Steering stops

Drive Shaft Service

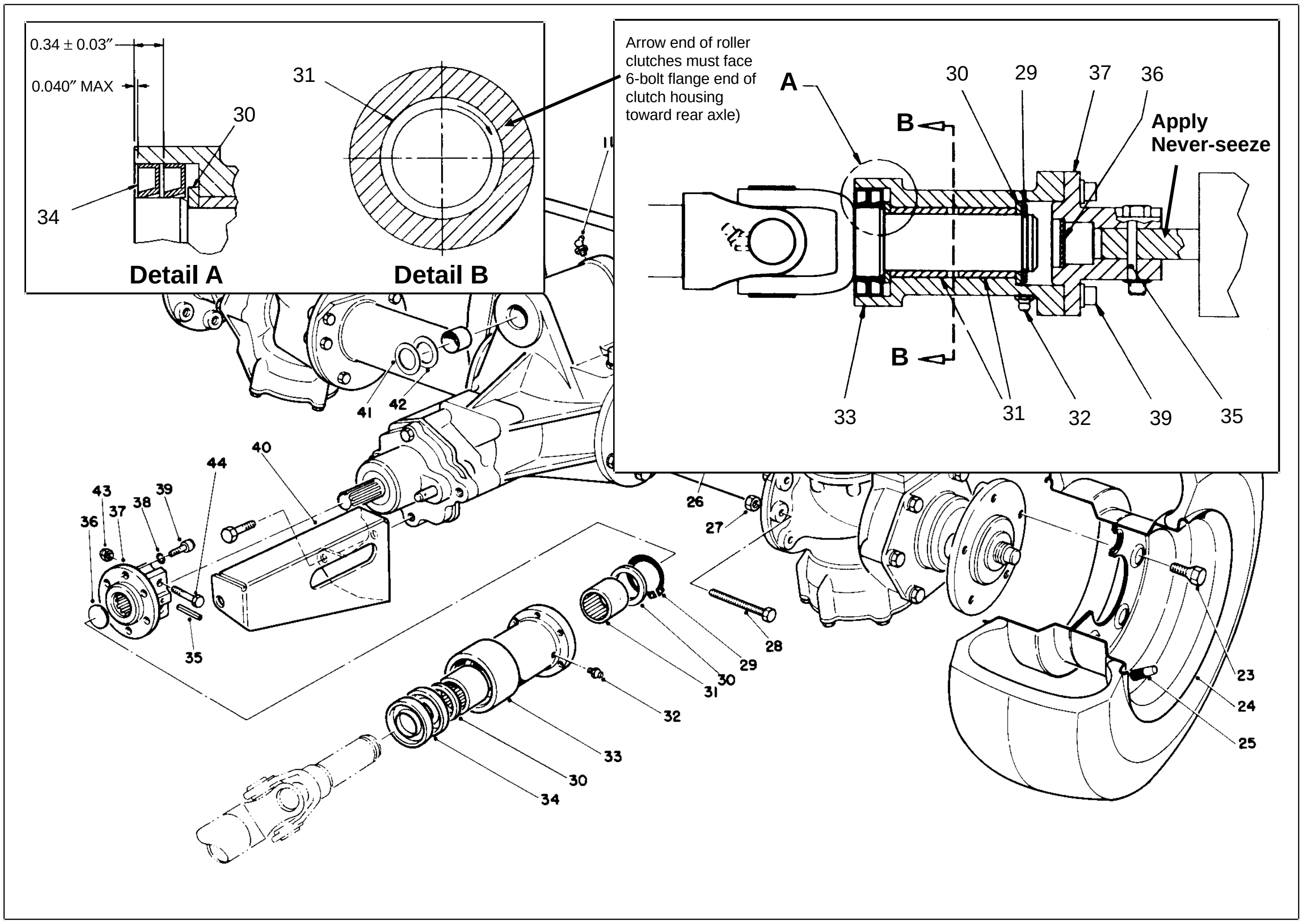


Figure 8

Removing Drive Shaft

1. Put machine on a level surface, lower cutting unit, stop the engine and remove the key from the ignition switch. Block the rear wheels to prevent the machine from moving.

2. Use a hammer and punch to drive roll pin (Fig. 8, Item 35) out of axle coupling (Item 37) and rear axle shaft. Loosen two (2) capscrews and locknuts securing coupling to axle shaft. Slide coupling off of shaft.

3. Remove six (6) socket head capscrews and lockwashers securing drive shaft yoke flange to flange on front axle differential (not shown).

Clutch Service

1. To disassemble clutch, remove six (6) capscrews (Item 17) and lockwashers (Item 16). Remove axle coupling (Item 15) from clutch housing (Item 23).

2. Remove retaining ring (Item 21). Clutch housing (Item 23), along with thrust washers (Item 14), roller clutches (Item 22) and seals (Item 13) can now be removed from yoke shaft (Item 12).

3. Inspect parts and replace as necessary.

4. Roller clutches (Item 22) must be installed into housing (Item 23) so end is flush to 0.040 in. inset with shoulder at each end of housing bore. Both roller clutches must be installed with arrow end toward 6-bolt flange end of housing as shown in view B - B.

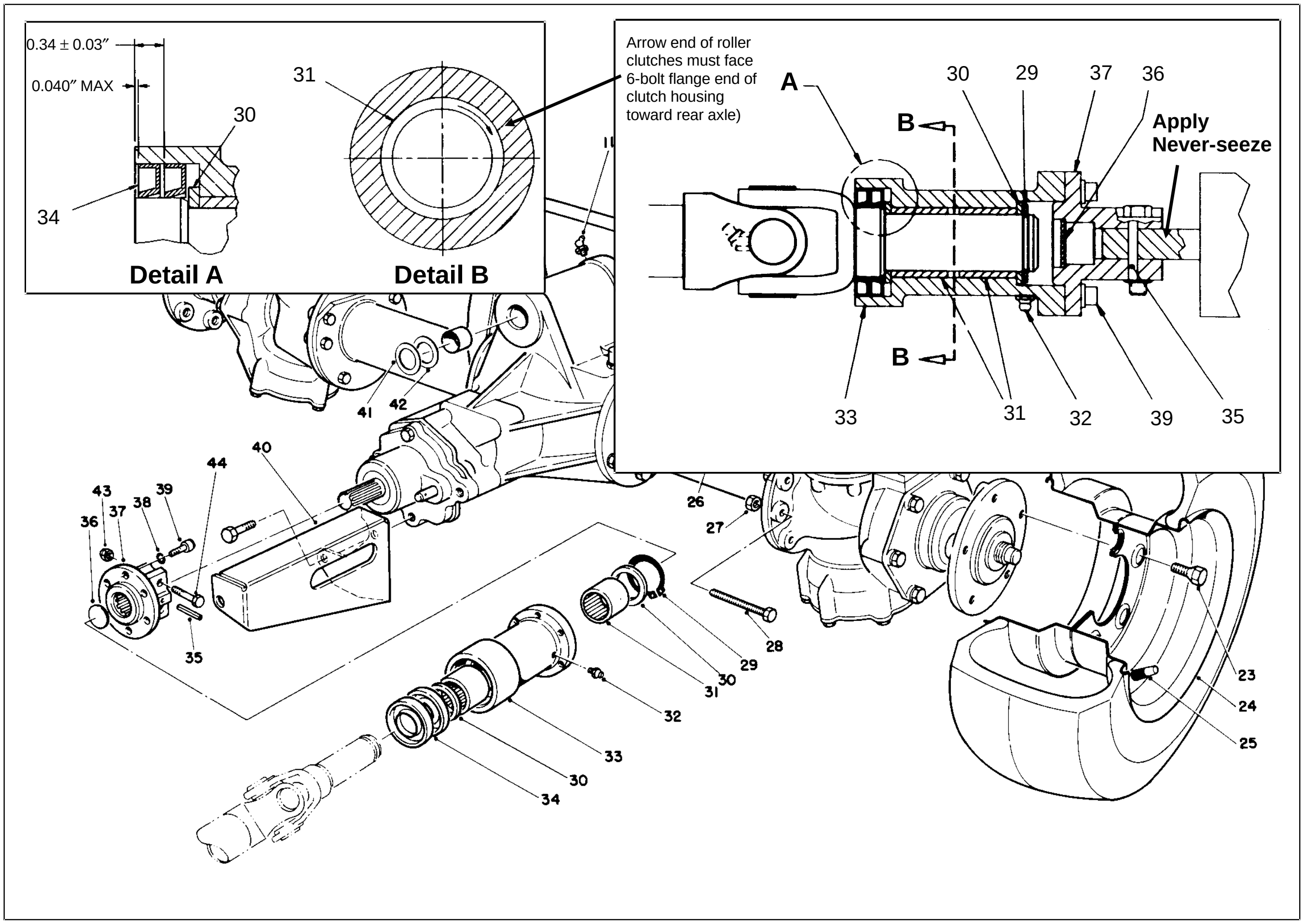


Figure 9

5. Put thrust washer (Item 14) in housing adjacent to roller clutch as shown. Press both seals (Item 13) into end of housing to dimensions shown. Seals must be installed with lip facing out.

6. Install clutch assembly onto yoke shaft, then install other thrust washer. Install retaining ring (Item 29) to secure clutch assembly to shaft. Install axle coupling (Item 37) to clutch housing with six (6) capscrews and lockwashers, then tighten capscrews evenly.

7. Lubricate clutch through grease fitting (Item 32) with No. 2 General Purpose Lithium Grease.

Installing Drive Shaft.

1. Apply never-seize to splines of traction shaft and axle input shaft.

2. Slide clutch end of drive shaft onto rear axle shaft spline, aligning roll pin hole in shaft with hole in axle coupling (Item 37). Install roll pin (Item 35) through coupling and shaft.

3. Tighten two (2) capscrews (Item 44) and locknuts (Item 43) to secure coupling to shaft.

4. Secure drive shaft yoke flange to flange on front axle differential with six (6) socket head capscrews and lockwashers (not shown).

Rear Axle Removal and Installation

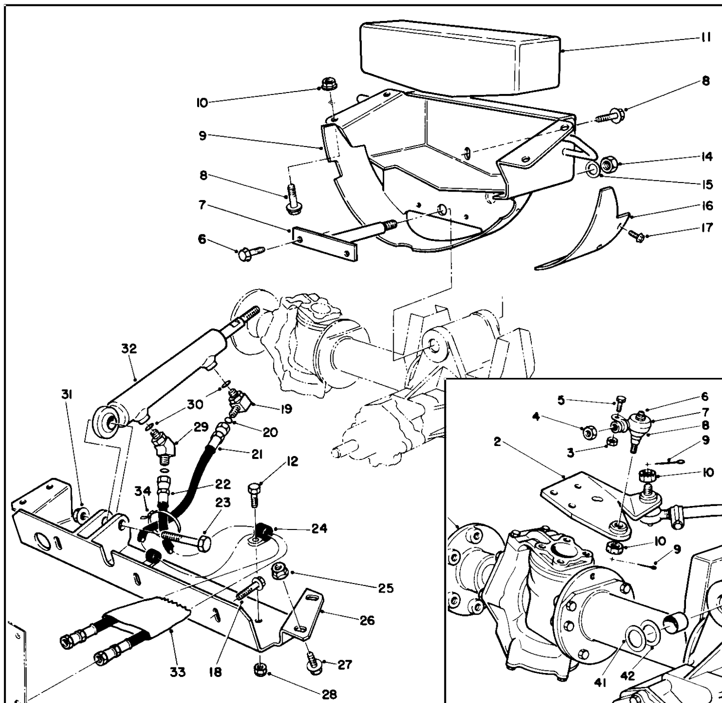


Figure 10A

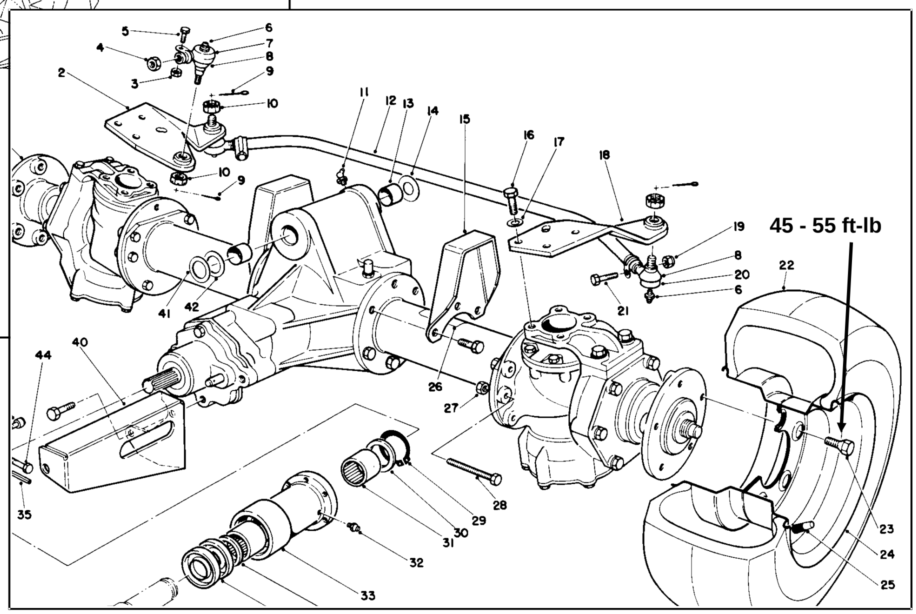


Figure 10B

1. Remove drain plugs from axle and allow oil to drain into a container (Fig. 2).

2. Remove drive shaft (see Drive Shaft Service).

3. Disconnect clutch engagement cable from rear axle.

4. Thoroughly clean around hydraulic hoses connections to steering cylinder. Mark hoses so they will be installed correctly during reassembly. Disconnect hoses from fittings on steering cylinder. Put plugs or caps on open hoses and fittings to prevent contamination of hydraulic system.

5. Loosen rear wheel capscrews (Fig. 10A, Item 23).

6. Block front tires and jack up rear of machine until there is approximately one inch clearance between rear tires and the ground. SECURELY BLOCK FRAME.

7. Remove rear wheels.

8. Remove nut (Fig. 10A, Item 14) and flatwasher (Item 15). Remove capscrews (Item 6) from pin (Item 7). Remove the pin. This will release the rear axle and washers from the support (Item 9). Carefully pull the axle out from under the machine.

NOTE: A varying number of washers (Fig. 10B, Item 41, 42) may have been installed between the axle pivot and axle support during manufacture. Make sure the same number of washers are installed during reassembly.

9. Reverse steps 1 - 8 to install axle. The washers (Fig. 10B, Item 41, 42) must be positioned between the front end of the axle pivot and the axle support (see the NOTE above). Make sure thrust washer (Fig. 10B, Item 14) is installed between rear end of axle pivot and the axle support.

Rear Axle Repair

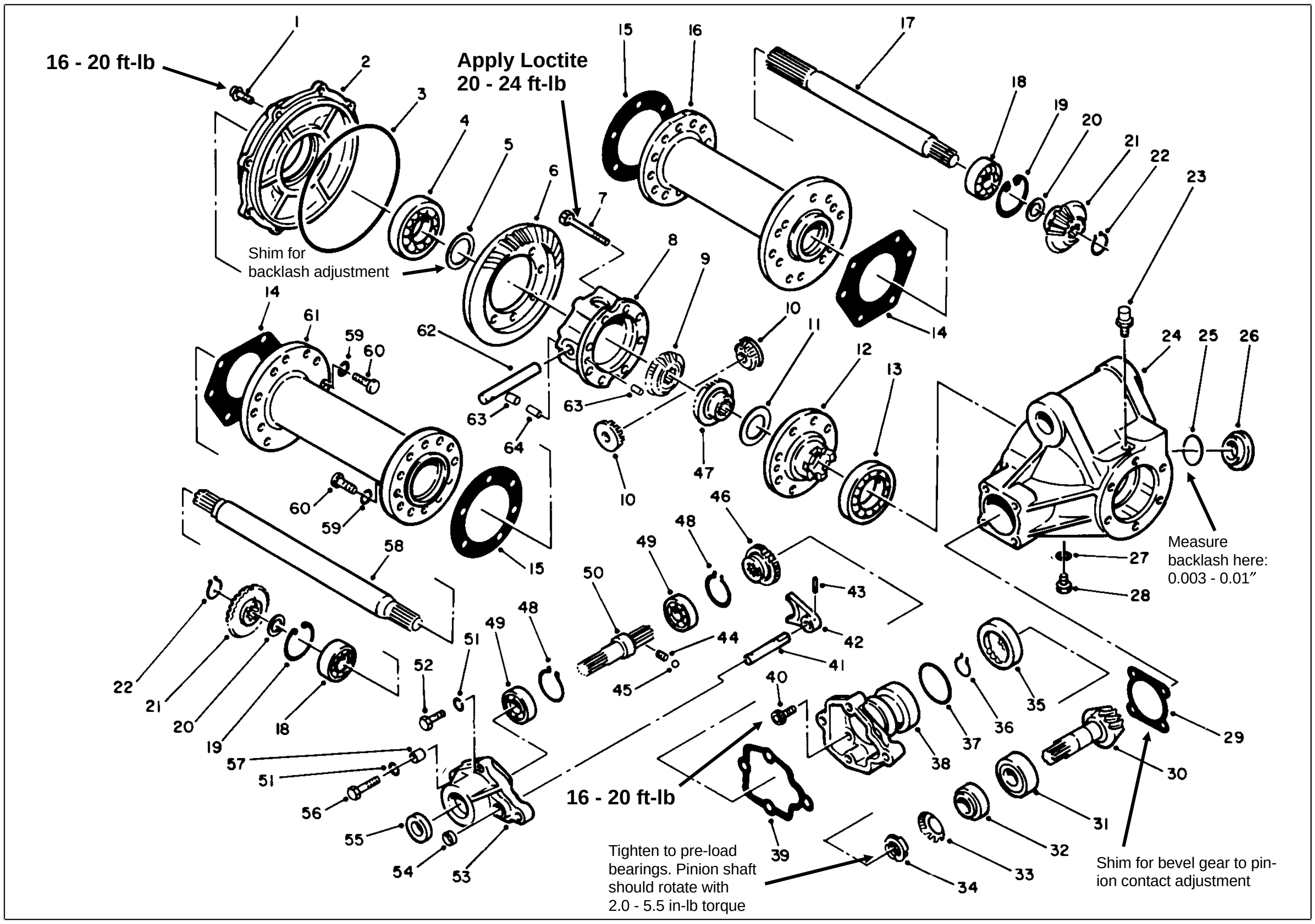


Figure 12

1. Remove bolts (Fig. 12, Item 60) securing axle tubes (Item 16, 61) to differential case (Item 24). Separate axle tubes and axles from differental case.

2. Remove bolts (Fig. 12, Item 60) securing axle tubes (Item 16, 61) to gearbox housings (Fig. 13, Item 23) of knuckle assemblies. Separate axle tubes and axles from knuckle assemblies.

3. Disassemble knuckle assembly (Fig .13):

A. Remove bolts (Item 28, 39) securing covers (Item 30, 26) to knuckle case (Item 28).

B. Pull out outer axle shaft (Item 35) and bevel gear (Item 5).

C. Remove capscrews (Item 10) securing knuckle arm (Item 8) to knuckle case (Item 28). Pull off knuckle arm toward upper side and pull off case toward bottom.

D. Remove capscrews (Item 13) and remove bearing retainer (Item 15). Remove bevel gear (Item 18) and knuckle pin (Item 20).

4. Disassemble differential case (Fig. 12):

A. Remove bolts (Item 53, 56) and remove clutch cover (Item 53).

B. Remove bolts (Item 40) and remove bearing case (Item 38) and pinion gear (Item 30) from differential case (Item 24).

C. Remove bolts (Item 1) and remove cover (Item 2). Remove differential assembly from differential case.

C. Remove bolts (Item 7) to disassemble differential.

Inspection

Inspect shaft splines, gears and bearings for wear and damage. Replace parts as necessary. Use suitable bearing pullers and an arbor press when replacing bearings.

NOTE: Ring gear (Item 6) and pinion (Item 30) are a matched set that must be replaced together.

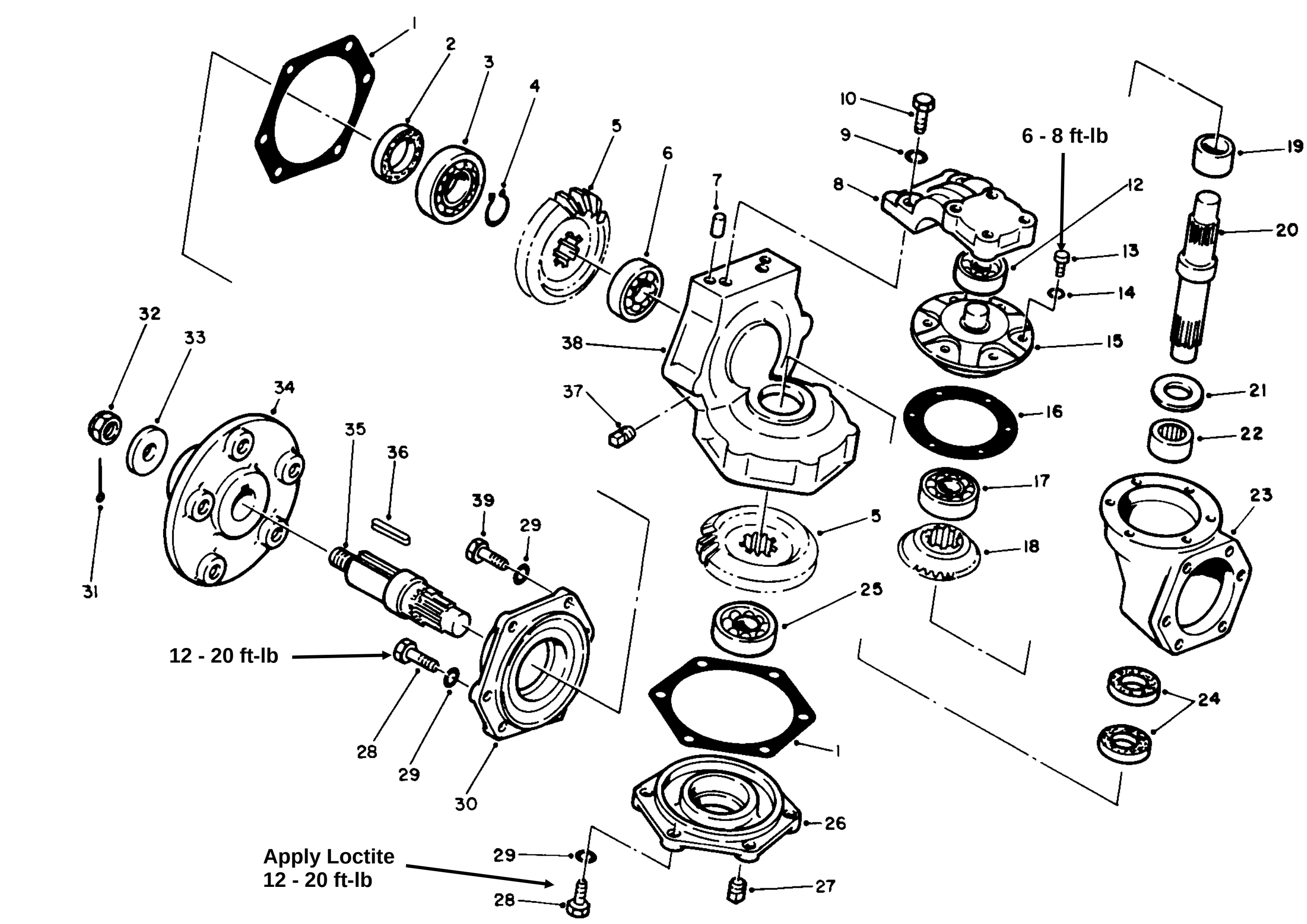


Figure 13

Assembly

1. Use new gaskets and seals when reassembling axle.

2. Assemble differential case (Fig. 12):

A. Assemble differential. Use medium strength Loctite on bolts (Item 7) and tighten evenly to a torque of 20 - 24 ft-lb (270-330 Kg-Cm).

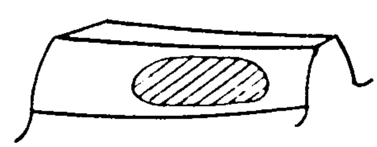
B. Assemble pinion gear (Item 30) and bearing case (Item 38). Tighten bearing nut (Item 34) to pre-load tapered roller bearings. Tighten so pinion shaft will rotate with 2 - 5.5 in-lb (2.0 - 6.5 Kg-Cm) of torque. Bend washer (Item 33) to prevent nut from loosening.

C. Adjust tooth contact of bevel gear (Item 6) to pinion (Item 30). Use shims (Item 29) to make good contact with light load between bevel gear and pinion (Fig. 13).

D. After adjusting tooth contact, use shims (Item 5) to make backlash 0.003 - 0.01 in. (0.08 - 0.25 mm). Check backlash through plug hole (Item 26) with a dial indicator.

E. Tighten bolts (Item 1, 40) to a torque of 16 - 20 ft-lb (220-280 Kg-Cm).

F. Assemble clutch parts and install clutch cover (Item 53). Install new oil seals (Item 54, 55).



Tooth contact between bevel gear and pinion with light load

Figure 14

3. Assemble knuckle assembly (Fig. 13):

A. Insert needle bearing (Item 22), washer (Item 21), knuckle pin (Item 20), spacer (Item 19) and bevel gear (Item 18) into axle gear box (Item 23). Fasten bearing retainer (Item 15) with bolts (Item 13) and tighten bolts evenly to a torque of 6 - 8 ft-lb (80-120 Kg-Cm).

B. Assemble knuckle pin (Item 20) and knuckle case (Item 38) to match knuckle arm (Item 8) with knuckle pin. Fasten capscrew (Item 10) temporarily (will be removed to fill with lubricant).

C. Assemble wheel shaft (Item 35) to cover (Item 30).

D. Assemble gear (Item 5) to wheel shaft and install cover and wheel shaft assembly to knuckle case (Item 38). Note that top two (2) capscrews (Item 39), securing cover (Item 30) are a shorter length.

E. Install bevel gear (Item 5) to knuckle pin and install cover (Item 26) to knuckle case (Item 38). Use medium strenght Loctite on capscrews (Item 28) securing cover (Item 26).

F. Evenly tighten capscrews (Item 28, 39) securing covers to a torque of 12 - 20 ft-lb (170-280 Kg-Cm).

4. Install axle on machine (see Rear Axle Removal and Installation).

5. Fill axle with proper lubricant to level of check plugs (see Specifications).

Chapter 10.1

GM 325–D or GM 328–D with Dae Dong Axle

4WD Rear Axle

Table of Contents

NOTE: For GM322–D or GM325–D with Inasaka axle, see Chapter 10 – 4WD Rear Axle in this manual.

SPECIFICATIONS 2
ADJUSTMENTS 3
Steering Stop Bolt Adjustment 3
REPAIRS 4
4WD Rear Axle 4
Removal 5
Installation 5
Bevel Gear Case and Axle Case 6
Removal 6
Inspection 7
Installation 8
Differential Shafts 10
Removal 10
Installation 10
Axle Shafts 11
Removal 11
Installation 11
Input Shaft/Pinion Gear 12
Removal 12
Installation 12
Differential Gear 14
Removal 14
Inspection 15
Installation 16
Pinion Gear to Ring Gear Engagement 17
Gear Pattern Movement Summary 18
Bidirectional Clutch 19
Bidirectional Clutch Service 20

Specifications

Item	Specification
Wheel lug nut torque (rear)	45 to 55 ft-lbs. (61 to 75 Nm)
Rear wheel toe-in	0.000 in. (0.0 mm)
Tire pressure (front and rear)	21 psi (145 kPa)
Rear axle lubricant	SAE 80W90, API GL-5 gear lube
Bidirectional clutch lubricant	Mobil 424 hydraulic fluid

Adjustments

Steering Stop Bolt Adjustment

The rear axle steering stop bolts help prevent over–travel of the steering cylinder in case of impacts on rear wheels. When the steering cylinder is fully extended, a gap of 1/16” (1.6 mm) should exist between left side bevel gear case casting and stop bolt (Fig. 1). When the steering cylinder is fully retracted, a gap of 1/16” (1.6 mm) should exist between right side bevel gear case casting and stop bolt.

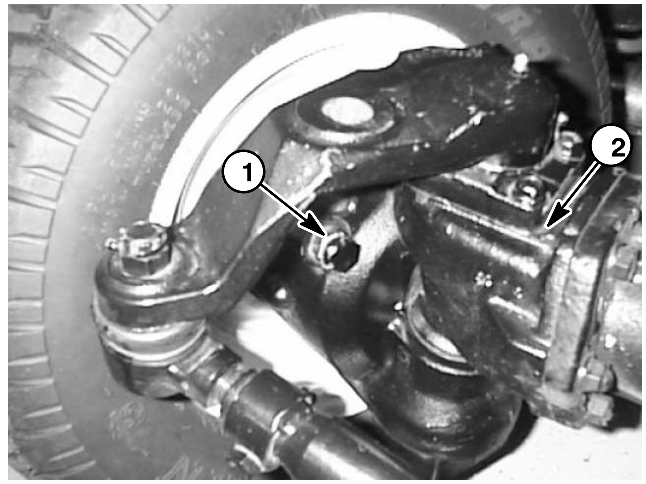


Figure 1

1. **Steering stop bolt**
2. **Bevel gear case (LH)**

Repairs

NOTE: See Traction Unit Operator's Manual for Maintenance intervals and instructions.

4WD Rear Axle

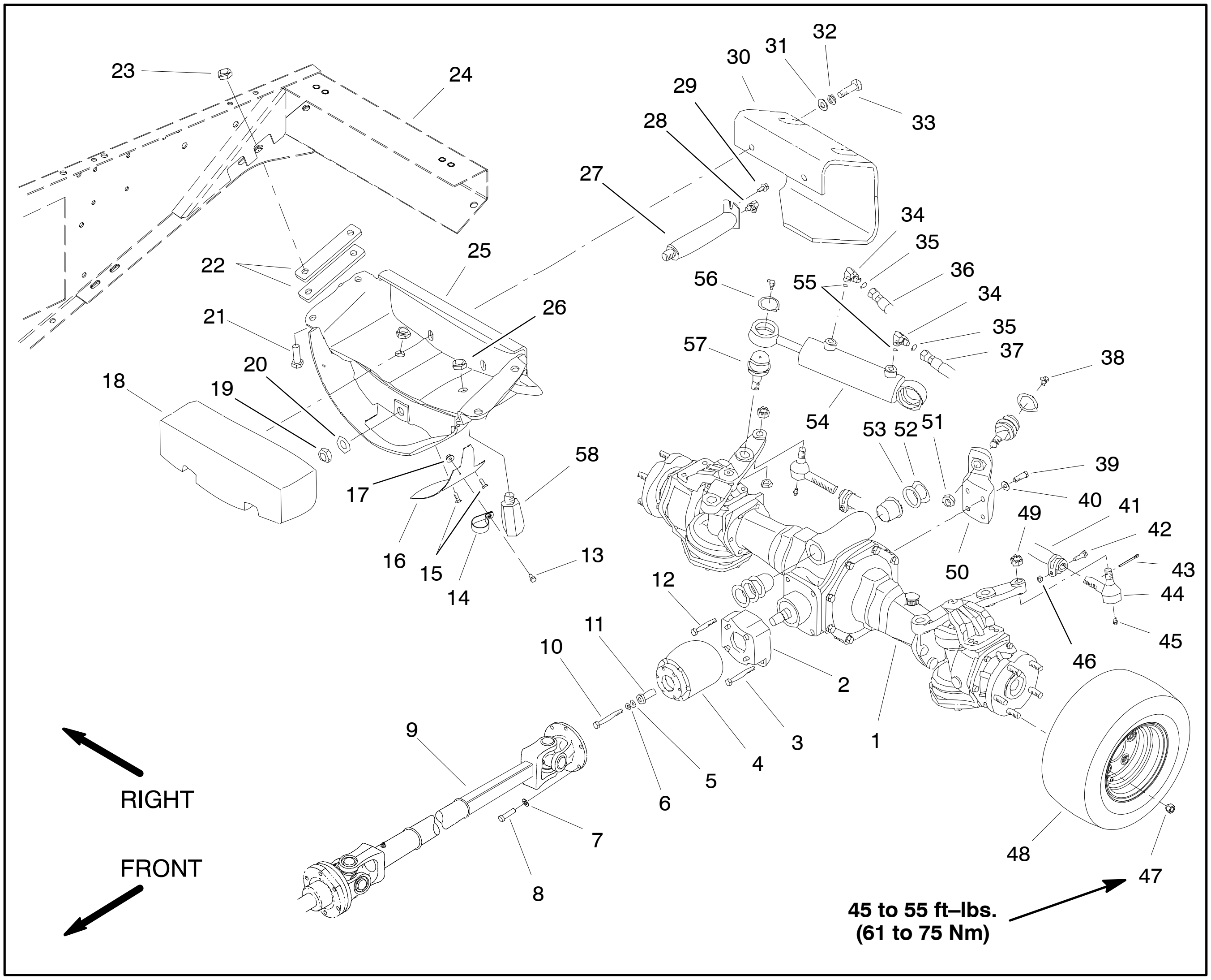


Figure 2

1. **4WD rear axle**
2. **Adaptor**
3. **Cap screw (2 used)**
4. **Bidirectional clutch**
5. **Flat washer**
6. **Lock washer**
7. **Lock washer (6 used)**
8. **Socket head screw (6 used)**
9. **Driveshaft**
10. **Cap screw**
11. **Spacer**
12. **Cap screw (2 used)**
13. **Cap screw**
14. **R–clamp**
15. **Washer head screw**
16. **Guard**
17. **Flange head nut**
18. **Rear weight**
19. **Jam nut**
20. **Thrust washer**
21. **Flange head screw (4 used)**
22. **Frame spacer (4 used)**
23. **Flange nut (4 used)**
24. **Main frame**
25. **Axle support**
26. **Lock nut (2 used)**
27. **Rear axle pin**
28. **Grease fitting**
29. **Washer head screw**
30. **Bumper**
31. **Flat washer (2 used)**
32. **Lock washer (2 used)**
33. **Cap screw (2 used)**
34. **Hydraulic fitting**
35. **O–ring**
36. **Hydraulic hose**
37. **Hydraulic hose**
38. **Grease fitting (2 used)**
39. **Cap screw (4 used)**
40. **Washer (4 used)**
41. **Tie rod**
42. **Cap screw (2 used)**
43. **Cotter pin (2 used)**
44. **Tie rod end (2 used)**
45. **Grease fitting (2 used)**
46. **Hex nut (2 used)**
47. **Lug nut (5 used per wheel)**
48. **Wheel (2 used)**
49. **Slotted hex nut (2 used)**
50. **Cylinder support bracket**
51. **Jam nut (2 used per ball joint)**
52. **Thrust washer (0.0179” thick)**
53. **Thrust washer (0.0329” thick)**
54. **Steering cylinder**
55. **O–ring**
56. **Retaining ring (2 used)**
57. **Steering cylinder ball joint (2 used)**
58. **Oscillation stop (2 used)**

Removal (Fig. 2)

1. Park machine on a level surface, lower cutting deck (or implement), stop engine, engage parking brake and remove key from the ignition switch.

2. Drain oil from rear axle (see Traction Unit Operator's Manual).

CAUTION

When changing attachments, tires, or performing other service, use correct blocks, hoists, and jacks. Make sure machine is parked on a solid, level surface such as a concrete floor. Prior to raising machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands or solid wood blocks to support the raised machine. If the machine is not properly supported by blocks or jack stands, the machine may move or fall, which may result in personal injury.

3. Chock front wheels and jack up rear of machine. Support machine with jack stands or solid wood blocks.

4. Remove wheels from rear axle.

5. Remove six (6) socket head screws (item 8) and lock washers (item 7) that secure driveshaft to bidirectional clutch on rear axle. Position end of driveshaft away from clutch.

6. Thoroughly clean around hydraulic hose connections to steering cylinder. Label hoses for assembly purposes. Disconnect hoses from fittings on steering cylinder. Put plugs or caps on open hoses and fittings to prevent contamination of hydraulic system.

7. If machine has rear weight(s) attached to frame, remove weight(s).

8. Support rear axle to prevent it from falling. Remove four (4) flange head screws (item 21) and flange nuts (item 23) that secure rear axle support to equipment frame. Lower rear axle and rear axle support from machine.

9. Locate and retrieve frame spacers (item 22).

10. Remove jam nut (item 19) and thrust washer (item 20) from rear axle pin (item 27) that attaches rear axle to rear axle support. Remove washer head screw (item 29) that secures flange of axle pin to rear axle support.

11. Remove rear axle pin. Separate rear axle support from rear axle. Note location and quantity of thrust washers (items 52 and 53) between axle boss and axle support.

Installation (Fig. 2)

1. Position rear axle support to axle. Install thrust washers (items 52 and 53) between axle boss and axle support to minimize clearance.

2. Install rear axle pin (item 27) to secure axle to rear axle support. Install thrust washer (item 20) and jam nut (item 19) onto pivot pin. Torque jam nut from 90 to 120 ft–lb (122 to 163 N–m). Secure pivot pin to axle support with washer head screw (item 29).

3. Position axle and axle support under machine with a jack. Place frame spacers (item 22) on axle support. Raise assembly to machine frame and align mounting holes of axle support, frame spacers and machine frame.

4. Secure rear axle support to frame with four (4) flange head screws (item 21) and flange nuts (item 23).

5. Remove plugs and caps from steering cylinder hydraulic hoses and fittings. Connect hoses to fittings on steering cylinder.

6. Position end of driveshaft to bidirectional clutch on rear axle. Secure driveshaft to clutch with six (6) socket head screws (item 8) and lock washers (item 7).

WARNING

Failure to maintain proper wheel lug nut torque could result in failure or loss of wheel and may result in personal injury.

7. Install wheels to axle. Torque wheel lug nuts from 45 to 55 ft-lbs. (61 to 75 Nm).

8. Lower machine to ground.

9. If any rear weight(s) were removed from machine, attach weight(s) to machine.

10. Fill axle and input gearbox with SAE 80W–90 weight gear lube (see Traction Unit Operator's Manual).

11. Check bidirectional clutch lubricant level (see Traction Unit Operator's Manual). Adjust if necessary.

12. Start engine and check for component interference as steering wheel is turned from lock to lock. Also, check for any hydraulic leaks.

13. Check rear wheel toe–in and adjust if necessary (see Traction Unit Operator's Manual).

14. Check adjustment of steering stop bolts (see Steering Stop Bolt Adjustment in the Adjustments section).

Bevel Gear Case and Axle Case

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove the mounting screws, nuts, and lock washers. Remove the bevel gear case/axle case assembly and O-ring from the axle support (Fig. 3).

2. Mark both right and left bevel gear case/axle case assemblies.

IMPORTANT: Do not interchange right and left bevel gear case/axle case assemblies.

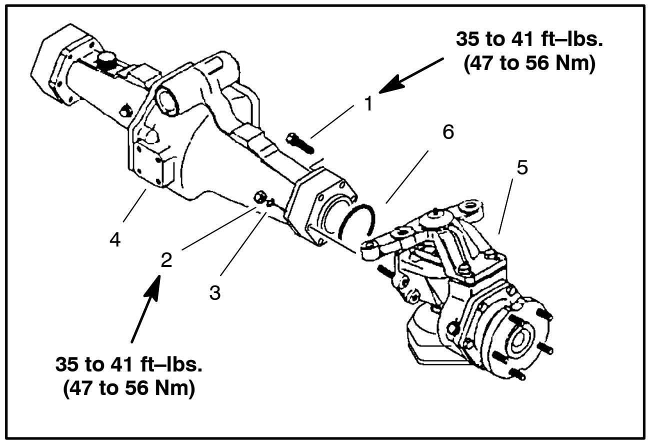


Figure 3

1. **Cap screw**
2. **Lock nut**
3. **Lock washer**
4. **Axle support**
5. **Bevel gear case/axle case assembly**
6. **O-ring**

3. Remove the axle cover mounting screws. Remove the axle cover from the axle case as an assembly (Fig. 4).

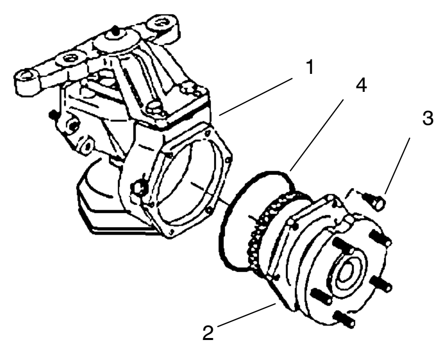


Figure 4

1. **Axle case**
2. **Axle cover assembly**
3. **Mounting screw**
4. **O-ring**

4. Remove the axle case support mounting screws, the axle case support, and the support shims (Fig. 5).

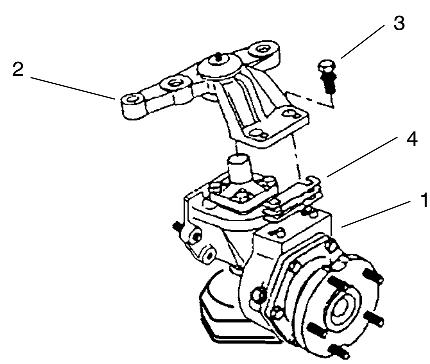


Figure 5

1. **Axle case**
2. **Axle case support**
3. **Mounting screw**
4. **Support shim**

5. Remove the knuckle pin mounting screws and the knuckle pin. Remove the gasket and any remaining gasket material from either mating surface (Fig. 6).

6. While holding the bevel gear case, lightly tap the upper end of the bevel gear shaft out of the upper bearing and upper bevel gear.

7. Pull the bevel gear case from the axle case and remove the upper bevel gear, collar, spacer, and thrust washer from the gear case.

8. Remove the axle case cover screws, cover, and the O-ring from the axle case.

9. Remove the plug and sealing washer from the center of the axle case cover. While holding the axle case cover, lightly tap the lower end of the bevel gear shaft out of the lower bearing and lower bevel gear.

10. Remove and discard bevel gear shaft seals from bevel gear case and axle case (Fig. 6).

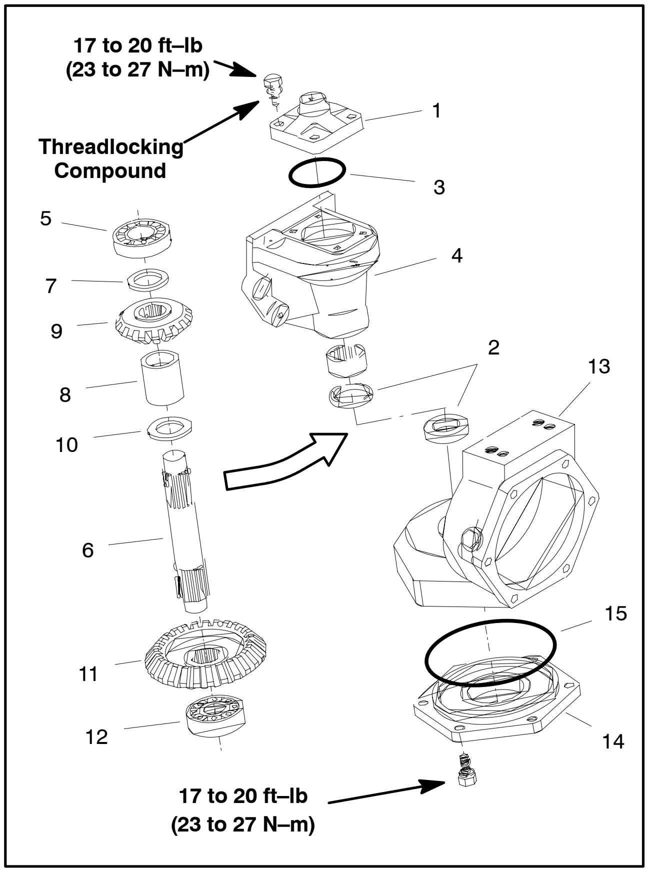


Figure 6

1. **Knuckle pin**
2. **Shaft seals**
3. **O–ring**
4. **Bevel gear case**
5. **Upper bearing**
6. **Bevel gear shaft**
7. **Collar**
8. **Spacer**
9. **Upper bevel gear**
10. **Thrust washer**
11. **Lower bevel gear**
12. **Lower bearing**
13. **Axle case**
14. **Axle case cover**
15. **O-ring**

Inspection

1. Measure the knuckle pin O.D. and the axle case support bushing I.D. to determine the bushing to pin clearance (Fig. 7). Replace components as necessary.

