PART NO. 95871SL Rev. D

TORO®

Service Manual

Reelmaster® 6500–D/6700–D

(With Peugeot Engine)

Preface

The purpose of this publication is to provide the service technician with information for troubleshooting, testing, and repair of major systems and components on the Reelmaster 6500–D and 6700–D.

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

The Toro Company
8111 Lyndale Avenue South
Minneapolis, MN 55420

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

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

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

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

Table Of Contents

Table of Contents

Safety Instructions

The REELMASTER 6500-D and 6700–D was tested and certified by TORO for compliance with the B71.4-1990 specifications of the American National Standards Institute when ballast is added. See Operator's Manual for ballast requirements. Although hazard control and accident prevention partially are dependent upon the design and configuration of the machine, these factors are also dependent upon the awareness, concern, and proper training of the personnel involved in the operation, transport, maintenance, and storage of the machine. Improper use or maintenance of the machine can result in injury or death. To reduce the potential for injury or death, comply with the following safety instructions.

CAUTION

TO REDUCE THE POTENTIAL FOR INJURY OR DEATH, COMPLY WITH THE FOLLOWING SAFETY INSTRUCTIONS.

Before Operating

1. Read and understand the contents of this manual before starting and operating the machine. Become familiar with the controls and know how to stop the machine and engine quickly. A free replacement manual is available by sending the complete model and serial number to:

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

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

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

2. Never allow children to operate the machine. Do not allow adults to operate machine without proper instruction. Only trained operators who have read this manual should operate this machine.

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

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

5. Always wear substantial shoes. Do not operate machine while wearing sandals, tennis shoes, sneakers or when barefoot. Do not wear loose fitting clothing that could get caught in moving parts and possibly cause personal injury. Wearing safety glasses, safety shoes, long pants and a helmet is advisable and required by some local ordinances and insurance regulations.

6. Assure interlock switches are adjusted correctly so engine cannot be started unless traction pedal is in NEUTRAL and cutting units are DISENGAGED.

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

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

A. Use an approved fuel container.

B. Do not remove fuel tank cap while engine is hot or running.

C. Do not smoke while handling fuel.

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

E. Wipe up any spilled fuel.

While Operating

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

10. Before starting the engine:

A. Engage the parking brake.

B. Make sure traction pedal is in NEUTRAL, throttle is in SLOW and the ENABLE / DISABLE switch is in DISABLE.

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; therefore, shut engine off and adjust until machine does not move when traction pedal is released.

11. Seating capacity is one person. Therefore, never carry passengers.

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

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

14. Using the machine demands attention and to prevent loss of control:

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

B. Drive slowly

C. Watch for holes or other hidden hazards.

D. Look behind machine before backing up.

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

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

G. Avoid sudden stops and starts.

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

16. 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. On 4 wheel drive model, always use the seat belt and ROPS together.

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

18. **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.

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

20. If cutting unit strikes a solid object or vibrates abnormally, stop cutting units immediately, turn engine off, set parking brake and wait for all motion to stop. Inspect for damage. If reel or bedknife is damaged, repair or replace it before operating. Do not attempt to free blocked cutting unit by reversing reel direction. Damage to reel may result.

21. Before getting off the seat:

A. Move traction pedal to neutral.

B. Set parking brake.

C. Disengage cutting units and wait for reels to stop.

D. Stop engine and remove key from switch.

E. Do not park on slopes unless wheels are chocked or blocked.

Maintenance and Service

22. Before servicing or making adjustments, stop engine and remove key from the switch.

23. When changing attachments, tires or performing other service, use the correct blocks, hoists and jacks. Always chock or block the wheels and 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, resulting in personal injury.

24. Make sure machine is in safe operating condition by keeping all nuts, bolts and screws tight.

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

26. Keep body and hands away from pin hole leaks in hydraulic lines that eject high pressure hydraulic fluid. Use cardboard or paper to find hydraulic leaks. Hydraulic fluid escaping under pressure can penetrate skin and cause injury. Fluid accidentally injected into the skin must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.

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

28. If major repairs are ever needed or assistance is desired, contact an Authorized Toro Distributor.

29. To reduce potential fire hazard, keep engine area free of excessive grease, grass, leaves and dirt. Clean protective screen on front of engine frequently.

30. If engine must be running to perform maintenance or an adjustment, keep hands, feet, clothing and other parts of the body away from cutting units and other moving parts. Keep everyone away.

31. Do not overspeed the engine by changing governor setting. To assure safety and accuracy, have an Authorized Toro Distributor check maximum engine speed.

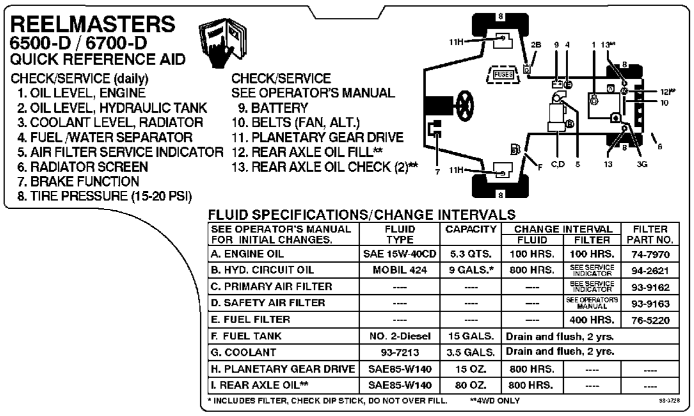
32. Shut engine off before checking or adding oil to the crankcase.

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

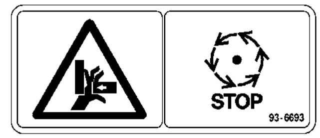
34. At the time of manufacture, the machine conformed to the safety standards for riding mowers. To assure optimum performance and continued safety certification of the machine, use genuine Toro replacement parts and accessories. Replacement parts and accessories made by other manufacturers may result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

Safety and Instruction Decals

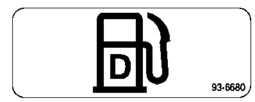
The following safety and instruction decals are affixed to the traction unit. If any decal becomes illegible or damaged, install a new decal. Part numbers are listed below and in your Parts Catalog.



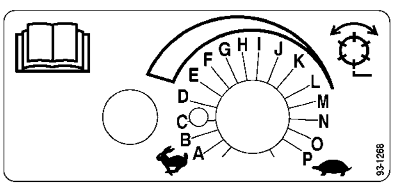
IN TOOL BOX
(Part No. 93–3728)
Quick Reference Aid



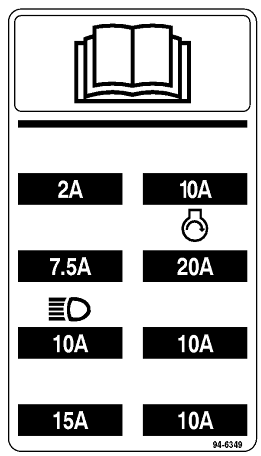
UNDER FLOOR PLATE
(Part No. 93–6693)
WARNING: Moving Parts under floor plate



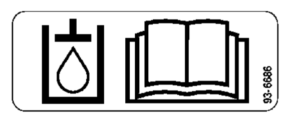
ON LEFT FENDER
(Part No. 93–6680)
Diesel Fuel Only



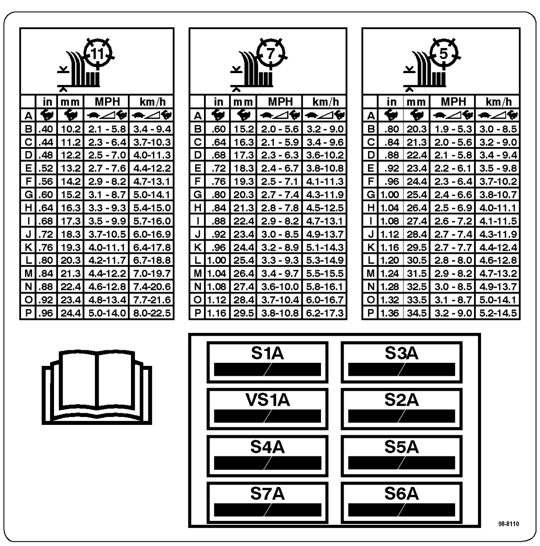
INSIDE CONTROL BOX
(Part No. 93–1268)
Operating Instructions
H.O.C. Selector



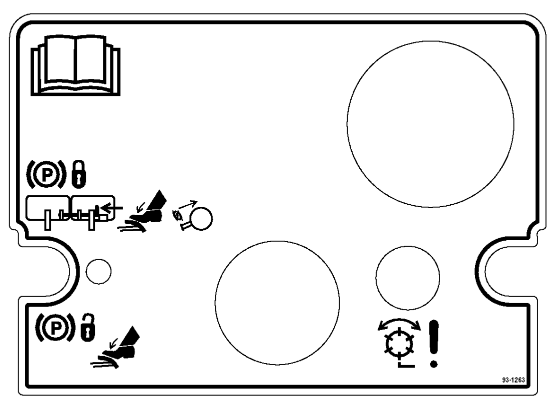
INSIDE CONTROL BOX
(Part No. 94–6349)
Fuse Locations



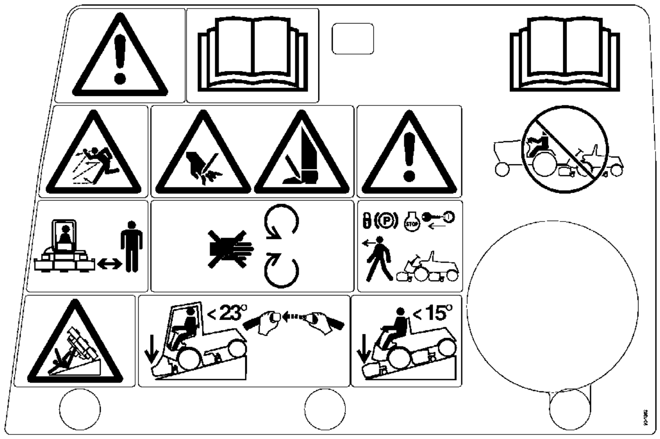
ON RIGHT FENDER
(Part No. 93–6686)
Hydraulic Oil Only



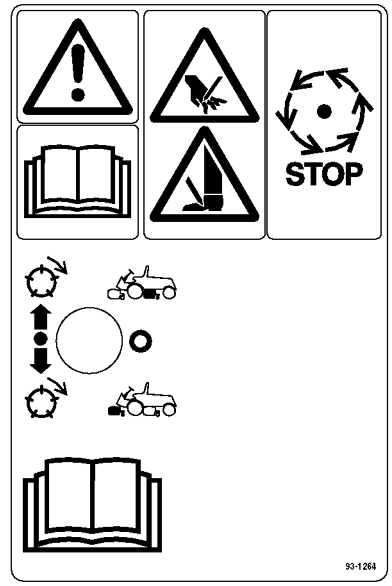
UNDER SEAT PLATE
(Part No. 98–8110)
Selecting Clip Rate & Solenoid Wire Identification



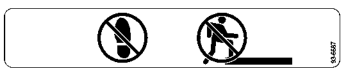
ON TOP OF STEERING TOWER
(Part No. 93–1263)
Brake Operation & reel Control Lamp



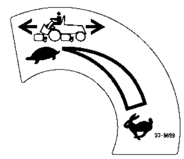
ON TOOL BOX
(Part No. 93–1262)
WARNING: Read Operating &
Safety Instructions



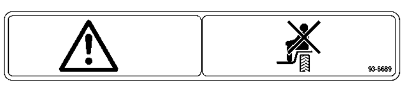
ON BACKLAP BRACKET
(Part No. 93–1264)
WARNING: Read Backlap, Operating
& Safety Instructions



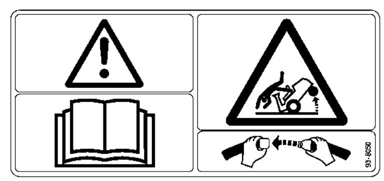
ON LIFT ARMS
(Part No. 93–6687)
Do Not Step



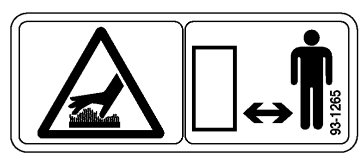
ON TOWER
(Part No. 93–6699)
Mowing Speed Control



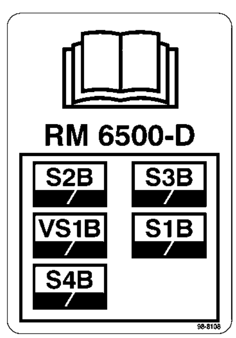
ON CONSOLES
(Part No. 93–6689)
WARNING: No Riders



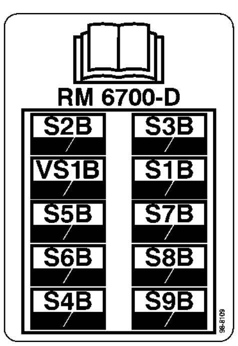
ON ROLL BAR ROOF
(Part No. 93–8050)
(Model 03804 only)
WARNING: Fasten Seat Belt



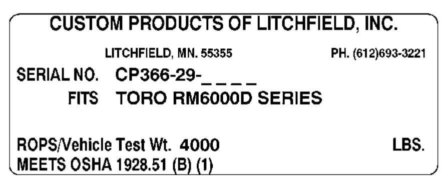
ON FRAME UNDER
MUFFLER
(Part No. 93–1265)
WARNING: Hot Surface
Do Not Touch!



ON UNDERSIDE OF SEAT PLATE
(Part No. 98–8108)
Solenoid Wire Identification



ON UNDERSIDE OF SEAT PLATE
(Part No. 98–8109)
Solenoid Wire Identification



ON ROLL BAR
(Part No. 92–7540)
(Model 03804 only)
ROPS Serial Tag

Chapter 2

Product Records and Manuals

Product Records and Manuals

Table of Contents

Product Records

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

Insert Operator's Manuals and Parts Catalogs for your machine at the end of this section.

Equivalents and Conversions

Decimal and Millimeter Equivalents

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

U.S to Metric Conversions

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

Torque Specifications

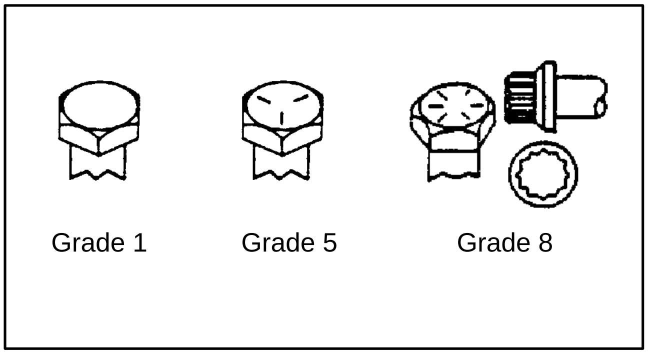
Recommended fastener torque values are listed in the following tables. For critical applications, as determined by Toro, either the recommended torque or a torque that is unique to the application is clearly identified and specified in this Service Manual.

These Torque Specifications for the installation and tightening of fasteners shall apply to all fasteners which do not have a specific requirement identified in this Service Manual. The following factors shall be considered when applying torque: cleanliness of the fastener, use of a thread sealant (Loctite), degree of lubrication on the fastener, presence of a prevailing torque feature, hardness of the surface underneath the fastener's head, or similar condition which affects the installation.

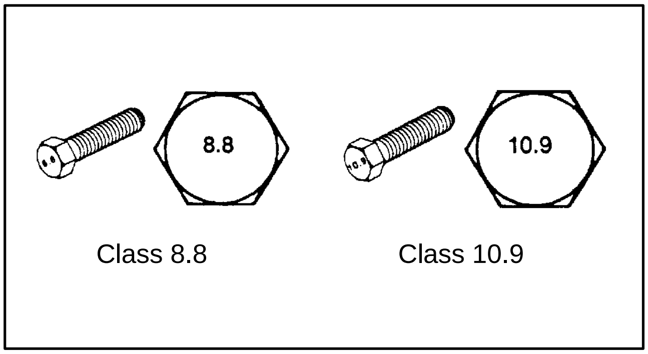
As noted in the following tables, torque values should be **reduced by 25% for lubricated fasteners** to achieve the similar stress as a dry fastener. Torque values may also have to be reduced when the fastener is threaded into aluminum or brass. The specific torque value should be determined based on the aluminum or brass material strength, fastener size, length of thread engagement, etc.

The standard method of verifying torque shall be performed by marking a line on the fastener (head or nut) and mating part, then back off fastener 1/4 of a turn. Measure the torque required to tighten the fastener until the lines match up.

Fastener Identification



Inch Series Bolts and Screws



Metric Bolts and Screws

Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Inch Series)

Thread Size	Grade 1, 5, & 8 with Thin Height Nuts	SAE Grade 1 Bolts, Screws, Studs, & Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)		SAE Grade 5 Bolts, Screws, Studs, & Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)		SAE Grade 8 Bolts, Screws, Studs, & Sems with Regular Height Nuts (SAE J995 Grade 5 or Stronger Nuts)	
	in–lb	**in–lb**	**N–cm**	**in–lb**	**N–cm**	**in–lb**	**N–cm**
# 6 – 32 UNC	10 ± 2	13 ± 2	147 ± 23	15 ± 2	170 ± 20	23 ± 2	260 ± 20
# 6 – 40 UNF				17 ± 2	190 ± 20	25 ± 2	280 ± 20
# 8 – 32 UNC	13 ± 2	25 ± 5	282 ± 30	29 ± 3	330 ± 30	41 ± 4	460 ± 45
# 8 – 36 UNF				31 ± 3	350 ± 30	43 ± 4	485 ± 45
# 10 – 24 UNC	18 ± 2	30 ± 5	339 ± 56	42 ± 4	475 ± 45	60 ± 6	675 ± 70
# 10 – 32 UNF				48 ± 4	540 ± 45	68 ± 6	765 ± 70
1/4 – 20 UNC	48 ± 7	53 ± 7	599 ± 79	100 ± 10	1125 ± 100	140 ± 15	1580 ± 170
1/4 – 28 UNF	53 ± 7	65 ± 10	734 ± 113	115 ± 10	1300 ± 100	160 ± 15	1800 ± 170
5/16 – 18 UNC	115 ± 15	105 ± 17	1186 ± 169	200 ± 25	2250 ± 280	300 ± 30	3390 ± 340
5/16 – 24 UNF	138 ± 17	128 ± 17	1446 ± 192	225 ± 25	2540 ± 280	325 ± 30	3670 ± 340
	ft–lb	**ft–lb**	**N–m**	**ft–lb**	**N–m**	**ft–lb**	**N–m**
3/8 – 16 UNC	16 ± 2	16 ± 2	22 ± 3	30 ± 3	41 ± 4	43 ± 4	58 ± 5
3/8 – 24 UNF	17 ± 2	18 ± 2	24 ± 3	35 ± 3	47 ± 4	50 ± 4	68 ± 5
7/16 – 14 UNC	27 ± 3	27 ± 3	37 ± 4	50 ± 5	68 ± 7	70 ± 7	95 ± 9
7/16 – 20 UNF	29 ± 3	29 ± 3	39 ± 4	55 ± 5	75 ± 7	77 ± 7	104 ± 9
1/2 – 13 UNC	30 ± 3	48 ± 7	65 ± 9	75 ± 8	102 ± 11	105 ± 10	142 ± 14
1/2 – 20 UNF	32 ± 3	53 ± 7	72 ± 9	85 ± 8	115 ± 11	120 ± 10	163 ± 14
5/8 – 11 UNC	65 ± 10	88 ± 12	119 ± 16	150 ± 15	203 ± 20	210 ± 20	285 ± 27
5/8 – 18 UNF	75 ± 10	95 ± 15	129 ± 20	170 ± 15	230 ± 20	240 ± 20	325 ± 27
3/4 – 10 UNC	93 ± 12	140 ± 20	190 ± 27	265 ± 25	359 ± 34	375 ± 35	508 ± 47
3/4 – 16 UNF	115 ± 15	165 ± 25	224 ± 34	300 ± 25	407 ± 34	420 ± 35	569 ± 47
7/8 – 9 UNC	140 ± 20	225 ± 25	305 ± 34	430 ± 45	583 ± 61	600 ± 60	813 ± 81
7/8 – 14 UNF	155 ± 25	260 ± 30	353 ± 41	475 ± 45	644 ± 61	660 ± 60	895 ± 81

Note: Reduce torque values listed in the table above by 25% for lubricated fasteners. Lubricated fasteners are defined as threads coated with a lubricant such as oil, graphite, or thread sealant such as Loctite.

Note: Torque values may have to be reduced when installing fasteners into threaded aluminum or brass. The specific torque value should be determined based on the fastener size, the aluminum or base material strength, length of thread engagement, etc.

Note: The nominal torque values listed above for Grade 5 and 8 fasteners are based on 75% of the minimum proof load specified in SAE J429. The tolerance is approximately ± 10% of the nominal torque value. Thin height nuts include jam nuts.

Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Metric Fasteners)

Thread Size	Class 8.8 Bolts, Screws, and Studs with Regular Height Nuts (Class 8 or Stronger Nuts)		Class 10.9 Bolts, Screws, and Studs with Regular Height Nuts (Class 10 or Stronger Nuts)	
M5 X 0.8	57 ± 5 in–lb	640 ± 60 N–cm	78 ± 7 in–lb	885 ± 80 N–cm
M6 X 1.0	96 ± 9 in–lb	1018 ± 100 N–cm	133 ± 13 in–lb	1500 ± 150 N–cm
M8 X 1.25	19 ± 2 ft–lb	26 ± 3 N–m	27 ± 2 ft–lb	36 ± 3 N–m
M10 X 1.5	38 ± 4 ft–lb	52 ± 5 N–m	53 ± 5 ft–lb	72 ± 7 N–m
M12 X 1.75	66 ± 7 ft–lb	90 ± 10 N–m	92 ± 9 ft–lb	125 ± 12 N–m
M16 X 2.0	166 ± 15 ft–lb	225 ± 20 N–m	229 ± 22 ft–lb	310 ± 30 N–m
M20 X 2.5	325 ± 33 ft–lb	440 ± 45 N–m	450 ± 37 ft–lb	610 ± 50 N–m

Note: Reduce torque values listed in the table above by 25% for lubricated fasteners. Lubricated fasteners are defined as threads coated with a lubricant such as oil, graphite, or thread sealant such as Loctite.

Note: Torque values may have to be reduced when installing fasteners into threaded aluminum or brass. The specific torque value should be determined based on the fastener size, the aluminum or base material strength, length of thread engagement, etc.

Note: The nominal torque values listed above are based on 75% of the minimum proof load specified in SAE J1199. The tolerance is approximately ± 10% of the nominal torque value.

Other Torque Specifications

SAE Grade 8 Steel Set Screws

Thread Size	Recommended Torque	
	Square Head	**Hex Socket**
1/4 – 20 UNC	140 ± 20 in–lb	73 ± 12 in–lb
5/16 – 18 UNC	215 ± 35 in–lb	145 ± 20 in–lb
3/8 – 16 UNC	35 ± 10 ft–lb	18 ± 3 ft–lb
1/2 – 13 UNC	75 ± 15 ft–lb	50 ± 10 ft–lb

Wheel Bolts and Lug Nuts

Thread Size	Recommended Torque**	
7/16 – 20 UNF Grade 5	65 ± 10 ft–lb	88 ± 14 N–m
1/2 – 20 UNF Grade 5	80 ± 10 ft–lb	108 ± 14 N–m
M12 X 1.25 Class 8.8	80 ± 10 ft–lb	108 ± 14 N–m
M12 X 1.5 Class 8.8	80 ± 10 ft–lb	108 ± 14 N–m

** For steel wheels and non–lubricated fasteners.

Thread Cutting Screws (Zinc Plated Steel)

Type 1, Type 23, or Type F	
Thread Size	**Baseline Torque***
No. 6 – 32 UNC	20 ± 5 in–lb
No. 8 – 32 UNC	30 ± 5 in–lb
No. 10 – 24 UNC	38 ± 7 in–lb
1/4 – 20 UNC	85 ± 15 in–lb
5/16 – 18 UNC	110 ± 20 in–lb
3/8 – 16 UNC	200 ± 100 in–lb

Thread Cutting Screws (Zinc Plated Steel)

Thread Size	Threads per Inch		Baseline Torque*
	Type A	**Type B**	
No. 6	18	20	20 ± 5 in–lb
No. 8	15	18	30 ± 5 in–lb
No. 10	12	16	38 ± 7 in–lb
No. 12	11	14	85 ± 15 in–lb

* Hole size, material strength, material thickness & finish must be considered when determining specific torque values. All torque values are based on non–lubricated fasteners.

Conversion Factors

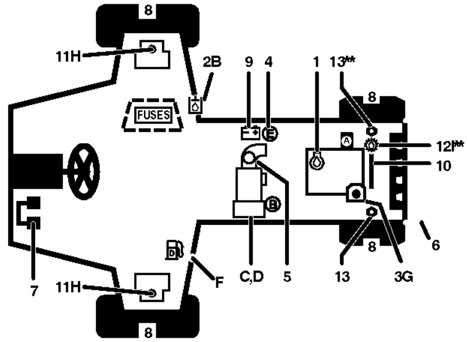
in–lb X 11.2985 = N–cm
ft–lb X 1.3558 = N–m

N–cm X 0.08851 = in–lb
N–m X 0.7376 = ft–lb

REELMASTERS 6500-D / 6700-D
QUICK REFERENCE AID

CHECK/SERVICE (daily)
1. OIL LEVEL, ENGINE
2. OIL LEVEL, HYDRAULIC TANK
3. COOLANT LEVEL, RADIATOR
4. FUEL /WATER SEPARATOR
5. AIR FILTER SERVICE INDICATOR
6. RADIATOR SCREEN
7. BRAKE FUNCTION
8. TIRE PRESSURE (15-20 PSI)

CHECK/SERVICE
SEE OPERATOR'S MANUAL
9. BATTERY
10. BELTS (FAN, ALT.)
11. PLANETARY GEAR DRIVE
12. REAR AXLE OIL FILL**
13. REAR AXLE OIL CHECK (2)**



FLUID SPECIFICATIONS/CHANGE INTERVALS

SEE OPERATOR'S MANUAL FOR INITIAL CHANGES.	FLUID TYPE	CAPACITY	CHANGE INTERVAL FLUID	CHANGE INTERVAL FILTER	FILTER PART NO.
A. ENGINE OIL	SAE 15W-40CD	5.3 QTS.	100 HRS.	100 HRS.	74-7970
B. HYD. CIRCUIT OIL	MOBIL 424	9 GALS.*	800 HRS.	SEE SERVICE INDICATOR	94-2621
C. PRIMARY AIR FILTER	----	----	----	SEE SERVICE INDICATOR	93-9162
D. SAFETY AIR FILTER	----	----	----	SEE OPERATOR'S MANUAL	93-9163
E. FUEL FILTER	----	----	----	400 HRS.	76-5220
F. FUEL TANK	NO. 2-Diesel	15 GALS.	Drain and flush, 2 yrs.		
G. COOLANT	93-7213	3.5 GALS.	Drain and flush, 2 yrs.		
H. PLANETARY GEAR DRIVE	SAE85-W140	15 OZ.	800 HRS.	----	----
I. REAR AXLE OIL**	SAE85-W140	80 OZ.	800 HRS.	----	----

* INCLUDES FILTER, CHECK DIP STICK, DO NOT OVER FILL. **4WD ONLY 98-3728

Lubricating Bearings and Bushings

CAUTION

Before servicing or making adjustments to the machine, stop engine and remove key from the switch.

The machine has grease fittings that must be lubricated regularly with No. 2 General Purpose Lithium Base Grease. If machine is operated under normal conditions, lubricate all bearings and bushings after every 50 hours of operation or immediately after every washing.

1. The grease fitting locations and quantities are: Cutting unit carrier frame and pivot (2 ea.) (Fig. 1); Rear axle tie rod (2), Steering cylinder ball joints (2), (Fig. 2); Front lift cylinders (3), (Fig. 4 and 8); Rear lift cylinder pivot (2), (Fig. 5); Lift arm pivot (3), (Fig. 6); Rear axle pivot (Fig. 7) Rear lift arm pivots (2) (Fig. 3) and Brake pedal shaft (1) (Fig. 9).

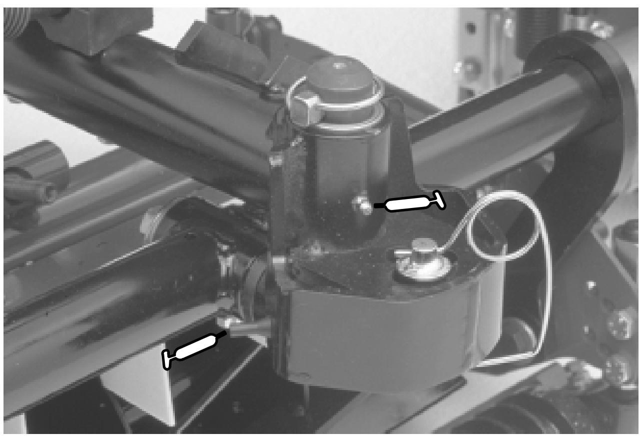


Figure 1

Figure 2

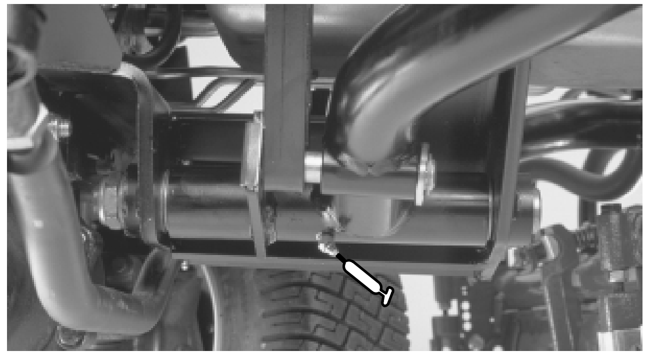


Figure 3

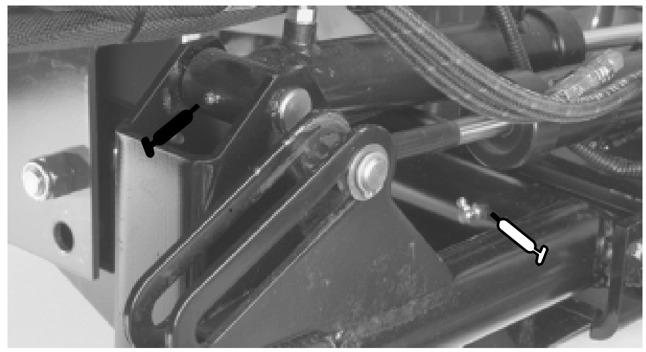


Figure 4

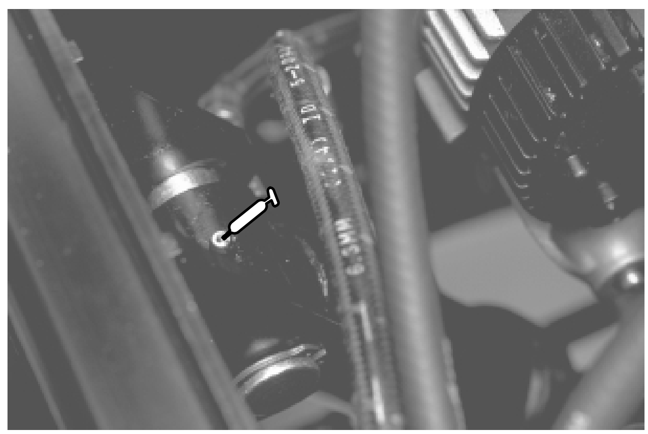


Figure 5

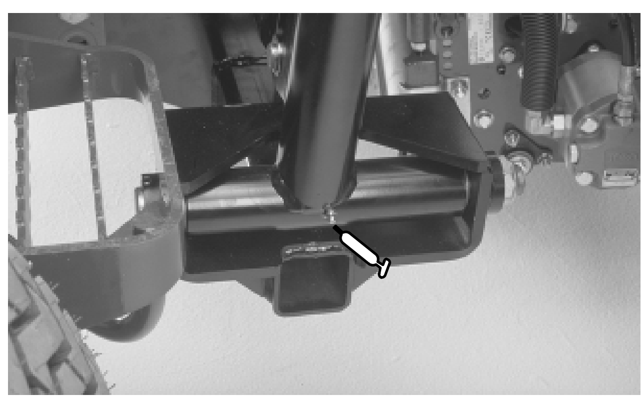


Figure 6

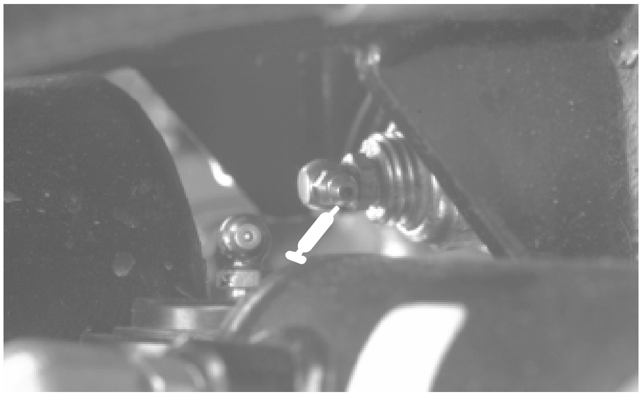


Figure 7

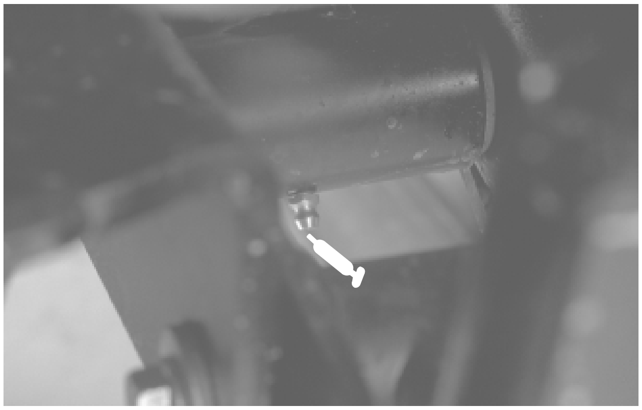


Figure 8

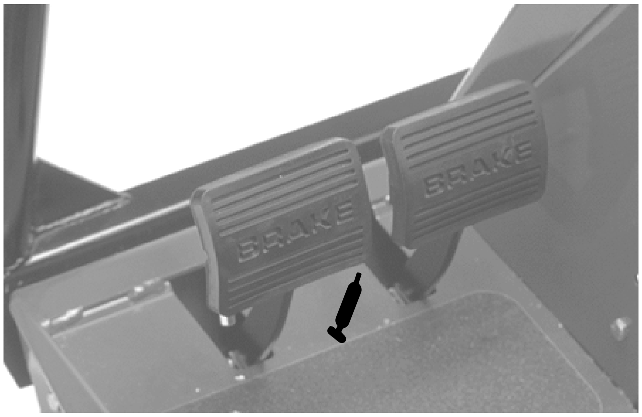


Figure 9

Product Records and Manuals

EQUIPMENT OPERATION AND SERVICE HISTORY REPORT
for
REELMASTER® 6500–D AND 6700–D

TORO Model and Serial Number: ______________–______________

Engine Numbers: ______________________________

Transmission Numbers: ______________________________

Drive Axle(s) Numbers: ______________________________

Date Purchased: ______________________________ Warranty Expires____________

Purchased From: ______________________________

____

____

Contacts: Parts ______________________________ Phone____________________

Service ______________________________ Phone____________________

Sales ______________________________ Phone____________________

REELMASTER 6500–D/6700–D Maintenance Schedule

Minimum Recommended Maintenance Intervals

	Maintenance Procedure	Maintenance Interval & Service
	Lubricate All Grease Fittings	Every 50hrs *A Level Service*
	Inspect Air Filter, Dust Cup, and Baffle	
	Check Battery Level/Cable Connections	
‡	Change Engine Oil and Filter	Every 100hrs *B Level Service*
	Inspect Cooling System Hoses	
†	Check Fan and Alternator Belt Tension	
†	Torque Wheel Lug Nuts	Every 200hrs *C Level Service*
●	Service Air Filter	Every 400hrs *D Level Service*
	Change Fuel Filter	
	Inspect Fuel Lines and Connections	
‡	Check Engine RPM (idle and full throttle)	
	Check Rear Axle Oil Level (4wd)	
	Check Front Planetary Gear Lube	
	Inspect Engine Timing Belt (see note below)	Every 800hrs *E Level Service*
	Drain and Clean Fuel Tank	
	Change Hydraulic Oil	
	Change Hydraulic Oil Filter	
■	Change Front Planetary Gear Lube	
	Pack 2WD Rear Axle Bearings	
	Change Rear Axle Oil Level (4wd)	
	Check Rear Wheel Toe–In	

† Initial break in at 10 hours
‡ Initial break in at 50 hours
■ Initial break in at 200 hours
● If indicator shows red

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

NOTE: Replace Timing Belt if worn, cracked or oil soaked. A new Timing Belt should be installed any time the Belt is removed or loosened.

REELMASTER 6500–D/6700–D Daily Maintenance Check List

Daily Maintenance: (duplicate this page for routine use)
Check proper section of Operator’s Manual for fluid specifications

Maintenance Check Item ⬇	Daily Maintenance Check For Week Of ________						
	MON	TUES	WED	THURS	FRI	SAT	SUN
✓ Safety Interlock Operation							
✓ Brake Operation							
✓ Engine Oil & Fuel Level							
✓ Cooling System Fluid Level							
Drain Water/Fuel Separator							
✓ Air Filter Restriction Indicator							
✓ Radiator & Screen for Debris							
✓ Unusual Engine Noises[1]							
✓ Unusual Operating Noises							
✓ Hydraulic System Oil Level							
✓ Hydraulic Filter Indicator[2]							
✓ Hydraulic Hoses for Damage							
✓ Fluid Leaks							
✓ Tire Pressure							
✓ Instrument Operation							
✓ Reel–to–Bedknife Adjustment							
✓ Height–of–Cut Adjustment							
Lubricate All Grease Fittings[3]							
Touch–up Damaged Paint							

[1]= Check glow plug and injector nozzles, if hard starting, excess smoke or rough running is noted.
[2]= Check with engine running and oil at operating temperature.
[3]= Immediately after every washing, regardless of the interval listed.

Notation for areas of concern: Inspection performed by________________

Item	Date	Information
1		
2		
3		
4		
5		
6		
7		
8		

REELMASTER® 6500-D, and 6700-D Supervisor Maintenance Work Order

Date: ______________

(duplicate this page for routine use)

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

Remarks:

A -Service (every 50 hours)
- ☐ Lubricate All Grease Fittings
- ☐ Inspect Air Filter, Dust Cup, and Baffle
- ☐ Check Battery Fluid Level
- ☐ Check Battery Cable Connections
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________

B -Service (every 100 hours)
- ☐ Change Engine Oil and Filter
- ☐ Inspect Cooling System Hoses
- ☐ Check Fan and Alternator Belt Tension
- ☐ **A-Service** required
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________

C -Service (every 200 hours)
- ☐ Torque Wheel Lug Nuts
- ☐ **A** and **B Service** required
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________

D -Service (every 400 hours)
- ☐ Service Air Filter
- ☐ Change Fuel Filter
- ☐ Inspect Fuel Lines and Connections
- ☐ Check Engine RPM (idle and full throttle)
- ☐ Check Rear Axle Oil Level (4wd)
- ☐ Check Front Planetary Gear Lube
- ☐ **A**, **B**, and **C Service** required
- ☐ ______________________
- ☐ ______________________

E -Service (every 800 hours)
- ☐ Inspect Engine Timing Belt
- ☐ Drain and Clean Fuel Tank
- ☐ Change Hydraulic Oil
- ☐ Change Hydraulic Oil Filter
- ☐ Change Front Planetary Gear Lube
- ☐ Pack 2WD Rear Axle Bearings
- ☐ Change Rear Axle Oil (4WD)
- ☐ Check Rear Wheel Toe-In
- ☐ **A**, **B**, **C**, and **D Service** required

Other - Annual Service and Specials
- ☐ Replace Moving Hoses
- ☐ Replace Safety Switches
- ☐ Coolant System - Flush/Replace Fluid
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________
- ☐ ______________________

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

Form No. 95-875-SL

Chapter 3

Engine

Table of Contents

Introduction

The following pages give information about specifications, maintenance, troubleshooting, testing and repair of the diesel engine used in the Reelmaster® 6500-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.

Service and repair parts for the Peugeot engine used in the Reelmaster 6500-D and 6700-D 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.

A plate, riveted to the left-hand side of the engine block carries the Engine Serial Number. Always include the engine serial number with parts orders and warranty claims.

Identification and Specifications

General Specifications

Item	Specification
Engine Type	Peugeot XUD9AI, 4 cycle, water cooled, 4 cylinder, vertical in-line cylinders, single overhead cam, indirect injection, naturally aspirated.
Compression ratio	23.5 : 1
Governor:	Mechanical centrifugal type integral with fuel injection pump.
Governor Adjustment	Reelmaster 6500-D: 2500 ± 50 RPM no load Reelmaster 6700-D: 2750 +100/–0 RPM no load 1600 +100/–0 RPM idle speed
Engine Rotation	Counterclockwise when facing flywheel.
Crankshaft	Forged steel, induction hardened bearing surfaces, 5 main bearing supports.
Cylinder Block	Cast iron with integral cylinder liners.
Cylinder Head	Cast aluminum material with single overhead camshaft.
Timing Drive	The camshaft, water pump and fuel injection pump are driven from the front end of the crankshaft through belt drive.
Piston and Piston Rings	Pistons are aluminum alloy castings with free-floating wrist pin.
Lubrication	Full pressure feed by gear type pump.
Oil Filter	Full flow, cartridge type, paper element with bypass.
Oil Capacity	5 liters (5.3 qt.), including oil filter.
Lubricating Oil	API class CD SAE 15W-40
Oil Pressure	0.5 Bar (7 PSI) minimum
Fuel Requirements	No. 2 diesel fuel (ASTM No. 2-D).
Fuel Filter	Replaceable paper element.
Crankcase Ventilation	Connected to intake manifold with PCV valve.
Cooling System	Water is circulated through the cylinder block and head by a centrifugal water pump mounted at the front of the cylinder block. The water pump operates at 1.05 times engine speed. Water flow is 92 liters/min. at 2500 engine RPM.
Firing Order (NO. 1 CYL. IS ON FLYWHEEL END)	1 - 3 - 4 - 2
Electrical System	12 volt, negative ground, 55 AMP alternator with integral regulator. 12 volt - 1.4 Kw starter motor with integral solenoid, pinion shaft type.

Cylinder Head

Cylinder head height **h** is measured with the camshaft in place fitted with two bearing caps.

h is measured on the oil seal lip contact diameter (the largest diameter).

h nominal: 157.40 to 157.75 mm

Maximum permissible bow on bottom of cylinder head: 0.07 mm (camshaft must turn freely).

Maximum permissible gasket face machining: 0.14 mm in relation to the measured **h** nominal.

Cylinder heads machined undersize are stamped **R** in the area (**a**):

After machining gasket face, the following operations must be done:

1. Valve seat machining to re-establish correct recess (see Valve Recess in this section).

2. Replacement of swirl chambers by repair dimension and correction of their protrusion (see Swirl Chambers in this section).

3. Fitting of 0.4 mm thick compensation washers under the valve springs (to match cylinder head machining.

Cylinder heads manufactured with oversize camshaft bearings (+0.5) are stamped **1** in the area (**a**)

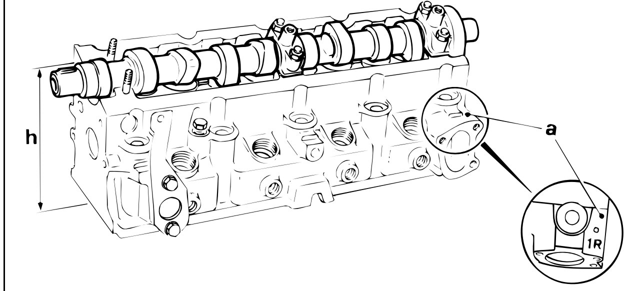


Figure 2

Cylinder Head Gasket

Thickness identification:

Units: mm

Identification (**c**)	Identification (**b**)	Thickness
No notch	2 notches	1.48
	3 notches	1.52
	4 notches	1.58
	5 notches	1.62

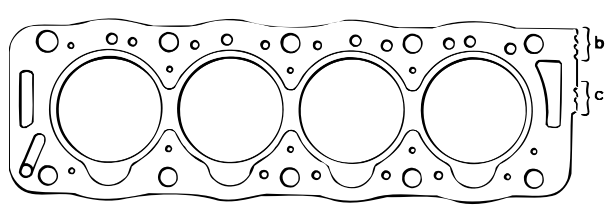


Figure 3

Camshaft

Camshafts with 0.5 mm oversize bearings* are identified by a yellow paint ring (**d**) between the cams of No. 1 cylinder.

* NOTE: These camshafts are installed only on exchange engines, and can be obtained on special order.

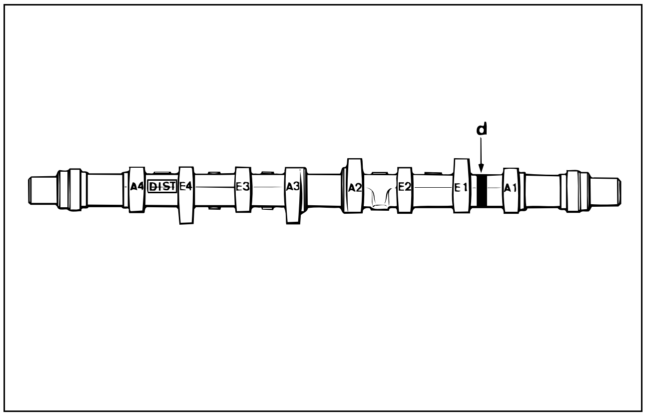


Figure 4

Valves

Units: mm

	Intake	Exhaust
Min. Length **l**	112.2	
ø**a** $^{+0}_{-0.015}$	8.005	7.985
ø**b** ± 0.1	38.5	33
a	90°	90°

Intake: Faces **x** and **y** can machined a maximum of 0.2 mm

Exhaust: No machining is permissible.

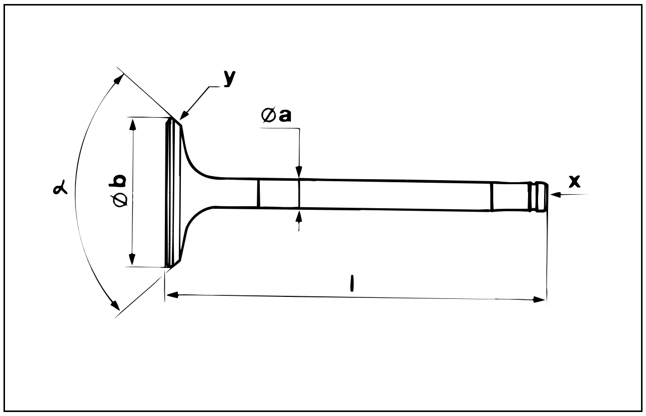


Figure 5

Valve Recess

Units: mm

	Intake	Exhaust
c	0.5 to 1.05	0.9 to 1.45

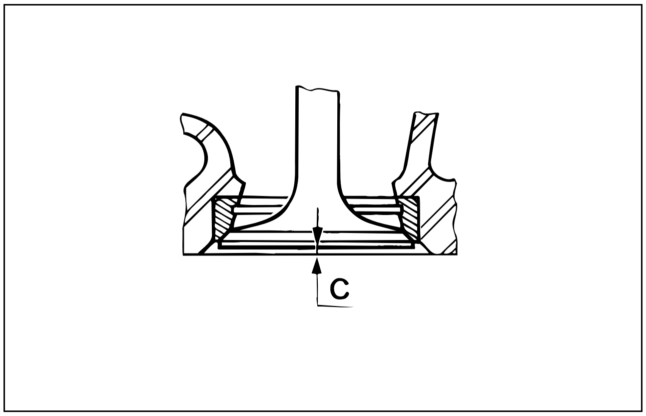


Figure 6

Valve Springs

Units: mm

	Spring
ød	29
P1: daN **e1**	18 42.4

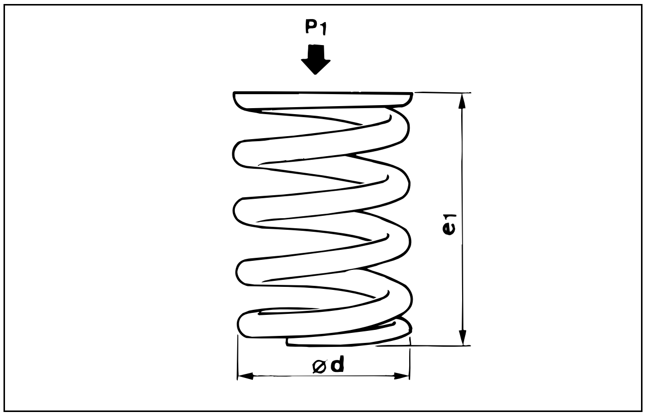


Figure 7

Valve Guides

Units: mm

	øf	øg	**h**	**j**	**øk**
Tolerance	0 – 0.011	+ 0.032 0	± 0.25	± 0.50	0 + 0.2
Production	14.02 14.13	13.981 14.051			
Repair 1	14.29	14.211	52.00	36.50	8.02
Repair 2	14.59	14.511			

øk is obtained by machining after fitting in the cylinder head

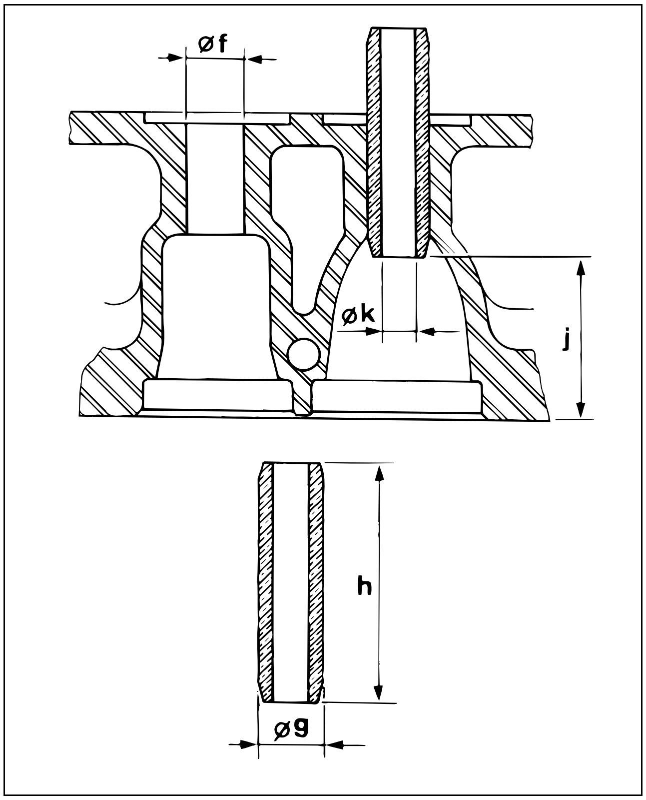


Figure 8

Valve Seats

Units: mm

Intake				
	øa	øb	**c**	**d**
Tolerance	0 – 0.025	± 0.025	0 – 0.1	± 0.15
Production	40.161 40.361	40 40.2	6.25 6.45	8.267 8.467
Repair 1	40.461	40.3	6.45	8.467
Repair 2	40.661	40.5	6.45	8.467

Units: mm

Exhaust				
	øa	øb	**c**	**d**
Tolerance	0 – 0.025	± 0.025	0 – 0.1	± 0.15
Production	34.137 34.337	34 34.2	6.05 6.25	8.15 8.35
Repair 1	34.437	34.3	6.25	8.35
Repair 2	34.637	34.5	6.25	8.35

After fitting valve seats into the cylinder head, machine them according to drawings (Fig. 9).

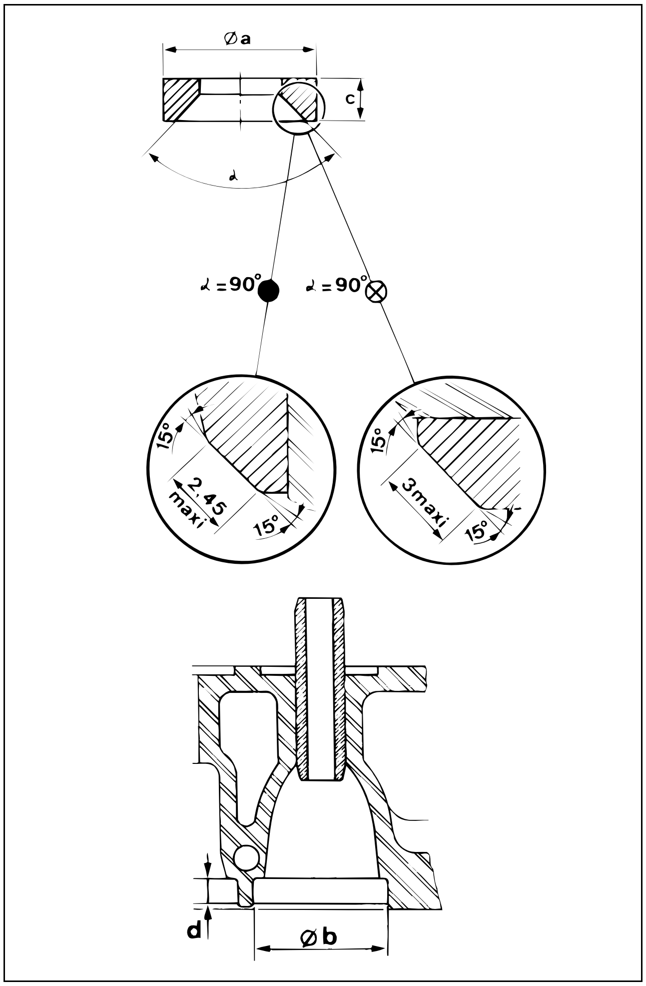


Figure 9

Swirl Chambers

Units: mm

	øe	øf	**g**	**h**
Tolerance	+ 0.099 – 0.060	+ 0.039 + 0	+ 0.020 – 0.025	+ 0.02 – 0.04
Production	32.05 32.25	32 32.2	4 4.1	3.9 4
Repair 1	32.45	32.4	4.2	4.1
Repair 2	32.65	32.6	4.3	4.2

The protrusion **j** must be between **0** and **0.03 mm**
Dimension **j** is obtained by machining faces (**x**) and (**y**)

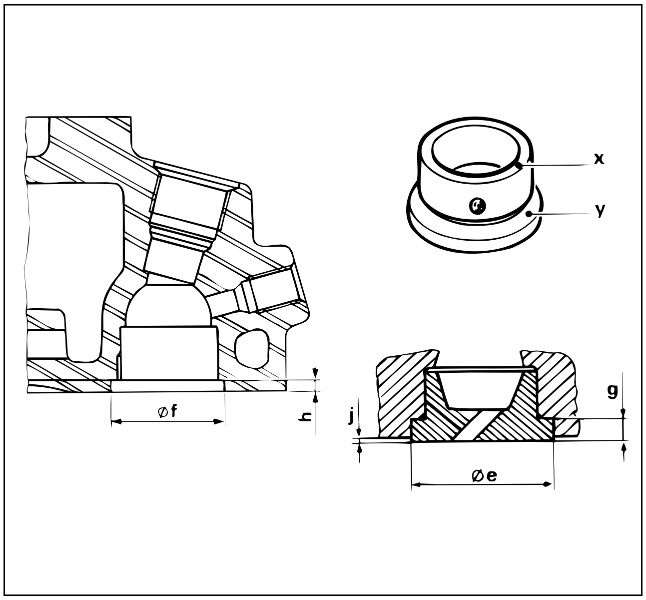


Figure 10

Cylinder / Piston Matching

Units: mm

	Identification (**x**)	CYLINDER ø**a** Tolerance: + 0.018 – 0	PISTON øb Tolerance: ± 0.009
Production	None	83	82.93
	A1	83.03	82.96
Repair 1	R1	83.20	83.13
Repair 2	R2	83.50	83.43
Repair 3	R3	83.80	83.73

NOTE: The piston ø**b** must be measured at dimension **c.**

C	25.00

NOTE: The repair dimension (**x**) is stamped on the cylinder block and pistons.

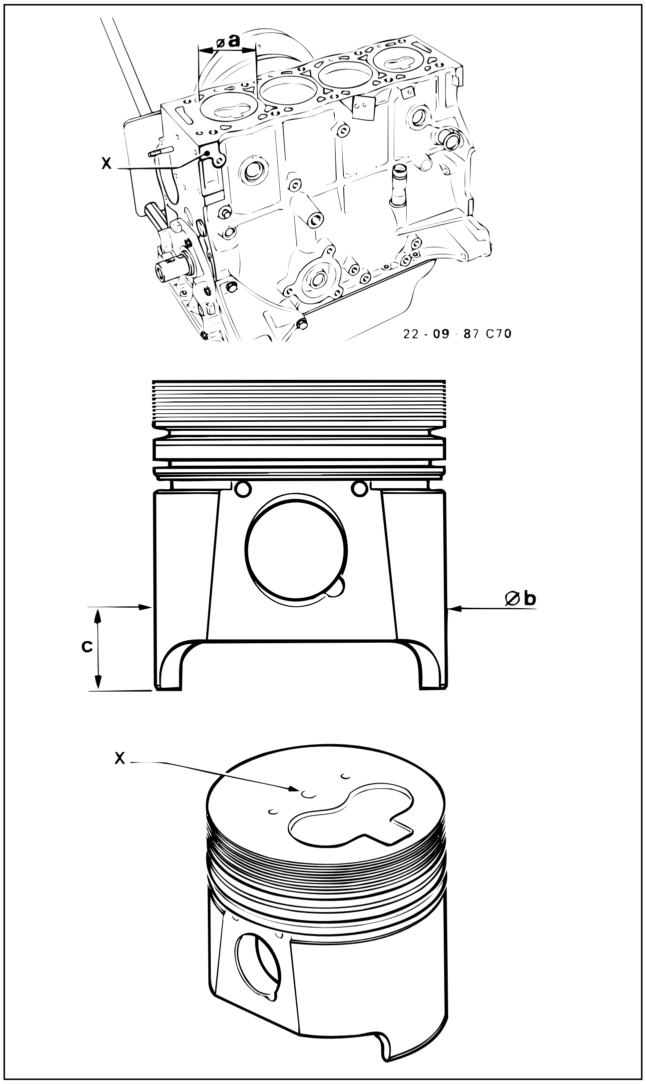


Figure 11

Piston Pin

Units: mm

Ø external	24.994 to 25
Ø internal	13.8 to 14.1

Crankshaft

Units: mm

Crank Pins and Journals				
	øa	b	**øc**	d
Tolerance	– 0 – 0.016	± 0.003	– 0 – 0.019	± 0.003
Production	50.00	1.827	60.00	1.842
Repair 1	49.70	1.977	59.70	1.992

NOTE: Repair 1 size connecting rod and main bearing shells can be identified by white paint (**1**) on the edge of the shell.

Units: mm

End Float		
	No. 2 Journal	Half Shell Thickness
	e	**f**
Tolerance	+ 0.05 0	± 0.025
Production	26.60	2.305
Repair 1	26.80	2.405
Repair 2	26.90	2.455
Repair 3	27.00	2.505

Units: mm

Oil Seal Contact Surface	
	øg
Tolerance	– 0 – 0.087
Production	90.00
Repair 1	89.80

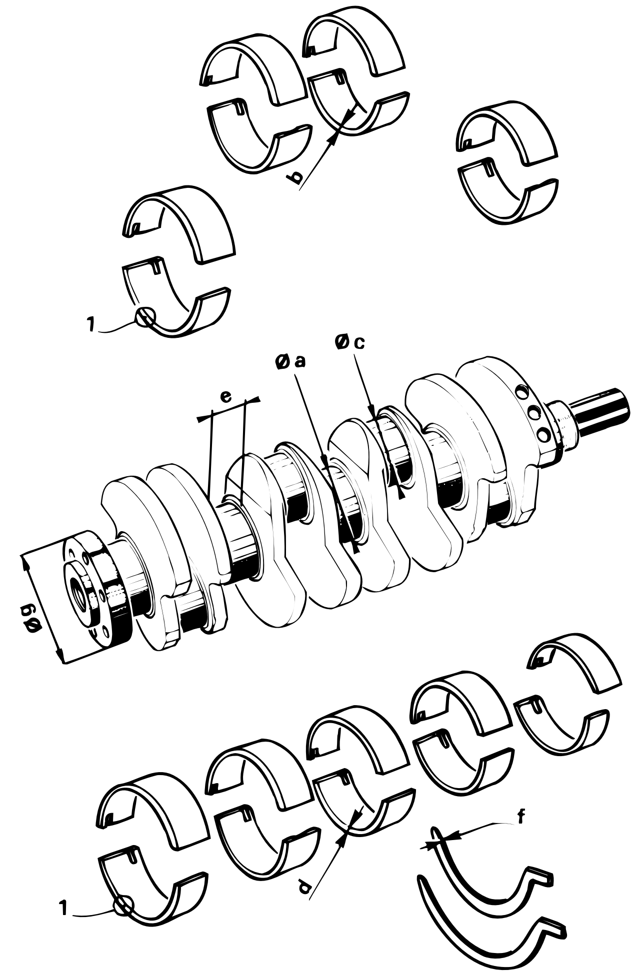


Figure 13

Tightening Torques

Part	Nm	Kgm	ft-lb
Connecting rod end caps	50	5	37
Camshaft bearing caps	17.5	1.8	13
Camshaft gear	40	4	30
Coolant pump	15	1.5	11
* Crankshaft pulley	40 + 60°	4 + 60°	30 + 60°
Cylinder head bolts pre-tightening * tightening	 30 70 +120°	 3 7 + 120°	 22 52 + 120°
Cylinder head cover	10	1	7
Flywheel	50	5	36
Glow plugs	22	2.2	16
Injector pump gear	47	4.7	33
Injector into Cylinder Head	90	9	66
Main bearing caps	70	7	52
Oil pump	20	2	15
Oil seal carrier, timing gear end	15	1.5	11
Sump to block	20	2	15
Timing belt tensioner	15	1.5	11
Water drain plug	25	2.5	18
Oil drain plug	37	3.7	27
Tension roller pin nut	17	1.7	12
Manifold screws	22	2.2	16
Alternator bracket	17	1.7	12

* NOTE: 40 + 60° is tighten to 40 Nm then an additional 60° (60 degrees) of rotation (one flat of bolt head)

Special Tools

NOTE: Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*. Some tools may be listed in the Reelmaster 6500-D Parts Catalog. Some tools may also be available from a local supplier.

TOR4033 Overhaul Tool Set

This tool kit includes tools required for overhauling the engine. TOR4035 Tune-Up Set will also be required if overhauling the engine.

TOR80504A1 Extension (Fig. 24)
TOR80110H Indicator Holder (Fig. 25)
TOR80110DZ 2mm Shim Cutoff Gauge (Fig. 23)
TOR80504A2 Indicator Holder (Fig. 30)
TOR80110GY Extension Rod Adapter (Fig. 24)
TOR70153A1 Main Seal Installer (Fig. 18)
TOR70153A2 Main Seal Installer Shims (Fig. 19)
TOR70153C Rear Main Seal Installer (Fig. 20)
TOR70153D Front Cover Seal Installer (Fig. 21)

TOR4035 Tune-Up Set

This tool kit includes tools required for doing timing belt replacement, injection pump timing, injector removal and camshaft seal replacement.

TOR976697 Camshaft Seal Installer (Fig. 31)
TOR2437T Dial Indicator (Fig. 16)
TOR70153N Flywheel TDC Locator Pin (Fig. 22)
TOR80117AM Injector Pump
Timing Tool Kit (Fig. 26)
TOR80117EZ Crankshaft Rotating Wrench (Fig.27)
TOR80149 Injector Socket (Fig. 28)

TOR2437T Dial Indicator

This dial indicator may be used with TOR80110H, TOR80117AM and TOR80504A2 to accomplish any of the following tasks: for checking the protrusion of the swirl chambers, valve recess and measurement for cylinder head gasket selection, adjusting the timing of the injection pump and for checking the crankshaft and float.

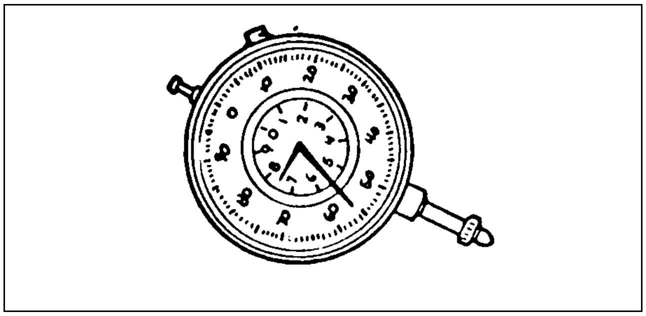


Figure 16

TOR4024T Valve Spring Compressor

This tool is used to compress valves for removal.

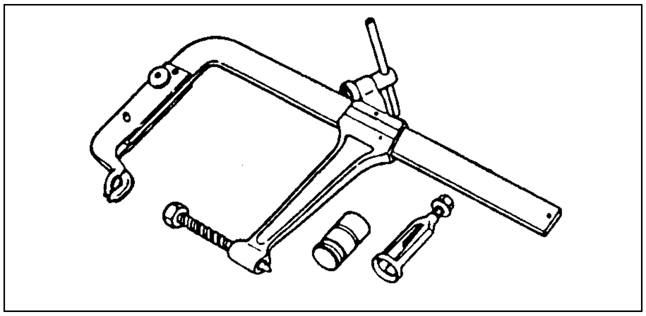


Figure 17

TOR70153A1 Main Seal Installer

Used to install the two side seals to the no. 1 main bearing cap.

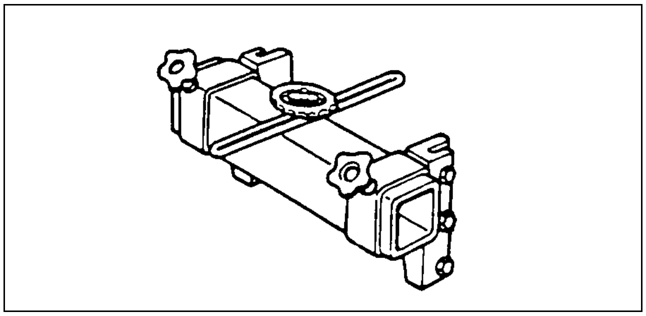


Figure 18

TOR70153A2 Shim Set

Used with main seal installer TOR70153A1.

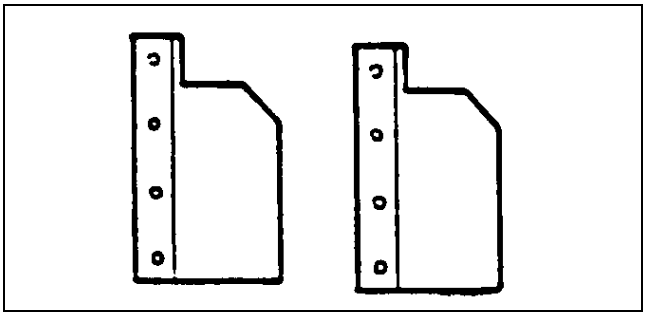


Figure 19

TOR70153C Rear Main Seal Installer

Used with a small hammer to install new rear main oil seal.

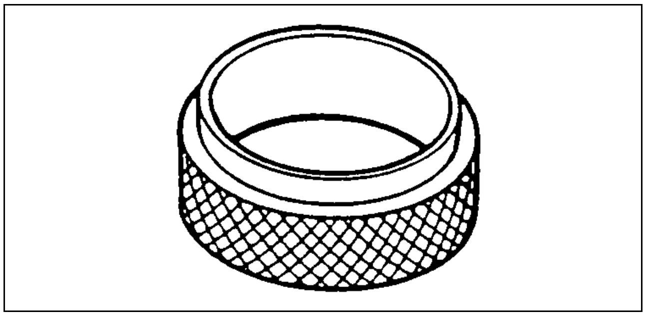


Figure 20

TOR70153D Front Cover Seal Installer

Used with a small hammer to install new front crankshaft seal.

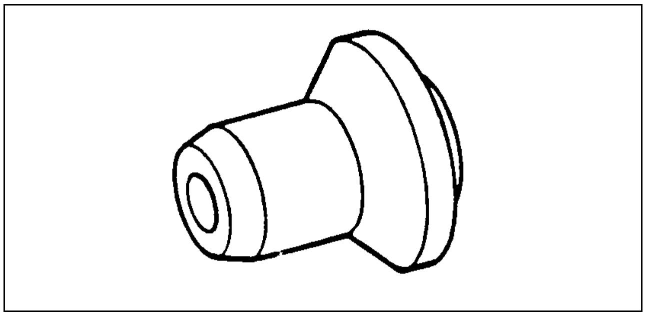


Figure 21

TOR70153N Flywheel T.D.C. Locator Pin

Used to set injection pump timing.

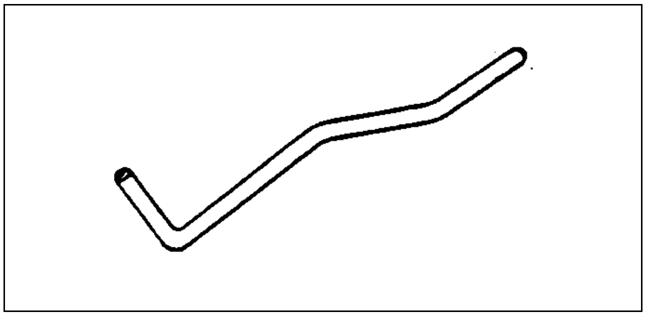


Figure 22

TOR80110DZ 2mm Shim Cut Off Gauge
With Cut Off Shim

Used to gage and gut off new side seals to 2mm height.

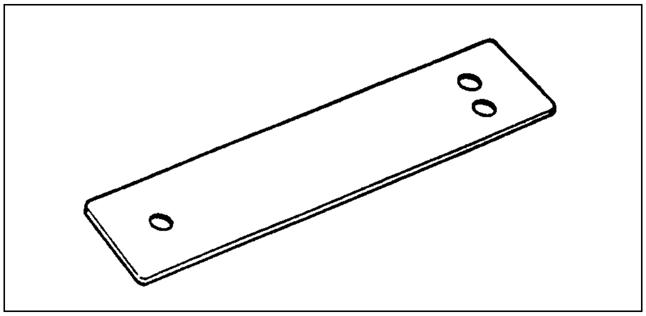


Figure 23

Engine

TOR80110GY Extension Rod and Adapter

Used with TOR 80504A1 and TOR80504A2 to check crankshaft end float.

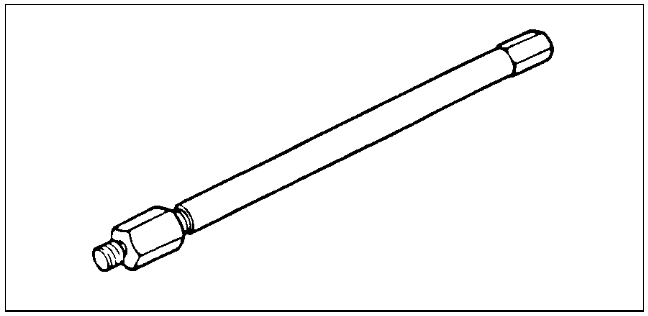


Figure 24

TOR80110H Indicator Holder

Block used to hold dial indicator to check protrusion of swirl chambers, valve recess and measurement for cylinder head gasket selection.

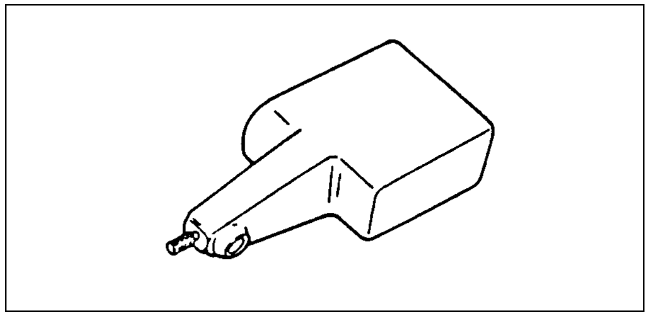


Figure 25

TOR80117AM Timing Tool Kit For Roto Diesel DPC Pump

Used with dial indicator to adjust timing of injection pump.

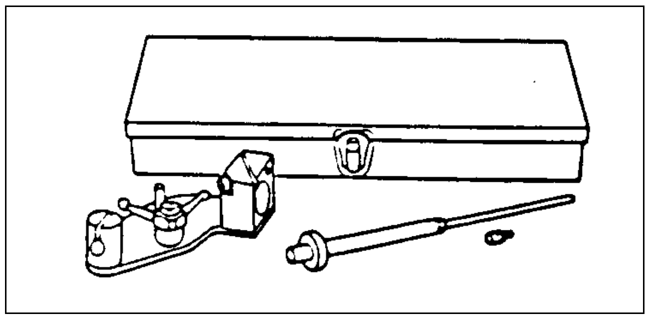


Figure 26

TOR80117EZ Crankshaft Rotating Wrench

Used with a 1/2" drive ratchet wrench to turn the crankshaft.

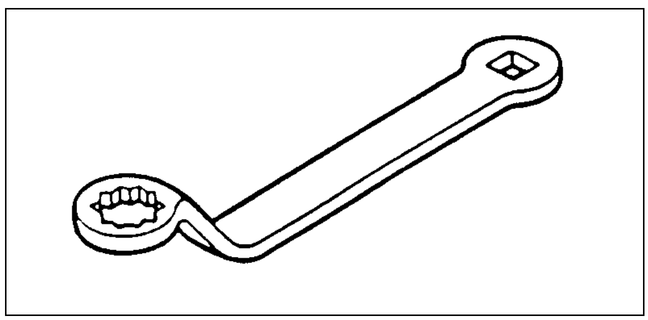


Figure 27

TOR80149 Injector Socket

Used to remove and install fuel injectors.

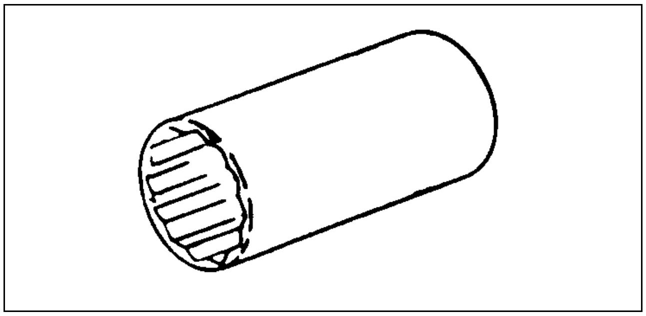


Figure 28

TOR80504A1 Extension

Used with TOR 80110GY and TOR 80504A2 to check crankshaft end float.

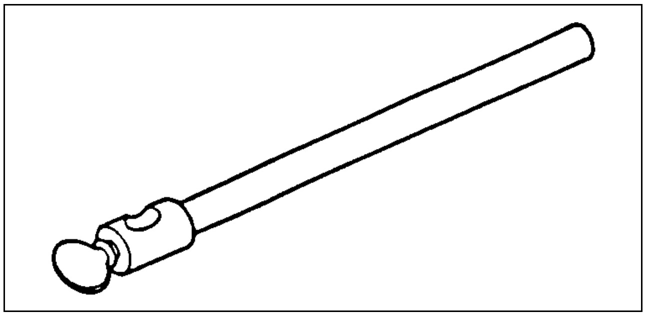


Figure 29

TOR 80504A2 Indicator Holder

Used with TOR80110GY and TOR 80504A1 to check crankshaft end float.

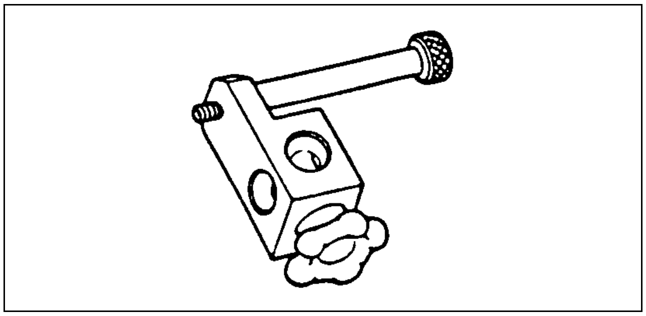


Figure 30

TOR976697 Camshaft Seal Installer

Used to install camshaft seal.

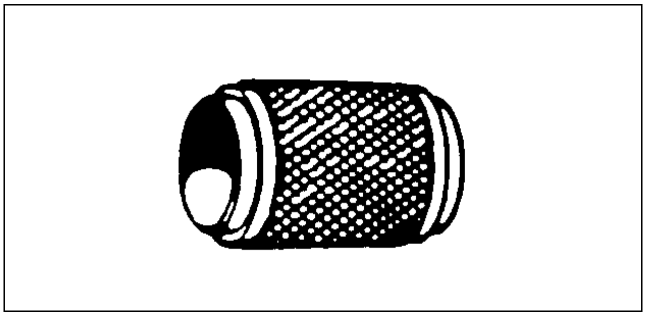


Figure 31

.0149 - Cylinder Head Separating Levers (Make Locally)

Used to remove cylinder head (qty. 2 required).

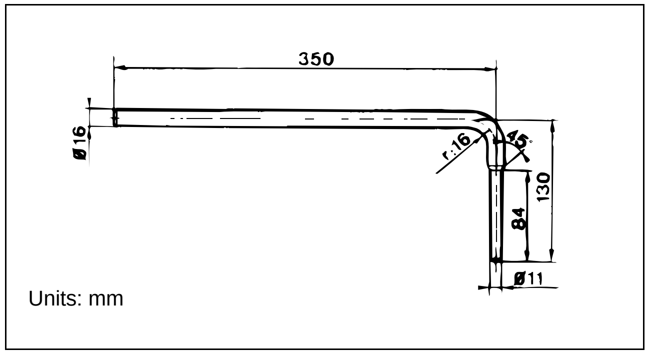


Figure 32

TOR70153H Injector Pump Gear Puller

Loosen the nut on the injector pump gear, then use this tool to loosen the pulley from the tapered shaft on the injector pump.

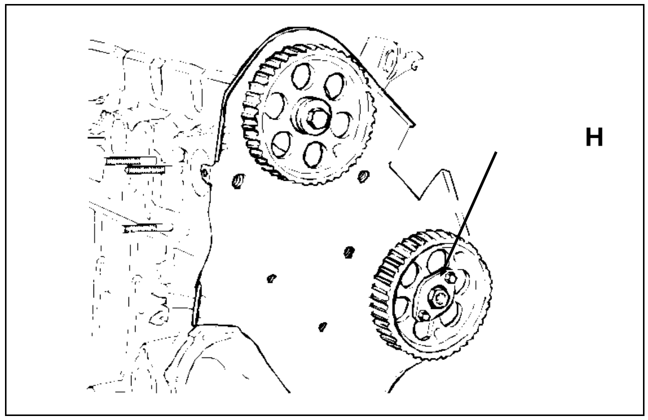


Figure 33

Adjustments

Valve Clearance Adjustment

(See Valve Clearance Adjustment in the Engine Overhaul Section.)

Engine Speed Adjustments

Maximum fuel flow and speed adjustments are sealed and should only be unsealed by a CAV Lucas ROTO-DIESEL service dealer.

Throttle Cable Adjustments

The throttle control lever at the operator's station must not touch the end of the slot during full range of motion from idle (SLOW) to full engine RPM (FAST).

Adjust throttle cable at injection pump so throttle lever on injection pump operates at full range of motion without throttle control lever at operator's station touching end of slot at either FAST or SLOW position.

Troubleshooting

Alternator

Problem	Possible Causes
Alternator is not charging.	Alternator belt loose. Charging circuit defective. Energizing circuit defective. Brushes worn or seized. Rotor winding defective. Stator winding defective. Regulator defective.
Output low or irregular.	Alternator belt loose. Charging circuit defective. Energizing circuit defective. Brushes worn or seized. Rotor winding defective. Stator winding defective. Regulator defective. Rotor partially short-circuited. Stator partially short-circuited. Rectifier diode defective. Rectifier diode short-circuited.
Battery voltage too high.	In-line diode defective. Regulator defective. Poor connections.
Alternator noisy.	Rectifier diode short-circuited. Belt worn. Alternator mounting loose. Alternator pulley loose. Worn bearings.

Fuel Injectors

Problem	Possible Cause	Correction
Bad spray pattern	Carbon deposit around the orifice	Clean
	Scored nozzle seat	Replace injector
	Needle damaged	Replace injector
Leaking injector	Foreign matter jammed between nozzle seat and needle	Clean
	Nozzle seat out-of-true	Replace injector
Needle seized or showing seizing marks	Water in fuel	Drain water and flush fuel feed system (1)
	Copper gasket not replaced	Replace gasket at each repair
	Injector nut too tight on injector body	Tighten injector nut (1)
Leakage collector fills too quickly	Leak between upper bearing face of nozzle and bearing face of injector body:	
	Foreign matter between bearing faces	Clean
	Unevenness	Replace injector
Blue needle point	Incorrect injection pump timing	Replace injector and adjust pump timing again
End of injector body corroded	Running temperature of engine too low	Check thermostat
	Intermittent operation	Run machine longer. Do not start and stop engine.

(1) In these cases, replace the injector

Fuel Injection Pump

Problem	Possible Cause	Correction
Engine has no power	Defective fuel supply	Check filter cartridge and pipes
	Incorrect pump timing	Correct timing
	Incorrect spray, or injector pressure out of adjustment	Check, clean and adjust injectors
	Air intake restriction	Check hoses and air cleaner
	Insufficient automatic advance	Have pump repaired
	Discharge rates too low	Have pump repaired
Idling too fast	Idling stop out of adjustment	Adjust stop and fast idling control
	Throttle cable out of adjustment	Adjust throttle cable
	Governor out of adjustment	Have pump repaired
Maximum speed too high	Max. speed stop out of adjustment	Have pump repaired
	Jammed discharged valve	Have pump repaired
	Blocked pump governor	Have pump repaired
Engine will not accelerate	Defective fuel supply	Check filter cartridge and pipes
	Seized pump plunger	Have pump repaired
	Broken pump plunger spring	Have pump repaired
	Hard discharge valve	Have pump repaired
	Seized feed pump	Drain water from tank, pipes and filter – have pump repaired
	Accelerator linkage defective	Repair linkage
Engine emits smoke	Air getting into feed system	Check gaskets and pipes
	Defective fuel supply	Check filter cartridge
	Incorrect pump timing	Correct timing
	Incorrect spray, or injectors out of adjustment	Check, clean and adjust injectors
	Insufficient automatic advance	Have pump repaired
	Discharge rates too high	Have pump repaired
	Air intake restriction	Check hoses and air cleaner

Problem	Possible Cause	Correction
Engine will not start	No preheating	Check glow plugs and relay
	No fuel supply	Make sure tank is not empty
		Check filter element and pipes
		Check system bleeding
	Defective solenoid valve	Check electric stop solenoid
	Seized pump plunger	Have pump repaired
	Discharge valve blocked in “stop” position	Have pump repaired
	Seized feed pump	Drain water from tank, pipes and filter – repair pump
Irregular engine speed	Defective fuel supply	Check filter cartridge and pipes
	Carbon fouled injectors	Check, clean and adjust injectors
	Unequal discharge rates	Have pump repaired
	Faulty governor	Have pump repaired
Noisy engine	Incorrect pump timing	Correct timing
	Blocked automatic advance	Have pump repaired
	Automatic advance to far advanced	Have pump repaired
Engine stalls at idling	Air getting into fuel system	Check gaskets and pipes
	Idling stop out of adjustment	Adjust idling stop
	Jammed discharge rate	Have pump repaired
Vibrating engine	Unequal discharge rate	Have pump repaired
	Air in fuel system	Check fuel lines and clamps
	Defective fuel injector	Check injectors
	Jammed discharge valve	Have pump repaired
Engine will not stop	Key switch defective	Replace key switch
	Defective electric stop solenoid	Check electric stop solenoid

Low Power

Problem	Possible Causes
Engine does not give full power	Injection pump timing Seized piston rings Defective injector(s) Air intake restricted Valve leaks Clogged fuel filter Injection pipe restriction due to excessive tightening of unions Defective injection pump
Irregular idling	Defective injection pump Air getting into fuel system Idling stop out of adjustment Leaky injection pipe unions
Speed fall-Off	Clogged fuel filter Defective injection pump
Engine speed rises to maximum	Defective injection pump Throttle cable jammed

Noisy Engine

Problem	Possible Causes
Knocking	Loose main bearings Broken part Leakage return collector clogged Lifters out of adjustment Foreign matter in a cylinder Seized injector Injection pump timing Sheared glow plug Timing out of adjustment
Whistling, blowing	Leaking cylinder head gasket Leaky glow plug Valve seats Leaky injector

Pre-heating

Problem	Possible Causes
Glow plug does not glow red hot	Faulty glow plug Faulty glow plug relay Damaged wiring or connector All four glow plugs burnt out / ends melted – injection pump timing out of adjustment (engine overheating) See Chapter 5 - Electrical System

Smoke During Operation

Problem	Possible Causes
Black	Defective injector Injection pump out of adjustment Injection pump timing Air intake restricted Inlet chambers clogged Not enough advance
Grey	Defective injector Injection pump timing Air intake restricted Not enough advance
Blue-Grey	Defective injector Injection pump timing Too much oil
Blue	Too much oil Wear
White	Injection pump timing Cylinder head gasket Cold engine

Starting Problems

Problem	Possible Causes
Engine will not start and emits black smoke	Air intake obstructed Defective injectors Lack of compression (seized rings, damaged or worn valve seats, or general wear) Injection pump timing
Engine will not start and emits white smoke	Leaking cylinder head gasket
Engine will not start and does not emit any smoke	Frozen fuel Injection pump does not work Leaking injection pipe unions Injection valve blocked No preheating Empty fuel tank Feed pipe obstructed Air getting in pipes Tank vent plugged Injection pump needs re-priming Shutdown control jammed in “stop” position
Starter does not crank or cranks slowly	Battery discharged Oil too thick Engine seized Faulty starter Faulty wiring

Testing and Inspection

Injection Pump Timing

(See Timing of Injection Pump in the Engine Overhaul section.)

Glow Plug Test

CAUTION

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

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

2. Remove the glow plug.

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

NOTE: If the metal of the glow plug end is melted, it is a sign of cylinder overheating.

4. Connect the positive (+) battery terminal to the glow plug terminal, and the negative (–) battery terminal to the plug body (Fig. 34). If the glow plug glows red-hot in 9 to 12 seconds, the glow plug is operating correctly. DO NOT leave on more than 20 seconds.

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

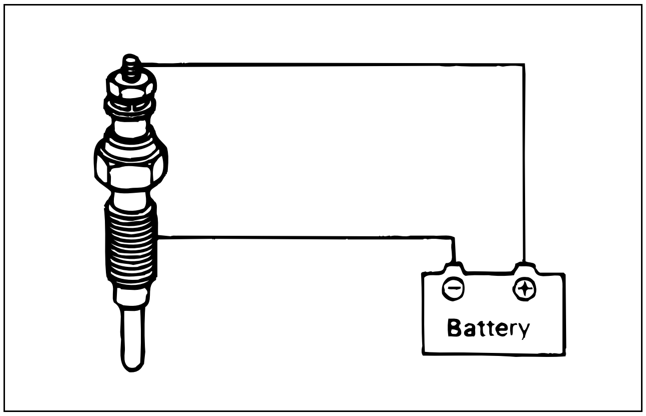


Figure 34

Engine

Compression Test

Minimum cylinder compression is 20 bar (290 psi) at 200 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 four cylinders.

2. Insert a compression gauge adapter into the glow plug hole.

3. Connect a high pressure compression gauge to the adapter.

4. Disconnect the fuel stop solenoid electrical connector or hold the fuel stop lever in the stop position to prevent fuel delivery during the compression test. This will prevent wash-down of the cylinders and inaccurate readings.

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

6. If the pressure is less than 20 bar (290 psi) it will be necessary to find the cause of low compression.

7. Repeat the test for the other three cylinders. Difference between cylinders should be no more than 5 bar (70 psi).

8. Connect the fuel stop solenoid electrical connector.

9. Install the glow plugs.

Injector Tests

There are several tests to examine the condition of the injection nozzles. These tests require the use of a nozzle tester and nozzle tester adapter.

CAUTION

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: 130 ± 5 bar or kg/cm^2 (1885 ± 70 psi)

6. Starting pressure can be adjusted by adding or removing shims from the nozzle. A 0.10 mm shim thickness will cause a 10 bar or kg/cm^2 (140 psi) starting pressure difference.

7. Repeat the test after installing shim to verify that a correct opening 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 (1 - 2 strokes per second). As the pump pressure reaches the starting pressure the nozzle valve will chatter or buzz as it opens and closes rapidly. A nozzle which does not chatter or buzz 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 20 bar or kg/cm^2 (280 psi) below opening pressure. 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. 35). 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 quickly (4 - 6 strokes per second).

2. Observe the injector nozzle spray. The spray pattern should be finely atomized in a broad, straight stream (Fig. 36).

3. If the nozzle fails to spray properly, it must be cleaned, repaired or replaced.

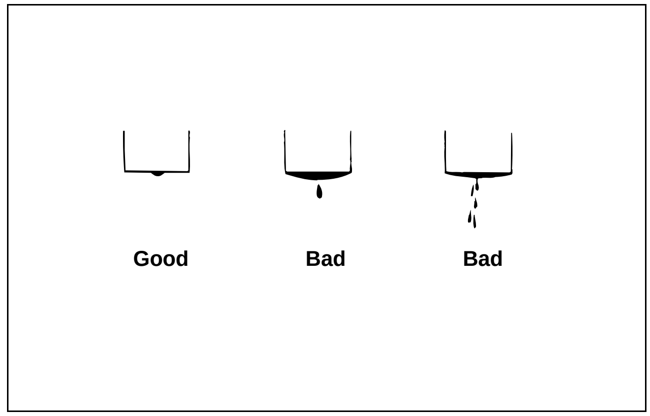


Figure 35

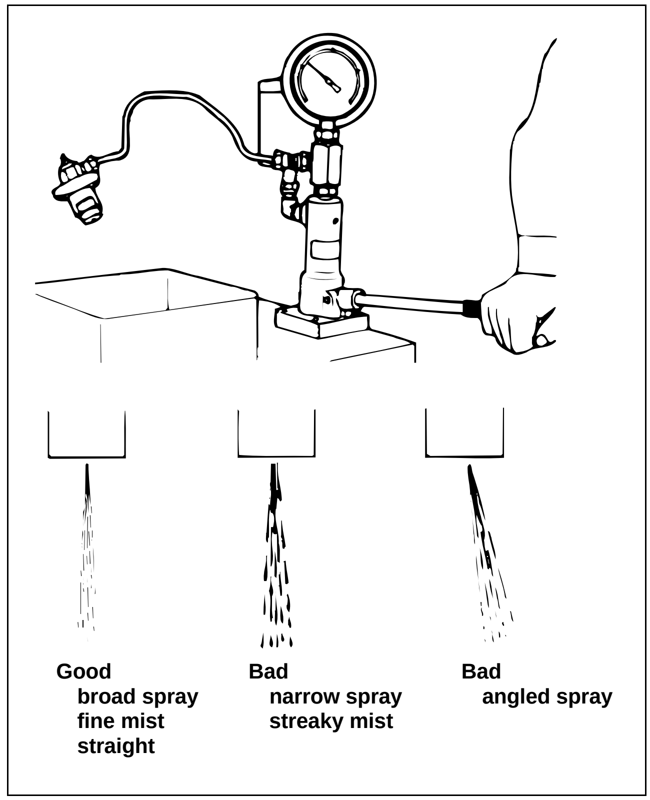


Figure 36

Injection Pump Testing

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.

2. Check the operating condition of the injection nozzles to make sure that the injection pressure is correct.

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.

CAUTION

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.

Thermostat Test

If the engine overheats or runs too cool, and a faulty thermostat is suspected, the thermostat should be tested.

1. Remove the thermostat.

2. Put the thermostat in a container of water with a thermometer and heat the water.

Starts to open at: 81^{o} C (178^{o} F)
7 mm (0.28 in.) full open at 88^{o} C (190^{o} F)

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

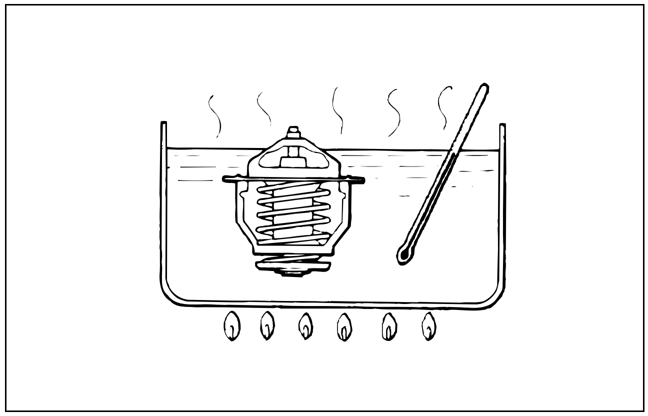


Figure 37

Fuel System Service

Priming Fuel System

1. Stop the engine. Unlatch and raise the hood

2. Fill the fuel tank.

3. Install a 3/16" hose over bleed screw. Put other end of hose into a container to catch fuel (Fig. 38).

4. Pump priming plunger until resistance is felt. Try to start engine. If engine does not start, go to step 5.

5.Loosen bleed screw a few turns. Pump priming plunger until a steady stream of fuel comes out of hole in bleed screw. When fuel stops foaming, tighten bleed screw during down stroke of priming plunger. Wipe up any spilled fuel.

NOTE: It may be necessary to bleed air out of the fuel line, between the fuel filter/water separator and the injection pump. To do this, loosen the fitting on the injection pump (Fig. 39) and pump priming plunger until a steady stream of fuel comes out of fitting. When fuel stops foaming, tighten the fitting during the down stroke of the priming plunger. Wipe up any spilled fuel.

NOTE: The high pressure fuel system is self-bleeding. It is not necessary to open the high pressure lines.

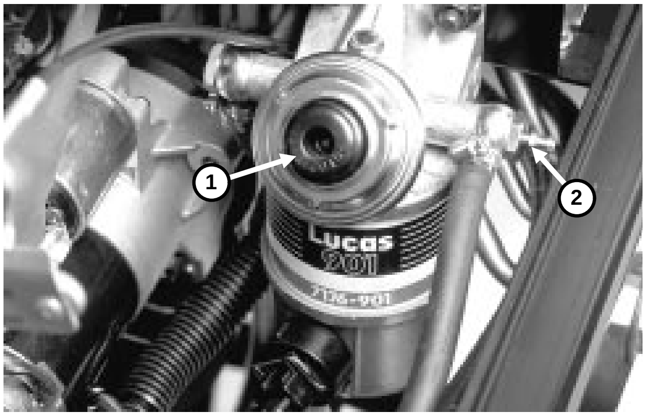


Figure 38

1. Primer plunger **2. Bleed screw**

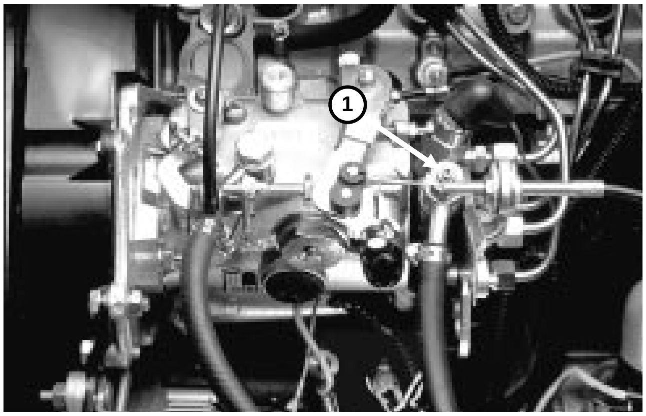


Figure 39

1. Injection pump fitting

Injection Pump Removal

(See Injection Pump Removal in the Engine Overhaul section.)

Injection Pump Repair

NOTE: If the pump needs to be inspected or repaired it is recommended that it be done by an authorized CAV Lucas ROTO DIESEL service dealer - especially during the warranty period. Repairs by non-authorized dealers WILL void the pump warranty.

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

Engine

Injector Service

NOTE: If injectors need to be inspected or repaired it is recommended that it be done by an authorized CAV Lucas ROTO DIESEL service dealer - especially during the warranty period. Repairs by non-authorized dealers WILL void the warranty on the injectors.

Removal

1. Clean top of cylinder head and injection pipes.

2. Remove injection pipes (Fig. 57, Item 12).

3. Disconnect injector leakage pipe.

4. Remove the injectors (Fig. 58, Item 19) and retrieve the copper washer (Item 20) and flame trap washer (Item 21).

NOTE: Never disassemble injector before checking its operation.

Disassembly and Cleaning

1. Secure the injector body in a “V” type injector holder.

2. Remove the injector holder nut.

3. Remove the injector, spacer, push rod, pressure setting spring, adjusting shims and body.

4. Dip all parts in clean diesel fuel.

5. Clean nozzle and needle in clean diesel fuel.

6. De-carbon injector nozzle using a wooden spatula. Never use metallic objects, emery cloth or rags. Do not attempt to grind the needle on its seat. Clean each injector separately to matched parts are not mixed up. The needle should slide freely and fall in the nozzle by its own weight.

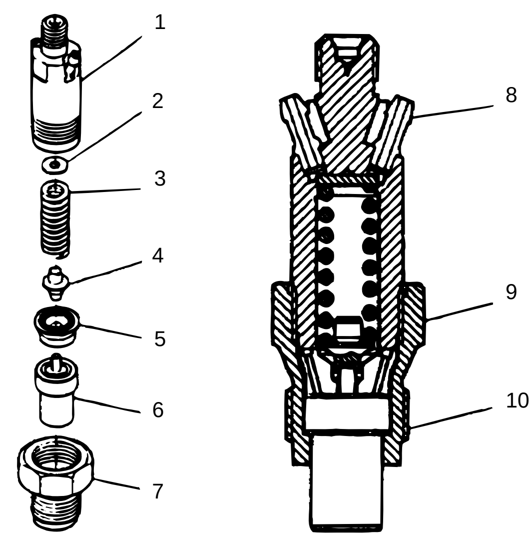


Figure 40

1. Body
2. Adjusting shim
3. Pressure setting spring
4. Push rod
5. 2-sealing face spacer
6. Injector
7. Injector nut
8. Leak return connectors
9. Injector holder nut
10. Thread

Assembly

1. Check all parts for condition and cleanliness. Oil parts before reassembly.

2. Secure the injector body in a “V” type injector holder.

3. Install the adjusting shims, spring, push rod, spacer and injector (Fig. 40, Items 2, 3, 4, 5, 6).

4. Install the injector holder nut (Fig. 28, Item 7) and tighten by hand.

5. Tighten injector nut to a torque of 10 Nm. Tighten the nut an additional 22° of rotation.

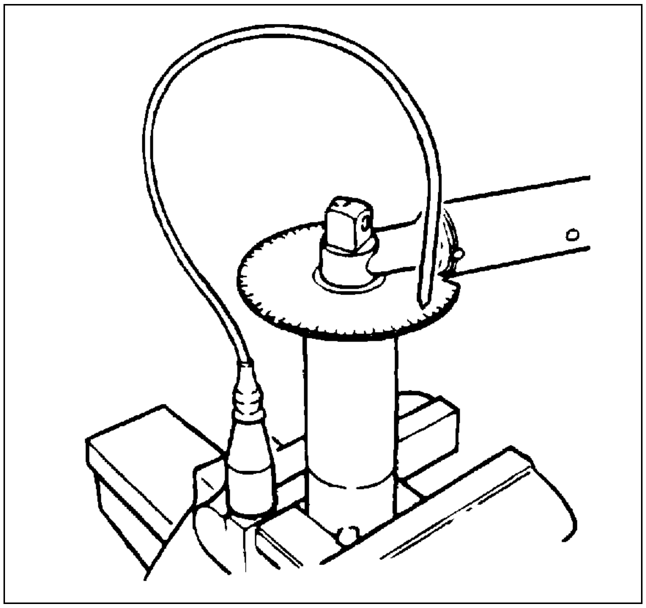


Figure 41

Installation

NOTE: Each time an injector is removed from the engine, new washers must be installed. Fire ring washer is installed with convex surface up.

1. Install new fire ring washers (Fig. 58, Item 21), convex surface facing up.

2. Install new copper washers (Fig. 58, Item 20).

3. Install the injectors and tighten to a torque of 90 Nm (66 ft-lb).

1. Install new flame arrestor steel washer and copper gasket.

2. Install injector in cylinder head.

3. Install injection pipe unions on pump and injectors and tighten by hand.

4. Moderately tighten each union, 25 Nm (18 ft-lb) max., on pump and injector. Over-tightening will distort the end of the injector line.

5. Connect fuel return pipe.

Engine

Timing Belt Replacement

Timing Belt Removal

IMPORTANT: Never install a used belt. When the timing belt is removed a NEW timing belt must be installed.

SPECIAL TOOLS REQUIRED:
Tune-Up Tool Set TOR 4035
1 ea. M8 x 125 x 40 Metric Bolt
2 ea. M8 x 125 x 35 Metric Bolt

1. Slowly turn the crankshaft in the operating direction (clockwise as viewed from the timing belt end) until the TDC Lock Pin tool (TOR 70153N) goes into the hole in the flywheel (Fig. 42).

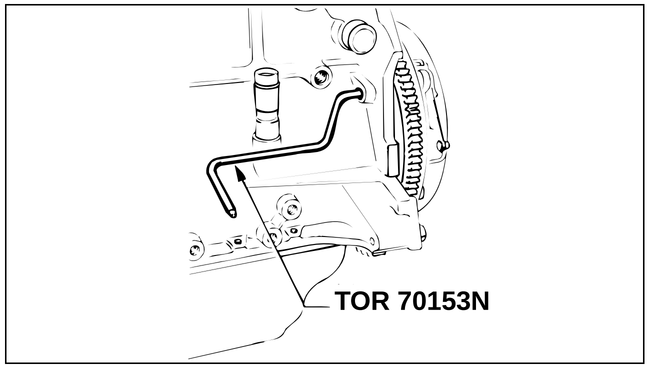


Figure 42

2. Remove the crankshaft pulley bolt (Fig. 43, Item 1) and the pulley. Note: The bolt is secured with thread locking compound and will be difficult to remove.

3. Remove cover attachment nut (Item 5), cover clips and timing belt covers (Item 2, 3 and 4) in the numbered order.

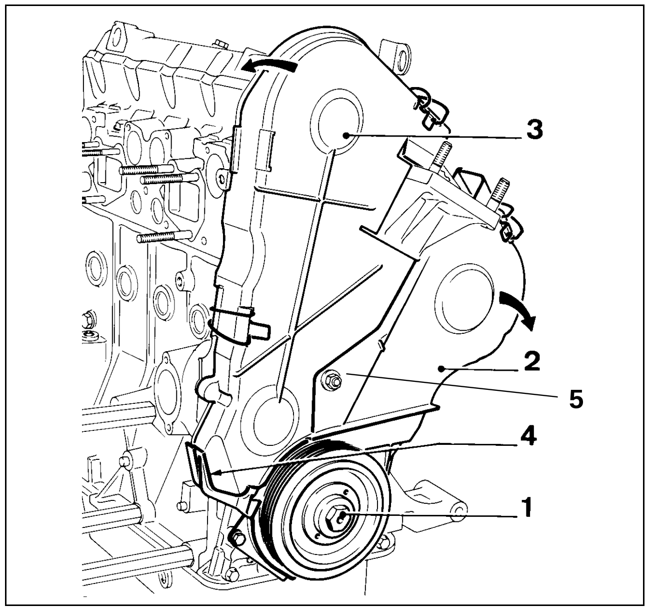


Figure 43

4. Re-install the crankshaft bolt (Fig. 44, Item 1) and the washer.

5. Lock the camshaft gear (Item 6) in position by installing an M8 x 125 x 40 bolt. Tighten finger tight.

6. Lock the injection pump gear (Item 7) in position with two M8 x 125 x 35 bolts. Tighten finger tight.

IMPORTANT: To prevent damage to the face of the injector pump housing and future timing problems, the camshaft gear and injection pump gear locking bolts must be tightened ONLY FINGER TIGHT.

NOTE: If the bolts in steps 5 and 6 cannot be installed because the holes in the gears and engine block do not align, remove the TDC Lock Pin tool and rotate the engine (clockwise) one revolution. Install the TDC Lock Pin, then install the bolts as instructed in steps 5 and 6.

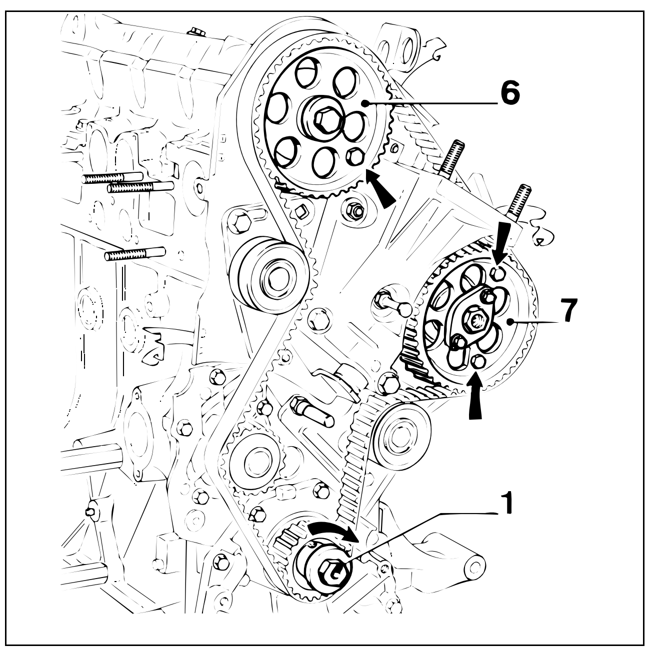


Figure 44

7. Loosen the nut (Fig. 45, Item 8) and the bolt (Item 9), securing the roller tensioner bracket (Item 10).

8. Rotate the roller tensioner bracket square (Item A) to compress the spring (Item 11).

9. Re-tighten the bolt (Item 9).

10. Remove the timing belt.

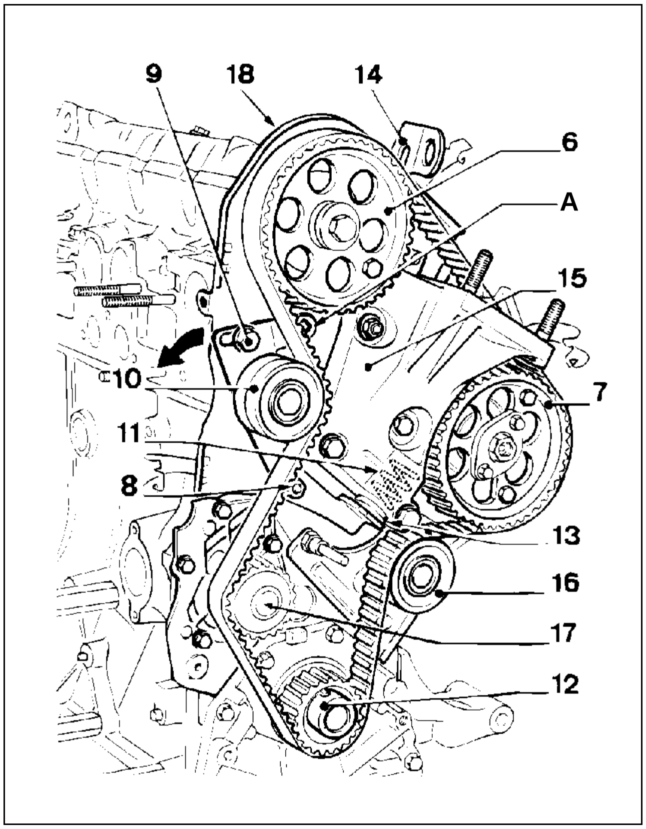


Figure 45

Engine

Timing Belt Installation

IMPORTANT: Never install a used belt. When the timing belt is removed a NEW timing belt must be installed.

1. Install the new timing belt, with the runs taut, in the following order (Fig. 46):

Crankshaft gear (Item 13)
Fixed roller (Item 11)
Injection pump gear (Item B)
Camshaft gear (Item C)
Tensioner roller (Item 17)
Coolant pump gear (Item 10).

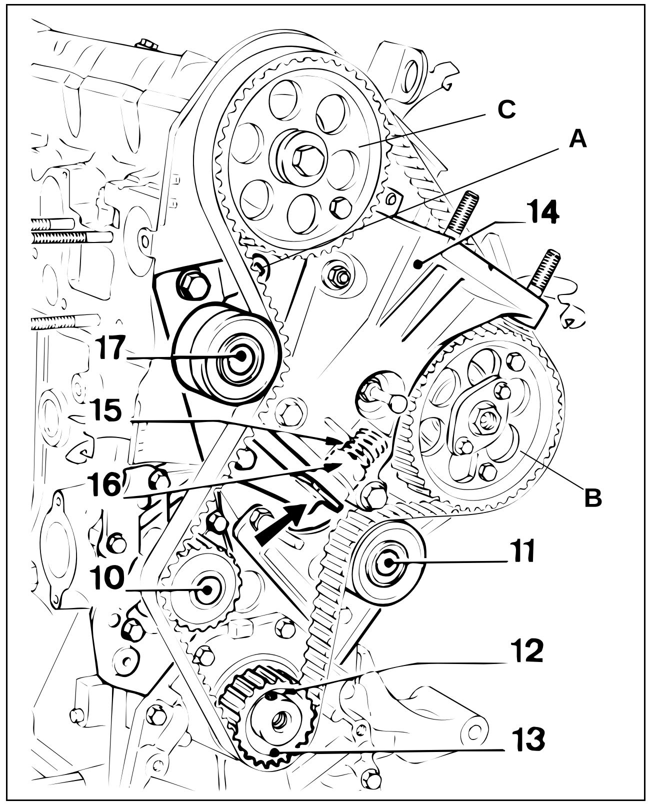


Figure 46

2. Loosen the bolt (Fig. 47, Item 18) and nut (Item 19) to release the tensioner roller. DO NOT use Item **A** to set tension. Tension on belt is only to be set by the spring (Fig. 46, Item 15) when tensioner plate is free to rotate.

3. Re-tighten the bolt (Item 18), then the nut (Item 19), when the belt is tensioned.

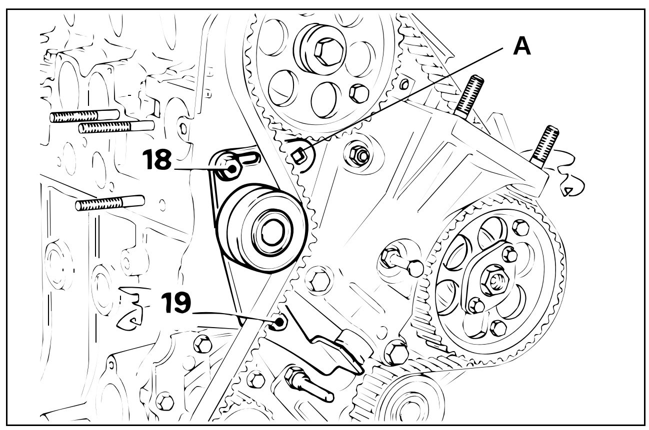


Figure 47

4. Remove the three gear locking bolts and TDC Lock Pin tool.

5. Turn the crankshaft two revolutions (clockwise).

6. Re-install the TDC Lock Pin tool TOR 70153 N and the three gear locking bolts.

IMPORTANT: If you can not install any one of the locking devices, repeat the Timing Belt Installation procedures from the beginning.

7. Loosen the bolt (Fig. 48, Item 18) and nut (Item 19) to release the tensioner roller.

8. Re-tighten the bolt (Item 18) then the nut (Item 19) to a torque of 17.5 Nm (13 ft-lb).

9. Remove the three gear locking bolts.

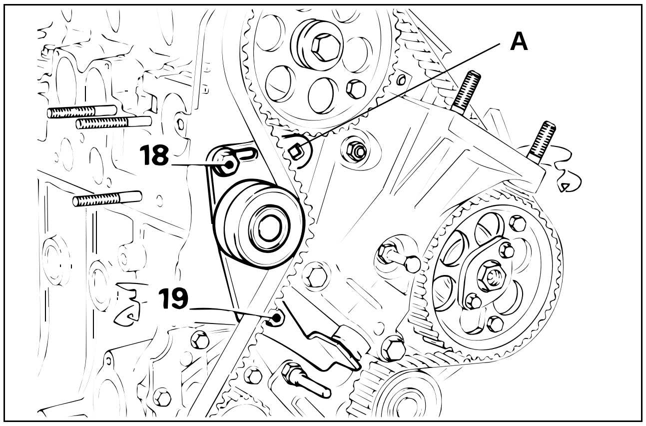


Figure 48

10. Install the covers (Fig. 49, Item 2, 3 and 4), cover clips and cover attachment nut (Item 5).

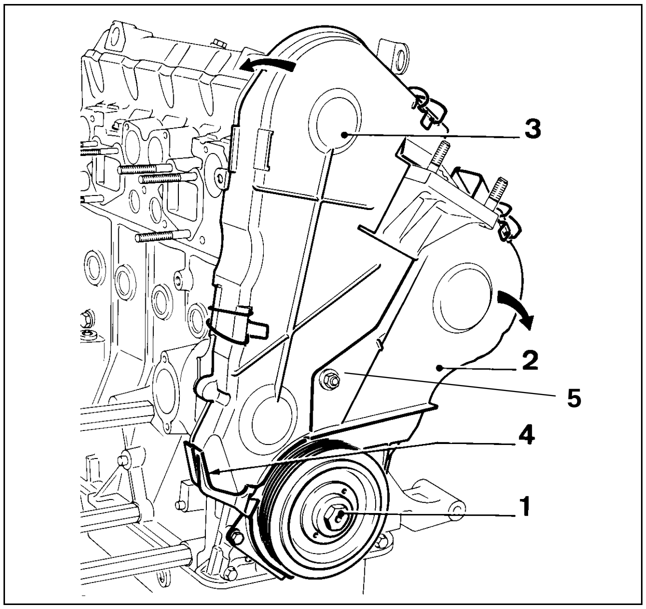


Figure 49

11. Install the pulley.

A. Clean with a brush and de-grease the threads of the bolt (Fig. 50, Item 1), the bearing faces of the washer (Item 2) and the head of the bolt (Item 1).

B. Coat the threads of the bolt (Item 1) with thread lock LOCTITE. Install the bolt (Item 1) and washer (Item 2) and tighten to a torque of 40 Nm (30 ft-lb).

C. Tighten the bolt 60° further (one flat).

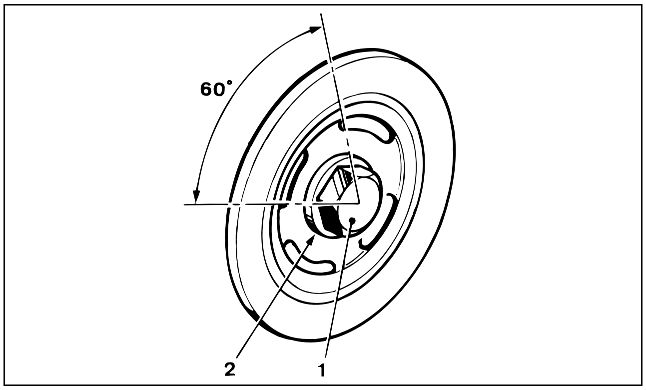


Figure 50

Injection Pump Timing

Timing of Injection Pump (Pump Mounted on Engine)

The adjustment position for start of injection varies on each pump (manufacturing tolerances). The adjustment position is given by measurement “X.XX” in one of three places on the pump (Fig. 51):

a. Tag on pump lever.
b. Bar code label
c. Inspection cap

NOTE: “PMH” in French = “TDC” in English.

1. Remove the cover attachment nut, cover clips and timing belt covers.

2. Slowly turn the crankshaft in the operating direction (clockwise as viewed from the timing belt end) until the TDC Lock Pin tool (TOR 70153N) goes into the hole in the flywheel (Fig. 52).

3. Verify that the camshaft and injection pump gears are properly timed:

A. Lock the camshaft gear (Fig. 53, Item 6) in position with a M8 x 125 x 40 bolt. Tighten finger tight.

B. Lock the injection pump gear (Item 7) in position with two M8 x 125 x 35 bolts. Tighten finger tight.

NOTE: If the locking bolts cannot be installed because the holes in the gears and engine block do not align, remove the TDC Lock Pin tool and rotate the engine (clockwise) one revolution. Install the TDC Lock Pin, then install the bolts as instructed.

IMPORTANT: To prevent damage to the face of the injector pump housing and future timing problems, the camshaft gear and injection pump gear locking bolts must be tightened ONLY FINGER TIGHT.

4. Remove the three locking bolts (Fig. 53).

5. Remove the TDC Lock Pin tool TOR 70153N, then turn the crankshaft 1/4 to 1/3 turn in the opposite direction of running (counterclockwise as viewed from the timing belt end).

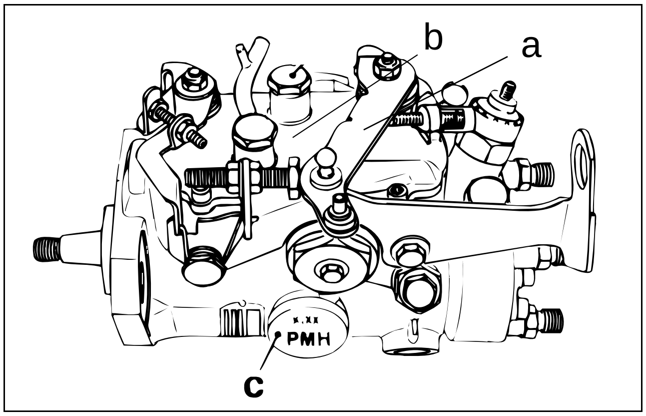


Figure 51

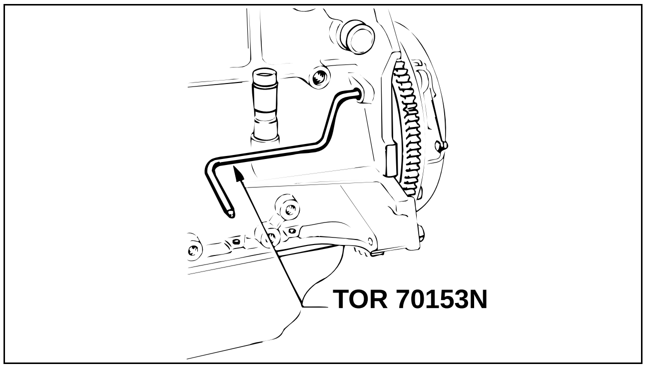


Figure 52

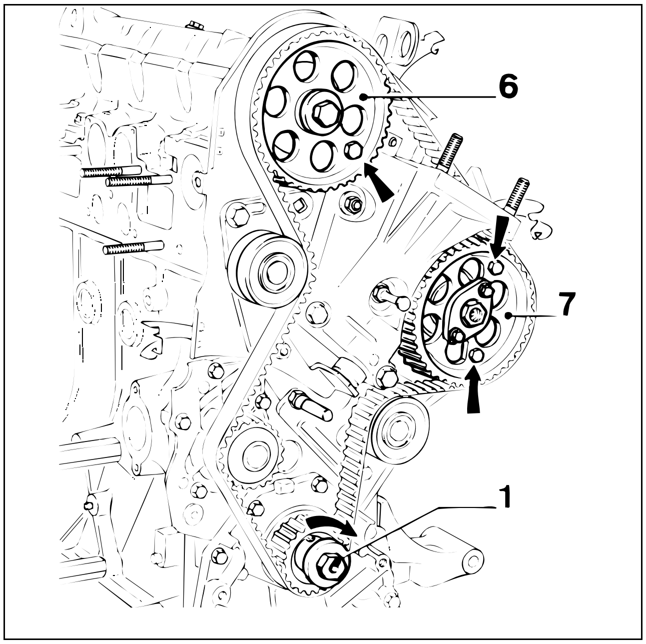


Figure 53

6. Clean the area around the pump timing plug (Fig. 54, Item d). Remove the pump timing plug.

7. Use Timing Tool Assembly TOR 80117 AM. Lubricate the timing rod (Fig. 55, Item 1) with Diesel fuel, then install the timing rod in the pump timing hole (Item d). Check to see that the rod moves freely in the bore.

8. Install the dial indicator (metric) on the indicator bracket (Item 2).

9. Install the indicator bracket with dial indicator on the plug boss. Set the dial indicator to “0.00 mm”.

10. Slowly turn the crankshaft in the operating direction (clockwise as viewed from the timing belt end) until the TDC Lock Pin tool (TOR 70153N) goes into the hole in the flywheel (Fig. 56).

11. The dial indicator should show the reading “X.XX” ±0.04 mm engraved on the injection pump. If adjustment is required, loosen the three bolts at the pump flange, one bolt at the rear, and the injection lines. Rotate the pump away from the engine, then slowly rotate the pump toward the engine in one smooth motion to obtain the reading “X.XX”. If you go to far and the reading is passed, stop. Again, rotate the pump away from the engine, then rotate the pump toward the engine in one smooth motion.

12. After obtaining the correct reading, be careful to keep the pump in position and tighten the pump bolts.

13. Remove the TDC Lock Pin tool TOR 70153 N.

14. Turn the crankshaft 1/4 to 1/3 turn in the opposite direction of running (counterclockwise as viewed from timing belt end). Check that the indicator reads 0.00.

15. Slowly turn the crankshaft in the operating direction (clockwise as viewed from the timing belt end) until the TDC Lock Pin tool (TOR 70153N) goes into the hole in the flywheel (Fig. 56).