BUSHING TO PIN CLEARANCE:
0.002 to 0.016 in. (0.05 to 0.40 mm)

KNUCKLE PIN O.D. (Factory Spec.):
0.982 to 0.983 in. (24.95 to 24.98 mm)

AXLE CASE SUPPORT BUSHING I.D.
(Factory Spec.):
0.984 to 0.987 in. (25.00 to 25.08 mm)

2. Inspect all gears, shafts, bearings, cases, and covers for damage and wear. Replace components as necessary.

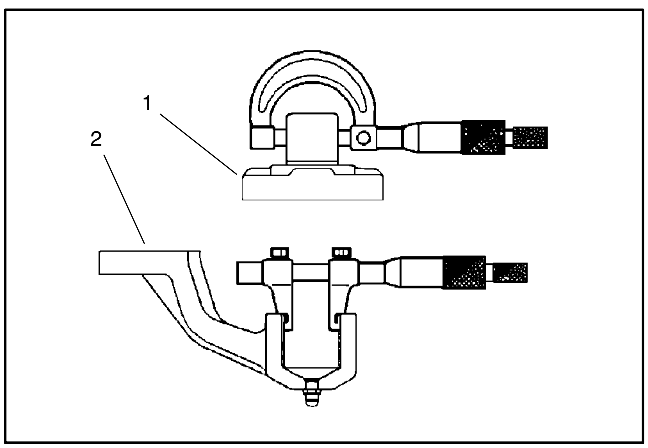


Figure 7

1. **Knuckle pin**
2. **Axle case support**

Installation

1. Coat new shaft seals with grease and install in axle case and bevel gear case as shown (Fig. 8).

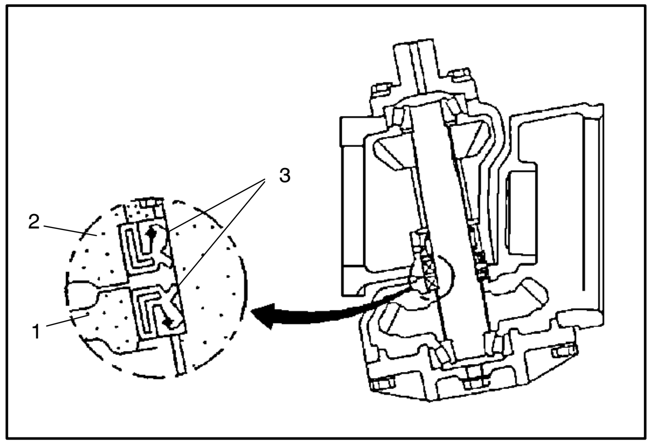


Figure 8

1. **Axle case**
2. **Bevel gear case**
3. **Shaft seal**

2. Install the lower bevel gear, and bevel gear shaft in the axle case cover. Coat a new O-ring with grease and install the axle case cover (Fig. 9). Tighten cover screws to 17 to 20 ft-lbs. (23 to 27 Nm).

3. Slide the bevel gear case over the bevel gear shaft and install the thrust washer, spacer, bevel gear, and collar. Make sure the bevel gear shaft is completely seated in the upper and lower bearings (Fig. 9).

4. Install the knuckle pin. Use medium strength Loctite thread locker and tighten the knuckle pin mounting screws to 17 to 20 ft-lbs. (23 to 27 Nm).

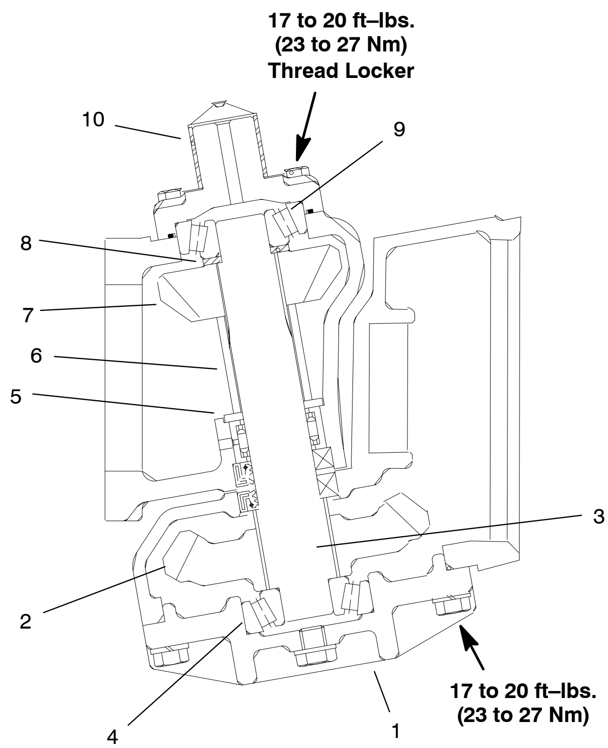


Figure 9

1. **Axle case cover**
2. **Lower bevel gear**
3. **Bevel gear shaft**
4. **Lower bearing**
5. **Thrust washer**
6. **Spacer**
7. **Upper bevel gear**
8. **Collar**
9. **Upper bearing**
10. **Knuckle pin**

5. Determine necessary quantity of support shims.

A. Lubricate the axle case support bushing with a thin coat of grease and slide axle case support onto knuckle pin.

B. Position support shims that were removed during disassembly between axle case support and axle case. Install mounting screws into axle case. Slowly tighten screws while frequently checking for clearance (vertical endplay) between axle case support and knuckle pin. If binding of components is noted before screws are fully tightened, add additional support shims. Torque screws from 57 to 67 ft–lbs. (77 to 91 Nm).

C. Use dial indicator to measure vertical endplay of axle case (Fig. 10).

AXLE CASE ASSEMBLY ENDPLAY:
0.001 to 0.008 in. (0.02 to 0.20 mm)

D. Adjust endplay by increasing or reducing number of axle case support shims.

NOTE: Axle case support shims are available in 0.004 in. (0.1 mm), 0.008 in. (0.2 mm), and 0.016 in. (0.4 mm) thickness.

6. After correct support shims have been determined, remove mounting screws, apply heavy strength Loctite thread locker to screw threads, reinstall screws, and torque from 57 to 67 ft–lbs. (77 to 91 Nm).

IMPORTANT: Correct engagement between bevel gears is critical to axle performance and durability.

7. Temporarily install the bevel gear case/axle case assembly on the axle support. Position a dial indicator at the tooths center. Prevent the axle from turning and measure the upper bevel gear to differential shaft gear backlash (Fig. 11).

UPPER BEVEL GEAR BACKLASH:
0.004 to 0.016 in. (0.10 to 0.40 mm)

8. Adjust backlash by increasing or reducing axle bearing shim thickness (see Differential Shafts in this section of this manual).

NOTE: Axle bearing shims are available in 0.004 in. (0.1 mm), 0.008 in. (0.2 mm), and 0.020 in. (0.5 mm) thickness.

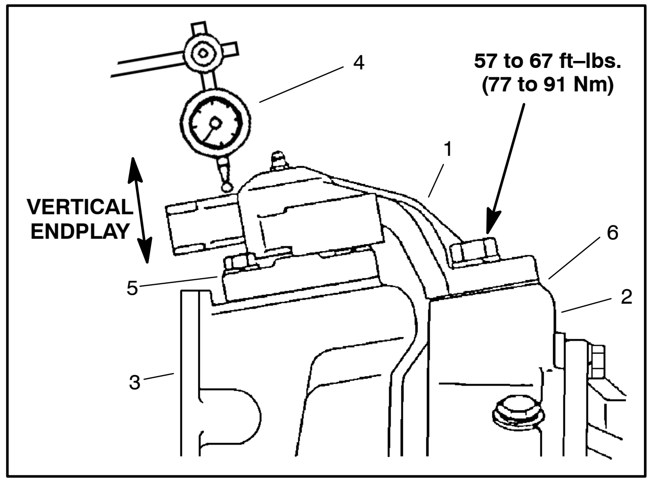


Figure 10

1. **Axle case support**
2. **Axle case**
3. **Bevel gearcase**
4. **Dial indicator**
5. **Knuckle pin**
6. **Support shim location**

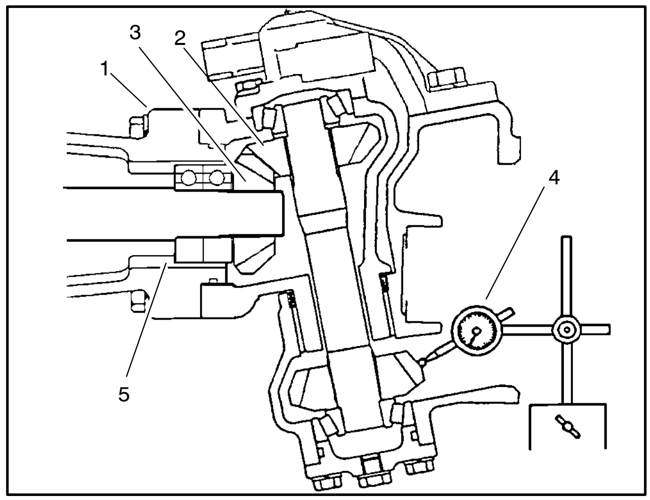


Figure 11

1. **Axle support**
2. **Upper bevel gear**
3. **Differential shaft gear**
4. **Dial indicator**
5. **Axle bearing shims**

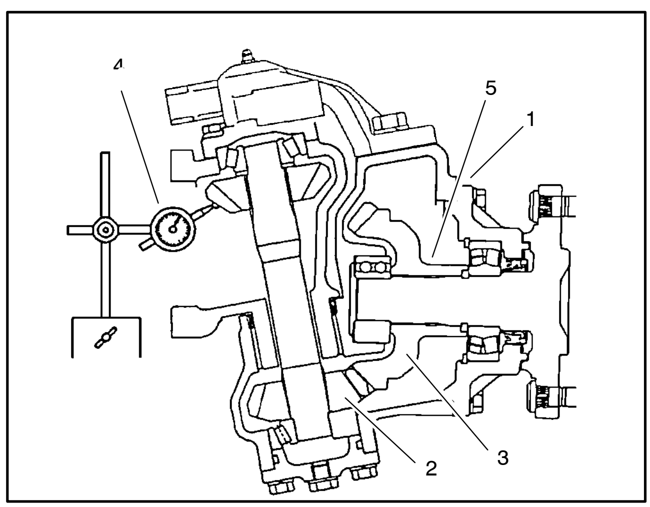


Figure 12

1. **Axle cover assembly**
2. **Lower bevel gear**
3. **Axle gear**
4. **Dial indicator**
5. **Axle bearing shims**

9. Remove the bevel gear case/axle case assembly from the axle support. Coat a new O-ring with grease and temporarily install the axle cover assembly. Position a dial indicator at the tooths center. Prevent the axle from turning and measure the lower bevel gear to axle gear backlash (Fig. 12).

LOWER BEVEL GEAR BACKLASH:
0.004 to 0.016 in. (0.10 to 0.40 mm)

10. Adjust backlash by increasing or reducing axle bearing shim thickness (see Axle Shafts in this section of this manual).

NOTE: Axle bearing shims are available in 0.008 in. (0.2 mm), 0.012 in. (0.3 mm), and 0.020 in. (0.5 mm) thickness.

11. Tighten axle cover screws from 17 to 20 ft-lbs. (23 to 27 Nm).

12. Coat a new O-ring with grease and install the bevel gear case/axle case assembly on the axle support. Tighten mounting screws and nuts from 35 to 41 ft-lbs. (47 to 56 Nm) (Fig. 13).

Differential Shafts

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

IMPORTANT: Do not interchange right and left differential shafts assemblies.

1. Remove the mounting screws, nuts, and lock washers. Remove the bevel gear case/axle case assembly and O-ring from the axle support (Fig. 13).

2. Mark and pull the differential shaft assembly from the axle support.

3. Remove the retaining ring and bevel gear (Fig 14).

4. Drive the differential shaft out of the bearings. Remove the bearings and bearing shims.

5. Inspect all gears, shafts, bearings, and cases for damage and wear. Replace components as necessary.

Installation

1. Press bearings onto differential shaft. Place correct combination of bearing shims in axle support and drive differential shaft and bearing assembly into axle support.

2. Install bevel gear and retaining ring.

3. Align differential shaft splines with differential gear assembly and slide differential shaft assembly onto axle support.

4. Coat new O-ring with grease. Install bevel gear case/axle case assembly (see Bevel Gear Case/Axle Case Assembly in this section of this manual).

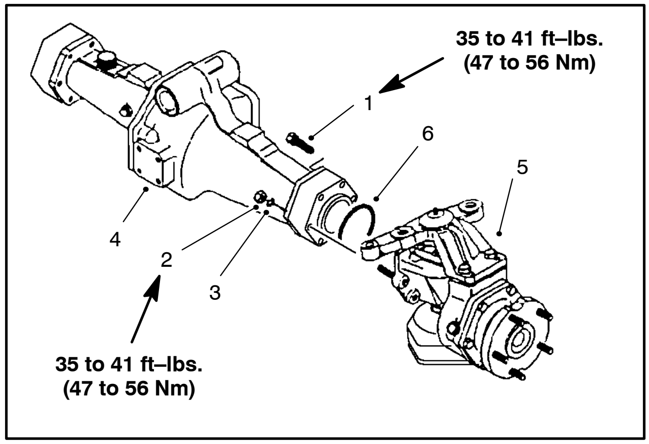


Figure 13

1. **Cap screw**
2. **Lock nut**
3. **Lock washer**
4. **Axle support**
5. **Bevel gear case/axle case assembly**
6. **O-ring**

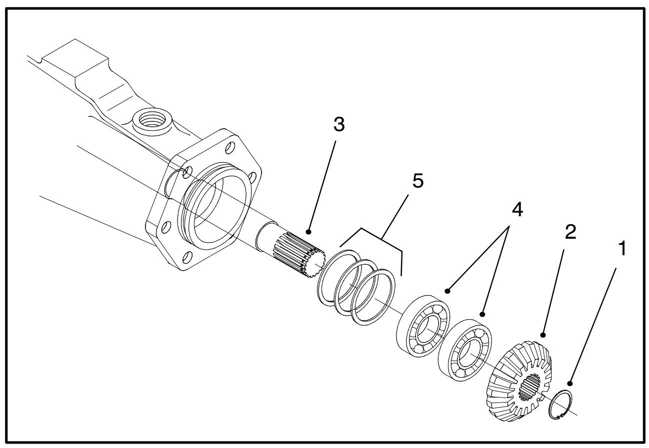


Figure 14

1. **Retaining ring**
2. **Bevel gear**
3. **Differential shaft**
4. **Bearing**
5. **Bearing shims**

Axle Shafts

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove the axle cover mounting screws. Remove the axle cover from the axle case as an assembly (Fig. 15).

2. Use a bearing puller to remove the bearing and bevel gear as shown (Fig. 16).

3. Remove the shims, spacer, and retaining ring. Drive the axle out of the bearing and cover. Remove and discard the axle shaft seal.

4. Inspect all gears, shafts, bearings, spacers, and cases for damage and wear. Replace components as necessary.

Installation

1. Coat new axle shaft seal with grease and install in axle cover as shown (Fig. 17).

2. Press the axle cover and bearing assembly onto the axle shaft. Press only on the inner race of the cover bearing (Fig. 17).

3. Install retaining ring, spacer, and correct combination of bearing shims. Install bevel gear and bearing.

4. Coat a new O-ring with grease and install the axle cover assembly. Tighten axle cover screws to 17 to 20 ft-lbs. (23 to 27 Nm).

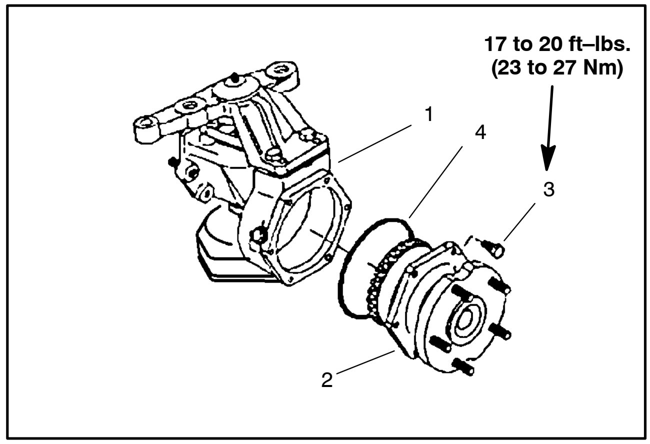


Figure 15

1. **Axle case**
2. **Axle cover assembly**
3. **Mounting screw**
4. **O-ring**

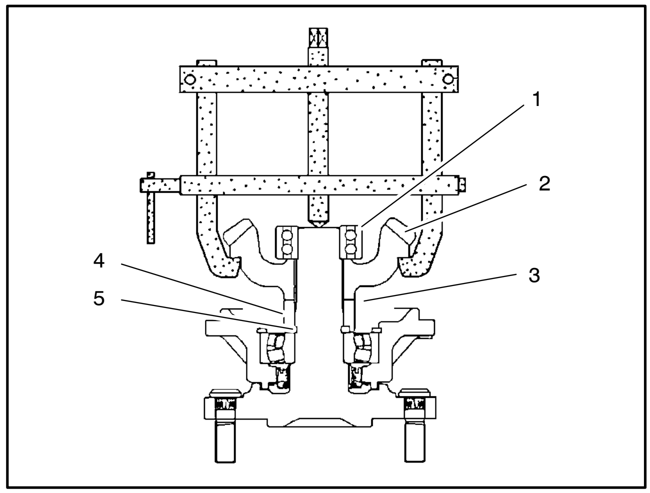


Figure 16

1. **Bearing**
2. **Bevel gear**
3. **Shims**
4. **Spacer**
5. **Retaining ring**

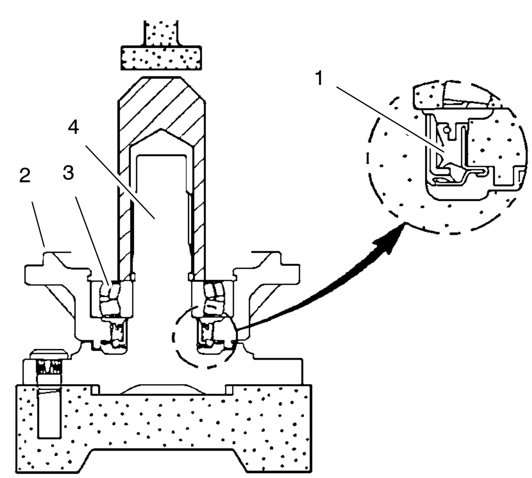


Figure 17

1. **Axle shaft seal**
2. **Axle cover**
3. **Bearing**
4. **Axle shaft**

Input Shaft/Pinion Gear

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove input shaft/pinion gear assembly from the axle support. Remove the shims and bearing case O-ring.

2. Release the stake washer and remove the locknut. Remove and discard the stake washer (Fig. 18).

3. Drive the input shaft/pinion gear out from the outer bearing cone and bearing case. Remove and discard the oil seal and O-ring.

4. Inspect all gears, shafts, bearings, spacers, and cases for damage and wear. Replace components as necessary.

NOTE: Replacement input shaft/pinion gears are only available in matched ring and pinion sets.

Installation

NOTE: When installing new bearing cones, press only on the inner race of the bearing cone.

1. If the inner bearing cone was removed, press a new bearing cone all the way onto the input shaft/pinion gear.

2. Place the shaft and bearing assembly in the bearing case and install the outer bearing cone.

NOTE: The bearings must be completely seated. There should be no input shaft/pinion gear end play.

3. Coat a new oil seal with grease and install as shown (Fig. 19).

4. Coat a new O-ring with grease. Install O-ring in the oil seal collar, and install the collar.

5. Install a new stake washer. Install the lock nut finger tight.

6. Set the bearing preload be securing the bearing case in a vise. Thread a M12 x 1.5 hex head capscrew into the splined end of the input shaft/pinion gear.

7. Slowly tighten the locknut until 4.0 to 6.0 in-lbs. (0.4 to 0.7 Nm) of force is required to rotate the input shaft/pinion gear in the bearing case.

8. Secure the lock nut with the stake washer.

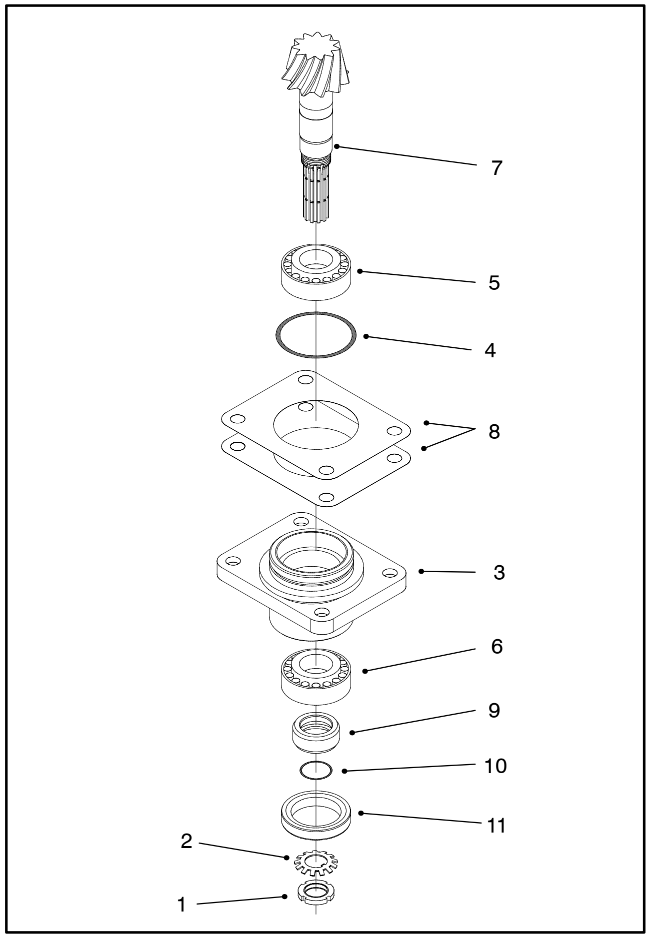


Figure 18

1. **Lock nut**
2. **Stake washer**
3. **Bearing case**
4. **Bearing case O-ring**
5. **Inner bearing**
6. **Outer bearing**
7. **Input shaft/pinion gear**
8. **Bearing case shims**
9. **Seal collar**
10. **O-ring**
11. **Oil seal**

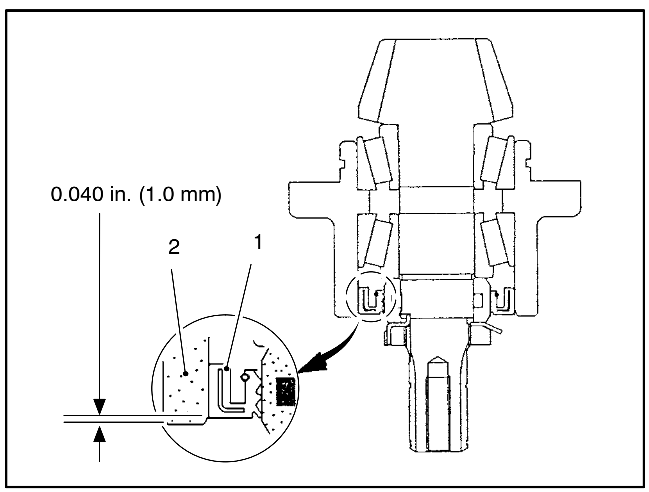


Figure 19

1. **Oil seal**
2. **Bearing case**

9. Use a depth gauge to measure the distance from the end face of the input shaft/pinion gear to the mating surface of the bearing case. Subtract the “Design Cone Center Distance” from this distance to determine initial shim thickness (Fig. 20).

DESIGN CONE CENTER DISTANCE
(distance from mating surface of axle support to end face of pinion gear):
1.870 $\pm$ 0.002 in. (47.5 $\pm$ 0.05 mm)

NOTE: Bearing case shims are available in 0.004 in. (0.1 mm) and 0.008 in. (0.2 mm) thickness.

10. Coat a new O-ring with grease. Place shims on the bearing case and temporarily install input shaft/pinion gear assembly into axle case. Tighten mounting screws to 35 to 41 ft-lbs. (47 to 56 Nm).

11. Insert a screwdriver through the drain plug hole to hold ring gear and measure the pinion gear to ring gear backlash (Fig. 21).

PINION GEAR TO RING GEAR BACKLASH:
0.004 to 0.016 in. (0.10 to 0.40 mm)

12. Adjust backlash by increasing or reducing bearing case shim thickness.

13. Check pinion gear to ring gear engagement (see Pinion Gear to Ring Gear Engagement in this section of this manual.

14. Place the correct combination of shims on the bearing case. Tighten mounting screws to 35 to 41 ft-lbs. (47 to 56 Nm).

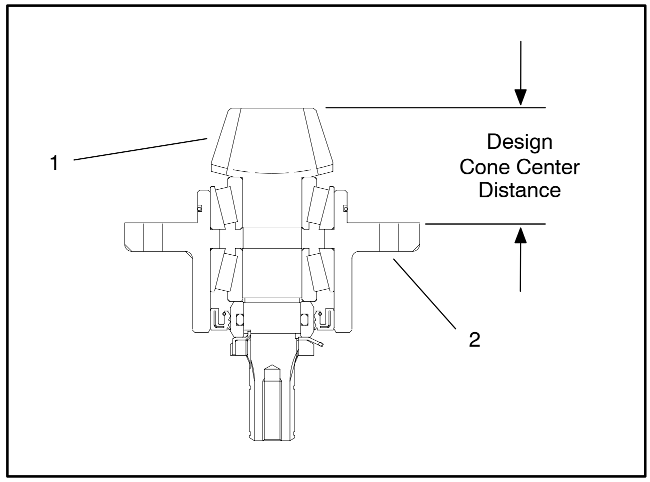


Figure 20
1. Input shaft/pinion gear **2. Bearing case**

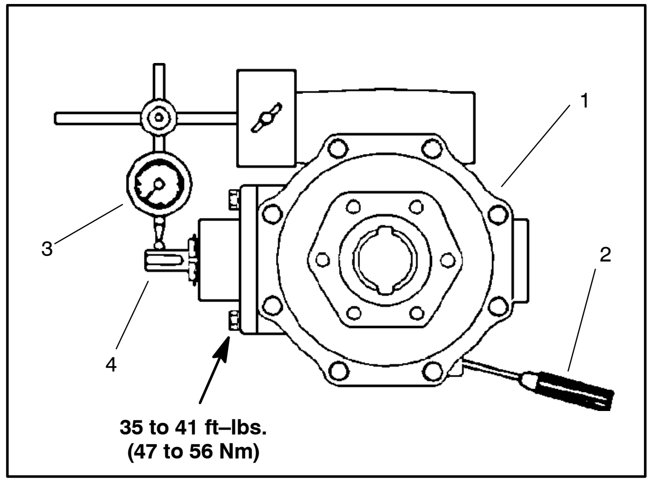


Figure 21
1. Axle case
2. Screwdriver
3. Dial indicator
4. Input shaft/pinion gear

Differential Gear

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove bevel gear case/axle case assemblies (see Bevel Gear Case/Axle Case Assembly in this section of this manual).

IMPORTANT: Do not interchange right and left differential shafts assemblies.

2. Mark and pull the differential shaft assemblies from the axle support (see Differential Shafts in this section of this manual).

3. Remove input shaft/pinion gear assembly, shims, and O-ring from the axle support (Fig. 22).

4. Remove the axle support case screws. Separate the axle support halves and remove the O-ring.

5. Remove the differential gear assembly, bearings, and adjusting shims from the axle case.

6. Drive the spring pin from the differential case with a punch and hammer. Discard the spring pin (Fig. 23).

NOTE: Mark and arrange all components so they can be reassembled in their original position.

7. Remove the differential pinion shaft, pinion gears, and pinion washers. Remove the differential side gears and side gear shims. Remove the ring gear from the differential case only if the ring gear will be replaced (Fig. 24).

NOTE: Replacement ring gears are only available in matched ring and pinion sets.

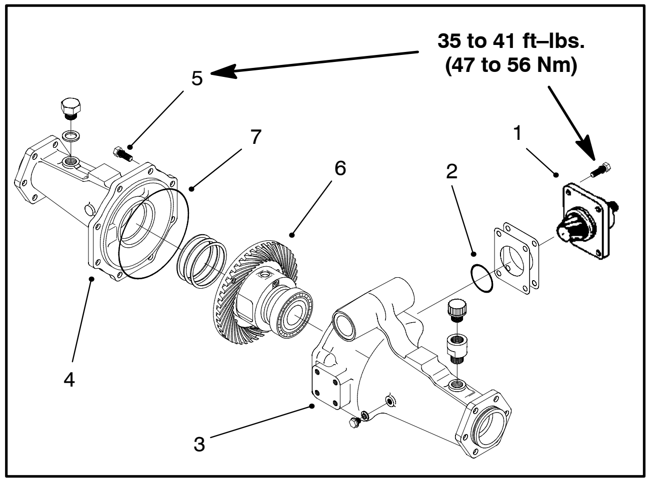


Figure 22

1. Pinion gear
2. O-ring
3. Axle support (right)
4. Axle support (left)
5. Case screws
6. Differential gear
7. O-ring

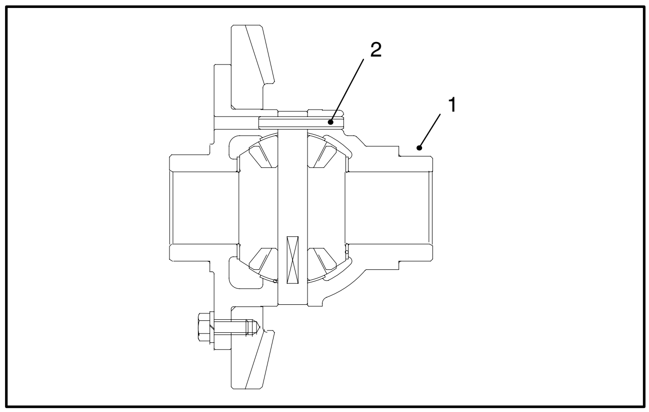


Figure 23

1. Differential case
2. Spring pin

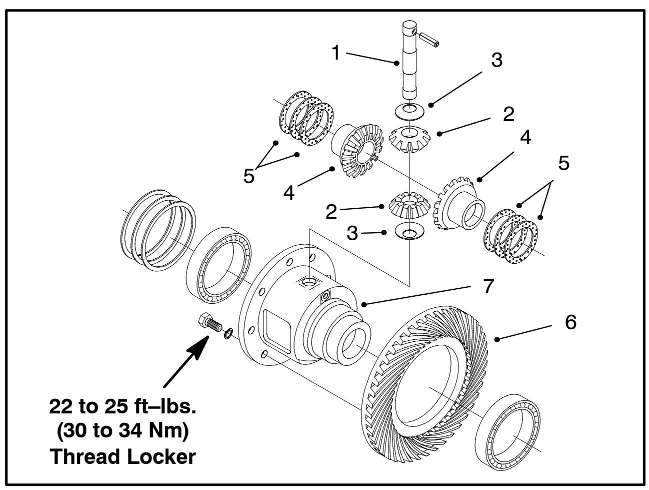


Figure 24

1. Differential pinion shaft
2. Pinion gear
3. Pinion washer
4. Side gear
5. Side gear shims
6. Ring gear
7. Differential case

Inspection

1. Measure the differential side gear O.D. and the differential case I.D. to determine the side gear to case clearance (Fig. 25). Replace components as necessary.

SIDE GEAR TO CASE CLEARANCE:
0.002 to 0.012 in. (0.05 to 0.30 mm)

SIDE GEAR O.D. (Factory Spec.):
1.335 to 1.337 in. (33.91 to 33.95 mm)

DIFFERENTIAL CASE I.D. (Factory Spec.):
1.339 to 1.341 in. (34.00 to 34.06 mm)

2. Measure the differential pinion shaft O.D. and the pinion gear I.D. to determine the pinion shaft to pinion gear clearance (Fig. 26). Replace components as necessary.

PINION SHAFT TO PINION GEAR CLEARANCE:
0.001 to 0.010 in. (0.03 to 0.25 mm)

PINION SHAFT O.D. (Factory Spec.):
0.550 to 0.551 in. (13.97 to 13.10 mm)

PINION GEAR I.D. (Factory Spec.):
0.551 to 0.552 in. (13.10 to 14.02 mm)

3. Inspect all gears, shafts, bearings, cases, and covers for damage and wear. Replace components as necessary.

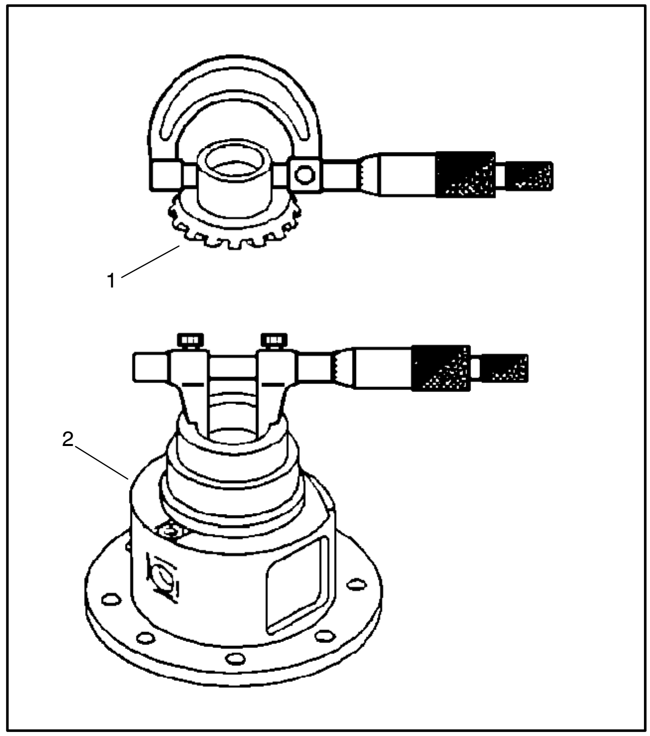


Figure 25

1. Side gear **2. Differential case**

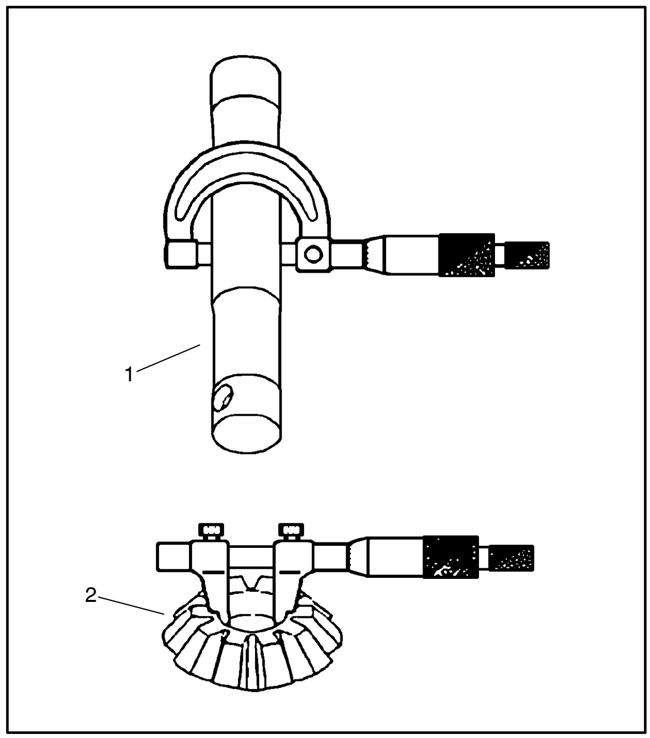


Figure 26

1. Pinion shaft **2. Pinion gear**

Installation

1. If the ring gear was removed from the differential case, use medium strength Loctite thread locker and tighten the mounting screws from 22 to 25 ft-lb (30 to 34 N–m).

2. Apply molybdenum disulfide lubricant (Three Bond 1901 or equivalent) to the splines and bearing surfaces of the differential pinion gears, pinion washers and side gears.

3. Install the side gear shims and side gears in their original location in the differential case.

4. Place the differential pinion gears and pinion washers in their original location in the differential case. Temporarily install the differential pinion shaft.

5. Secure the differential case in a soft jawed vise. Position a dial indicator on a tooth of the differential pinion gear. Press the pinion and side gear against the differential case and measure the pinion gear to side gear backlash (Fig. 27).

PINION GEAR TO SIDE GEAR BACKLASH:
0.004 to 0.016 in. (0.10 to 0.40 mm)

6. Adjust backlash by increasing or reducing side gear shim thickness.

NOTE: Side gear shims are available in 0.043 in. (1.10 mm), 0.047 in. (1.20 mm) and 0.051 in. (1.30 mm) thickness.

7. Apply gear marking compound, such as DyKem® Steel Blue lightly over several gear teeth.

8. While applying a light load to either side gear, rotate either pinion gear until the side gears have made one complete revolution.

9. Ideal tooth contact should cover more than 35% of each tooth surface. The contact area should be in the center of each tooth and extend 1/3 to 1/2 way across each tooth from the toe (small) end (Fig. 28).

10. Adjust side gear shims if necessary to correct tooth contact. Recheck differential pinion gear to side gear backlash if any changes are made.

11. After backlash and tooth contact have been adjusted, align the hole in the differential pinion shaft with the hole in the differential case and install a new spring pin.

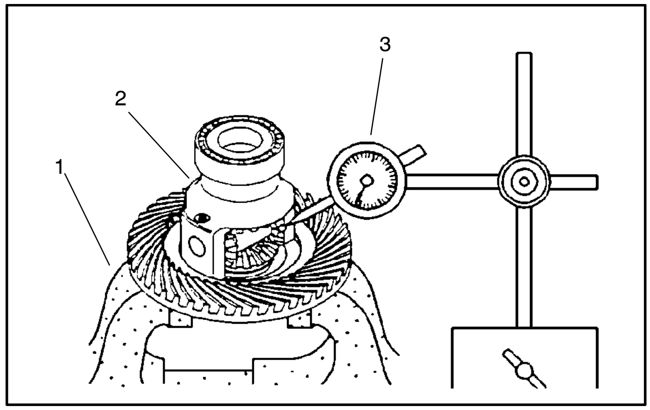


Figure 27

1. **Vise**
2. **Differential gear case**
3. **Dial indicator**

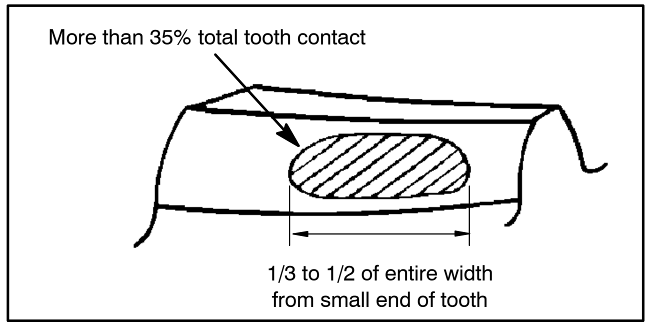


Figure 28

12. Install differential gear assembly in right side axle support half.

13. Coat a new o-ring with grease and install left side axle support half. Tighten axle support case screws from 35 to 41 ft-lb (47 to 56 N–m).

14. Install input shaft/pinion gear assembly (see Input Shaft/Pinion Gear in this section of this manual).

15. Coat new o-rings with grease, align differential shaft splines with differential gear assembly and slide differential shaft assemblies onto axle support (see Differential Shafts in this section of this manual).

16. Install bevel gear case/axle case assemblies (see Bevel Gear Case/Axle Case Assembly in this section of this manual).

Pinion Gear to Ring Gear Engagement

The final position of the pinion gear is verified by using the gear contact pattern method as described in the following procedure.

GEAR TOOTH DEFINITIONS (Fig. 29):

Toe – the portion of the tooth surface at the end towards the center.

Heel – the portion of the gear tooth at the outer end.

Top Land – top surface of tooth.

1. Paint the teeth of the ring gear, both drive and coast side, with a gear marking compound, such as DyKem® Steel Blue.

2. Install the input shaft/pinion gear assembly into axle case.

3. While applying a light load to the ring gear, rotate the pinion gear in the direction of forward travel until the ring gear has made one complete revolution.

Ideal tooth contact observed on the ring gear should cover more than 35% of each tooth surface. The contact area should be in the center of each tooth and extend 1/3 to 1/2 way across each tooth from the toe end (Fig. 30).

Adjustments to the gear contact position are made by moving the input shaft/pinion gear (bearing case shims) or by moving the differential gear case (differential bearing shims) (Fig. 31).

NOTE: Bearing case shims are available in 0.004 in. (0.10 mm) and 0.008 in. (0.20 mm) thickness.

NOTE: Differential bearing shims are available in 0.004 in. (0.10 mm), 0.008 in. (0.20 mm) and 0.016 in. (0.40 mm) thickness.

Study the different contact patterns (Figs. 32 and 33) and correct gear engagement as necessary.

NOTE: When making changes, note that two variables are involved (see Gear Pattern Movement Summary in this section of this manual).

Example: If the pinion gear to ring gear backlash is set correctly to specifications and the bearing case shim is changed to adjust tooth contact, it may be necessary to readjust backlash to the correct specification before checking the contact pattern.

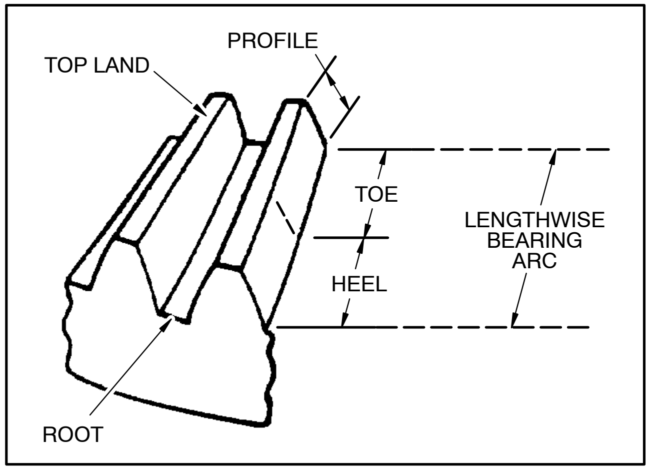


Figure 29

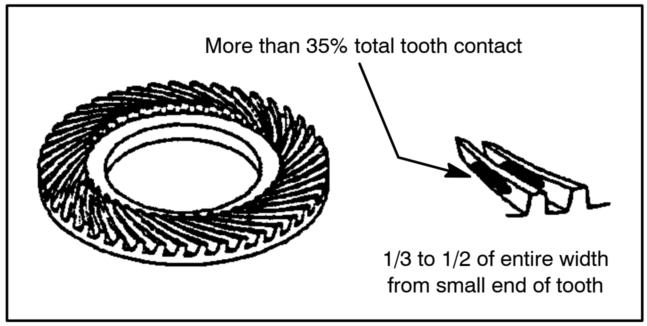


Figure 30

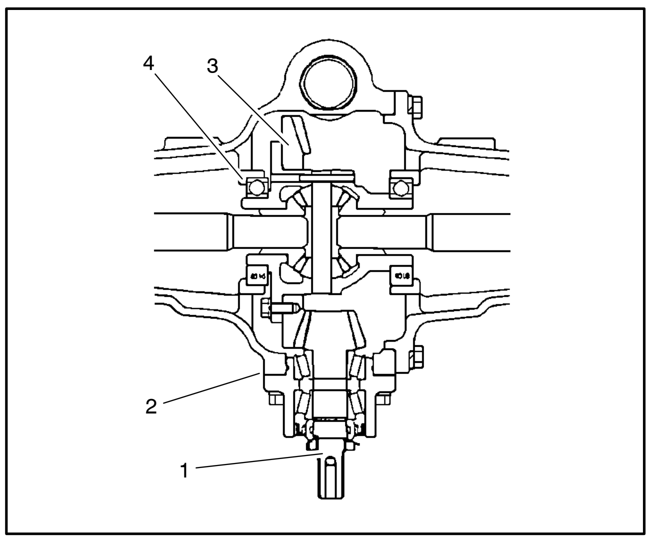


Figure 31

1. **Input shaft/pinion gear**
2. **Bearing case shims**
3. **Differential gear case**
4. **Differential bearing shims**

Gear Pattern Movement Summary

Every gear has a characteristic pattern. The illustrations show typical patterns only and explain how patterns shift as gear location is changed.