16. In this position the dial indicator mounted on the pump should read the value “X.XX” shown on the pump ±0.04 mm.

17. Check to make sure the three lock bolts fit in the cam pulley and injection pump pulley (Fig. 53).

18. Repeat steps 11 and 12 if necessary.

19. Remove TDC Lock Pin tool, three lock bolts, indicator and indicator bracket. Install pump cover plug.

20. Tighten injector lines.

21. Install timing belt covers, clips and attachment nut.

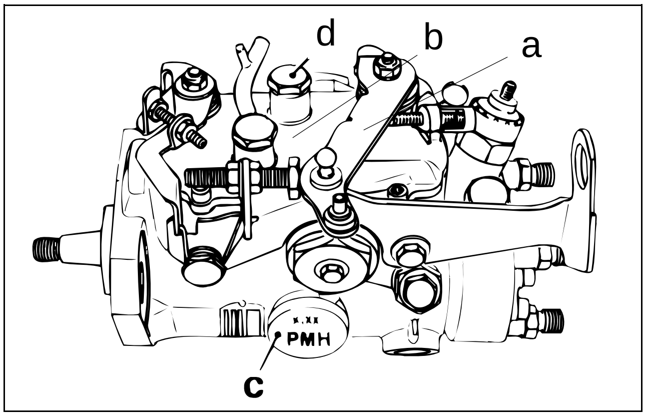


Figure 54

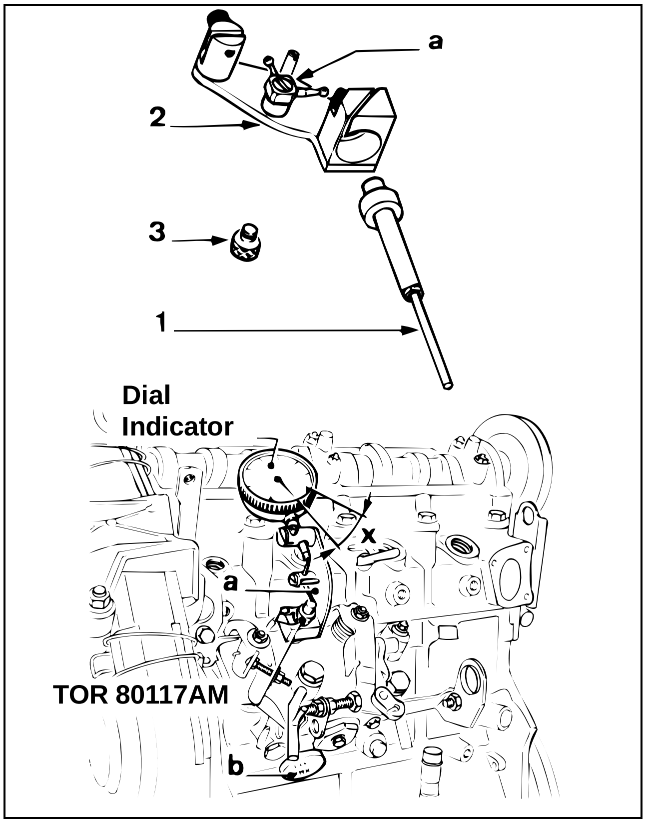


Figure 55

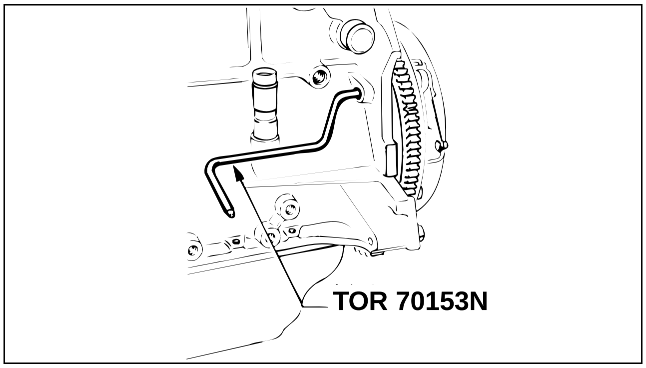


Figure 56

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 all disassembled parts 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.

IMPORTANT: Apply clean engine oil to all surfaces when engine is assembled to prevent marking when engine is first started.

Cylinder and Cylinder Block Overhaul

Before removing any parts, disassembly or overhaul of the Peugeot 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 4 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.)

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.

Engine Removal and Installation

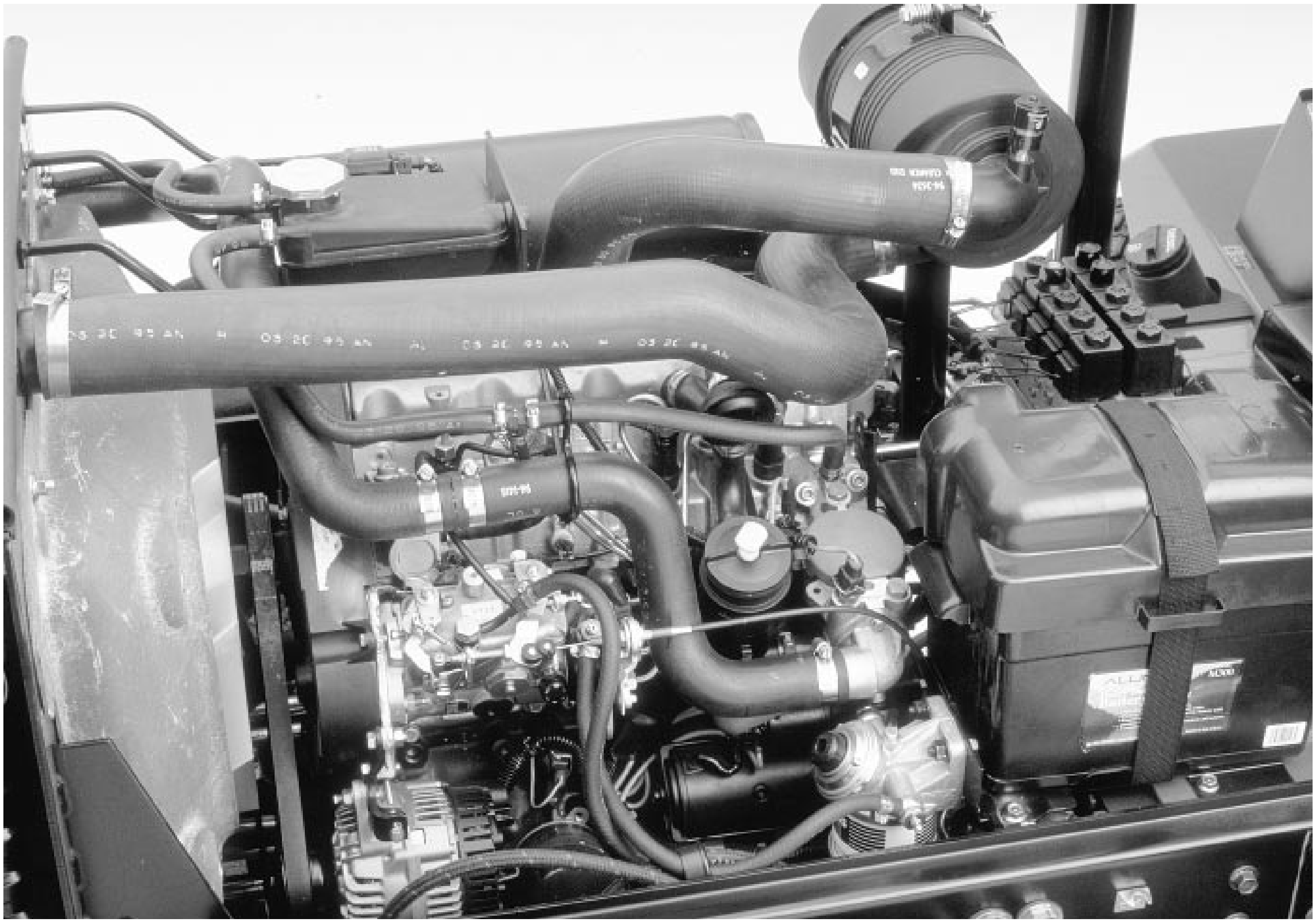


Figure 57

Removing the Engine

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

2. Drain oil from engine.

3. Remove the hood.

4. Disconnect positive (+) and negative (–) battery cables from battery. Remove battery.

5. Open the radiator cap. Open radiator drain valve or remove lower radiator hose and allow coolant to drain into a pan.

6. Drain coolant from engine block.

CAUTION

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

7. Disconnect upper and lower radiator hoses from engine and radiator.

8. Remove fuel hose from injector pump. Plug end of fuel line to prevent fuel leakage. Disconnect injector return hose.

9. Disconnect PCV hose from engine.

10. Disconnect and tag electrical wires that attach to the engine or engine components: alternator, starter motor and solenoid, ground cable, oil pressure switch, tem-

Engine

perature gauge sender, thermoswitch, fuel stop (ETR) solenoid, glow plugs.

11. Remove fan shroud from radiator.

12. Support hydraulic pump assembly, then disconnect hydraulic pump assembly from engine. Do not disconnect hydraulic lines from hydraulic pumps.

13. Disconnect throttle cable from speed control lever on fuel injection pump. Loosen clamp and remove throttle cable and from engine bracket.

14. Remove any other parts and components that interfere with removal of the engine.

15. Remove fasteners securing engine to engine mounts.

16. Attach a short section of chain between the two lifting brackets on the engine. Connect hoist, or block and tackle chain at center of the short section of chain. One person should operate hoist or block and tackle and other person should help guide engine out of chassis. Remove engine from chassis. Be careful when removing engine to prevent damage to engine, radiator or other parts. Mount engine in an engine rebuilding stand.

17. Remove muffler, brackets, coolant expansion tank and accessories from engine as necessary. Drain oil from engine and remove engine oil filter.

Installing the Engine

1. To install the engine, perform steps 2- 17 of Removing the Engine in reverse order.

2. After disassembling or overhauling the engine, install a new oil filter. Replace this filter after the first 20 to 50 hours of operation.

3. Fill the engine with the correct oil. Fill the cooling system with recommended antifreeze, and clean, soft water. Check for oil and coolant leaks and repair as necessary.

Peugeot recommended Coolant/Antifreeze is available in 1 U.S. Gallon containers under Toro Part No. 93-7213.

IMPORTANT: The anti-freeze should contain no Borate and have a Ph of 7 to 8.5.

4. Adjust the throttle linkage.

Engine Overhaul

Disassembly of External Components

1. Remove TDC sensor and clutch housing centering pin.

2. Mount the engine on a stand.

3. Lock the flywheel with TOR FD86 tool.

4. Remove exhaust manifold and inlet manifold.

5. Remove the coolant manifold.

6. Remove the alternator and belt.

7. Remove the oil filter (Fig. 57, Item 10).

8. Remove the injector pipes (Item 12).

9. Remove the glow plug leads.

10. Remove the crankcase breather pipes/oil filter/filter pipe assembly (Item 13).

11. Remove the oil pressure switch (Item 14).

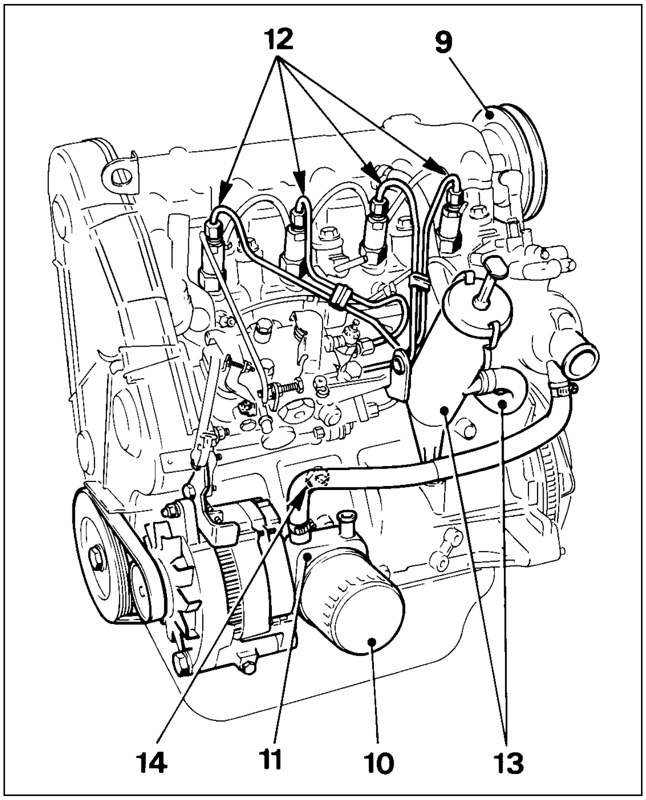


Figure 57

Engine

12. Remove the thermostat housing cover (Fig. 58, Item 17).

13. Remove the thermostat housing (Item 18).

14. Remove the injectors (Item 19) and retrieve the copper washer (Item 20), and flame trap washer (Item 21).

15. Remove the glow plugs (Item 22).

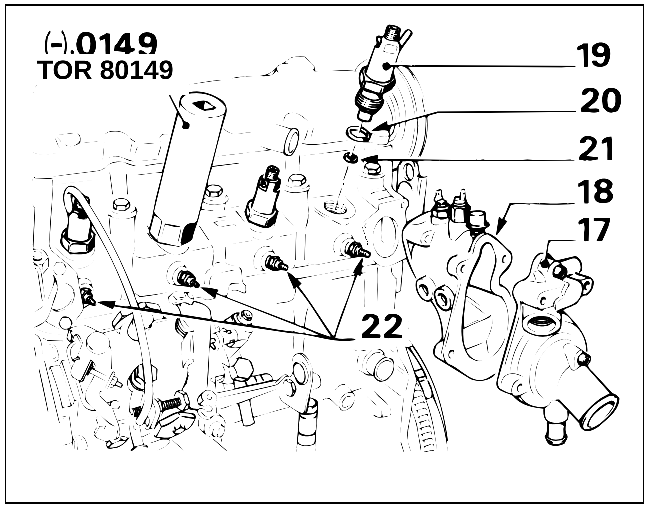


Figure 58

Injection Pump Removal

1. Remove the timing belt.

2. Use injector pump gear puller TOR70153H, to remove injector pump gear (Fig. 58a, Item 5).

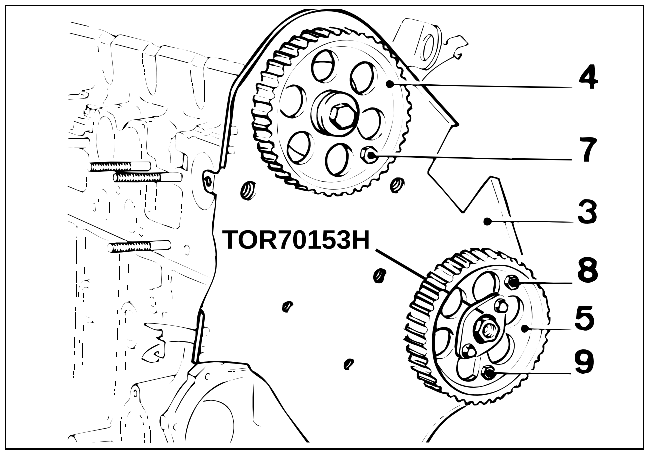


Figure 58a

3. Remove the injection pump (Fig. 58b, Item 19).

4. Remove bracket (Item 20).

NOTE: If the pump needs to be inspected or repaired it is recommended that is be done by an authorized CAV Lucas ROTO DIESEL service dealer - especially during the warranty period. Repairs by non-authorized dealers WILL void the pump warranty.

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

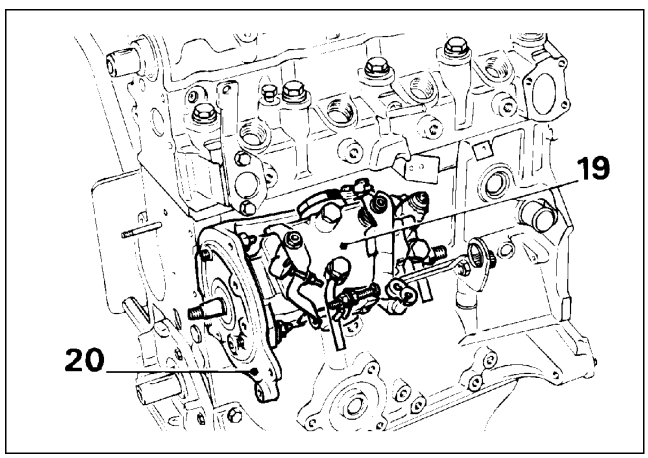


Figure 58b

Cylinder Head Removal

1. Remove the cylinder head cover.

2. Use a Torx head T55 tool to loosen the cylinder head bolts, working in a spiral from the outside. Remove the cylinder head bolts.

IMPORTANT: DO NOT pry at gasket surface to loosen cylinder head from block.

3. Use levers (0.0149) to release the cylinder head from the block.

4. Remove the cylinder head and gasket.

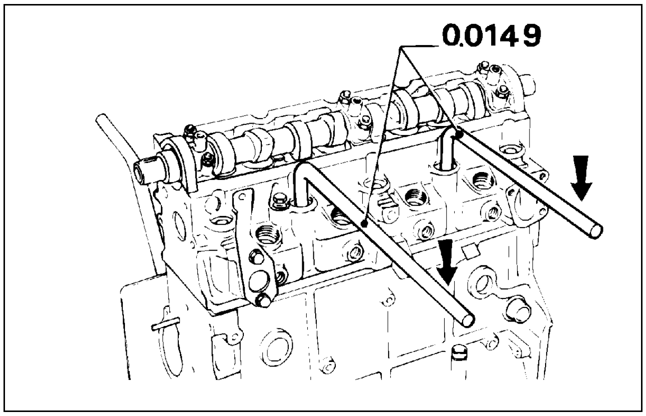


Figure 59

Oil Pump Removal

1. Remove the oil pan and gasket

IMPORTANT: Use solvent and a wood or plastic scraper to remove the silicone gasket material. Be careful not to damage the sealing face of the block.

2. Remove the bolts (Fig. 60, Item 1, 2, and 3).

3. Remove the seal carrier plate (Item 4).

IMPORTANT: The bolt (Item 1) is a special bolt that centers the pump in the correct location.

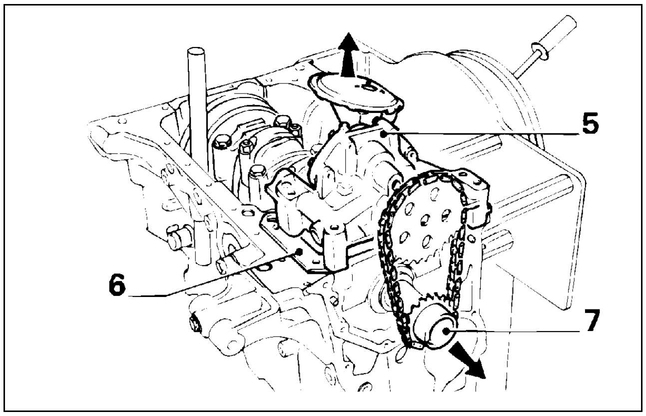


Figure 60

4. Remove the pump (Fig. 61, Item 5) / drive chain / crankshaft sprocket (Item 7) assembly. NOTE: Item 6 - spacer is not used on engines used in TORO machines.

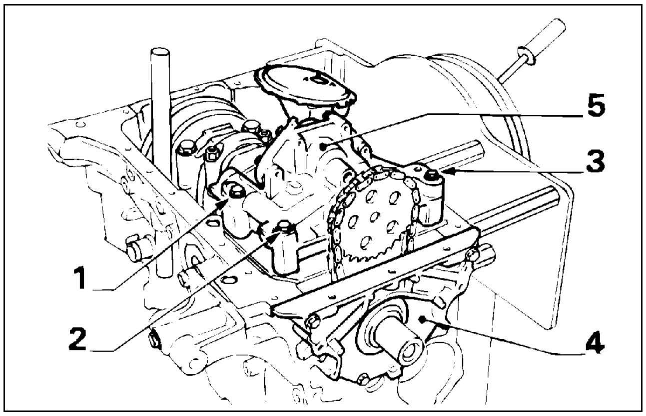


Figure 61

Engine

Crankshaft and Piston Removal

1. Remove flywheel locking tool.

2. Remove the connecting rod end caps (Fig. 62, Item 8), marking each cap for re-installation in the same location.

NOTE: Connecting rods and end caps are not numbered. Once they are removed there is no way of knowing the correct location for installation unless you mark them for re-installation.

3. Remove the flywheel.

4. Remove the main bearing caps (Item 9) (marks are cast-in).

5. Retrieve end float washers with No. 2 cap.

5. Remove the oil seal (Fig. 63, Item 10).

6. Remove the end float washers (Item 11).

7. Remove the crankshaft.

8. Remove the main bearing shells.

9. Remove the piston/connecting rod assemblies, marking each piston and connecting rod for re-installation in the same location.

NOTE: Connecting rods and end caps are not numbered. Once they are removed there is no way of knowing the correct location for installation unless you mark them for re-installation.

10. Remove the piston pin circlips and separate the pistons from the connecting rods.

11. Remove the plugs (Fig. 63 and 64, Item 12) from the oil galleries.

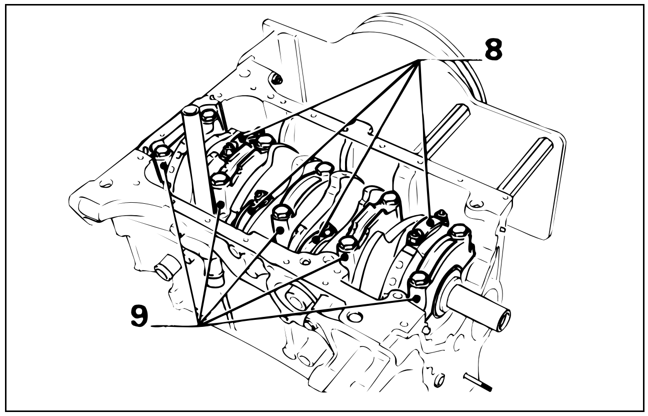


Figure 62

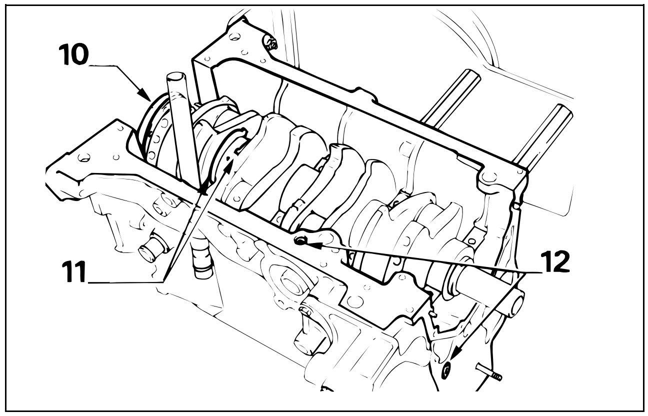


Figure 63

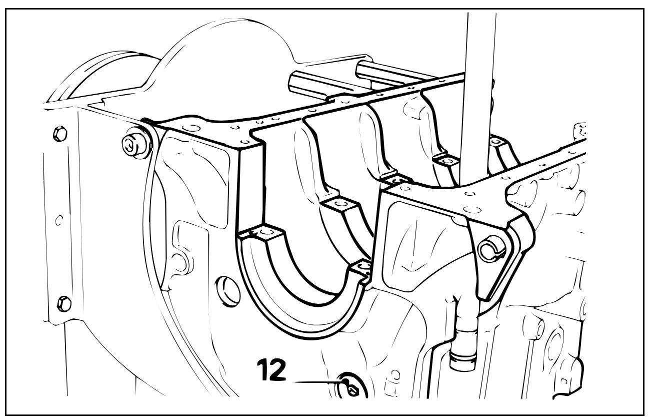


Figure 64

Cylinder Head Overhaul

1. Progressively slacken the camshaft bearing caps (Fig. 65, Item 1).

2. Remove the bearing caps (Item 1), oil seals (Item 2), camshaft (Item 3), tappets (Item 4) and adjustment shims (Item 5). Mark adjustment shims and tappets so they will be re-installed in the same location – #1 intake, #1 exhaust, #2 intake, #2 exhaust, etc.

NOTE: The shims are small and can stick to the tappets.

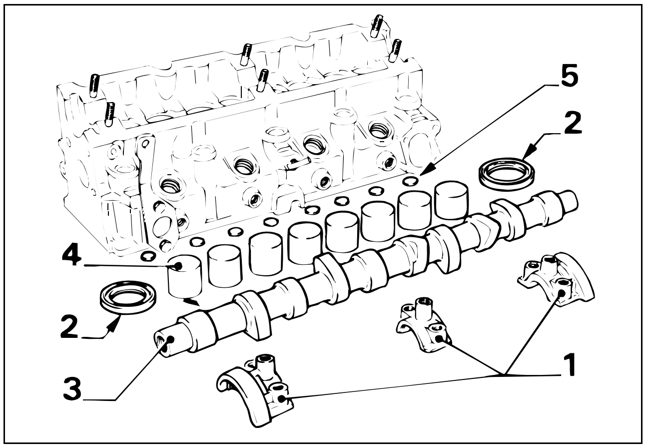


Figure 65

3. Use a valve compressor to remove the eight valves (Fig. 66).

4. Use a hammer and drift to remove the swirl chambers from the injector orifices, if necessary.

NOTE: Swirl chambers do not need to be removed unless cylinder head is to be machined or replaced.

5. Clean the cylinder head. Use a wooden scraper and gasket stripping solvent to clean the gasket face. DO NOT use a metal scraper.

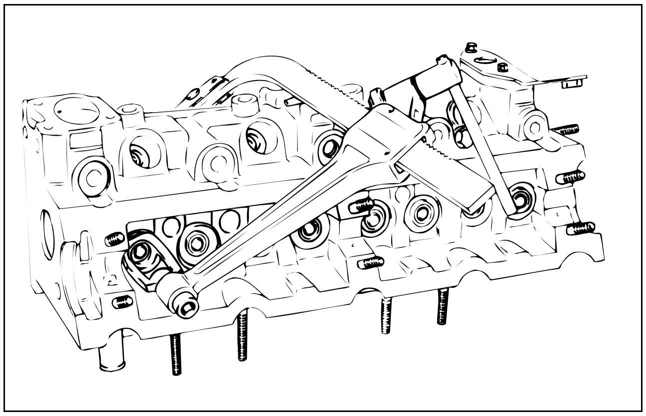


Figure 66

6. Check the gasket face for bow (flatness). Check corner to corner and side to side (Fig. 67).

Maximum bow: 0.7 mm.

7. Check the condition of the valve seats and guides, valve, valve springs, swirl chambers, camshaft, camshaft bearings and all tapped holes. (See Identification and Specifications section.)

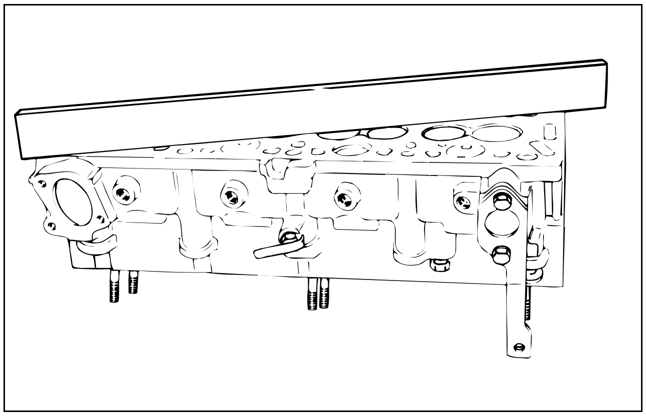


Figure 67

Engine

8. Check the protrusion of the swirl chambers (Fig. 68, A).

Protrusion: 0 to 0.03 mm

Achieve this dimension by machining faces (a) and (b).

9. Check the valve recess (B).

Exhaust: 0.9 to 1.45 mm
Inlet: 0.5 to 1.05 mm

Achieve this dimension by machining the valve seats.

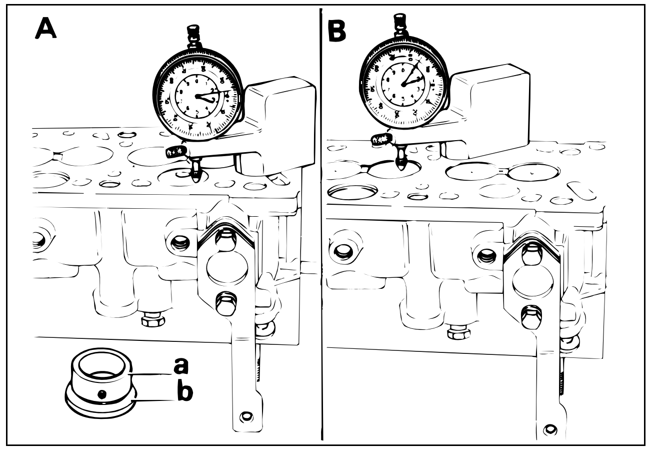


Figure 68

10. Lap in the valves.

11. Re-install the valves.

IMPORTANT: If the cylinder head has been machined, fit compensating washers under the valve springs. (See Identification and Specifications section.)

12. Install the shims as removed in step 2. If replacing cylinder head or if cylinder head has been machined, install a basic shim (Fig. 69, Item 6) (2.425 mm thick) to each valve stem and check that each shim is higher than the spring cup (Item c). If a shim is not higher than the cup, grind the top of the cup (Item c).

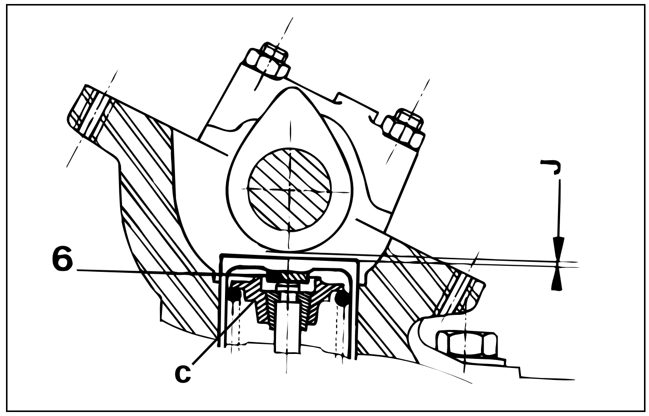


Figure 69

13. Re-install the tappets.

14. Oil the camshaft bearings.

15. Install the camshaft, with the **DIST** mark at the timing gear end.

16. Progressively tighten the bearing caps to a torque of 17.5 Nm (13 ft-lb). The bearing caps have cast-in markings for correct installation.

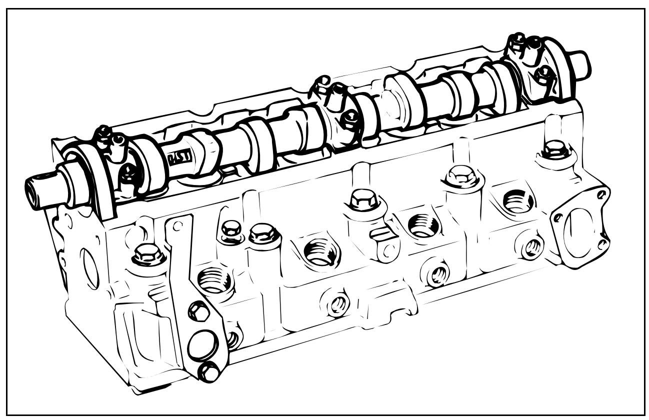


Figure 70

Crankshaft Installation

1. Put thread lock Loctite on the oil gallery plugs and install them in the cylinder block.

2. Install the grooved main bearing shells. (See Crankshaft in the Inspection and Specifications section for main bearing shell thickness.)

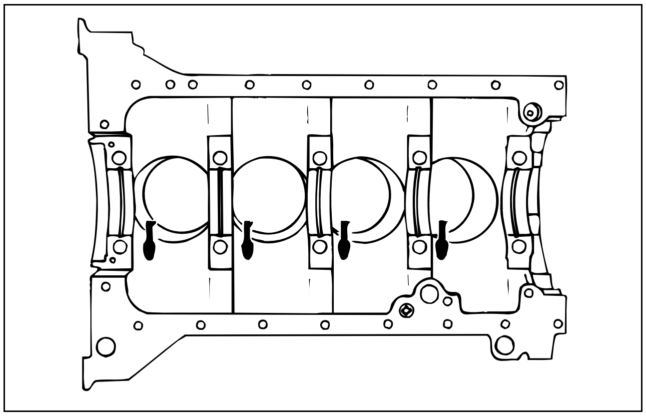


Figure 71

3. Install the crankshaft.

4. Install the no. 3, 4 and 5 main bearing caps.

5. Install the two end float half-washers (Fig. 72, Item 1), with the anti-friction faces towards the crankshaft.

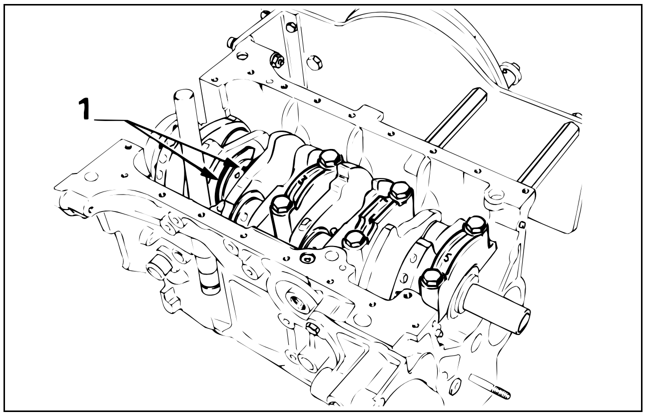


Figure 72

6. Install the no. 2 main bearing cap (Fig. 73, Item 2) with its two end float half-washers, with the anti-friction faces towards the crankshaft.

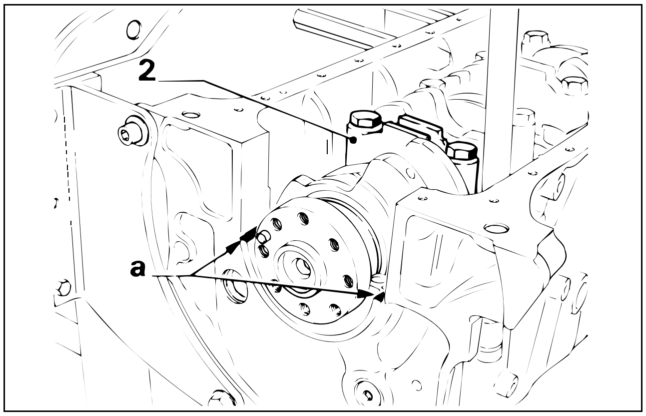


Figure 73

Engine

7. Check crankshaft end float (Fig. 74):

A. Install the dial indicator, using tools TOR 80110G1, TOR 80504 A1 and A2.

B. End float must be between 0.07 and 0.32 mm.

NOTE: For choice of half-washer thickness see Crankshaft in the Identification and Specifications section.

8. Apply a thin coat of Formetanch or Permatex No. 2 sealant to surface of block where bearing cap will mate (Fig. 73, Item a).

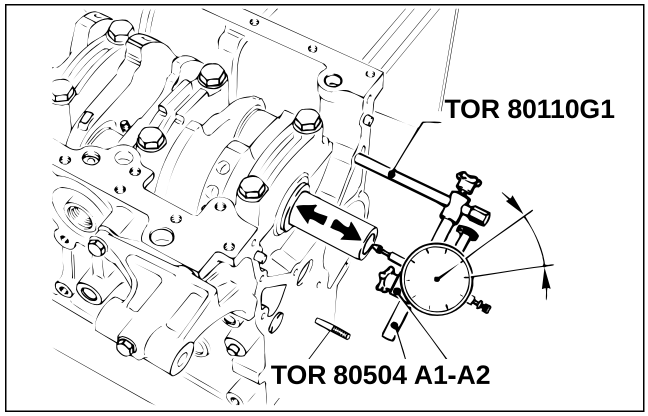


Figure 74

9. Install the two new side seals (Fig. 75, Item 3) to no. 1 main bearing cap.

10. Using a bolt and washer (Item 5), attach tool 80153 fitted with shims A2 to no. 1 main bearing cap (Item 4).

11. Adjust the height (**x**) of the shims.

x = 0.5 mm above flat on side of rear main cap

12. Oil the shims and the housing.

IMPORTANT: To avoid stretching the side seals, fit the cap as follows:

A. Engage it in its housing at 45°.

B. Straighten it.

C. Lower it slowly.

D. Tighten the two bearing cap bolts (Item 6) finger tight.

E. Remove the capscrew securing the tool to the main bearing cap and withdraw the tool horizontally.

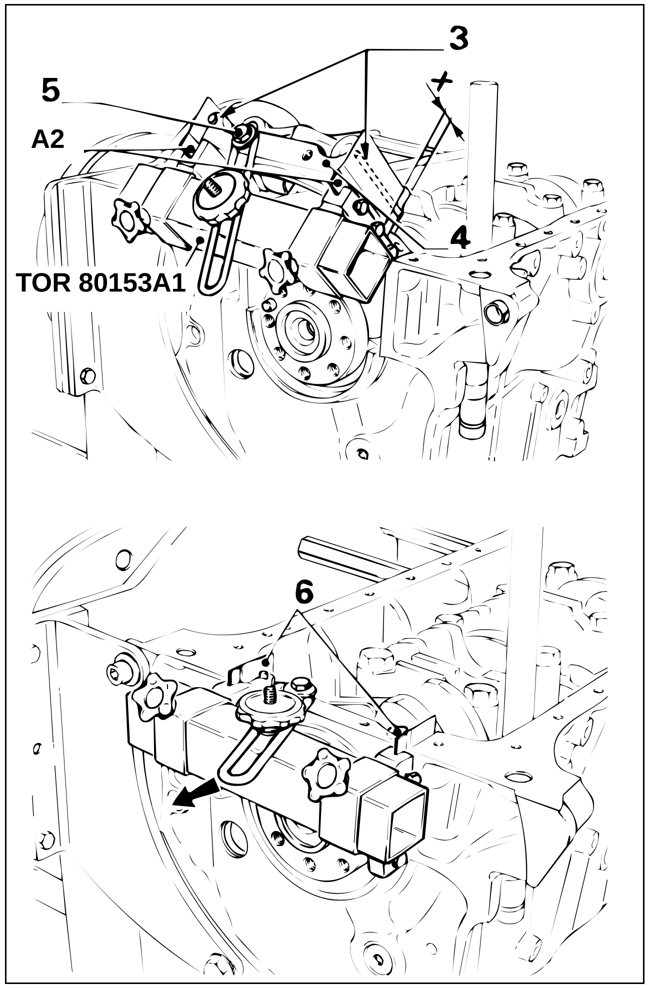


Figure 75

13. Tighten the bearing cap bolts to a torque of 70 Nm (52 ft-lb).

14. Using shim TOR 80110DZ, cut off the side seals so that they protrude 2 mm.

15. Check that the crankshaft rotates without tight spots.

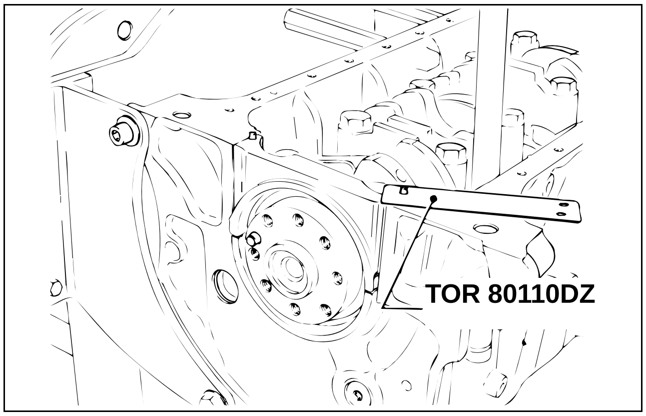


Figure 76

Pistons and Connecting Rod Assembly

1. Assemble the connecting rods and pistons with the bearing shell tab recess (Fig. 77, Item a) on the same side as the piston crown recess (Item b).

2. Use a piston rings pliers to install the piston rings:

NOTE: The marked face of the tapered ring must be towards the combustion chamber.

(1) – scraper ring
(2) – tapered ring
(3) – domed chrome ring

Space the ring gaps at 120° in relation to the scraper ring gap (Item c).

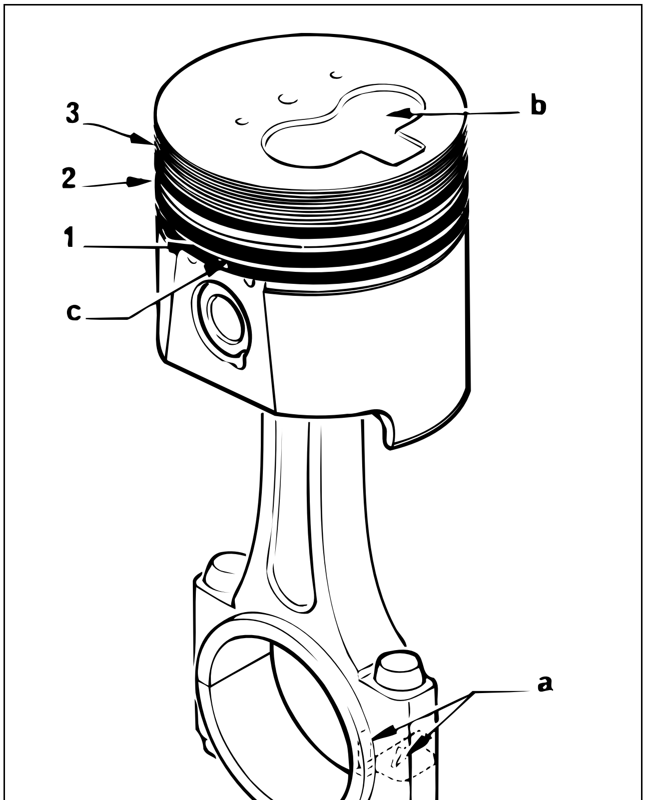


Figure 77

3. Oil the piston and tighten the piston ring clamp (Fig. 78, Item 4).

4. Remove the connecting rod end caps.

5. Install the pistons in the bores, matching the markings made when removed, and aligning the crown recess (Item a) on the oil filter side of the block.

6. Install the connecting rod end caps. Tighten the nuts to a torque of 50 Nm (37 ft-lb).

NOTE: For choice of bearing shell thickness, see Crankcase in Identification and Specifications section.

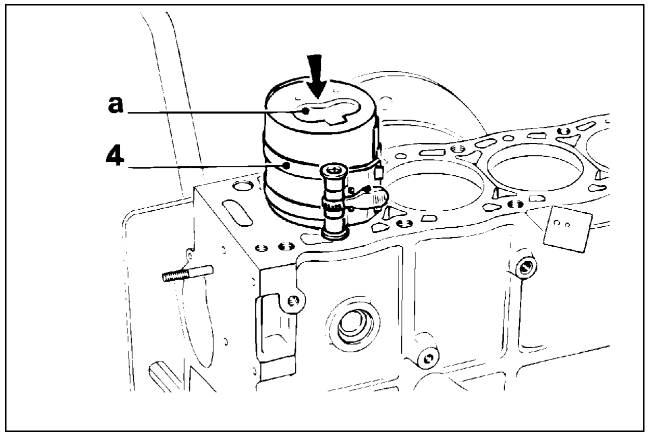


Figure 78

Oil Seal Installation

1. Put a new oil seal on tool TOR 70153 C.

2. Install seal with lip toward the inside of the engine block to keep the oil in. Fit the seal by tapping fully home with a mallet.

3. Withdraw the tool with a twisting movement.

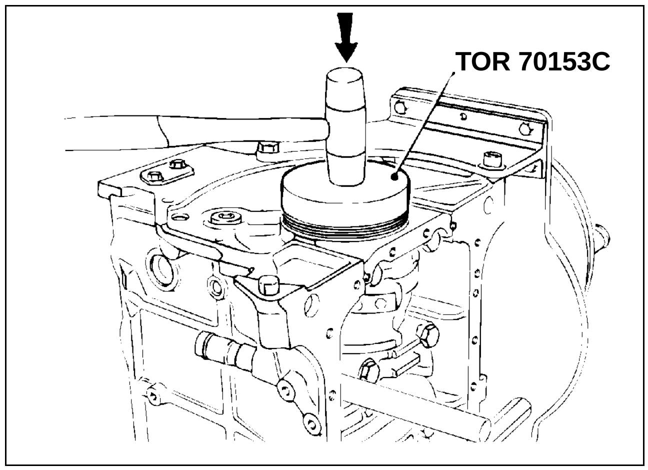


Figure 79

Oil Pump Installation

1. Install the key (Fig. 80, Item 6).

2. Install the pump (Item 7), drive chain and sprocket (Item 8) assembly.

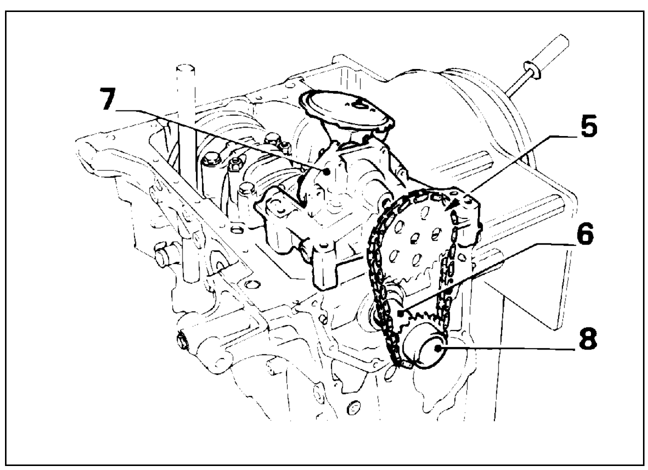


Figure 80

3. Install the special shoulder bolt (Fig. 81, Item 1) to center the pump in the proper location.

4. Install the other bolts and tighten the bolts (Item 1, 2, 3) to a torque of 20 Nm (15 ft-lb).

5. Install the seal carrier plate and a new gasket (Item 4) and tighten the bolts to a torque of 15 Nm (11 ft-lb).

6. Put a new oil seal on tool TOR 70153 D.

7. Install the seal by tapping it fully home with a mallet.

8. Apply Formetanch or Permatex No. 2 sealant as shown (Item a).

9. Apply silicone sealant to the oil pan using the pattern shown in Figure 81a. Wait 10 minutes before installing the oil pan to allow partial hardening of the gasket material.

10. Install the oil pan (Item 5).

11. Install the bolts (Item b).

NOTE: The two shorter bolts are installed into the main bearing cap.

12. Tighten the bolts (Item b) to a torque of 20 Nm (15 ft-lb).

13. Wait a minimum of 1 hour for the oil pan gasket to harden before filling with oil.

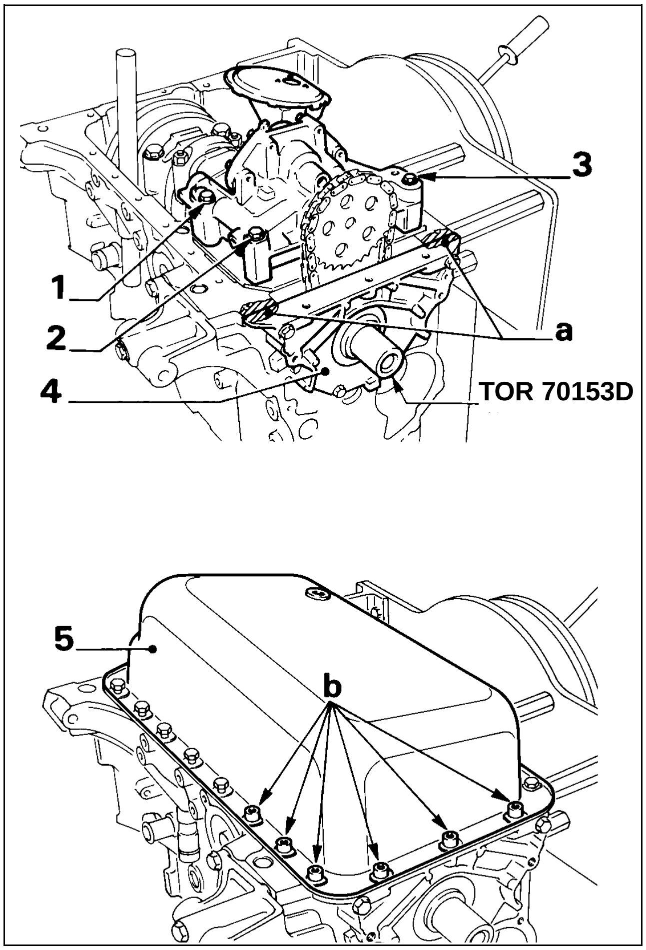


Figure 81

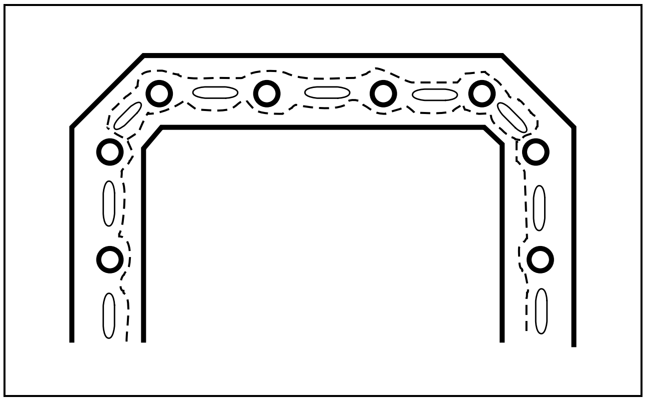


Figure 81a

Flywheel Installation

1. Install the flywheel. Put Locket thread lock on the flywheel mounting bolts.

2. Install a TORFD86 flywheel locking tool.

3. Tighten the flywheel bolts to a torque of 50 Nm (37 ft-lb).

4. Remove the flywheel locking tool.

Cylinder Head Gasket Selection

1. Install the dial indicator on support TOR 80110 H and zero it on a surface plate.

2. Turn the crankshaft and measure the protrusion of each piston at TDC.

3. Note the maximum protrusion (Fig. 82, Item d).

4. Select a cylinder head gasket of suitable thickness.

Units: mm

Piston protrusion (**d**)	Thickness identification
0.56 to 0.71	2 notches
0.71 to 0.75	3 notches
0.75 to 0.79	4 notches
0.79 to 0.83	5 notches

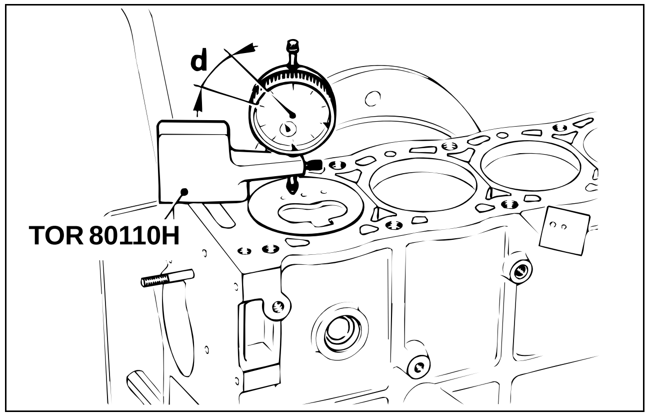


Figure 82

Cylinder Head Installation

1. Turn the crankshaft to put the pistons at mid-stroke with damper pulley key (Fig. 83, Item 6) at the 9 o'clock position.

2. Clean the tapped holes in the cylinder block (12 x 150 thread).

3. Install the centralizing dowel (Item 7).

4. Install a new head gasket (dry).

5. Install the cylinder head.

6. Carefully clean the threads of the cylinder head bolts with a brush.

7. Coat the bolt threads and washer contact faces with MOLYKOTE G RAPID.

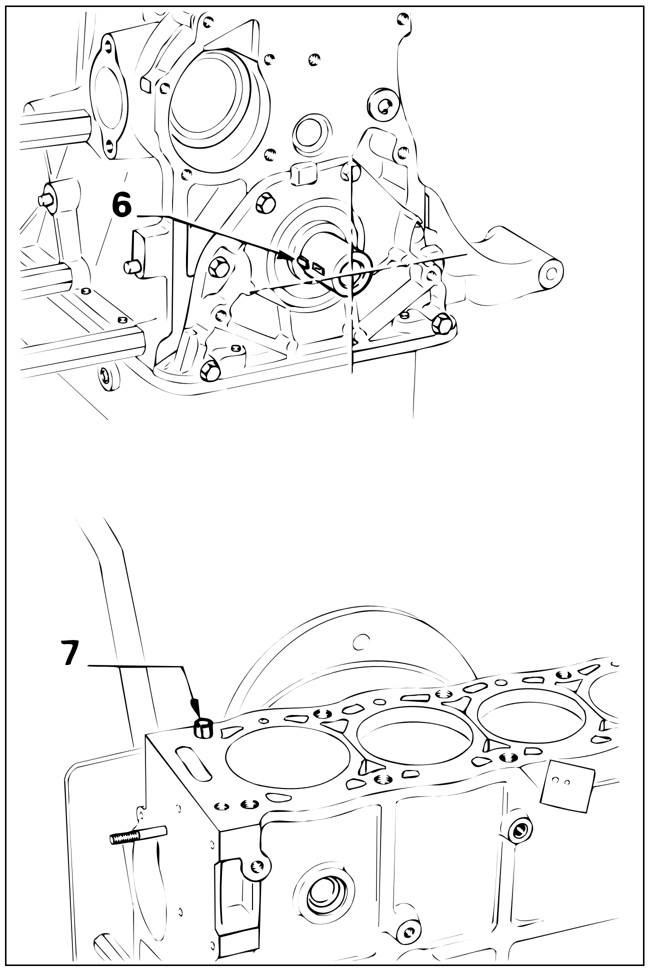


Figure 83

Cylinder Head Tightening

1. Install new washers on the bolts.

2. Pre-tighten the bolts in the order shown (Fig. 84) to a torque of 30 Nm (22 ft-lb).

3. Tighten the bolts in the order shown to a torque of 70 Nm 52 ft-lb).

4. Tighten each bolt in the order shown an additional 120° ± 2°.

NOTE: The special cylinder head bolts (Item B) do not require re-tightening. The bolts can be removed and re-installed 5 times before replacing with new bolts.

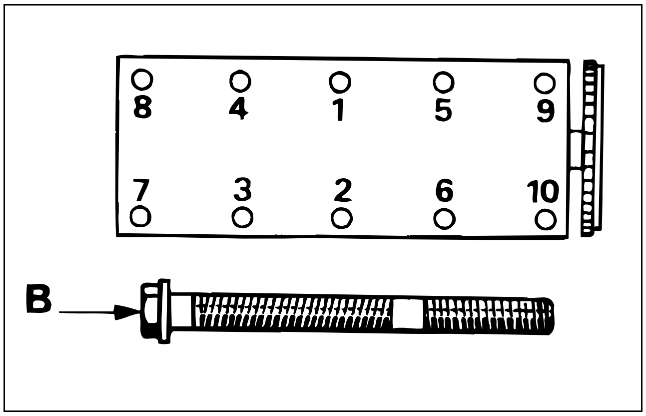


Figure 84

Valve Clearance Adjustment

NOTE: If all valve parts are re-installed in their original location it should not be necessary to adjust valve clearance, unless the head has been machined or valves ground.

1. Install the camshaft gear. (Fig. 85, Item 1).

2. Check the valve clearance:

Units: mm

	Running Clearance
Inlet	0.15
Exhaust	0.30
Tolerance	± 0.04

Set “on the rock”	Inlet 4, Exhaust 4	Inlet 1, Exhaust 1
Check	Inlet 1, Exhaust 1	Inlet 4, Exhaust 4
	Inlet 2, Exhaust 3	Inlet 3, Exhaust 2

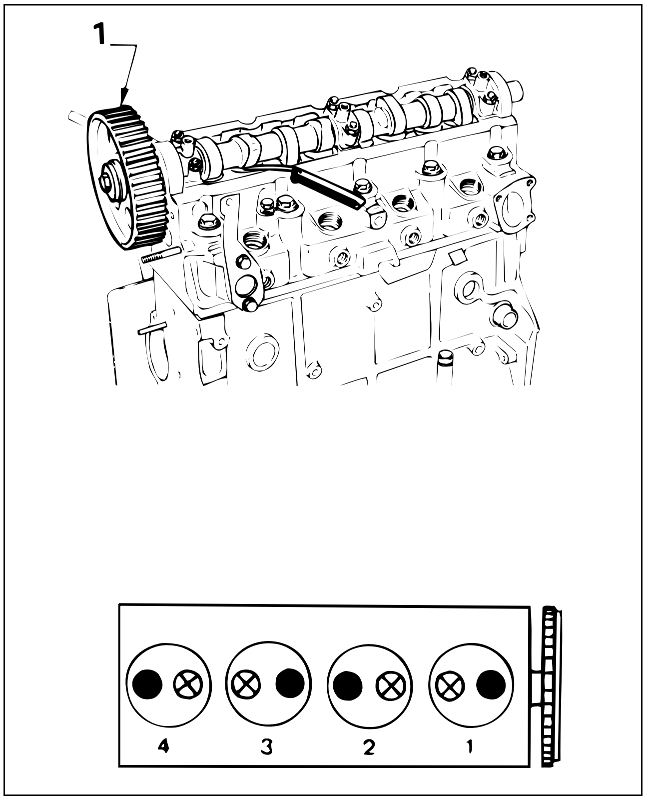


Figure 85

Engine

3. Remove the camshaft gear (Fig. 86, Item 1).

4. Remove the camshaft bearing caps (Item 2).

5. Remove the camshaft (Item 3).

6. Remove the tappets (Item 4).

7. Remove the basic shims (Item 5).

8. Determine the shim thickness to be fitted for each valve. Example:

Units: mm

	No. 1 Intake valve
Specified clearance	0.15
Clearance measured	0.25
Difference	+ 0.10
Shim installed	2.425 *
Shim to be installed	2.50
Clearance obtained	0.175

* Basic shim

9. Install the shims as determined in step 8.

10. Install the tappets.

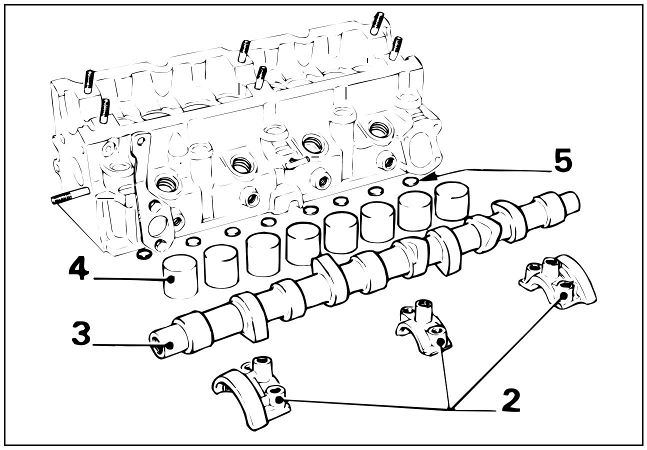


Figure 86

11. Apply a thin coat of Formetanch or Permatex No. 2 sealant to each end of the bearing housing at (Fig. 87, Item a).

12. Apply MOLYKOTE G RAPID to the bearing surfaces on the camshaft.

13. Install the camshaft (Item 3) with the DIST marking at the timing gear end.

14. Install the camshaft bearing caps (Item 2) as shown by cast-in markings.

15. Progressively tighten the bearing caps to 17.5 Nm (13 ft-lb).

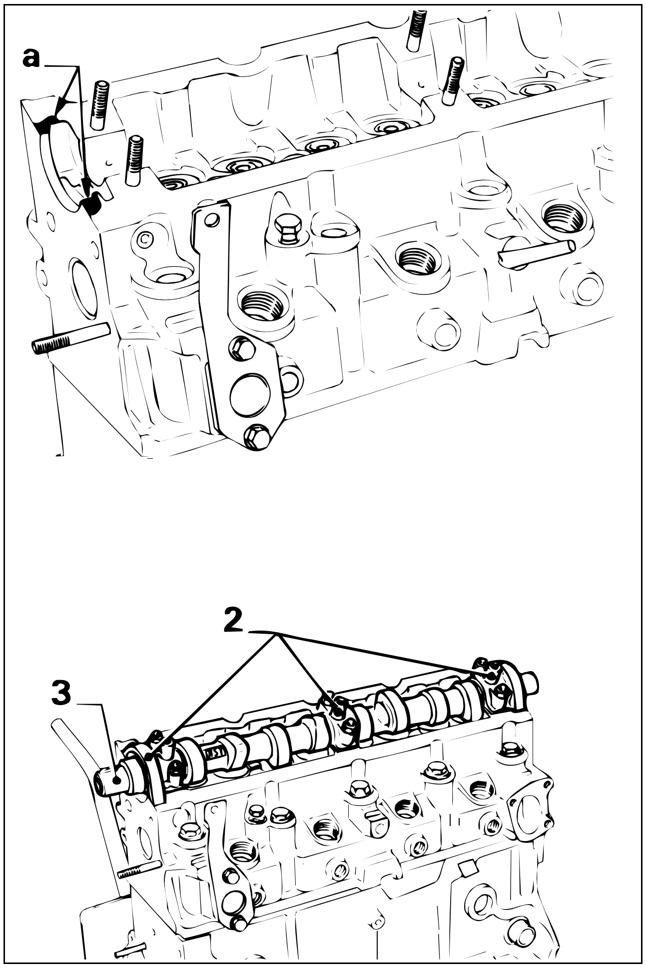


Figure 87

16. Install a new oil seal on tool TOR 976697 on the side where the inner flange is the farthest away (Fig. 88).

17. Use a camshaft gear or pulley bolt to install the two camshaft oil seals.

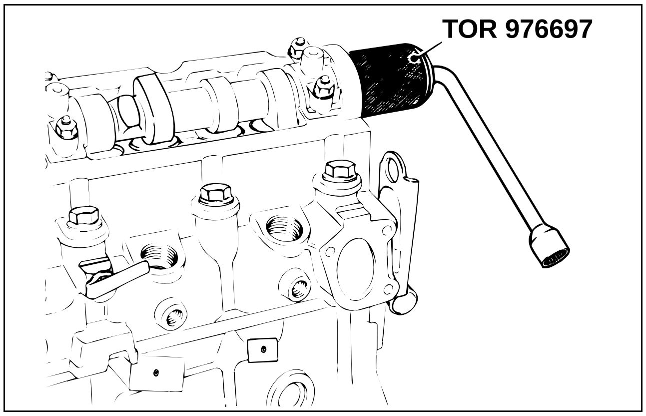


Figure 88

Engine

Assembly of External Components

1. Install new fire ring washers (Fig. 89, Item 1), convex surface facing up.

2. Install new copper washers (Item 2).

3. Install the injectors and tighten to a torque of 90 Nm (66 ft-lb).

4. Install the pre-heat plugs (Item 4) and tighten to a torque of 22 Nm (16 ft-lb).

5. Install the thermostat housing (Item 5) and cover (Item 6), fitted with a new thermostat and gasket.

6. Install the cylinder head cover (Item 7), and tighten to a torque of 10 Nm (7 ft-lb).

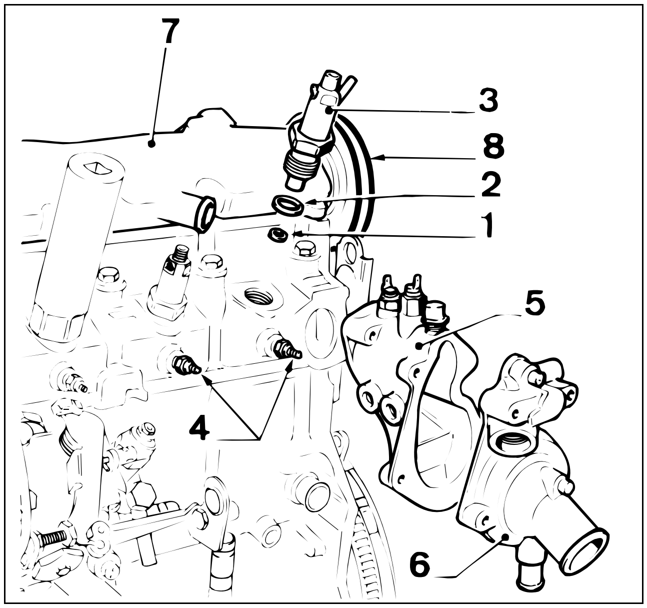


Figure 89

7. Install the pre-heat plug wires.

8. Install the breather pipe assembly, with oil filler pipes and filler orifice (Fig. 90, Item 13).

9. Install the injector pipes (Item 12).

10. Install the oil pressure switch (Item 14) and tighten to a torque of 27.5 Nm (20 ft-lb).

11. Install a new oil filter (Item 10). (See Break-in Engine After Overhaul.)

12. Install the alternator and alternator belt.

13. Install the water inlet housing.

14. Install the exhaust manifold with new seals.

15. Install the intake manifold.

16. Remove the engine from the stand.

17. Install the clutch housing centering pin.

18. Install the TDC sensor.

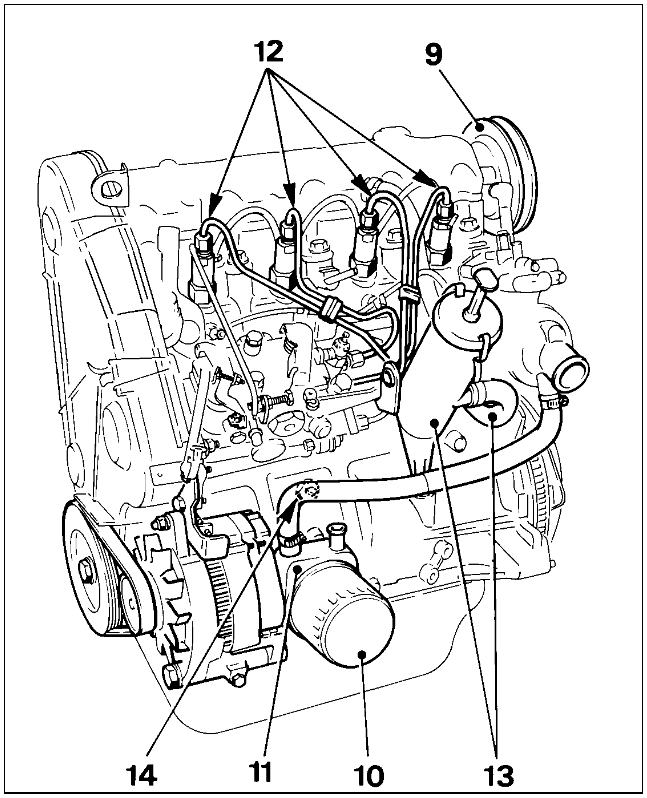


Figure 90

Break-in Engine After Overhaul

After disassembling or overhauling the engine, install the a new oil filter. Replace this filter with a new filter after the first 20 to 50 hours of operation.

Engine

Chapter 4

Hydraulic System

Table of Contents

Specifications

Item	Description
Traction Pump Traction Relief Pressure Charge Pressure	Servo controlled piston pump 3800 – 4200 PSI 150 – 210 PSI
Traction Motor (front & rear w/4WD)	Fixed displacement piston motor
Steering/Reel Pump Steering Relief Pressure	3-section gear pump 1350 – 1450 PSI
Valve Blocks Front & Rear Reel Circuit Relief Pressure Lift Relief Pressure	Cartridge logic, elec./hyd., solenoid actuated 3000 – 3200 PSI 2600 – 2900 PSI
Reel Motor Cross–over Relief Pressure	Gear motor 1400 – 1600 PSI
Hydraulic Filter	Spin–on cartridge type, 50 PSI by-pass
Hydraulic Fluid Group 1 (for ambient temp. consistently below 100F) Group 2 (Biodegradable)	 ISO type 46/68 anti–wear hydraulic fluid (Mobil 424 or equiv.*) ISO VG 32/46 anti–wear hydraulic fluid (Mobil EAL 224 H)
Reservoir (Fig. 1)	Reservoir capacity approx. 8.5 gal. U.S. System capacity approx. 10 gal.U.S.

***Equivalent Hydraulic Fluids (interchangeable):**

Amoco 1000
International Harvester Hy–Tran
Texaco TDH
Shell Donax TD
Union Oil Hydraulic/Tractor Fluid
Chevron Tractor Hydraulic Oil
BP HYD TF
Exxon Torque Fluid
Conoco Power–Tran 3
Kendall Hyken 052
Phillips HG Fluid

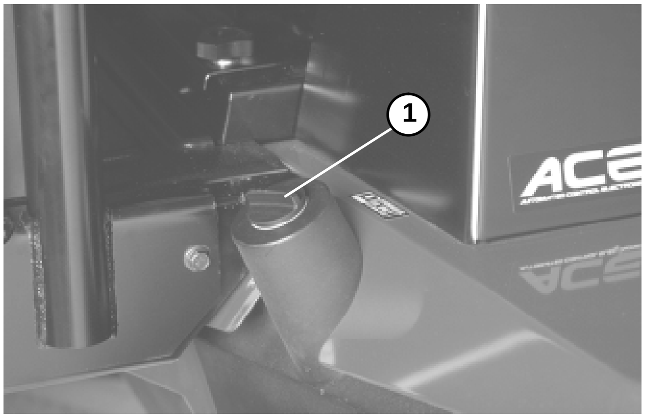


Figure 1

1. Hydraulic Reservoir Cap

NOTE: A red dye additive for the hydraulic oil is available in 2/3 oz. bottles. One bottle is sufficient for 4 to 6 gallons of hydraulic oil. Order Part No. 44–2500 from your authorized Toro Distributor.

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 hydraulic system, all pressure in system must be relieved by stopping the engine and lowering or supporting the box and/or other attachment.

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 (Fig. 2, 3)

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

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

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

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

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

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

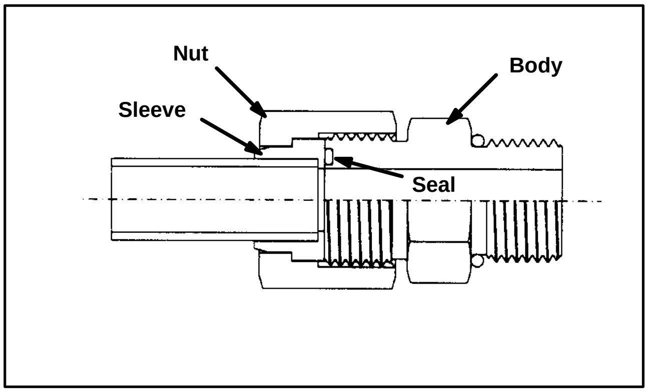


Figure 2

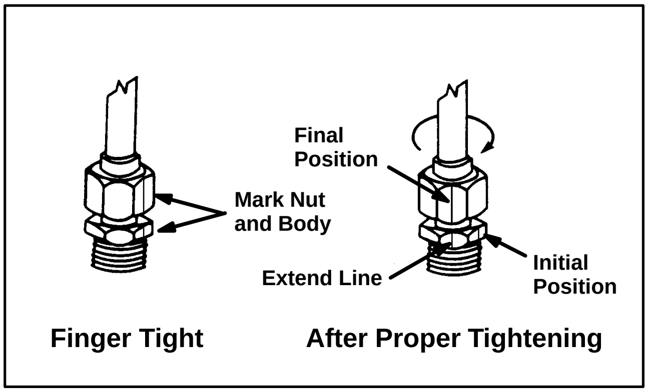


Figure 3

Hydraulic System

SAE Straight Thread O–Ring Port – Non–adjustable (Fig. 4)

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.

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

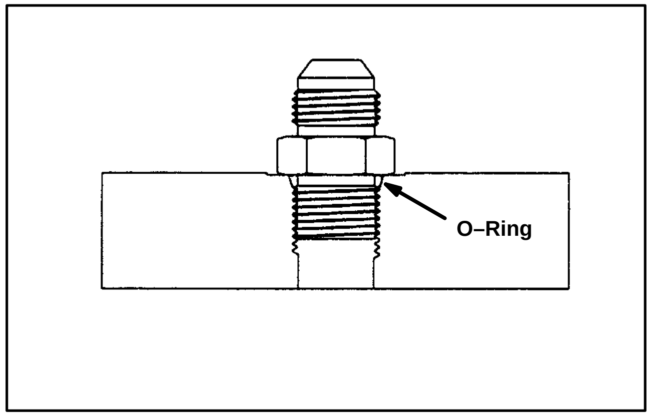


Figure 4

SAE Straight Thread O–Ring Port – Adjustable (Fig. 5, 6)

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. 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

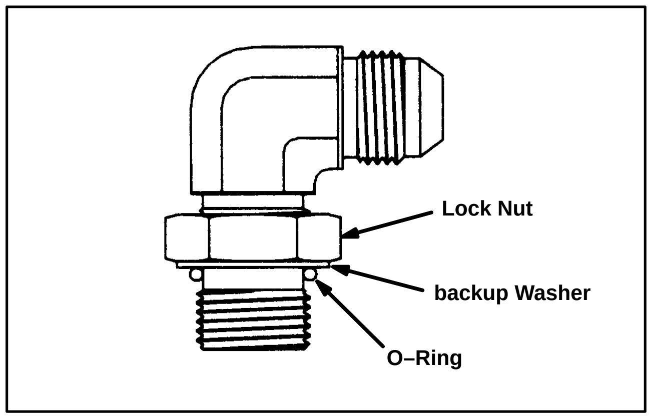


Figure 5

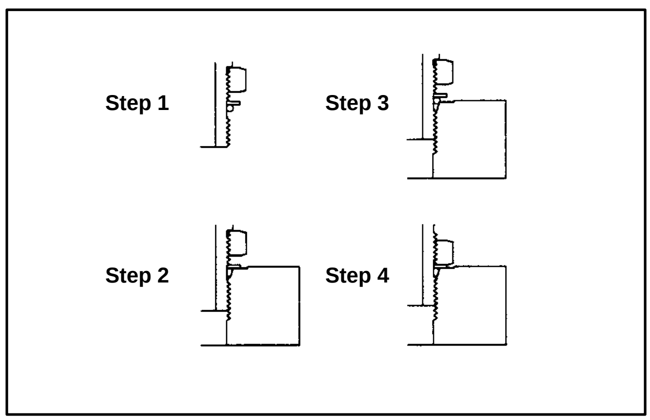


Figure 6

Pushing or Towing Traction Unit

In an emergency, the Reelmaster 6500–D can be moved by actuating the by–pass valve in the variable displacement hydraulic pump and pushing or towing the machine.

IMPORTANT: Do not push or tow the machine faster than 2–3 mph (3–4.8 km/hr) because internal transmission damage may occur. The by–pass valve must be open whenever the machine is pushed or towed.

1. By–pass valve is located on top of variable displacement pump (Fig. 7). Rotate the valve 90°, in either direction, to open and allow oil to by–pass internally. Because fluid is by–passed, the machine can be moved – slowly – without damaging the transmission.

2. Close by–pass valve before starting the engine. However, do not exceed 5–8 ft–lb (7–11 Nm) torque to close the valve.

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

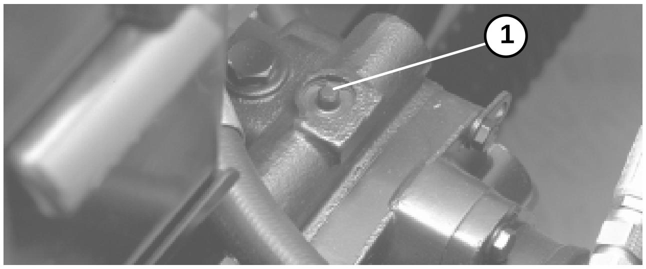


Figure 7

1. By–Pass Valve

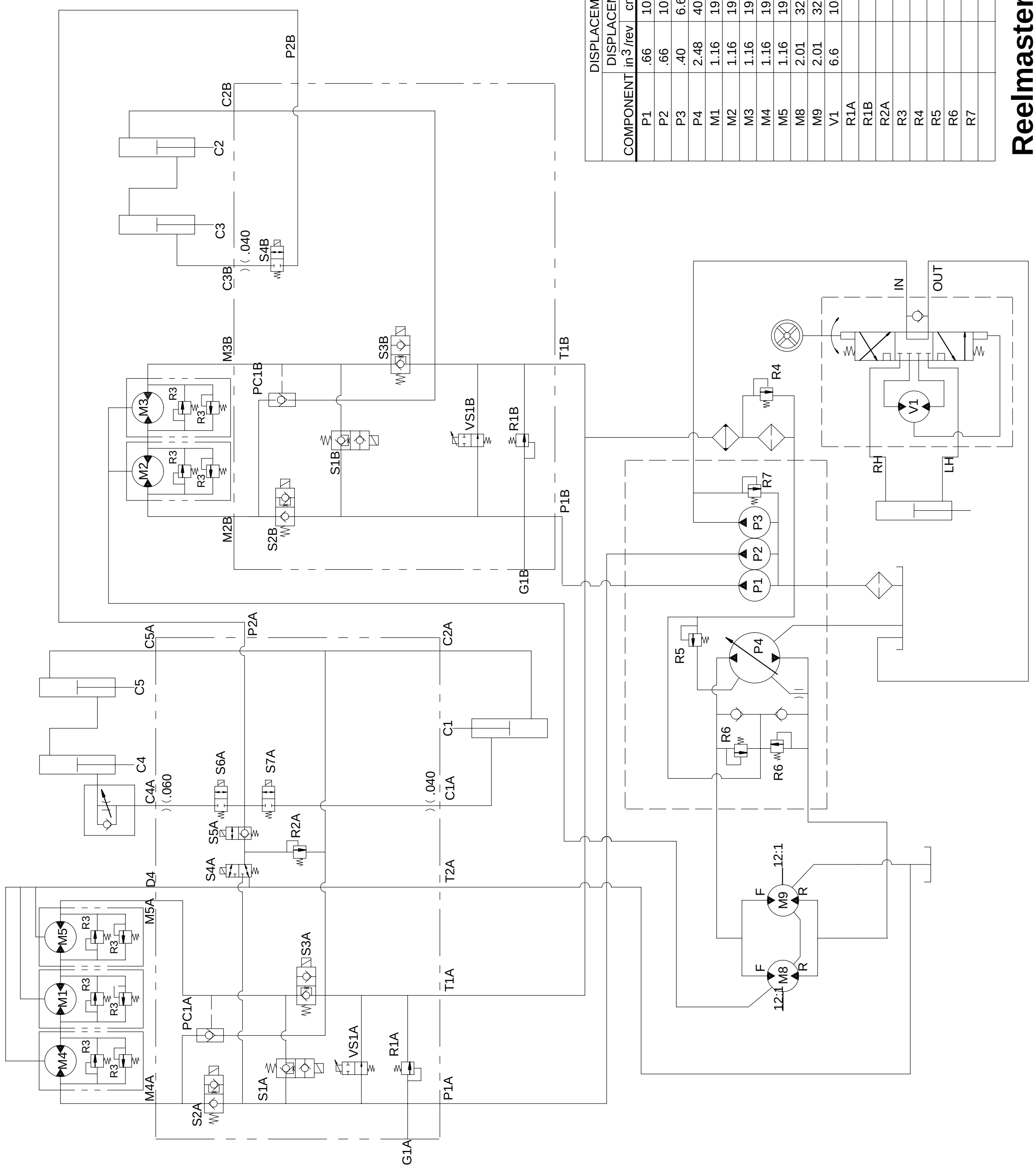
Hydraulic System

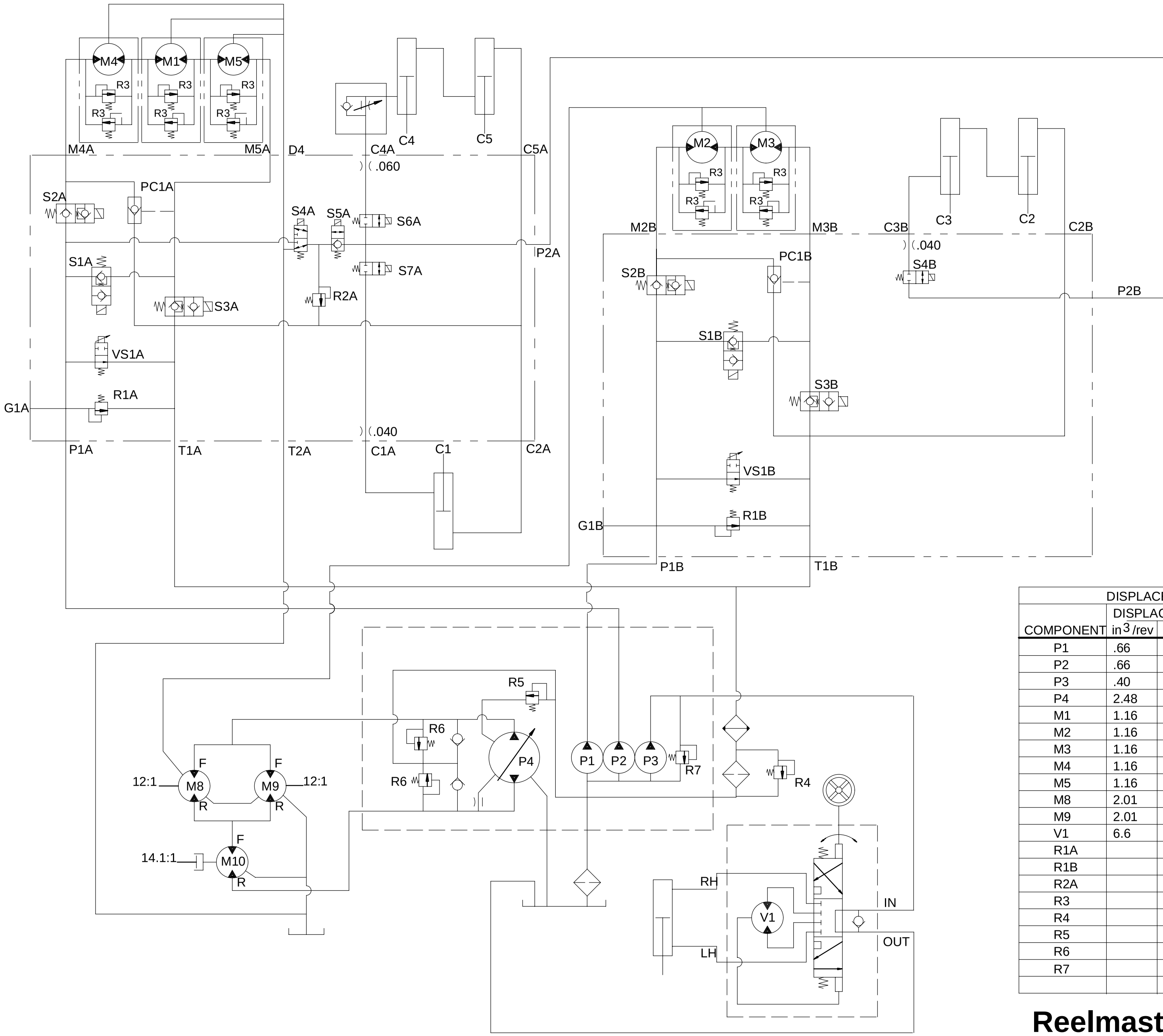
Hydraulic Schematics

COMPONENT	DISPLACEMENT in^3/rev	DISPLACEMENT cm^3/rev	PRESSURE lbs/in^2	PRESSURE BARS	*FLOW RATE GPM	*FLOW RATE LPM
P1	.66	10.8			7.0	26.5
P2	.66	10.8			7.0	26.5
P3	.40	6.6			4.2	15.9
P4	2.48	40.6			26.3	99.5
M1	1.16	19				
M2	1.16	19				
M3	1.16	19				
M4	1.16	19				
M5	1.16	19				
M8	2.01	32.9				
M9	2.01	32.9				
V1	6.6	108				
R1A			3000	207		
R1B			3000	207		
R2A			2750	190		
R3			1500	103		
R4			50	3		
R5			180	12		
R6			4000	276		
R7			1250	86		

DISPLACEMENT AND PRESSURE CHART

Reelmaster 6500–D 2WD



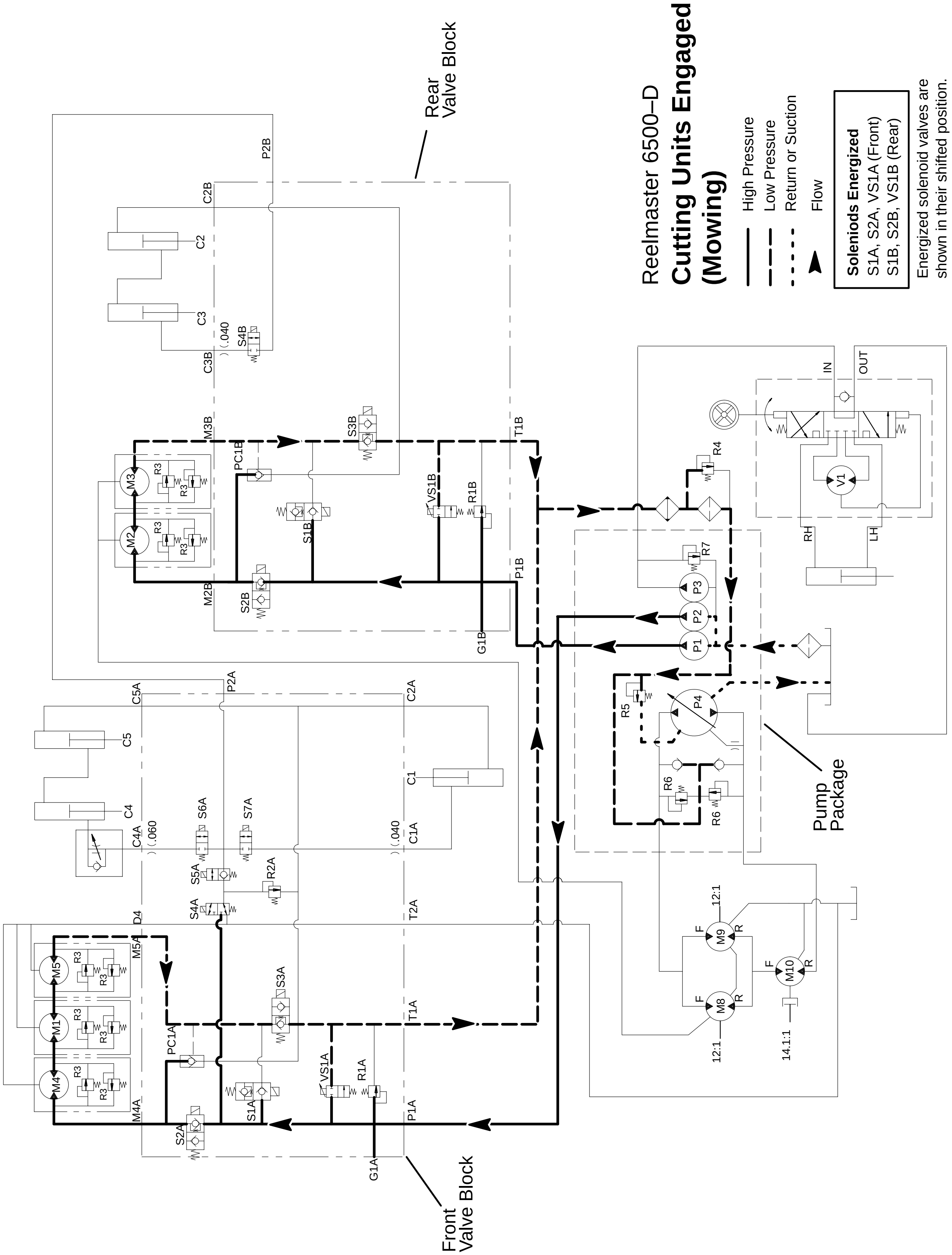


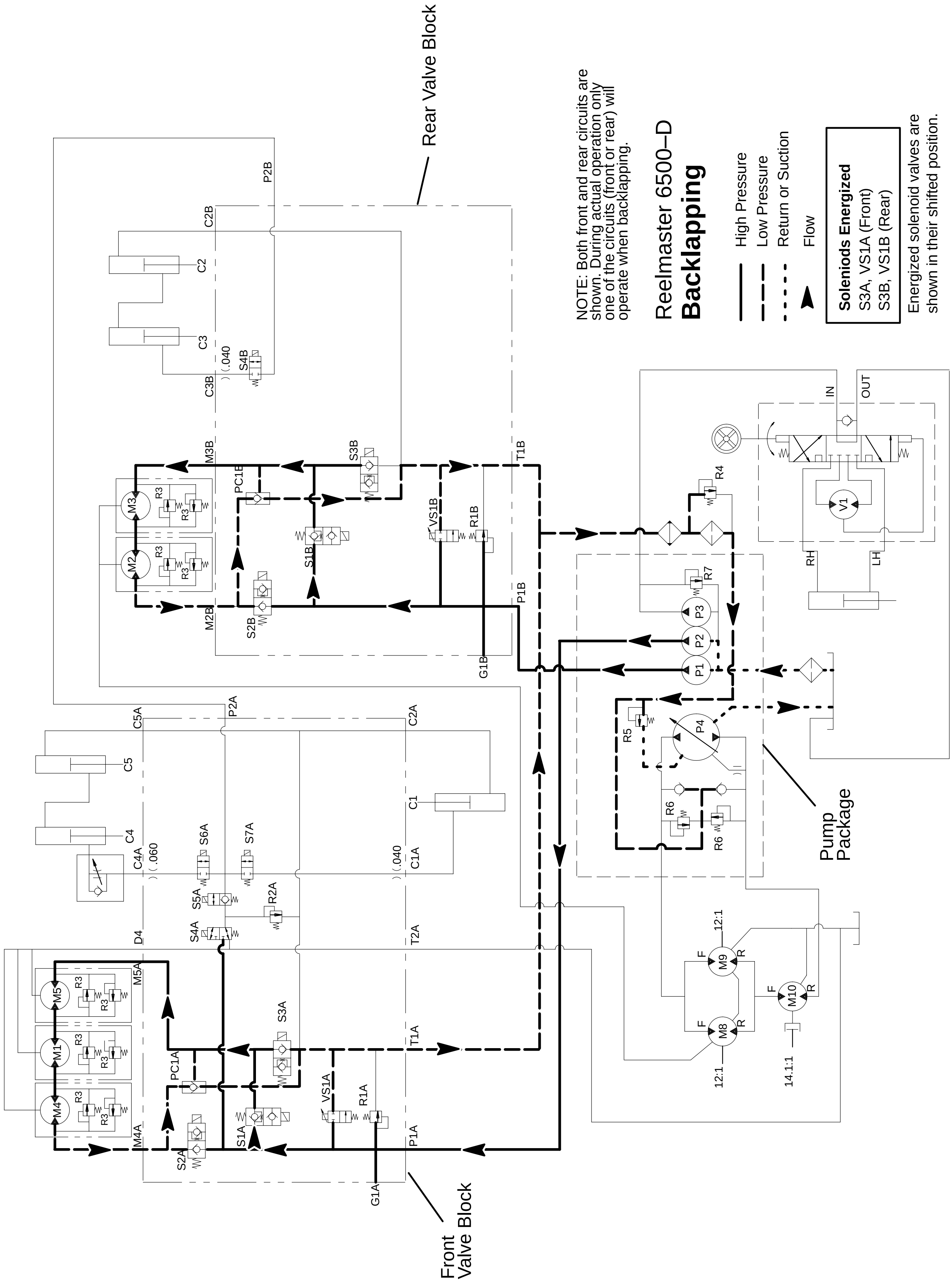
DISPLACEMENT AND PRESSURE CHART						
	DISPLACEMENT		PRESSURE		*FLOW RATE	
COMPONENT	in^3/rev	cm^3/rev	lbs/in^2	BARS	GPM	LPM
P1	.66	10.8			7.0	26.5
P2	.66	10.8			7.0	26.5
P3	.40	6.6			4.2	15.9
P4	2.48	40.6			26.3	99.5
M1	1.16	19				
M2	1.16	19				
M3	1.16	19				
M4	1.16	19				
M5	1.16	19				
M8	2.01	32.9				
M9	2.01	32.9				
V1	6.6	108				
R1A			3000	207		
R1B			3000	207		
R2A			2750	190		
R3			1500	103		
R4			50	3		
R5			180	12		
R6			4000	276		
R7			1250	86		

Reelmaster 6500–D 4WD

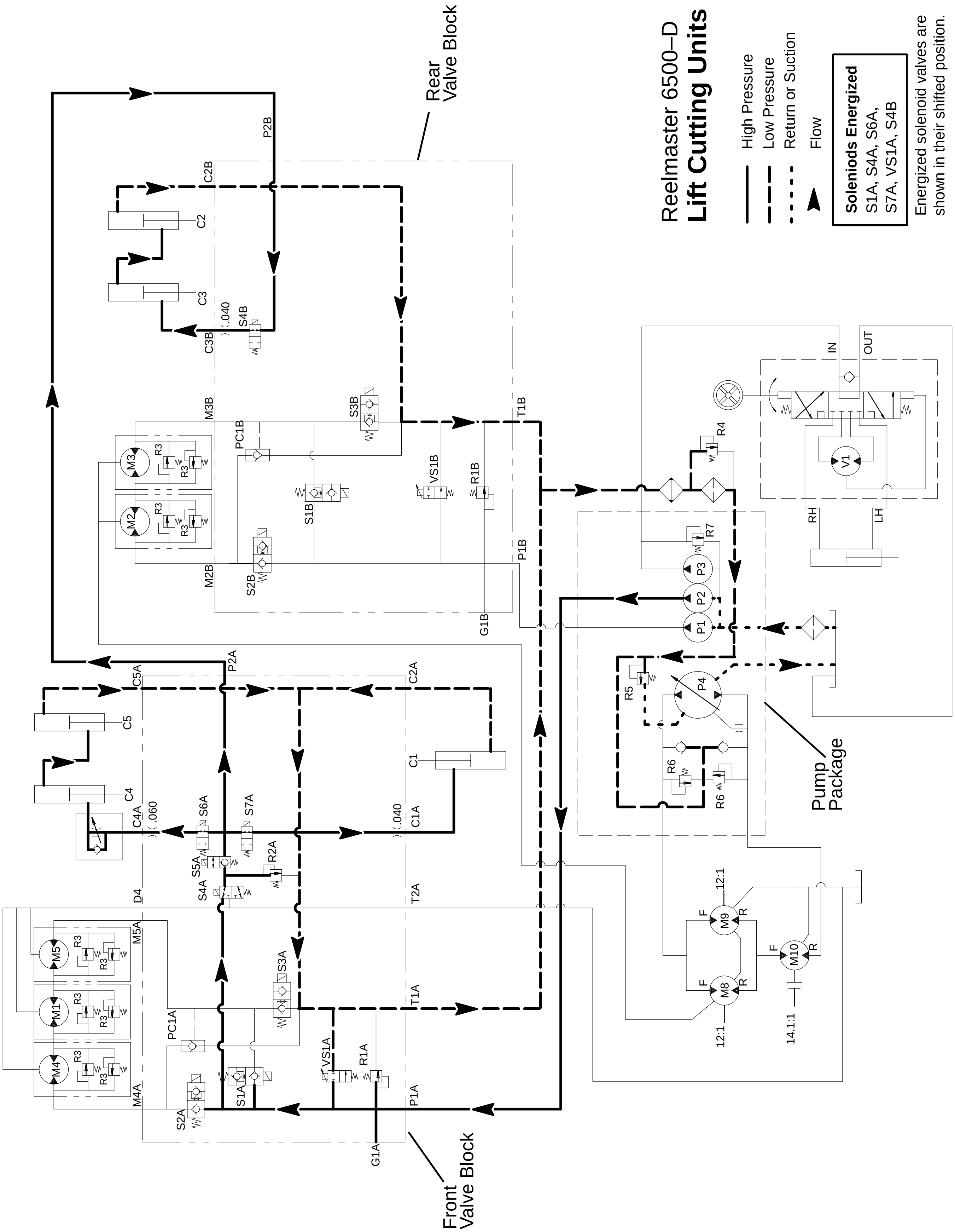
Hydraulic System

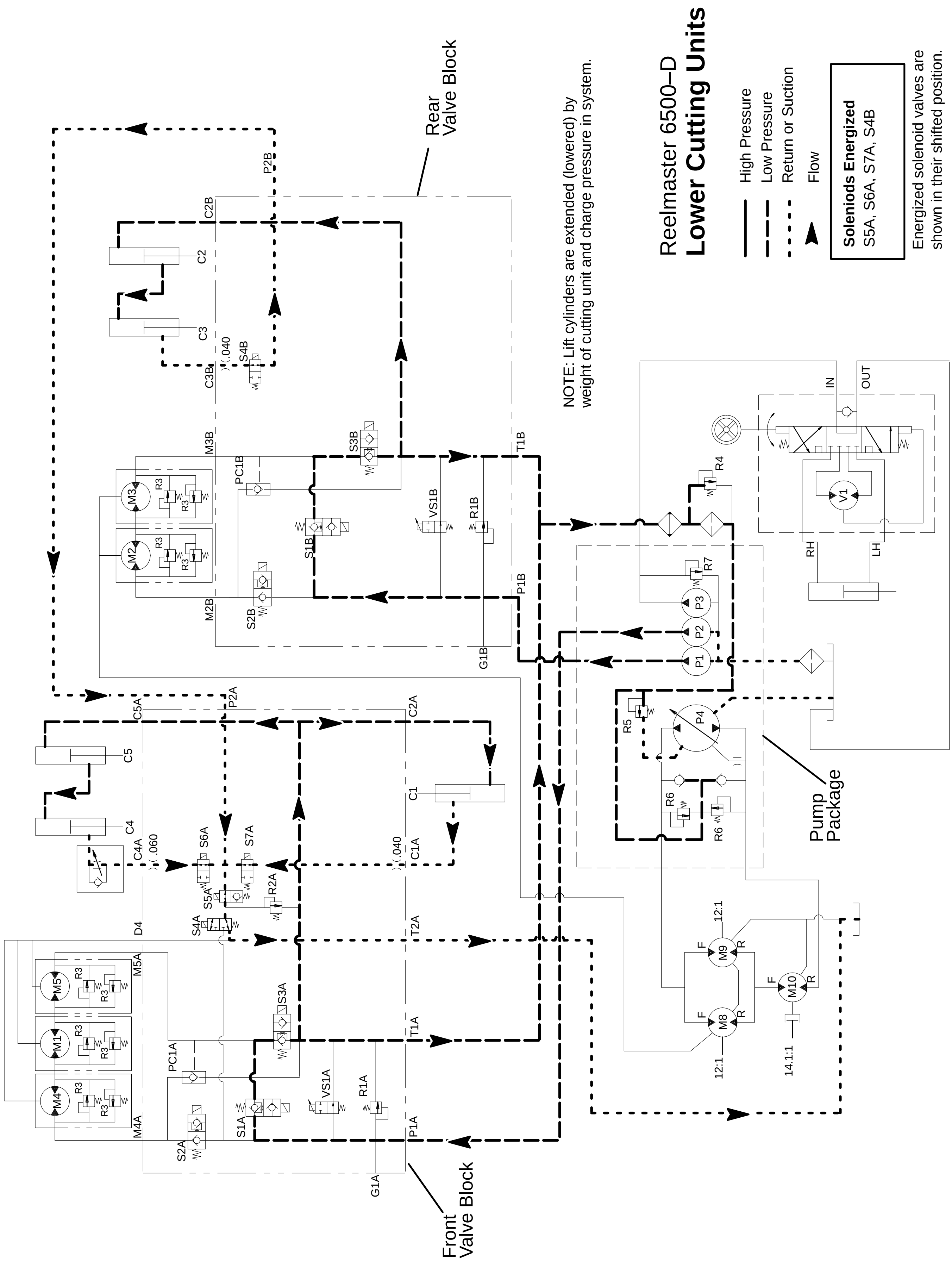
Reelmaster 6500–D
Cutting Units Engaged (Mowing)

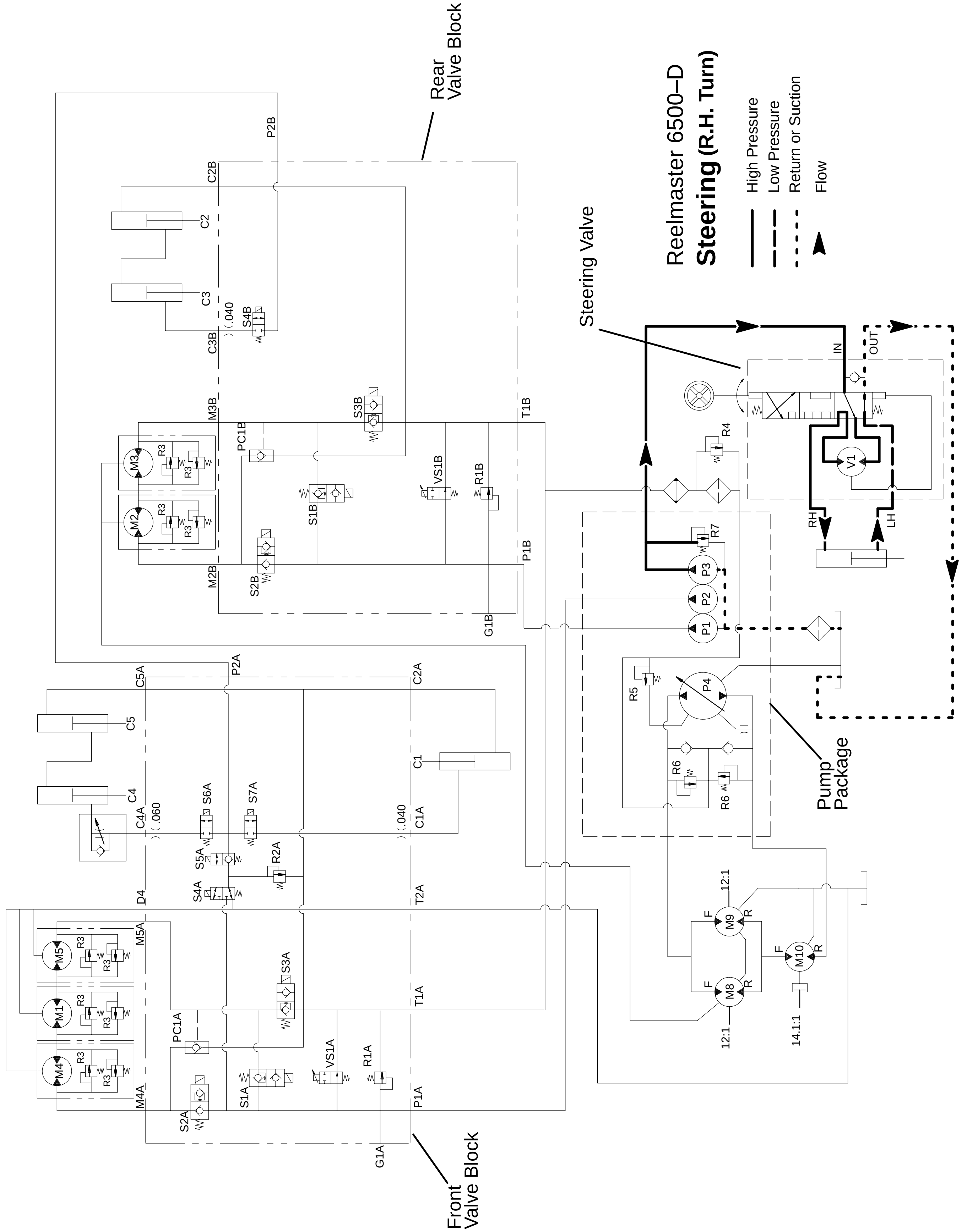


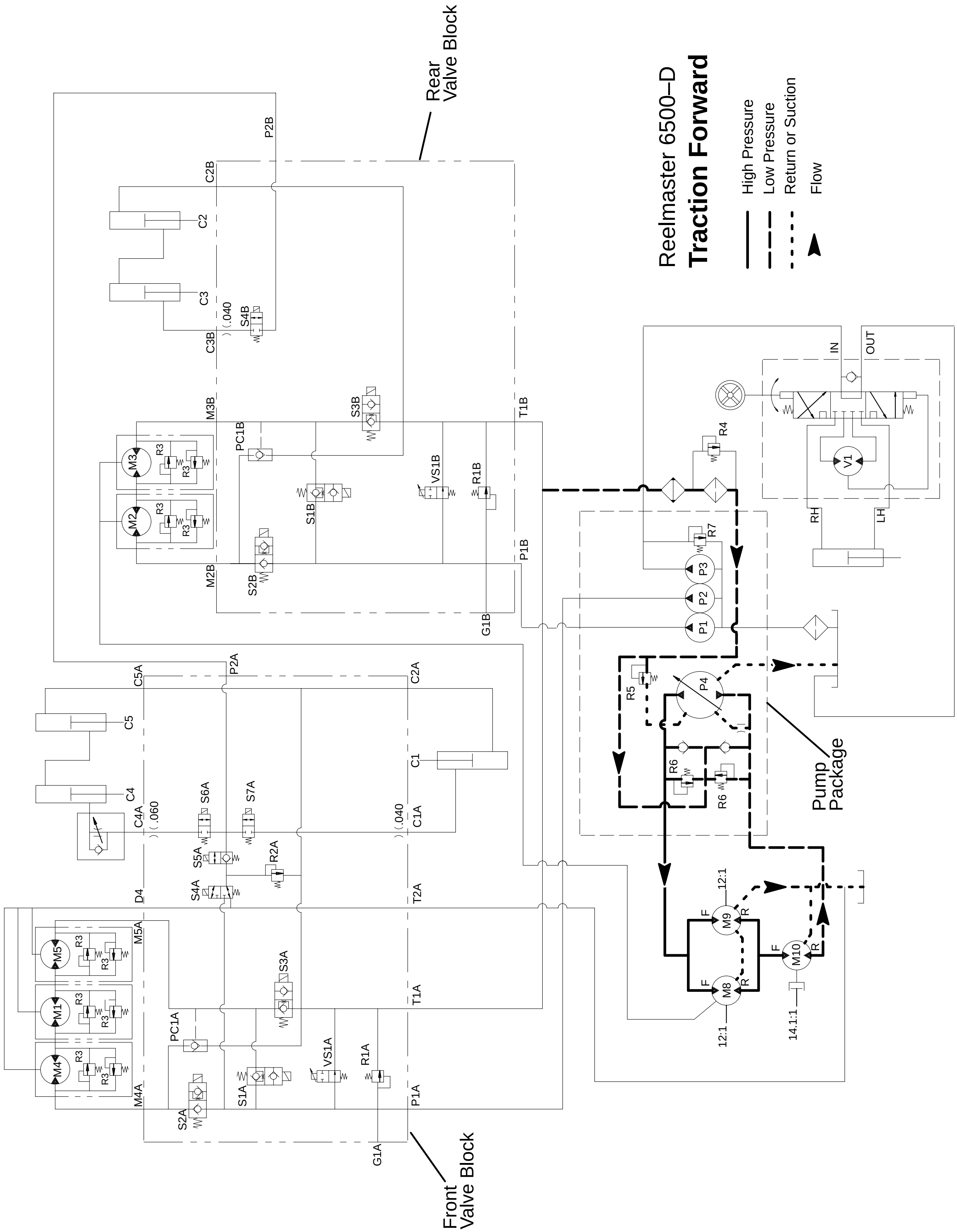


Hydraulic System

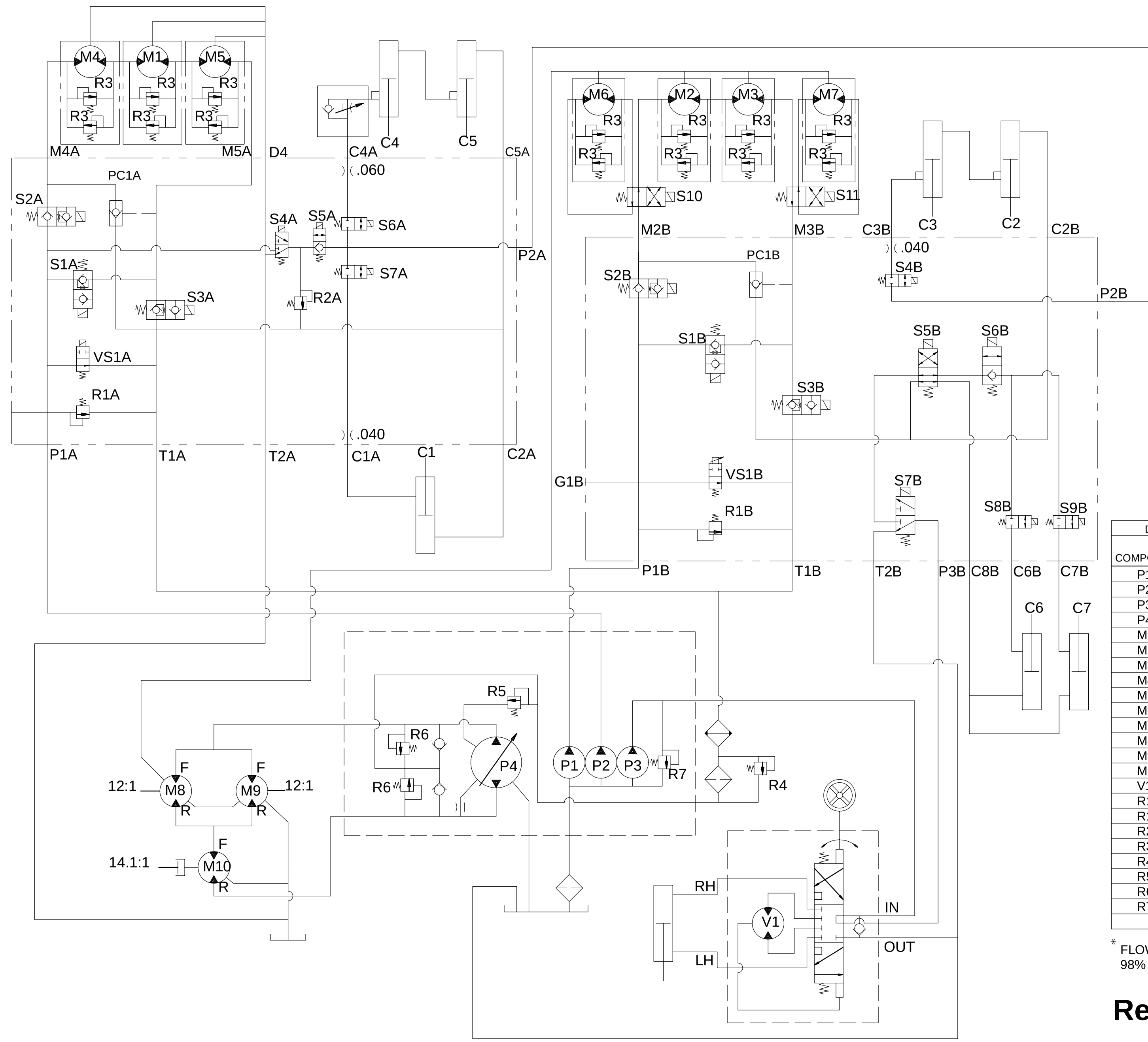

Reelmaster 6500–D
Lift Cutting Units
High Pressure
Low Pressure
Return or Suction
Flow
Soleniods Energized
S1A, S4A, S6A,
S7A, VS1A, S4B
Energized solenoid valves are shown in their shifted position.
Rear Valve Block
Front Valve Block
Pump Package
P2B
C2B
C2
C3
C3B
.040
S4B
M3B
S3B
T1B
PC1B
M3
M2
R3
VS1B
R1B
S1B
S2B
M2B
P1B
G1B
P2A
C5A
C2A
C5
C1
C4
C4A
.060
S6A
S7A
.040
C1A
S5A
R2A
S4A
D4
T2A
M5A
M5
M1
M4
S3A
T1A
PC1A
VS1A
R1A
S1A
S2A
M4A
P1A
G1A
IN
OUT
R4
V1
RH
LH
R7
P3
P2
P1
R5
P4
R6
12:1
F
R
M9
M10
M8
14.1:1


Reelmaster 6500–D
Lower Cutting Units
High Pressure
Low Pressure
Return or Suction
Flow
Soleniods Energized
S5A, S6A, S7A, S4B
Energized solenoid valves are shown in their shifted position.
NOTE: Lift cylinders are extended (lowered) by weight of cutting unit and charge pressure in system.
Rear Valve Block
Front Valve Block
Pump Package
C2B
P2B
C2
C3
C3B
.040
S4B
M3B
M3
M2
R3
PC1B
S3B
VS1B
R1B
S1B
S2B
M2B
T1B
P1B
G1B
R4
IN
OUT
V1
RH
LH
R7
P1
P2
P3
P4
R5
R6
C5A
P2A
C2A
C5
C4
C1
C4A
.060
S6A
S7A
.040
C1A
S5A
R2A
S4A
D4
T2A
M5A
M5
M1
M4
S3A
T1A
PC1A
VS1A
R1A
S1A
S2A
M4A
P1A
G1A
12:1
F
R
M9
M10
M8
14.1:1


Reelmaster 6500–D
Steering (R.H. Turn)
High Pressure
Low Pressure
Return or Suction
Flow
Rear Valve Block
Front Valve Block
Steering Valve
Pump Package
IN
OUT
RH
LH
V1
R4
R7
P1
P2
P3
P4
R5
R6
M1
M2
M3
M4
M5
M8
M9
M10
F
R
12:1
14.1:1
C1
C2
C3
C4
C5
D4
P2B
C2B
C3B
M3B
M2B
T1B
P1B
G1B
PC1B
S1B
S2B
S3B
S4B
VS1B
R1B
(.040
P2A
C5A
C2A
C4A
C1A
(.060
(.040
S4A
S5A
S6A
S7A
R2A
T2A
M5A
T1A
S3A
PC1A
S1A
VS1A
R1A
M4A
P1A
S2A
G1A
R3



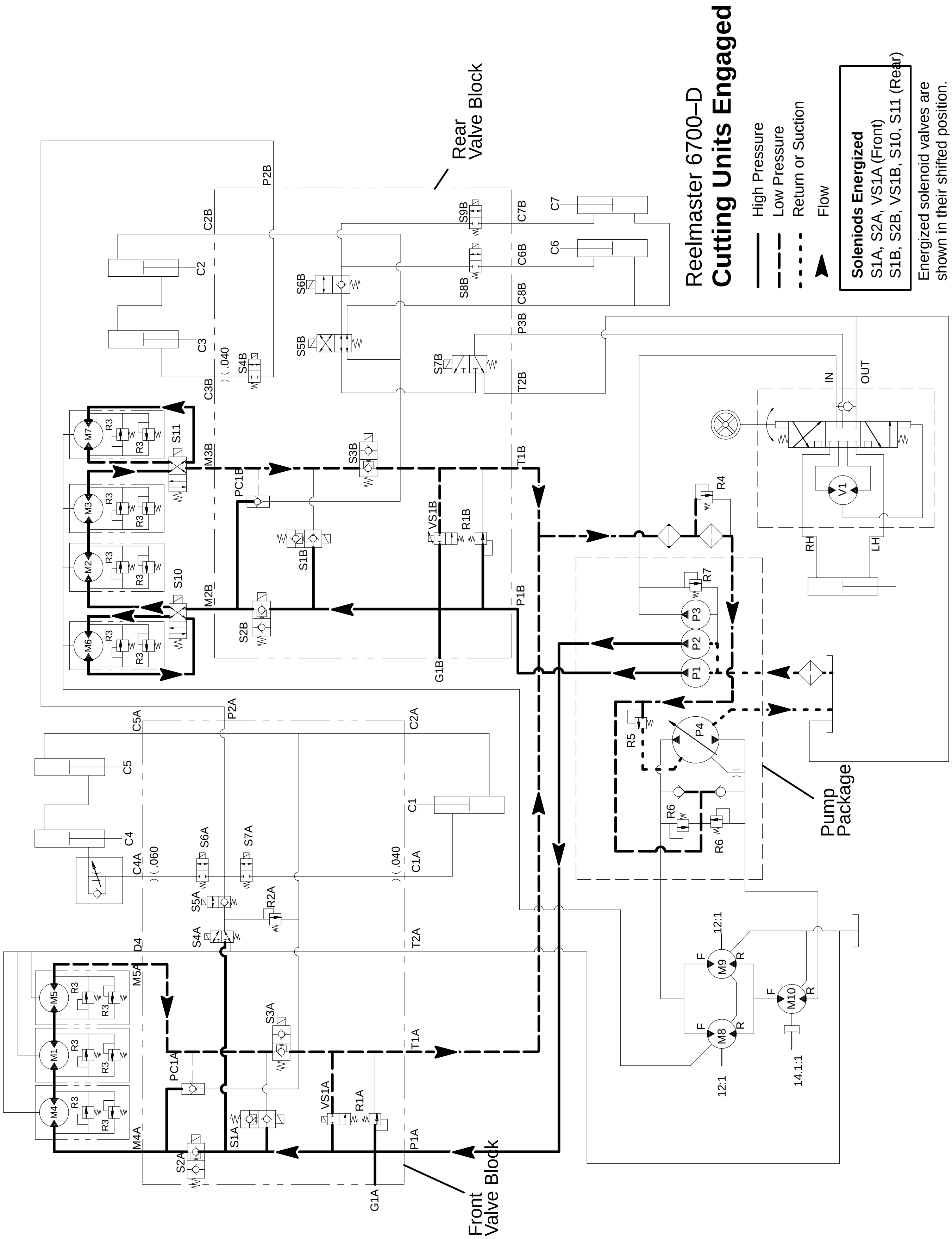
Hydraulic System

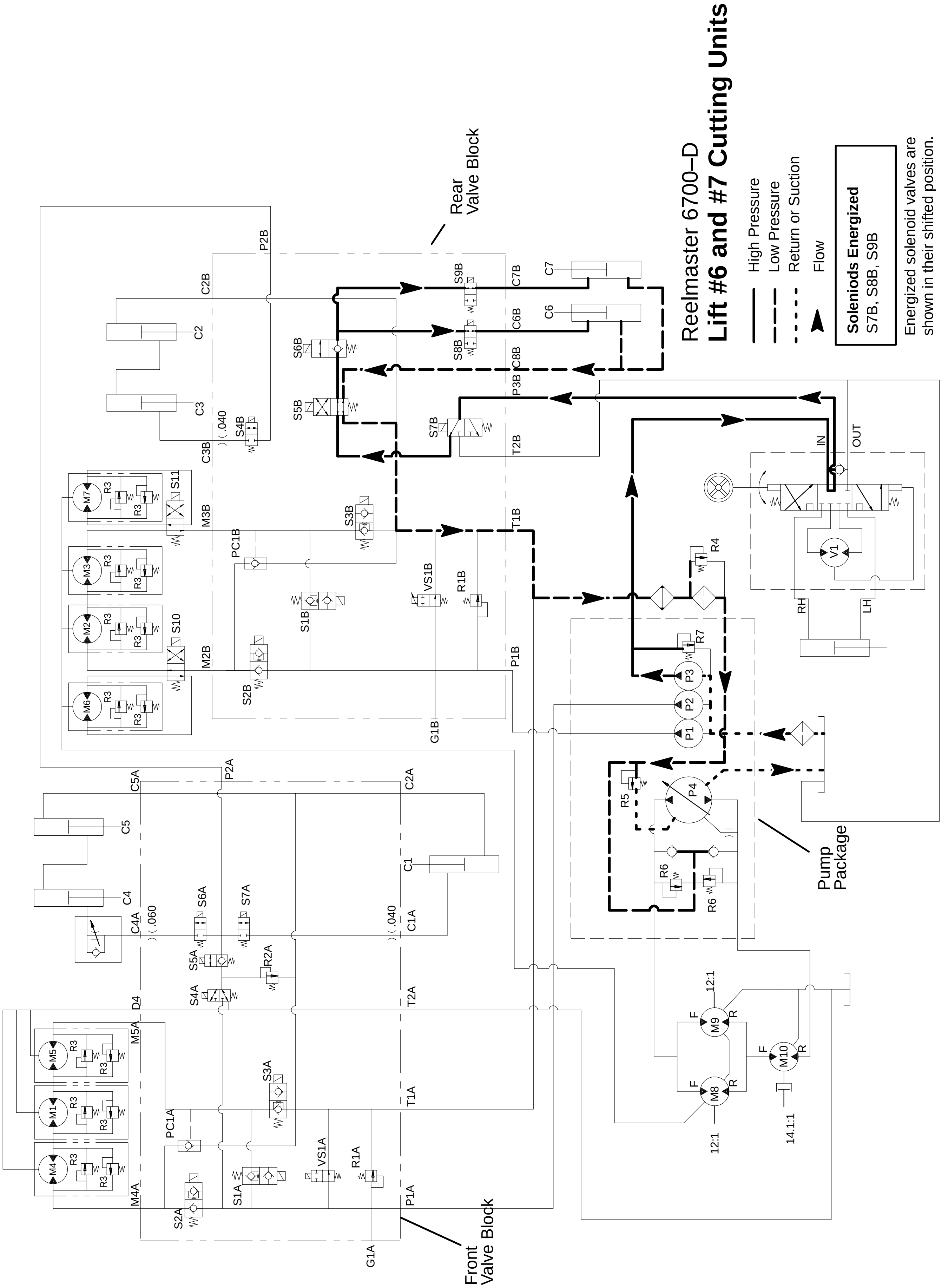


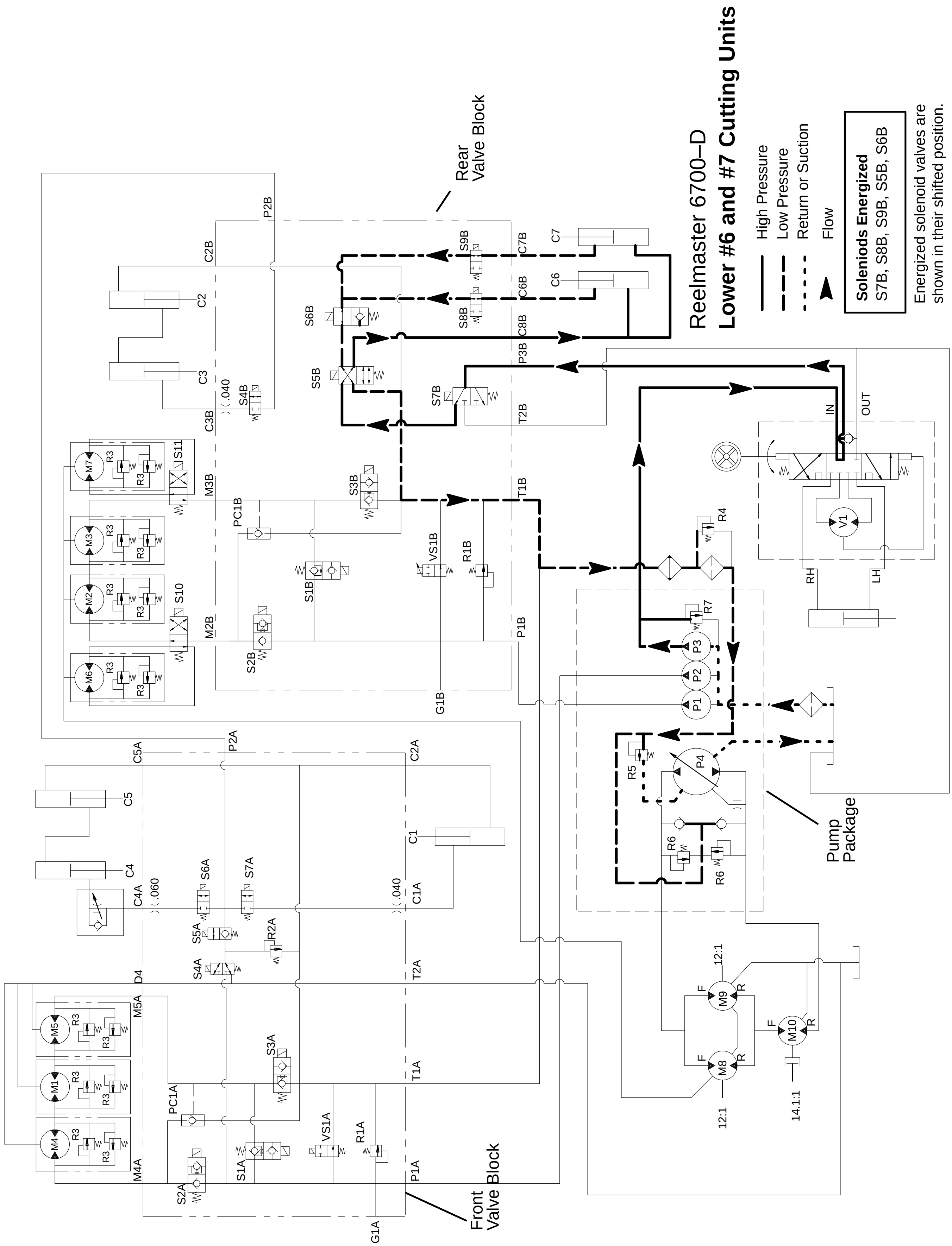
DISPLACEMENT, FLOW RATE, AND PRESSURE CHART						
	DISPLACEMENT		PRESSURE		FLOW RATE*	
COMPONENT	in^3/rev	cm^3 /rev	lbs/in^2	BARS	GPM	LPM
P1	.58	9.5			7.0	29.1
P2	.58	9.5			7.0	29.1
P3	.31	5.1			4.2	17.6
P4	2.48	40.6			28.9	109.5
M1	1.16	19				
M2	1.16	19				
M3	1.16	19				
M4	1.16	19				
M5	1.16	19				
M6	1.16	19				
M7	1.16	19				
M8	2.01	32.9				
M9	2.01	32.9				
M10	2.48	40.6				
V1	6.6	108				
R1A			3000	207		
R1B			3000	207		
R2A			2750	190		
R3			1500	103		
R4			50	3		
R5			180	12		
R6			4000	276		
R7			1250	86		

* FLOW RATE CALCULATED AT 2750 RPM AND 98% EFFICIENCY.