1. If contact is toward the heel or base of the gear (Fig. 32):

   A. Install thicker or additional bearing case shim(s) to move pinion shaft toward ring gear.

   B. Install thinner or remove differential bearing shim(s) to move ring gear backward.

   C. Repeat until proper tooth contact and pinion gear to ring gear backlash are correct.

2. If contact is toward the toe or tip of the gear (Fig. 33):

   A. Install thinner or remove bearing case shim(s) to move pinion shaft away from ring gear.

   B. Install thicker or additional differential bearing shim(s) to move ring gear forward.

   C. Repeat until proper tooth contact and pinion gear to ring gear backlash are correct.

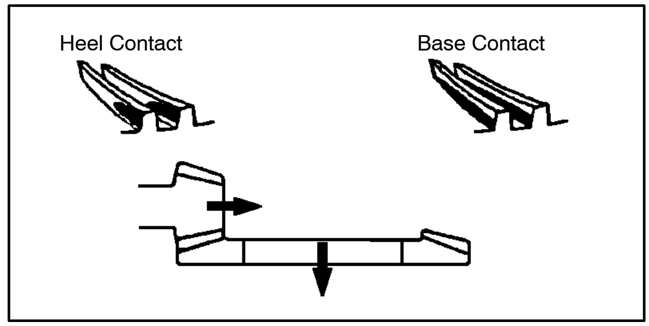


Figure 32

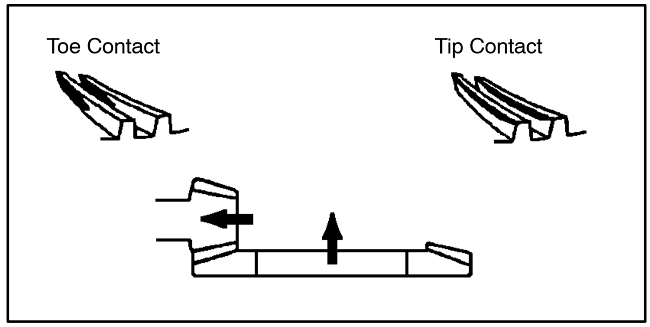


Figure 33

Bidirectional Clutch

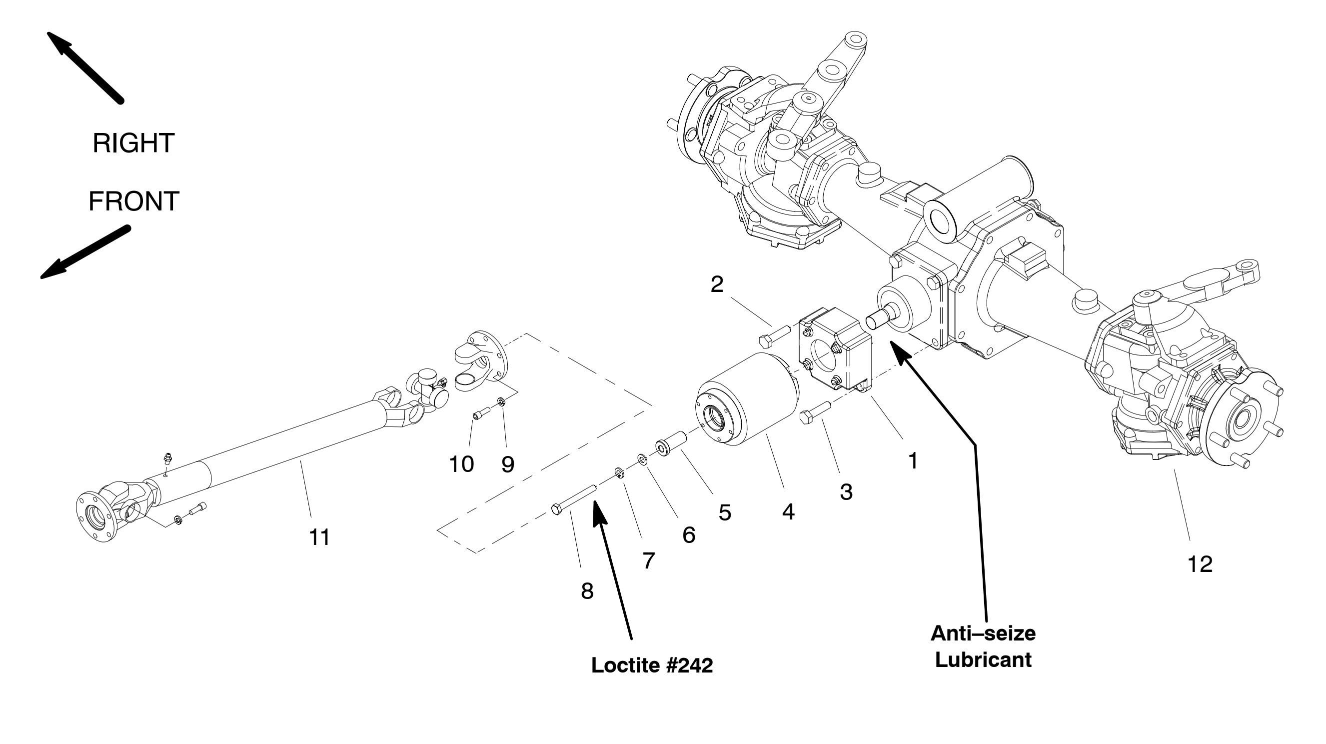


Figure 34

1. **Clutch locator adapter**
2. **Cap screw (2 used)**
3. **Cap screw (2 used)**
4. **Bidirectional clutch**
5. **Spacer**
6. **Flat washer**
7. **Lock washer**
8. **Cap screw**
9. **Lock washer (6 used)**
10. **Socket head screw (6 used)**
11. **Drive shaft assembly**
12. **Rear axle assembly**

Removal (Fig. 34)

1. Park machine on a level surface, lower cutting deck (or implement), stop engine, engage parking brake and remove key from the ignition switch.

2. Drain oil from bidirectional clutch (see Traction Unit Operator's Manual).

3. Remove six (6) socket head screws (item 10) and lock washers (item 9) that secure driveshaft to bidirectional clutch on rear axle. Position end of driveshaft away from clutch.

4. Remove cap screw (item 8), lock washer (item 7) and flat washer (item 6) that secure clutch to rear axle. Locate and retrieve spacer (item 5).

5. Pull bidirectional clutch from rear axle input shaft.

Installation (Fig. 34)

1. Apply anti–seize lubricant to splines of rear axle input shaft.

2. Slide bidirectional clutch onto rear axle input shaft. Align notches in clutch housing with cap screw heads on axle clutch locator adapter.

3. Apply Loctite #242 (or equivalent) to threads of cap screw (item 8) that secures clutch to rear axle shaft.

4. Secure clutch to axle shaft with cap screw, lock washer (item 7), flat washer (item 6) and spacer (item 5).

5. Position end of driveshaft to bidirectional clutch on rear axle. Secure driveshaft to clutch with six (6) socket head screws (item 10) and lock washers (item 9).

6. Fill clutch with oil to the proper level (see Traction Unit Operator's Manual).

Bidirectional Clutch Service

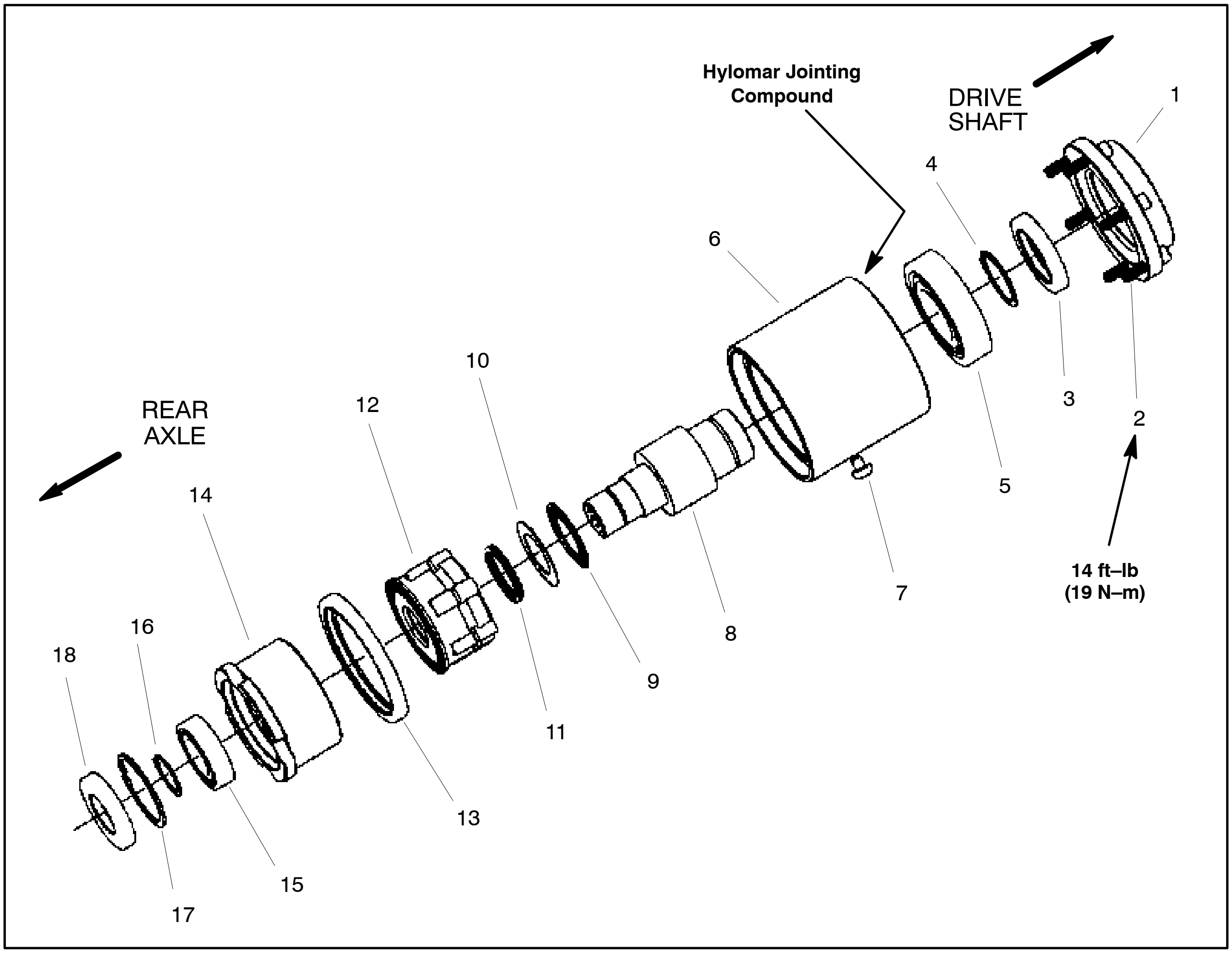


Figure 35

1. End plate	**7. Phillips head screw w/o–ring**	**13. Oil seal**
2. Socket head screw (6 used)	**8. Hub**	**14. Bearing Housing**
3. Oil seal	**9. Needle bearing**	**15. Bearing**
4. Snap ring	**10. Thrust washer**	**16. Snap ring**
5. Bearing	**11. Wave spring**	**17. Retaining ring**
6. Housing	**12. Roller cage assembly**	**18. Oil seal**

Disassembly (Fig. 35)

1. Thoroughly clean exterior of clutch before disassembly.

2. Disassemble clutch using Figure 35 as a guide.

Assembly (Fig. 35)

1. Lightly lubricate clutch components with clean Mobil Fluid 424 before assembly.

2. Assemble clutch using Figure 35 as a guide.

3. When installing oil seals, make sure that seal lips are facing in.

4. Apply Hylomar Jointing Compound (or equivalent) to end plate (item 1) mating surface before installing end plate.

5. Secure end plate with six (6) socket head cap screws. Torque screws 14 ft–lb (19 N–m).

Chapter 11

72″ Cutting Units

Table of Contents

SPECIFICATIONS 2
GENERAL INFORMATION 3
    Grass Deflector 3
TROUBLESHOOTING 4
ADJUSTMENTS 5
    Height of Cut Adjustment 5
    Mismatch Adjustments 6
    Belt Tension Adjustment 7
REPAIRS 8
    Blade Service 8
    Belt Replacement 10
Caster Arm Bushing Replacement 11
Rear Caster Wheel Bearing Service 12
Front Caster Wheel Bearing Service 13
Separating Cutting Unit From Traction Unit 14
Mounting Cutting Unit to Traction Unit 16
Push Arm and Torsion Spring Service 18
Gearbox Removal and Installation 21
Gearbox Service 23
Blade Spindle Service 26

Specifications

ITEM	SPECIFICATION
Cutting width	71.5 inch
Height of cut range	1 to 4 inch
Height of cut adjustment	0.5 inch increments
Blade bolt torque	75 to 100 ft-lb (left-hand thread)
Spindle nut torque	140 - 160 ft-lb.
Spindle end play	.006 inch max.
Spindle rolling torque	10 in-lb max.
Gearbox lubricant	SAE 80W90, API GL-5 gear lube

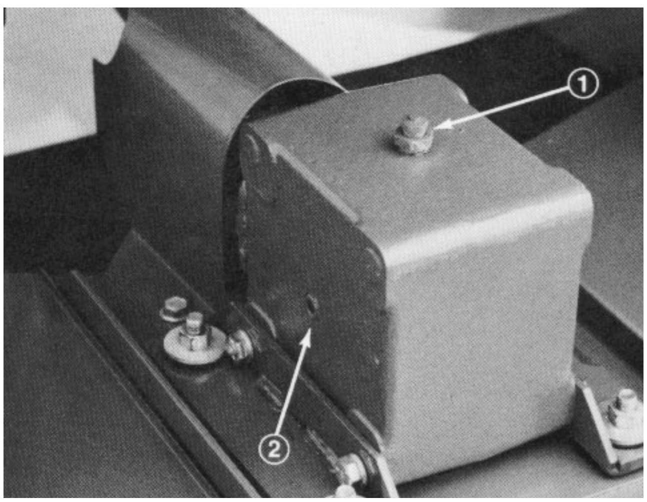


Figure 1

1. Filler plug
2. Check plug

Grass Deflector

WARNING

The grass deflector (Fig. 2) is a safety device that diverts grass and other foreign objects being discharged downward. WE STRONGLY RECOMMEND THAT THE DEFLECTOR BE IN ITS NORMAL OPERATING POSITION WHENEVER THE CUTTING UNIT IS ENGAGED. NEVER OPERATE CUTTING UNIT WITH THE DEFLECTOR REMOVED FROM THE CUTTING UNIT OR TIED/BLOCKED IN A RAISED POSITION, SINCE THE BLADES COULD THEN THROW DEBRIS A CONSIDERABLE DISTANCE WITH SUFFICIENT FORCE TO CAUSE PERSONAL INJURY OR DAMAGE TO PROPERTY. If the grass deflector is damaged, repair or replace the affected part(s).

NOTE: The deflector is spring loaded into its downward normal operating position, but the operator can temporarily swing it out of the way to facilitate loading in a trailer or when otherwise necessary.

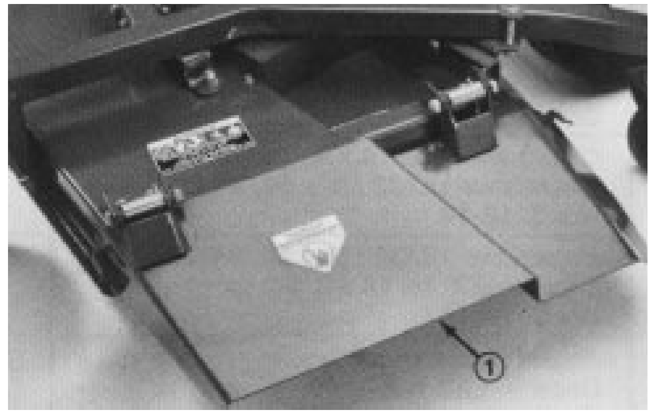
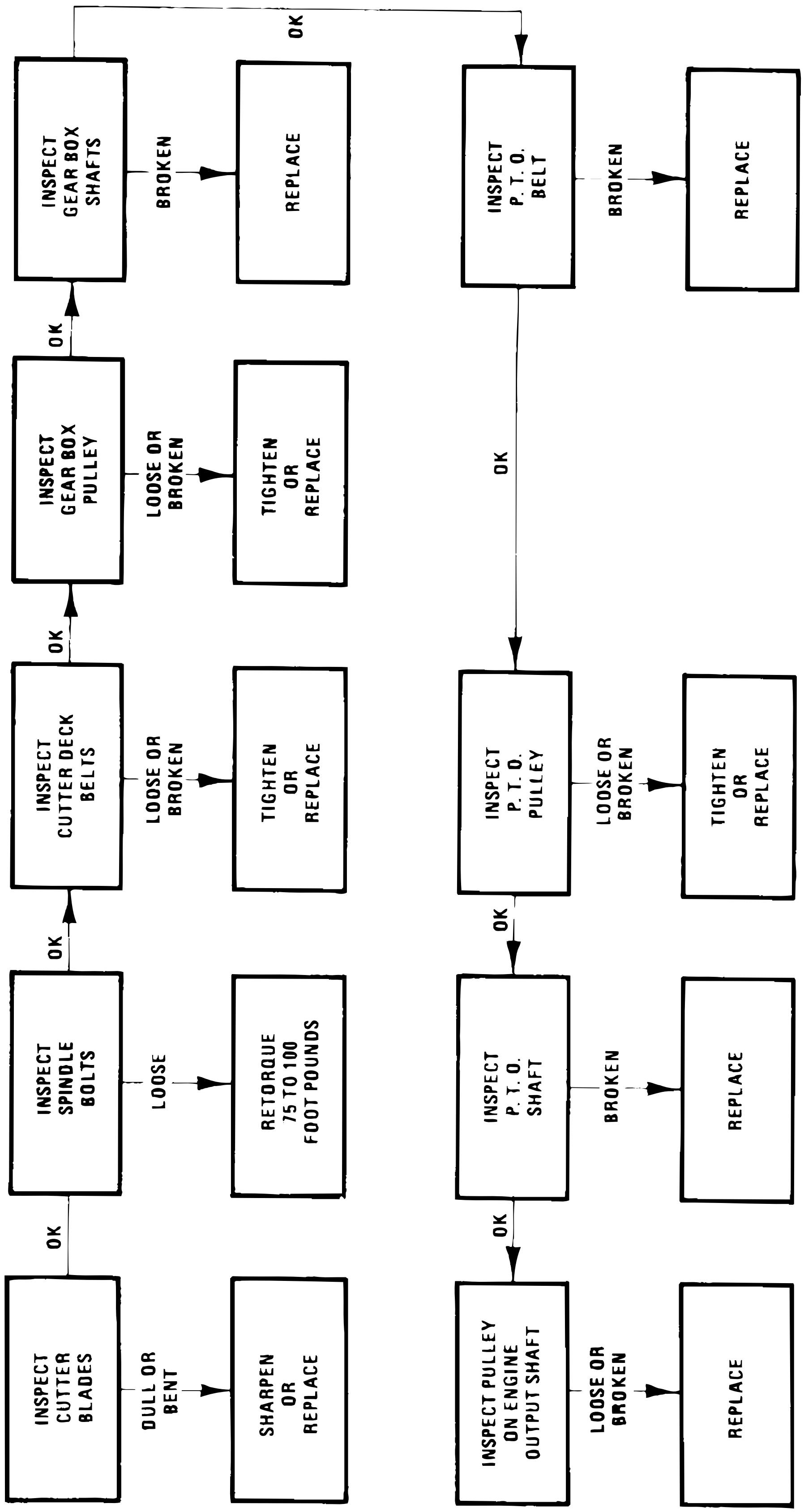


Figure 2

1. Deflector in lowest position

Troubleshooting



Adjustments

Height of Cut Adjustment (Fig. 3, 4)

The height of cut is adjustable from 1 to 4 inches in 1/2 inch increments, by adding or removing an equal number of spacers on the front and rear caster forks. The height of cut chart below gives the combinations of spacers to use for all height of cut settings.

NOTE: 1/4 inch spacers are available and can be ordered from your Toro distributor by Toro Part No. 27-1040. (Quantity - 8).

Height of Cut		**Spacers Below Caster Arms**	
inches	mm	Front	Rear
1	25	0	0
1-1/2	38	1	1
2	51	2	2
2-1/2	64	3	3
3	76	4	4
3-1/2	89	5	5
4	102	6	6

NOTE: A more optimum cutting appearance of the turf can be achieved in the lower heights of cut by lowering the rear of the cutting unit. Accomplish this by relocating the rear caster wheel axles in the upper hole of the caster forks. Replace the axles into the lower caster fork holes for higher height of cut settings where optimum cutting appearance is not required.

IMPORTANT: Do not attempt to cut off more than one inch of the grass blades in the one (1) inch height of cut setting with the rear of the cutting unit lowered, as this may cause the engine to labor excessively.

1. Start the engine and raise cutting unit so front caster height of cut can be changed. Stop engine after cutting unit is raised. Rear caster height of cut can be changed with cutting unit lowered.

2. Squeeze back of wire and rotate wire on lynch pin. Pull pin out of caster spindle. Slide spacers onto the caster spindle to get desired height of cut. Then slide washer onto spindle.

3. Push caster spindle through caster arm. Slide any remaining spacers onto spindle. Install lynch pin to retain parts in place.

NOTE: When cutting unit is used in 1 inch or 1-1/2 inch height of cut setting, front and rear rollers must be positioned in the upper bracket holes.

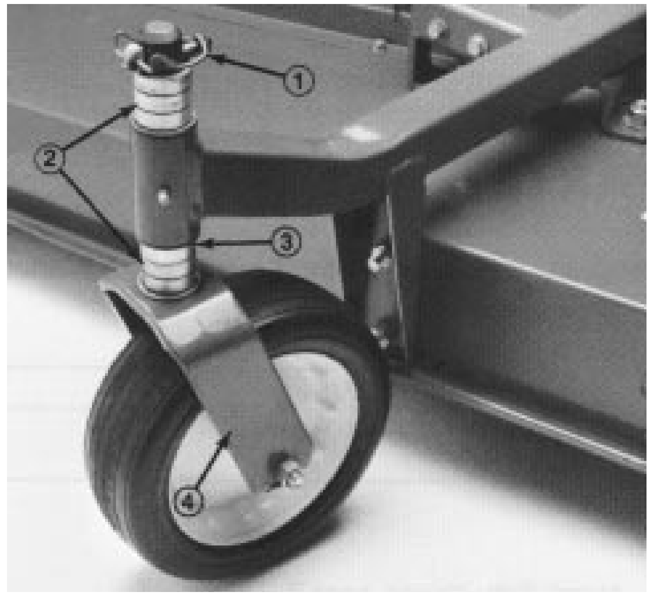


Figure 3

1. Lynch pin
2. Spacers
3. Thrust washer
4. Large (front) caster spindle

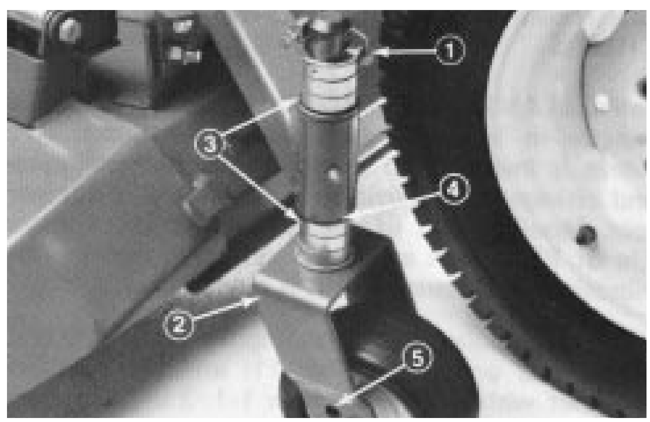


Figure 4

1. Lynch pin
2. Small (rear) caster
3. Spacers
4. Washer
5. For 1 in. H.O.C. only

Checking and Correcting Mismatch of Blades (Fig. 5)

If there is mismatch between the blades, the grass will appear streaked when it is cut. This problem can be corrected by making sure the blades are straight and all blades are cutting on the same plane.

1. Using a 3 foot long carpenters level, find a flat surface on the shop floor.

2. Set rear caster wheels in the upper hole of caster forks and adjust height of cut so all six height of cut spacers are below the caster arm.

3. Lower cutting unit onto flat surface. Remove covers from top of cutting unit. Loosen idler pulleys to release tension against all three belts.

4. Rotate blades until the ends face forward and backward. Measure from floor to front tip of cutting edge and remember this dimension. Then rotate same blade so opposite end is forward and measure again. The difference between dimensions must not exceed 1/8 inch. If difference exceeds 1/8 inch, replace the blade because it is bent. Make sure to measure all three blades.

5. Compare measurements of outer blades with the center blade. Center blade must not be more than 3/8 inch lower than outer blades. If center blade is more than 3/8 inch lower than outer blades, proceed to step 7 and add shims between spindle housing and bottom of cutting unit.

6. Rotate blades so tips line up with one another. Tips of the adjacent blades must be within 1/8 inch of each other. If tips are not within 1 /8 inch of each other, proceed to step 7 and add shims between spindle housing and bottom of cutting unit.

7. Remove cap screws, flat washers, lock washers and nuts from outer spindle, in the area where shims must be added. To raise or lower the blade, add a shim, Part No. 3256-24, between spindle housing and bottom of cutting unit. Continue to check alignment of blade and add shims until tips of blades are within the required dimension.

IMPORTANT: Do not use more than three shims at any one hole location. Use decreasing numbers of shims in adjacent holes if more than one shim is added to any one hole location.

8. Tension idler pulleys against all three belts. Also install covers to top of cutting unit.

9. Set rear caster wheels in lower holes in caster forks if height of cut is above one (1) inch and adjust height of cut.

10. Mount cutting unit to traction unit: refer to Mounting Cutting Unit To Traction Unit

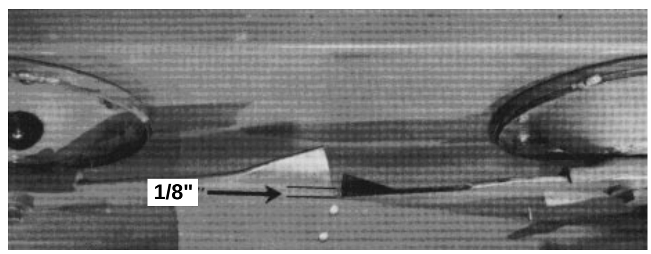


Figure 5

Belt Tension Adjustment (Fig. 6)

1. Lower the cutting unit to the floor and shut off the engine. Engage the parking brake.

2. Remove the deck covers from the top of the cutting unit.

3. Loosen the idler pulley for the belt being adjusted and move idler into belt using a pry bar, until you get the proper tension. Tighten the idler pulley flange nut.

Recommended tension is 3/8 inch deflection when an eight (8) pound load is applied to the center of the 25 inch span between pulleys. Deflection is measured at the position on the belt where the load is applied.

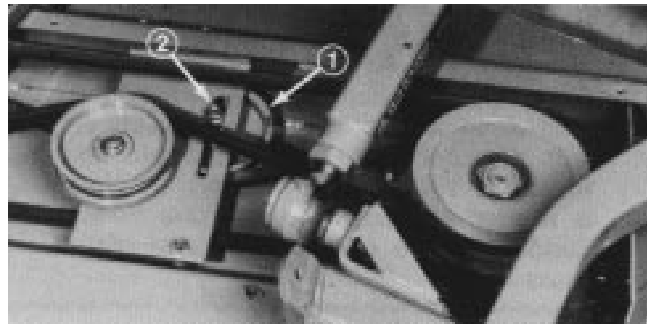


Figure 6

1. Lower belt idler **2. Flange nut**

Repairs

Blade Service (Fig. 7, 8, 9)

The blade must be replaced if a solid object is hit, the blade is out of balance, worn or bent. Always use genuine TORO replacement blades to ensure safety and optimum performance. Never use blades made by other manufacturers because they could be dangerous.

Do not try to straighten a blade that is bent, and never weld a broken or cracked blade. Always use a new TORO blade to assure continued safety certification of the product.

1 . Raise cutting unit to highest position, shut the engine off and engage parking brake. Block cutting unit to prevent it from falling accidentally.

2. Grasp end of blade using a rag or thickly padded glove. Remove special screw, belleville washer and blade from spindle assembly.

NOTE: The special screw has left hand thread.

3. To install the blade, assemble parts in reverse order, and make sure the blade sail is facing up. Tighten special screw to 75 to 100 ft-lb.

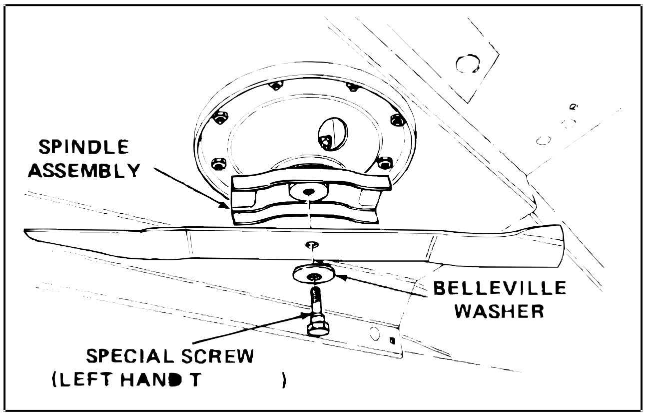


Figure 7

Inspecting and Sharpening Blade

1. Raise cutting unit to highest position, shut the engine off and engage parking brake. Block cutting unit to prevent it from falling accidentally.

2. Examine cutting ends of the blade carefully, especially where the flat and curved parts of the blade meet. Since sand and abrasive material can wear away the metal that connects the flat and curved parts of the blade, check the blade before using the machine. If any wear is noticed, replace the blade: refer to Removing Cutter Blade.

WARNING

If the blade is allowed to wear, a slot will form between the sail and flat part of the blade. Eventually, a piece of the blade may break off and be thrown from under the housing, possibly resulting in serious injury to yourself or bystander.

3. Examine cutting edges of all blades. Sharpen the cutting edges if they are dull or nicked. Sharpen only the top side of the cutting edge and maintain the original cutting angle to assure sharpness. The blade will remain balanced if same amount of metal is removed from both cutting edges.

4. To check blade for being straight and parallel, lay blade on level surface and check its ends. Ends of blade must be slightly lower than the center, and cutting edge must be lower than heel of the blade. This blade will produce good quality of cut and require minimal power from the engine. By contrast, a blade that is higher at the ends than the center, or cutting edge higher than the heel of the blade is warped or bent and must be replaced.

5. To install the blade, ,assemble parts in reverse order, and make sure the blade sail is facing up. Tighten special screw to 75 to 100 ft-lb.

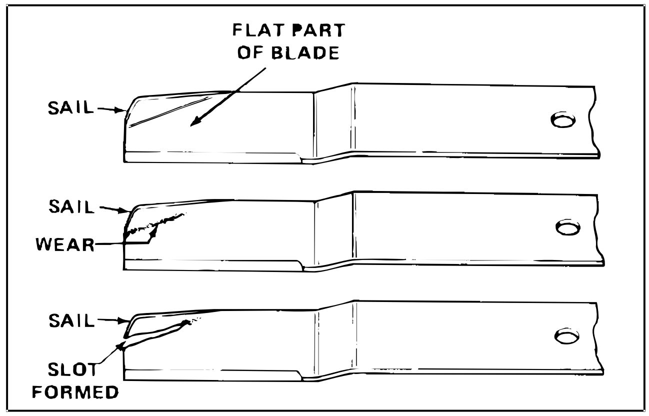


Figure 8

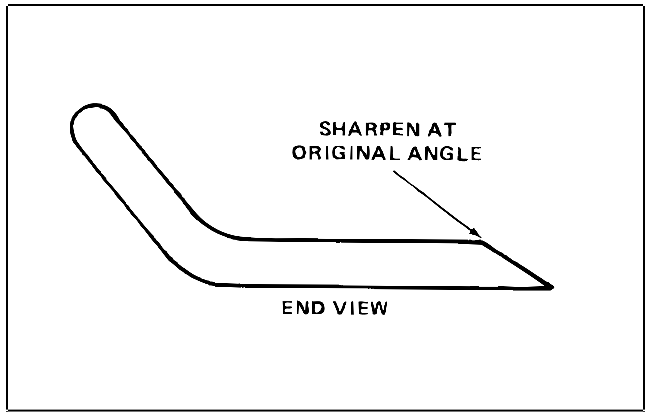


Figure 9

Belt Replacement (Fig. 10)

1. Lower cutting unit to the shop floor, shut off the engine and engage the parking brake. Remove covers on top of cutting unit and set covers aside. Loosen idler pulleys to release tension of belts.

2. Remove carriage bolts, lock washers and nuts holding gear box in place. Lift gear box off mounting plate and lay it on top of cutting unit.

3. Remove belts from spindle pulleys.

4. Mount a belt on lower pulley groove of left spindle, slide belt under belt idler mount plate and install around center spindle pulley. Tension belt by levering idler pulley against belt and tighten idler pulley flange nut.

5. Place the right spindle belt under the gear box mount plate and the opposite end on top of the right spindle pulley. Place the left spindle belt under the gear box mount plate and the opposite end on top of the left spindle pulley. Mount the gear box and loop the belts around the gear box pulley.

6. Feed the right and left spindle belts over the pulleys by rotating the cutter blades. Tighten the gear box mounting fasteners.

7. Tension idler pulleys against both belts. Install covers on top of cutting unit.

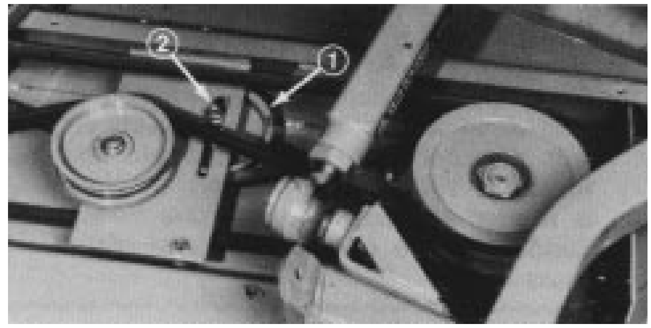


Figure 10

1. Lower belt idler **2. Flange nut**

Caster Arm Bushing Service (Fig. 11)

The caster arms have bushings pressed into the top and bottom portion of the tube and after many hours of operation, the bushings will wear. To check the bushings, move caster fork back and forth and from side-to-side. If caster spindle is loose inside the bushings, bushings are worn and must be replaced.

1. Raise cutting unit and block it so it cannot fall accidentally.

2. Remove lynch pin and spacers from top of caster spindle.

3. Pull caster spindle out of mounting tube. Allow spacer(s) and thrust washer to remain on bottom of spindle to assure same height of cut when caster spindle is reinstalled.

4. Insert pin punch into top or bottom of mounting tube and drive bushing out of tube. Also drive other bushing out of tube. Clean inside of tubes to remove dirt.

5. Apply grease to inside and outside of new bushings. Using a hammer and flat plate, drive bushings into mounting tube.

6. Inspect caster spindle for wear and replace it if damaged.

7. Push caster spindle through bushings and mounting tube. Slide spacers onto spindle. Install lynch pin through caster spindle to retain all parts in place.

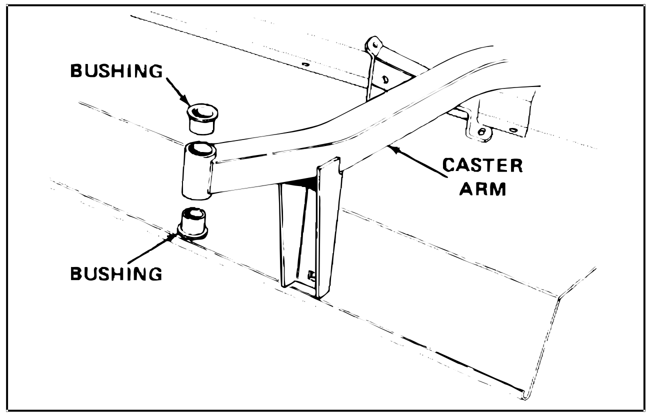


Figure 11

Rear Caster Wheel Bearing Service (Fig. 12)

The rear caster wheels rotate on high quality roller bearings which are supported by spanner bushings. Even after many hours of use, provided that the bearing was kept well-lubricated, bearing wear will be minimal. However, failure to keep bearings lubricated will cause rapid wear. A wobbly caster wheel usually indicates a worn bearing.

1. Remove capscrew and locknut holding caster wheel and (2) washers between caster fork.

2. Pull spanner bushing out of wheel hub.

3. Remove bushing from wheel hub and allow bearing to fall out. Remove bushing from opposite side of wheel hub.

4. Check the bearing, spanner and inside of wheel hub for wear. Replace defective parts.

5. To assemble the caster wheel, push bushing into wheel hub. Slide bearing into wheel hub. Push other bushing into open end of wheel hub to captivate the bearing inside the wheel hub.

6. Carefully slide spanner through the bushings and wheel hub.

7. Install caster wheel assembly and (2) washers between caster fork, and secure all parts in place with capscrew and locknut.

8. Lubricate caster wheel bearing through grease fitting, using No. 2 general purpose lithium grease.

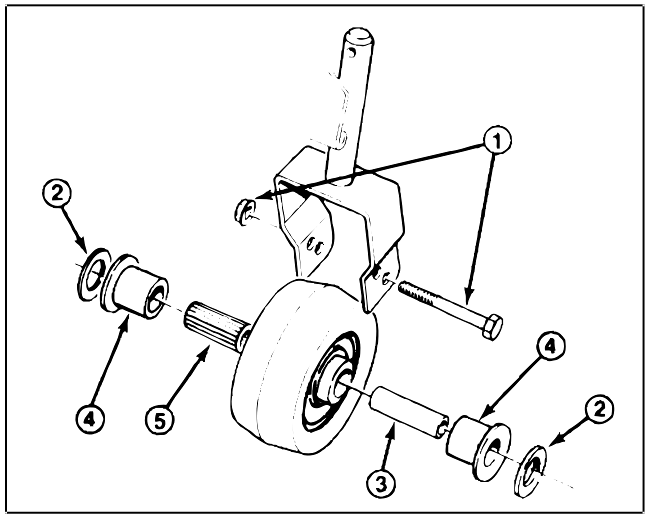


Figure 12

Front Caster Wheel Bearing Service (Fig. 13)

The front caster wheels rotate on high-quality roller bearings which are supported by spanner bushings. Even after many hours of use, provided that the bearing was kept well-lubricated, bearing wear will be minimal. However, failure to keep bearings lubricated will cause rapid wear. A wobbly caster wheel usually indicates a worn bearing.

1. Remove capscrew and locknut holding caster wheel and (2) washers between caster fork.

2. Pull spanner bushing out of wheel hub.

3. Remove bushing from wheel hub and allow bearing to fall out. Remove bushing from opposite side of wheel hub.

4. Check the bearing, spanner and inside of wheel hub for wear. Replace defective parts.

5. To assemble the caster wheel, push bushing into wheel hub. Slide bearing into wheel hub. Push other bushing into open end of wheel hub to captivate the bearing inside the wheel hub.

6. Carefully slide spanner through the bushings and wheel hub.

7. Install caster wheel assembly and (2) washers between caster fork, and secure all parts in place with capscrew and locknut.

8. Lubricate caster wheel bearing through grease fitting, using No. 2 general purpose lithium grease.

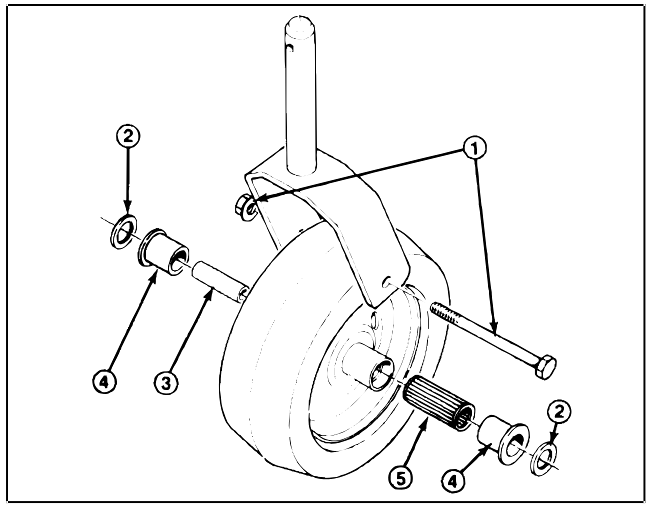


Figure 13

Separating Cutting Unit From Traction Unit (Fig. 14, 15, 16, 17)

1. Position machine on level surface, lower cutting unit to the shop floor, shut engine off and engage parking brake.

2. Remove self-tapping screws securing shield to top of cutting unit and set shield aside.

3. Drive roll pin out of yoke and input shaft of gear box. Also, loosen cap screws and lock nuts. Slide yoke off the input shaft. If traction unit will be used without the cutting unit, drive roll pin out of yoke at PTO pivot shaft and remove entire universal shaft from traction unit.

DANGER

Do not start the engine and engage the PTO lever when PTO shaft is not connected to gear box on cutting unit. If engine is started and PTO shaft is allowed to rotate, serious injury could result.

4. Disconnect spring from lift cylinder cotter pin. Remove cotter pins and clevis pins securing lift chains to lift arm.

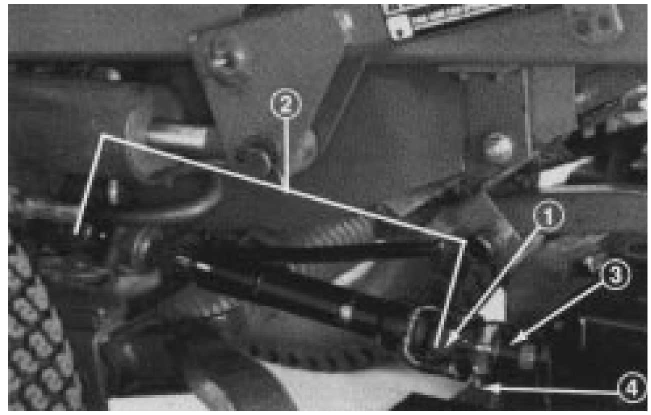


Figure 14

1. PTO yoke
2. Yokes in phase
3. Roll pin
4. Capscrews & locknuts

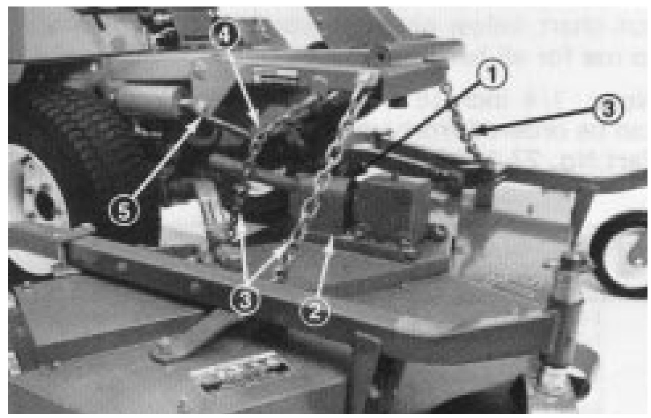


Figure 15

1. PTO shield
2. Self-tapping screws
3. Lift chain
4. Spring in 4th link
5. Spring in cotter pin

WARNING

Since the right hand push arm is spring-loaded to about 100 pounds and left hand push arm is spring-loaded to about 150 pounds, a helper is needed to release push arms from cutting unit. Sudden release of the push arms could cause injury.

5. Have a helper push down on the right push arm while you remove the cap screws, flat washers, lock washers and nuts securing ball joint mount to caster arm on cutting unit. Now the helper can carefully allow push arm to move upward, which will gradually release the 100 pounds of spring load.

6. Have a helper push down on the left push arm while you remove the cap screws, flat washers, lock washers and nuts securing ball joint mount to mount bracket on cutting unit. Now the helper can carefully allow push arm to move upward which will gradually release the 150 pounds of spring load.

7. Roll the cutting unit away from the traction unit.

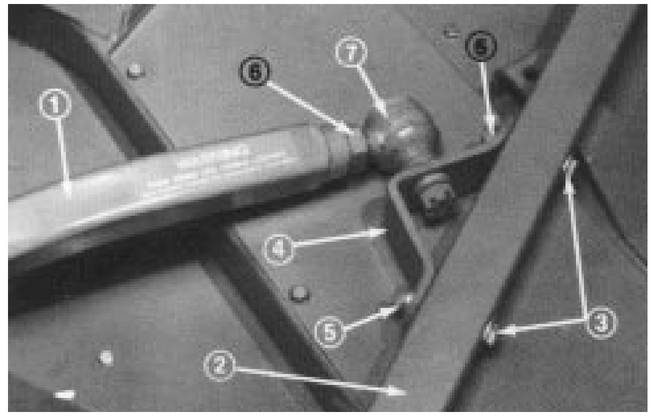


Figure 16

1. R.H. push arm
2. Caster arm
3. Capscrews & flatwashers
4. Ball joint mount
5. Flange locknuts
6. Jam nut
7. Ball joint

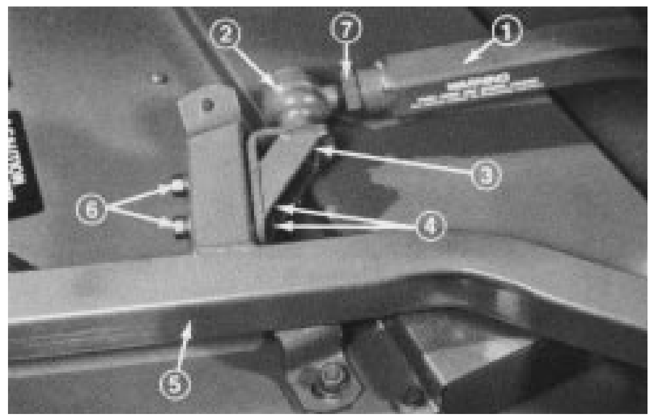


Figure 17

1. L.H. push arm
2. Ball joint
3. Ball joint mount
4. Capscrews & locknuts
5. Caster arm
6. Flange locknuts
7. Jam nuts

Mounting Cutting Unit to Traction Unit (Fig. 18, 19, 20, 21)

1. Position machine on level surface and shut engine off.

2. Move cutting unit into position in front of traction unit.

WARNING

Since the right hand push arm is spring-loaded to about 100 pounds and left hand push arm is spring-loaded to about 150 pounds, a helper is needed to push the push arm down. Sudden release of the push arm could cause injury.