Reelmaster 6700–D


Reelmaster 6700–D
Cutting Units Engaged
High Pressure
Low Pressure
Return or Suction
Flow
Soleniods Energized
S1A, S2A, VS1A (Front)
S1B, S2B, VS1B, S10, S11 (Rear)
Energized solenoid valves are shown in their shifted position.
Rear Valve Block
Front Valve Block
Pump Package


Reelmaster 6700–D
Lift #6 and #7 Cutting Units
High Pressure
Low Pressure
Return or Suction
Flow
Soleniods Energized
S7B, S8B, S9B
Energized solenoid valves are shown in their shifted position.
Rear Valve Block
Front Valve Block
Pump Package
P2B
C2B
C2
C3
C3B
S4B
(.040
S5B
S6B
S7B
S8B
S9B
C7B
C6B
C8B
P3B
T2B
T1B
P1B
G1B
C7
C6
M7
M3
M2
M6
R3
S11
S10
M3B
M2B
PC1B
S3B
S1B
S2B
VS1B
R1B
R4
R7
P1
P2
P3
P4
R5
R6
V1
IN
OUT
RH
LH
P2A
C5A
C2A
C5
C4
C1
C4A
C1A
(.060
(.040
S6A
S7A
S5A
R2A
S4A
T2A
D4
M5A
M5
M1
M4
M4A
S3A
T1A
PC1A
VS1A
R1A
S1A
S2A
P1A
G1A
M8
M9
M10
F
R
12:1
14.1:1



Hydraulic System

Special Tools

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

Hydraulic Pressure Test Kit – TOR47009

Use to take various pressure readings for diagnostic tests. Quick disconnect fittings provided attach directly to mating fittings on machine test ports without tools. A high pressure hose is provided for remote readings. Contains one each: 1000 PSI (70 Bar), 5000 PSI (350 Bar) and 10000 PSI (700 Bar) gauges. Use gauges as recommended in Testing section of this chapter.

Figure 8

Hydraulic Test Fitting Kit – TOR4079

This kit includes a variety of O–ring Face seal fittings to enable you to connect test gauges into the system.

The kit includes: tee’s, unions, reducers, plugs, caps, and male test fittings.

Figure 9

Measuring Container – TOR4077

Use this container for doing hydraulic motor efficiency testing (motors with case drain lines only). Measure efficiency of a hydraulic motor by restricting the outlet flow from the motor and measuring leakage from the case drain line while the motor is pressurized by the hydraulic system.

Figure 10

Hydraulic Tester – With Pressure and Flow Capabilities – TOR214678

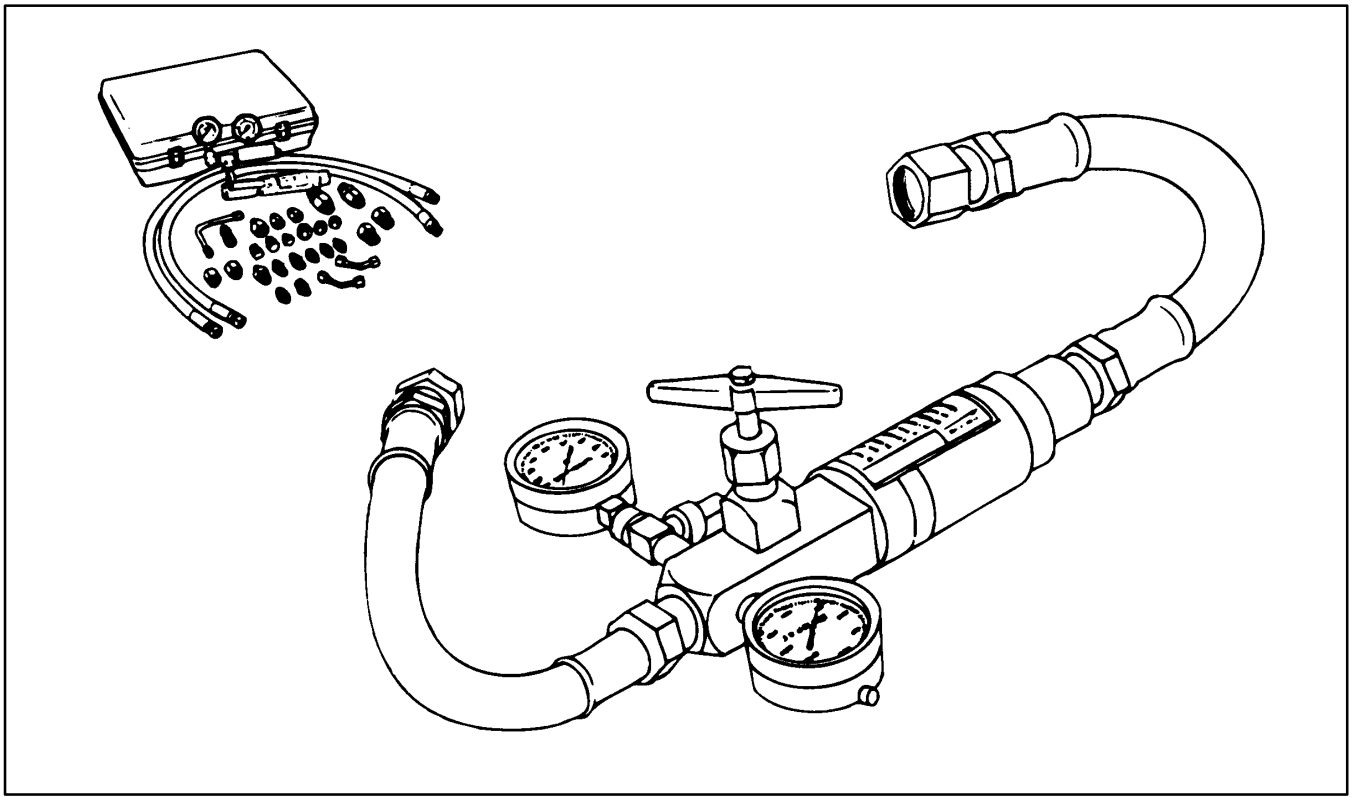


Figure 11

You must have o–ring face seal (ORFS) adapter fittings for this tester to use it on the Workman vehicle.

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 – 5,000 PSI.

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 information to assist in troubleshooting. There may possibly be more than one cause for a machine malfunction.

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

General Troubleshooting

Cause	Correction
Hydraulic oil leak(s).	Fitting(s), hose or tube loose or damaged. Missing or damaged o–ring.

Difficult to Find Neutral

Cause	Correction
External control linkage misadjusted, disconnected, binding or damaged.	Adjust or repair linkage.
Servo control valve faulty.	Inspect control valve for: Plugged control orifices. Damaged mounting gasket. Misadjusted or damaged neutral return spring. Broken control connector pin. Galled or stuck control spool. Neutral switch misadjusted. Repair or replace control valve if necessary.
Pump worn or damaged.	Repair or replace pump.

Traction Pedal is Sluggish

Cause	Correction
Charge pressure low.	TEST NO. 1. Inspect charge relief valve. Repair or replace if defective.
Servo control valve faulty.	Inspect control valve for: Missing center orifice. Plugged control orifices. Galled or stuck control spool. Repair or replace control valve if necessary.

Transmission or Hydraulic System is Operating Hot

Cause	Correction
Oil in reservoir is below level.	Fill reservoir to proper level.
Contaminated oil.	Drain reservoir and refill with clean oil.
Oil in system too light.	Drain reservoir and refill with proper viscosity oil.
Heat exchanger defective.	Check oil cooler for obstructed air flow. Replace damaged or plugged oil cooler.
Charge pressure low.	TEST NO. 1. Inspect charge relief valve. Repair or replace if defective.
Transmission pressure high.	Reduce transmission load. Check to make sure brakes are not engaged.
Towing by–pass is open or defective.	Close towing by–pass valve. Repair or replace if necessary.
Wheel motor(s) worn or damaged. NOTE: If a motor has internal damage, it is likely that the pump and other motor are also damaged.	Inspect wheel motors and repair or replace if worn or damaged.
Pump worn or damaged.	Inspect pump and repair or replace if worn or damaged.

Hydraulic System

Transmission Operates in One Direction Only

Cause	Correction
External control linkage misadjusted, disconnected, binding or damaged.	Adjust or repair.
Servo control valve faulty.	Inspect control valve for: Plugged control orifices. Damaged mounting gasket. Misadjusted or damaged neutral return spring. Broken control connector pin. Galled or stuck control spool. Neutral switch misadjusted. Repair or replace control valve if necessary.
Transmission relief valve faulty.	Inspect relief valve and replace if necessary. NOTE: Relief valves can be exchanged in forward and reverse pump circuits for testing.
Pump worn or damaged.	Replace pump.

Transmission Response Sluggish

Cause	Correction
Charge pressure low.	TEST NO. 1. Inspect charge relief valve. Repair or replace if defective.
Servo control valve faulty.	Inspect control valve for: Plugged control orifices. Damaged mounting gasket. Misadjusted or damaged neutral return spring. Broken control connector pin. Galled or stuck control spool. Neutral switch misadjusted. Repair or replace control valve if necessary.
Towing by–pass valve open.	Close valve.
Wheel motor(s) worn or damaged. NOTE: If a motor has internal damage, it is likely that the pump and other motor are also damaged.	Inspect wheel motors and repair or replace if worn or damaged.
Pump worn or damaged.	Inspect pump and repair or replace if worn or damaged.

Transmission Will Not Operate in Either Direction

Cause	Correction
Oil level in reservoir is low.	Fill reservoir to proper level.
External control linkage misadjusted, disconnected, binding or damaged.	Adjust or repair linkage.
Towing by–pass valve open.	Close valve.
Charge pressure low.	TEST NO. 1. Inspect charge relief valve. Repair or replace if defective.
Servo control valve faulty.	Inspect control valve for: Plugged control orifices. Damaged mounting gasket. Misadjusted or damaged neutral return spring. Broken control connector pin. Galled or stuck control spool. Neutral switch misadjusted. Repair or replace control valve if necessary.

Cause	Correction
Wheel motor(s) worn or damaged. NOTE: If a motor has internal damage, it is likely that the pump and other motor are also damaged.	Inspect wheel motors and repair or replace if worn or damaged.
Pump worn or damaged.	Inspect pump and repair or replace if worn or damaged.

Wheel Motor Turns While Unloaded, But Slows Down or Stops When Load Applied

Cause	Correction
Scored valve plate on wheel motor.	Remove backplate and inspect bronze surface of valve plate. Replace valve plate if scored.
Scored or worn piston shoes on wheel motor.	Disassemble motor and inspect condition of shoes on pistons. Replace rotating kit assembly as a complete set. DO NOT lap pistons.

Wheel Will Not Turn

Cause	Correction
Severely scored internal parts in wheel motor.	Disassemble motor completely. Inspect and clean all parts. Replace all worn parts or replace complete motor if necessary. Flush hydraulic system.
Brakes binding.	See Chapter6 – Wheels, Brakes and Steering.
Splined coupler between wheel motor shaft and planetary wheel drive damaged or broken.	See Chapter 6 – Wheels, Brakes and Steering.
Planetary wheel drive damaged.	See Chapter 6 – Wheels, Brakes and Steering.

Wheel Motor Will Not Hold Load When System is in Neutral

Cause	Correction
No make up fluid from charge pump.	TEST NO. 1. Inspect charge relief valve. Repair or replace if defective.
Scored valve plate or piston shoes on wheel motor.	Disassemble motor and inspect valve plate and piston shoes. Replace as required.

Excessive Wheel Motor Case Drain Flow

Cause	Correction
Excessive internal wear in wheel motor.	Disassemble motor completely. Inspect parts and replace as necessary. Case drain flow should not exceed 7.6 L/m [2 gal/m] at full pressure.

Noisy Gear Pump Caused by Cavitation

Cause	Correction
Oil too heavy.	Change to proper viscosity oil.
Suction line restricted.	Check for bent or collapsed suction line. Check suction screen in reservoir for blockage – drain and clean reservoir if necessary.
Air leak in suction line.	Tighten fittings or repair suction plumbing..

Foaming Oil

Cause	Correction
Low oil level.	Fill reservoir.
Air leak in suction line.	Tighten fittings or repair suction plumbing.
Wrong kind of oil.	Drain and flush system. Fill with correct oil.

Front Reels Will Not Turn

Cause	Correction
S1A not shifting. NOTE: Lift function will also be affected.	Do electrical diagnostics to make sure that voltage is being applied to S1A and that there is no electrical fault. See Chapter 5 – Electrical System. Do cartridge valve service procedure for valve S1A. Interchange S1A with S1B and check operation. Replace S1A with a new valve if faulty.
Relief valve R1A stuck open. NOTE: Lift function will also be affected.	TEST NO. 5. Adjust relief valve if necessary. Do cartridge valve service procedure for valve R1A. Replace R1A with a new valve if faulty.

Cause	Correction
VS1A not shifting. NOTE: Lift function will also be affected.	Do electrical diagnostics to make sure that voltage is being applied to VS1A and that there is no electrical fault. See Chapter 5 – Electrical System. Do cartridge valve service procedure for valve VS1A. Interchange VS1A with VS1B and check operation. Replace VS1A if faulty.
S2A not shifting. NOTE: System will go over relief. Lift and backlap will still function.	Do electrical diagnostics to make sure that voltage is being applied to S2A and that there is no electrical fault. See Chapter 5 – Electrical System. Do cartridge valve service procedure for valve S2A. Interchange S2A with S2B and check operation. Replace S2A with a new valve if faulty.
P2 pump section damaged.	TEST NO. 7. Repair or replace pump.

Front Reel(s) Turn Too Slow

Cause	Correction
R1A stuck partially open or pressure setting too low.	TEST NO. 5. Adjust relief valve if necessary. Do cartridge valve service procedure for valve R1A. Replace R1A with a new valve.
S1A partially shifted.	Do cartridge valve service procedure for valve S2A and S1A. Interchange S2A with S2B and check operation. Replace S2A if faulty. Interchange S1A with S1B and check operation. Replace S1A if faulty.
P2 pump section inefficient.	TEST NO. 7. Repair or replace pump.
Internal leakage (by-passing oil) in reel motor or malfunctioning cross–over relief valve in motor.	TEST NO. 8. Excessive case drain flow may identify faulty motor. Use hydraulic tester to perform reel motor efficiency test. Repair or replace reel motor if faulty.
VS1A not operating properly.	So electrical diagnostics to make sure that voltage is being applied to VS1A and that there is no electrical fault. See Chapter 5 – Electrical System. Do cartridge service procedure for VS1A. Interchange VS1A with VS1B and check operation. Replace VS1A if faulty.

Front Reels Turn Too Fast

Cause	Correction
VS1A not operating properly.	Do electrical diagnostics to make sure that voltage is being applied to VS1A and that there is no electrical fault. See Chapter 5 – Electrical System. Do cartridge service procedure for VS1A. Interchange VS1A with VS1B and check operation. Replace VS1A if faulty.

Front Reels Won’t Backlap (Mowing Operation OK)

Cause	Correction
S3A not shifting.	Do electrical diagnostics to make sure that voltage is being applied to S3A and that there is no electrical fault. See Chapter 5 – Electrical System. Do cartridge service procedure for S3A. Interchange S3A with S3B and check operation. Replace S3A if faulty.

Front Reels Stop or Won’t Start – During Backlap Only

Cause	Correction
Motors stalling.	Increase flow to motors by adjusting HOC selector knob.
Load too high for motor.	Decrease load.

Front Reels Stop Under Load

Cause	Correction
R1A bypassing.	TEST NO. 5. Adjust relief valve if necessary. Do cartridge valve service procedure for valve R1A. Replace R1A with a new valve.
P2 pump section inefficient.	TEST NO. 7. Repair or replace pump.
Internal leakage (by-passing oil) in reel motor or malfunctioning cross–over relief valve in motor.	TEST NO. 8. Excessive case drain flow may identify faulty motor. Use hydraulic tester to perform reel motor efficiency test. Repair or replace reel motor if faulty.

Front Reel Speed Erratic

Cause	Correction
Reel bearing or bedknife to reel adjustment too tight.	See Chapter 8 – Cutting Units.
Electrical problem.	See Chapter 5 – Electrical System.

REAR Cutting Unit Problems

Cause	Correction
For problems with rear cutting unit reel operation, refer to the Correction recommended for the front cutting units. NOTE: Rear cutting unit LIFT functions are controlled by front valve block and pump section P2.	Substitute R1A with R1B S1A with S1B S2A with S2B VS1A with VS1B S3A with S3B

Cutting Unit(s) Will Not Raise

Cause	Correction
S1A, S4A, S6A, S7A, VS1A, S4B not shifting (See Hydraulic Schematics to see which valve controls what lift cylinders). Reelmaster 6700–D only – check S7B, S8B, S9B for No. 6 and 7 lift functions.	Do electrical diagnostics to make sure that voltage is being applied to solenoid for affected circuit and that there is no electrical fault. See Chapter 5 – Electrical System. Test solenoid coil for valve of affected circuit. Replace if faulty. See 5 – Electrical System. Do cartridge valve service procedure for valve in affected circuit. Interchange solenoid from affected circuit with another similar valve and check operation. Replace or repair affected valve if faulty.
Lift arm pivots bindings.	Lubricate bushings. Inspect for damage. Repair or replace damaged parts.
R2A bypassing.	TEST NO. 4. Adjust relief valve if necessary. Do cartridge valve service procedure for valve R2A. Replace R2A with a new valve.
P2 pump section inefficient.	TEST NO. 7. Repair or replace pump.
Internal leakage in lift cylinder(s).	Check lift cylinder(s) and repair or replace if faulty.

Hydraulic System

Cutting Units Raise, But Will Not Stay Up

NOTE: Lift cylinders and check valves cannot provide an absolutly perfect seal. The lift arms will eventually lower if left in the raised position during storage. It is recommended that the machine be stored with the cutting units in the lowered position. This also prevents accidental lowering of the cutting units if the lift lever (joysitck) is bumped while the key switch is on.

Cause	Correction
S5A leaking down (not seating properly). Reelmaster 6700–D only – S6B affects No. 6 and 7 cutting units.	Do cartridge valve service procedure for valve S5A. Replace S5A with a new valve if faulty.
Excessive internal leakage in lift cylinder(s).	Check lift cylinder(s) and repair or replace if faulty.

Front Outer Cutting Units Lower Too Fast or Too Slow

Cause	Correction
One-way variable orifice not properly adjusted (#4 and #5 cutting units only) - see Hydraulic Schematics.	Adjust variable orifice for affected circuit.

Cutting Units Will Not Lower

Cause	Correction
S5A not shifting. Reelmaster 6700–D only – S6B affects No. 6 and 7 cutting units.	Do electrical diagnostics to make sure that voltage is being applied to solenoid for affected circuit and that there is no electrical fault. See Chapter 5 – Electrical System. Do cartridge valve service procedure for valve S5A.

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

Before Performing Hydraulic Tests

Do electrical diagnostics before performing 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.

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

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved by stopping the engine and lowering or supporting the cutting units or other implements.

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 load valve in hydraulic tester (when using 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: Traction Circuit Charge Pressure

1. Make sure hydraulic oil is at normal operating temperature before doing test.

2. Park the machine on a level surface, engage the parking brake and stop the engine.

3. Connect a 1000 PSI gauge onto charge pressure test port.

4. Start the engine and put throttle at full engine RPM (approx. 2500 RPM for 6500–D and 2750 RPM for 6700–D) with no load on the system.

5. Also take a gauge reading while operating the ma–chine in forward and reverse. Start the engine and put throttle at full engine RPM. Apply the brakes and push the traction pedal forward, then reverse.

GAUGE READING: 180 +/– 30 PSI.

6. Stop the engine. If pressure is low, inspect charge relief valve and valve seat. Charge pressure can be adjusted by changing shim thickness behind the spring.

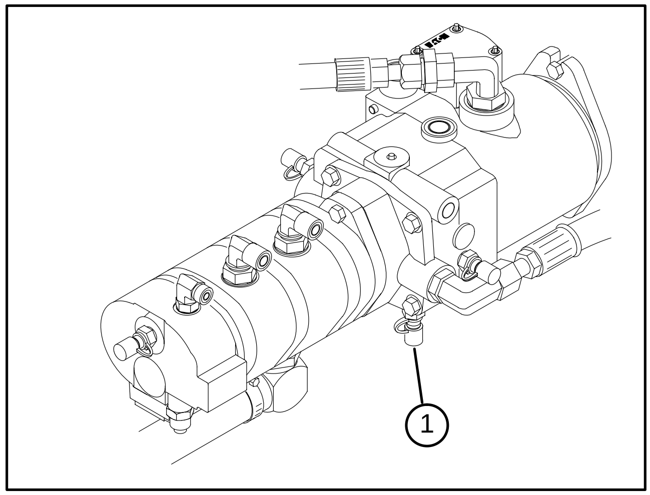


Figure 12

1. Charge pressure test port

TEST NO. 2: Traction Circuit System Pressure

1. Make sure hydraulic oil is at normal operating temperature before doing test.

2. Drive machine to an open area, lower cutting units, and shut off the engine.

3. Connect a 10,000 psi gauge to traction circuit test port for function to be checked.

4. Start the engine and move throttle to full speed (approx. 2500 RPM for 6500–D and 2750 RPM for 6700–D).

CAUTION

Move machine to an open area, away from people and obstructions.

5. With brakes locked, slowly depress the traction pedal. While pushing traction pedal down, look at pressure reading on gauge.

GAUGE READING: 4000 +/– 200 PSI.

6. Stop the engine.

7. If traction pressure is too low, inspect relief valves. If problem occurs in one direction only, interchange the relief valves to see if the problem changes to the other direction. Clean or replace valves as necessary. These cartridge type valves are factory set, and are not adjustable. If relief valves are in good condition, traction pump or wheel motors should be suspected of wear and inefficiency.

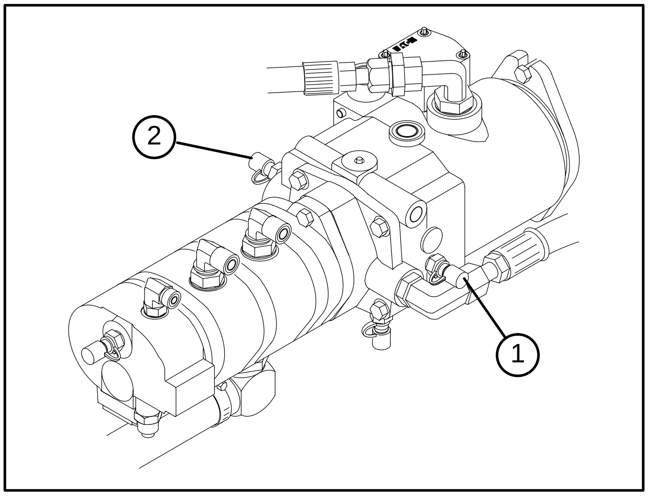


Figure 13

1. FORWARD test port **2. REVERSE test port**

Hydraulic System

TEST NO. 3: Steering Circuit Pressure

1. Make sure hydraulic oil is at normal operating temperature before doing test.

2. Park the machine on a level surface, engage the parking brake and stop the engine.

3. Connect a 5000 PSI gauge onto steering pressure test port.

4. Start the engine and put throttle at full engine RPM (approx. 2500 RPM for 6500–D and 2750 RPM for 6700–D).

5. Turn steering all the way in one direction and momentarily hold the steering wheel against resistance.

GAUGE READING: 1350 +/– 100 PSI.

6. Stop the engine.

7. If pressure is too high or low, check charge pressure and adjust as necessary (charge pressure affects steering pressure). If pressure is low, inspect relief valve. If relief valve is operating properly, steering pump should be suspected of wear and inefficiency. If steering wheel continues to turn at end of cylinder travel (with lower than normal effort), cylinder or steering valve should be suspected of wear or damage.

NOTE: Steering pump also provides pressure and flow for lift of no. 6 and 7 cutting units on Reelmaster 6700–D.

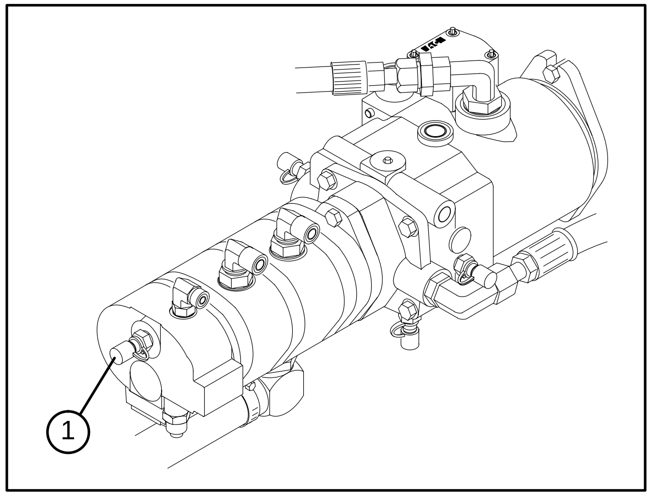


Figure 14

1. Steering circuit pressure test port

TEST NO. 4: Lift Circuit Pressure

1. Make sure hydraulic oil is at normal operating temperature before doing test.

2. Lower cutting units, engage parking brake and stop the engine.

3. Raise seat to get access to hydraulic test fittings. Remove access cover from in front of hydraulic valve block. Install a 5000 PSI gauge with extension hose onto quick disconnect fitting in port G1A. Put gauge and hose through opening in front of hydraulic valve block, then lower the seat.

4. Sit on the seat and start the engine. Move throttle to full speed (approx. 2500 RPM for 6500–D and 2750 RPM for 6700–D).

5. While sitting on the seat, pull “Lower–Mow/Raise” control lever back to the RAISE position to lift the cutting units. Hold the lever in the RAISE position while looking at the gauge.

GAUGE READING: 2750 +/– 150 PSI.

6. Stop the engine. If pressure is too high or low, check charge pressure and adjust as necessary (charge pressure affects lift pressure). If pressure is too high, remove cap on relief valve R2A and adjust screw to get correct pressure. If pressure is too low, remove cap from relief valve R2A and adjust screw to get correct pressure. If pressure is still too low, pump or lift cylinder(s) should be suspected of wear, damage or inefficiency.

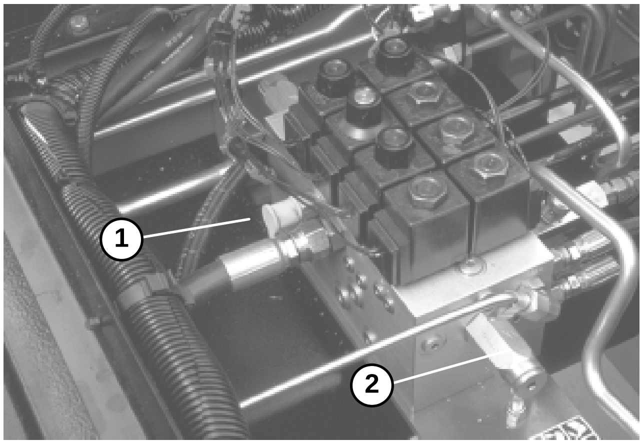


Figure 15
(Front Valve Block)

1. Test Port G1A
2. Relief valve R2A

Hydraulic System

TEST NO. 5: Front Mow Circuit Pressure

1. Make sure hydraulic oil is at normal operating temperature before doing test.

2. Lower cutting units, engage parking brake and stop the engine. Set HOC Selector Knob, located under the instrument panel, to position A (full speed). Make sure Backlap switch is OFF.

3. Raise seat to get access to hydraulic test fittings. Remove access cover from in front of hydraulic valve block. Install a 5000 PSI gauge with extension hose onto quick disconnect fitting in port G1A. Put gauge and hose through opening in front of hydraulic valve block, then lower the seat.

4. Sit on the seat and start the engine. Move throttle to full speed (approx. 2500 RPM for 6500–D and 2750 RPM for 6700–D).

WARNING

Keep away from reels during tests to prevent personal injury from rotating reel blades.

5. While sitting on seat, move “Enable/Disable” switch to ENABLE. Move “Lower–Mow/Raise” lever forward to engage cutting units, then look at the gauge.

GAUGE READING:
Approx. 1000 PSI (free running)
1500 to 1800 PSI (mowing)

6. Stop the engine. If pressure is too high, bedknife to reel contact may be too tight and/or the cutting units are dull. If pressure is too low, do relief pressure test.

Relief Pressure Test

7. Disconnect wire connector from solenoid S2A.

8. While sitting on seat, move “Enable/Disable” switch to ENABLE. Move “Lower–Mow/Raise” lever forward to engage cutting units, then look at the gauge.

GAUGE READING: 2800 – 3200 PSI

9. Stop the engine. If pressure is too low, remove cap from relief valve R1A and adjust screw to get correct pressure. If pressure will not increase by adjusting relief valve, the relief valve may be stuck open. If relief valve is operating properly, solenoid valve VS1A or S1A may be stuck open or pump should be suspected of wear and inefficiency.

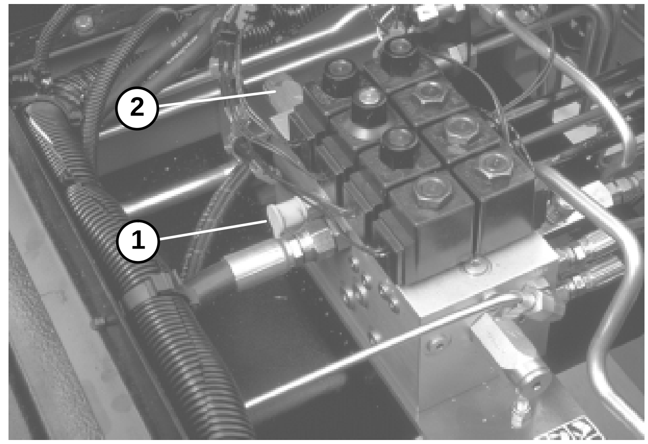


Figure 16
(Front Valve Block)

1. Test Port G1A
2. Relief valve R1A

TEST NO. 6: Rear Mow Circuit Pressure

1. Make sure hydraulic oil is at normal operating temperature before doing test.

2. Lower cutting units, engage parking brake and stop the engine. Set HOC Selector Knob, located under the instrument panel, to position A (full speed). Make sure Backlap switch is OFF.

3. Raise hood to get access to hydraulic test fittings. Remove fiberglass access cover from behind seat. Install a 5000 PSI gauge with extension hose onto quick disconnect fitting in port G1B. Carefully close hood and put gauge and hose through opening in front of hood where access cover was removed.

4. Sit on the seat and start the engine. Move throttle to full speed (approx. 2500 RPM for 6500–D and 2750 RPM for 6700–D).

> **WARNING**
>
> **Keep away from reels during tests to prevent personal injury from rotating reel blades.**

5. While sitting on seat, move “Enable/Disable” switch to ENABLE. Move “Lower–Mow/Raise” lever forward to engage cutting units, then look at the gauge.

GAUGE READING:

6500–D:	Approx. 800 PSI (free running) 1000 to 1200 PSI (mowing)
6700–D:	Approx. 1200 PSI (free running) 2000 to 2400 PSI (mowing with all cutting units lowered)

6. Stop the engine. If pressure is too high, bedknife to reel contact may be too tight and/or the cutting units are dull. If pressure is too low, do relief pressure test.

Relief Pressure Test

7. Disconnect wire connector from solenoid S2B.

8. While sitting on seat, move “Enable/Disable” switch to ENABLE. Move “Lower–Mow/Raise” lever forward to engage cutting units, then look at the gauge.

GAUGE READING: 2800 – 3200 PSI

9. Stop the engine. If pressure is too low, remove cap from relief valve R1B and adjust screw to get correct pressure. If pressure will not increase by adjusting relief valve, the relief valve may be stuck open. If relief valve is operating properly, solenoid valve VS1B or S1B may be stuck open or pump should be suspected of wear and inefficiency.

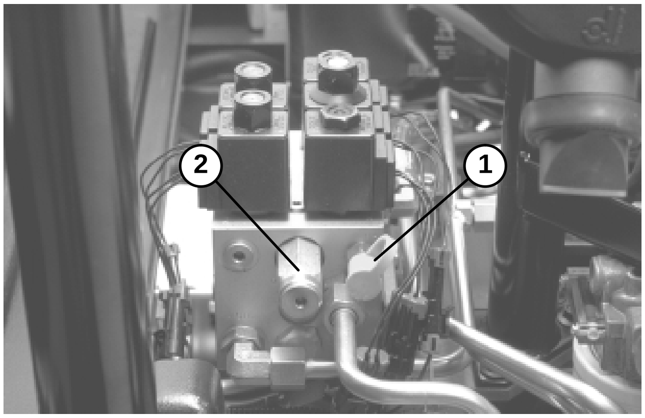


Figure 17
(Rear Valve Block)
(Reelmaster 6500–D Shown)

1. Test port G1B
2. Relief valve R1B

TEST NO. 7: Reel Drive/Lift Pump Efficiency
(Using Tester with Pressure Gauges and Flow Meter)

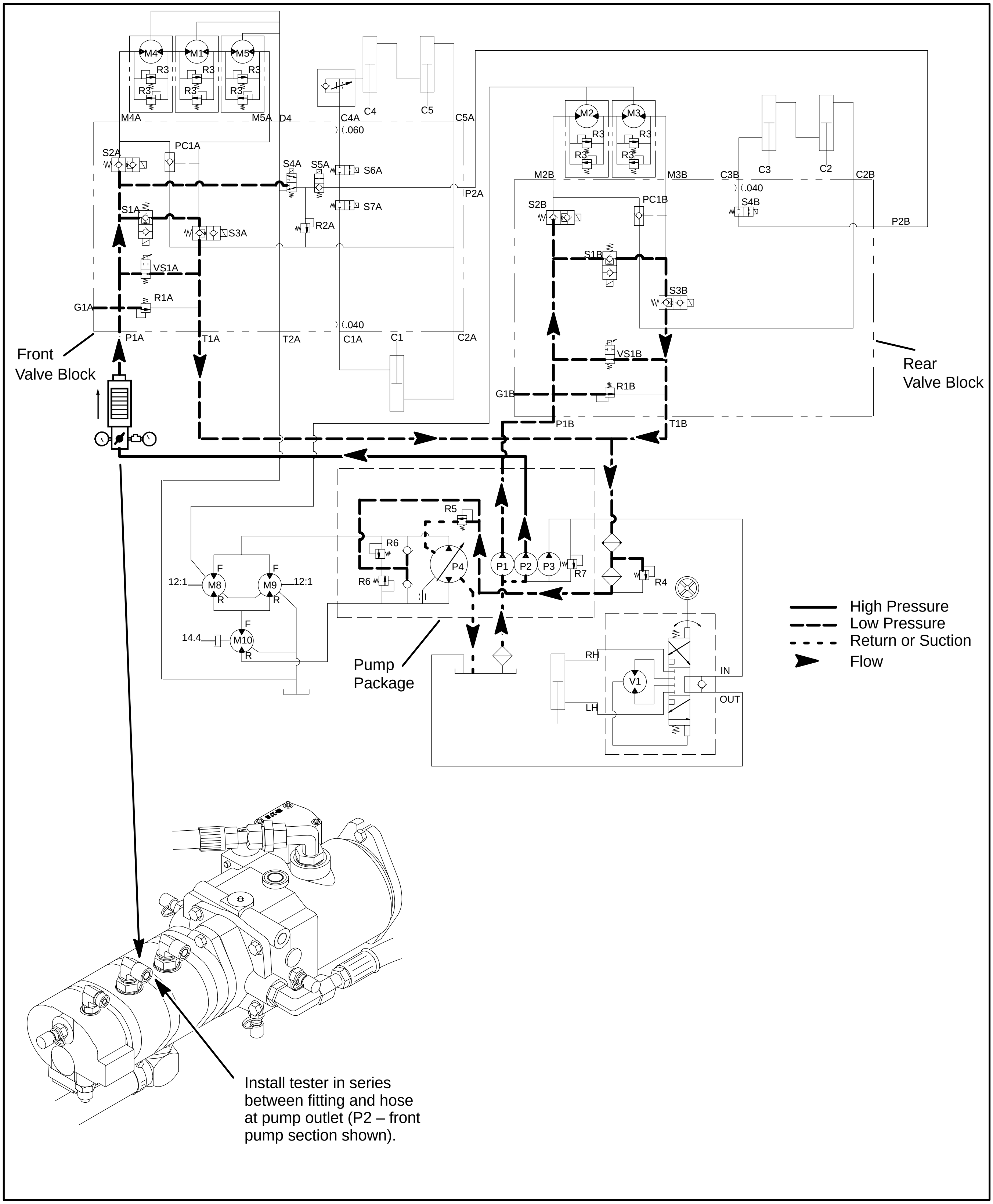


Figure 18

Reel Drive/Lift Pump Efficiency Test

Over a period of time, the gears and wear plates in the pump can wear. A worn pump will by–pass oil and make the pump less efficient. Eventually, enough oil loss will occur to cause the reels to stall in heavy cutting conditions. Continued operation with a worn, inefficient pump can generate excessive heat and cause damage to seals and other components in the hydraulic system.

1. Make sure hydraulic oil is at normal operating temperature before doing test.

2. Lower cutting units, engage parking brake and stop the engine.

3. Install tester in series between pressure hose and fitting suspected bad pump section. Make sure the tester flow control valve is OPEN.

IMPORTANT: Make sure that the oil flow indicator arrow on the flow gauge is showing that the oil will flow from the pump, through the tester and into the valve block.

IMPORTANT: The pump is a positive displacement type. If pump flow is completely restricted or stopped, damage to the pump, tester or other components could occur.

4. Start the engine and move throttle to full speed (approx. 2500 RPM for 6500–D and 2750 RPM for 6700–D). DO NOT engage the cutting units.

5. While watching pressure gauge, slowly close flow control valve until 2500 PSI is obtained on gauge.

TESTER READING:
Flow not less than 6 GPM at 2500 PSI.

6. Stop the engine. If flow was lower than 6 GPM or a pressure of 2500 PSI cannot be obtained, check for restriction in pump intake line. If not restricted, replace or repair pump.

TEST NO. 8: Reel Drive Motor Cross Over Relief Pressure Test

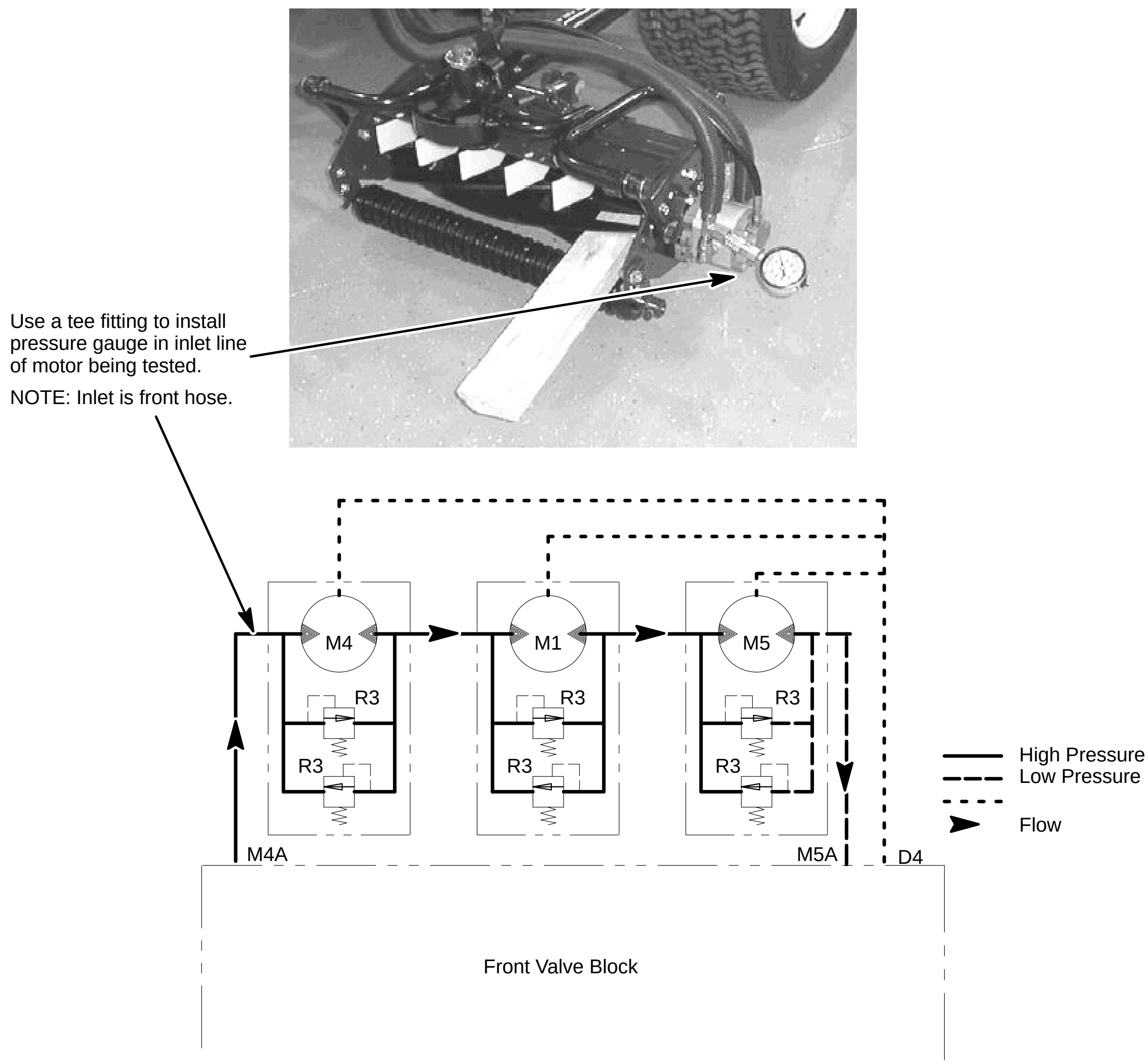


Figure 16.1

1. Make sure hydraulic oil is at normal operating temperature before doing test.

CAUTION

Keep away from reels during tests to prevent personal injury from rotating reel blades. Do not stand in front of the machine.

2. Determine which reel motor is malfunctioning.

   One way to find a bad motor is to have another person observe the machine while mowing in dense turf. A bad motor will run slower, produce fewer clippings and could cause marcelling (or a washboard appearance) of the turf.

NOTE: The three reel motors in the front circuit (No. 1, 4 and 5) and two reel motors in the rear circuit (No. 2 and 3) are connected in series (No. 2, 3, 6 and 7 on RM6700–D). To isolate a faulty motor you may have to test all motors in the circuit, starting with the first one in series.

3. Lower cutting units, engage parking brake and stop the engine.

4. Install a tee fitting between the motor inlet fitting and hose. Install a 5000 PSI pressure gauge on the tee fitting.

5. Set HOC Selector Knob, located under the instrument panel, to position A (full speed). Make sure Backlap switch is OFF.

6. Put a block of wood between the blades of the cutting unit being tested to prevent the reel from rotating.

7. One person should sit on the seat and operate the machine while another person reads the tester. Start the engine and move “Enable/Disable” switch to ENABLE. Move “Lower–Mow/Raise” lever forward to engage the cutting units.

   TESTER READING: Approx. 1400 – 1600 PSI.

8. Disengage the cutting units and stop the engine. If pressure is less than 1400 PSI, crossover relief valve on motor is malfunctioning or there is internal leakage in the reel motor and the motor efficiency should be checked.

TEST NO. 9: Reel Drive Motor Efficiency
(Using Tester with Pressure Gauges and Flow Meter)

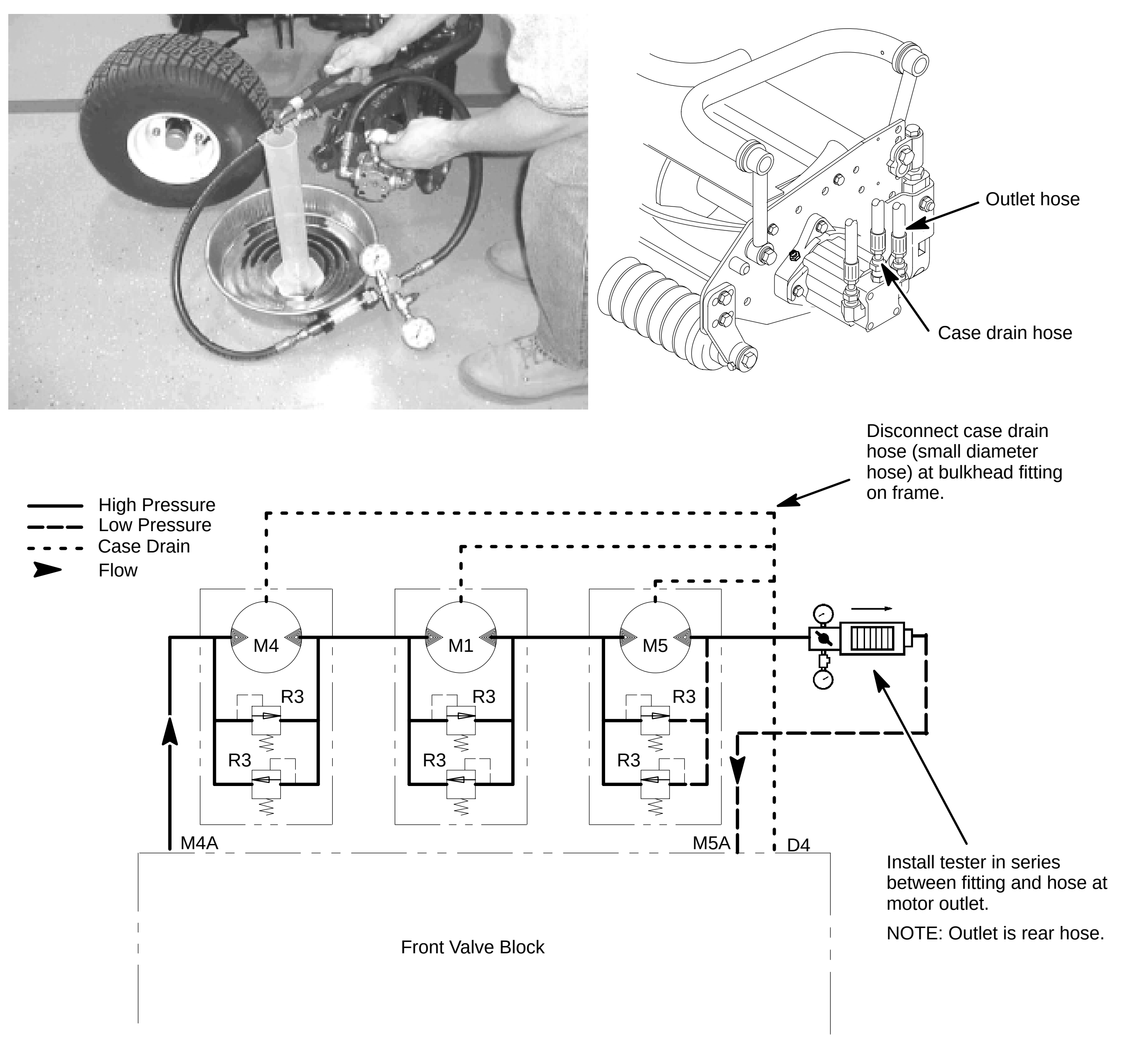


Figure 19

Over a period of time, the motor can wear internally. A worn motor will by–pass oil to the case drain line and make the motor less efficient. Eventually, enough oil loss will occur to cause the motor to stall in heavy cutting conditions. Continued operation with a worn, inefficient motor can generate a lot of heat, cause damage to seals and other components in the hydraulic system and affect quality of cut.

1. Make sure hydraulic oil is at normal operating temperature before doing test.

2. Determine which reel motor is turning too slow.

One way to find a bad motor is to have another person observe the machine while mowing in dense turf. A bad motor will run slower, produce fewer clippings and could cause marcelling (or a washboard appearance) of the turf.

NOTE: The three reel motors in the front circuit (No. 1, 4 and 5) and two reel motors in the rear circuit (No. 2 and 3) are connected in series (No. 2, 3, 6 and 7 on RM6700–D). To isolate a faulty motor you may have to test all motors in the circuit, starting with the first one in series.

3. Lower cutting units, engage parking brake and stop the engine.

4. Loosen bedknife to reel adjustment so their is no bedknife to reel contact on all cutting units

5. Set HOC Selector Knob, located under the instrument panel, to position A (full speed). Make sure Backlap switch is OFF.

6. Install tester in series between outlet fitting and hose of last motor in series. Make sure the tester flow control valve is OPEN.

CAUTION

Keep away from reels during tests to prevent personal injury from rotating reel blades. Do not stand in front of the machine.

IMPORTANT: Make sure that the oil flow indicator arrow on the flow gauge is showing that the oil will flow from the motor, through the tester and into the next motor or the valve block.

7. One person should sit on the seat and operate the machine while another person reads the tester. Start the engine and move “Enable/Disable” switch to ENABLE. Move “Lower–Mow/Raise” lever forward to engage the cutting units. While watching pressure gauges, slowly close flow control valve until a pressure of 2000 PSI is obtained. Disengage the cutting units and stop the engine.

8. Disconnect case drain hose (at bulkhead fitting on frame) from motor being tested. Put a steel cap on the bulkhead fitting. Leave the case drain hose open. One person should sit on the seat and operate the machine while another person holds the hose. Put the case drain hose into a graduated measuring container, such as special tool TOR4077.

9. While sitting on seat, move “Enable/Disable” switch to ENABLE. Move “Lower–Mow/Raise” lever forward to engage cutting units. Have another person measure flow from the case drain line for 15 seconds. Move the switch to DISABLE and stop the engine.

TEST RESULTS: Flow not more than .7 GPM.

10. Measure the amount of oil collected in the container. Multiply the amount collected by 4 (to get gallons per minute) or use the chart below. If flow exceeded .7 GPM, the reel motor should be repaired or replaced.

GPM	Milliliters in 15 sec.	Ounces in 15 sec.
.1	95	3.2
.2	189	6.4
.3	284	9.6
.4	378	12.8
.5	473	16.0
.6	568	19.2
.7	662	22.4
.8	756	25.6
.9	852	28.8
1.0	946	32.0

Adjustments

Traction Drive Neutral Adjustment

The machine must not creep when traction pedal is released. If it does creep, an adjustment is required.

1. Park machine on a level surface, shut engine off and lower cutting units to the floor. Depress only the right brake pedal and engage the parking brake.

2. Jack up left side of machine until front tire is off the shop floor. Support machine with jack stands to prevent it from falling accidentally.

NOTE: On 4 wheel drive models, left rear tire must also be off the shop floor.

3. Start engine and allow run at low idle.

4. Adjust jam nuts on pump rod end to move pump control tube fore ward to eliminate forward creep or rearward to eliminate rearward creep.

5. After wheel rotation ceases, tighten jam nuts to secure adjustment.

6. Stop the engine and release the right brake. Remove jack stands and lower the machine to the shop floor. Test drive the machine to make sure it does not creep.

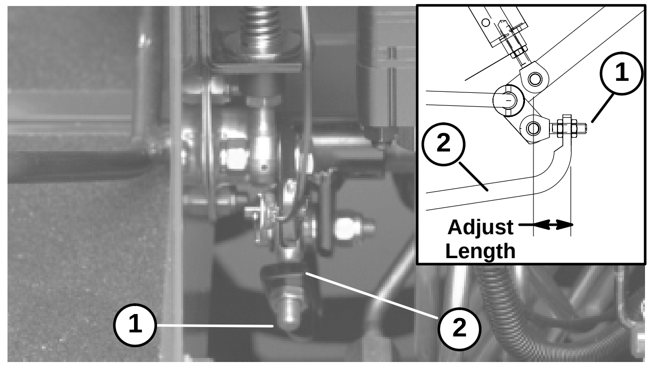


Figure 20

1. Pump rod **2. Pump control tube**

Front Outer Cutting Unit Lift Rate Adjustment

The #4 (left front) and #5 (right front) cutting unit lift circuit is equipped with a adjustable valve to ensure the front cutting units lower evenly. Adjust cutting units as follows:

1. Locate valve under seat.

2. Loosen setscrew on valve. Rotate valve clockwise to slow down drop rate of front outside cutting units.

3. Verify lift rate adjustment by raising and lowering cutting units several times. Readjust as required.

4. After desired drop rate is attained, tighten set screw to lock adjustment.

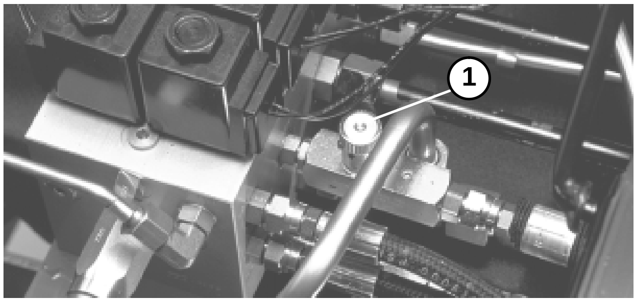


Figure 21

1. Cutting unit adjustment valve

Repairs

Removing Hydraulic System Components

1. Thoroughly clean the machine before disconnecting, removing 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 or fittings left open or exposed.

3. Put labels on disconnected hydraulic lines and hoses for proper installation after repairs are completed.

After Repair or Replacement of Components

1. Check oil level in hydraulic reservoir and add correct oil if necessary. Drain and refill hydraulic system reservoir and change oil filter if component failure was severe or system is contaminated.

2. After repairs, check control linkage for proper adjustment, binding or broken parts.

3. After disconnecting or replacing any hydraulic components, operate machine functions slowly until air is out of system.

4. Check for hydraulic oil leaks. Shut off engine and correct leaks if necessary. Check oil level in hydraulic reservoir and add correct oil if necessary.

Servo Controlled Piston Pump (Traction Pump)

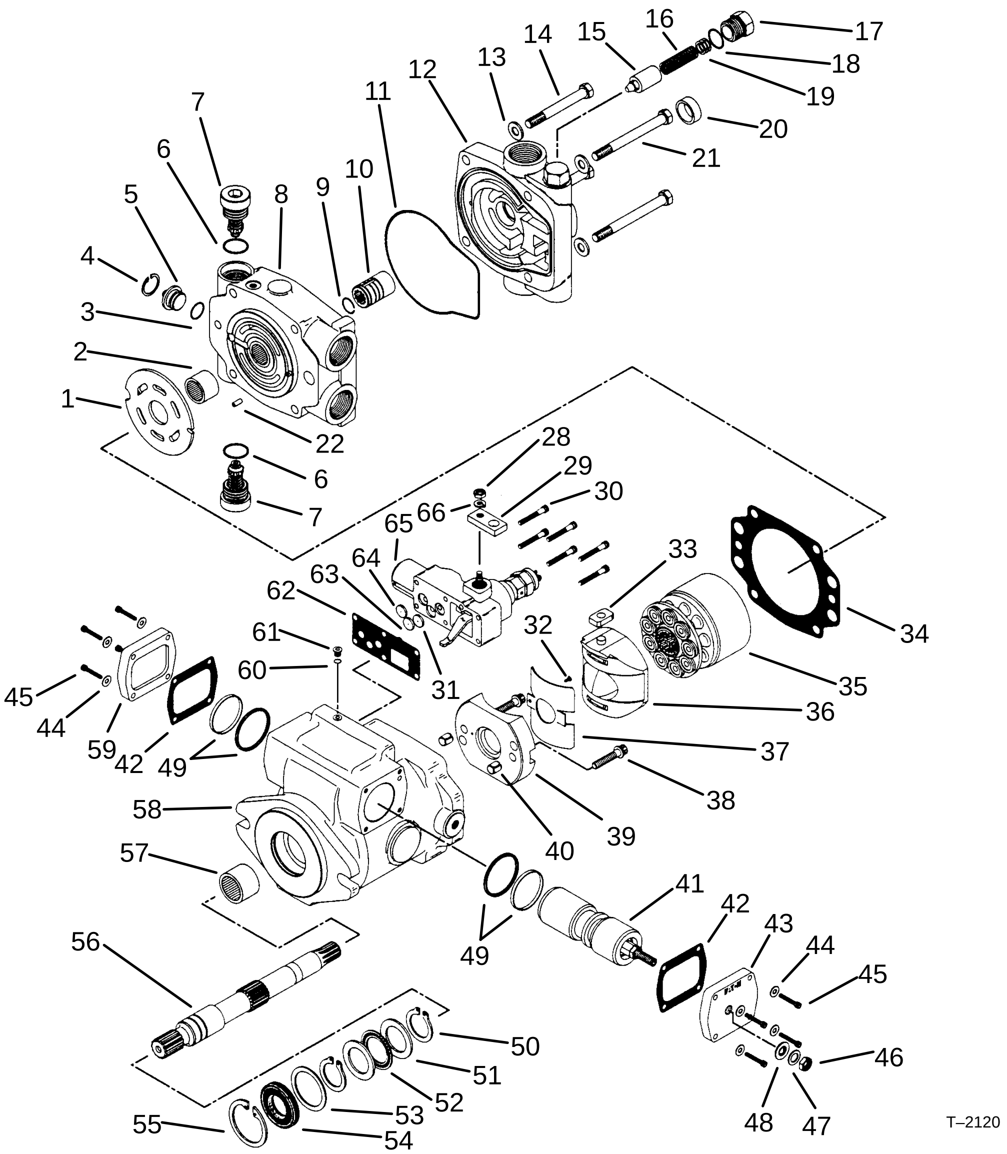


Figure 22

1. Valve Plate
2. Bearing
3. Quad Ring
4. Retaining Ring
5. Dump Valve Plug
6. O–Ring
7. Relief Valve
8. Backplate Assembly
9. Lock Ring
10. Coupler
11. Molded O–Ring
12. Charge Relief Adaptor
13. Flat Washer
14. Cap Screw
15. Poppet
16. Spring
17. Plug
18. O–Ring
19. Washer
20. Bushing
21. Cap Screw
22. Roll Pin
28. Nut
29. Control Arm
30. Cap Screw
31. Control Valve Orifice
32. Screw
33. Piston Follower
34. Housing Gasket
35. Rotating Kit Assembly
36. Camplate Assembly
37. Bushing
38. Cap Screw
39. Cradle Assembly
40. Bushing Dowel
41. Servo Piston Assembly
42. Cover Plate Gasket
43. Cover Plate
44. Flat Washer
45. Cap Screw
46. Jam Nut
47. Washer
48. Seal Washer
49. Seal
50. Retaining Ring
51. Thrust Race
52. Thrust Bearing
53. Washer
54. Shaft Seal
55. Retaining Ring
56. Drive Shaft
57. Bearing
58. Housing Assembly
59. Cover Plate
60. O–Ring
61. Plug
62. Gasket
63. Control Valve Orifice
64. Control Valve Orifice
65. Manual Servo Control
66. Lock Washer

Disassembly – Servo Controlled Piston Pump

The following instructions apply to a single servo controlled piston pump with or without a gerotor charge pump. A tandem pump assembly should be separated into individual pumps before disassembly.

1. Position the pump into a protected jaw vise, clamping onto the outer portion of the flange, with the cap screws up. Mark the relationship of the working ports (for reassembly identification) to the servo control assembly with a scribe. Remove the four screws retaining backplate (14, 21).

2. Lift the charge pump adapter assembly (12) straight up off backplate (8) and shaft (56).

3. Remove o–ring (11) from charge pump adapter (12).

4. Remove the coupler (10) from shaft (56).

5. Lift backplate (8) straight up off shaft (56) and housing (58). Remove valve plate (1) from backplate (8) or from rotating kit assembly (35), still in housing (58).

6. From backplate (8), remove dump valve retaining ring (4), dump valve plug (5), and relief valve assemblies (7). Note: Mark the relief valve in relationship to the cavity it was removed, for reassembly purposes.

Backplate Inspection:

- Check the bearing (2) (press fit) in backplate (8). If needles remain in cage, move freely, and setting is at the dimension shown in Figure 23, removal not required.

- Check roll pin (22) in backplate (8). If tight and set to the dimension shown in Figure 23, removal not required.

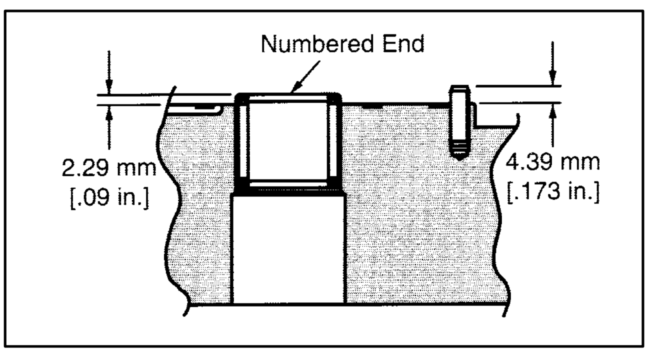


Figure 23

7. Remove housing gasket (34) from housing (58) or backplate (8).

8. With pump still in vise, remove the six cap screws (30) retaining the manual servo control assembly (65). Remove the control assembly and control housing gasket (62) from the housing. Remove orifice plates, noting location for reassembly. Remove nut (28) and lock washer (66) from control arm (29), remove arm. Note position of control arm for reassembly.

9. To remove rotating kit assembly (35) from housing (58), first remove pump from vise holding the rotating kit assembly in position. Lower pump so that the shaft end (flange end) is up. Set the rear of housing onto table with housing flat and rotating kit assembly at rest on table. (Hole in table, for protruding shaft, is required.) Lift and remove the housing (58) and shaft (56) from rotating kit assembly (35), and camplate (36).

10. Remove camplate (36) from rotating kit assembly (35) and servo piston follower (33) from camplate (36).

Camplate Inspection:

- The finish on the piston shoe surfaces of the camplate (36) should show no signs of scoring.

- Inspect camplate bushing (37) surface for wear and surface for coating transfer from bushing.

11. To remove servo piston assembly (41) from housing (58), start with the four each cap screws (45) and washers (44) retaining each cover plate (43 & 59).

12. In removing the cover plate (43) from the servo piston bolt, remove jam nut (46), washer (47), and seal washer (48). Hold the servo Diston bolt with hex key and unscrew cover plate (43) off of bolt.

13. Remove servo piston assembly (41) and seal sub–assemblies (two sets) (49) from housing. Note: Disassembly of servo piston assembly is not required.

14. Remove retaining ring (55) from the front of housing (58). Press the shaft (56), shaft seal (54), and washer (53) from housing. Remove retaining ring (50), thrust washer (51), thrust bearing (52), second thrust washer (51), and second retaining ring (53) from shaft (56).

Housing Inspection:

- Check the bearing (57) (press fit) in housing (58). If needles remain in cage, move freely, and setting at the dimension shown in figure 24, removal not required.

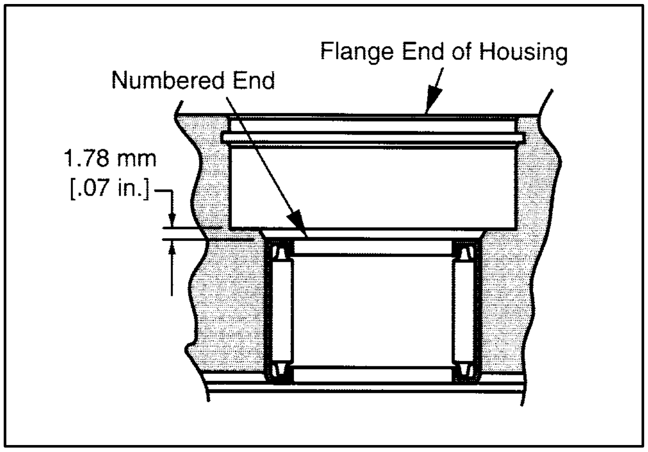


Figure 24

15. To remove cradle sub–assembly (39), remove the two cap screws (38) retaining cradle inside housing. Move the cradle sub–assembly back–and–forth to release dowel bushings (40) and remove cradle sub–assembly from housing.

16. Remove button head cap screw (32) to remove bushing from cradle.

Bushing Inspection:

- Inspect bushing (37) for contamination embedment within coating of bushing surface coming in contact with camplate (36).

17. Remove all plugs (61) from housing.

18. Discard the shaft seal (54), gaskets (34, 42, 62), and o–rings from all assemblies. Replace with new seals upon reassembly.

Reassembly – Servo Controlled Piston Pump

1. All parts should be cleaned and critical moving parts lubricated before reassembly.

2. If necessary, press new bearing in housing to dimension shown in Figure 24 with the numbered end of bearing outward.

3. Install the two new seal sub–assemblies (49) into the servo piston cavity of housing (58).

4. Screw the cover plate (43) onto the servo piston assembly (41). Install new cover plate gasket (42) in place on housing (58). Install servo piston assembly (41) and cover plate (43) into servo piston bore in right side of housing (as shown in Figure 25). Retain cover plate with four each washers (44) and cap screws (45). Torque cap screws 4.5 to 5.4 Nm [40 to 48 lbf•in.]. To obtain neutral, centering the servo piston assembly is required. Measure in from the left side and set servo piston 12.7 mm [.5 in.] from surface of housing servo bore as shown in Figure 25.

NOTE: Re–adjustment may be required for neutral at unit start–up.

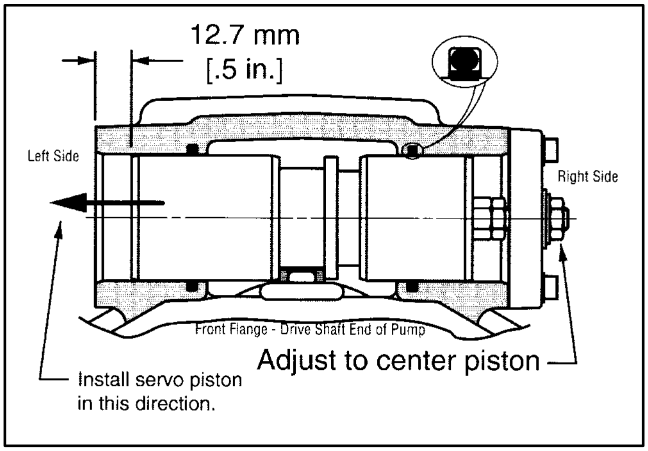


Figure 25

5. Install new seal washer (48), washer (47), and jam nut (46) to servo piston bolt. Holding servo piston bolt with hex key wrench. Torque jam nut 17 to 18 Nm [150 to 160 lbf•in]. Check the centering of servo piston assembly (41). Install new cover plate gasket (42) and cover plate (59) to left side of servo piston and retain with four each washers (44) and #10–24 cap screws (45). Torque cap screws 4.5 to 5.4 Nm [40 to 48 lbf•in.].

6. To assemble cradle sub–assembly (39), press dowel bushings (40) into cradle and install bushing (37) onto cradle retaining with button head cap screw (32). Torque button head cap screw 1.6 to 1.8 Nm [14 to 16 lbf•ft.]

7. Place cradle sub–assembly (39) into housing (58) making sure dowel bushings (40) and cradle (39) are completely seated into housing. Retain cradle sub–assembly (39) with two cap screws (38) after applying Loctite #277 (or equivalent) to the end of threads. Torque cap screws 34 to 38 Nm [25 to 28 lbf•ft.].

8. To install shaft (56), place exterior retaining ring (50), thrust race (51), thrust bearing (52), second thrust race (51), and second retaining ring (50) onto shaft (56). Position washer (53) and shaft seal (54) onto shaft (56).

9. Install shaft assembly into front of housing. Seat seal (54) into position with seal driver and retain with interior retaining ring (55).

10. Install servo piston follower (33) onto camplate dowel pin. Install camplate (36) carefully onto bushing (37) (coat bushing surface with hydraulic oil), aligning servo piston follower (33) with slot in servo piston assembly (41).

11. To install rotating kit assembly (35), leave housing (58) and shaft (56) in the horizontal position. Holding camplate (36) into position with screw driver through controller linkage passageway at the top of housing, place rotating kit assembly over shaft and into housing until pistons are in against camplate (36). Make sure all parts are in housing completely and properly positioned. Return the pump to the vise with open end of housing up, clamping housing on the outer portion of the flange.

12. Install gasket (34) onto housing.

13. If necessary, press new bearing (2) and roll pin (22) in backplate (8) to dimension shown in Figure 23. Bearing installed with the numbered end outward. Roll pin installed with split oriented away from bearing.

14. Install new o–ring (6) on relief valves (7). Install relief valve (7) in its original cavity in backplate (8) that it was removed. Torque 136 to 149 Nm [100 to 110 lbf•ft.]

15. Install new Quad–ring (3) on dump valve plug (5). Install dump valve plug (5) and retain with retaining ring (4) into backplate (8). Note: Make sure paddle of dump valve plug (5) is perpendicular to relief valve axis prior to installing or damage could result.

16. Apply a small amount of petroleum jelly to the steel side of valve plate (1) to hold in place for installation. Aligning the index pin, place the valve plate (1) in position onto the backplate (8), with steel side against backplate.

17. Install backplate assembly (8) onto housing assembly (58). Make sure ports are positioned correctly, valve plate (1) and gasket (34) stay in place.

18. Retain backplate (8) and adapter plate (12) with four cap screws (14 & 21). Torque 37 to 42 Nm [27 to 31 lbf•ft].

19. Install control housing gasket (62) onto housing (58). Install orifices (63 & 64) into control assembly (65) and retain in position with petroleum jelly. Position the feedback link at 90 degrees from control housing. Install manual servo control assembly (65) onto housing making sure feedback link entered small groove in servo piston assembly (41).

20. Retain control assembly with six cap screws (30). Torque 4.5 to 5.4 Nm [3.3 to 4.0 lbf•ft].

21. Install control arm (29) onto control assembly input arm. Retain with lock washer (66) and nut (28). Torque 5 to 8 Nm [4 to 6 lbf•ft].

22. Install new o–rings (60) on all plugs (61). Install plugs (61) into housing (58). Torque 3/4 in. plug 28 to 32 Nm [21 to 24 lbf•ft]. Torque 1–1/4 in. plug 54 to 61 Nm [40 to 45 lbf•ft].

Servo Control

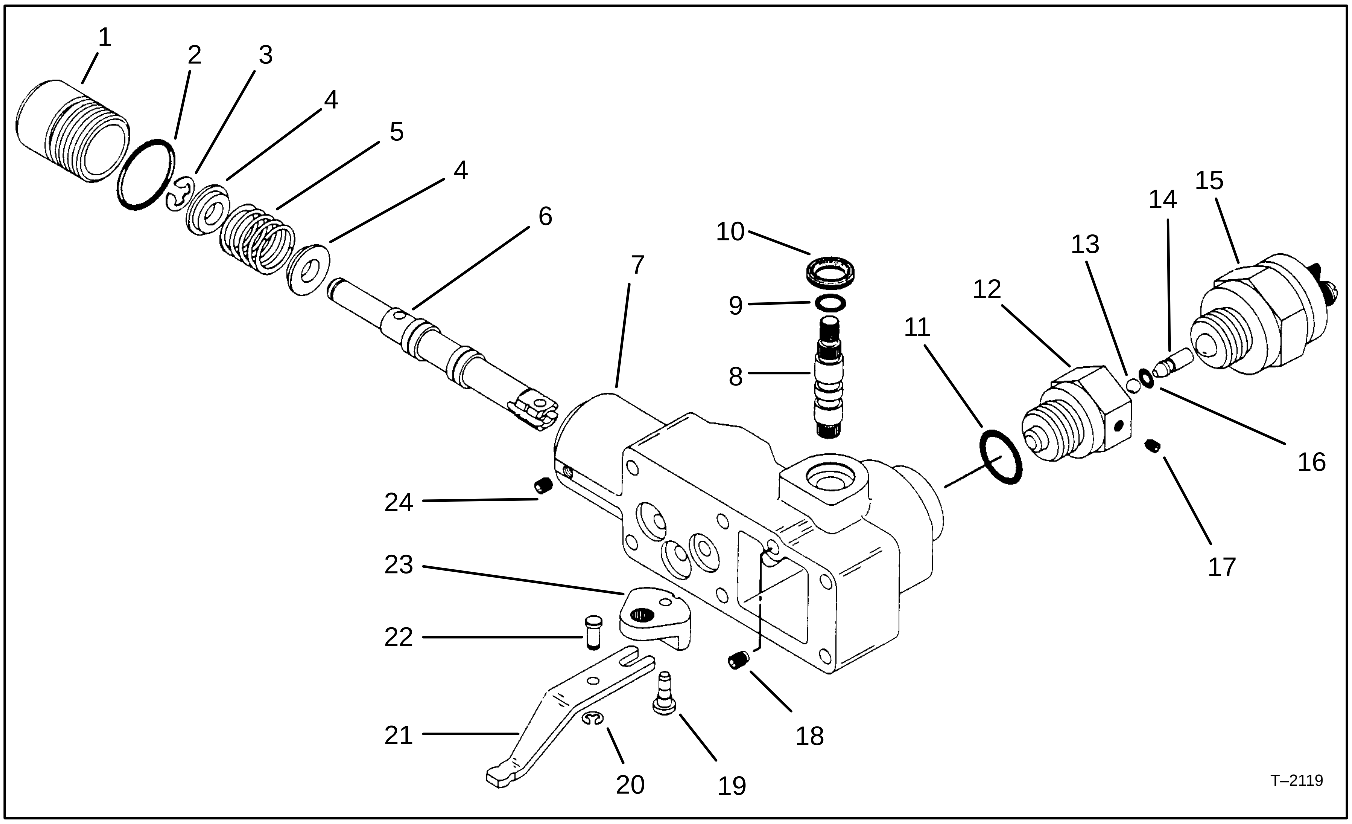


Figure 26

1. Plug	**9. O–Ring**	**17. Set Screw**
2. O–Ring	**10. Wiper Seal**	**18. Set Screw**
3. Retaining Ring	**11. O–Ring**	**19. Pin**
4. Spring Retainer	**12. Adaptor**	**20. Retaining Ring**
5. Spring	**13. Ball**	**21. Link**
6. Spool Valve	**14. Pin**	**22. Dowel Pin**
7. Control Housing	**15. Switch**	**23. Bell Crank**
8. Input Shaft	**16. O–Ring**	**24. Set Screw**

Disassembly – Manual Servo Control Assembly

1. Remove wiper seal (10) with screw driver. Remove set screw (18) retaining input shaft (8) and remove input shaft from control housing (7).

2. Remove set screw (24) from plug (1) retaining valve spool (6) and remove plug.

3. Remove E–ring (20) from pin (22) retaining feedback link (21) and valve spool (6). Remove pin (22), feedback link (21), valve spool (6), and bell crank (23) from control housing (7).

4. Compress spring (5) and remove E–ring (3), spring retainer (4), spring (5), and second spring retainer (4) from valve spool (6).

5. Remove o–rings (2 & 9) from plug (1) and input shaft (8). Clean all parts and lubricate in prep for reassembly.

Reassembly – Manual Servo Control Assembly

1. Install spring retainer (4), spring (5), and second spring retainer (4) onto spool (6). Compress spring with retainer and retain with E–ring (3) onto valve spool (6).

2. Install valve spool (6) into control housing (7) making sure that metering notches on valve spool can be seen in the metering ports.

3. Position bell crank (23) in housing (7). Slide feedback link (21) into position between clevis on valve spool, aligning holes, and install dowel pin (22) retaining with E–ring (20).

4. Install new o–ring (9) onto input shaft (8). Hold bell crank (23) in position with feedback link slot and align splined hole of bell crank with input shaft cavity. Install input shaft (8) into control housing (7) and bell crank (23).

5. Apply Loctite #242 or equivalent to set screw (18) and install, retaining input shaft (8). Adjust set screw until it bottoms out on input shaft and back out one–quarter turn.

6. Install wiper seal (10) on input shaft (8).

7. Install new o–ring (2) onto plug (1), retaining valve spool (6), and install plug. Adjust plug until there is no play in the valve spool with input shaft held stationary. Lock in place with set screw (24). Torque set screw 2 to 3 Nm [17 to 25 lbf•ft].

Disassembly – Neutral Lockout Switch

1. Loosen set screw (17) in adapter (12) and remove neutral lockout switch (15) from adapter (12).

2. Remove Neutral lockout adapter (12) from control assembly (7).

3. Remove pin (14), ball (13), and o–rings (16) from adapter (12).

Reassembly – Neutral Lockout Switch

1. Install new o–ring (11) onto adapter (12) and new o–ring (16) onto pin (14).

2. Install ball (13) and pin (14) into adapter (12). Lubricate with petroleum jelly to hold in place during installation.

3. Install adapter (12) into control assembly (7). Torque 60 to 70 Nm [44 to 53 lbf•ft].

4. Apply Loctite #222 or equivalent to threads of switch (15) and install neutral lockout switch (15) into adapter (12). The adjustment procedures for the switch are as follows.

A. Install switch, while moving control arm back and forth, until "detent" action is detected. Back out the switch until the "detent" action is very slight.

B. Obtain a test light or use a multimeter. Attach the leads from the test light to the switch or the wiring connector.

C. Move the control arm out of the detent position. The test light will go on. Screw in the switch until the light goes off. Mark this as position "A" See Figure 27. Move the control arm to the detent position and the test light should come back on.

D. Leaving the control arm in the detent position, the light will remain on. Screw in the switch until the light goes off. Mark this position "B".

E. Unscrew the switch one third of the distance between "B" and "A". Install and tighten the hex socket head set screw in one of the upper quadrants of the hex of the switch adapter. See Figure 27. Torque set screw 3.2 to 3.8 Nm [28 to 34 lbf•ft].

5. Test the switch by moving the control arm to the detent position, the light should be on. Move the control arm out of detent, the light should go off.

6. Remove test light and put servo control assembly into operation.

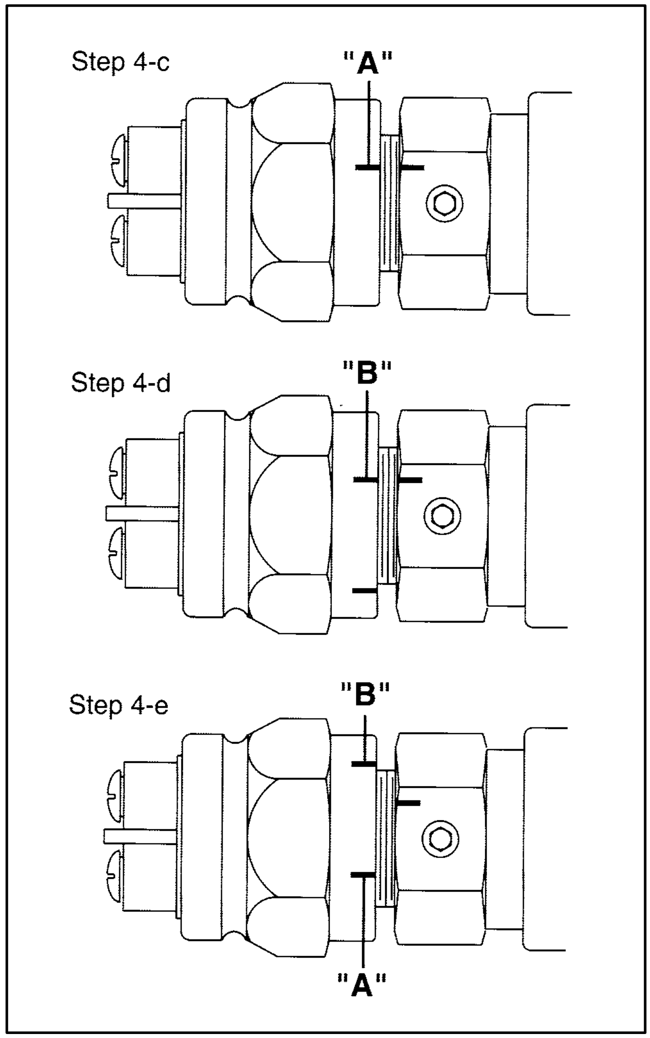


Figure 27

Wheel Motor

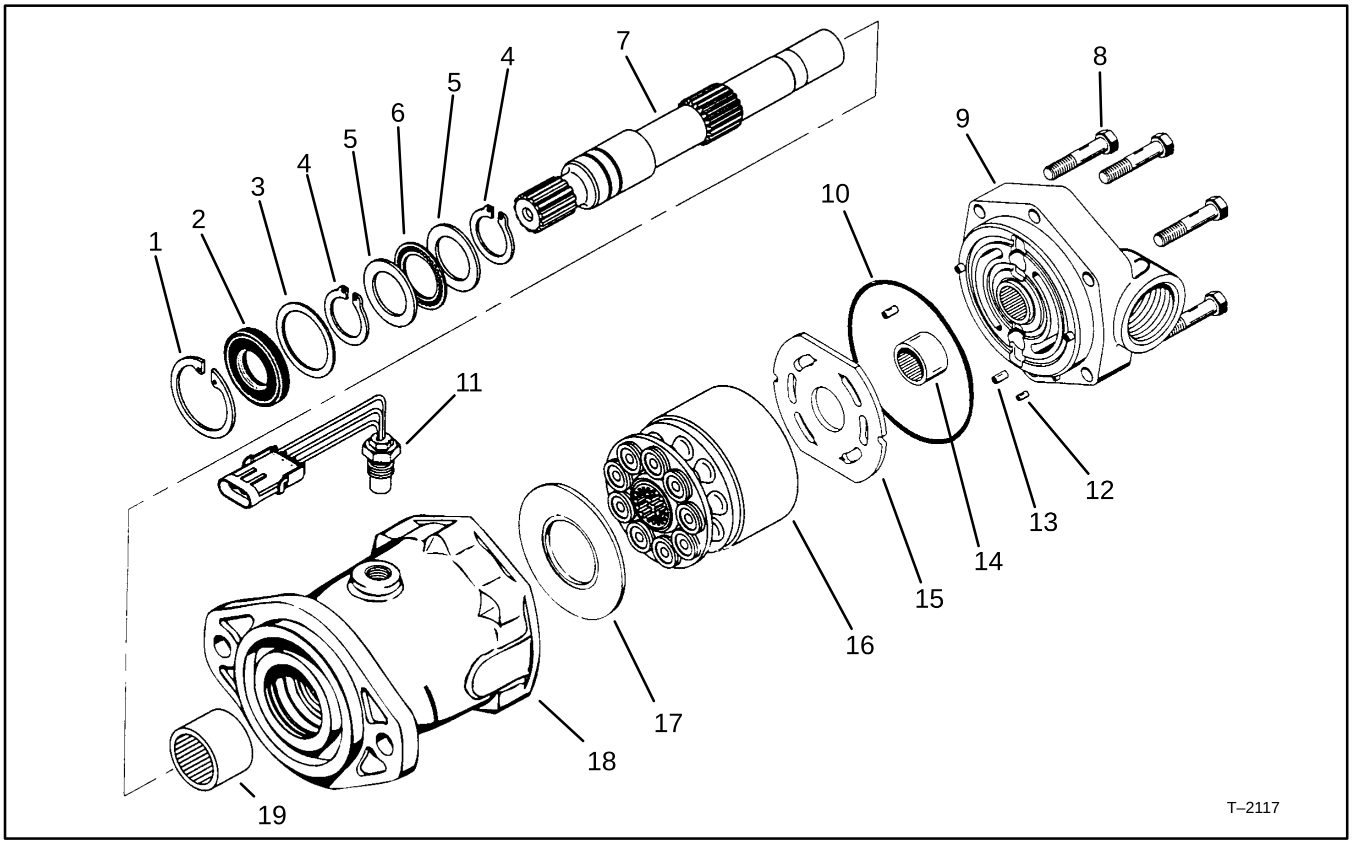


Figure 28

1. Retaining Ring	**8. HH Screw**	**15. Valve Plate**
2. Shaft Seal	**9. Backplate Assembly**	**16. Rotating Kit**
3. Washer	**10. O–Ring**	**17. Camplate Insert**
4. Retaining Ring	**11. Speed Pickup Sensor**	**18. Housing**
5. Thrust Race	**12. Dowel Pin**	**19. Needle Bearing**
6. Thrust Bearing	**13. Dowel Pin**	
7. Splined Drive Shaft	**14. Needle Bearing**	

Cleanliness is extremely important when repairing these motors. Work in a clean area. Before disconnecting the lines, clean port area of motor. Disconnect hydraulic lines, removing motor assembly from vehicle and plug ports. Thoroughly clean the outside of the motor. After cleaning, remove port plugs and drain oil.

Tools Required for Disassembly and Reassembly

1/2 in. Socket
Ratchet Wrench
Torque Wrench, 68 Nm [50 Ibs. ft.]
Soft Face Hammer
Internal Retaining Ring Pliers
(Straight 2.3mm[.090 in.] Tip)
External Retaining Ring Pliers
(Straight 1.8mm[.070 in.] Tip)
Seal Driver or Similar Tool
Petroleum Jelly (Such as Vaseline)

Disassembly

1. Clamp the drive shaft end of the piston motor in a protected jaw vise with the cap screws up. Remove the six cap screws (8) from the motor assembly.

2. Use a mallet and tap the backplate (9) to loosen and remove from housing.

3. Remove valve plate (15) and O–ring (10) from backplate. It is not necessary to remove roll pins in backplate.

4. Remove motor from vise and remove rotating assembly (16) from motor housing.

5. Remove the camplate insert (17) from housing (18). Use caution not to mar the finish that makes contact with pistons.

6. Remove retaining ring (1) from housing. Press shaft (7) from housing (18) and remove shaft seal (2), and washer (3).

7. Remove retaining ring (4) from shaft and remove thrust washers (5) and thrust bearing (6).

8. Discard the shaft seals and o–ring, and replace with new items upon reassembly.

Inspection

1. Check the condition of the needle bearing (14) in backplate (10) and replace if necessary.

2. Inspect valve plate (15) on the bronze side next to the piston block for wear. A smooth surface is required. **Do not lap valve plate bronze surface.** Replace valve plate if any wear exists.

3. Inspect the piston block surface that makes contact with valve plate. This surface should be smooth and free of deep scratches. **Do not lap piston block.**

4. The pistons should move freely in the piston block bore. If they are sticky in the bore, examine the bore for scoring or contamination.

5. Examine the O.D. of the pistons for finish condition. They should not show wear or deep scratches. Inspect the shoes for a snug fit on the ball end of the pistons and a flat smooth surface that comes in contact with the camplate. **Do not lap piston shoes.**

6. Examine the spider for wear in the pivot area

7. Examine the pivot to insure smoothness and no signs of wear.

8. The polished finish on the shoe surface of the camplate insert (17) should show no signs of scoring.

9. Inspect the shaft (7) for wear in the seal, bearing and spline areas.

10. Inspect thrust bearing (6) and washers (5) for wear.

11. Check the condition of the needle bearing (19) in housing (18) and replace if necessary.

Reassembly

1. Clean all parts in suitable solvent and lubricate all critical moving parts before reassembly.

2. If necessary, install new needle bearing (19) in housing (18) with numbered end of the bearing outward.

3. Install retaining ring (4) on shaft (7). Install thrust washer (5), thrust bearing (6), and second thrust washer (5). Secure with second retaining ring (4).

4. Install shaft in housing. Install washer (3), new shaft seal (2), and retain with retaining ring (1).

5. Install camplate insert (17) with the lettering side of insert to the front of the housing. Use petroleum jelly to hold in place during assembly.

6. Clamp motor assembly in a protected jaw vise with the open end of the housing up.

7. If roll pins were removed install to dimension shown and with opening of roll pin oriented away from bearing within 5 degrees of bearing center line.

8. To replace bearing (14) in backplate (9). Press bearing down to the dimension shown protruding from backplate with number end of bearing facing up next to valve plate.

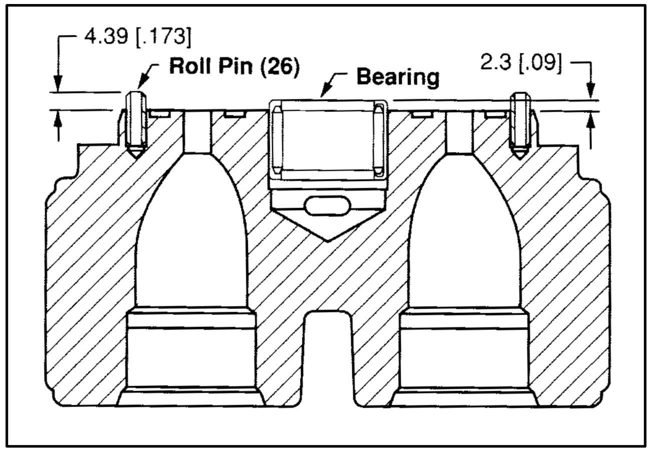


Figure 29
Roll Pin and Bearing Installation

9. Apply small amount of petroleum jelly to the steel side of valve plate (15) to hold in place for installation. Place the valve plate (15) in position onto the backplate (9), with steel side against backplate, bronze colored side against piston block.

10. Placing new o–ring (10) onto backplate, install backplate assembly (9) onto housing assembly (18). Make sure valve plate stays in position.

11. Insert the cap screws (8) and torque 20.3 to 24.4 Nm [15 to 18 lbs•ft.] in a criss–cross pattern.

12. Install speed sensor in R.H. wheel motor. See **Speedometer Sensor Installation** in Repairs section of Chapter 5 – Electrical System.

13. Fill case half full of hydraulic oil and install on vehicle.

4WD Rear Axle Motor

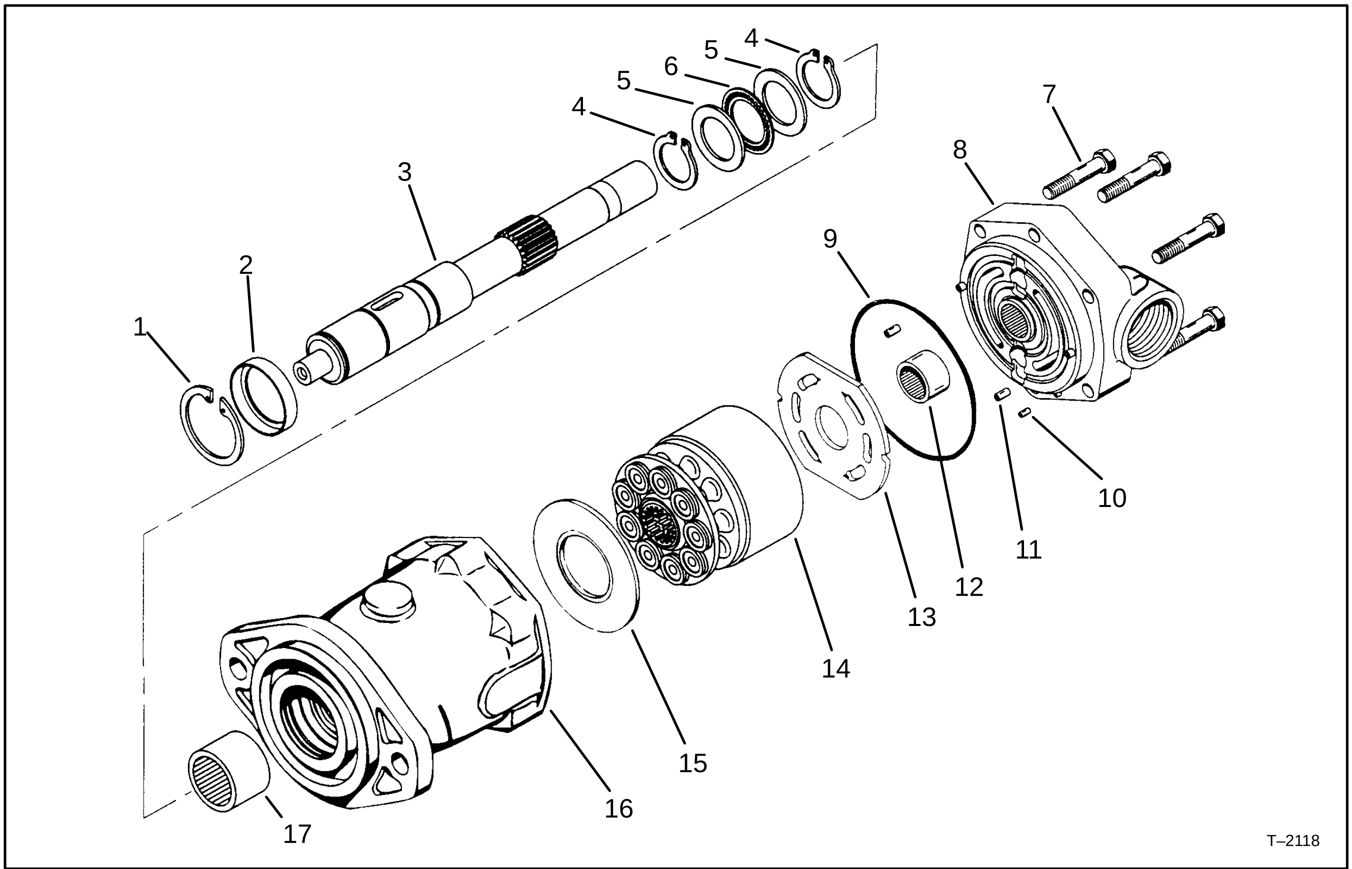


Figure 30

1. Retaining Ring	**7. HH Screw**	**13. Valve Plate**
2. Spacer	**8. Backplate Assembly**	**14. Rotating Kit**
3. Straight Drive Shaft	**9. O–Ring**	**15. Camplate Insert**
4. Retaining Ring	**10. Dowel Pin**	**16. Housing**
5. Thrust Race	**11. Dowel Pin**	**17. Needle Bearing**
6. Thrust Bearing	**12. Needle Bearing**	

Cleanliness is extremely important when repairing these motors. Work in a clean area. Before disconnecting the lines, clean port area of motor. Disconnect hydraulic lines, removing motor assembly from vehicle and plug ports. Thoroughly clean the outside of the motor. After cleaning, remove port plugs and drain oil.

Tools Required for Disassembly and Reassembly

1/2 in. Socket
Ratchet Wrench
Torque Wrench, 68 Nm [50 Ibs. ft.]
Soft Face Hammer
Internal Retaining Ring Pliers
(Straight 2.3mm[.090 in.] Tip)
External Retaining Ring Pliers
(Straight 1.8mm[.070 in.] Tip)
Seal Driver or Similar Tool
Petroleum Jelly (Such as Vaseline)

Disassembly

1. Clamp the drive shaft end of the piston motor in a protected jaw vise with the cap screws up. Remove the six cap screws (7) from the motor assembly.

2. Use a mallet and tap the backplate (8) to loosen and remove from housing.

3. Remove valve plate (13) and O–ring (9) from backplate. It is not necessary to remove roll pins in backplate.

4. Remove motor from vise and remove rotating assembly (14) from motor housing.

5. Remove the camplate insert (15) from housing (16). Use caution not to mar the finish that makes contact with pistons.

6. Remove retaining ring (1) from housing. Press shaft (3) from housing (16) and remove spacer (2).

7. Remove shaft (3) from housing.

8. Remove retaining ring (4) from shaft and remove thrust washers (5) and thrust bearing (6).

9. Discard the shaft seals and o–ring, and replace with new items upon reassembly.

Inspection

1. Check the condition of the needle bearing (12) in backplate (8) and replace if necessary.

2. Inspect valve plate (13) on the bronze side next to the piston block for wear. A smooth surface is required. **Do not lap valve plate bronze surface.** Replace valve plate if any wear exists.

3. Inspect the piston block surface that makes contact with valve plate. This surface should be smooth and free of deep scratches. **Do not lap piston block.**

4. The pistons should move freely in the piston block bore. If they are sticky in the bore, examine the bore for scoring or contamination.

5. Examine the O.D. of the pistons for finish condition. They should not show wear or deep scratches. Inspect the shoes for a snug fit on the ball end of the pistons and a flat smooth surface that comes in contact with the camplate. **Do not lap piston shoes.**

6. Examine the spider for wear in the pivot area.

7. Examine the pivot to insure smoothness and no signs of wear.

8. The polished finish on the shoe surface of the camplate insert (11) should show no signs of scoring.

9. Inspect the shaft (3) for wear in the seal, bearing and spline areas.

10. Inspect thrust bearing (6) and washers (5) for wear.

11. Check the condition of the needle bearing (17) in housing (16) and replace if necessary.

Reassembly

1. Clean all parts in suitable solvent and lubricate all critical moving parts before reassembly.

2. If necessary, install new needle bearing (17) in housing (16) with numbered end of the bearing outward.

3. Install retaining ring (4) on shaft (3). Install thrust washer (5), thrust bearing (6), and second thrust washer (5). Secure with second retaining ring (4).

4. Install shaft in housing. Install new spacer (2), and retain with retaining ring (1).

5. Install camplate insert (15) with the lettering side of insert to the front of the housing. Use petroleum jelly to hold in place during assembly.

6. Clamp motor assembly in a protected jaw vise with the open end of the housing up.

7. If roll pins were removed install to dimension shown and with opening of roll pin oriented away from bearing within 5 degrees of bearing center line.

8. To replace bearing (12) in backplate (8). Press bearing down to the dimension shown protruding from backplate with number end of bearing facing up next to valve plate.

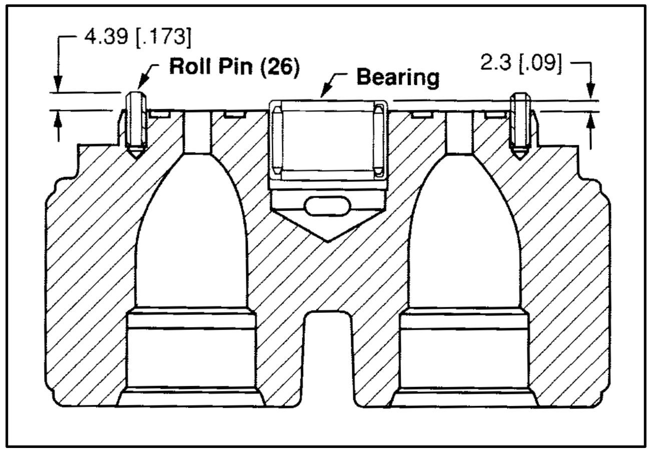


Figure 31

Roll Pin and Bearing Installation

9. Apply small amount of petroleum jelly to the steel side of valve plate (13) to hold in place for installation. Place the valve plate (13) in position onto the backplate (8), with steel side against backplate, bronze colored side against piston block.

10. Placing new o–ring (9) onto backplate, install backplate assembly (8) onto housing assembly (16). Make sure valve plate stays in position.

11. Insert the cap screws (7) and torque 20.3 to 24.4 Nm [15 to 18 Ibs•ft.] in a criss–cross pattern.

12. Fill case half full of hydraulic oil and install on vehicle.

Gear Pump

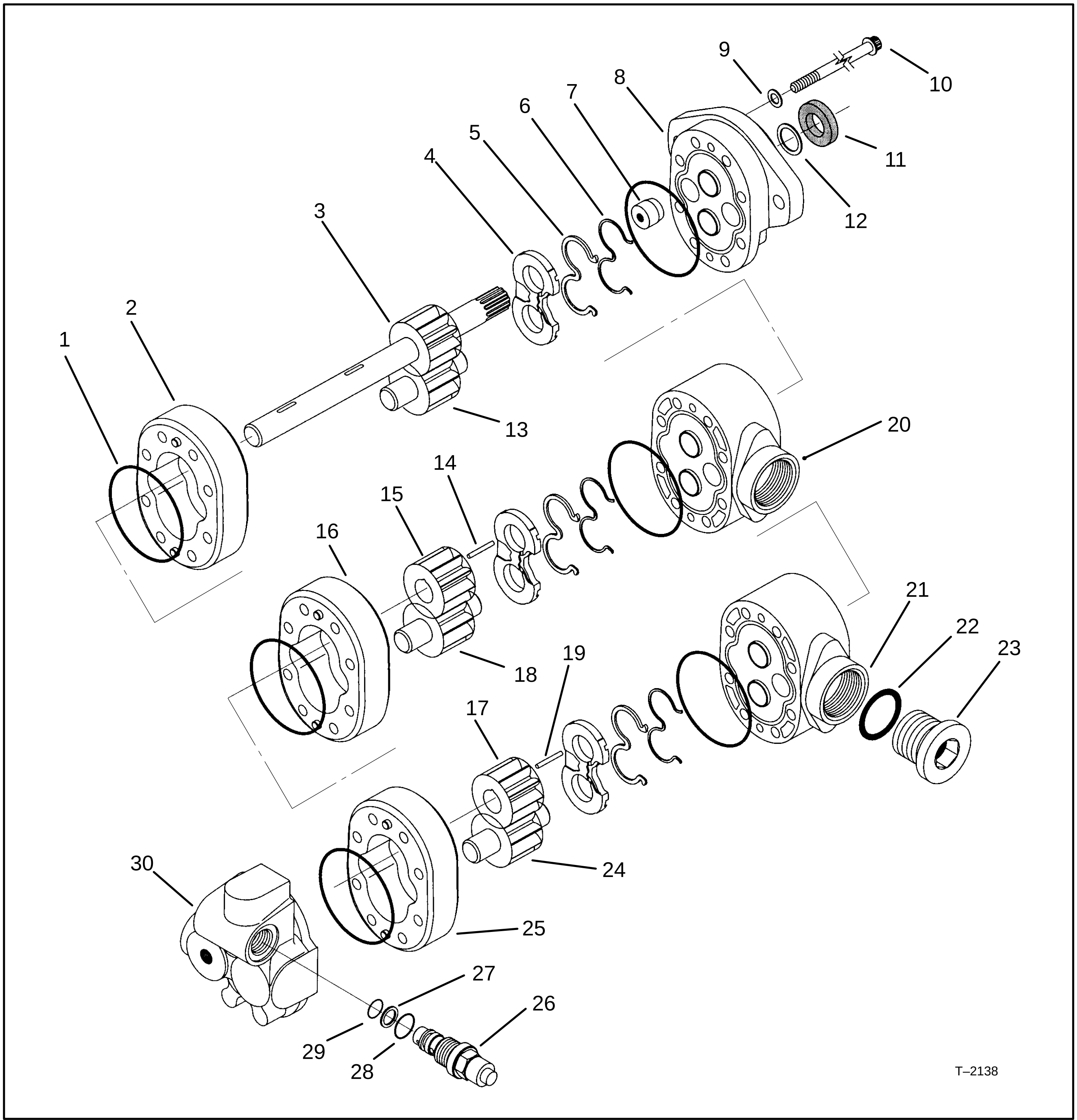


Figure 32

1. O–Ring
2. Front body
3. Drive gear assembly
4. Wear plate
5. Balance pressure seal
6. Backup gasket
7. Plug
8. Front plate assembly
9. Copper washer
10. Cap Screw
11. Shaft seal
12. Washer
13. Idler gear assembly
14. Key
15. Gear
16. Middle body
17. Gear
18. Idler gear
19. Key
20. Front adapter plate
21. Rear adapter plate
22. O–Ring
23. Plug
24. Idler gear
25. Rear body
26. Relief valve
27. Backup washer
28. O–Ring
29. O–Ring
30. Backplate assembly

Hydraulic System

Repair Information

Work in a clean area, cleanliness is extremely important when repairing hydraulic pumps. Before disconnecting the lines, clean port area of pump. Disconnect hydraulic lines, removing pump assembly from vehicle and plug ports. Thoroughly clean the outside of pump. After cleaning then remove port plugs and drain oil.

Disassembly

1. Scribe a line, at an angle, across front plate (8), bodies (2, 16, 25), adapter plates (20, 21) and backplate (30). This will assure proper reassembly.

NOTE: To maintain maximum pump efficiency, keep body, gears and wear plates for each section together. DO NOT mix parts between different sections.

2. Clamp pump in vise, shaft end up.

3. Remove the eight cap screws (10).

4. Remove pump from vise, hold pump in hands and bump shaft against wooden block to separate front pump sections. Front body (2) will remain with either front plate (8) or front adapter plate (20).

5. Place front idler gear (13) into gear pocket and tap with soft face hammer until the front body separates. Now remove idler gear from front plate or adapter plate.

6. Remove plug (7) from front plate (8).

7. Remove front adapter plate (20) from body (2) by tapping on the adapter plate with a plastic hammer or rawhide mallet.

8. Remove idler gear (18), slip fit gear (15), and key (14).

9. Remove backplate (30) from body (25) by tapping on backplate with plastic hammer or rawhide mallet.

10. Remove rear idler gear (24), slip fit gear (17) and key (19).

11. Remove drive gear assembly (3) from adapter plate (21).

12. Place rear idler gear assembly (24) back into gear pocket and tap protruding end with soft face hammer to remove rear body (25) from the backplate assembly (30) or the rear adapter plate (21).

13. Remove the wear plates (4) from front plate (8), front adapter plate (20), and rear adapter plate (21).

14. Remove o–rings (1) from front plate (8), adapter plates (20, 21), and backplate (30).

15. Remove backup gaskets (6) and balance pressure seals (5) from front plate (8) and adapter plates (20, 21) by prying out with a sharp tool.

16. Remove shaft seal (11) and washer (12) from front plate (8) by prying with a screw driver.

17. Remove plug (23) and washer (22) from rear adapter plate (21).

18. Remove relief valve (26) from backplate assembly (30).

19. Remove O–ring (29), backup washer (27), and O–ring (28) from relief valve (26).

Inspect Parts for Wear General

1. Clean and dry all parts.

2. Remove nicks and burrs from all parts with emery cloth.

Gear Assembly Inspection

1. Check spline drive shaft for twisted or broken teeth or check keyed drive shaft for broken or chipped keyway. Also check for broken keyway, on drive shaft, that drives the slip fit gear of the rear pump.

2. Inspect both the drive gear and idler gear shafts at bushing points and seal area for rough surfaces and excessive wear.

3. Replace gear assembly if shaft measures less than .873 in. [22,17mm] in bushing area. (One gear assembly may be replaced separately; shafts and gears are available as assemblies only. The slip fit gear is available separately).

4. Inspect gear face for scoring and excessive wear.

5. Replace gear assembly if gear width is below 1.181 in. [30,00 mm].

6. Assure that snap rings are in grooves on either side of drive and idler gears.

7. If edge of gear teeth are sharp, break edge with emery cloth.

Front Plate, Backplate and Adapter Plates Inspection

1. Oil groove in bushings in front plate, backplate and adapter plates should be in line with dowel pin holes and 180 degrees apart. This positions the oil grooves closest to respective dowel pin holes.

2. Replace the backplate, front plate or adapter plates if I.D. of bushings exceed .879in. [22,33mm] (Bushings are not available as separate items).

3. Bushings in front plate and backup gasket side of adapter plates should be flush with face of plate.

4. Check for scoring on face of backplate or adapter plates. Replace if wear exceeds .0015 in. [,038mm].

Body Inspection

1. Check bodies inside gear pockets for excessive scoring or wear.

2. Replace bodies if I.D. of gear pockets exceeds 2.1 in. [53,54mm].

General Information

It is important that the relationship of the backplate, adapter plates, bodies, wear plate and front plate is correct. You note two half moon cavities in the body which must face away from the front plate or adapter plate. Note: The smaller half moon port cavity must be on the pressure side of the pump. The side of wear plate with mid section cut out must be on suction side of pump. Suction side of backplate or adapter plate is always the side with larger port boss.

Reassembly

1. Replace the wear plates, bearing seals, backup gaskets, shaft seal and o–rings as new parts.

2. Install o–rings (1) in groove of front plate (8), adapter plates (20, 21), and backplate (30) with a small amount of petroleum jelly to hold in place.

3. Tuck backup gasket (6) in front plate (8) and adapter plates (20, 21) with open part of “V” section down.

4. Place balance pressure seal (5) in groove in front plate (8) and adapter plates (20, 21).

5. Place plug (7) into pocket of front plate (8).

6. Apply a thin coat of petroleum jelly to both milled gear pockets of front body (2). Slip body onto front plate (8) with half moon port cavities in body facing away from front plate.

NOTE: The small half moon port cavity must be on the pressure side of pump.

7. Place wear plate (4) on top of backup gasket (6) with bronze face up. The side with the mid section cut away must be on suction side of pump.

8. Dip drive gear assembly (3) and idler gear assembly (13) into oil. Slip both gear assemblies into gear pocket of front body (2) and into front plate bushings.

9. Place wear plate (4) on top of backup gasket (6) with bronze face up. The side with the mid section cut away must be on suction side of pump.

10. Install front adapter plate (20) in place on front body (2). Check positioning marks.

11. Install middle body (16) onto front adapter plate (20) and install wear plate (4).

12. Install key (14) in slot of drive gear shaft (3). Dip slip fit gear (15) in oil and slip on shaft and into gear pocket of middle body (16). Check key for proper alignment.

13. Dip idler gear (18) in oil and install in gear pocket of middle body (16).

14. Install rear adapter plate (21) in place on middle body (16). Check positioning mark on all sections of pump.

15. Install rear body (25) onto adapter plate (21) and install wear plate (4).

16. Install key (19) in slot of drive gear shaft assembly. Dip slip fit gear (17) in oil and slip on shaft and into gear pocket of rear body. Check key for proper location.

17. Dip rear idler gear (24) in oil and install in gear pocket of rear body (25).

18. Position backplate (30) over shafts until dowel pins in body are engaged.

19. Secure with cap screws (10). Tighten cap screws evenly in a crisscross pattern to 25 to 28 ft–lbs. [34 to 38 Nm] torque.

20. Place washer (12) over drive shaft into housing. Liberally oil shaft seal (11) and install over drive shaft carefully so that rubber sealing lips are not cut.

21. Place 1–3/8” O.D. sleeve over shaft and press in shaft seal (11) .20 in. (5.08mm) below front surface of front plate.

22. Install key on keyed shaft.

Valve Blocks

Solenoid Wire Identification

Solenoid	Power Wire Color	Function
VS1A	Orange/Black	Front Reel Speed, Front Lift Speed
S1A	Black/Red	Front Reels On/Off, Front Lift
S2A	Violet/Red	Front Reels/Lift Selector
S3A	Blue/White	Front Reels Mow/Backlap Selector
S4A	Orange/Blue	Lift All
S5A	Brown/White	Lower All
S6A	Yellow/Black	Lift/Lower #4, #5
S7A	Yellow/White	Lift/Lower #1

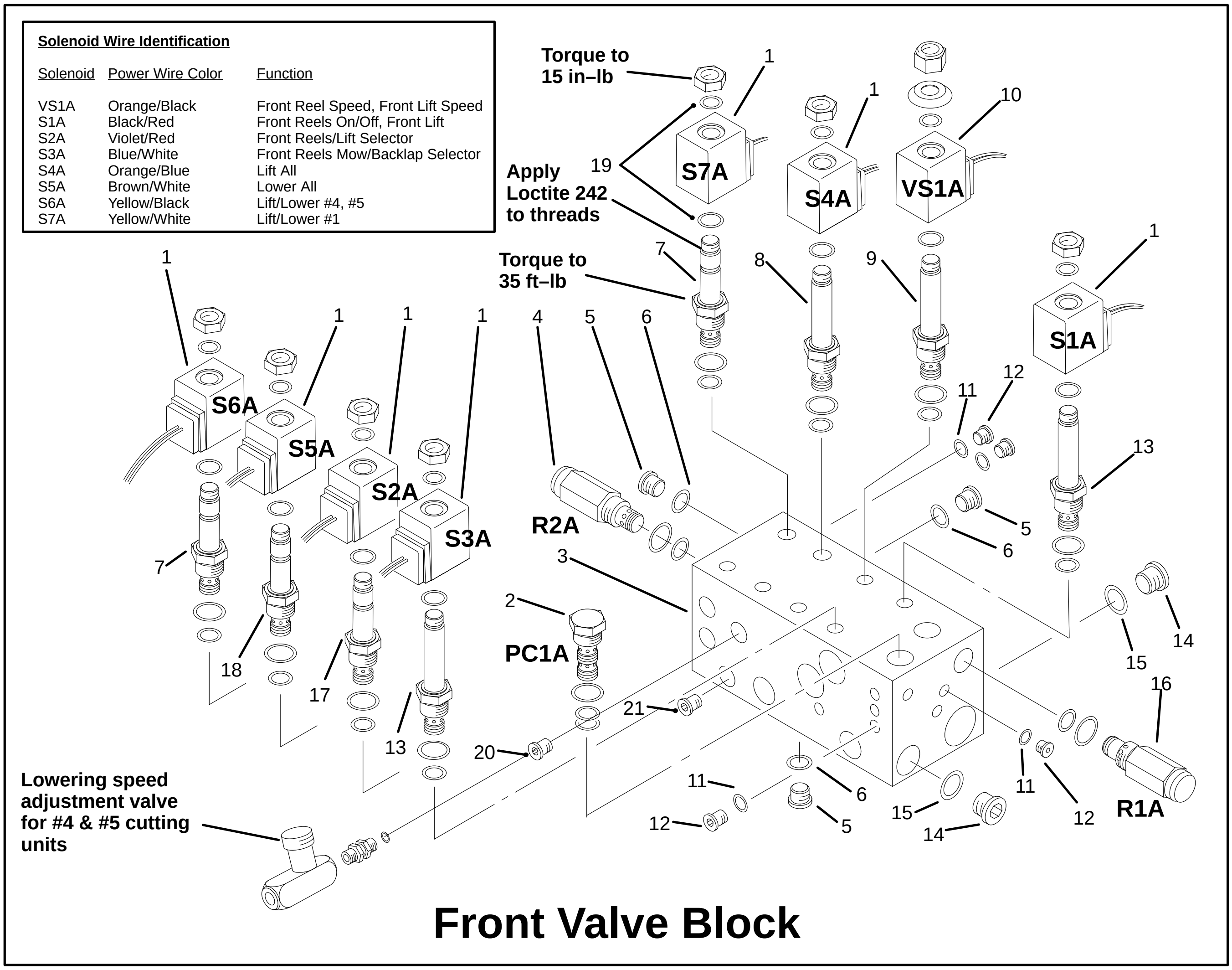


Figure 33

1. Solenoid – 20 Watt
2. Pilot check cartridge
3. Front manifold block
4. Relief cartridge – 2750 PSI
5. Plug
6. O–ring.
7. Cartridge – N.C. (2)
8. Cartridge
9. Cartridge – N.O.
10. Solenoid – 28 Watt
11. O–ring
12. Plug
13. Cartridge – N.O. poppet
14. Plug
15. O–ring
16. Relief cartridge – 3000 PSI
17. Cartridge – N.O. poppet
18. Cartridge – N.C. poppet
19. Seal
20. Orifice (.060)
21. Orifice (.040)

1. Before removing any parts from the valve block, park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove key from ignition switch.

2. Raise seat and secure with prop rod to get access to valve block.

NOTE: Ports on valve block are marked for easy identification of components. Example: S1A is front mow circuit solenoid valve and R1A is front mow/lift circuit relief valve. (See Hydraulic Schematics to identify function of hydraulic lines and cartridge valves at each port location).