3. Slide a large flat washer (1/2 I.D. x 1-1/4 in. O.D.) onto both cap screws (7/16 - 14 x 3 in.).

4. Have a helper carefully push down on right hand push arm until holes in ball joint mount line up with holes in caster arm. Secure ball joint mount to caster arm with two cap screws w/large flat washers, one flat washer (15/32 I.D. x 59/64 in. O.D.), two lock washers and nuts (7/16 - 14). Heads of cap screws and large flat washers must be on outside of caster arm.

5. Slide flat washers (1 5/32 1. D. x 59/64 in. O.D.) onto two cap screws (7/16 - 14 x 3 in.).

6. Have a helper carefully push down on left hand push arm until holes in ball joint mount are in line with holes in mount bracket on cutting unit. Immediately slide 4 x 4 in. block of wood between top of push arm and underside of chassis.

WARNING

Make sure wooden block does not slip out accidentally.

7. Secure ball joint mount to mount bracket with two cap screws, flat washers, and flange lock nuts (7/16 -14). Heads of cap screws and flat washers must contact ball joint mount.

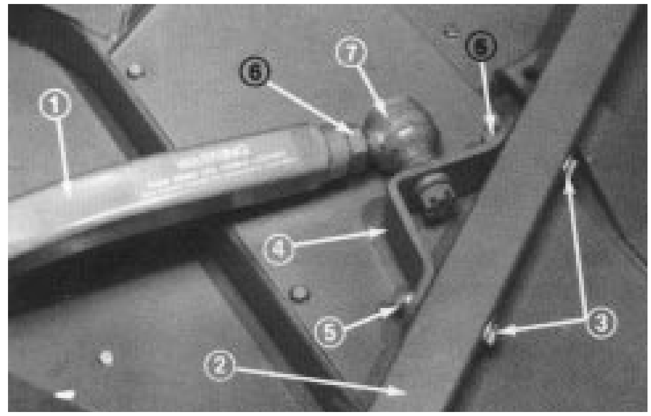


Figure 18

1. R.H. push arm
2. Caster arm
3. Capscrews & flatwashers
4. Ball joint mount
5. Flange locknuts
6. Jam nut
7. Ball joint

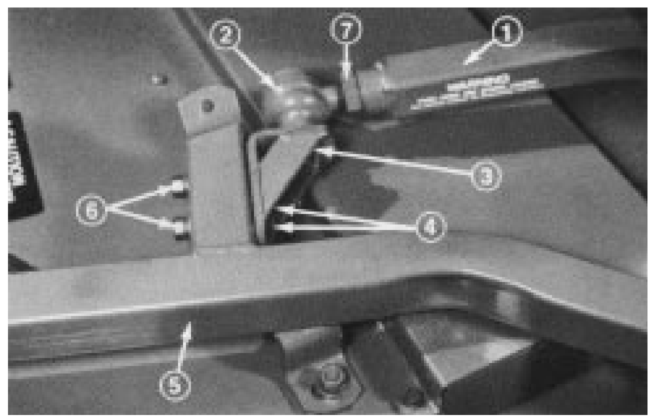


Figure 19

1. L.H. push arm
2. Ball joint
3. Ball joint mount
4. Capscrews & locknuts
5. Caster arm
6. Flange locknuts
7. Jam nuts

8. Line up holes in yoke and input shaft of gear box. Slide yoke onto shaft and secure parts together with roll pin (3/16 x 1-1/2 in.). Tighten (2) capscrews and locknuts securing yoke to input shaft.

9. Mount PTO shield over input shaft and onto gear box mounting plate with two self-tapping screws.

10. Attach lift chains to lift arm and cutting unit with six (6) shackles, shackle pins (3/8 x 1-1/2 in.) and cotter pins (1/8 x 3/4 in.). Adjust chain length so both become tight at the same time when lifting lift arm.

11. Connect ends of tension spring between fourth link of rear chain and eye of cotter pin that holds cylinder pin in place. Adjust length of chain so rear caster wheels are off the ground in transport position.

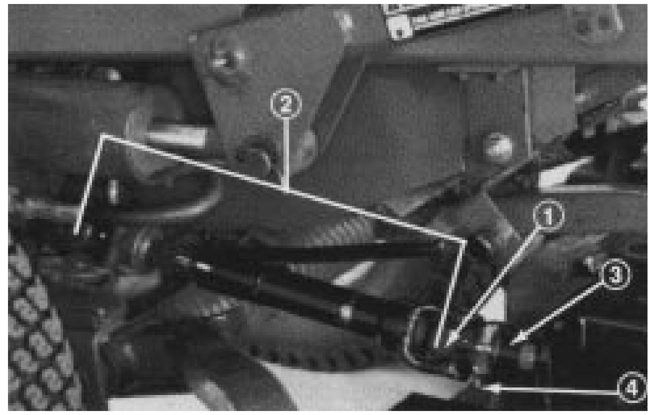


Figure 20

1. PTO yoke
2. Yokes in phase
3. Roll pin
4. Capscrews & locknuts

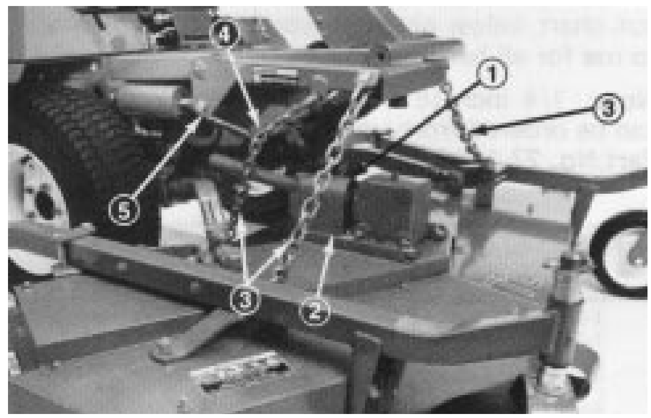


Figure 21

1. PTO shield
2. Self-tapping screws
3. Lift chain
4. Spring in 4th link
5. Spring in cotter pin

Push Arm and Torsion Spring Service (Fig. 22, 23, 24, 25, 26, 27, 28)

Removing Push Arms,
Torsion Springs and Bushings

1. Separate cutting unit from traction unit and roll cutting unit away from traction unit.

2. Have a helper push down on the left push arm while you put a 4" x 4" block of wood between the chassis and the top of the push arm, and across the full width of the machine.

3. Loosen the large jam nut on the left-hand ball joint at the end of the push arm. Remove the ball joint (mount attached) from the push arm.

4. Remove the self-tapping screws holding the floor plate to the main frame. Raise the floor plate and set it aside.

5. Disconnect the right-hand brake cable from the brake strut. Remove the jam nut holding the brake cabled in the mount on the frame and slide the cable through the hole in the push arm bracket.

6. Remove the cotter pin from the end of the parking brake rod. Slide the rod out of the latch.

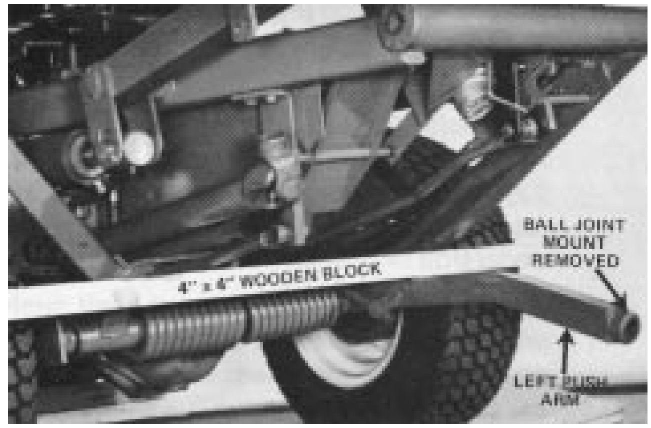


Figure 22

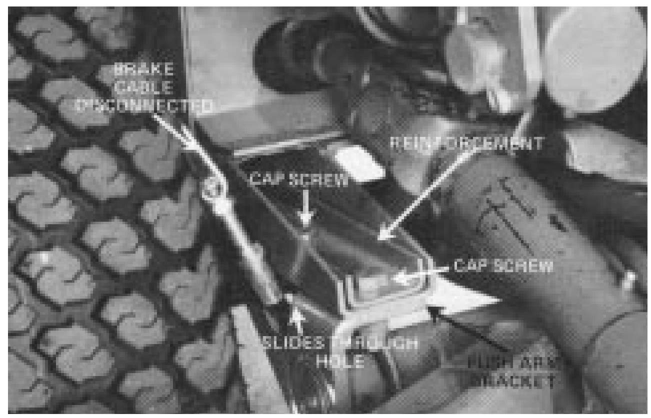


Figure 23

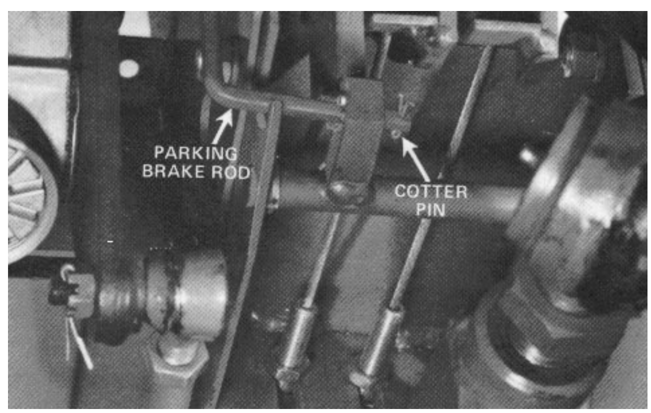


Figure 24

7. Remove the cap screws, locknuts, carriage bolts, lock washers and nuts holding the brake mount and pedal assembly in place. Lay the brake mount and the pedal assembly on the wheel.

8. Have a helper push down slightly on the left push arm while you remove the block of wood between the push arm and the chassis. Slowly and carefully allow the push arm to move upward until all spring load is released.

9. Remove the cap screws, locknuts, support plate and push arm bracket holding the left side of the push arm and pivot shaft to the main frame.

10. Remove the cap screws, locknuts, reinforcement and push arm bracket holding the right side of the push arm and pivot shaft to the main frame. The entire push arm and pivot shaft assembly should now be free of the main frame.

11. Drive the roll pins out of the pivot shaft and slide the push arm assemblies off of the shaft.

12. Drive the pushing out of both push arm pivot tubes. Clean the inside of the pivot tubes to remove all dirt and other material.

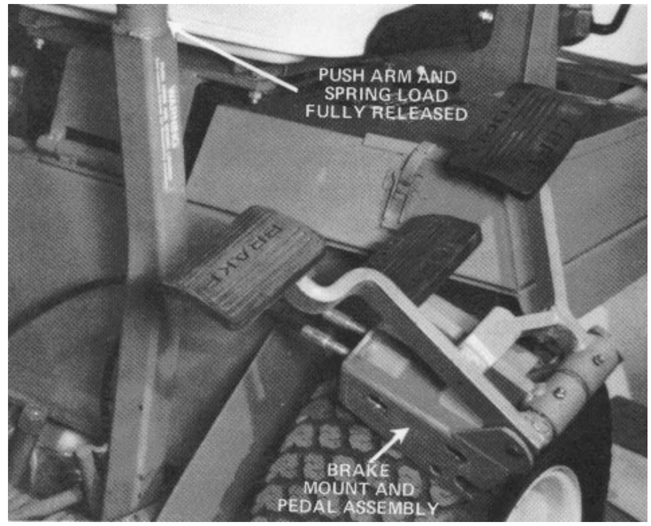


Figure 25

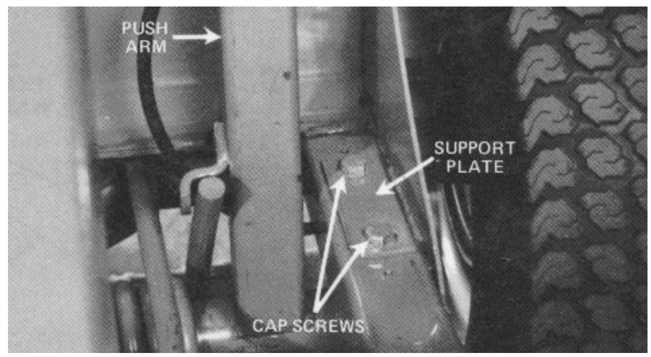


Figure 26

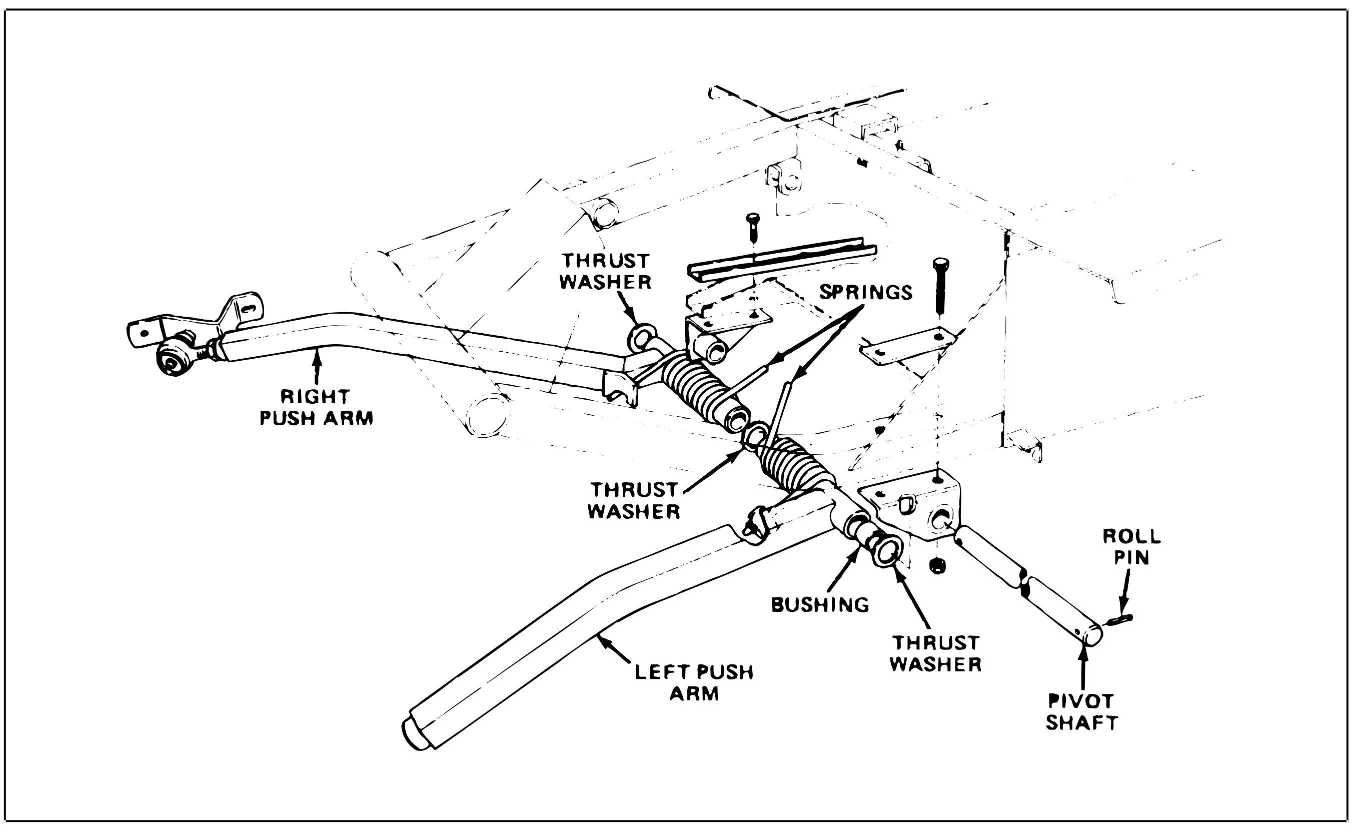


Figure 27

Installing Push Arms, Torsion Springs and Bushings

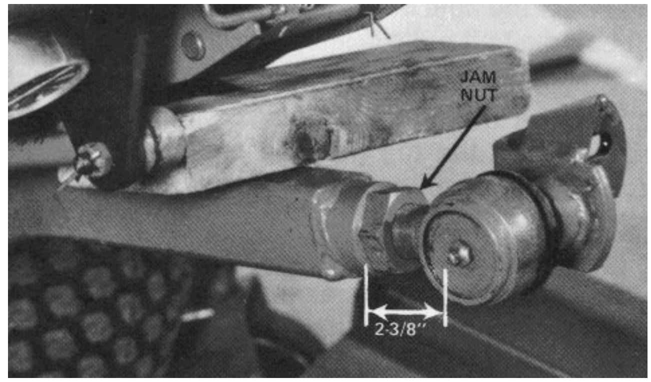


Figure 28

1. Apply grease to inside and outside of new bushings. Using a hammer and flat plate, carefully drive the bushings into the push arm pivot tubes. The bushings must be flush with the end of the tube.

2. Inspect the torsion springs. If the springs are damaged, use new springs when assembling the parts.

3. Slide the torsion springs onto the inside of the push arm pivot tubes. Install the washers, push arms with springs and push arm brackets onto the pivot shaft. Install the roll pins to secure the parts in place.

4. Raise the push arm and pivot shaft assembly into position and secure it in place with cap screws, support plate, reinforcement support and locknuts. Make sure the springs contact the retainer plate on the push arms and the underside of the frame.

5. Have a helper push down on the left push arm while you place a 3 ft. long block of wood between the chassis and to top of the push arms, across the full width of the machine.

NOTE: After the wood block is installed, there should be enough clearance for installing the ball joint into the front of the push arm.

6. Thread jam nut fully onto the left-hand ball joint. Screw the ball joint into the left-hand push arm until the center of the ball joint is 2-3/8 inches away from the front of the push arm. Do not tighten the jam nut until the deck is mounted.

7. Install the brake mount and pedal assembly with cap screws, locknuts, carriage bolts, lock washer and nuts. Route the right-hand brake cable through the hole in the right-hand push arm bracket. Connect the cable to the brake strut with the clevis pin and the tension spring. Hook the opposite end of the tension spring into the hole in the side of the chassis. Also install the cable into the mount on the frame.

Gearbox Removal and Installation (Fig. 29, 30)

Removing Gearbox and Drive Pulley

1. Lower the cutting unit, shut engine off and engage the parking brake.

2. Remove shroud covering universal drive shaft. Disconnect drive shaft from gearbox. Remove belt covers from top of cutting unit.

DANGER

Do not start the engine and engage the P.T.O. when the P.T.O. shaft is not connected to the gearbox. If engine is started and the P.T.O. shaft is allowed to rotate, serious injury could result.

3. Loosen idler pulleys for cutting unit drive belts and remove belts from gearbox pulley.

4. Disassemble fasteners securing gearbox to cutting unit and remove gearbox.

5. Remove the set screws from the taper lock bushing. Install one setscrew into the hole that is threaded on the side of taper lock. Tighten the setscrew until the taper lock is loose from the inside of the pulley hub.

NOTE: Only one setscrew is used to loosen the taper lock.

6. Slide the gearbox pulley and taper lock off of the gearbox output shaft. Account for the woodruff key that positions the pulley on the shaft, and remove the setscrew from the side of the taper lock.

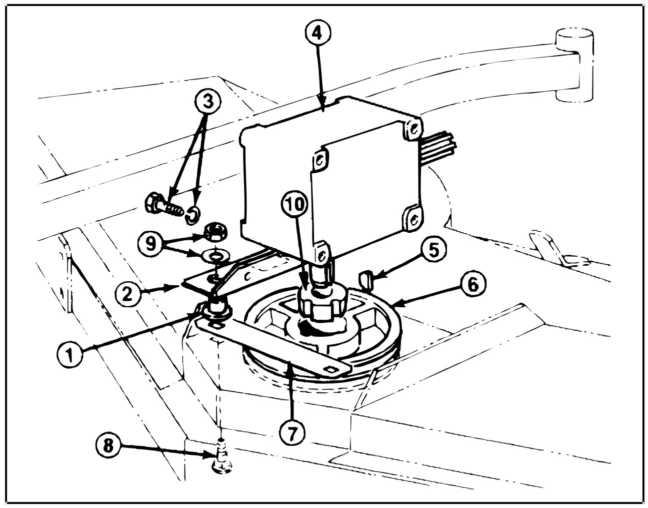


Figure 29

1. Isolation mounts
2. Brackets
3. Capscrews & lockwashers
4. Gear box
5. Woodruff key
6. Pulley assembly
7. Metal straps
8. Carriage bolts
9. Flatwashers & nuts
10. Taper lock

Installing Gearbox and Drive Pulley

1. Install four (4) isolation mounts into two (2) brackets. Use water or lubricant to ease installation. Install mounts from bottom of bracket.

2. Install bracket on each side of gearbox with capscrews and lockwashers. Tighten capscrews to a torque of 20 - 26 ft-lb.

3. To install the pulley, slide the taper lock - small end first - into the pulley hub.

4. Insert the woodruff key into the keyway in the gearbox shaft. Slide the pulley with the taper lock onto the gearbox shaft while aligning the key and keyway.

NOTE: The large hub on the pulley must face away from the gearbox, and like the taper lock, the pulley must contact the shoulder on the gearbox shaft.

5. Rotate the pulley to get the non-threaded holes in the taper lock to line up with the two threaded holes in the hub of the gearbox pulley. Start threading the setscrews into the two holes and tighten them alternately and evenly until both setscrews are tight.

6. Using a brass drift pin or sleeve and a hammer, hit the taper lock firmly. Now tighten the setscrews to 55 in-lb. Continue to hit the taper lock and tighten the set screws until the 55 in-lb of torque will not turn the setscrews.

7. Check the alignment of the gearbox with a spindle pulley. Loosen and relocate the taper lock to adjust, if necessary.

8. Fill the recessed socket head in each setscrew, and the other taper lock holes, with grease to prevent dirt from packing into the holes.

9. Align holes in thin metal strip with the two front gearbox mounting holes on base plate.

10. Mount gearbox with brackets onto top of cutting unit. Insert four (4) carriage bolts up from bottom of cutting unit and install flatwasher and nut on each bolt to secure the gearbox. Tighten nuts to 20 - 26 ft-lb.

11. Install drive belts onto gear box pulley and adjust idlers to tension belts.

12. Install cutting unit covers.

13. Install drive shaft to gear box and secure with a new roll pin.

14. Remove the gear box fill plug and check plug. Add SAE 80W90 API GL-5 gear lube until level is to the bottom of the check plug hole. Install plugs in gear box.

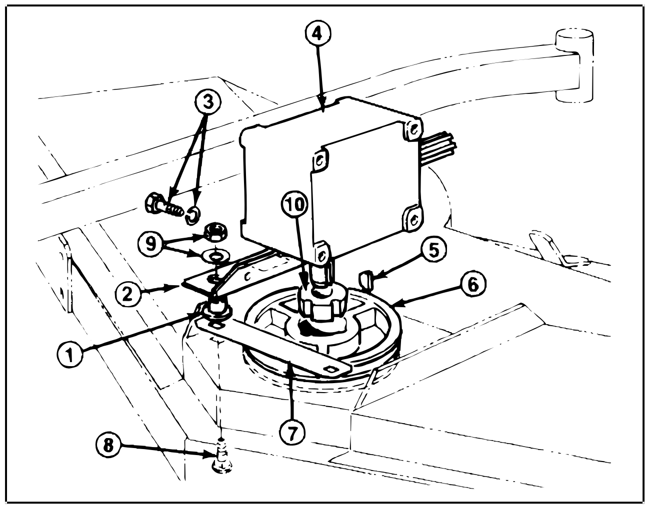


Figure 30

1. Isolation mounts	**6. Pulley assembly**
2. Brackets	**7. Metal straps**
3. Capscrews & lockwashers	**8. Carriage bolts**
4. Gear box	**9. Flatwashers & nuts**
5. Woodruff key	**10. Taper lock**

Gear Box Repair (Fig. 31, 32, 33)

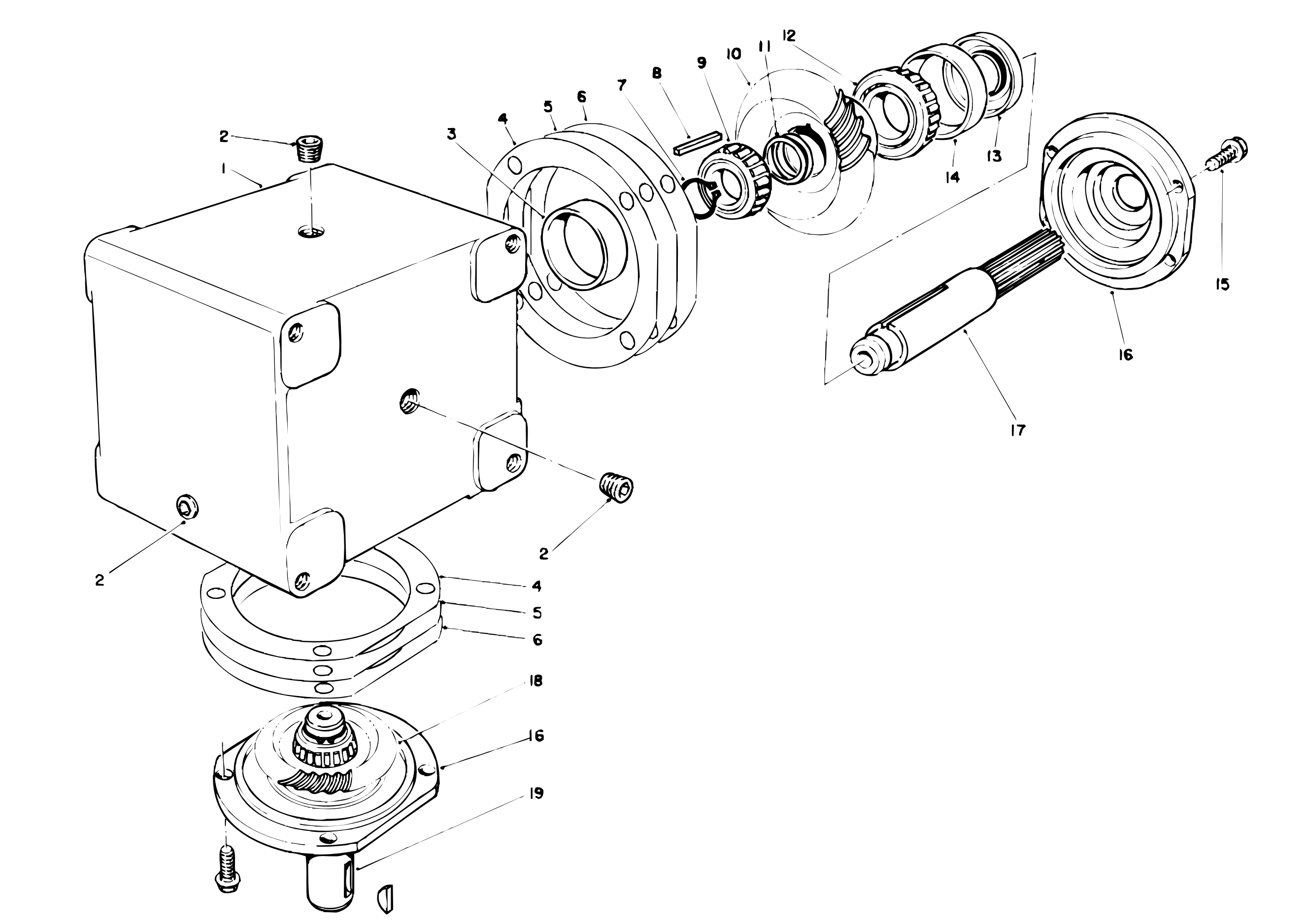


Figure 31

Gear Box Disassembly

1. Drain lubricant from gear box.

2. Remove capscrews and lift out shaft and cap assemblies.

3. Remove cap assemblies and bearing cones (Item 12) from shafts (Item 17, 19).

NOTE: Mark each gear (Item 10 and 18) so they are installed on the proper shaft (Item 17 or 19) when re-assembled.

4. Remove retaining rings (Item 7).

5. Press shafts (Item 17, 19) back through bearing cones (Item 9). When bearing cone is free, gears (Item 10, 18), keys (Item 8) and shims (Item 11) may be removed from the shaft.

6. Remove bearing cups (Item 14) from cap by putting a punch through the shaft bore and through the seal and then tapping against the back of the bearing cup until driven out of the cap.

7. If the oil seal (Item 13) is removed, it will be destroyed. To remove the oil seal, cut it out of the bore with a screw driver or chisel.

8. To remove the bearing cups (Item 3) from the housing a slide hammer puller may be used, or if this is not available, the bearing cups may be knocked out with a punch by coming down through the opposite cap bore and tapping against the back side of the bearing cup until it comes out.

9. Remove the plugs (Item 2) from the housing.

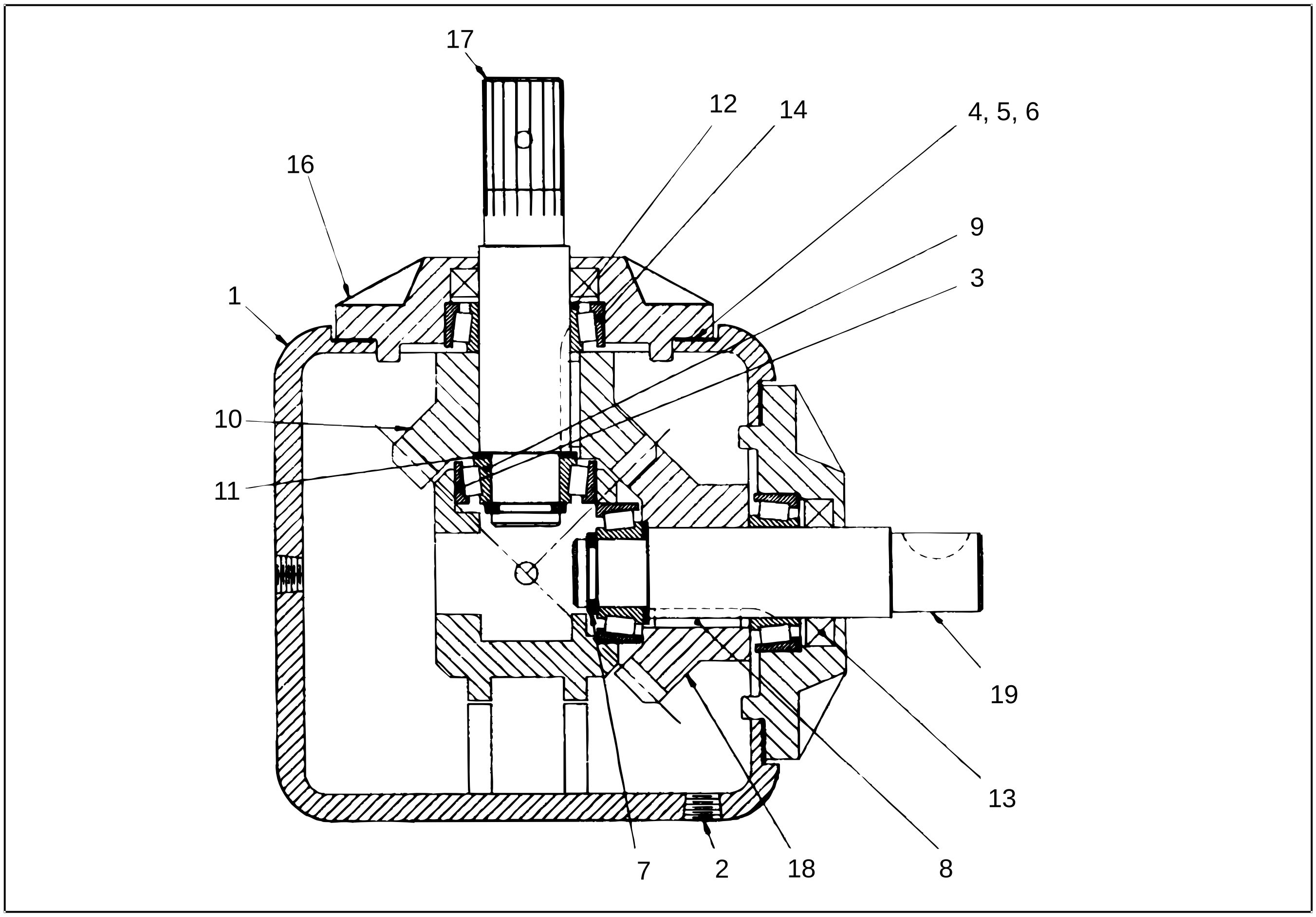


Figure 32

Gear Box Pre-Assembly

1. Start with one of the shafts (Item 17) and put one of the gears (Item 10) over the shaft so the tooth side is towards the turned end of the shaft. Align the keyway in the gear with the keyway in the shaft and install one of the keys (Item 8) in the keyway.

2. Install one set of shims (Item 11) onto the turned end of the shaft. Press one of the bearing cones (Item 9) over the turned end of the shaft. Be sure the bearing cone is installed as shown in the illustration (Fig. 42B). Install a retaining ring (Item 7) on the turned end of the shaft.

3. Put one of the bearing cones (Item 12) over the other end of the shaft and down against the hub side of the gear. Be sure the bearing cone is installed as shown in the illustration.

4. Repeat steps 1 - 3 with the other set of parts to complete the assembly.

5. Put one of the caps (Item 16) down, with the machined surface facing up. Install a new seal (Item 13) into the cap with the open side toward the machined side of the cap.

6. Install the bearing cup (Item 14) into the cap. Make sure the bearing cup is installed as shown in the illustration.

7. Repeat steps 5 - 6 with the other set of parts to complete the two cap assemblies.

8. Take one of the shaft and gear assemblies and wrap the end of the shaft with a piece of shim stock to keep from cutting the oil seal on the keyway or splines. Put the cap assembly down over the shaft so the bearing cone (Item 12) on the shaft mates with the bearing cone (Item 14) in the cap. Remove the shim stock from the shaft that was used to protect the seal.

9. Press the bearing cups (Item 3) into both bearing bores in the housing (Item 1). Make sure the cups are installed as shown in the illustration. Install the plugs (Item 2) into the tapped holes in the housing.

Gear Box Final Assembly

1. Bearing drag is adjusted by the amount of gaskets (Item 4, 5, 6) used between the cap and housing machined surfaces.

2. Put two 0.015 in. gaskets on the machined surface of the housing, then install the shaft and cap assembly in the housing so the bearing cone (Item 9) on the shaft assembly and bearing cup (Item 3) in the housing are mating. Align the holes in the cap with the holes in the gaskets and housing.

3. Install capscrews and tighten.

4. The shaft should have a very slight amount of bearing drag. If the shaft turns hard, the cap must be removed and gasket(s) need to be added. If the shaft has no bearing drag, or has end play, the cap must be removed and gasket(s) taken out. The cap must be adjusted to where the shaft has no end play and only a slight amount of bearing drag.

5. Repeat steps 1 - 4 with the other shaft and cap assembly.

6. After installing the gear box on the cutting unit, fill it with SAE 80W90 API GL-5 lubricant to the level of the check plug (see Maintenance section in this chapter).

Blade Spindle Service (Fig. 34, 35, 36, 37, 38)

Removing Spindle and Bearings From Spindle Housing

1. Lower the cutting unit, shut the engine off and engage the parking brake.

2. Remove deck covers from top of cutting unit. Loosen idler pulley(s) to release belt tension.

3. Remove belt from spindle to be serviced.

4. Start the engine and raise the cutting unit. Turn the engine OFF and remove the key from the key switch. Block up the cutting unit so it cannot fall accidentally.

5. Remove the bolts (Item 13) and flange nuts (Item 8) securing spindle housing to deck. Slide spindle housing assembly out the bottom of the cutting unit.

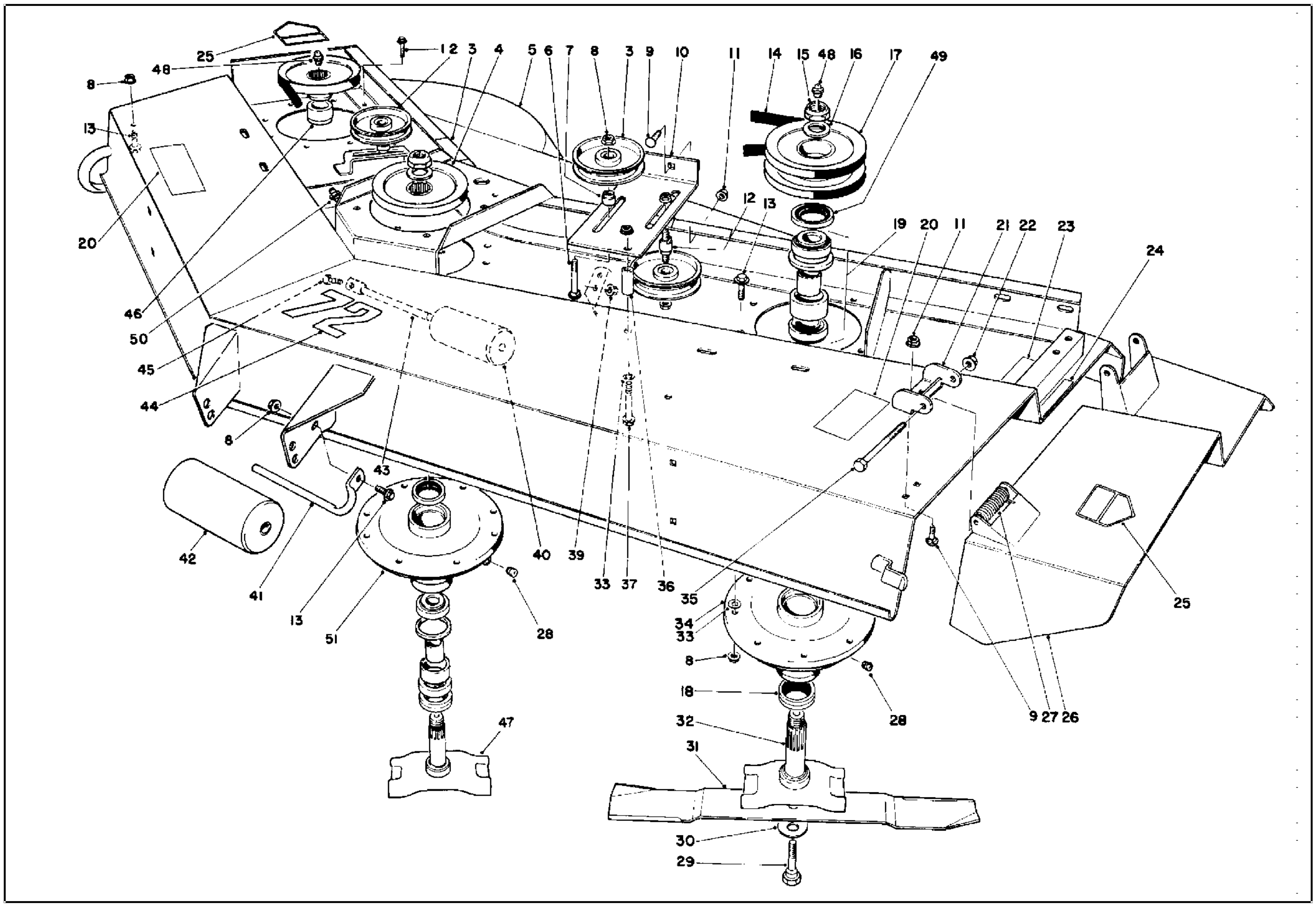


Figure 34

6. Remove the lock nut and flat washer retaining the spindle pulley on the spindle shaft. Slide the pulley off of the shaft.

NOTE: All three spindle housing assemblies are different from one another. A spacer is located beneath the right-hand pulley (Fig. 35).

7. If the spindle shaft will be replaced, remove the blade bolt (left hand thread), belleville washer and blade from the spindle shaft. Otherwise, the blade may be left on the spindle shaft.

8. Press the spindle shaft out of the spindle housing using an arbor press. The small bearing spacer should remain on the spindle shaft as the shaft is being removed.

9. The seals will be removed next; however, notice the orientation of the seal lips. The lips of the lower seals face outward. On spindle assemblies that have the grease fitting on the housing (shown in Fig. 36), the lip of the upper seal faces inward. On spindle assemblies that have the grease fitting on the top of the spindle shaft (shown in Fig. 34), the lip of the upper seal faces outward. After noting orientation of seals, remove seals from the spindle housing.

10. Allow the bearings and small thick spacer to fall out of the spindle housing.

11. Using a punch and hammer, drive both of the bearing cups out of the spindle housing. Also, drive the large spacer out of the housing.

12. A large snap ring is still inside the spindle housing and it should remain there because it cannot be easily removed.

IMPORTANT: If new bearings will be installed into a used spindle housing that has the original snap ring installed, discard the large snap ring that came with the bearings because it is not needed. However, new bearings with their matched spacer set and snap ring must always be installed when the spindle housing is being replaced. Replacement bearings are sold only with a matched snap ring and spacer set. These parts cannot be purchased separately.

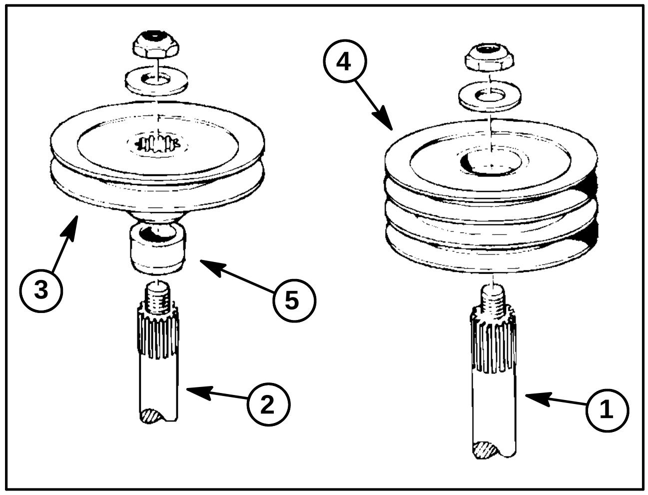


Figure 35

1. **Left hand spindle**
2. **Right hand spindle**
3. **Right hand pulley**
4. **Left hand pulleu**
5. **Spacer**

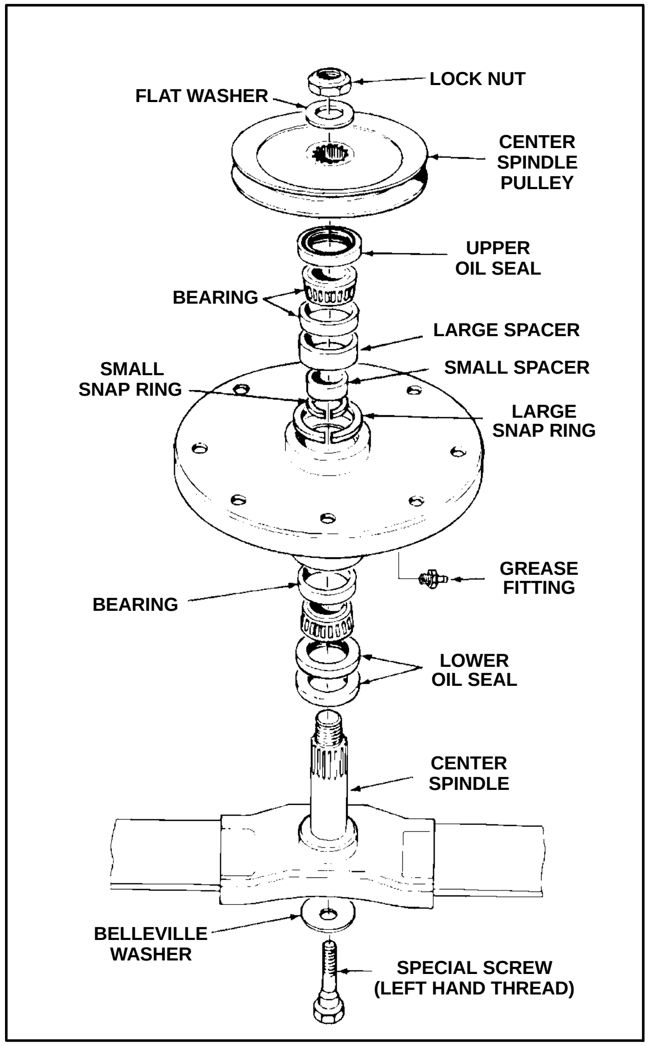


Figure 36

Installing Spindle, Bearings and Seals Into Spindle Housing

IMPORTANT: If a new spindle housing is being used, new bearings and the matched snap ring set must be installed; refer to step 1 below. Never use the old bearings, spacer and snap ring with a new spindle housing. By contrast, use only new bearings with cups and spacer – not the large snap ring because it is not required – when installing bearings into a used spindle housing that has the large snap ring installed; refer to step 2 below.