3. If necessary, valve block can be removed:

A. Disconnect solenoid electrical connectors.

B. Disconnect hydraulic lines. Put caps or plugs on disconnected hoses and fittings to prevent contamination.

C. Remove capscrews from bottom of valve block and lift valve block out of machine.

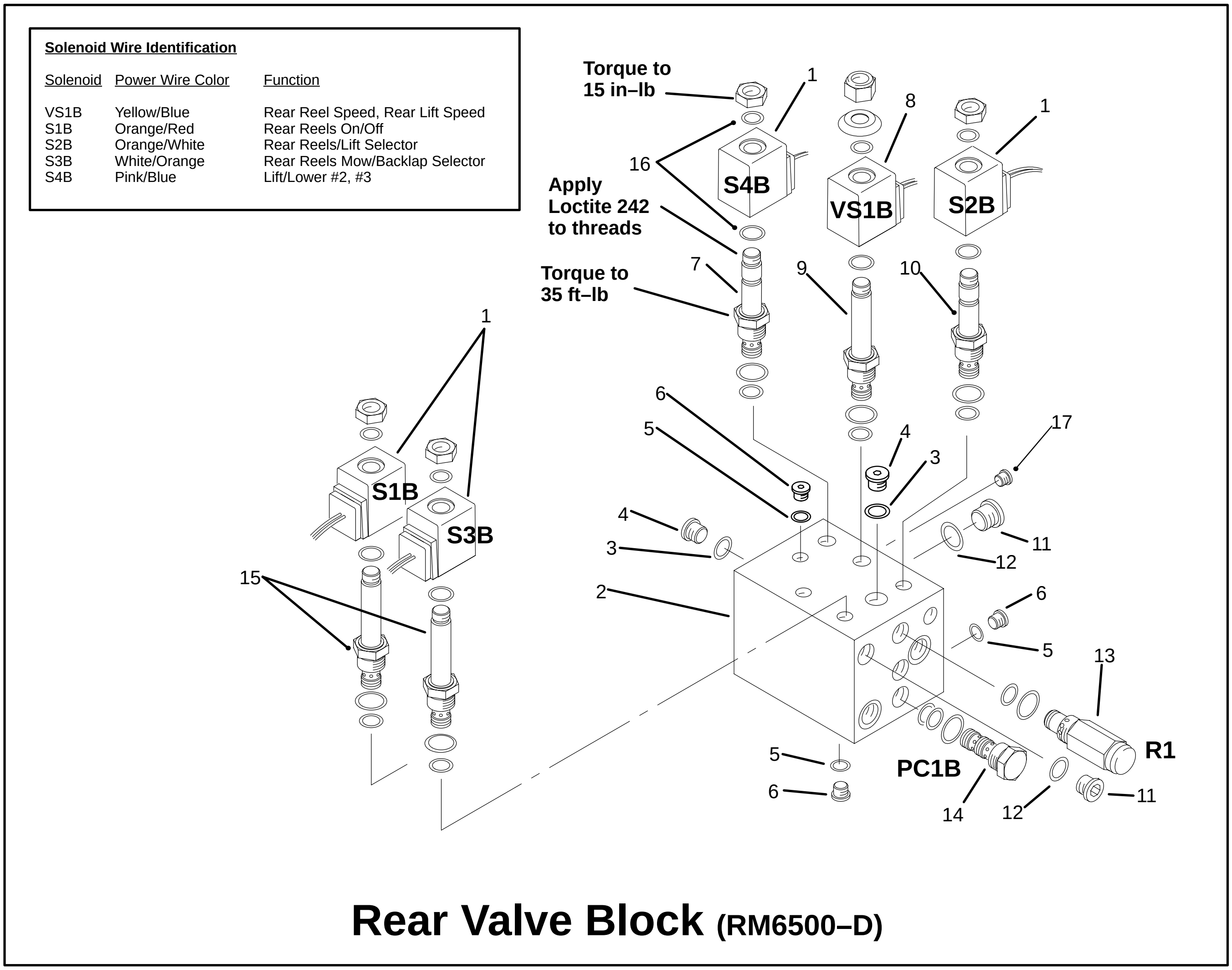


Figure 34

1. Solenoid – 20 Watt
2. Rear Manifold Block
3. O–ring
4. Plug
5. O–ring
6. Plug
7. Cartridge – N.C. Spool
8. Solenoid – 28 Watt
9. Cartridge – No Flow
10. Cartridge – N.C. Poppet
11. Plug
12. O–ring
13. Relief cartridge – 3000 PSI
14. Pilot check cartridge
15. Cartridge – N.O. poppet (2)
16. Solenoid seal
17. Orifice (.040)

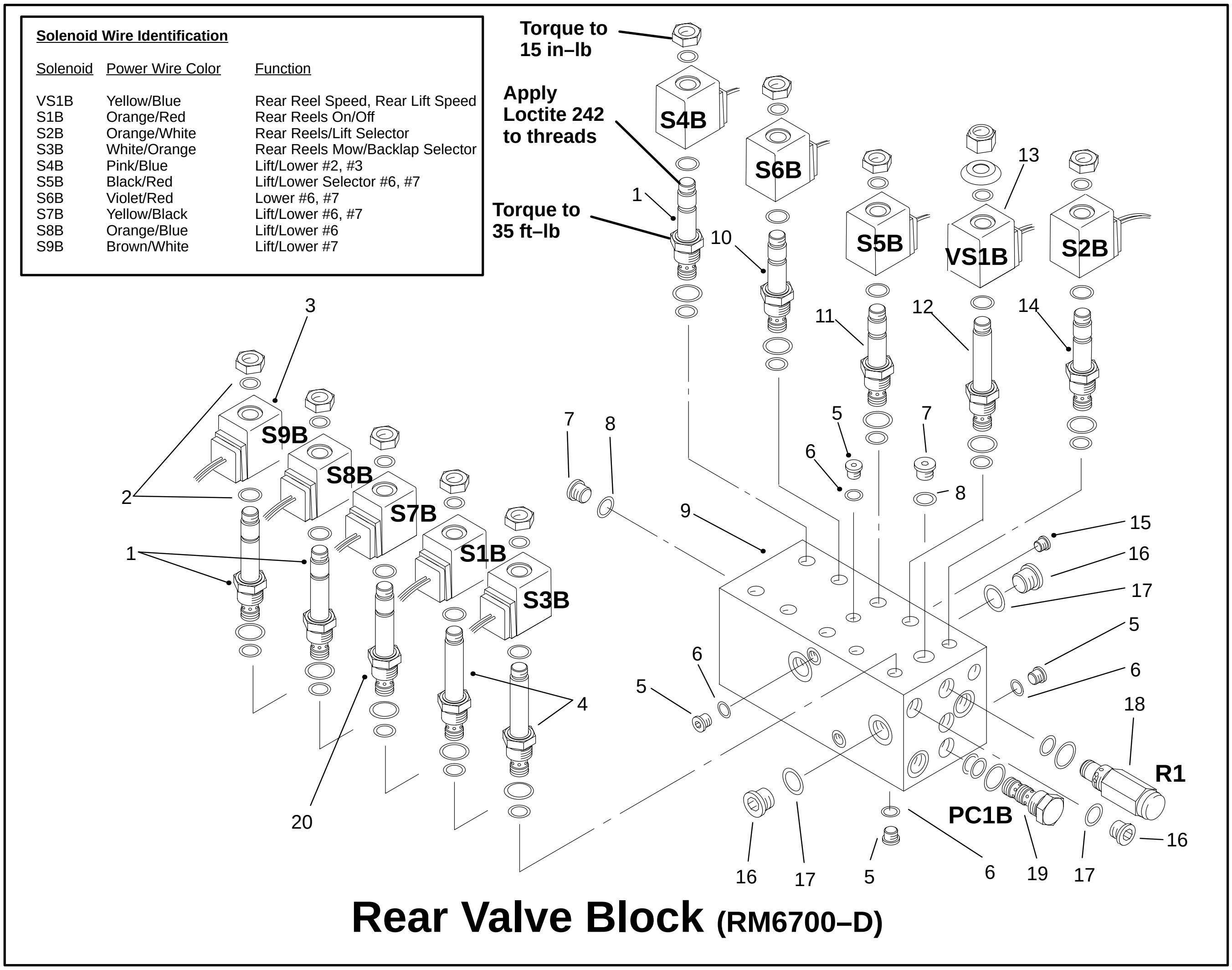


Figure 35

1. Cartridge – N.C. spool (3)
2. Seal
3. Solenoid – 20 Watt
4. Cartridge – N.O. poppet (2)
5. Plug
6. O–ring
7. Plug
8. O–ring
9. Rear manifold block
10. Cartridge – N.C. poppet
11. Cartridge – W/2P
12. Cartridge – No flow
13. Solenoid – 28 Watt
14. Cartridge – N.C. poppet
15. Orifice (.040)
16. Plug
17. O–ring
18. Relief cartridge – 3000 psi
19. Cartridge – N.O. poppet
20. Cartridge – 3W2P pull

Cartridge Valves

1. Clean valve block to prevent contamination when valve cartridge is removed.

2. Remove cartridge valve:

   A. Remove nut from solenoid.

   B. Remove solenoid coil and o–ring at each end of solenoid coil.

   C. Use a deep socket to remove cartridge valve. NOTE: Use care when handling valve cartridges, because slight bending or distortion of stem tube can cause binding and malfunction.

3. Visually inspect port in block for damage to sealing areas, damaged threads or contamination.

4. Visually inspect cartridge for damaged seals and contamination.

   A. O–rings and backup rings must be arranged properly on the valve for proper operation and sealing. Replace any damaged seals.

   B. Contamination may cause valves to stick or hang up. Contamination can become lodged in small valve orifices or seal areas on poppet type valves causing malfunction.

   C. If cartridge valve seals appear pitted or damaged, the hydraulic system may be overheating or there may be water in the system.

5. Clean and check for proper valve operation:

   A. Use clean mineral spirits to clean cartridge valve. Submerge the valve in clean mineral spirits and use a probe to push the internal spool in and out 20 to 30 times to flush out contamination. Mineral spirits does not affect the o–ring material. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves.

Cartridge Installation

1. Lubricate all o–rings with clean hydraulic oil.

2. Carefully thread cartridge into the port by hand. Valve cartridge should go in easily without binding.

3. Use a torque wrench and deep socket to tighten cartridge valves to a torque of 35 ft–lb. Excessive torque may cause the spool to bind and malfunction.

NOTE: Use care when handling solenoid valve cartridges because slight bending or distortion of stem tube can cause binding and malfunction.

4. Install solenoid coil. Make sure there is an o–ring at each end of the coil. Apply “Loctite 242” or equivalent to threads of stem tube before installing nut. Tighten nut to a torque of 15 in–lb.

5. If problem still exists, remove valve and clean again or replace valve.

Figure 36

Reel Motor

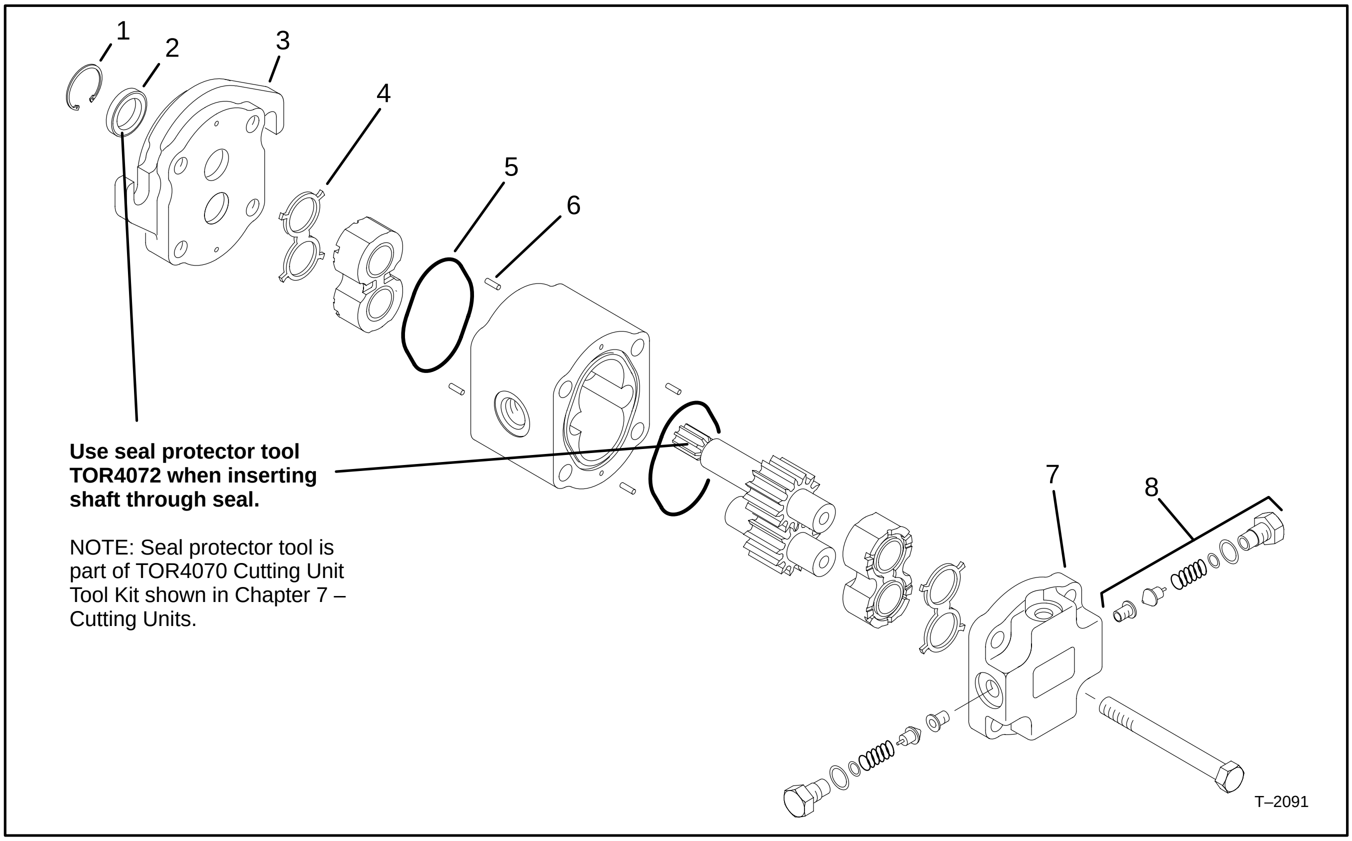


Figure 37

1. Retaining Ring
2. Shaft seal
3. Flange
4. E–Seal
5. O–Ring
6. Dowel pin
7. Valve Block
8. Adjusting valve

Adjusting Valve (Cross–over Relief Valve) Service

NOTE: The adjusting valve (8) must be replaced as a complete assembly. Disassemble parts for cleaning and inspection only.

1. Disassemble the adjusting valve parts. DO NOT attempt to remove the valve seat. It is installed with thread locking compound at the factory.

2. Inspect adjusting valve bore and seat in valve block.

3. Inspect spring for damage.

4. Clean and air dry all parts. Apply hydraulic oil to parts and install in the same order they were removed.

Disassembly

NOTE: Parts must be replaced as a kit. Gears, gear housing and bearing blocks cannot be serviced separately. Replace complete motor if these parts are damaged or severly worn.

IMPORTANT: The motor is “run–in” at the factory to obtain precise parts tolerances. Keep housing, gears and bearings for each motor together. DO NOT mix parts between different motors.

1. Plug ports and wash exterior of motor with cleaning solvent.

2. Draw a line across seam areas on flange, gear housing and valve block with a scribe or marker to ensure proper reassembly.

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

3. Secure the flange end of the motor (3) in a vise with the drive shaft pointing down.

4. Remove the four capscrews.

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

6. Remove valve block (7).

7. Remove gear housing. Make sure rear bearing block remains on drive and idler gear shafts.

8. Remove rear bearing block from drive and idler gear shafts.

9. Before removing gear set, apply marking dye to mating teeth to retain “timing”. Motor efficiency may be affected if the teeth are not installed in the same position during reassembly.

10. Remove idler gear.

11. Remove drive gear and shaft slowly until drive end is through shaft seal.

12. Remove front bearing block.

13. Wash all parts in cleaning solvent. Check all parts for burrs, scoring, nicks and other damage. If gears, housing or bearing blocks are damaged or severely worn, entire motor should be replaced.

Seal Replacement (Motor Disassembled)

1. Put flange (3) on a clean, flat surface with shaft seal (2) facing up. Remove retaining ring (1).

2. Remove shaft seal, being careful not to scratch seal bore in flange. Scratches in seal bore could cause leakage. Make sure seal bore is clean.

3. Put new shaft seal (part number side up) in seal bore and press seal into bore until seal reaches bottom of bore. Uniform pressure must be applied to face of shaft seal to prevent damage to seal and misalignment in seal bore.

4. Install retaining ring with sharp edge facing out.

E–seal Replacement

1. Put bearing block on a clean, flat surface with E–seal (4) facing up. Remove E–seal. Clean E–seal groove.

2. Apply a light coating of grease or petroleum jelly in E–seal groove and on back (flat) side of new E–seal. Put E–seal, flat side up, into groove in bearing block.

3. Repeat for other bearing block.

O–ring Replacement

1. Remove dowel pins (6) and O–rings (5) from gear housing. Clean O–ring grooves.

2. Apply a light coating of grease or petroleum jelly to O–ring grooves in gear housing and install new O–rings in each groove.

Reassembly

1. Put flange (3) on a flat surface with shaft seal facing down. Make sure back side of flange is free of contamination.

2. Put front bearing block, seal side down, on flange.

3. Apply a light coating of oil to exposed face of bearing block. Put tape or seal protector tool (TOR4072) over splined end of drive shaft. Insert drive shaft through bearing block and shaft seal.

4. Put idler gear on bearing block. Apply a light coating of oil to back face of drive and idler gears.

5. Put rear bearing block, seal side up, on drive and idler gear shafts.

6. Install the two front dowel pins in the flange.

7. Carefully install gear housing over rear bearing block and slide gear housing down over the gears and front bearing block. Make sure the markings put on the flange and housing earlier line up.

8. The rear bearing block should sit just below back face of gear housing. If bearing block sits higher that rear face of housing, remove gear housing and check that E–seal or O–ring did not shift out of place during assembly.

9. Install remaining two dowel pins in rear of gear housing, then put end cover on back of motor.

10. After motor has been assembled, tighten capscrews by hand. Tighten the capscrews evenly in a crossing pattern to a torque of 40 – 45 ft–lb.

11. Put a small amount of hydraulic oil in port on motor and rotate driveshaft one revolution. Protect the shaft if using a pliers. If drive shaft binds, disassemble motor and repeat assembly process.

Steering Cylinder (2WD)

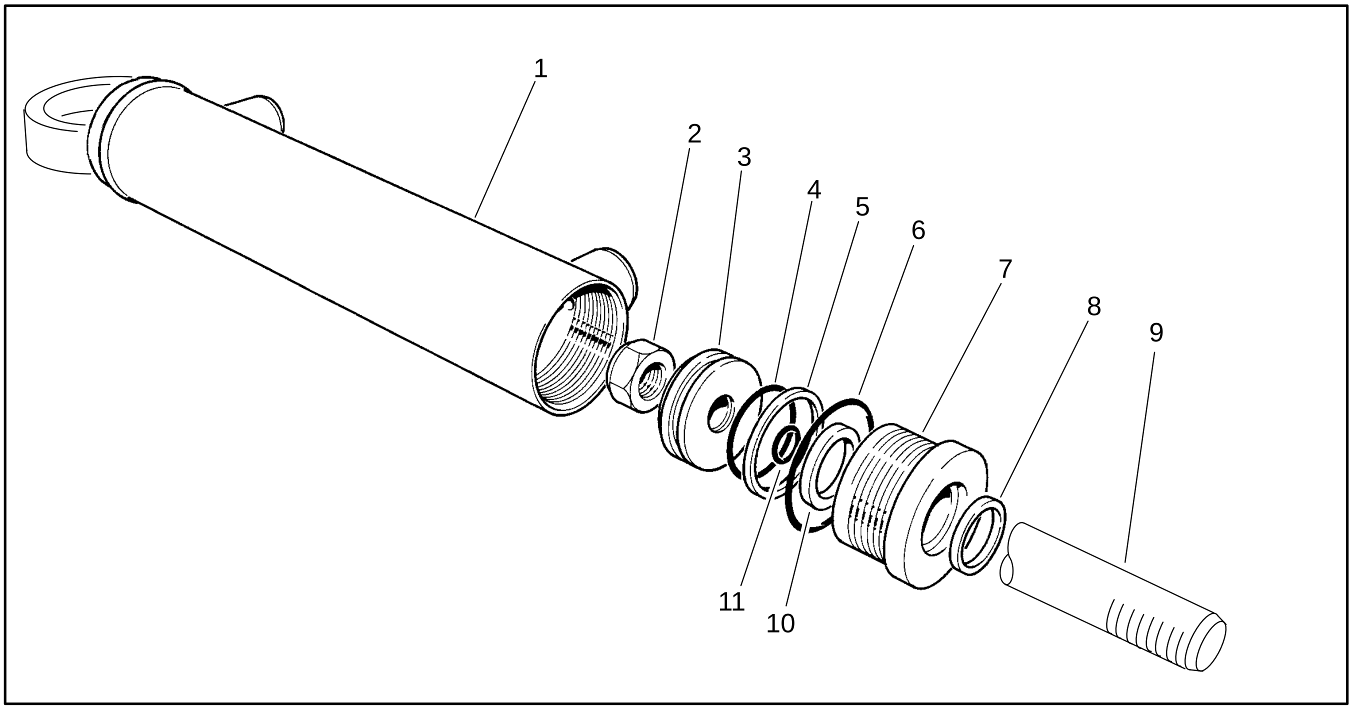


Figure 38

1. Butt & Tube Assembly	**5. Teflon Seal**	**9. Piston Rod**
2. Lock Nut	**6. O–Ring**	**10. U–cup**
3. Piston	**7. Gland**	**11. O–Ring**
4. O–Ring	**8. Wiper**	

IMPORTANT: To prevent damage when clamping cylinder barrel or rod in a vise, clamp only on pivotal ends.

1. After removing cylinder, pump oil out of cylinder into a drain pan by SLOWLY moving rod and piston in and out of cylinder bore.

2. Plug ports and clean outside of cylinder.

3. Mount cylinder in a vise so piston rod end of cylinder is tilted up slightly. Do not close vise so firmly that cylinder tube could become distorted. Loosen gland.

4. Grasp end of piston rod and use a twisting and pulling motion to carefully extract piston, piston rod, and head from cylinder barrel.

5. Securely mount piston, piston rod, and head into vise and remove nut.

IMPORTANT: Do not clamp vise jaws against smooth piston rod surface; the piston rod will become damaged.

6. Remove piston.

7. Remove all seals and O–rings.

8. Wash part 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.

9. Carefully inspect internal surface of barrel for damage (deep scratches, out–of–round, etc.). Replace entire cylinder if barrel is damaged. Inspect piston rod, and piston for evidence of excessive scoring, pitting, or wear. Replace any damaged parts.

10. Use a complete repair kit when rebuilding the cylinder. Put a coating of oil on all new seals, and O–rings. Install the new seal and O–rings.

11. Install piston onto piston rod with O–ring seal (11) and tighten hex nut.

12. Put a coating of oil on all cylinder parts to ease assembly.

13. Slide piston rod assembly into cylinder tube.

14. Install gland.

Steering Cylinder (4WD)

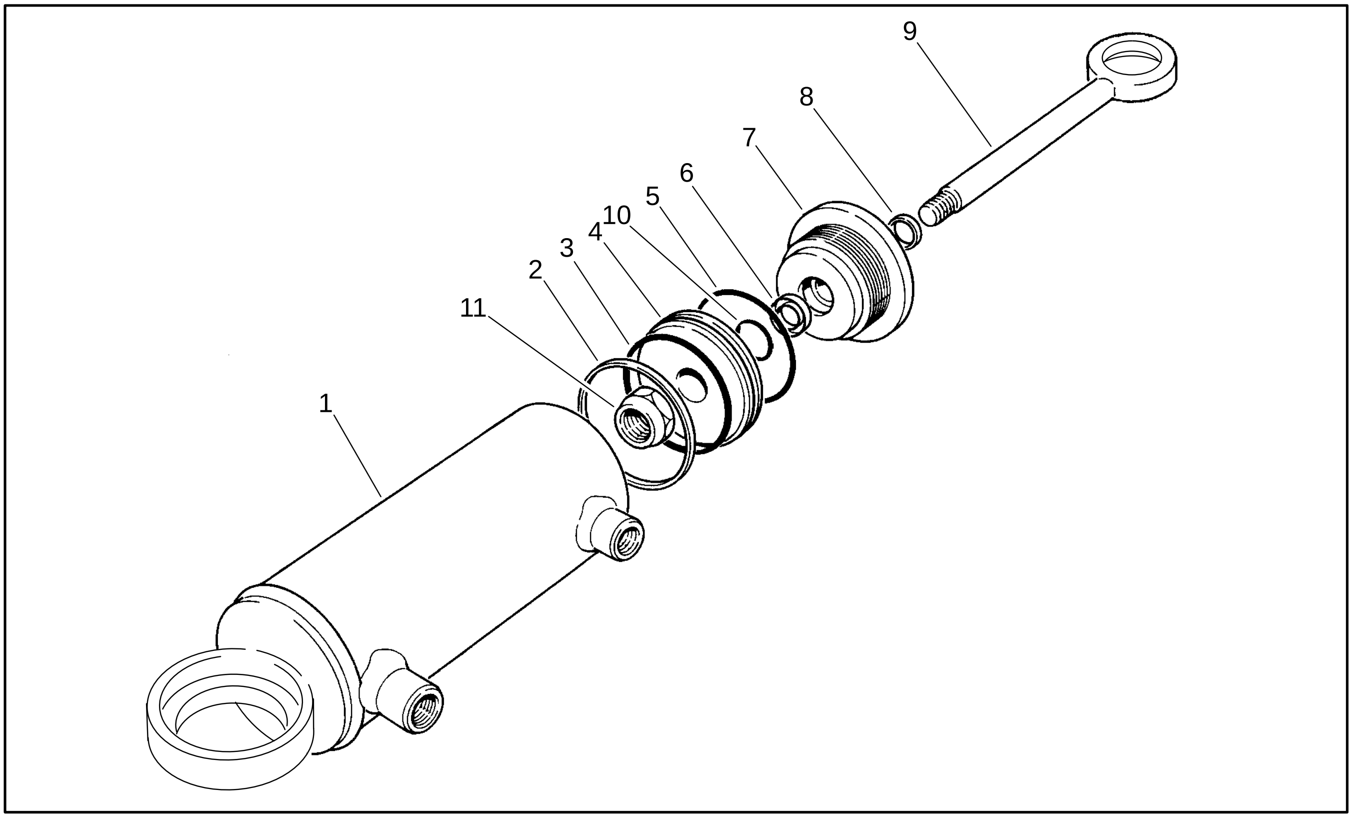


Figure 39

1. Butt & Tube Assembly	**5. O–Ring**	**9. Piston Rod Assembly**
2. Teflon Seal	**6. U–cup**	**10. O–Ring**
3. O–Ring	**7. Gland**	**11. Lock Nut**
4. Piston	**8. Wiper**	

IMPORTANT: To prevent damage when clamping cylinder barrel or rod in a vise, clamp only on pivotal ends.

1. After removing cylinder, pump oil out of cylinder into a drain pan by SLOWLY moving rod and piston in and out of cylinder bore. Plug ports and clean outside of cylinder.

2. Mount cylinder in a vise so piston rod end of cylinder is tilted up slightly. Do not close vise so firmly that cylinder tube could become distorted. Loosen gland.

3. Grasp end of piston rod and use a twisting and pulling motion to carefully extract piston, piston rod, and head from cylinder barrel.

4. Securely mount piston, piston rod, and head into vise and remove nut. Remove piston.

IMPORTANT: Do not clamp vise jaws against smooth piston rod surface; the piston rod will become damaged.

5. Remove all seals and O–rings.

6. Wash part 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.

7. Carefully inspect internal surface of barrel for damage (deep scratches, out–of–round, etc.). Replace entire cylinder if barrel is damaged. Inspect piston rod, and piston for evidence of excessive scoring, pitting, or wear. Replace any damaged parts.

8. Use a complete repair kit when rebuilding the cylinder. Put a coating of oil on all new seals, and O–rings. Install the new seal and O–rings.

9. Install piston onto piston rod with O–ring seal (10) and tighten hex nut.

10. Put a coating of oil on all cylinder parts to ease assembly.

11. Slide piston rod assembly into cylinder tube.

12. Install gland.

Front Lift Cylinders

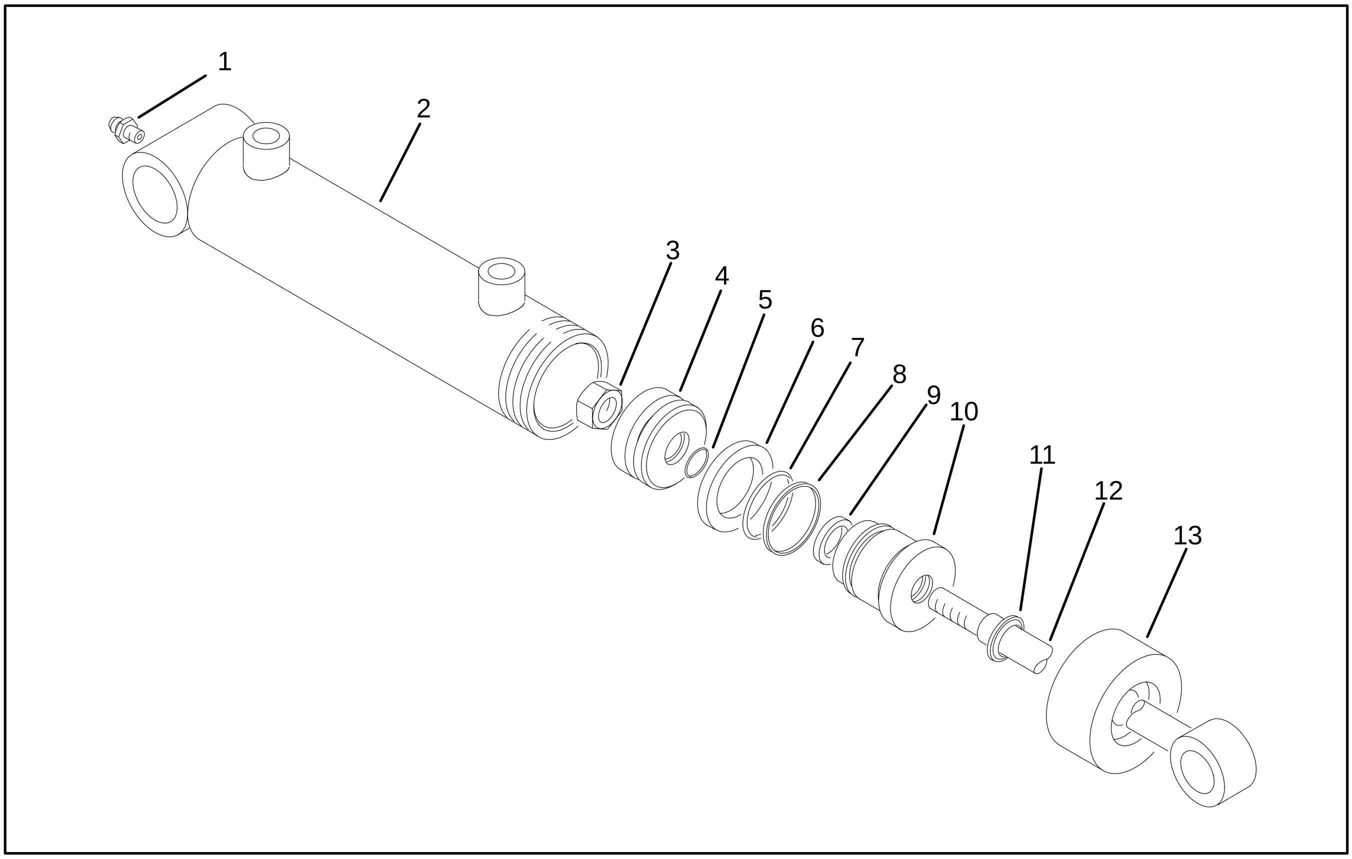


Figure 40

1. Grease Fitting
2. Barrel Assembly
3. Locknut
4. Piston
5. O–Ring
6. Special Seal
7. O–Ring
8. Backup
9. Rod Seal
10. Head
11. Dust Seal
12. Shaft w/Clevis
13. Collar

IMPORTANT: To prevent damage when clamping the cylinder barrel in a vise, clamp only on the pivot end. Do not clamp the vise jaws against the smooth shaft surface. Protect the shaft surface before mounting in the vise.

1. After removing cylinder, pump the oil out of cylinder into a drain pan by SLOWLY moving piston in and out of cylinder bore.

2. Plug ports and wash outside of cylinder with cleaning solvent.

3. Mount the cylinder in a vise so shaft end of cylinder is tilted up slightly. Do not close the vise so firmly that the barrel could become distorted. Unscrew collar.

4. Grasp the clevis end of shaft and use a twisting and pulling motion to carefully extract piston, shaft, and head from barrel.

5. Securely mount clevis end of shaft in a vise and remove lock nut from piston end of shaft. Remove the piston. Slide the head off of shaft.

6. Remove and discard all seals and backup rings.

7. Wash parts in cleaning solvent. Dry parts with compressed air. DO NOT wipe dry with a cloth or paper as lint and dirt may remain.

8. Inspect internal surface of barrel for damage (deep scratches, out–of–round, etc.). Inspecthead, shaft and piston for evidence of excessive scoring, pitting, or wear. Replace any defective parts.

9. Put a light coating of hydraulic oil on all other new seals and backup washers. Install new seals and backup washers. Install head onto piston rod. Install piston onto shaft and tighten lock nut.

10. Put a heavy coating of hydraulic oil on all cylinder parts to ease assembly. Slide shaft assembly and head into the barrel. Install collar to secure assembly in barrel.

Rear Lift Cylinders

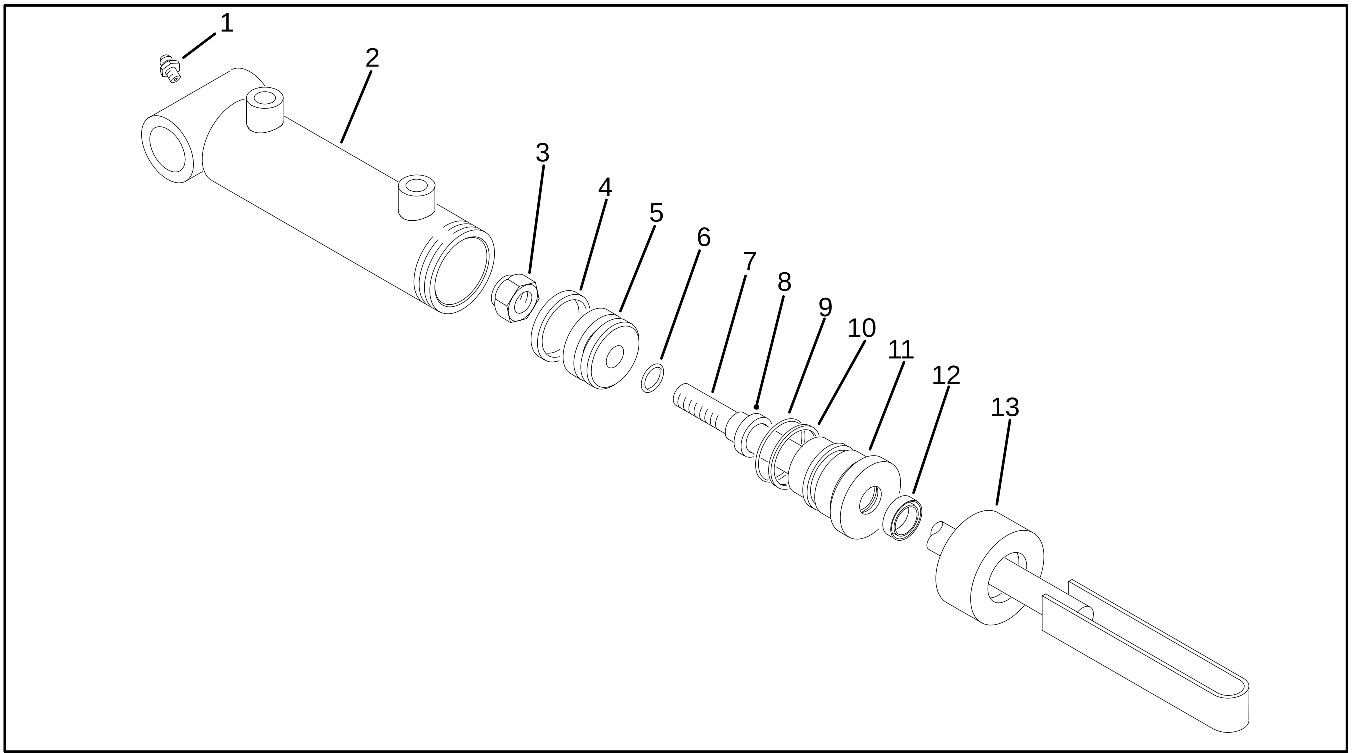


Figure 41

1. Grease Fitting	**6. O–Ring**	**11. Head**
2. Barrel Assembly	**7. Shaft w/Clevis**	**12. Dust Seal**
3. Nut	**8. Rod Seal**	**13. Collar**
4. Uni–Ring	**9. O–Ring**	
5. Piston	**10. Backup**	

IMPORTANT: To prevent damage when clamping the cylinder barrel in a vise, clamp only on the pivot end. Do not clamp the vise jaws against the smooth shaft surface. Protect the shaft surface before mounting in the vise.

1. After removing cylinder, pump oil out of cylinder into a drain pan by SLOWLY moving piston in and out of cylinder bore.

2. Plug ports and wash outside of cylinder with cleaning solvent.

3. Mount cylinder in a vise so shaft end of cylinder is tilted up slightly. Do not close the vise so firmly that the barrel could become distorted. Unscrew collar.

4. Grasp clevis end of shaft and use a twisting and pulling motion to carefully extract piston, shaft, and head from barrel.

5. Securely mount clevis end of shaft in a vise and remove nut from piston end of shaft. Remove piston. Slide head off of shaft.

6. Remove and discard all seals and backup rings.

7. Wash the parts in cleaning solvent. Dry parts with compressed air. DO NOT wipe dry with a cloth or paper as lint and dirt may remain.

8. Inspect internal surface of barrel for damage (deep scratches, out–of–round, etc.). Inspect head, shaft and piston for evidence of excessive scoring, pitting, or wear. Replace any defective parts.

9. To install the two piece Uni–ring piston seal:

A. Soak seal rings in hot water so they will stretch over the piston.
B. Apply hydraulic oil to black inner ring and install ring into seal groove on piston.
C. Apply hydraulic oil to purple outer ring and install ring into same groove over black ring.

10. Put a light coating of hydraulic oil on all other new seals and backup washers. Install the new seals and backup washers. Install head onto piston rod. Install piston onto shaft and tighten lock nut.

11. Put a heavy coating of hydraulic oil on all cylinder parts to ease assembly. Slide shaft assembly and head into barrel. Install collar to secure assembly in barrel.

#6 and #7 Lift Cylinders (RM6700–D)

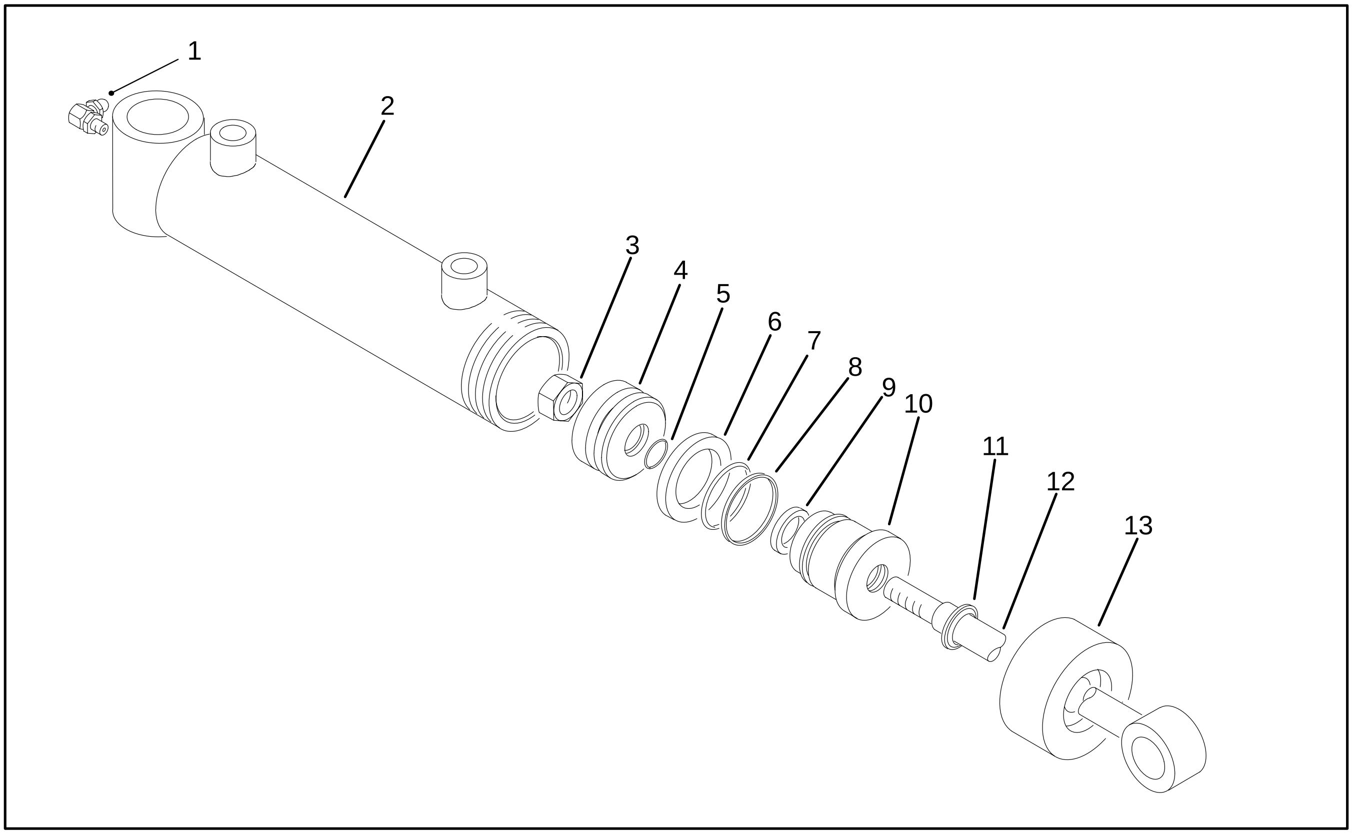


Figure 42

1. Grease Fitting
2. Barrel Assembly
3. Locknut
4. Piston
5. O–Ring
6. Special Seal
7. O–Ring
8. Backup
9. Rod Seal
10. Head
11. Dust Seal
12. Shaft w/Clevis
13. Collar

IMPORTANT: To prevent damage when clamping the cylinder barrel in a vise, clamp only on the pivot end. Do not clamp the vise jaws against the smooth shaft surface. Protect the shaft surface before mounting in the vise.

1. After removing cylinder, pump oil out of cylinder into a drain pan by SLOWLY moving piston in and out of cylinder bore.

2. Plug ports and wash outside of cylinder with cleaning solvent.

3. Mount cylinder in a vise so shaft end of cylinder is tilted up slightly. Do not close the vise so firmly that the barrel could become distorted. Unscrew collar.

4. Grasp clevis end of shaft and use a twisting and pulling motion to carefully extract piston, shaft, and head from barrel.

5. Securely mount the clevis end of the shaft in a vise and remove the lock nut from the piston end of the shaft. Remove the piston. Slide the head off of the shaft.

6. Remove and discard all seals and backup rings.

7. Wash parts in cleaning solvent. Dry parts with compressed air. DO NOT wipe dry with a cloth or paper as lint and dirt may remain.

8. Inspect internal surface of the barrel for damage (deep scratches, out–of–round, etc.). Inspect head, shaft and piston for evidence of excessive scoring, pitting, or wear. Replace any worn or damaged parts.

9. Put a light coating of hydraulic oil on all other new seals and backup washers. Install the new seals and backup washers. Install head onto piston rod. Install piston onto the shaft and tighten lock nut.

10. Put a heavy coating of hydraulic oil on all cylinder parts to ease assembly. Slide shaft assembly and head into barrel. Install collar to secure assembly in barrel.

Steering Valve (75–0600 or 92–7544)

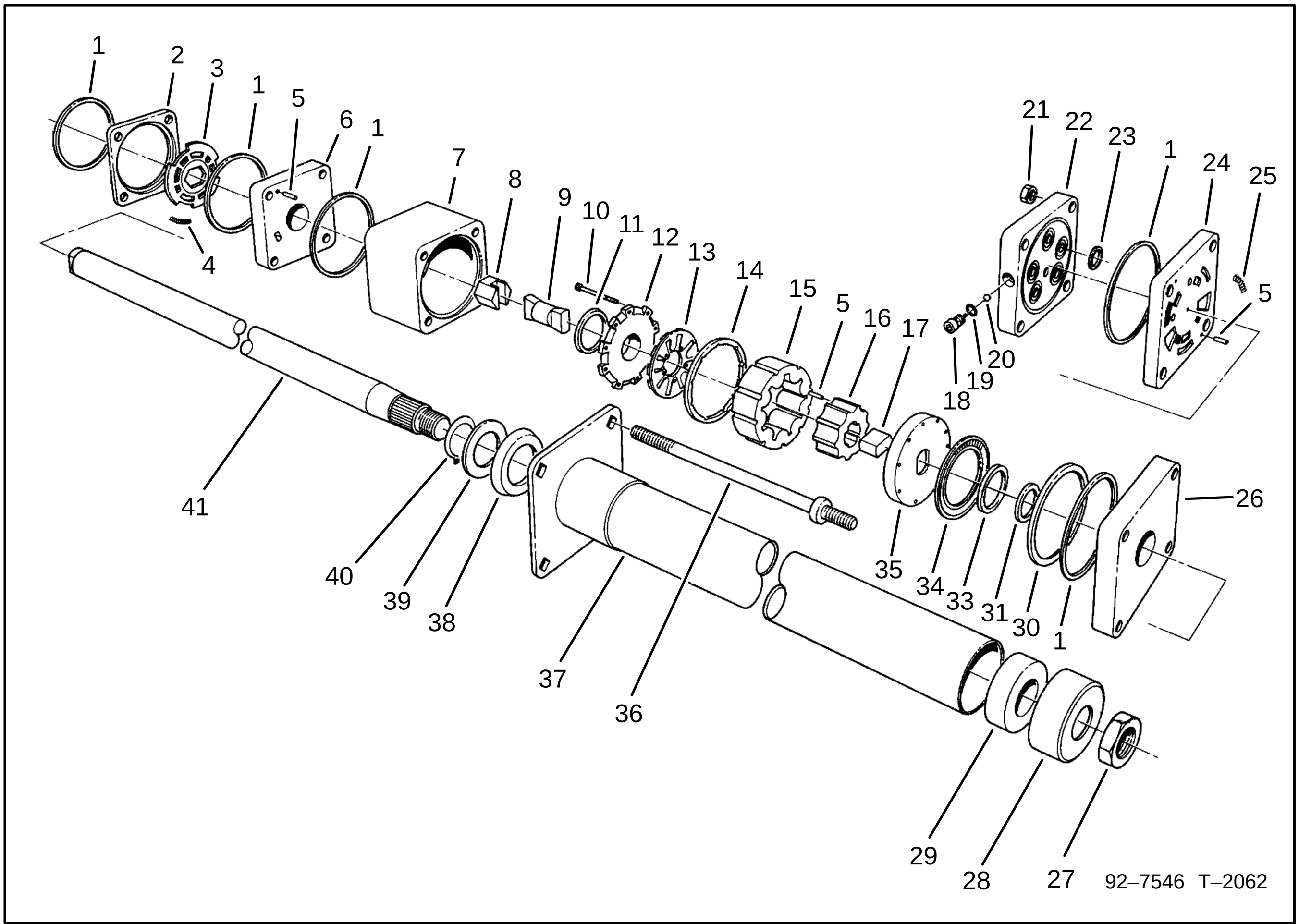


Figure 41

1. Seal Ring
2. Valve Ring
3. Valve Plate
4. Spring
5. Alignment Pin
6. Isolation Manifold
7. Metering Ring
8. Hex Drive Assembly
9. Drive Link
10. HSH Screw
11. Commutator Seal
12. Commutator Cover
13. Commutator
14. Commutator Ring
15. Stator
16. Rotor
17. Link Drive Spacer
18. Plug
19. O–Ring
20. Ball
21. Hex Nut
22. Port Cover
23. O–Ring
24. Port Manifold
25. Spring
26. Upper Cover Plate
27. Nut
28. Seal
29. Bushing
30. Thrust Bearing Spacer
31. Seal Spacer
33. Face Seal
34. Thrust Bearing
35. Drive Plate
36. Special Bolt
37. Upper Cover & Jacket
38. Retaining Plate
39. Retaining Plate Washer
40. Retaining Plate
41. Input Shaft

Hydraulic System

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. 42).

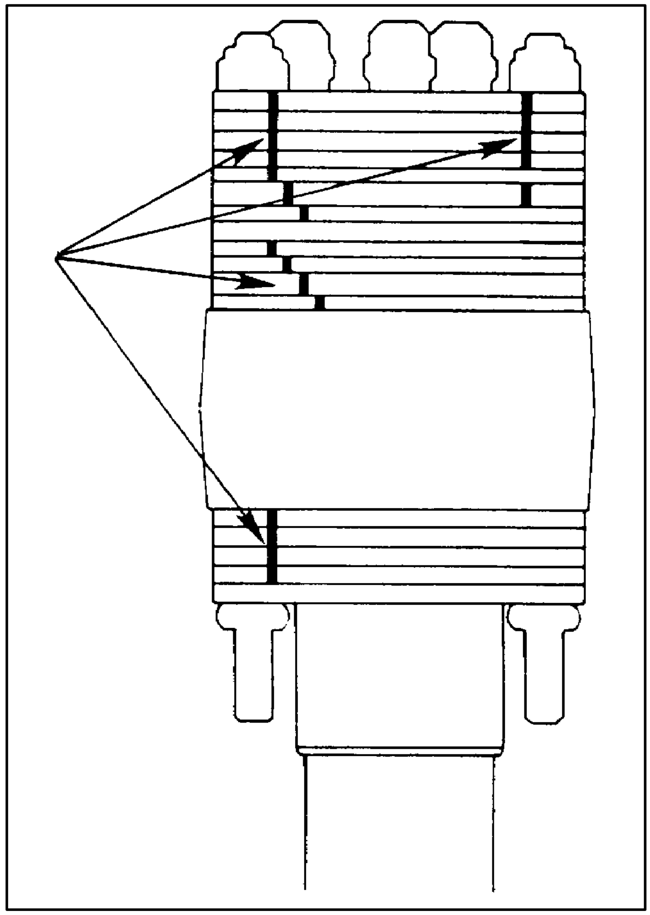


Figure 42

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. 43). 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. 44).

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. 42).

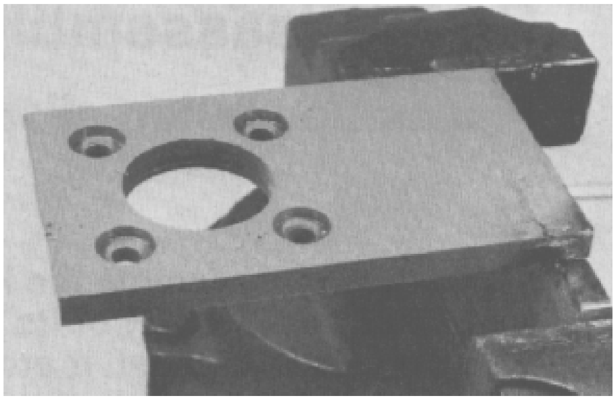


Figure 43

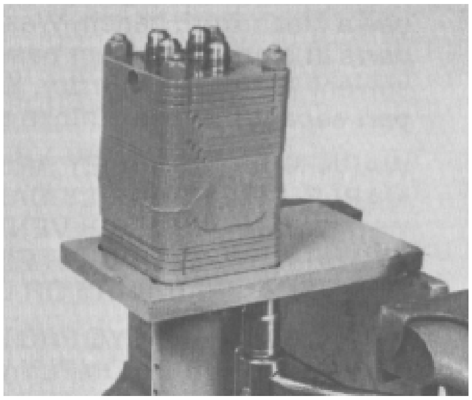


Figure 44

2. Use a slot type screwdriver or screwdriver socket to loosen the plug assembly one turn counterclockwise. (Fig. 45). Do not remove the plug assembly.

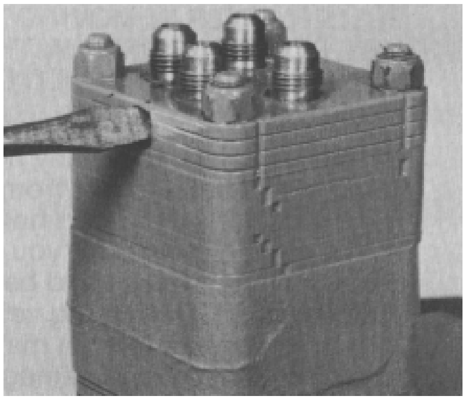


Figure 45

3. Remove the four nuts from the port cover assembly. Be careful not to damage the ports (Fig. 46).

IMPORTANT: The nuts are a special self–locking type. Do not substitute any other type.

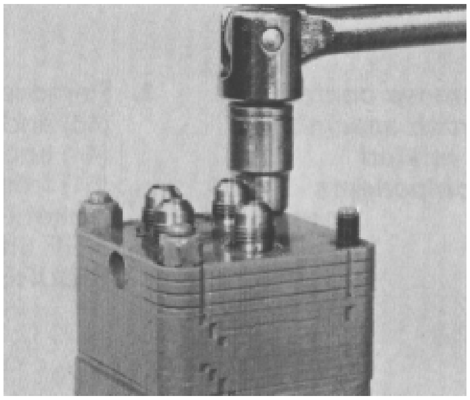


Figure 46

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. 47).

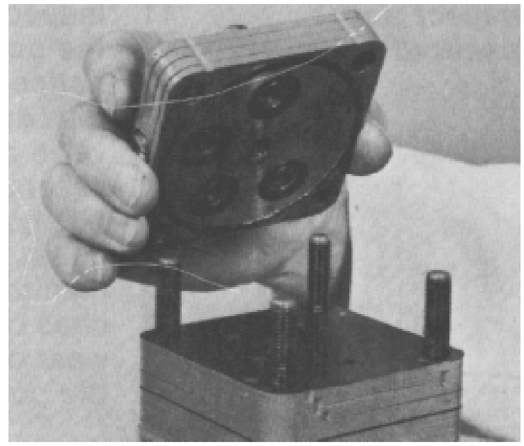


Figure 47

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. 48). 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.

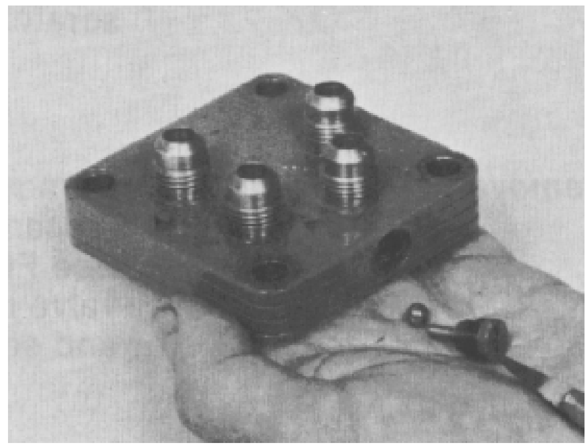


Figure 48

7. Carefully lift the port manifold (3 plates bonded together) from the unit (Fig. 49).

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.

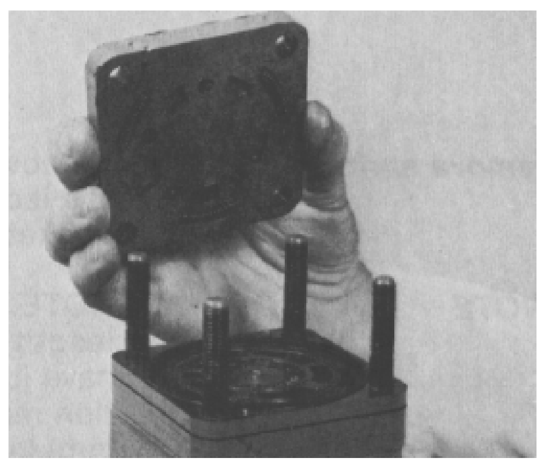


Figure 49

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. 50). Remove and discard the two seal rings (Fig. 51). The valve ring should be free of nicks and scoring.

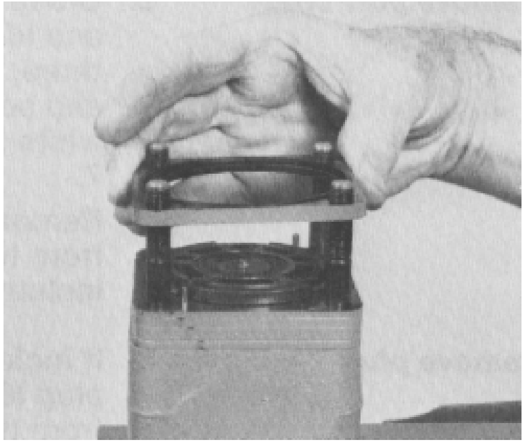


Figure 50

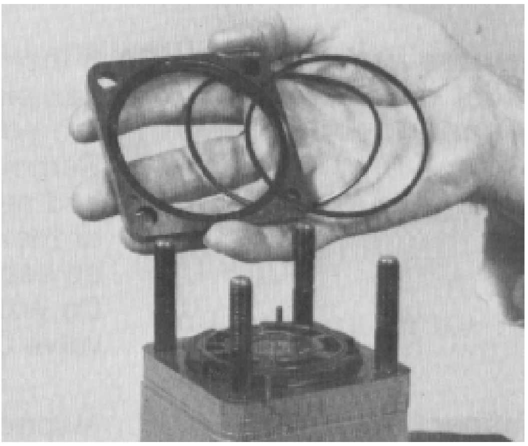


Figure 51

12. Remove the valve plate by lifting it from the isolation manifold (Fig. 52).

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.

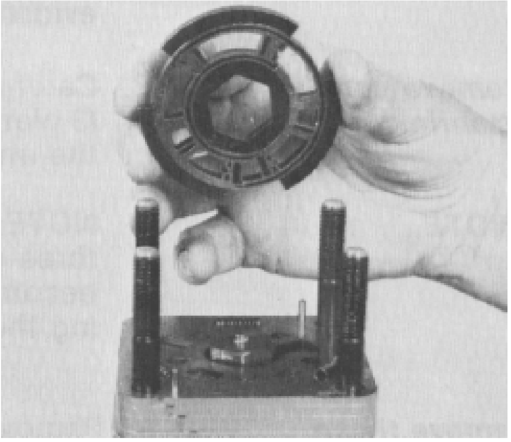


Figure 52

Hydraulic System

14. Remove three springs from the isolation manifold pockets (Fig. 53).

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.

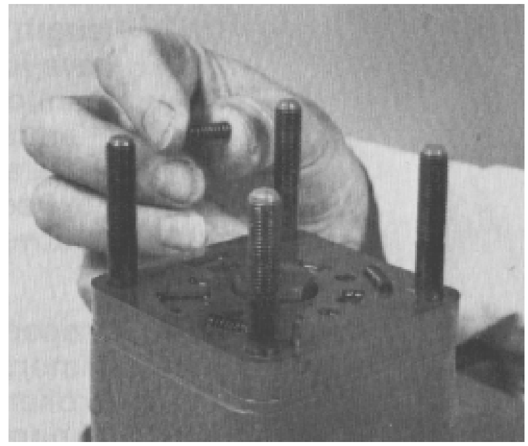


Figure 53

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. 54).

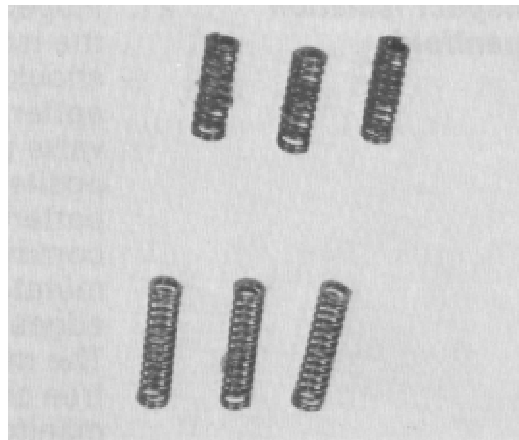


Figure 54

16. Remove the hex drive assembly from the drive link (Fig. 55).

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.

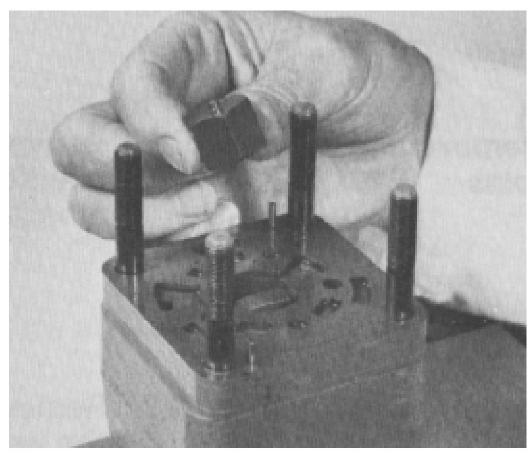


Figure 55

18. Remove the two alignment pins that align the port manifold, valve ring and isolation manifold (Fig. 56).

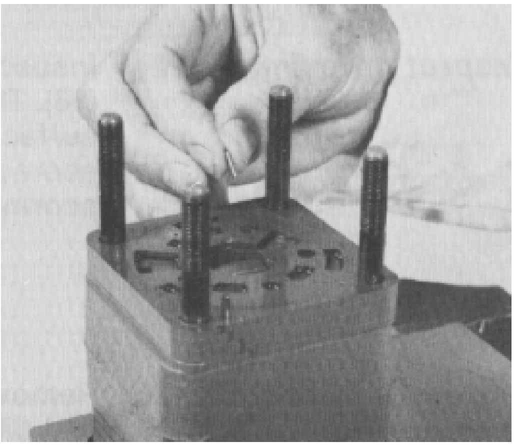


Figure 56

19. Remove the isolation manifold (four plates bonded together) (Fig. 57).

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.

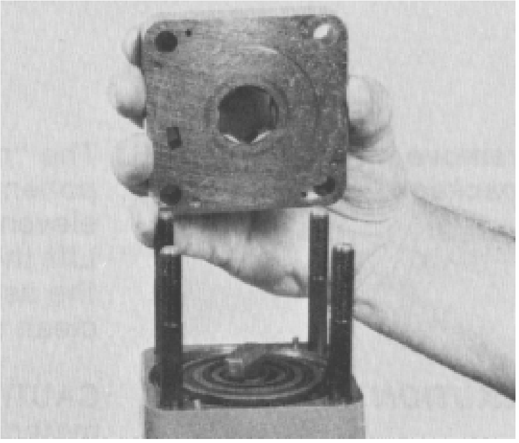


Figure 57

21. Remove the two isolation manifold–metering ring alignment pins (Fig. 58).

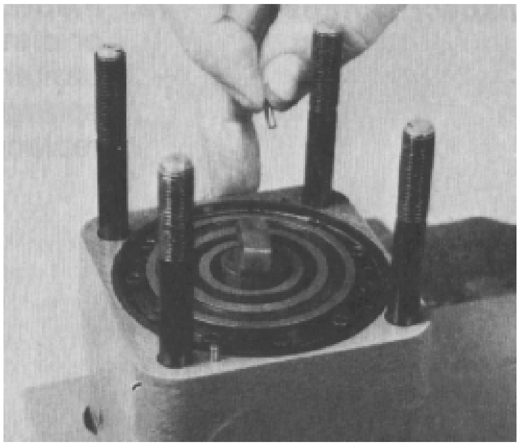


Figure 58

22. Remove the drive link from the unit (Fig. 59).

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.

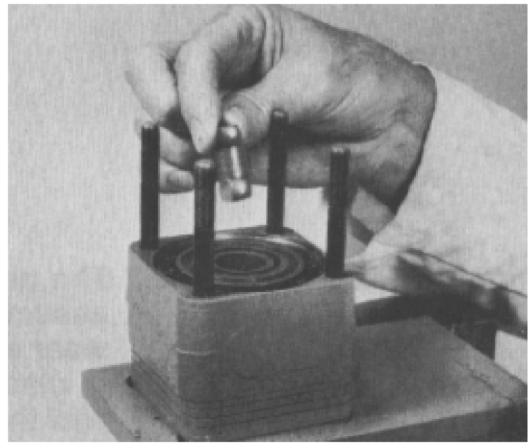


Figure 59

24. Remove the metering ring and discard the two seal rings (Fig. 60). If the metering ring bore is scored, it should be replaced.