1. Install the large snap ring into the groove in the bore of the spindle housing. Assure the snap ring is seated in the groove.

2. Using an arbor press, push the large spacer into the top of the spidle housing; tightly against the snap ring. The spacer must contact the snap ring to be sure of the correct assembly of the parts.

3. Thoroughly oil the bearing cups and using an arbor press, push the bearing cups, smallest inside diameter first , into the top and bottom of the spindle housing. The top bearing cup must contact the spacer that was installed in step 2, and the bottom bearing cup must contact the large snap ring to be sure of the correct assembly of parts. Insure that the assembly is correct be supporting the first cup and pressing the second against it.

4. Install the lower bearing and the lower oil seals into the bottom of the spindle housing. Remember, the bottom seals must have the lip facing outward, not toward the inside of the spindle housing.

5. Check the spindle shaft to make sure it is free of burrs and nicks that could possibly cut the seals. Thoroughly lubricate the spindle shaft and seal lips.

6. Slide the small, thick spacer into the spindle housing. Then, install the upper bearing and seal into the top of the spindle housing. On spindle assemblies that have the grease fitting on the housing (shown in Fig. 36), the lip of the upper seal faces inward. On spindle assemblies that have the grease fitting on the top of the spindle shaft (shown in Fig. 34), the lip of the upper seal faces outward.

7. Slide the bearing spacer onto the spindle shaft. Carefully slide the spindle shaft up through the spindle housing. The bottom seal and bearing spacer should fit together when the spindle is installed.

8. Push the pulley onto the splines of the spindle shaft and retain the parts together with the large flat washer and lock nut. Tighten the nut to 100 – 120 ft–lb (136 – 162 N–m). After tightening, rotate the spindle shaft to be sure that the shaft rotates freely.

9. Slide the pulley end of the spindle assembly through the hole in the cutting unit. Mount the spindle assembly in place with the eight (8) hex flange head bolts and flange nuts.

10. Install the belt and adjust idler to get proper belt tension.

11. Reinstall the belt covers.

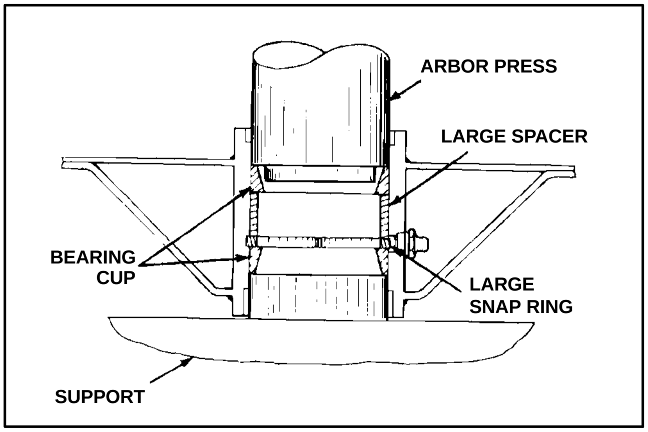


Figure 37

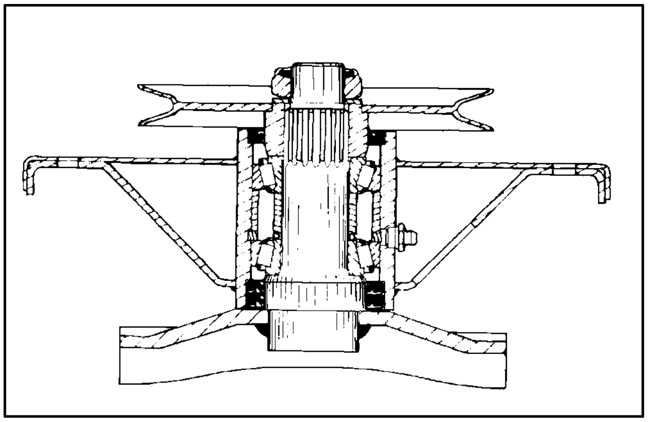


Figure 38

TORO®

Chapter 12

Triflex® 88″ Cutting Unit

Table of Contents

SPECIFICATIONS 2
GENERAL INFORMATION 3
Grass Deflectors 3
TROUBLESHOOTING 4
ADJUSTMENTS 5
Mechanical Door 5
Skid and Roller Adjustment 5
Height of Cut Adjustment 6
Mismatch Adjustments 8
Belt Tension Adjustment 9
Wing Pulley Section Brake 11
Wing Shaft End Play 11
Wing Lift Cylinders 12
Wing Stop Adjustment 12
REPAIRS 13
Blade Service 13
Belt Replacement 15
Caster Arm Bushing Replacement 17
Rear Caster Wheel Bearing Service 18
Front Caster Wheel Bearing Service 19
Separating Cutting Unit From Traction Unit 20
Mounting Cutting Unit to Traction Unit 21
Push Arm and Torsion Spring Service 23
Gear Case Removal and Installation 26
Gear Case Service 28
Blade Spindle Service 31

Specifications

ITEM	SPECIFICATION
Cutting width Center section only With one wing disengaged	88 inches 54 inches 71 inches
Height of cut range	1 to 4 inches
Height of cut adjustment	0.5 inch increments
Blade bolt torque	85 to 110 ft-lb
Spindle nut torque	140 - 160 ft-lb.
Spindle end play	.006 inch max.
Spindle rolling torque	10 in-lb max.
Gear case lubricant	SAE 80W90, API GL-5 gear lube

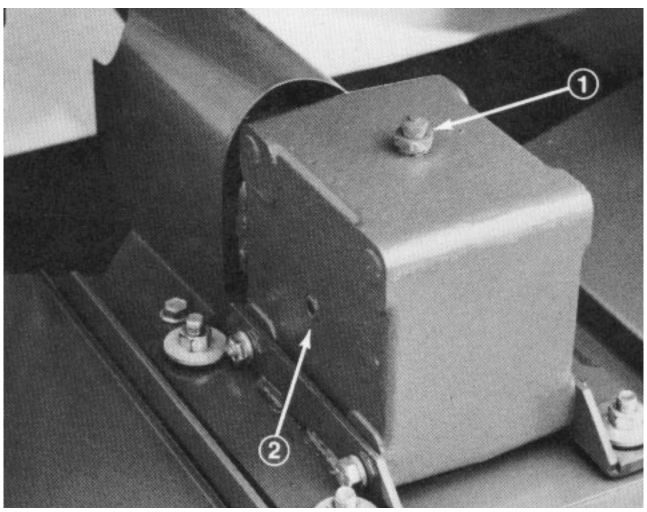


Figure 1

1. Filler plug
2. Check plug

General Information

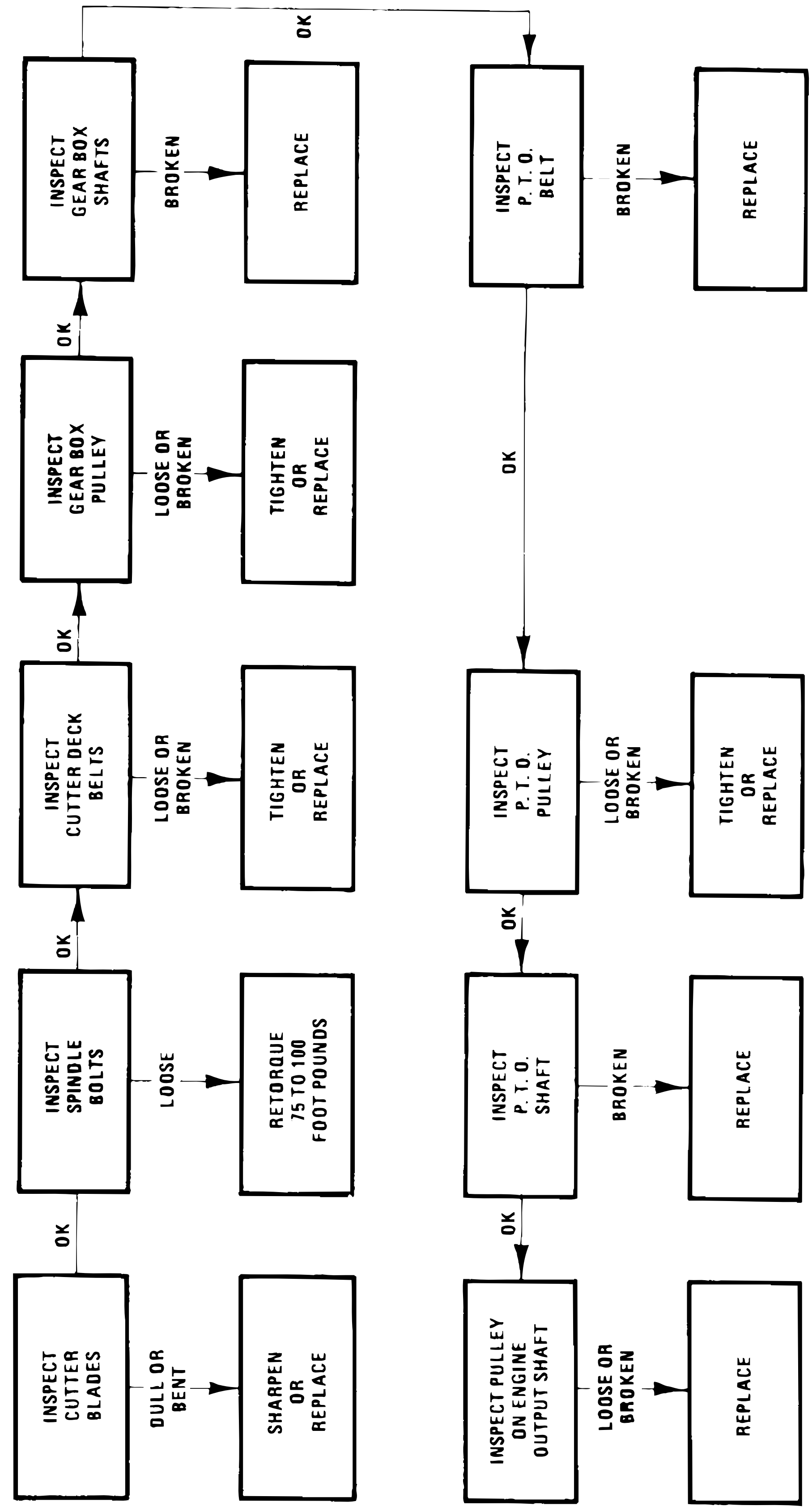
Grass Deflectors

> **WARNING**
>
> **The grass deflectors (Fig. 2) are safety devices that divert grass and other foreign objects being discharged downward. WE STRONGLY RECOMMEND THAT THE DEFLECTORS BE IN THEIR NORMAL OPERATING POSITION WHENEVER THE CUTTING UNIT IS ENGAGED. NEVER OPERATE CUTTING UNIT WITH THE DEFLECTORS REMOVED FROM THE CUTTING UNIT OR TIED/BLOCKED IN A RAISED POSITION, SINCE THE BLADES COULD THEN THROW DEBRIS A CONSIDERABLE DISTANCE WITH SUFFICIENT FORCE TO CAUSE PERSONAL INJURY OR DAMAGE TO PROPERTY. If a grass deflector is damaged, repair or replace the affected part(s).**

Figure 2

1. Grass deflector (2)

Troubleshooting



Adjustments

Mechanical Door (Fig. 3)

On each side of the deck center section is a mechanical door that opens and closes as the wing sections are lowered and raised. The doors open to provide overlap of the cutter blades when the wing units are down. The doors close to provide safety and protection when the wing units are raised.

To adjust mechanical door, disconnect threaded rod from the door by removing cotter pin. Loosen the jam nut and turn the rod in or out so that the bottom of the door is 1/4 inch up from the bottom of the deck side panel when the wing is fully raised. Tighten jam nut and install the cotter pin.

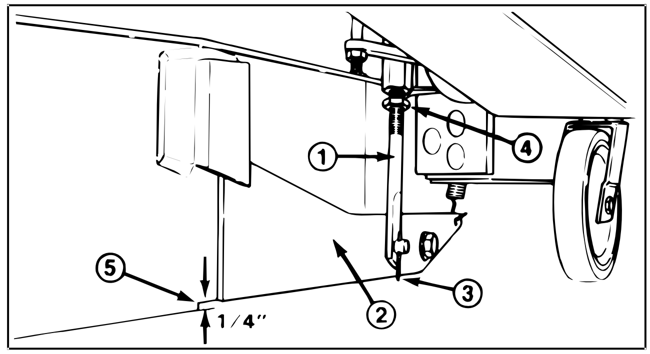


Figure 3

1. Threaded rod
2. Mechanical door
3. Cotter pin
4. Jam nut
5. 1/4" (6 mm) gap

Skid and Roller Adjustment (Fig. 4, 5)

When height of cut is set or changed, skids and anti-scalp rollers should also be adjusted (adjust on a hard level surface).

1 inch height of cut – skids all the way up.

1-1/2 inch height of cut – skids 3/8 inch to 1/2 inch off the ground.

2-1/2 inch height of cut – skids all the way down.

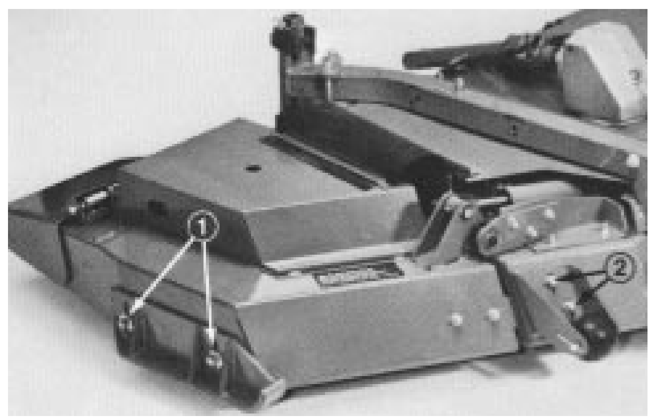


Figure 3

1. Skid adjustment **2. Anti-scalp roller adjustment**

When height of cut is set at 1 to 1-1/2 inches, the center anti-scalp roller and the two ball rollers on the front of the deck should be in the upper position. when the height of cut is 2 to 4 inches the rollers should be in the lower position.

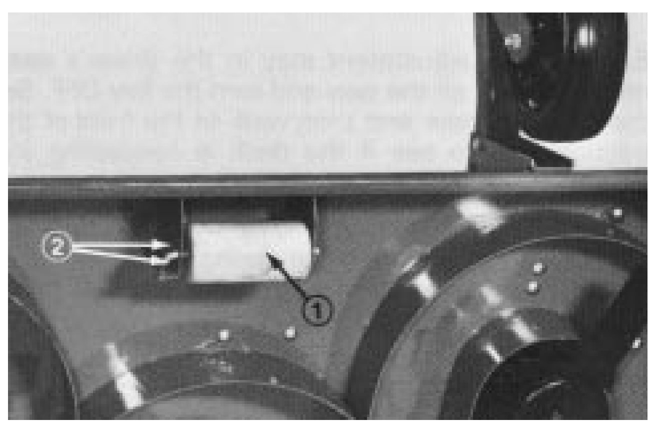


Figure 3

1. Center anti-scalp roller **2. Upper and lower holes**

Height of Cut Adjustment (Fig. 6, 7, 8)

The height of cut is adjustable from 1 to 4 inches in 1/2 inch increments, by adding or removing an equal number of spacers on the front and rear caster forks. The height of cut chart below gives the combinations of spacers to use for all height of cut settings.

Height of cut		Spacers Below Caster Arms	
inches	mm	Front	Rear
1	25	0	0
1-1/2	38	1	1
2	51	2	2
2-1/2	64	3	3
3	76	4	4
3-1/2	89	5	5
4	102	6	6

NOTE: A more optimum cutting appearance in the 1 inch height of cut setting can be achieved by lowering the rear of the cutting unit. Do this by relocating the rear caster wheel axles in the upper holes of the caster forks. Install the axles into the lower caster fork holes for settings above 1 inch.

IMPORTANT: The rear caster wheel mounting hole in use must be towards the rear of the deck. This is necessary to provide adequate clearance between the caster wheel and the mechanical door. If necessary, the caster fork assembly should be removed from the square tube and turned around so that the mounting hole with the axle through it is toward the rear. The caster wheel grease fittings should always face outward.

IMPORTANT: Do not attempt to cut off more than one inch of the grass blades in the one (1) inch height of cut setting with the rear of the cutting unit lowered, as this may cause the engine to labor excessively.

1. Start the engine and raise cutting unit so height of cut can be changed. Stop engine after cutting unit is raised.

2. Squeeze back of wire and rotate wire on lynch pin. Pull pin out of caster spindle. Slide spacers onto the caster spindle to get desired height of cut. Then slide washer onto caster shaft (front only).

3. Push caster shaft through caster arm. Slide any remaining spacers onto spindle. Install lynch pin to retain parts in place. Always have the same number of spacers on each caster when adjusting height of cut.

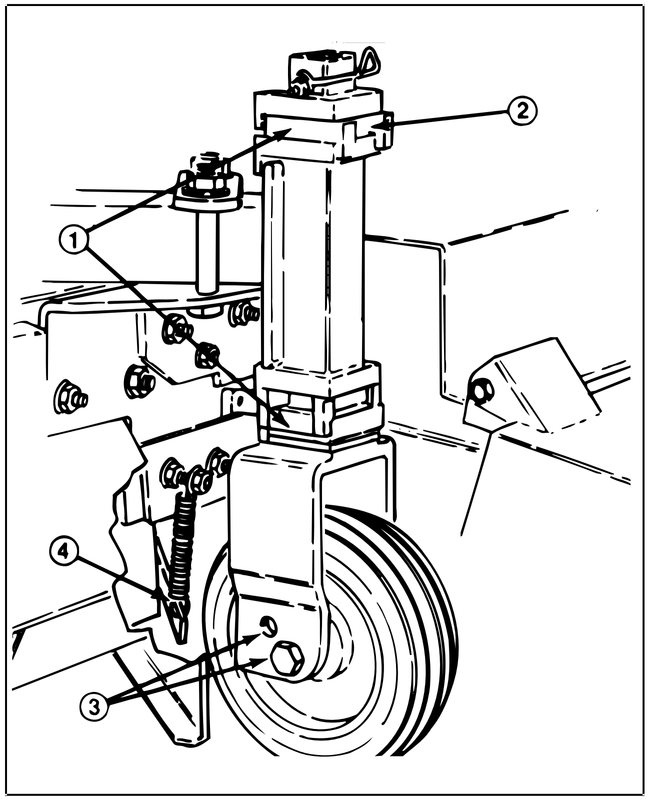


Figure 6

1. “U” spacers (6)
2. Spacer opening
3. Caster wheel axle holes
4. Mechanical door

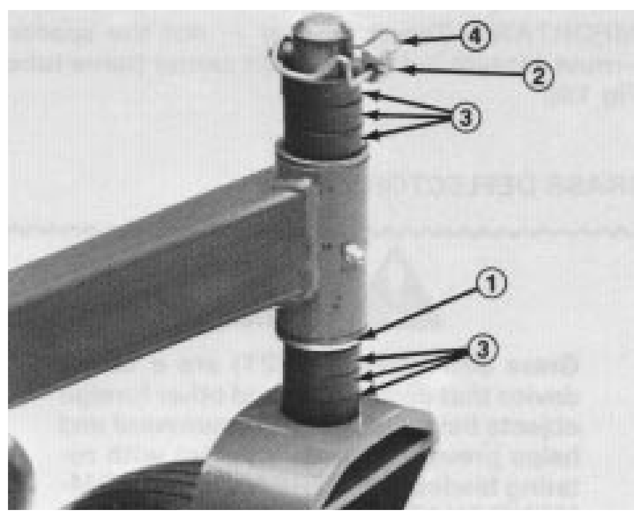


Figure 7

1. Thrust washer
2. Lynch pin
3. Spacers (6)
4. Wire spring

IMPORTANT: All six “U” shaped spacers must be on rear square caster shafts – if one is left off, remaining spacers will not stay in position during operation. Always install spacers on caster shafts with the spacer opening facing forward or to the rear. Never install with the spacer facing the side or middle of the deck (the arrow on the spacer should be in the same direction as the pin).

NOTE: On front caster shafts, insert lynch pin in front side of shaft with caster wheels in position as if deck were traveling in forward direction. When inserted from the front, the wire loop is less likely to be flipped up during operation, causing the pin to fall out.

IMPORTANT: The thrust washer – not the spacers – must contact bottom of front carrier frame tube.

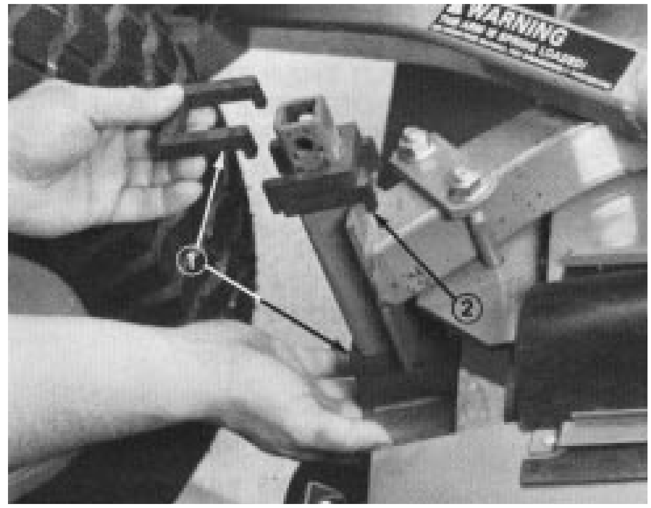


Figure 8

1. Rear caster spacers **2. Hooked over plate**

Checking and Correcting Mismatch of Blades (Fig. 9, 10)

If there is mismatch between the blades, the grass will appear streaked when it is cut. This problem can be corrected by making sure the blades are straight and all blades are cutting on the same plane.

1. Put the deck into position on a flat 4 x 8 foot sheet of plywood that is at least 3/4 inch thick.

IMPORTANT: If the rear caster wheel axle is in the lower hole, put a 3/4 inch block under each front caster wheel to level the deck. This is not necessary if the rear caster wheel axle is in the upper hole.

2. Adjust height of cut so all six (6) height of cut spacers are below the caster arm (highest height of cut).

3. Lower cutting unit onto flat surface.

4. Rotate blades until the ends face forward and backward. Measure from floor to front tip of cutting edge and record this dimension. Then rotate same blade so opposite end is forward and measure again. The difference between dimensions must not exceed 1/8 inch. If difference exceeds 1/8 inch, replace the blade because it is bent. Make sure to measure all five (5) blades.

5. Rotate blades until the ends face forward and backward. Measure and record the dimensions from floor to tips of blades at the front and the rear. Rotate blades until ends face side to side. Measure and record dimensions from floor to tips of blades at each end of blades. Compare measurements of all five blades. the maximum difference between any two adjacent blades should not exceed 1/4 inch. the maximum difference between the highest and lowest blade should not exceed 3/8 inch. The three center section blades can be adjusted with shims (see Step 7). The wing blades can be adjusted by repositioning the hinge bushing brackets and/or the wing stops (see Step 8).

6. Rotate blades so tips line up with on another. Tips of adjacent blades must be within 1/8 inch of each other. If tips are not within 1/8 inch of each other, proceed to step 7 and add shims between spindle housing and bottom of cutting unit or Step 8 to adjust wing sections.

Center Section:

7. Remove locknuts from spindle, in the area where shims must be added. To lower a blade, add a shim, Part No. 3256-24, between spindle housing and bottom of cutting unit. Continue to check alignment of blade and add shims until tips of blades are within the required dimension.

IMPORTANT: Do not use more than three (3) shims at any one hole location. Use decreasing numbers of shims in adjacent holes of more than one shim is added to any one hole location.

Wing Sections:

8. Raise or lower hinge bushing brackets and/or adjust front and rear stops to achieve proper blade match and height of cut. Each wing section should rest against the front and back stops. A 1/2 inch gap between the wing section and the center section should be maintained. Torque fasteners to 65 ft-lb. Adjust wing lift cylinders and belt tension after making wing adjustments. Install covers on top of cutting unit.

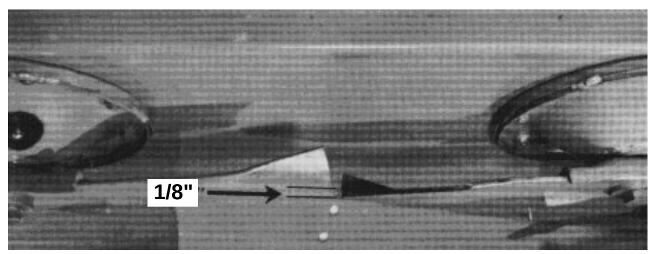


Figure 9

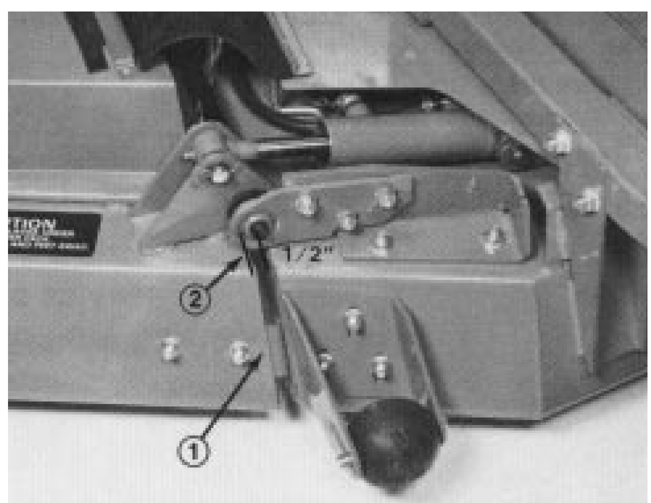


Figure 10

1. Adjustable stop 2. 1/2″ gap

Belt Tension Adjustment (Fig. 11, 12, 13)

NOTE: Check that belts are in good condition and positioned correctly in the sheaves of the pulleys on the center section and wing sections of the deck.

IMPORTANT: Check tension on new belts after 10 hours of use.

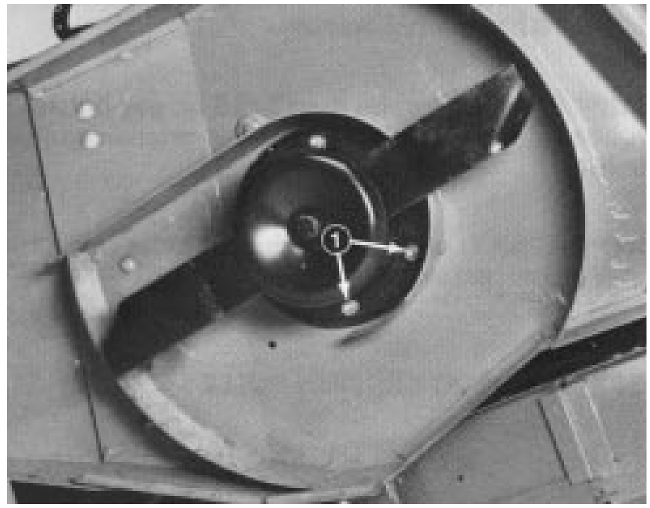


Figure 11

1. Spring bracket retaining nuts

Wing Section:

NOTE: Block deck in raised position so that it cannot accidentally lower while belts are being adjusted. Wings should be in lowered position.

Loosen two (2) capscrews securing spring bracket (nuts are located under the deck). Slide the spring bracket so that the rubber bumper at one end just contacts the edge of the idler arm and tighten the nuts under the deck to secure the spring bracket. With the spring bracket in this position the belt is properly tensioned.

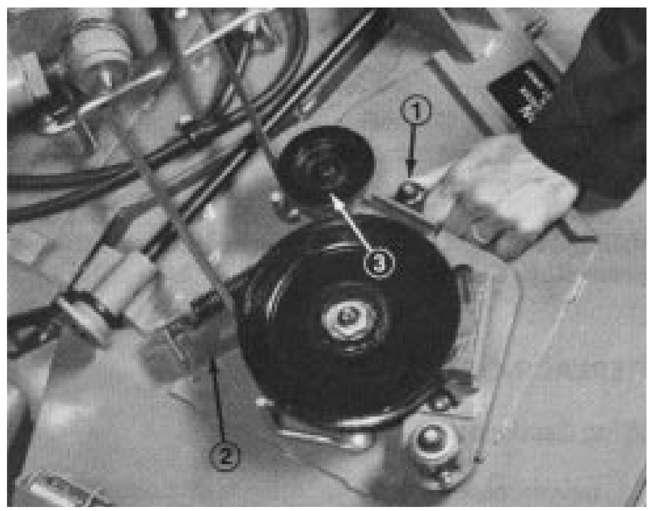


Figure 12

1. Rubber bumper
2. Spring bracket
3. Idler pulley bolt

Center Section:

NOTE: Spring tension is only 10 to 15 lbs. on the wing section, but is 80 to 90 lbs. on the center section, requiring the use of a threaded rod for adjustments.

1. Loosen nuts securing the spring bracket to the deck. Loosen the jam nut on the threaded rod.

2. Adjust the spring bracket so that the lip on the spring bracket just contacts the rubber stop on the idler arm. Use the threaded rod to make belt adjustments. Tighten the capscrews and nuts securing the spring bracket in position and tighten the jam nut on the threaded rod.

3. Be sure all belt guides are in the correct position and secured to the deck before operating the cutting unit.

IMPORTANT: If there is a gap of more than 3/16 inch between the rubber stop and the idler arm a belt adjustment is necessary.

IMPORTANT: Too much tension on the belt will cause early belt failure.

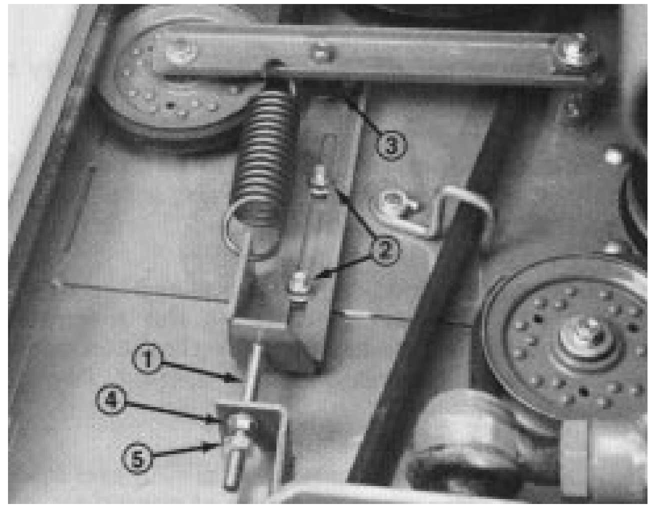


Figure 13

1. Threaded rod
2. Spring bracket nuts
3. Rubber stop
4. Tensioning nut
5. Jam nut

Wing Pulley Brake (Fig. 14)

Raise wing to be adjusted, 15 degrees (use a magnetically mounted compass) and loosen brake pad capscrews with an Allen wrench. Push brake pad against pulley with one hand and tighten capscrews with the other hand.

NOTE: Idler arm assembly is shimmed to center the brake pad (vertically) in the pulley groove. Add washers under the idler arm pivot hub as necessary.

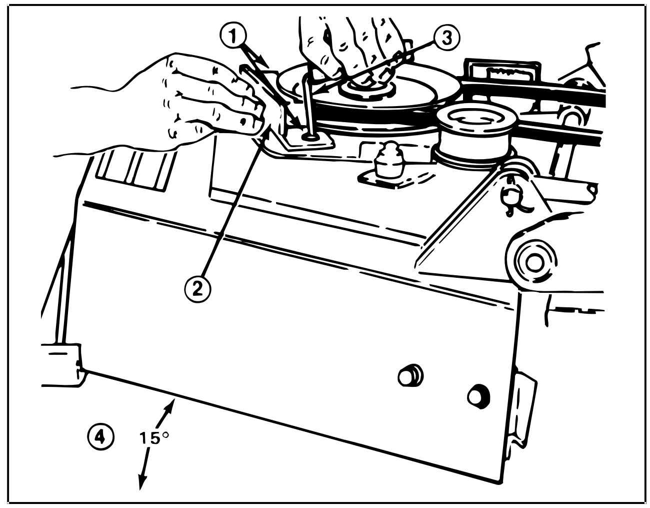


Figure 14

1. Brake pad capscrews (2) per wing
2. Brake pad
3. Allen wrench
4. 15° angle

Wing Shaft End Play (Fig. 15)

Slotted holes in the hinge bracket allow for adjustment of wing shaft end play. End play should be no more than 1/16 inch.

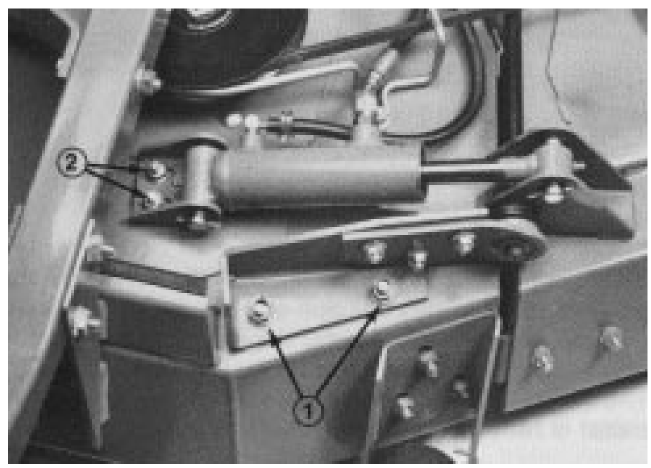


Figure 15

1. Slotted wing shaft bracket holes
2. Slotted lift cylinder bracket holes

Wing Lift Cylinders (Fig. 16, 17)

Slotted holes in the lift cylinder bracket allow for adjustment of the wing lift cylinders. With the cylinder fully extended manually pull the pivot pin outward. The pivot pin should rest up against the outer edge of the pivot hole on each wing section.

Tighten the bolts to a torque of 65 ft-lb. Once the cylinder is in the correct position, adjust the wing vertical stop on the top of the deck.

NOTE: If the wings do not raise all the way (perpendicular to the deck), the wing lift cylinders may need adjustment. Adjust the wing stops after adjusting the wing lift cylinders.

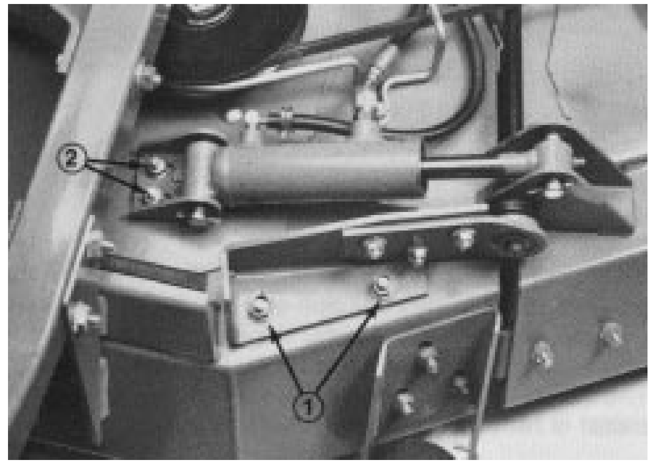


Figure 16

1. Slotted wing shaft bracket holes
2. Slotted lift cylinder bracket holes

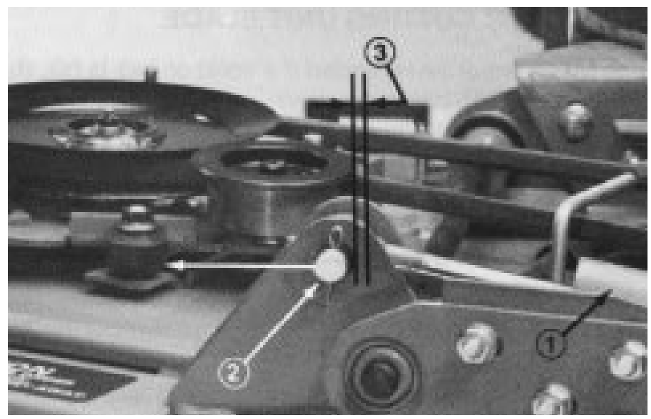


Figure 17

1. Wing lift cylinder
2. Manually pull pin forward
3. Designed gap

Wing Stop Adjustment (Fig. 18)

1. Lower deck to floor, remove wing cover and raise wings to 90° (perpendicular to deck). Block mechanical door in fully raised position. Loosen jam nuts.

2. Pull up on mechanical door lift lever. Tighten the wing bolt jam nuts by hand so that there is no gap between the bolt head and the main deck surface.

3. Tighten jam nuts, lower wings and install covers. Adjust mechanical door height if necessary.

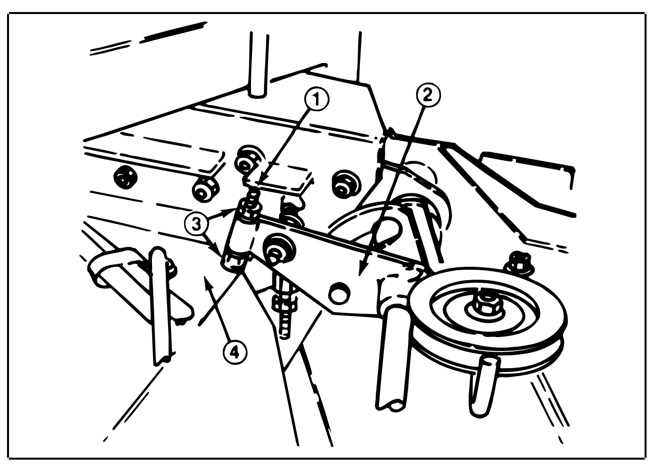


Figure 18

1. Wing stop bolt
2. Mechanical door lift lever
3. Jam nuts
4. Main deck surface

Blade Service (Fig. 19, 20, 21)

The blade must be replaced if a solid object is hit, the blade is out-of-balance, worn or bent. Always use genuine TORO replacement blades to ensure safety and optimum performance. Never use blades made by other manufacturers because they could be dangerous.

CAUTION

Do not try to straighten a blade that is bent, and never weld a broken or cracked blade. Always use a new TORO blade to assure continued safety certification of the product.

1 . Raise cutting unit to highest position, shut the engine off and engage parking brake. Block cutting unit to prevent it from falling accidentally.

2. Grasp end of blade using a rag or thickly padded glove. Remove special screw, washer, anti-scalp cup and blade from spindle assembly.

3. To install the blade, assemble parts in reverse order, and make sure the blade sail is facing up. Tighten special screw to 85 to 110 ft-lb.

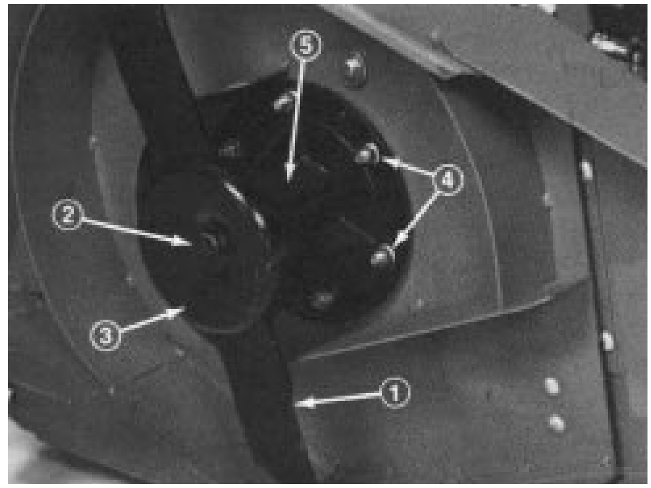


Figure 19

1. Cutting blade
2. Mounting screw and washer
3. Anti-scalp cup
4. Flange bolts (6)
5. Spindle housing

Inspecting and Sharpening Blade

1. Raise cutting unit to highest position, shut the engine off and engage parking brake. Block cutting unit to prevent it from falling accidentally.

2. Examine cutting ends of the blade carefully, especially where the flat and curved parts of the blade meet. Since sand and abrasive material can wear away the metal that connects the flat and curved parts of the blade, check the blade before using the machine. If any wear is noticed, replace the blade: refer to Removing Cutter Blade.

WARNING

If the blade is allowed to wear, a slot will form between the sail and flat part of the blade. Eventually, a piece of the blade may break off and be thrown from under the housing, possibly resulting in serious injury to yourself or bystander.

3. Examine cutting edges of all blades. Sharpen the cutting edges if they are dull or nicked. Sharpen only the top side of the cutting edge and maintain the original cutting angle to assure sharpness. The blade will remain balanced if same amount of metal is removed from both cutting edges.

4. To check blade for being straight and parallel, lay blade on level surface and check its ends. Ends of blade must be slightly lower than the center, and cutting edge must be lower than heel of the blade. This blade will produce good quality-of-cut and require minimal power from the engine. By contrast, a blade that is higher at the ends than the center, or cutting edge higher than the heel of the blade is warped or bent and must be replaced.

5. To install the blade, assemble parts in reverse order, and make sure the blade sail is facing up. Tighten special screw to 85 to 110 ft-lb.

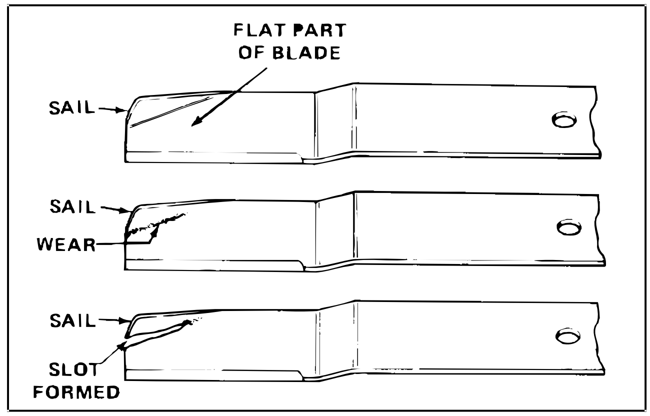


Figure 20

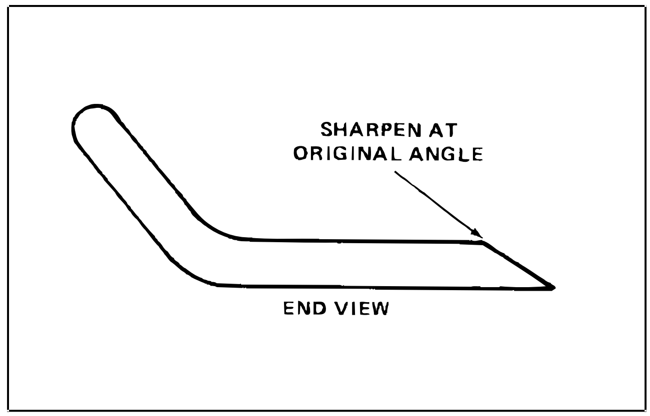


Figure 21

Belt Replacement (Fig. 22, 23, 24, 25)

Wing Sections:

1. Lower cutting unit to shop floor, turn off engine and remove key. Remove belt covers.

NOTE: To remove center section belt, the wing section belts have to be removed first.

2. With the wing unit raised, loosen nuts on capscrews holding the spring bracket from under the deck.

NOTE: Block deck in raised position so that it cannot accidentally lower while belts belt tension is being adjusted. Wings should be in lowered position.

3. With spring tension relaxed, lower the wings. Loosen or remove the idler pulley bolt to allow the belt to pass between the belt guide and the idler pulley.

4. Loosen or remove belt guides as necessary to allow removal of belts from remaining pulleys.

5. Put new belt into correct position in groove of pulley on center section and wing section of deck, then tighten idler pulley boot.

6. Replace or reposition all belt guides and adjust belt tension.

7. Adjust wing pulley brake, then install covers.

IMPORTANT: Check new belt tension and brake adjustment after initial 10 hours of operation.

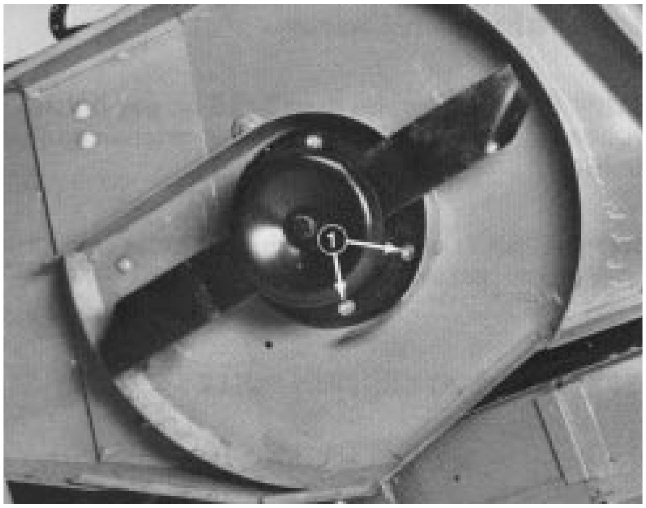


Figure 22

1. Spring bracket retaining nuts

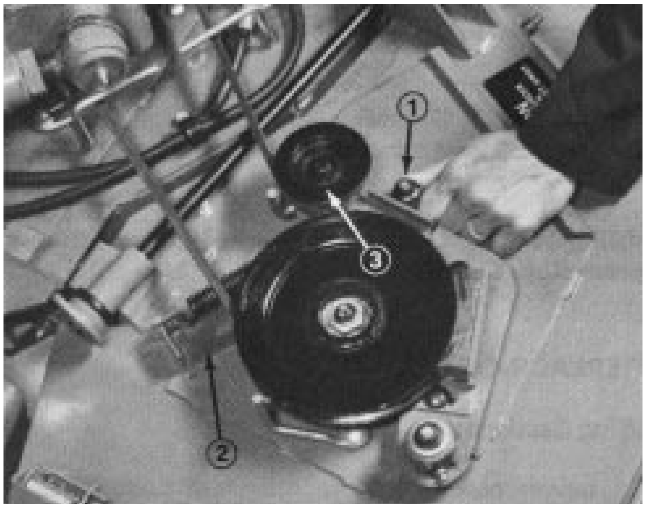


Figure 23

1. Rubber bumper
2. Spring bracket
3. Idler pulley bolt

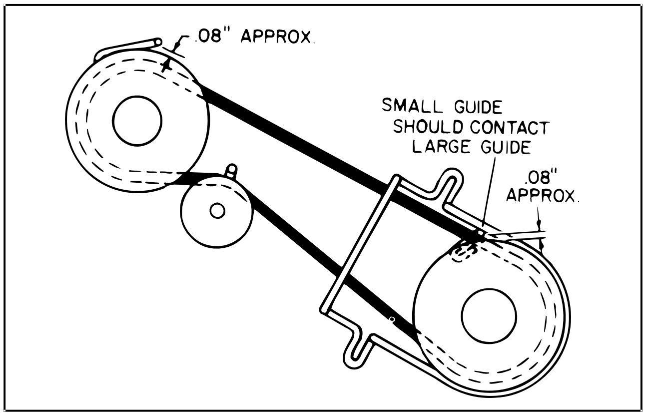


Figure 24

Center Section:

NOTE: Wing belts must be removed first.

1. Loosen capscrew nuts holding the spring bracket to the deck. Loosen the threaded rod jam nut, then gradually loosen the tension nut to release the spring tension.

CAUTION

Loosen capscrew nuts holding the spring bracket to the deck before loosening threaded rod to avoid sudden movement of the spring bracket.

2. With belt tension released, remove idler arm and belt guides as necessary and remove the belt.

3. Position new belt correctly in the center section pulleys. Replace and tighten the idler arm and guide.

4. Be sure all belt guides are in the correct position and secured to the deck and adjust belt tension by following the procedure described above.

IMPORTANT: Check tension of new belts after initial 10 hours of operation.

IMPORTANT: If there is a gap of more than 3/16 inch between the rubber stop and the idler arm a belt adjustment is necessary.

IMPORTANT: Too much tension on the belt will cause early belt failure.

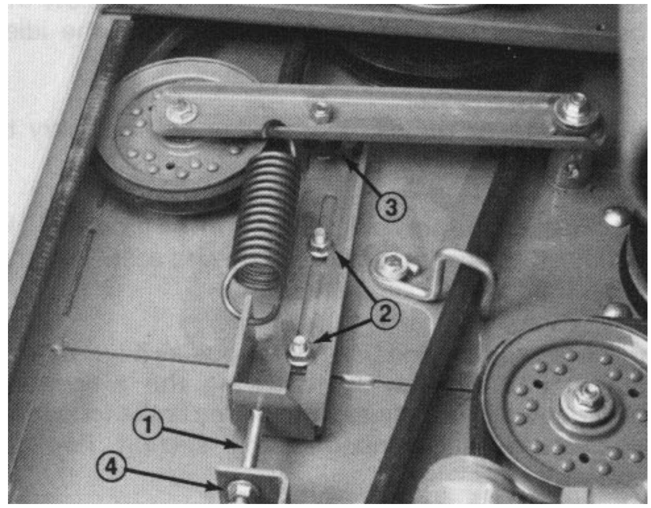


Figure 25A

1. **Threaded rod**
2. **Spring bracket nuts**
3. **Rubber stop**
4. **Tension nut**
5. **Jam nut**

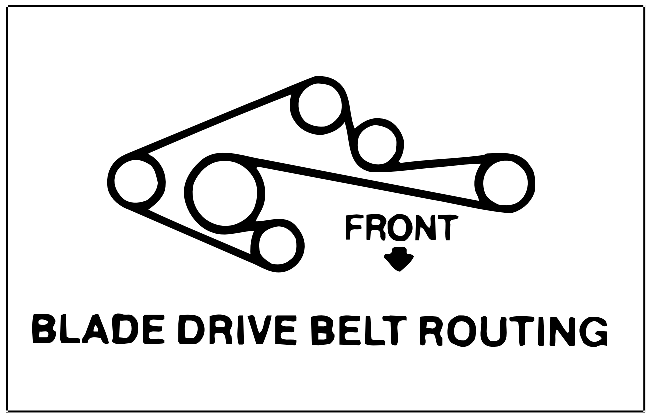


Figure 25B

Caster Arm Bushing Service (Fig. 26)

The caster arms have bushings pressed into the top and bottom portion of the tube and after many hours of operation, the bushings will wear. To check the bushings, move caster fork back and forth and from side-to-side. If caster spindle is loose inside the bushings, bushings are worn and must be replaced.

1. Raise cutting unit and block it so it cannot fall accidentally.

2. Remove lynch pin and spacers from top of caster spindle.

3. Pull caster spindle out of mounting tube. Allow spacer(s) and thrust washer to remain on bottom of spindle to assure same height of cut when caster spindle is reinstalled.

4. Insert pin punch into top or bottom of mounting tube and drive bushing out of tube. Also drive other bushing out of tube. Clean inside of tubes to remove dirt.

5. Apply grease to inside and outside of new bushings. Using a hammer and flat plate, drive bushings into mounting tube.

6. Inspect caster spindle for wear and replace it if damaged.

7. Push caster spindle through bushings and mounting tube. Slide spacers onto spindle. Install lynch pin through caster spindle to retain all parts in place.

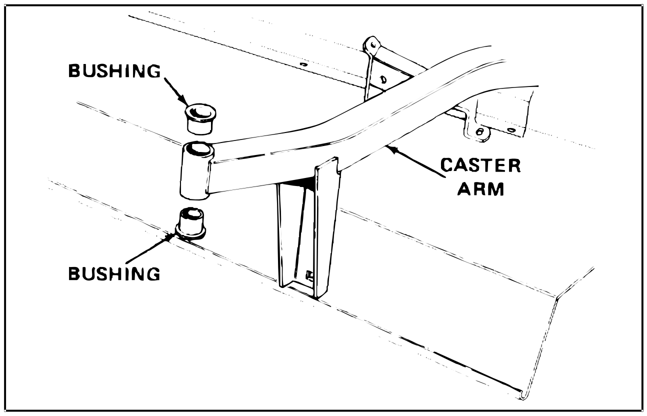


Figure 26

Rear Caster Wheel Bearing Service (Fig. 27)

The rear caster wheels rotate on high quality roller bearings which are supported by spanner bushings. Even after many hours of use, provided that the bearing was kept well-lubricated, bearing wear will be minimal. However, failure to keep bearings lubricated will cause rapid wear. A wobbly caster wheel usually indicates a worn bearing.

1. Remove capscrew and locknut holding caster wheel and (2) washers between caster fork.

2. Pull spanner bushing out of wheel hub.

3. Remove bushing from wheel hub and allow bearing to fall out. Remove bushing from opposite side of wheel hub.

4. Check the bearing, spanner and inside of wheel hub for wear. Replace defective parts.

5. To assemble the caster wheel, push bushing into wheel hub. Slide bearing into wheel hub. Push other bushing into open end of wheel hub to captivate the bearing inside the wheel hub.

6. Carefully slide spanner through the bushings and wheel hub.

7. Install caster wheel assembly and (2) washers between caster fork, and secure all parts in place with capscrew and locknut.

8. Lubricate caster wheel bearing through grease fitting, using No. 2 general purpose lithium grease.

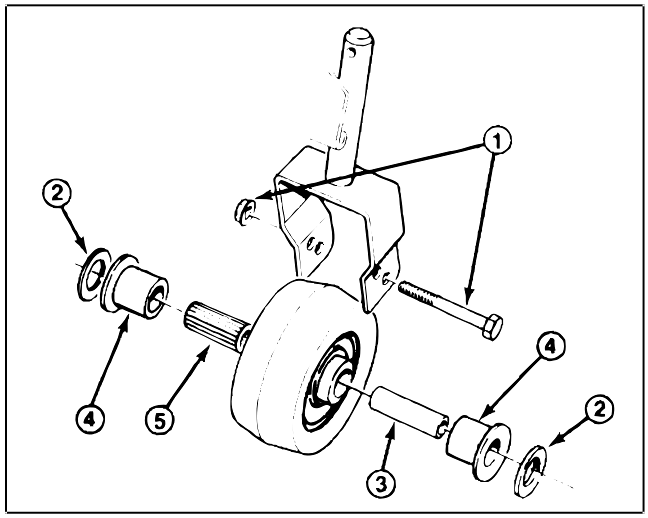


Figure 27

Front Caster Wheel Bearing Service (Fig. 28)

The front caster wheels rotate on high-quality roller bearings which are supported by spanner bushings. Even after many hours of use, provided that the bearing was kept well-lubricated, bearing wear will be minimal. However, failure to keep bearings lubricated will cause rapid wear. A wobbly caster wheel usually indicates a worn bearing.

1. Remove capscrew and locknut holding caster wheel and (2) washers between caster fork.

2. Pull spanner bushing out of wheel hub.

3. Remove bushing from wheel hub and allow bearing to fall out. Remove bushing from opposite side of wheel hub.

4. Check the bearing, spanner and inside of wheel hub for wear. Replace defective parts.

5. To assemble the caster wheel, push bushing into wheel hub. Slide bearing into wheel hub. Push other bushing into open end of wheel hub to captivate the bearing inside the wheel hub.

6. Carefully slide spanner through the bushings and wheel hub.

7. Install caster wheel assembly and (2) washers between caster fork, and secure all parts in place with capscrew and locknut.

8. Lubricate caster wheel bearing through grease fitting, using No. 2 general purpose lithium grease.

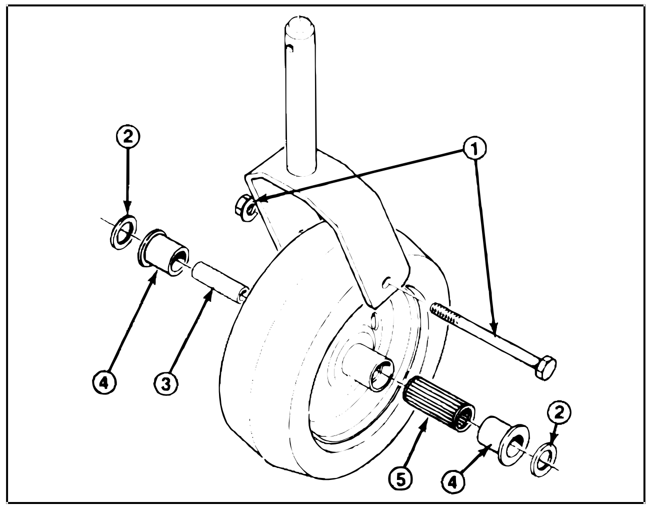


Figure 28

Separating Cutting Unit From Traction Unit (Fig. 29)

1. Position machine on level surface, lower cutting unit to the shop floor, shut engine off and engage parking brake.

2. Disconnect three (3) hydraulic lines at mounting bracket, located next to traction pedal, using quick disconnects. Immediately put attached rubber plugs in disconnects on both the traction unit and deck hoses.

3. Remove PTO shield from top of cutting unit and set shield aside.

4. Drive roll pin out of yoke and input shaft of gear case. Loosen capscrews and nuts securing yoke to shaft. Slide yoke off the input shaft. If traction unit will be used without the cutting unit, drive roll pin out of yoke at PTO pivot shaft and remove entire universal shaft from traction unit.

DANGER

Do not start the engine and engage the PTO lever when PTO shaft is not connected to gear case on cutting unit. If engine is started and PTO shaft is allowed to rotate, serious injury could result.

5. Disconnect spring from lift cylinder cotter pin. Remove cotter pins and clevis pins securing lift chains to lift arm.

WARNING

Since the right hand push arm is spring-loaded to approximately 100 pounds and left hand push arm is spring-loaded to approximately 150 pounds, another person is needed to help release push arms from cutting unit. Sudden release of the push arm could cause injury.

6. Have another person help push down on the right push arm while you remove the capscrews, flat washers and nuts securing ball joint mount to caster arm on cutting unit. Now the person helping can carefully allow push arm to move upward, which gradually releases the 100 pounds of spring load.

7. Have another person help push down on the left push arm while you remove the capscrews, flat washers and nuts securing ball joint mount to carrier frame on cutting unit. Now the person helping can carefully allow push arm to move upward which will gradually release the 150 pounds of spring load.

8. Roll the cutting unit away from the traction unit.

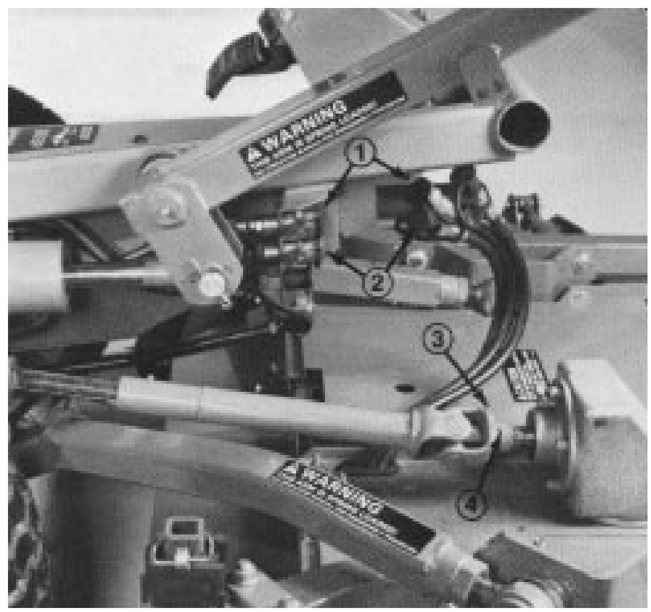


Figure 29

1. Hose plugs
2. Quick disconnects
3. Yoke
4. Roll pin

Mounting Cutting Unit to Traction Unit (Fig. 30, 31, 32, 33)

1. Position machine on level surface and shut engine off.

2. Move cutting unit into position in front of traction unit.

WARNING

Since the right hand push arm is spring-loaded to about 100 pounds and left hand push arm is spring-loaded to about 150 pounds, another person is needed to help push the push arm down. Sudden release of the push arm could cause injury.

3. To assure correct alignment, measure from the end of each push arm to the center line of the ball joint. Adjust to 2-3/8 inches. If adjustment is required, leave the lock nut loose.

4. Have a helper carefully push down on left hand push arm until holes in bracket line up with holes in caster arm. Immediately slide a 4 x 4 inch block of wood between top of push arm and under side of chassis.

5. Secure mounting bracket to caster arm with mounting hardware. Tighten bolts to a torque of 45 ft-lbs. Tighten lock nut where ball joint connects to lift arm.

WARNING

Make sure wooden block does not slip out accidentally.

6. Have a helper carefully push down on right hand push arm until holes in bracket line up with holes in caster arm. Immediately slide a 4 x 4 inch block of wood between top of push arm and under side of chassis.

7. Secure mounting bracket to caster arm with mounting hardware. Bolts should be tighten to 45 ft-lbs. Tighten lock nut where ball joint connects to lift arm.

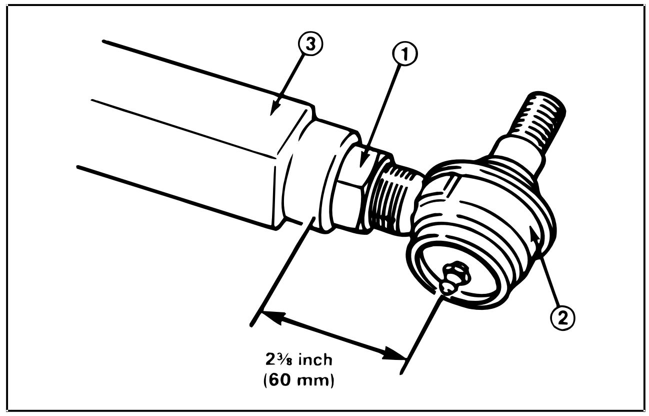


Figure 30

1. Lock nut **2. Ball joint** **3. Push arm**

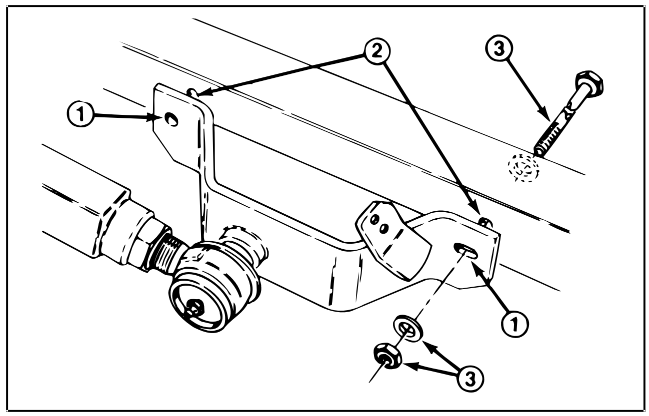


Figure 31

1. Mounting bracket holes **2. Carrier frame holes** **3. Mounting hardware**

Figure 32

1. Right push arm ball joint **2. Mounting bracket** **3. Mounting hardware**

IMPORTANT: The PTO shaft yokes must be exactly in line with each other when outer PTO is installed on splined shaft. Remove sleeve and change yoke position if alignment is not correct. Misalignment of the two yokes will shorten life of PTO shaft assembly and cause unnecessary vibration when cutting unit is operated.

8. Line up holes in yoke and input shaft of gear case. Slide yoke onto shaft and secure parts together with roll pin, capscrews and nuts.

9. Mount PTO shield over input shaft and onto gear case mounting plate with two self tapping screws.

10. Attach three (3) lift chains to lift arm and cutting unit with six (6) shackles, shackle pins and cotter pins. Adjust chain length so that the front of the deck raises level (side to side). When main lift cylinder is fully extended the left push arm should be just below the frame stop (1/16 to 3/8 inch). Half chain link adjustments can be made by switching mounting holes in push arm brackets. Tie up extra chain links if additional length may be needed in the future.

IMPORTANT: Improper chain adjustment could result in main deck lift arm damage if deck contacts traction unit.

NOTE: As starting points use the following settings:
Right front chain – 10 links, lower bracket hole.
Left front chain – 14 links, lower hole
Rear chain – 10 links, upper and front holes

11. Adjust length of rear chain so rear caster wheels are as far as possible from the ground but carrier frame does not contact right push arm when deck is lifted.

CAUTION

Improper chain adjustment may result in the deck contacting the traction pedal and forcing it into reverse.

12. To check adjustment, stay in the driver's seat, raise the deck all the way and turn the key OFF. Set the parking brake and then walk to the front of the traction unit to see if the deck is contacting the linkage.

13. Connect ends of tension spring between fourth link of rear chain and eye of cotter pin that holds cylinder pin in place.

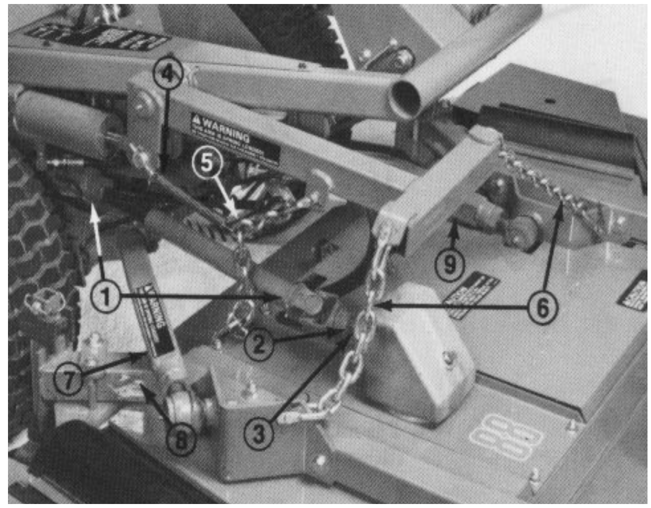


Figure 33

1. PTO shaft yokes in phase
2. Roll pin
3. Gear case input shaft
4. Tension spring
5. Rear lift chain
6. Front lift chains
7. Right push arm
8. Carrier frame
9. Left push arm

Push Arm and Torsion Spring Service (Fig. 34, 35, 36, 37, 38, 39, 40)

Removing Push Arms, Torsion Springs and Bushings

1. Separate cutting unit from traction unit and roll cutting unit away from traction unit.

2. Have a helper push down on the left push arm while you put a 4" x 4" block of wood between the chassis and the top of the push arm, and across the full width of the machine.

3. Loosen the large jam nut on the left-hand ball joint at the end of the push arm. Remove the ball joint (mount attached) from the push arm.

4. Remove the self-tapping screws holding the floor plate to the main frame. Raise the floor plate and set it aside.

5. Disconnect the right-hand brake cable from the brake strut. Remove the jam nut holding the brake cabled in the mount on the frame and slide the cable through the hole in the push arm bracket.

6. Remove the cotter pin from the end of the parking brake rod. Slide the rod out of the latch.

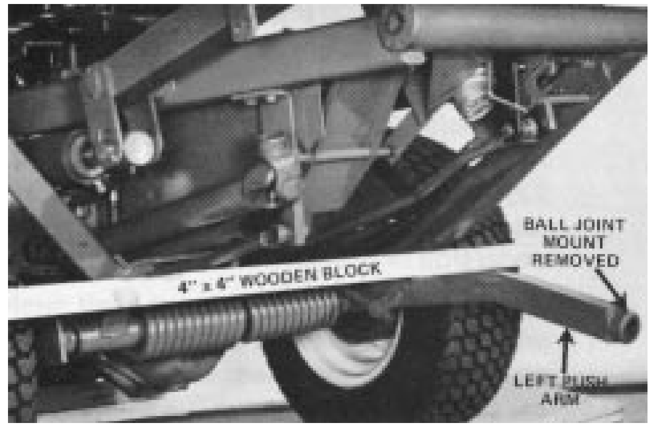


Figure 34

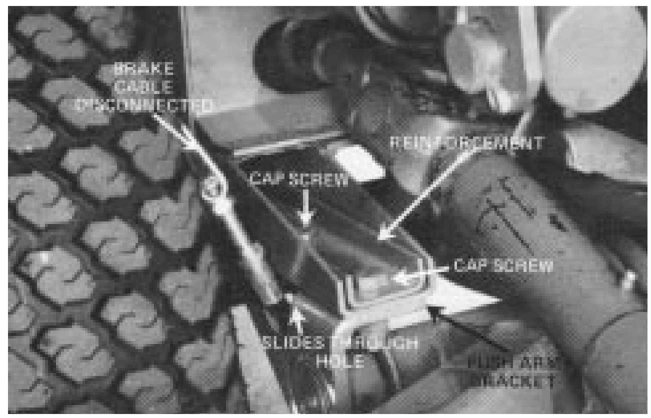


Figure 35

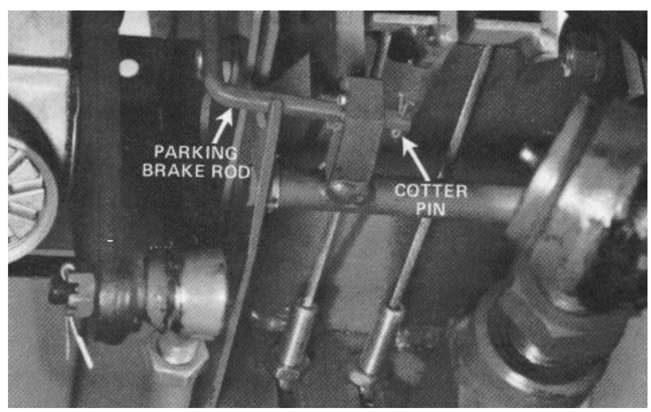


Figure 36

7. Remove the cap screws locknuts, carriage bolts, lock washers and nuts holding the brake mount and pedal assembly in place. Lay the brake mount and the pedal assembly on the wheel.

8. Have a helper push down slightly on the left push arm while you remove the block of wood between the push arm and the chassis. Slowly and carefully allow the push arm to move upward until all spring load is released.

9. Remove the cap screws, locknuts, support plate and push arm bracket holding the left side of the push arm and pivot shaft to the main frame.

10. Remove the cap screws, locknuts, reinforcement and push arm bracket holding the right side of the push arm and pivot shaft to the main frame. The entire push arm and pivot shaft assembly should now be free of the main frame.

11. Drive the roll pins out of the pivot shaft and slide the push arm assemblies off of the shaft.

12. Drive the pushing out of both push arm pivot tubes. Clean the inside of the pivot tubes to remove all dirt and other material.

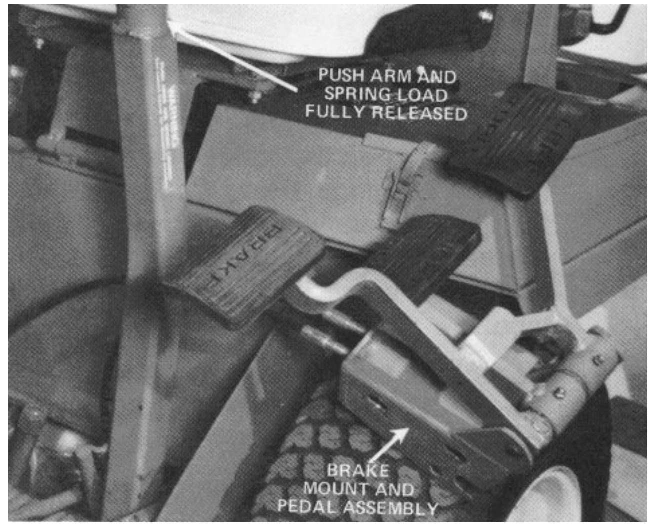


Figure 37

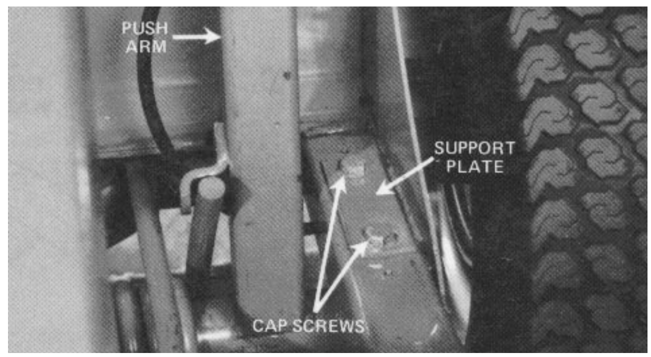


Figure 38

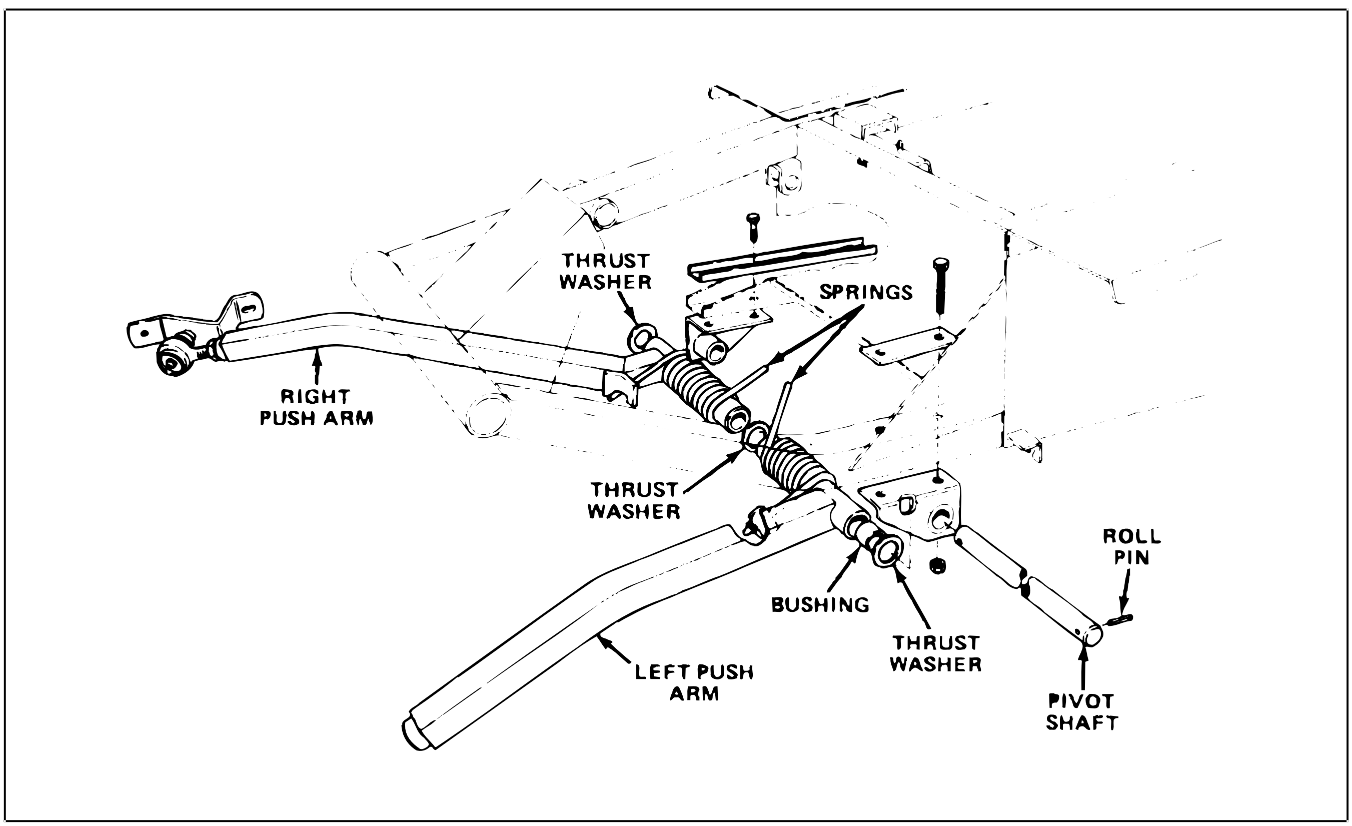


Figure 39

Installing Push Arms, Torsion Springs and Bushings

1. Apply grease to inside and outside of new bushings. Using a hammer and flat plate, carefully drive the bushings into the push arm pivot tubes. The bushings must be flush with the end of the tube.

2. Inspect the torsion springs. If the springs are damaged, use new springs when assembling the parts.

3. Slide the torsion springs onto the inside of the push arm pivot tubes. Install the washers, push arms with springs and push arm brackets onto the pivot shaft. Install the roll pins to secure the parts in place.

4. Raise the push arm and pivot shaft assembly into position and secure it in place with cap screws, support plate, reinforcement support and locknuts. Make sure the springs contact the retainer plate on the push arms and the underside of the frame.

5. Have a helper push down on the left push arm while you place a 3 ft. long block of wood between the chassis and to top of the push arms, across the full width of the machine.

NOTE: After the wood block is installed, there should be enough clearance for installing the ball joint into the front of the push arm.

6. Thread jam nut fully onto the left-hand ball joint. Screw the ball joint into the left-hand push arm until the center of the ball joint is 2-3/8 inches away from the front of the push arm. Do not tighten the jam nut until the deck is mounted.

7. Install the brake mount and pedal assembly with cap screws, locknuts, carriage bolts, lock washer and nuts. Route the right-hand brake cable through the hole in the right-hand push arm bracket. Connect the cable to the brake strut with the clevis pin and the tension spring. Hook the opposite end of the tension spring into the hole in the side of the chassis. Also install the cable into the mount on the frame.

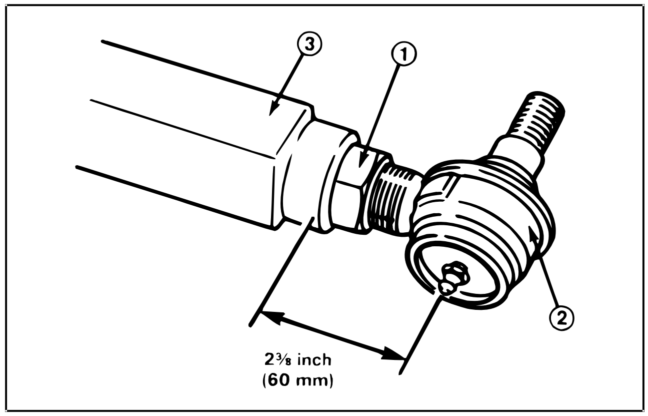


Figure 40

1. Lock nut
2. Ball joint
3. Push arm

Gear Case Removal and Installation (Fig. 41, 42)

Removing Gear Case and Drive Pulley

1. Lower the cutting unit, shut engine off and engage the parking brake.

2. Remove shroud (Item 20) covering universal drive shaft. Disconnect drive shaft from gear case. Remove belt covers from top of cutting unit.

DANGER

Do not start the engine and engage the P.T.O. when the P.T.O. shaft is not connected to the gear case. If engine is started and the P.T.O. shaft is allowed to rotate, serious injury could result.

3. Loosen belt tension and remove belt from gear case pulley.

4. Remove flange nuts and carriage bolts securing gear case mount plate (Item 22) to cutting unit and remove plate and gear case.

5. Remove the set screws (Item 28) from the taper lock bushing (Item 27). Install one setscrew into the hole that is threaded on the side of taper lock. Tighten the setscrew until the taper lock is loose from the inside of the pulley hub.

NOTE: Only one setscrew is used to loosen the taper lock.

6. Slide the gear case pulley (Item 26) and taper lock (Item 27) off of the gear case output shaft. Account for the woodruff key (Item 24) that positions the pulley on the shaft, and remove the setscrew from the side of the taper lock.

7. Remove gear case from mount plate and remove brackets (Item 18) from gear case.

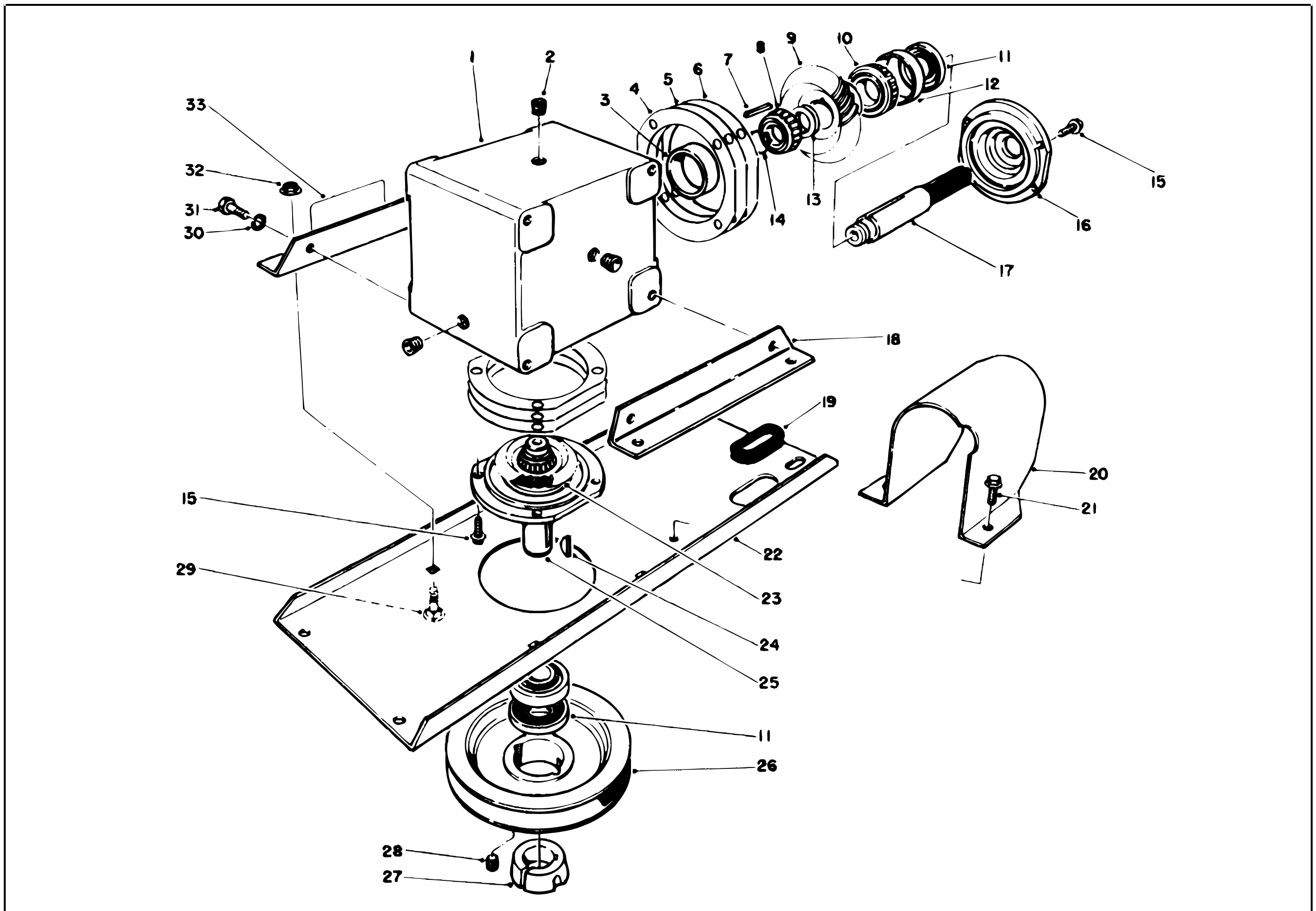


Figure 41

Installing Gear Case and Drive Pulley

1. Install bracket (Item 18) on each side of gear case with capscrews and lockwashers. Tighten capscrews to a torque of 20 - 26 ft-lb. Install gear case and bracket assembly to mount plate (Item 22) with carriage bolts and flange nuts.

2. To install pulley (Item 26) and slide taper lock (Item 27), small end first, into pulley hub.

3. Insert woodruff key (Item 24) into keyway in gear case shaft. Slide pulley with taper lock onto gear case shaft while aligning key and keyway.

NOTE: Large hub on pulley must face away from gear case, and like the taper lock, the pulley must contact the shoulder on the gear case shaft.

4. Rotate pulley to get non-threaded holes in taper lock to line up with the two threaded holes in hub of gear case pulley. Start threading setscrews (Item 28) into the two holes and tighten setscrews alternately and evenly until both setscrews are tight.

5. Using a brass drift pin or a sleeve and hammer, hit taper lock firmly. Now tighten setscrews to 55 in-lb. Continue to hit taper lock and tighten set screws until 55 in-lb of torque will not turn the setscrews.

6. Check alignment of gear case with a spindle pulley. Loosen and relocate taper lock to adjust, if necessary.

7. Fill recessed socket head in each setscrew, and the other taper lock holes, with grease to prevent dirt from packing into the holes.

8. Mount gear case with brackets onto top of gear case mount plate (Item 22) with carriage bolts and flange nuts.

9. Mount gear case mount plate to cutting unit with carriage bolts and flange nuts.

10. Install drive belt onto gear case pulley and adjust belt tension.

11. Install belt covers.

12. Install drive shaft to gear box and secure with a new roll pin.

13. Remove gear case fill plug and check plug. Add SAE 80W90 API GL-5 gear lube until level is to the bottom of check plug hole. Install plugs in gear case.

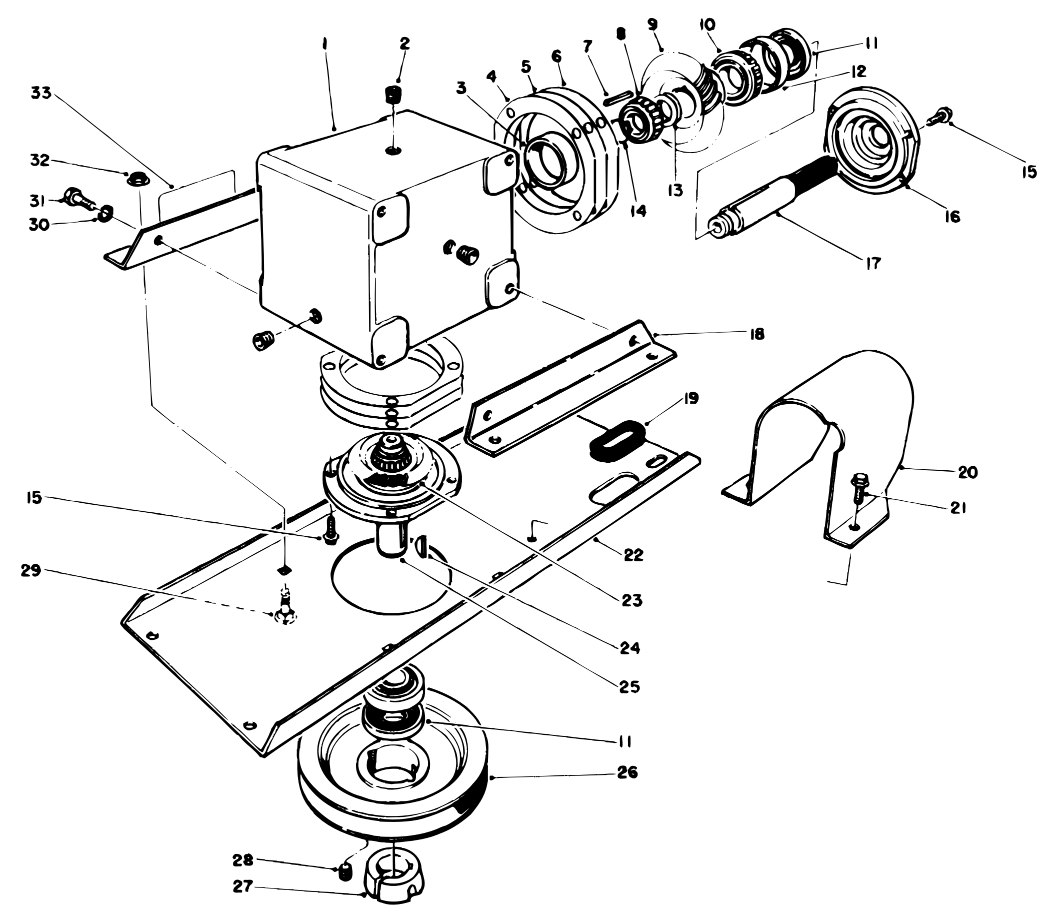


Figure 42

Gear Case Repair (Fig. 43, 44)

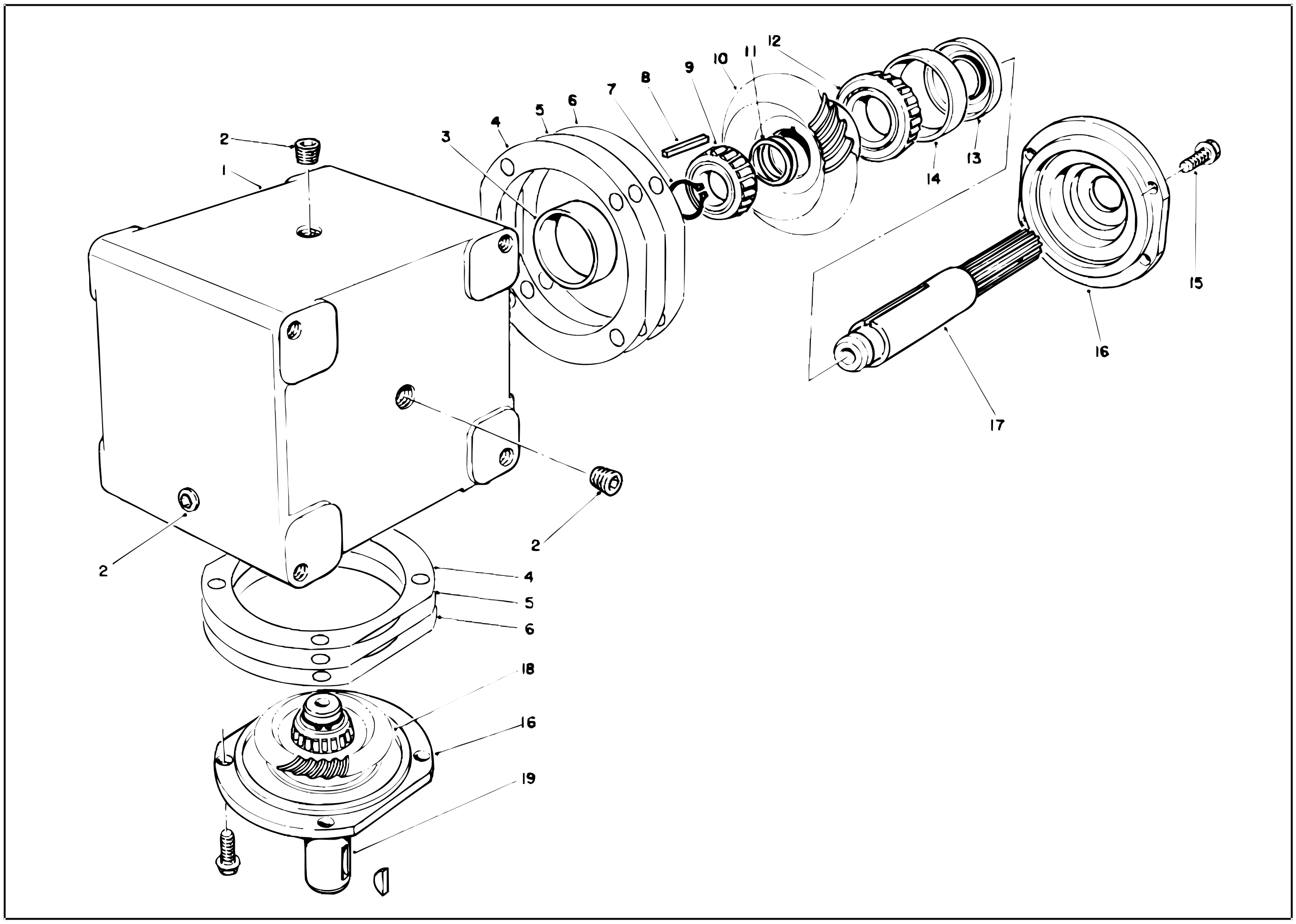


Figure 43

Gear Case Disassembly

1. Drain lubricant from gear case.

2. Remove capscrews and lift out shaft and cap assemblies.

3. Remove cap assemblies and bearing cones (Item 12) from shafts (Item 17, 19).

NOTE: Mark each gear (Item 10 and 18) so they are installed on the proper shaft (Item 17 or 19) when re-assembled.

4. Remove retaining rings (Item 7).

5. Press shafts (Item 17, 19) back through bearing cones (Item 9). When bearing cone is free, gears (Item 10, 18), keys (Item 8) and shims (Item 11) may be removed from the shaft.

6. Remove bearing cups (Item 14) from cap by putting a punch through the shaft bore and through the seal and then tapping against the back of the bearing cup until driven out of the cap.

7. If the oil seal (Item 13) is removed, it will be destroyed. To remove the oil seal, cut it out of the bore with a screw driver or chisel.

8. To remove the bearing cups (Item 3) from the housing a slide hammer puller may be used, or if this is not available, the bearing cups may be knocked out with a punch by coming down through the opposite cap bore and tapping against the back side of the bearing cup until it comes out.

9. Remove the plugs (Item 2) from the housing.

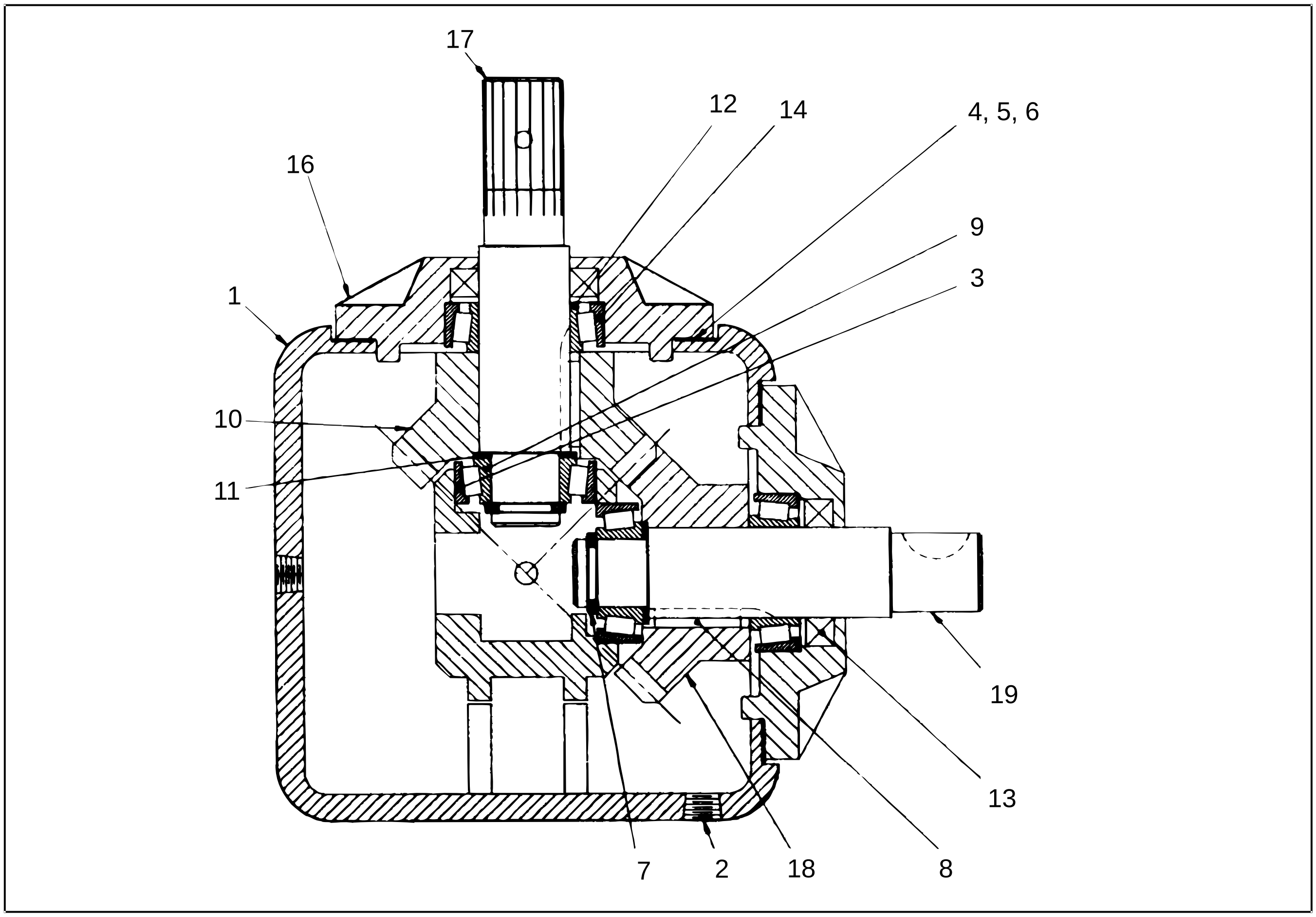


Figure 44

Gear Case Pre-Assembly

1. Start with one of the shafts (Item 17) and put one of the gears (Item 10) over the shaft so the tooth side is towards the turned end of the shaft. Align the keyway in the gear with the keyway in the shaft and install one of the keys (Item 8) in the keyway.

2. Install one set of shims (Item 11) onto the turned end of the shaft. Press one of the bearing cones (Item 9) over the turned end of the shaft. Be sure the bearing cone is installed as shown in the illustration (Fig. 42B). Install a retaining ring (Item 7) on the turned end of the shaft.

3. Put one of the bearing cones (Item 12) over the other end of the shaft and down against the hub side of the gear. Be sure the bearing cone is installed as shown in the illustration.

4. Repeat steps 1 - 3 with the other set of parts to complete the assembly.

5. Put one of the caps (Item 16) down, with the machined surface facing up. Install a new seal (Item 13) into the cap with the open side toward the machined side of the cap.

6. Install the bearing cup (Item 14) into the cap. Make sure the bearing cup is installed as shown in the illustration.

7. Repeat steps 5 - 6 with the other set of parts to complete the two cap assemblies.

8. Take one of the shaft and gear assemblies and wrap the end of the shaft with a piece of shim stock to keep from cutting the oil seal on the keyway or splines. Put the cap assembly down over the shaft so the bearing cone (Item 12) on the shaft mates with the bearing cone (Item 14) in the cap. Remove the shim stock from the shaft that was used to protect the seal.

9. Press the bearing cups (Item 3) into both bearing bores in the housing (Item 1). Make sure the cups are installed as shown in the illustration. Install the plugs (Item 2) into the tapped holes in the housing.

Gear Case Final Assembly

1. Bearing drag is adjusted by the amount of gaskets (Item 4, 5, 6) used between the cap and housing machined surfaces.

2. Put two 0.015 in. gaskets on the machined surface of the housing, then install the shaft and cap assembly in the housing so the bearing cone (Item 9) on the shaft assembly and bearing cup (Item 3) in the housing are mating. Align the holes in the cap with the holes in the gaskets and housing.

3. Install capscrews and tighten.

4. The shaft should have a very slight amount of bearing drag. If the shaft turns hard, the cap must be removed and gasket(s) need to be added. If the shaft has no bearing drag, or has end play, the cap must be removed and gasket(s) taken out. The cap must be adjusted to where the shaft has no end play and only a slight amount of bearing drag.

5. Repeat steps 1 - 4 with the other shaft and cap assembly.

6. After installing the gear box on the cutting unit, fill it with SAE 80W90 API GL-5 lubricant to the level of the check plug.

Blade Spindle Service (Fig. 45, 46, 47)

Removing Spindle Housing Assembly

1. Lower the cutting unit, shut the engine off and engage the parking brake.

2. Remove deck covers from top of cutting unit. Release belt tension. Remove belt from spindle to be serviced.

3. Start the engine and raise the cutting unit. Turn the engine OFF and remove the key from the key switch. Block up the cutting unit so it cannot fall accidentally.

4. Using a rag or thickly padded glove, grasp end of blade. Remove blade bolt, flat washer, anti-scalp cup and blade from spindle assembly.

5. Remove flange nuts and carriage bolts securing spindle housing to deck. Slide spindle housing assembly out the bottom of the cutting unit.

Disassembly

1. Remove the nut and flat washer retaining the spindle pulley on the spindle shaft. Slide pulley off of shaft.

2. Press the spindle shaft out of the spindle housing using an arbor press. The bearing spacer remains on the spindle shaft as the shaft is being removed.

3. Remove seals from spindle housing.

4. Allow the bearings and small thick spacer to fall out of the spindle housing.

5. Using a punch and hammer, drive both of the bearing cups out of the spindle housing. Also drive the large spacer out of the housing.

6. A large snap ring is still inside the spindle housing and it should remain there because it cannot be easily removed.

IMPORTANT: If new bearings will be installed into a used spindle housing that has the original snap ring installed, discard the large snap ring that came with the bearings because it is not needed. However, new bearings with their matched spacer and snap ring must always be installed when the spindle housing is being replaced. Replacement bearings are sold only with a matched snap ring and spacer set. These parts cannot be purchased separately.

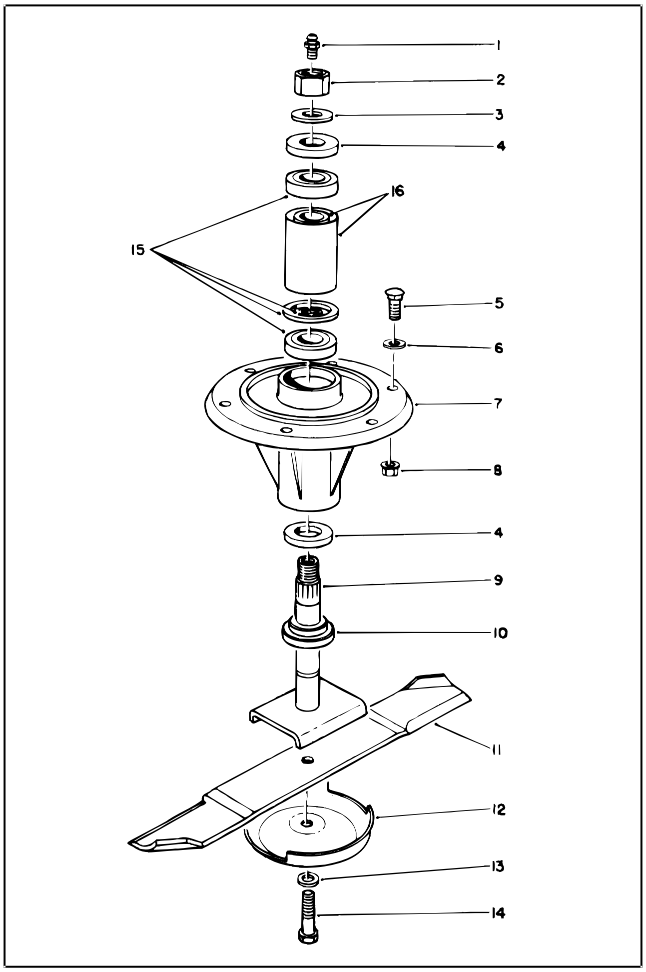


Figure 45

1. Grease fitting
2. Jam nut
3. Washer
4. Wave seal
5. Carriage bolt
6. Flat washer
7. Spindle housing
8. Flange nut
9. Spindle shaft
10. Spindle spacer
11. Blade
12. Anti-scalp cup
13. Flat washer
14. Capscrew
15. Bearing assembly
16. Spacer – matched set

Assembly and Installation of Spindle

IMPORTANT: If a new spindle housing is being used, new bearings and matched snap ring set must be installed; see step 1 below. Never use old bearings, spacer, and snap ring with a new spindle housing. If installing bearings into a used spindle housing that still has a snap ring installed, use only new bearings with cups and spacer – not the large snap ring because it is not required; see step 2 below.

1. Install large snap ring into groove in bore of spindle housing. Make sure snap ring is seated in groove.

2. Using an arbor press, push large spacer into top of spindle housing; tightly against snap ring. The spacer must contact the snap ring to be sure of the correct assembly of the parts.

3. Thoroughly oil the bearing cups and using an arbor press, push the bearing cups, smallest inside diameter first, into the top and bottom of the spindle housing. The top bearing cup must contact the spacer that was installed in step 2, and the bottom bearing cup must contact the snap ring to be sure of the correct assembly of parts. Insure that the assembly is correct by supporting the first cup and pressing the second against it.

4. Apply a film of grease on lips of both seals, then install bearing and seal into bottom of spindle housing. Remember, the BOTTOM SEAL MUST HAVE THE LIP FACING OUTWARD, not toward the inside of the spindle housing.

5. Check the spindle shaft to make sure it is free of burrs and nicks that could possibly cut the seals and thoroughly lubricate both the shaft and seal lips.

6. Slide small, thick spacer into spindle housing, then install bearing and seal into top of spindle housing. LIP OF UPPER SEAL MUST FACE INWARD.

7. Slide bearing spacer onto spindle shaft. Carefully slide spindle shaft through spindle housing. The bottom seal and bearing spacer fit together when the spindle is installed.

8. Push pulley onto splines of spindle shaft and retain the parts together with the large flat washer and nut. Tighten the nut to 100 - 120 ft-lb and rotate the spindle shaft to be sure that the shaft rotates freely.

9. Slide pulley end of spindle assembly through hole in cutting unit. Mount the spindle assembly in place with the carriage bolts and flange nuts.

10. Install the belt and adjust belt tension.

11. Reinstall the belt covers.

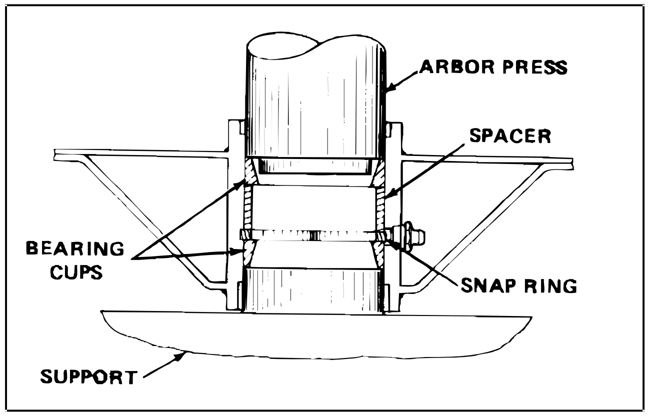


Figure 46

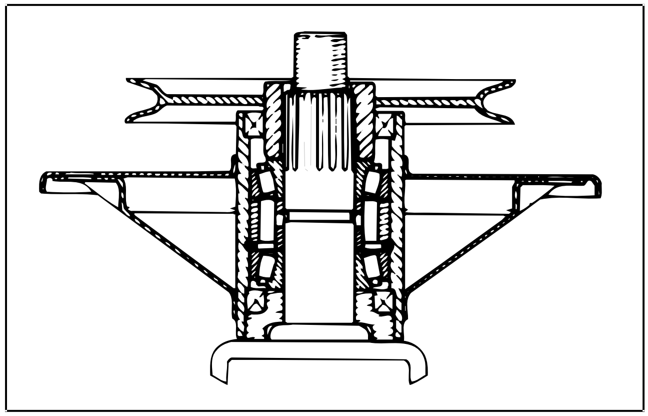


Figure 47

Chapter 13

Guardian® 72″ Recycler® Cutting Unit

Table of Contents

SPECIFICATIONS 2
TROUBLESHOOTING 3
ADJUSTMENTS 4
Height of Cut Adjustment 4
Adjusting Skids 5
Mismatch Adjustments 6
REPAIRS 7
Blade Service 7
Belt Replacement 9
Caster Arm Bushing Replacement 10
Caster Wheel Bearing Service 11
Separating Cutting Unit From Traction Unit. . . . 12
Mounting Cutting Unit to Traction Unit. 13
Push Arm and Torsion Spring Service 14
Gearbox Removal and Installation 17
Gearbox Service 19
Blade Spindle Service 22

Specifications

ITEM	SPECIFICATION
Cutting width	72 inches
Height of cut range	2 to 5 inches
Height of cut adjustment	0.5 inch increments
Blade bolt torque	85 to 110 ft-lb
Spindle nut torque	140 - 160 ft-lb.
Gearbox lubricant	SAE 80W90, API GL-5 gear lube

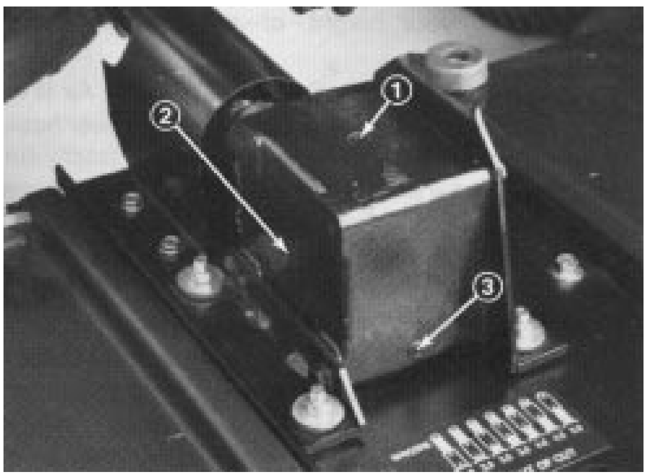
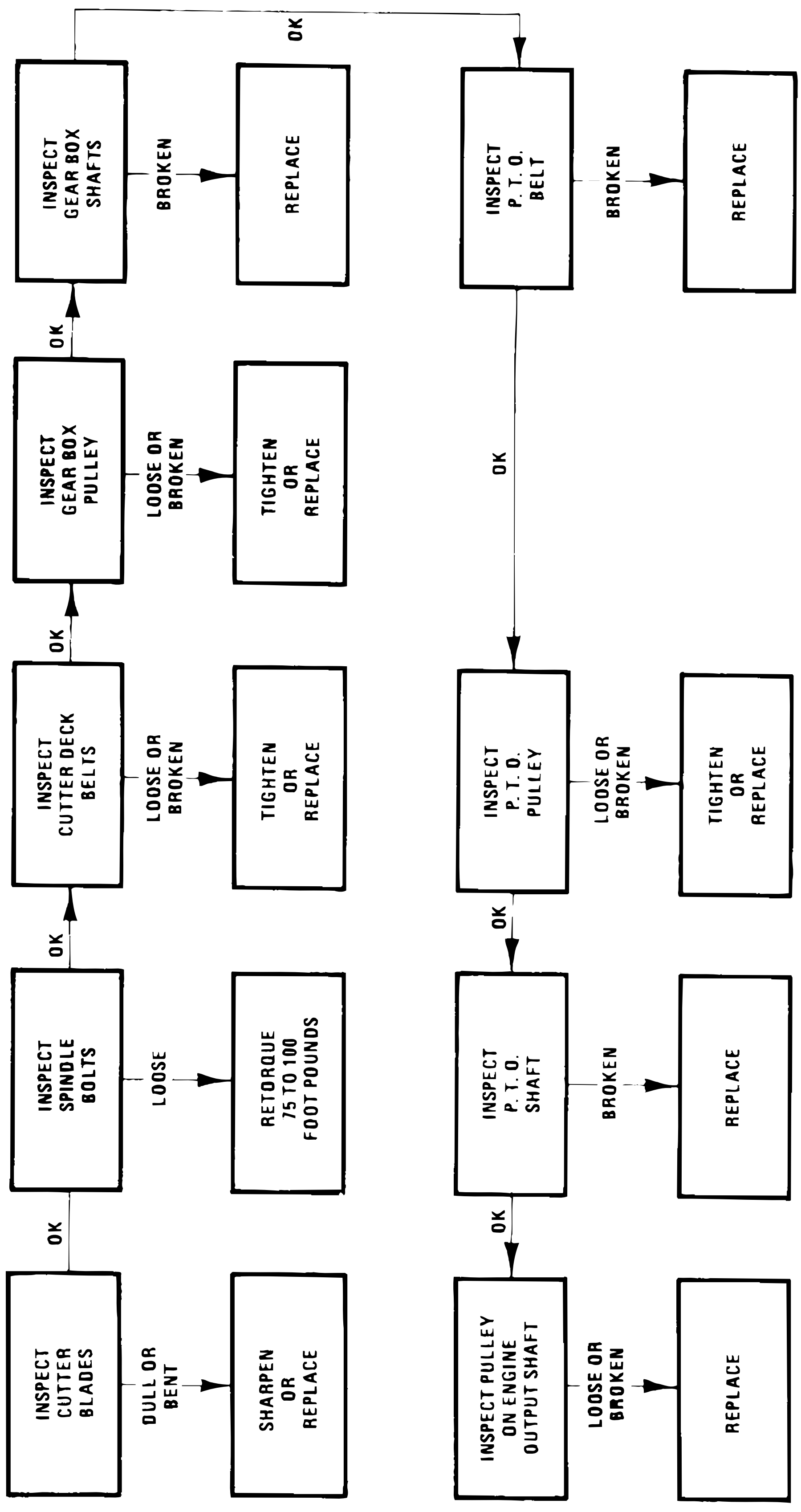


Figure 1

1. Filler plug
2. Check plug
3. Drain plug

Troubleshooting



Adjustments

Height of Cut Adjustment (Fig. 2, 3)

The height of cut is adjustable from 2 to 5 inches in 1/2 inch increments, by adding or removing an equal number of spacers on the front and rear caster forks. The height of cut chart below gives the combinations of spacers to use for all height of cut settings.

Height of Cut		Spacers Below Caster Arms	
inches	mm	Front	Rear
2	50	0	0
2-1/2	64	1	1
3	76	2	2
3-1/2	89	3	3
4	102	4	4
4-1/2	114	5	5
5	127	6	6

1. Start the engine and raise cutting unit so height of cut can be changed. Stop engine after cutting unit is raised.

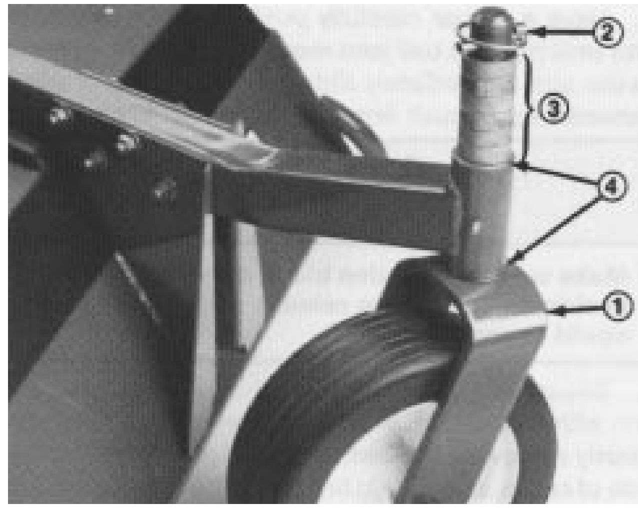


Figure 2

1. Front caster wheel
2. Lynch pin
3. Spacers
4. Thrust washer

Front Caster Wheels

1. Squeeze back of wire and rotate wire on lynch pin. Pull pin out of caster spindle and slide spindle out of front caster arm. Slide spacers onto the caster spindle to get desired height of cut. Then slide washer onto spindle.

2. Push caster spindle through caster arm. Install other thrust washer and remaining spacers onto spindle. Install lynch pin to retain parts in place.

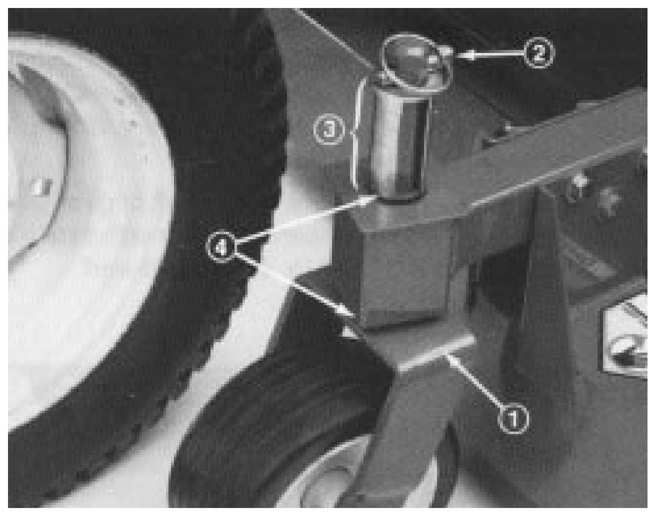


Figure 3

1. Rear caster wheel
2. Lynch pin
3. Spacers
4. Thrust washer

Rear Caster Wheels

1. Squeeze back of wire and rotate wire on lynch pin. Pull pin out caster spindle.

NOTE: Rear caster fork assembly does not need to be removed from caster arm to change height of cut.

2. Remove or add “C” shaped spacers at narrow part of spindle shaft, below caster arm, to get desired height of cut. Make sure thrust washers, not spacers, contact top and bottom of caster arm.

3. Install lynch pin to secure caster wheel assembly.

4. Make sure all four caster wheels are set at same height of cut.

Adjusting Skids (Fig. 4)

1. Adjust each skid by loosening the three (3) flange nuts and moving the skid to the desired position. Tighten the flange nuts to secure the skid in position.

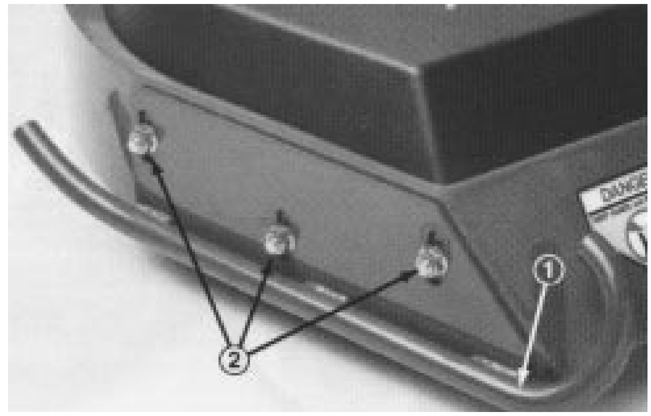


Figure 4

1. Skid **2. Flange nuts**

Checking and Correcting Mismatch of Blades (Fig. 5)

If there is mismatch between the blades, the grass will appear streaked when it is cut. This problem can be corrected by making sure the blades are straight and all blades are cutting on the same plane.

1. Using a 3 foot long carpenters level, find a flat surface on the shop floor.

2. Adjust height of cut so all six height of cut spacers are below the caster arm.

3. Lower cutting unit onto flat surface. Remove covers from top of cutting unit. Release belt tension.

4. Rotate blades until the ends face forward and backward. Measure from floor to front tip of cutting edge and remember this dimension. Then rotate same blade so opposite end is forward and measure again. The difference between dimensions must not exceed 1/8 inch. If difference exceeds 1/8 inch, replace the blade because it is bent. Make sure to measure all three blades.

5. Compare measurements of outer blades with the center blade. Center blade must not be more than 3/8 inch lower than outer blades. If center blade is more than 3/8 inch lower than outer blades, proceed to step 7 and add shims between spindle housing and bottom of cutting unit.

6. Rotate blades so tips line up with one another. Tips of the adjacent blades must be within 1/8 inch of each other. If tips are not within 1/8 inch of each other, proceed to step 7 and add shims between spindle housing and bottom of cutting unit.

7. Remove cap screws, flat washers, lock washers and nuts from outer spindle, in the area where shims must be added. To raise or lower the blade, add a shim, Part No. 3256-24, between spindle housing and bottom of cutting unit. Continue to check alignment of blade and add shims until tips of blades are within the required dimension.

IMPORTANT: Do not use more than three shims at any one hole location. Use decreasing numbers of shims in adjacent holes if more than one shim is added to any one hole location.

8. Adjust belt tension and install covers.

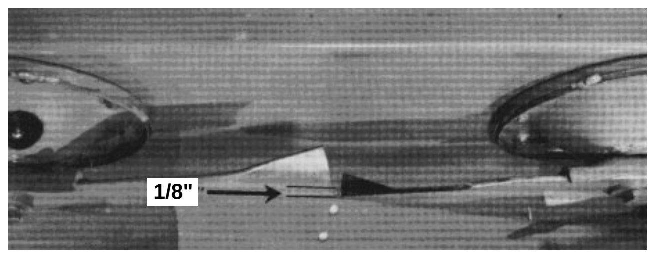


Figure 5

Blade Service (Fig. 6, 7, 8)

The blade must be replaced if a solid object is hit, or if the blade is out-of-balance, worn or bent. Always use genuine TORO replacement blades to ensure safety and optimum performance. Never use blades made by other manufacturers because they could be dangerous.

CAUTION

Do not try to straighten a blade that is bent, and never weld a broken or cracked blade. Always use a new TORO blade to assure continued safety certification of the product.

1 . Raise cutting unit to highest position, shut the engine off and engage parking brake. Block cutting unit to prevent it from falling accidentally.

2. Grasp end of blade using a rag or thickly padded glove. Remove blade bolt, lockwasher, anti-scalp cup and blade from spindle shaft.

3. Install the blade, anti-scalp cup, lockwasher and blade bolt. Make sure blade sail is facing up toward cutting unit. Tighten blade bolt to a torque of 85 to 110 ft-lb.

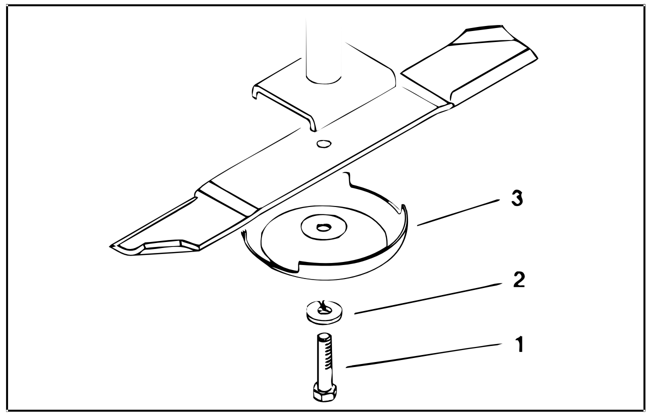


Figure 6

1. Blade bolt
2. Lockwasher
3. Anti-scalp cup

Inspecting and Sharpening Blade

1. Raise cutting unit to highest position, shut the engine off and engage parking brake. Block cutting unit to prevent it from falling accidentally.

2. Examine cutting ends of the blade carefully, especially where the flat and curved parts of the blade meet. Since sand and abrasive material can wear away the metal that connects the flat and curved parts of the blade, check the blade before using the machine. If any wear is noticed, replace the blade: refer to Removing Cutter Blade.

> **WARNING**
>
> **If the blade is allowed to wear, a slot will form between the sail and flat part of the blade. Eventually, a piece of the blade may break off and be thrown from under the housing, possibly resulting in serious injury to yourself or bystander.**

3. Examine cutting edges of all blades. Sharpen the cutting edges if they are dull or nicked. Sharpen only the top side of the cutting edge and maintain the original cutting angle to assure sharpness. The blade will remain balanced if same amount of metal is removed from both cutting edges.

4. To check blade for being straight and parallel, lay blade on level surface and check its ends. Ends of blade must be slightly lower than the center, and cutting edge must be lower than heel of the blade. This blade will produce good quality-of-cut and require minimal power from the engine. By contrast, a blade that is higher at the ends than the center, or cutting edge higher than the heel of the blade is warped or bent and must be replaced.

5. To install the blade, ,assemble parts in reverse order, and make sure the blade sail is facing up. Tighten blade bolt to a torque of 85 to 110 ft-lb.

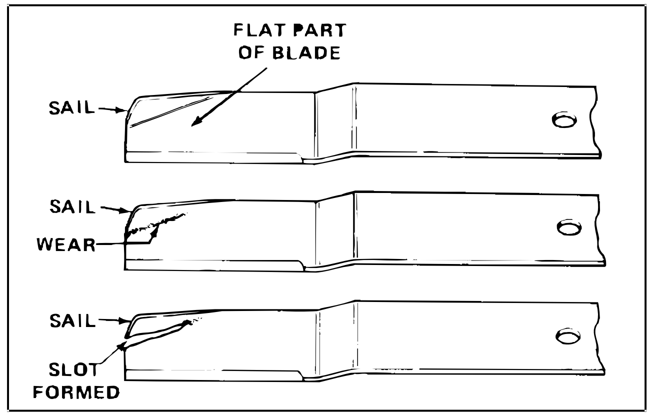


Figure 7

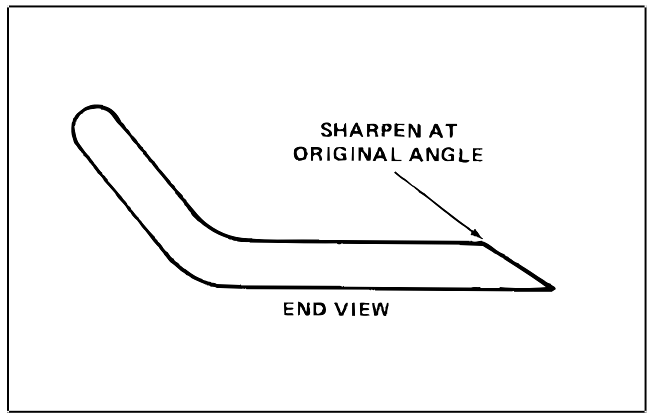


Figure 8

Belt Replacement (Fig. 9, 10, 11)

Signs of a worn belt are: squealing when belt is rotating, blades slipping when cutting grass, frayed belt edges, burn marks and cracks. Replace the belt if any of these conditions are evident.

The blade drive belt is held under tension by a spring loaded idler.

1. Lower cutting unit to shop floor, stop the engine and engage the parking brake. Remove belt covers from top of cutting unit.

2. Disconnect spring from idler arm bracket to release belt tension. Remove cotter pin and clevis pin securing idler arm bracket to idler arm.

3. Remove capscrews and nuts securing gear box plate to deck channels. Lift gear box plate and gear box off deck channels and lay it on top of deck.

4. Remove belt from around spindle pulleys and through idler pulley assembly.

5. Install belt around spindle pulleys and through idler pulley assembly.

6. Install gear box plate on deck channels while routing belt around gear box pulley. Mount gear box plate to deck channels with capscrews and nuts.

7. Install idler arm bracket to idler arm with cotter pin and clevis pin. Hook spring onto idler arm bracket. To make sure there is proper belt tension on drive belt, spring should be extended to a length of approximately 7.00 inches. If spring is not extended to this length, move spring rod to other mounting holes further away from belt.

8. Install belt covers.

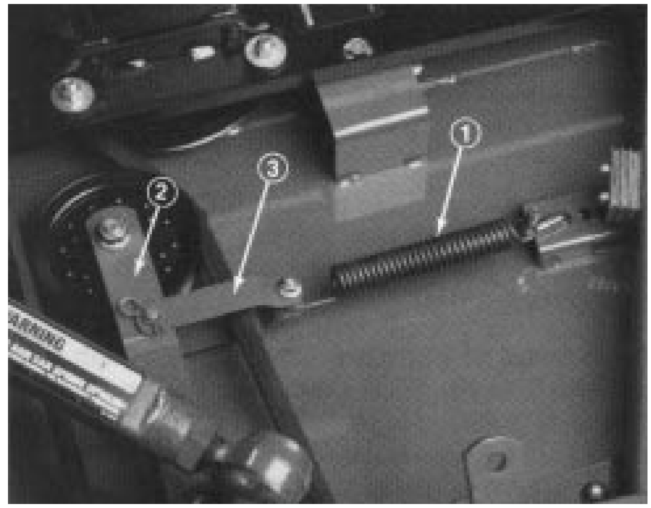


Figure 9

1. Spring **2. Idler arm** **3. Idler arm bracket**

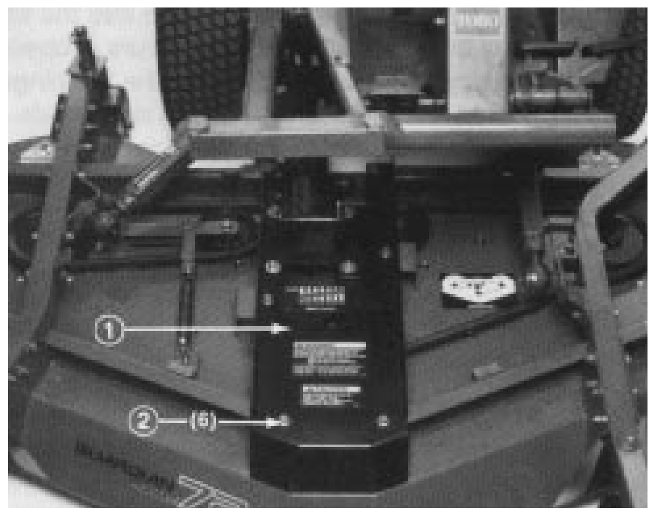


Figure 10

1. Gear box plate **2. Capscrews and nuts**

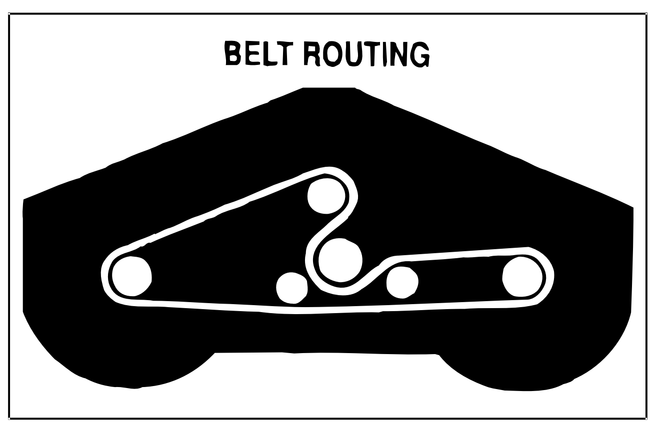


Figure 11

Caster Arm Bushing Service (Fig. 12)

The caster arms have bushings pressed into the top and bottom portion of the tube and after many hours of operation, the bushings will wear. To check the bushings, move caster fork back and forth and from side-to-side. If caster spindle is loose inside the bushings, bushings are worn and must be replaced.

1. Raise cutting unit and block it so it cannot fall accidentally.

2. Remove lynch pin and spacers from top of caster spindle.

3. Pull caster spindle out of mounting tube. Allow spacer(s) and thrust washer to remain on bottom of spindle to assure same height of cut when caster spindle is reinstalled.

4. Insert pin punch into top or bottom of mounting tube and drive bushing out of tube. Also drive other bushing out of tube. Clean inside of tubes to remove dirt.

5. Apply grease to inside and outside of new bushings. Using a hammer and flat plate, drive bushings into mounting tube.

6. Inspect caster spindle for wear and replace it if damaged.

7. Push caster spindle through bushings and mounting tube. Slide spacers onto spindle. Install lynch pin through caster spindle to retain all parts in place.

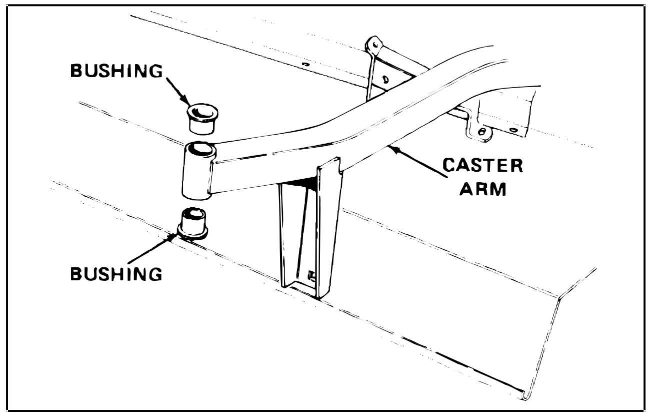


Figure 12

Caster Wheel Bearing Service (Fig. 13)

The rear caster wheels rotate on high quality roller bearings which are supported by spanner bushings. Even after many hours of use, provided that the bearing was kept well-lubricated, bearing wear will be minimal. However, failure to keep bearings lubricated will cause rapid wear. A wobbly caster wheel usually indicates a worn bearing.

1. Remove capscrew and locknut holding caster wheel between caster fork.

2. Pull spanner bushing out of wheel hub.

3. Remove bushing from wheel hub and allow bearing to fall out. Remove bushing from opposite side of wheel hub.

4. Check the bearing, spanner and inside of wheel hub for wear. Replace defective parts.

5. To assemble the caster wheel, push bushing into wheel hub. Slide bearing into wheel hub. Push other bushing into open end of wheel hub to captivate the bearing inside the wheel hub.

6. Carefully slide spanner through the bushings and wheel hub.

7. Install caster wheel assembly between caster fork, and secure all parts in place with capscrew and locknut.

8. Lubricate caster wheel bearing through grease fitting, using No. 2 general purpose lithium grease.

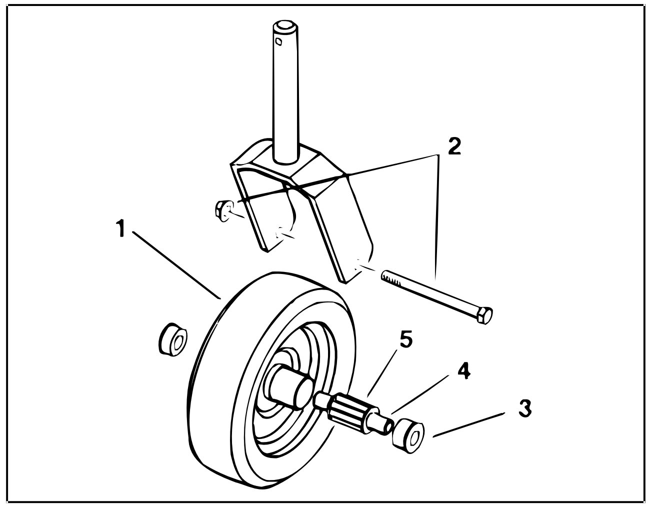


Figure 13

1. Caster wheel
2. Capscrew and locknut
3. Bushing (2)
4. Spanner bushing
5. Roller bearing

Separating Cutting Unit From Traction Unit (Fig. 14, 15, 16)

1. Position machine on level surface, lower cutting unit to the shop floor, shut engine off and engage parking brake.

2. Remove self-tapping screws securing shield to top of cutting unit and set shield aside.

3. Drive roll pin out of yoke and input shaft of gear box. Also, loosen cap screws and lock nuts. Slide yoke off the input shaft. If traction unit will be used without the cutting unit, drive roll pin out of yoke at PTO pivot shaft and remove entire universal shaft from traction unit.

DANGER

Do not start the engine and engage the PTO lever when PTO shaft is not connected to gear box on cutting unit. If engine is started and PTO shaft is allowed to rotate, serious injury could result.

4. Disconnect cotter pins and clevis pins securing lift chains to lift arms.

WARNING

Since the right hand push arm is spring-loaded to about 100 pounds and left hand push arm is spring-loaded to about 150 pounds, a helper is needed to release push arms from cutting unit. Sudden release of the push arms could cause injury.

5. Have a helper push down on the right push arm while you remove the cap screws, flat washers, lock washers and nuts securing ball joint mount to caster arm on cutting unit. Now the helper can carefully allow push arm to move upward, which will gradually release the 100 pounds of spring load.

6. Have a helper push down on the left push arm while you remove the cap screws, flat washers, lock washers and nuts securing ball joint mount to mount bracket on cutting unit. Now the helper can carefully allow push arm to move upward which will gradually release the 150 pounds of spring load.

7. Roll the cutting unit away from the traction unit.

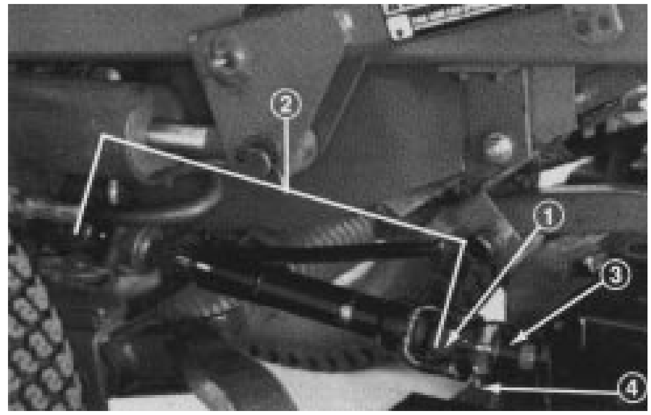


Figure 14

1. Drive shaft yokes	**3. Roll pin**
2. Yokes in phase	**4. Capscrews**

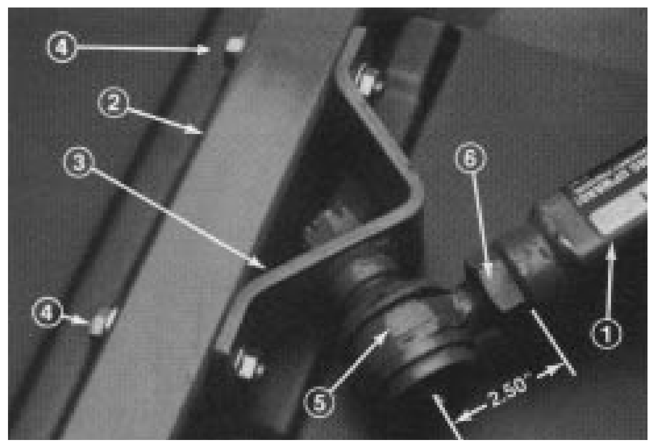


Figure 15

1. R.H. push arm	**4. Capscrews and washers**
2. Caster arm	**5. Ball joint**
3. Ball joint mount	**6. Jam nut**

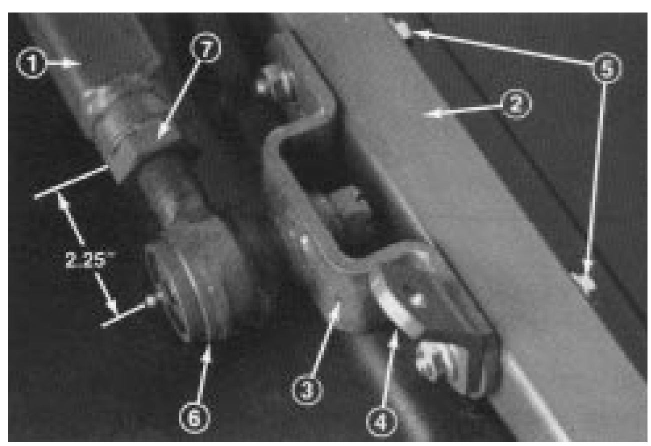


Figure 16

1. L.H. push arm	**5. Capscrews and washers**
2. Caster arm	**6. Ball joint**
3. Ball joint mount	**7. Jam nut**
4. Chain mount	

Mounting Cutting Unit to Traction Unit (Fig. 14, 15, 16, 17)

1. Position machine on level surface and shut engine off.

2. Move cutting unit into position in front of traction unit.

WARNING

Since the right hand push arm is spring-loaded to about 100 pounds and left hand push arm is spring-loaded to about 150 pounds, a helper is needed to push the push arm down. Sudden release of the push arm could cause injury.

3. Have a helper carefully push down on right hand push arm until holes in ball joint mount line up with holes in caster arm.

4. Secure ball joint mount to caster arm with capscrews, flat washers and flange nuts. Flat washers must be installed to outside of caster arm.

5. Have a helper carefully push down on left hand push arm until holes in ball joint mount are in line with holes in mount bracket on cutting unit. Immediately slide 4 x 4 in. block of wood between top of push arm and underside of chassis.

WARNING

Make sure wooden block does not slip out accidentally.

6. Secure ball joint mount and chain bracket to caster arm with capscrews, flat washers and flange nuts. Flat washers must be installed to outside of caster arm. Chain bracket must be installed using forward set of holes.

7. Carefully remove wood block holding push arm down.

8. Line up holes in yoke and input shaft of gear box. Slide yoke onto shaft and secure parts together with roll pin. Tighten (2) capscrews and locknuts securing yoke to input shaft.

9. Mount PTO shield over input shaft and onto gear box mounting plate with two self-tapping screws.

10. Connect lift chains to lift arm and cutting unit chain brackets with (6) shackles, shackle pins and cotter pins. To make sure cutting unit lifts properly, secure chains to the following links when connecting:

Front left – 11th link
Front right – 8th link
Rear – 7th link

11. Check operation to make sure chains lift deck tight against stops when lift arm is raised.

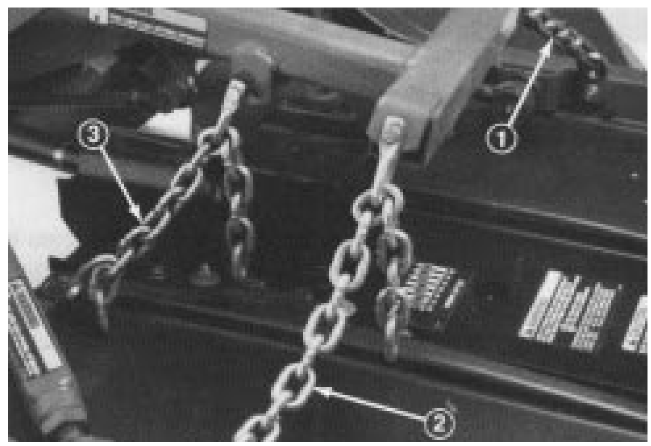


Figure 17

1. Front left lift chain
2. Front right lift chain
3. Rear lift chain

Push Arm and Torsion Spring Service (Fig. 18, 19, 20, 21, 22, 23, 24)

Removing Push Arms,
Torsion Springs and Bushings

1. Separate cutting unit from traction unit and roll cutting unit away from traction unit.

2. Have a helper push down on the left push arm while you put a 4" x 4" block of wood between the chassis and the top of the push arm, and across the full width of the machine.

3. Loosen the large jam nut on the left-hand ball joint at the end of the push arm. Remove the ball joint (mount attached) from the push arm.

4. Remove the self-tapping screws holding the floor plate to the main frame. Raise the floor plate and set it aside.

5. Disconnect the right-hand brake cable from the brake strut. Remove the jam nut holding the brake cabled in the mount on the frame and slide the cable through the hole in the push arm bracket.

6. Remove the cotter pin from the end of the parking brake rod. Slide the rod out of the latch.

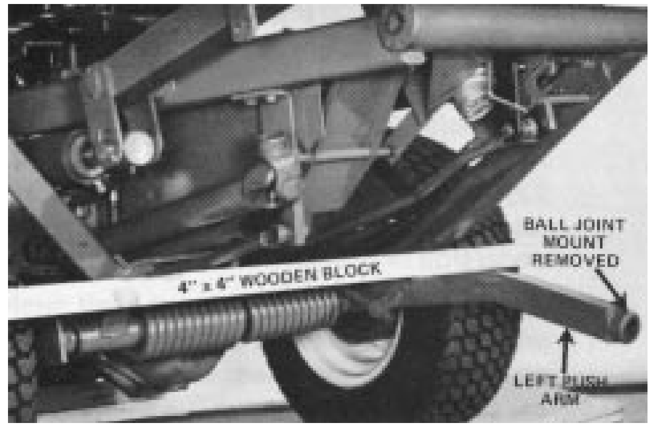


Figure 18

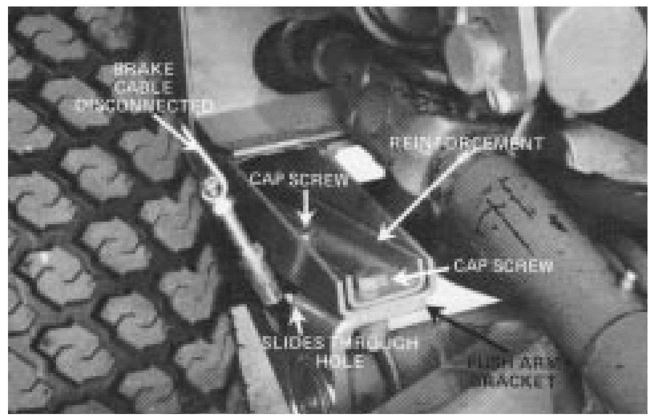


Figure 19

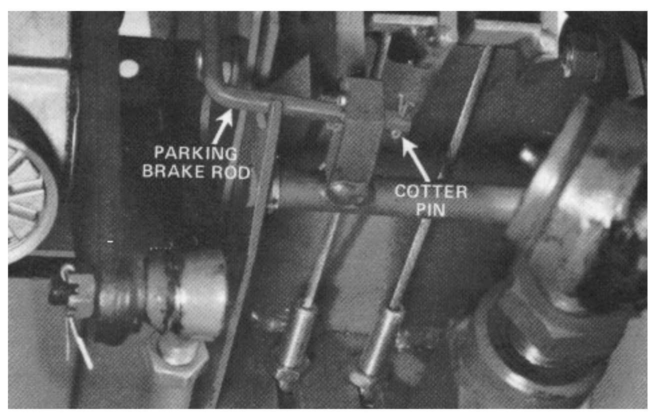


Figure 20

7. Remove the cap screws, locknuts, carriage bolts, lock washers and nuts holding the brake mount and pedal assembly in place. Lay the brake mount and the pedal assembly on the wheel.

8. Have a helper push down slightly on the left push arm while you remove the block of wood between the push arm and the chassis. Slowly and carefully allow the push arm to move upward until all spring load is released.

9. Remove the cap screws, locknuts, support plate and push arm bracket holding the left side of the push arm and pivot shaft to the main frame.

10. Remove the cap screws, locknuts, reinforcement and push arm bracket holding the right side of the push arm and pivot shaft to the main frame. The entire push arm and pivot shaft assembly should now be free of the main frame.

11. Drive the roll pins out of the pivot shaft and slide the push arm assemblies off of the shaft.

12. Drive the pushing out of both push arm pivot tubes. Clean the inside of the pivot tubes to remove all dirt and other material.

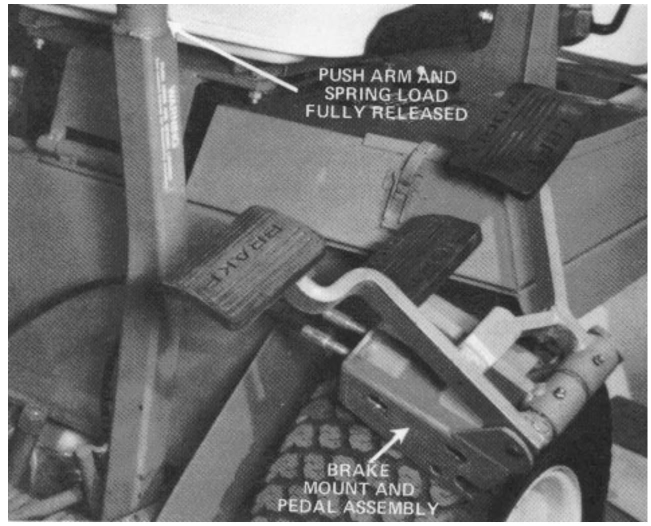


Figure 21

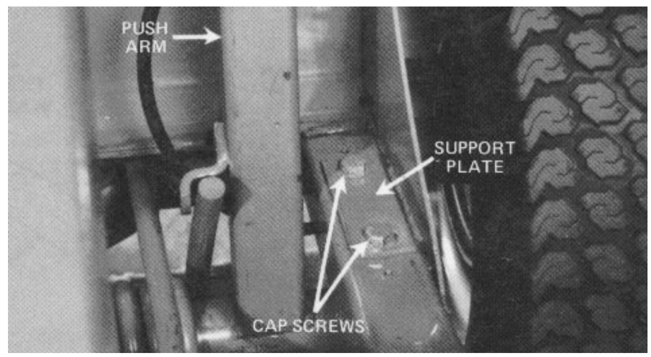


Figure 22

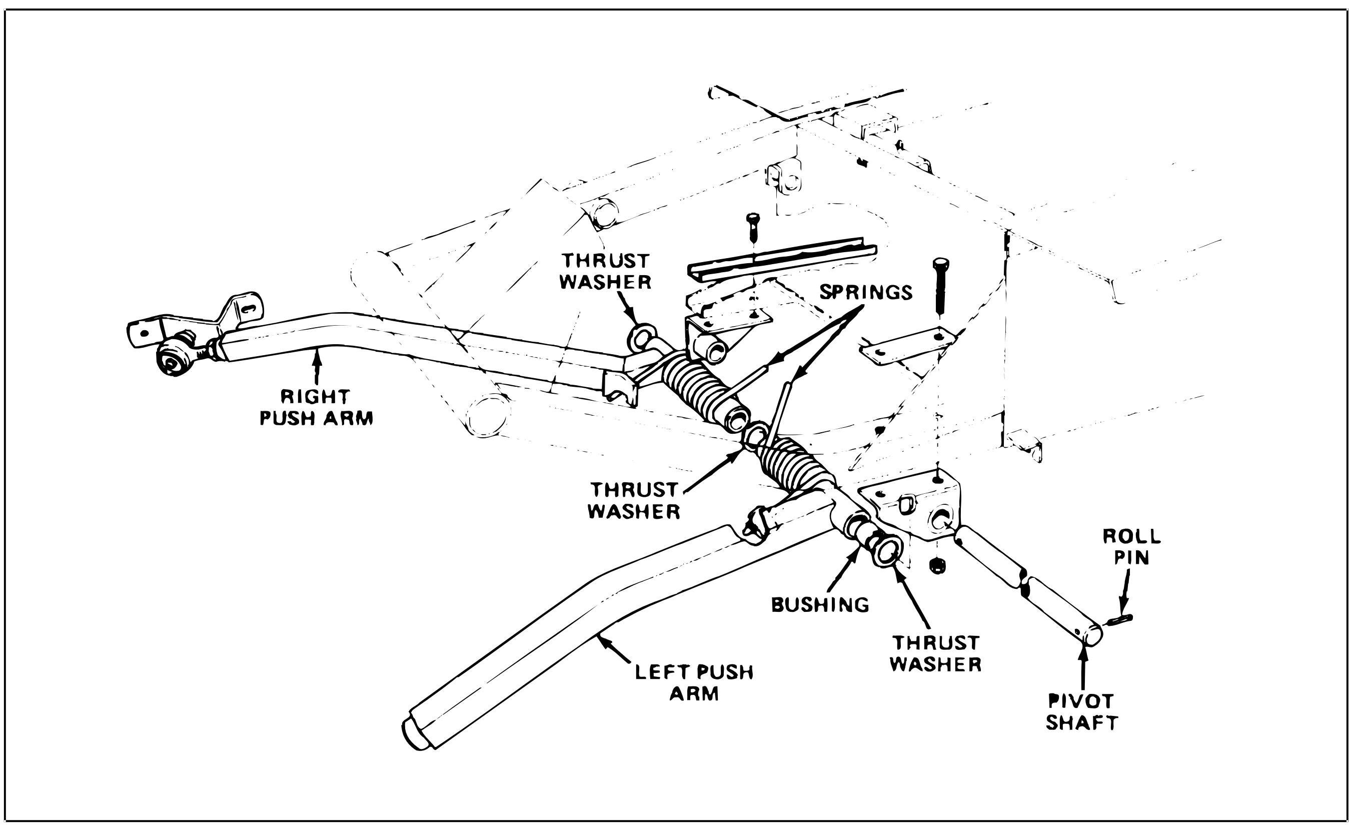


Figure 23

Installing Push Arms, Torsion Springs and Bushings

1. Apply grease to inside and outside of new bushings. Using a hammer and flat plate, carefully drive the bushings into the push arm pivot tubes. The bushings must be flush with the end of the tube.

2. Inspect the torsion springs. If the springs are damaged, use new springs when assembling the parts.

3. Slide the torsion springs onto the inside of the push arm pivot tubes. Install the washers, push arms with springs and push arm brackets onto the pivot shaft. Install the roll pins to secure the parts in place.

4. Raise the push arm and pivot shaft assembly into position and secure it in place with cap screws, support plate, reinforcement support and locknuts. Make sure the springs contact the retainer plate on the push arms and the underside of the frame.

5. Have a helper push down on the left push arm while you place a 3 ft. long block of wood between the chassis and to top of the push arms, across the full width of the machine.

NOTE: After the wood block is installed, there should be enough clearance for installing the ball joint into the front of the push arm.

6. Thread jam nut fully onto the left-hand ball joint. Screw the ball joint into the left-hand push arm until the center of the ball joint is 2.25 inches away from the front of the push arm. Do not tighten the jam nut until the deck is mounted.

7. Install the brake mount and pedal assembly with cap screws, locknuts, carriage bolts, lock washer and nuts. Route the right-hand brake cable through the hole in the right-hand push arm bracket. Connect the cable to the brake strut with the clevis pin and the tension spring. Hook the opposite end of the tension spring into the hole in the side of the chassis. Also install the cable into the mount on the frame.

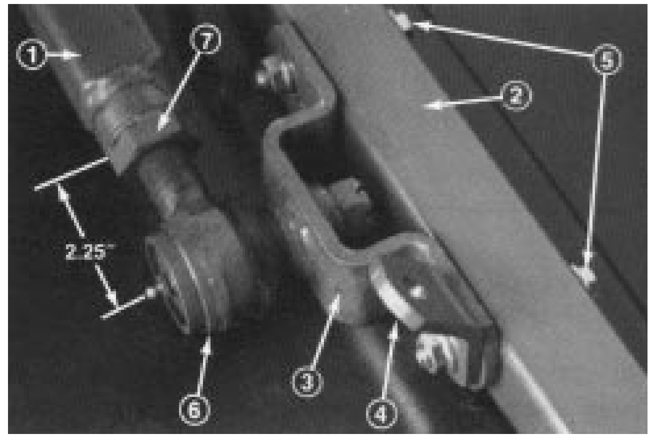


Figure 24

1. L.H. push arm
2. Caster arm
3. Ball joint mount
4. Chain mount
5. Capscrews and washers
6. Ball joint
7. Jam nut

Gearbox Removal and Installation (Fig. 25, 26)

Removing Gearbox and Drive Pulley

1. Lower cutting unit to shop floor, stop the engine and engage the parking brake. Remove belt covers from top of cutting unit.

2. Remove shroud (Item 9) covering universal drive shaft. Disconnect drive shaft from gearbox.

DANGER

Do not start the engine and engage the P.T.O. when the P.T.O. shaft is not connected to the gearbox. If engine is started and the P.T.O. shaft is allowed to rotate, serious injury could result.

3. Disconnect spring from idler arm bracket to release belt tension. Remove cotter pin and clevis pin securing idler arm bracket to idler arm.

4. Remove capscrews and nuts securing gear box plate (Item 10) to deck channels.

5. Remove the set screws (Item 19) from the taper lock bushing (Item 18). Install one setscrew into the hole that is threaded on the side of taper lock. Tighten the setscrew until the taper lock is loose from the inside of the pulley hub.

NOTE: Only one setscrew is used to loosen the taper lock.

6. Slide the gearbox pulley (Item 17) and taper lock off of the gearbox output shaft. Account for the woodruff key that positions the pulley on the shaft, and remove the setscrew from the side of the taper lock.

7. Disassemble fasteners securing gear box to gear box mount plate and remove gearbox. Remove brackets (Items 6, 13) from gear box.

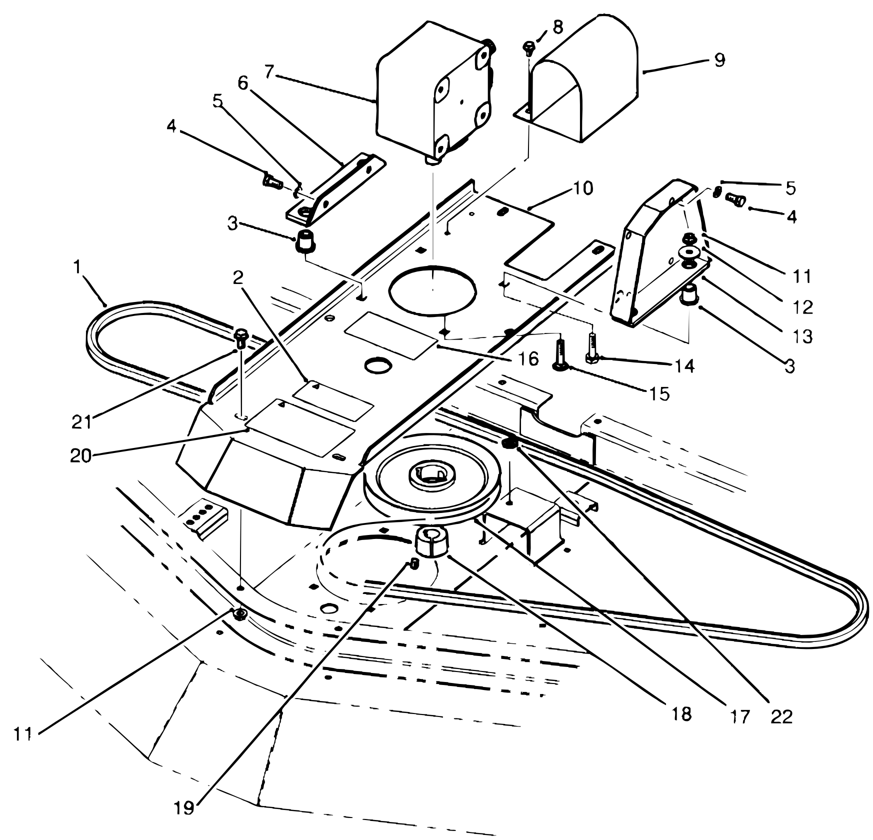


Figure 25

Installing Gearbox and Drive Pulley

1. Install isolation mounts (Item 3) into brackets (Item 7, 13). Use water or lubricant to ease installation. Install mounts from bottom of bracket.

2. Install bracket on each side of gearbox with capscrews and lockwashers. Tighten capscrews to a torque of 20 - 26 ft-lb.

3. Install gearbox with brackets to gear box mount plate (Item 10).

4. To install pulley (Item 17), slide taper lock (Item 18), small end first, into pulley hub.

5. Insert woodruff key into keyway in gearbox shaft. Slide pulley with taper lock onto gearbox shaft while aligning key and keyway.

NOTE: Large hub on pulley must face away from gearbox, and like the taper lock, the pulley must contact shoulder on the gearbox shaft.

6. Rotate pulley to get non-threaded holes in taper lock to line up with the two threaded holes in hub of gearbox pulley. Start threading set screws (Item 19) into the two holes and tighten them alternately and evenly until both set screws are tight.

7. Using a brass drift pin or sleeve and a hammer, hit taper lock firmly. Now tighten set screws to 55 in-lb. Continue to hit taper lock and tighten set screws until 55 in-lb of torque will not turn the set screws.

8. Check alignment of gearbox with a spindle pulley. Loosen and relocate taper lock to adjust, if necessary.

9. Fill recessed socket head in each setscrew, and other taper lock holes, with grease to prevent dirt from packing into holes.

10. Install gear box plate on deck channels while routing belt around gear box pulley. Mount gear box plate to deck channels with capscrews and nuts.

11. Install idler arm bracket to idler arm with cotter pin and clevis pin. Hook spring onto idler arm bracket. To make sure there is proper belt tension on drive belt, spring should be extended to a length of approximately 7.00 inches. If spring is not extended to this length, move spring rod to other mounting holes further away from belt.

12. Install belt covers. Install drive shaft to gear box and secure with a new roll pin.

13. Remove gear box fill plug and check plug. Add SAE 80W90 API GL-5 gear lube until level is to bottom of check plug hole. Install plugs in gear box.

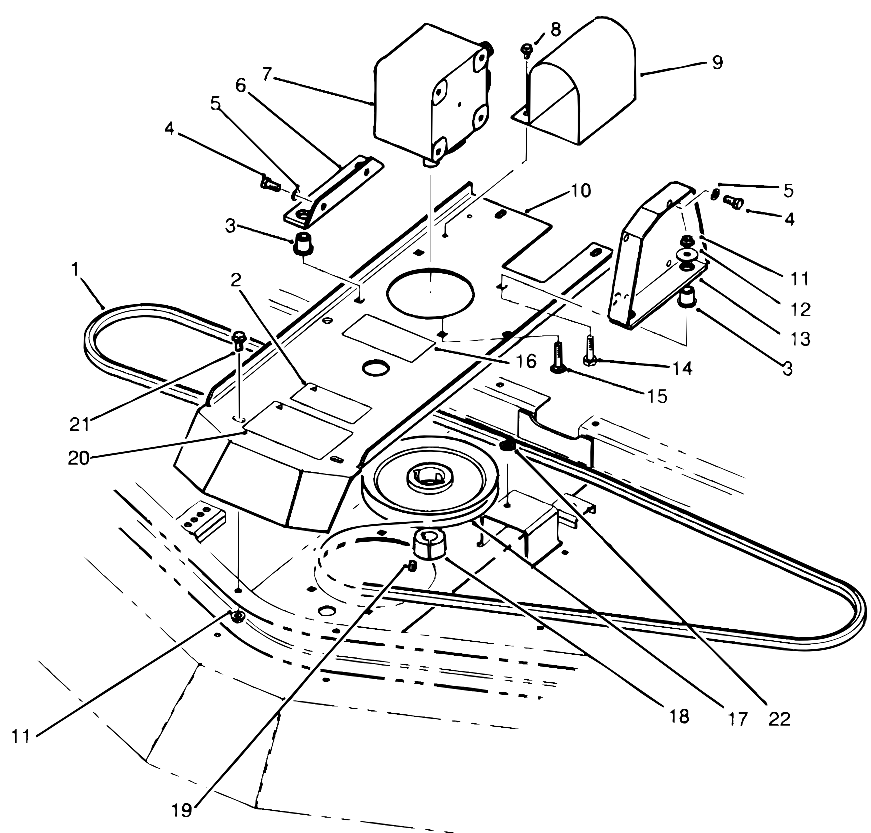


Figure 26

Gear Box Repair (Fig. 27, 28)

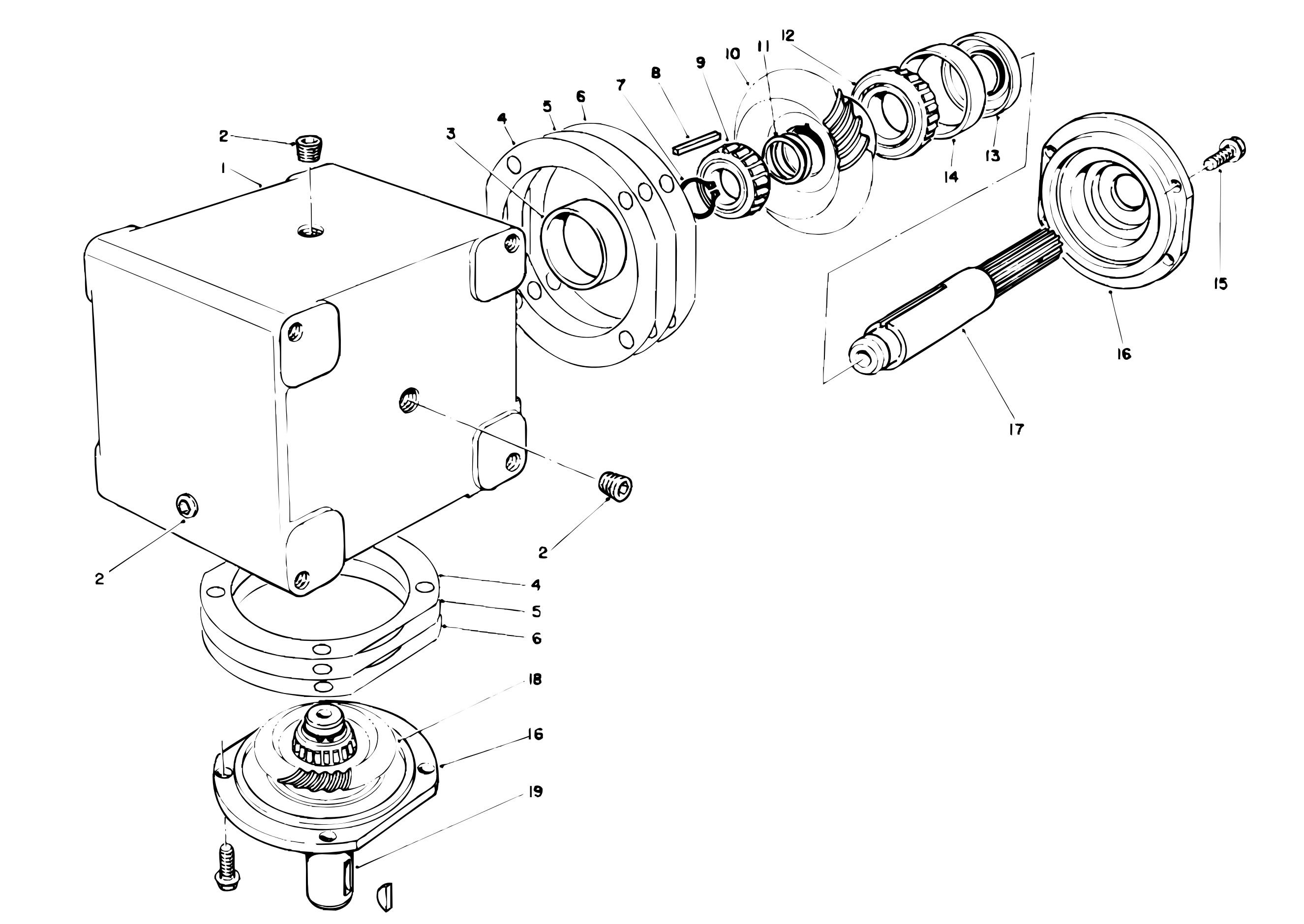


Figure 27

Gear Box Disassembly

1. Drain lubricant from gear box.

2. Remove capscrews and lift out shaft and cap assemblies.

3. Remove cap assemblies and bearing cones (Item 12) from shafts (Item 17, 19).

NOTE: Mark each gear (Item 10 and 18) so they are installed on the proper shaft (Item 17 or 19) when re-assembled.

4. Remove retaining rings (Item 7).

5. Press shafts (Item 17, 19) back through bearing cones (Item 9). When bearing cone is free, gears (Item 10, 18), keys (Item 8) and shims (Item 11) may be removed from the shaft.

6. Remove bearing cups (Item 14) from cap by putting a punch through the shaft bore and through the seal and then tapping against the back of the bearing cup until driven out of the cap.

7. If the oil seal (Item 13) is removed, it will be destroyed. To remove the oil seal, cut it out of the bore with a screw driver or chisel.

8. To remove the bearing cups (Item 3) from the housing a slide hammer puller may be used, or if this is not available, the bearing cups may be knocked out with a punch by coming down through the opposite cap bore and tapping against the back side of the bearing cup until it comes out.

9. Remove the plugs (Item 2) from the housing.

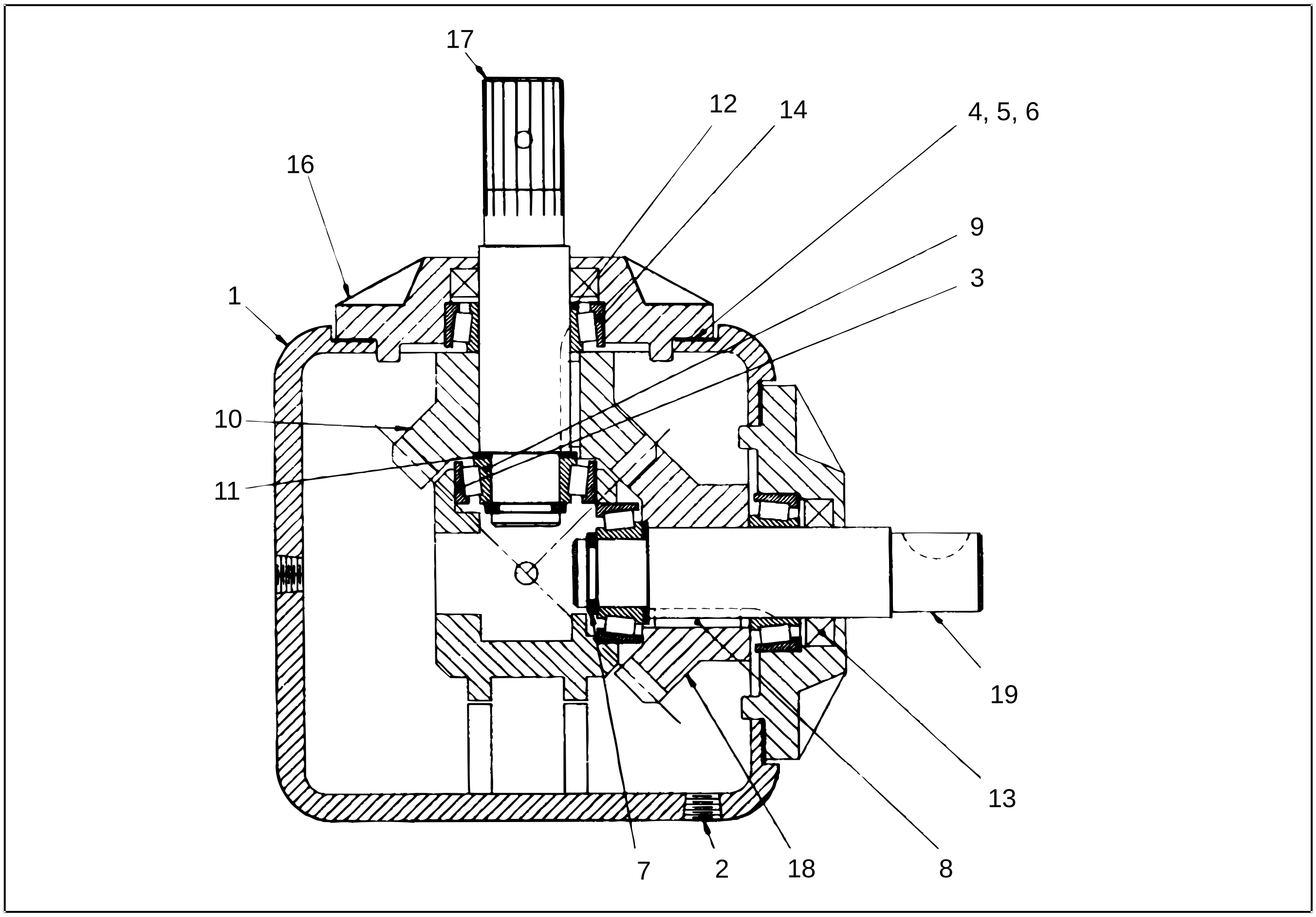


Figure 28

Gear Box Pre-Assembly

1. Start with one of the shafts (Item 17) and put one of the gears (Item 10) over the shaft so the tooth side is towards the turned end of the shaft. Align the keyway in the gear with the keyway in the shaft and install one of the keys (Item 8) in the keyway.

2. Install one set of shims (Item 11) onto the turned end of the shaft. Press one of the bearing cones (Item 9) over the turned end of the shaft. Be sure the bearing cone is installed as shown in the illustration (Fig. 42B). Install a retaining ring (Item 7) on the turned end of the shaft.

3. Put one of the bearing cones (Item 12) over the other end of the shaft and down against the hub side of the gear. Be sure the bearing cone is installed as shown in the illustration.

4. Repeat steps 1 - 3 with the other set of parts to complete the assembly.

5. Put one of the caps (Item 16) down, with the machined surface facing up. Install a new seal (Item 13) into the cap with the open side toward the machined side of the cap.

6. Install the bearing cup (Item 14) into the cap. Make sure the bearing cup is installed as shown in the illustration.

7. Repeat steps 5 - 6 with the other set of parts to complete the two cap assemblies.

8. Take one of the shaft and gear assemblies and wrap the end of the shaft with a piece of shim stock to keep from cutting the oil seal on the keyway or splines. Put the cap assembly down over the shaft so the bearing cone (Item 12) on the shaft mates with the bearing cone (Item 14) in the cap. Remove the shim stock from the shaft that was used to protect the seal.

9. Press the bearing cups (Item 3) into both bearing bores in the housing (Item 1). Make sure the cups are installed as shown in the illustration. Install the plugs (Item 2) into the tapped holes in the housing.

Gear Box Final Assembly

1. Bearing drag is adjusted by the amount of gaskets (Item 4, 5, 6) used between the cap and housing machined surfaces.

2. Put two 0.015 in. gaskets on the machined surface of the housing, then install the shaft and cap assembly in the housing so the bearing cone (Item 9) on the shaft assembly and bearing cup (Item 3) in the housing are mating. Align the holes in the cap with the holes in the gaskets and housing.

3. Install capscrews and tighten.

4. The shaft should have a very slight amount of bearing drag. If the shaft turns hard, the cap must be removed and gasket(s) need to be added. If the shaft has no bearing drag, or has end play, the cap must be removed and gasket(s) taken out. The cap must be adjusted to where the shaft has no end play and only a slight amount of bearing drag.

5. Repeat steps 1 - 4 with the other shaft and cap assembly.

6. After installing the gear box on the cutting unit, fill it with SAE 80W90 API GL-5 lubricant to the level of the check plug (see Maintenance section in this chapter).

Blade Spindle Service (Fig. 29, 30, 31)

Removing Spindle Housing Assembly

1. Lower the cutting unit, shut the engine off and engage the parking brake.

2. Remove deck covers from top of cutting unit. Release belt tension. Remove belt from spindle to be serviced.

3. Start the engine and raise the cutting unit. Turn the engine OFF and remove the key from the key switch. Block up the cutting unit so it cannot fall accidentally.

4. Using a rag or thickly padded glove, grasp end of blade. Remove blade screw, flat washer, anti-scalp cup and blade from spindle assembly.

5. Remove flange nuts and carriage bolts securing spindle housing to deck. Slide spindle housing assembly out the bottom of the cutting unit.

Disassembly

1. Remove lock nut retaining the spindle pulley on spindle shaft. Slide pulley off of shaft.

2. Press the spindle shaft out of the spindle housing using an arbor press. The bearing spacer remains on the spindle shaft as the shaft is being removed.

3. Remove seals from spindle housing.

4. Allow the bearings and small thick spacer to fall out of the spindle housing.

5. Using a punch and hammer, drive both of the bearing cups out of the spindle housing. Also drive the large spacer out of the housing.

6. A large snap ring is still inside the spindle housing and it should remain there because it cannot be easily removed.

IMPORTANT: If new bearings will be installed into a used spindle housing that has the original snap ring installed, discard the large snap ring that came with the bearings because it is not needed. However, new bearings with their matched spacer and snap ring must always be installed when the spindle housing is being replaced. Replacement bearings are sold only with a matched snap ring and spacer set. These parts cannot be purchased separately.

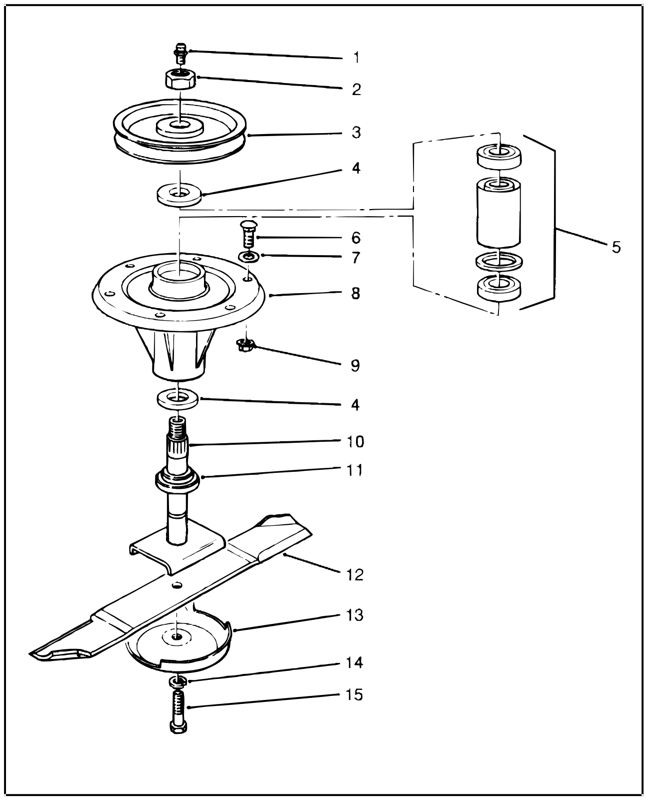


Figure 29

1. **Grease fitting**
2. **Lock nut**
3. **Spindle pulley**
4. **Wave seal**
5. **Bearing assembly**
6. **Carriage bolt**
7. **Flat washer**
8. **Spindle housing**
9. **Flange nut**
10. **Spindle shaft**
11. **Spindle shaft spacer**
12. **Blade**
13. **Anti-scalp cup**
14. **Lock washer**
15. **Blade screw**

Installing Spindle, Bearings and Seals Into Spindle Housing

IMPORTANT: If a new spindle housing is being used, new bearings and matched snap ring set must be installed; see step 1 below. Never use old bearings, spacer, and snap ring with a new spindle housing. If installing bearings into a used spindle housing that still has a snap ring installed, use only new bearings with cups and spacer – not the large snap ring because it is not required; see step 2 below.

1. Install large snap ring into groove in bore of spindle housing. Make sure snap ring is seated in groove.

2. Using an arbor press, push large spacer into top of spindle housing; tightly against snap ring. The spacer must contact the snap ring to be sure of the correct assembly of the parts.

3. Thoroughly oil the bearing cups and using an arbor press, push the bearing cups, smallest inside diameter first, into the top and bottom of the spindle housing. The top bearing cup must contact the spacer that was installed in step 2, and the bottom bearing cup must contact the snap ring to be sure of the correct assembly of parts. Insure that the assembly is correct by supporting the first cup and pressing the second against it.

4. Apply a film of grease on lips of both seals, then install bearing and seal into bottom of spindle housing. Remember, the BOTTOM SEAL MUST HAVE THE LIP FACING OUTWARD, not toward the inside of the spindle housing.

5. Check the spindle shaft to make sure it is free of burrs and nicks that could possibly cut the seals and thoroughly lubricate both the shaft and seal lips.

6. Slide small, thick spacer into spindle housing, then install bearing and seal into top of spindle housing. LIP OF UPPER SEAL MUST FACE INWARD.

7. Slide bearing spacer onto spindle shaft. Carefully slide spindle shaft through spindle housing. The bottom seal and bearing spacer fit together when the spindle is installed.

8. Push pulley onto splines of spindle shaft and retain the parts together with the large flat washer and nut. Tighten the nut to 100 - 120 ft-lb and rotate the spindle shaft to be sure that the shaft rotates freely.

9. Slide pulley end of spindle assembly through hole in cutting unit. Mount the spindle assembly in place with the carriage bolts and flange nuts.

10. Install the belt and adjust belt tension.

11. Reinstall the belt covers.

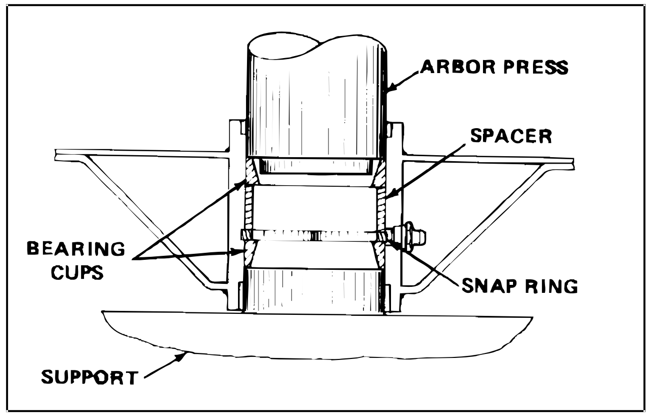


Figure 30

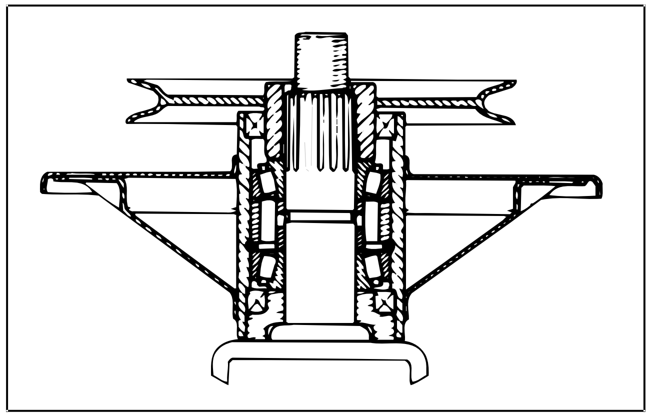


Figure 31

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