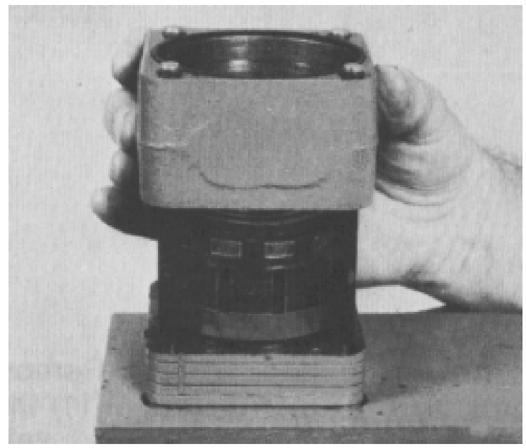


Figure 60

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. 61).

IMPORTANT: Do not clamp the metering package in a vise, as this could damage the components.

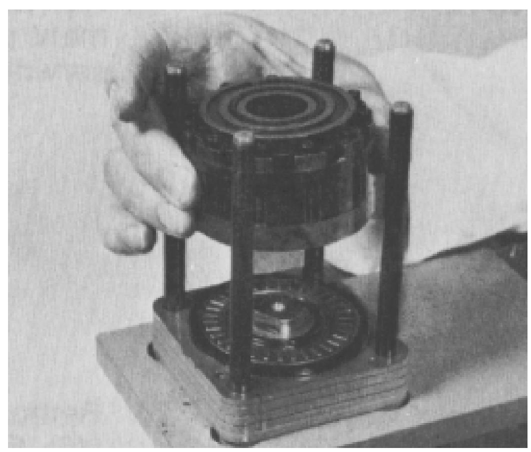


Figure 61

26. Remove and discard the commutator seal from the commutator cover (Fig. 62).

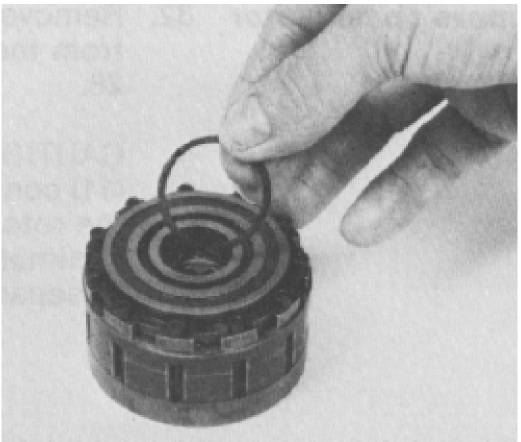


Figure 62

27. Remove the eleven hex socket head screws, that hold the metering package together (Fig. 63). Use a 3/32 in. Allen wrench. Inspect the screws for thread and socket damage and replace as necessary.

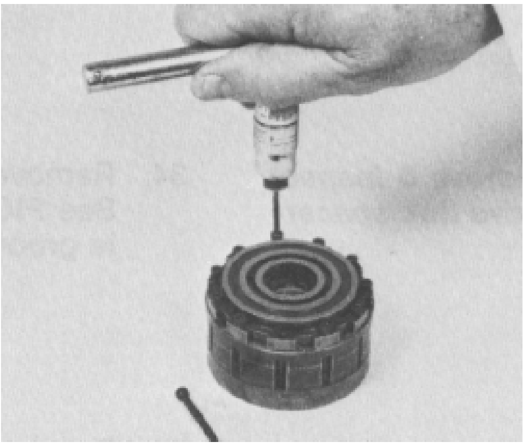


Figure 63

28. Lift the commutator cover from the metering package (Fig. 64).

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.

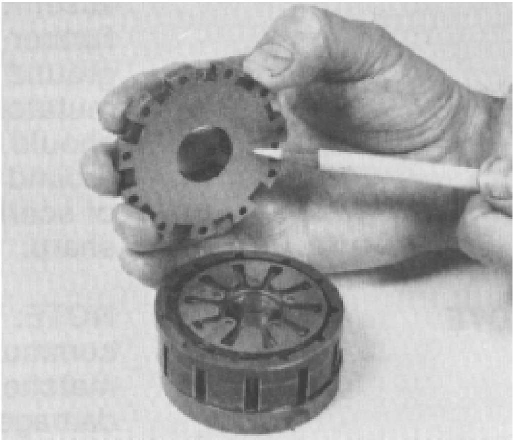


Figure 64

30. Remove the commutator ring (Fig. 65). Inspect for cracks, burrs and scoring.

IMPORTANT: Handle the commutator ring with care, as it is easily broken.

Figure 65

31. Remove the commutator from the rotor (Fig. 66).

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.

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.

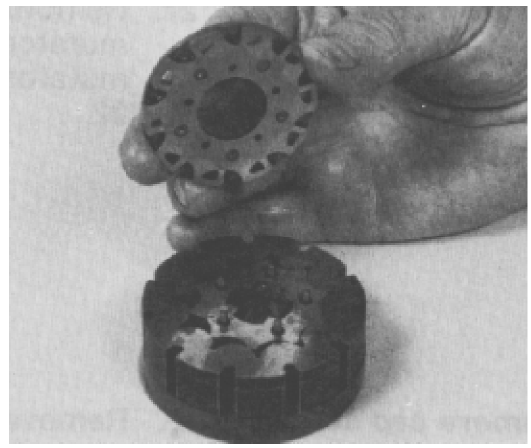


Figure 66

33. Remove the five alignment pins (Fig. 67).

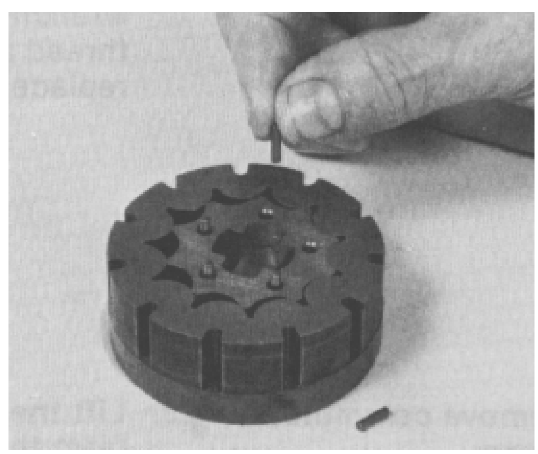


Figure 67

34. Remove the drive link spacer (Fig. 68). 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.

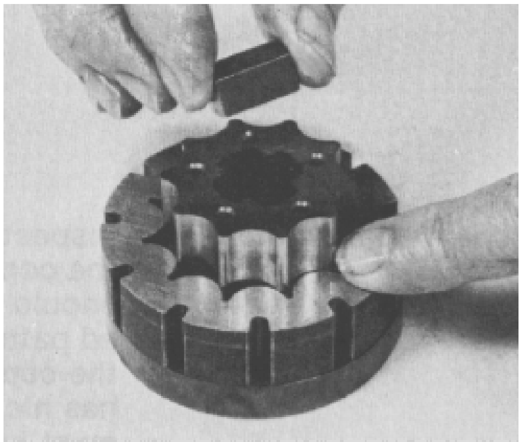


Figure 68

36. Check the rotor lobe “tip” to stator lobe “tip” clearance, with a feeler gauge (Fig. 69). The rotor lobe, directly across from the rotor lobe tip being measured (see pointer in Fig. 69) 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)

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.

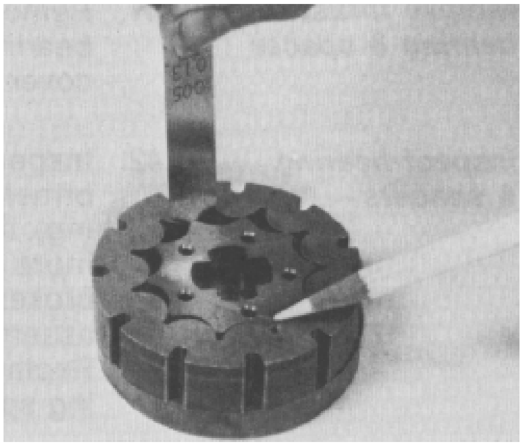


Figure 69

Hydraulic System

38. The rotor side of the drive plate (Fig. 70) should show the “normal” spiral pattern due to rotor movement.

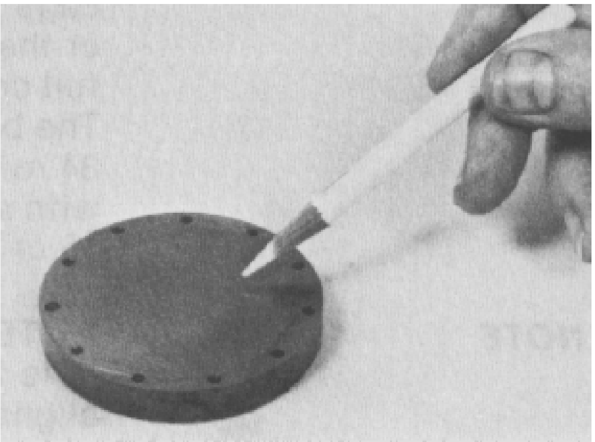


Figure 70

39. Inspect the thrust bearing side of the drive plate (Fig. 71) 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.

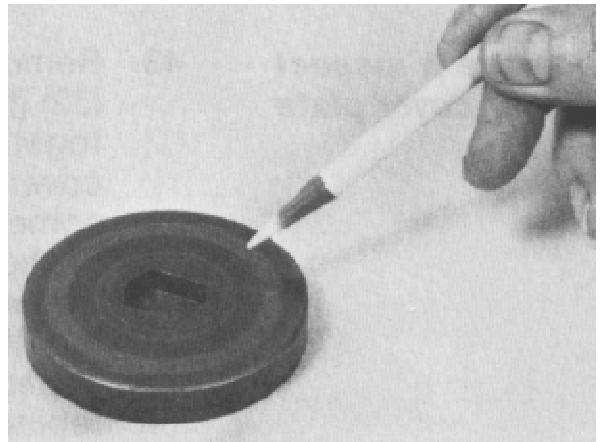


Figure 71

40. Remove the face seal, backup ring, and face seal spacer from the upper cover plate (Fig. 72). Discard the face seal and backup ring. Keep the metal spacer.

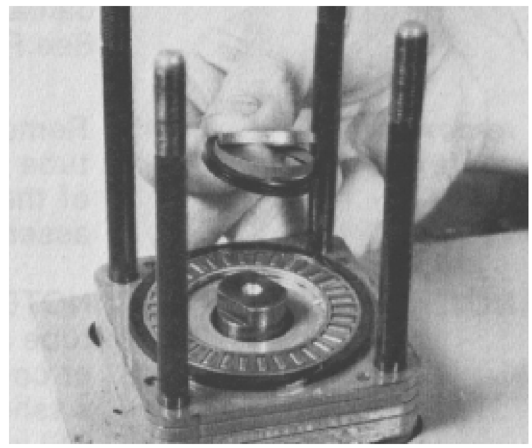


Figure 72

41. Remove the thrust bearing and bearing spacer from the upper cover plate (Fig. 73).

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.

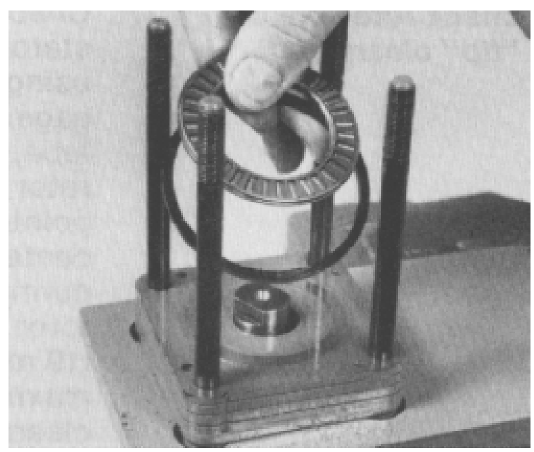


Figure 73

43. Remove the upper cover plate (four plates bonded together) (Fig. 74). 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.

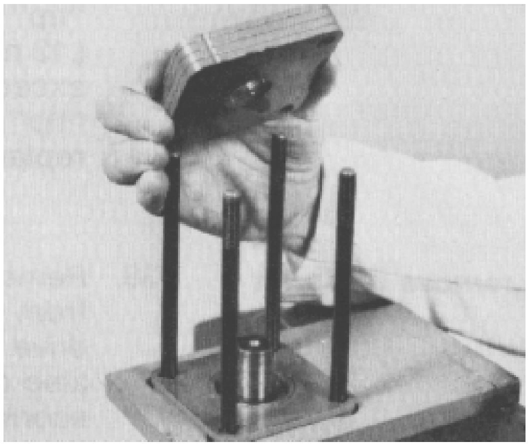


Figure 74

44. Slide the seal from the jacket tube (Fig. 75). If the seal is worn or damaged, it must be replaced.

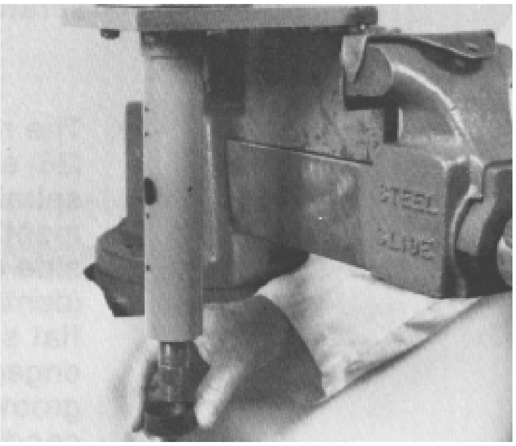


Figure 75

45. Remove the input shaft and snap ring, sliding it out of the upper cover end of the assembly (Fig. 76).

46. Inspect the input shaft serrations, threads and flats for grooves, wear, or damage.

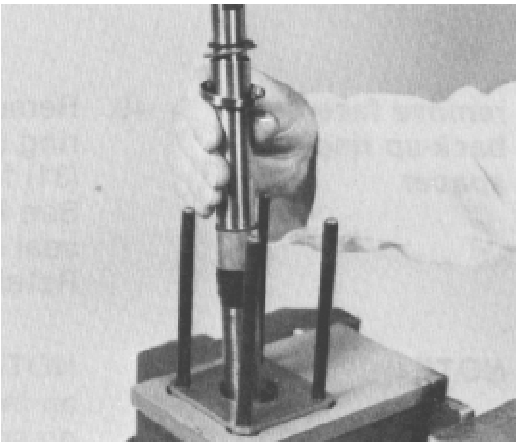


Figure 76

Hydraulic System

47. Remove the washer and upper cover & jacket (Fig. 77).

NOTE: The retaining plate and upper cover & jacket are a matched set. If either part is worn or damaged, both must be replaced.

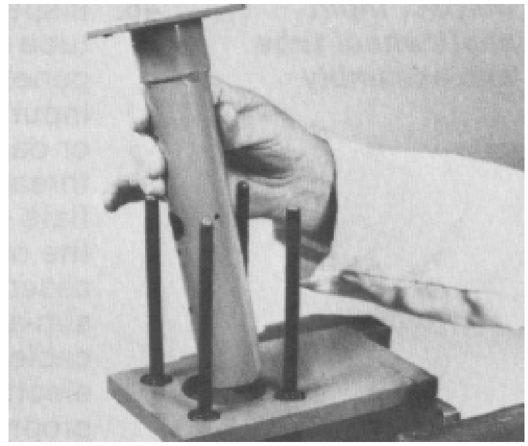


Figure 77

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. 78).

IMPORTANT: Hold the steering tube in a soft–jaw vise. Be careful not to damage the steering tube.

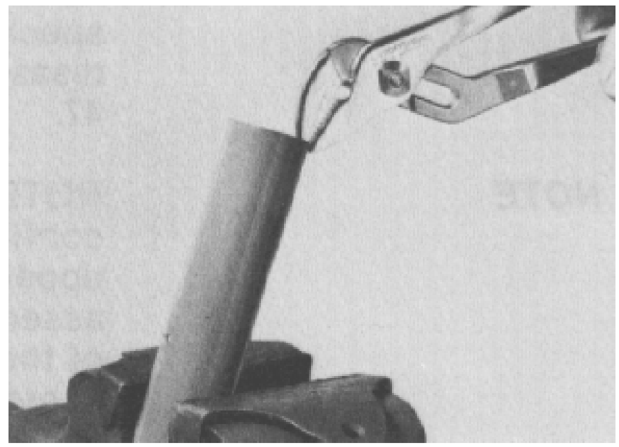


Figure 78

49. Use a bearing puller to remove the bushing (Fig. 79).

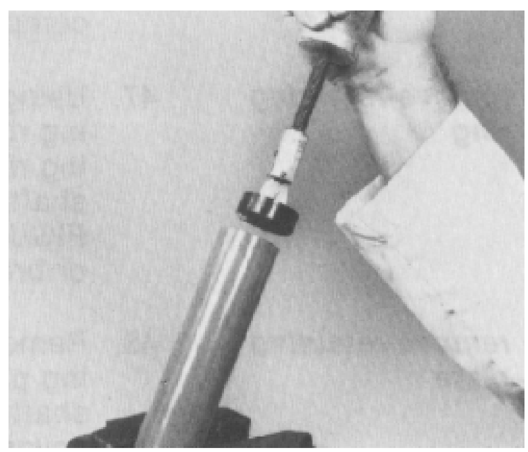


Figure 79

50. Remove the nuts holding the four bolts to the fixture, and remove the bolts (Fig. 80). Check the bolt threads for wear or damage.

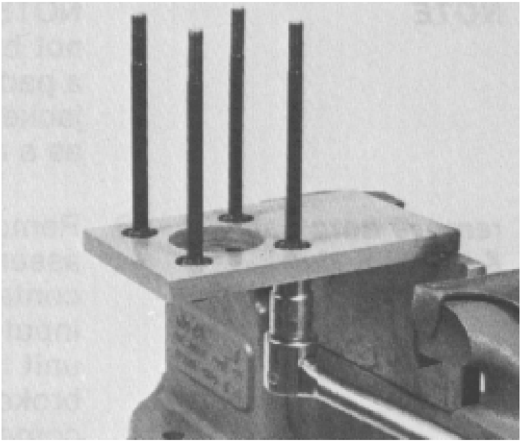


Figure 80

Hydraulic System

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. 81). 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. 82). 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 90o away from the original crimped areas (Fig. 83). Put clean multi–purpose grease on the inside of the bushing.

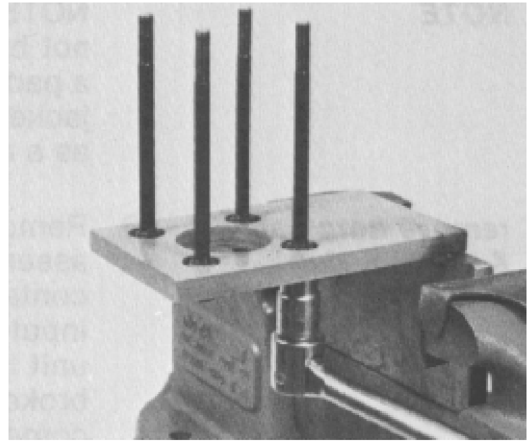


Figure 81

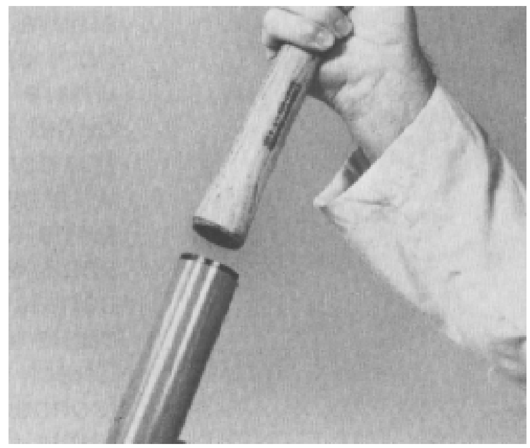


Figure 82

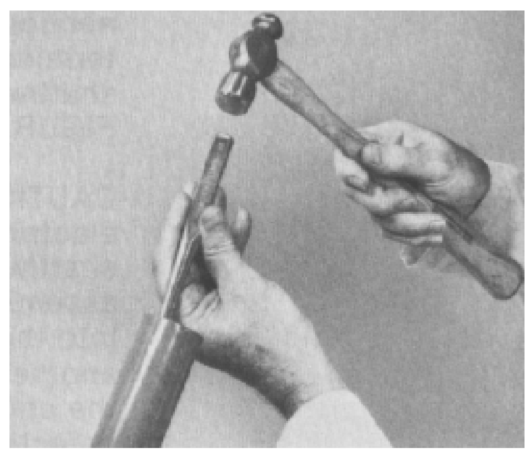


Figure 83

3. Put the upper cover and jacket on the four bolts with the jacket tube pointing down through the hole in fixture (Fig. 84). 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.

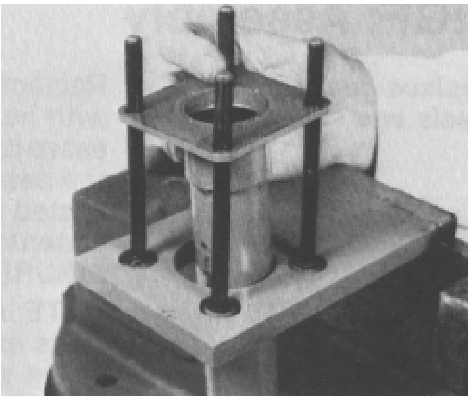


Figure 84

5. Install the snap ring onto the input shaft if it was removed (Fig. 85).

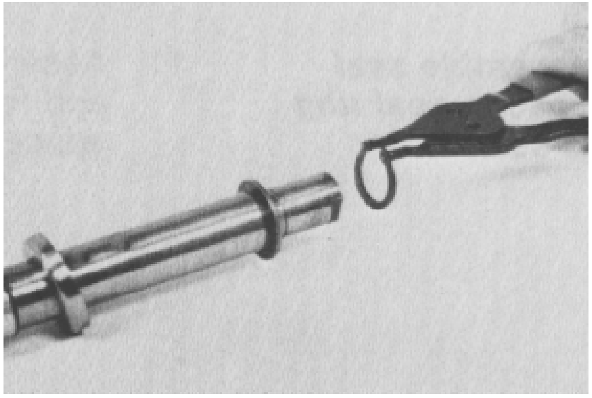


Figure 85

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. 86).

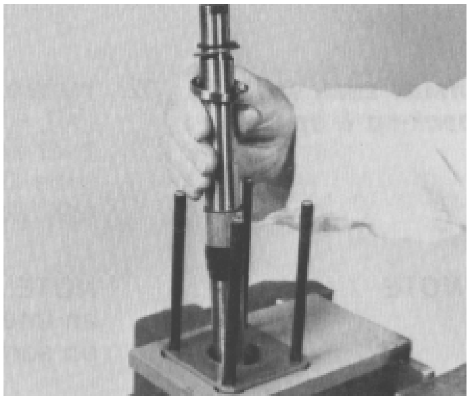


Figure 86

7. Install the upper cover plate over the four bolts with the highly polished surface up (Fig. 87).

IMPORTANT: The alignment grooves must be all on one side of the steering valve for proper operation.

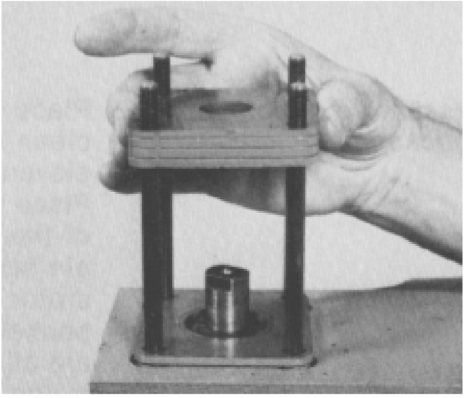


Figure 87

8. Apply clean multi–purpose grease to the face of the upper cover plate, input shaft and face seal (Fig. 88).

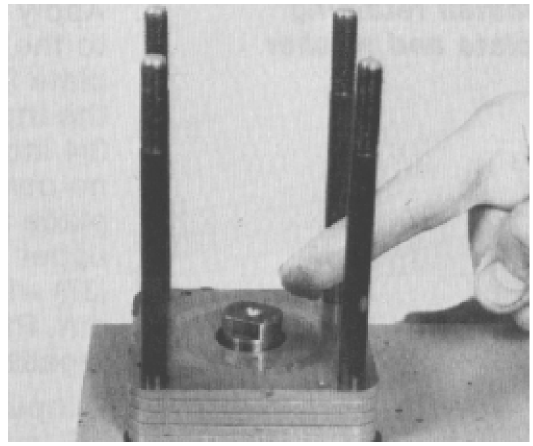


Figure 88

9. Assemble the seal backup ring and face seal onto the seal spacer (Fig. 89).

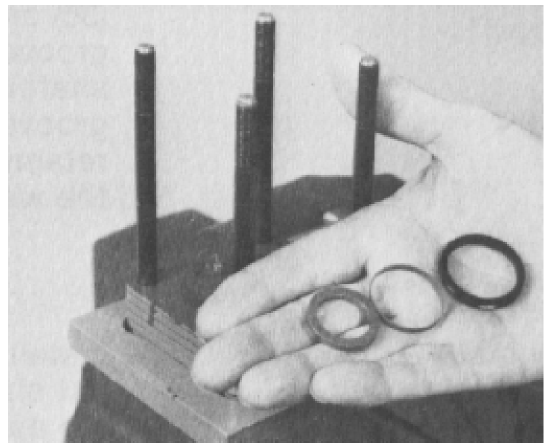


Figure 89

10. Install the face seal, backup ring and spacer assembly over the end of the input shaft and onto the upper cover plate (Fig. 90).

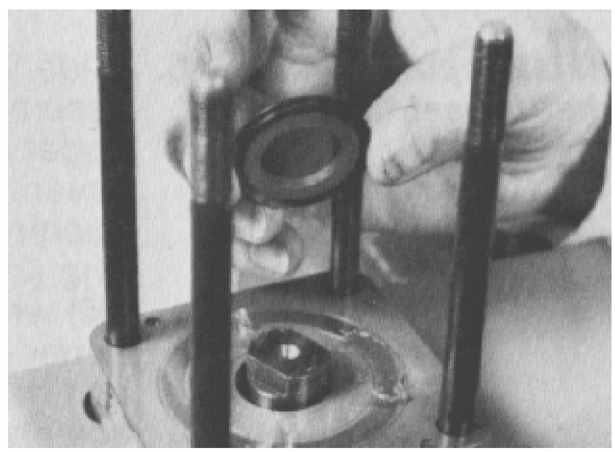


Figure 90

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. 91).

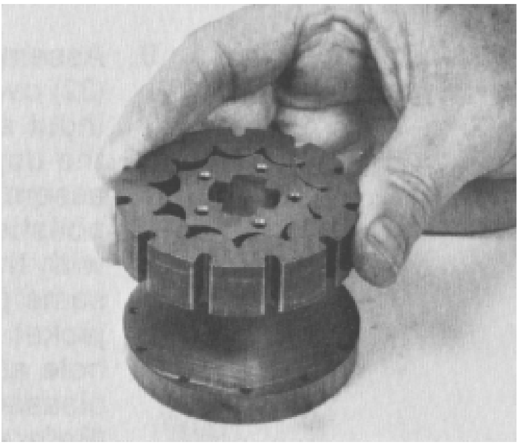


Figure 91

12. Apply a small amount of clean multi–purpose grease to the spacer and insert it into the drive slot in the rotor (Fig. 92). The grease will aid in retaining the spacer during other assembly procedures.

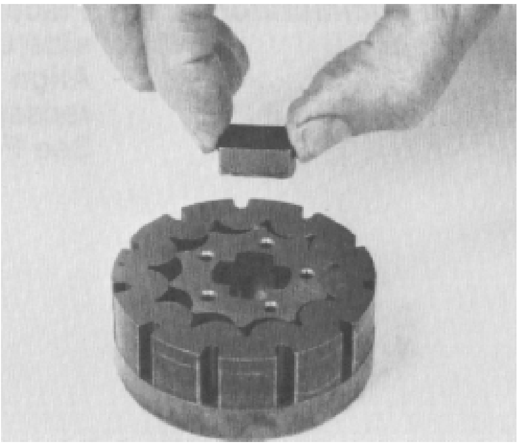


Figure 92

13. Put the commutator on top of the rotor. Be sure the correct surface (Fig. 93) is towards the rotor.

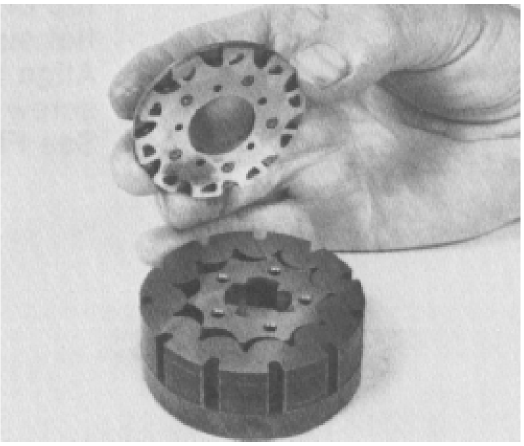


Figure 93

Hydraulic System

14. Align the five holes and press the five alignment pins in place (Fig. 94).

IMPORTANT: Make sure the five alignment pins are pressed below the surface of the commutator.

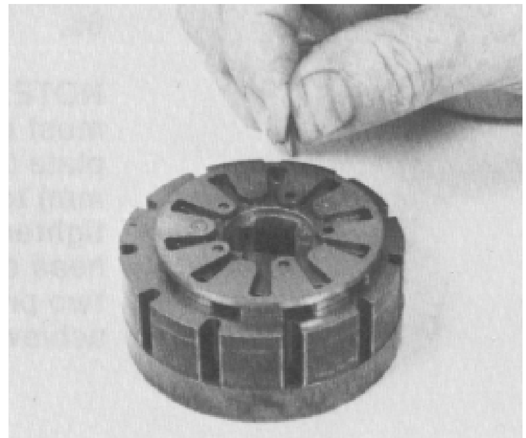


Figure 94

15. Put a few drops of oil into each recess in the commutator (Fig. 95).

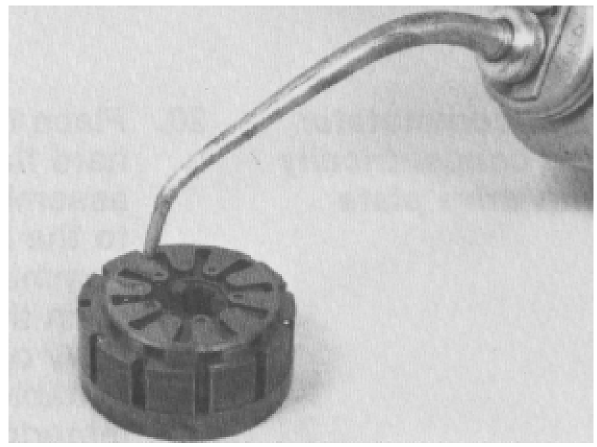


Figure 95

16. Put the commutator ring (either side up) on top of the stator (Fig. 96). Align the commutator ring screw recesses with the stator screw slots.

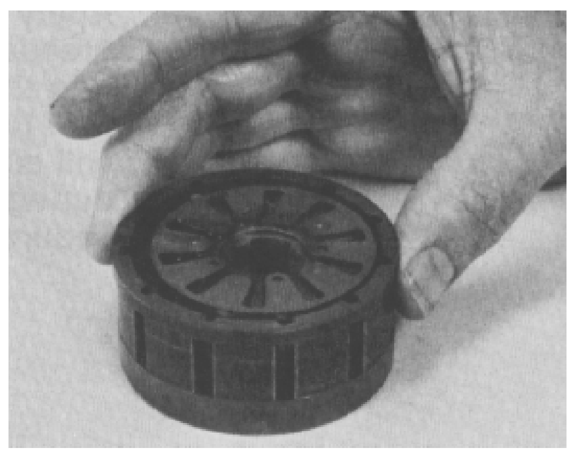


Figure 96

17. Put the commutator cover on top of the commutator ring with the flat surface towards the commutator (Fig. 97). Align the screw holes in the cover, with the screw holes in the drive plate.

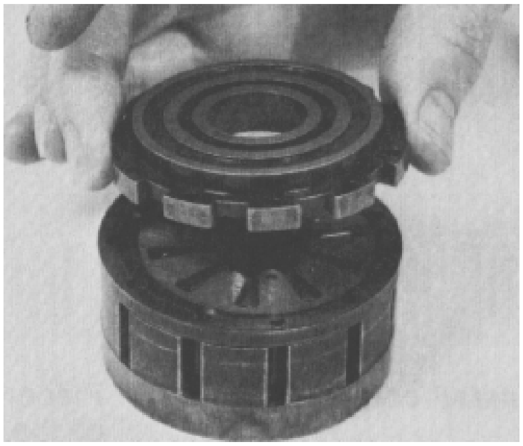


Figure 97

18. Screw the eleven hex socket head cap screws loosely into the metering package (Fig. 98).

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.

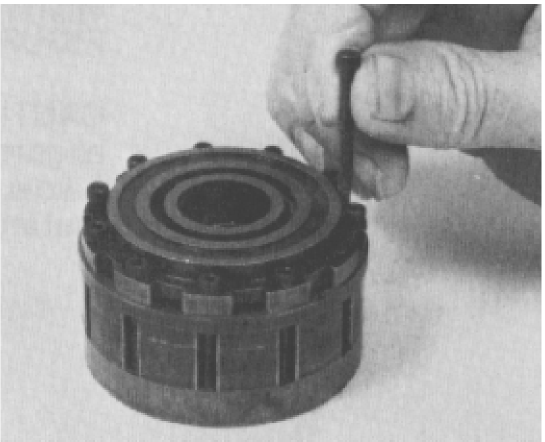


Figure 98

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. 99). (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.

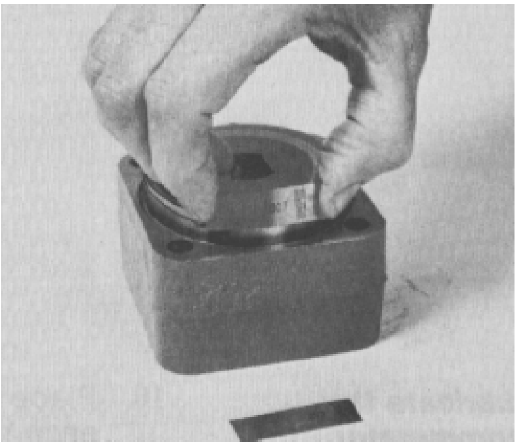


Figure 99

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. 100).

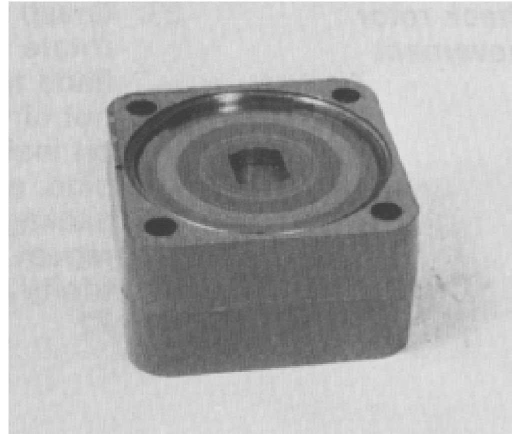


Figure 100

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 101 at least twice until a final torque of 11 – 13 in–lb (1.24 – 1.47 Nm) is reached (Fig. 101 and 102). Remove the metering package and shims from the metering ring. Discard the shims.

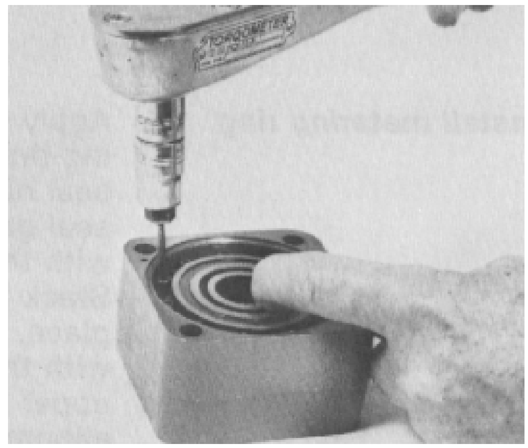


Figure 101

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.

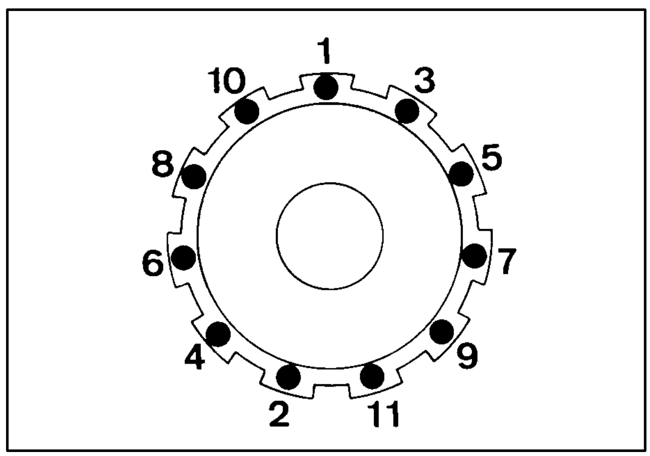


Figure 102

22. Insert the LARGE tang of the drive link into the slot in the rotor (Fig. 103).

IMPORTANT: An incorrect (reversed) assembly of the drive link will prevent the assembly of the hex drive.

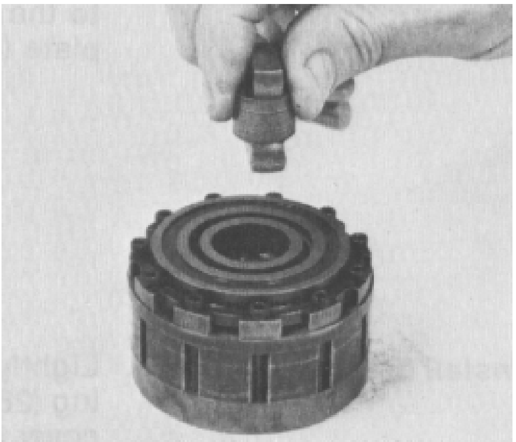


Figure 103

23. Grasp the drive link and rotate the metering package by hand to make sure the parts do not bind (Fig. 104). The rotor should orbit inside the stator. If they bind, disassemble the metering package, correct the cause and repeat the assembly and concentricity procedures.

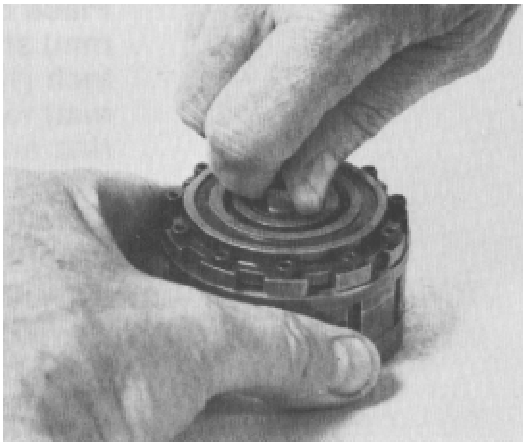


Figure 104

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. 105). This is required so the other components can be aligned correctly.

IMPORTANT: Make sure the seal ring does not slip from position.

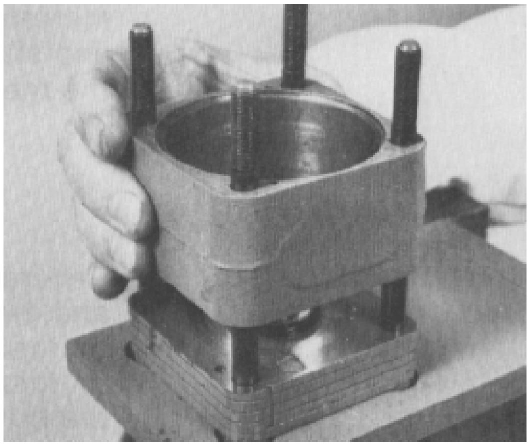


Figure 105

25. Put the bearing spacer onto the face of the upper cover plate (Fig. 106).

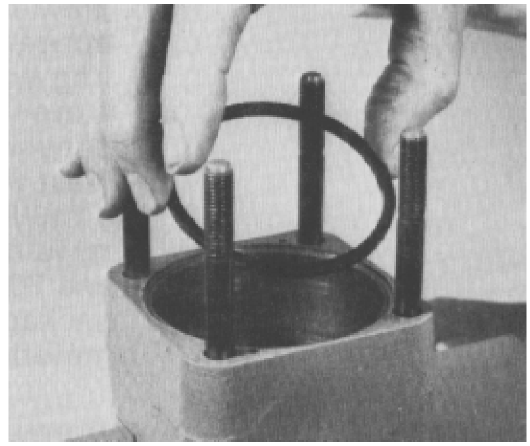


Figure 106

26. Lightly grease the roller thrust bearing and put it on the upper cover plate, inside the bearing spacer (Fig. 107).

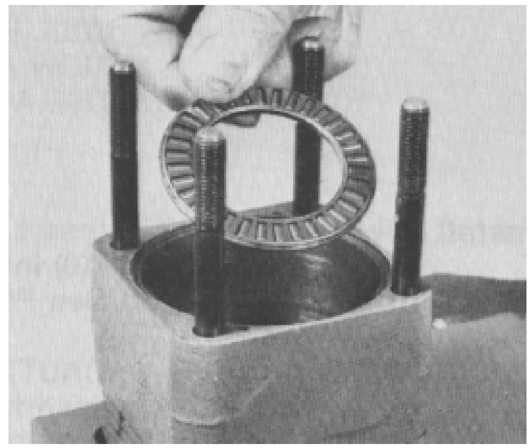


Figure 107

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. 108).

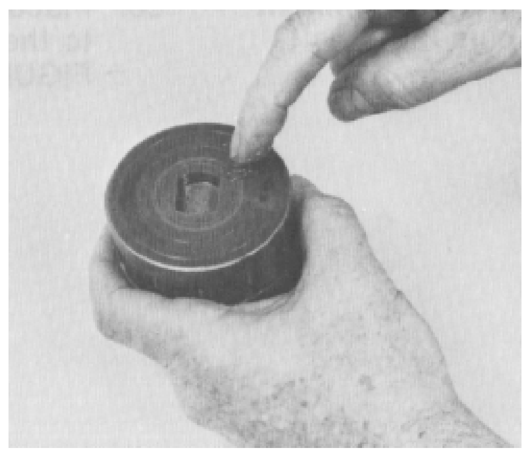


Figure 108

28. Put the metering package, drive plate side first, into the metering ring (Fig. 109). 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.

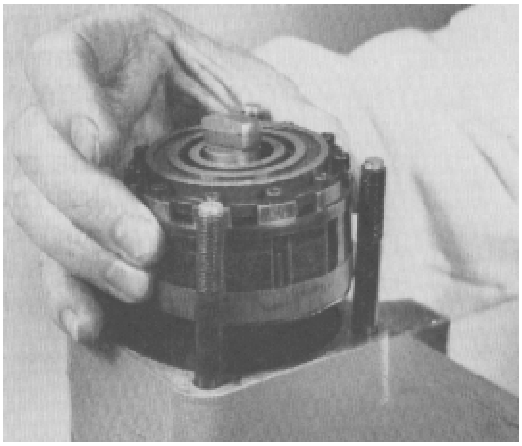


Figure 109

29. Apply clean multi–purpose grease on the new commutator seal and put it into the commutator cover seal groove (Fig. 110). The rubber portion (the softer side) of the seal with the yellow mark must be put into the seal groove.

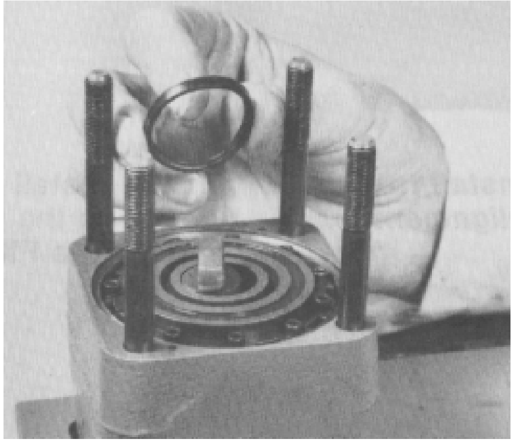


Figure 110

30. Apply clean multi–purpose grease to the metering ring seal ring. Put the seal ring into the metering ring seal ring groove (Fig. 111).

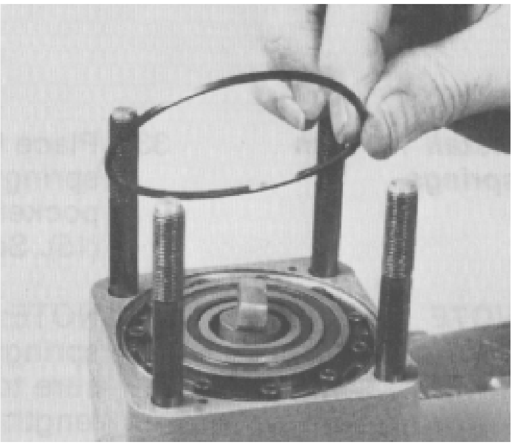


Figure 111

31. Put two alignment pins into the metering ring (Fig. 112).

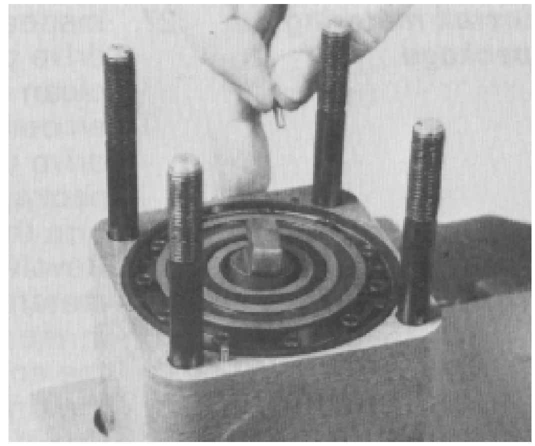


Figure 112

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. 113). 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.

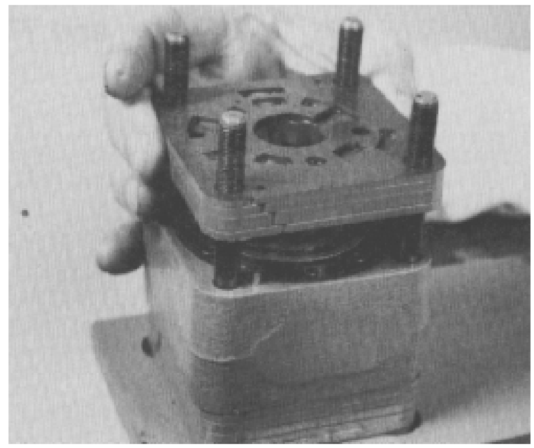


Figure 113

33. Install two alignment pins into the isolation manifold (Fig. 114).

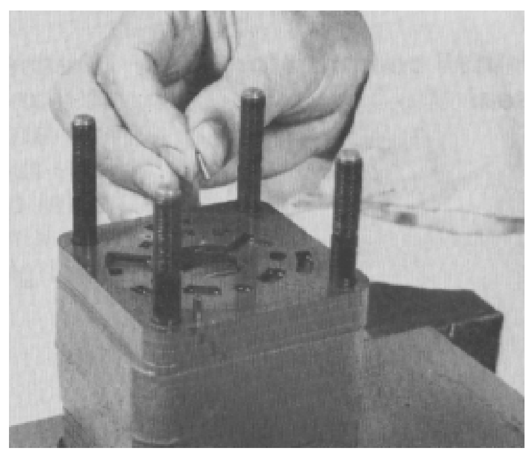


Figure 114

34. Put the three 1/2 in. (13 mm) springs into the spring pockets of the isolation manifold (Fig. 115).

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.

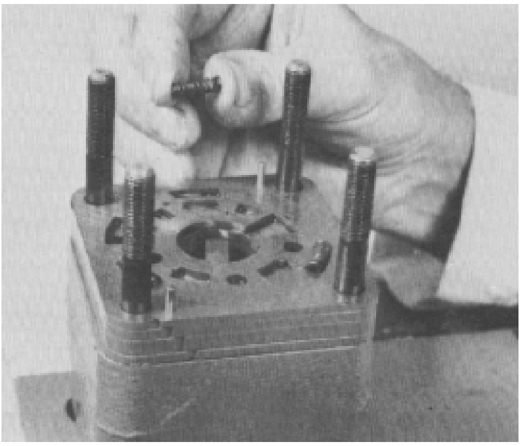


Figure 115

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. 116).

IMPORTANT: Be sure the seal ring is seated correctly after the valve ring is assembled.

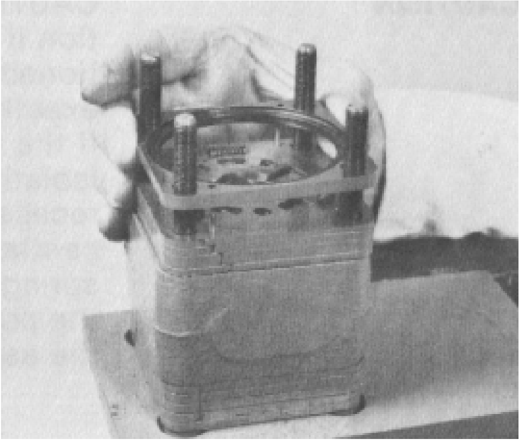


Figure 116

36. Put the hex drive assembly, pin side up, through the hole in the isolation manifold (Fig. 117). 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).

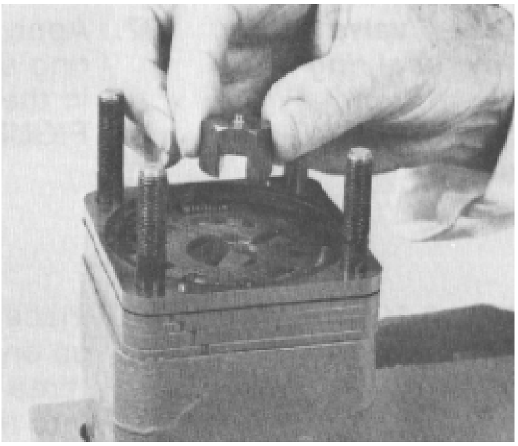


Figure 117

Hydraulic System

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. 118), must be placed over the spring and spring recess in the isolation manifold at the top (12 o’clock position) as shown (Fig. 118 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 119. 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.

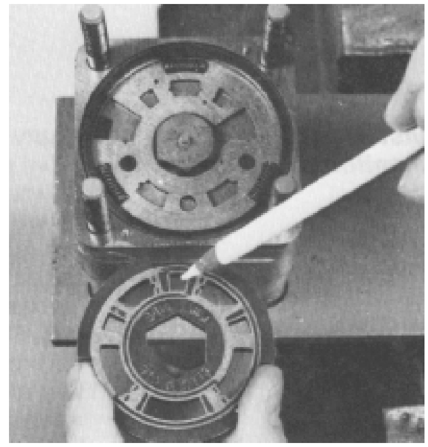


Figure 118

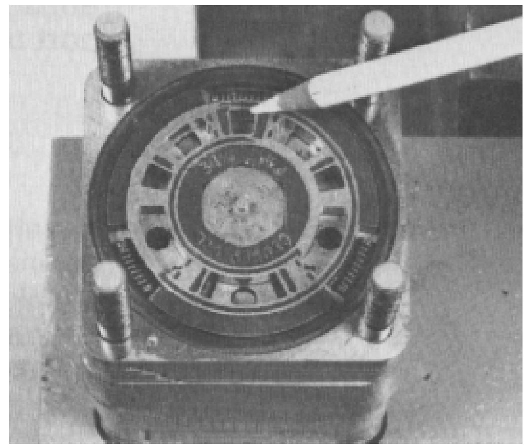


Figure 119

38. Apply clean multi–purpose grease to the valve ring seal ring. Install the seal ring in the valve ring (Fig. 120).

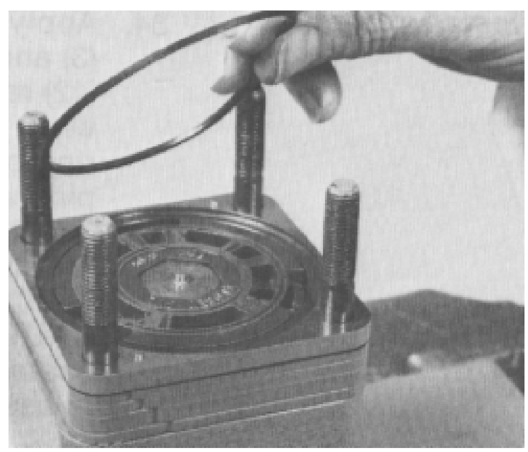


Figure 120

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. 121).

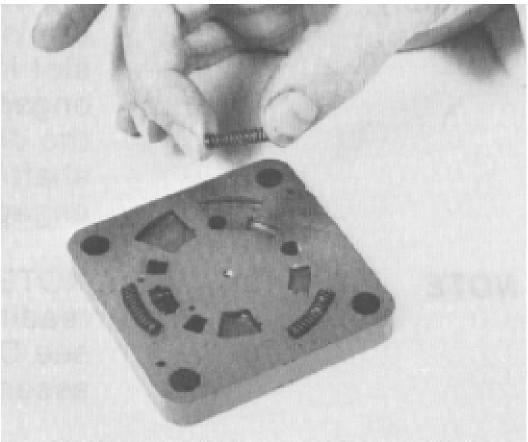


Figure 121

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. 122). 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.

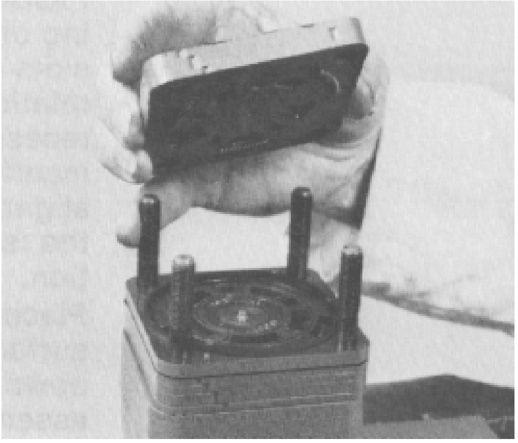


Figure 122

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. 123).

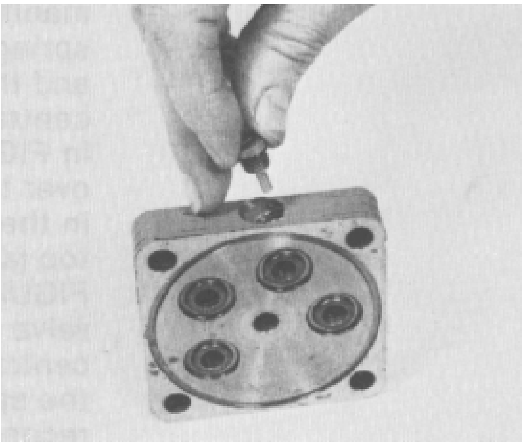


Figure 123

Hydraulic System

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. 124).

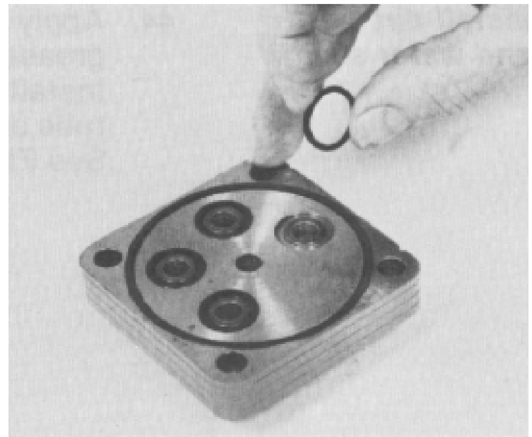


Figure 124

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. 125).

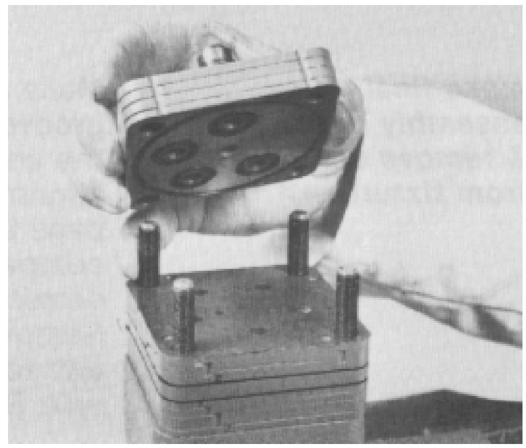


Figure 125

44. Install the lock nuts onto the bolts. Tighten each nut gradually until resistance is felt (Fig. 126). Tighten to a torque of 20 – 24 ft–lb (27 – 33 Nm) in the sequence shown (Fig. 127).

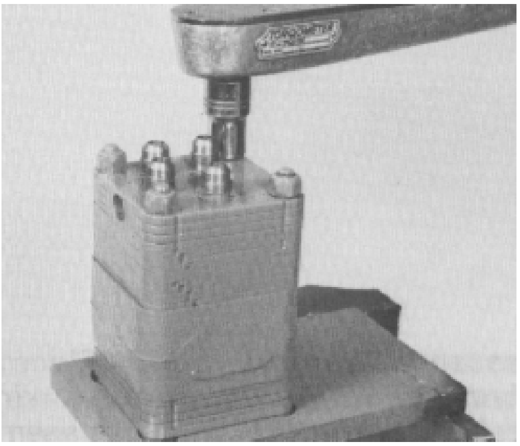


Figure 126

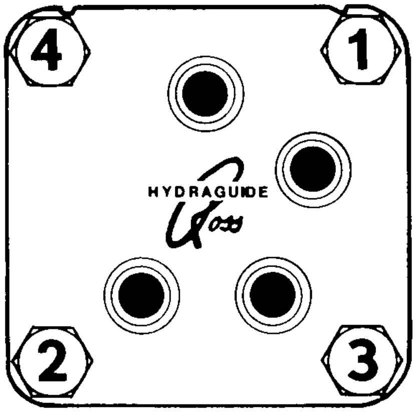


Figure 127

45. Tighten the plug to a torque of 8 – 12 ft–lb (11 – 16 Nm) (Fig. 128).

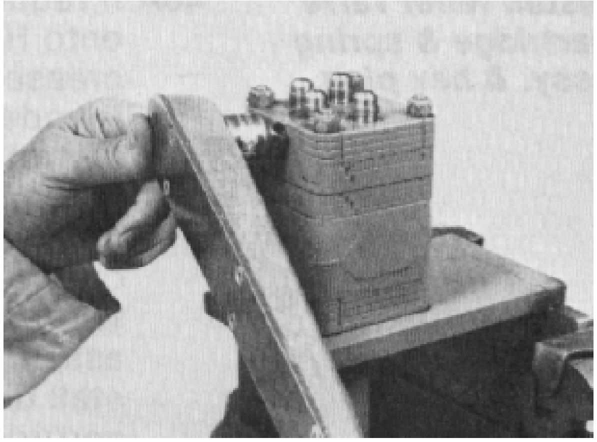


Figure 128

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. 129).

47. Make a final inspection of the relative groove positions on the side of the unit (Fig. 42). 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. 42). Disassemble and correct the assembly if necessary.

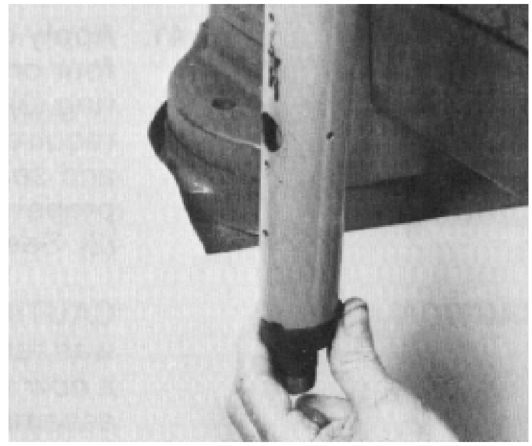


Figure 129

48. Remove the four nuts holding the unit to the fixture and remove the unit (Fig. 130).

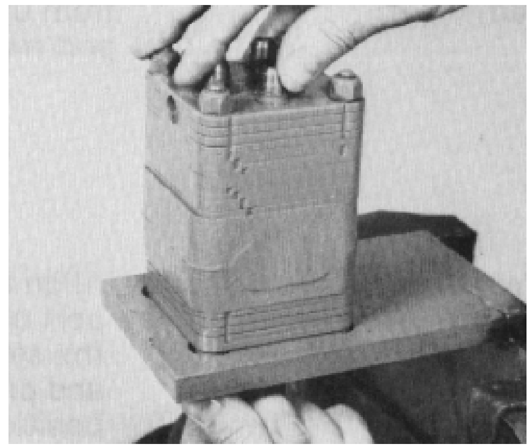


Figure 130

Hydraulic Reservoir

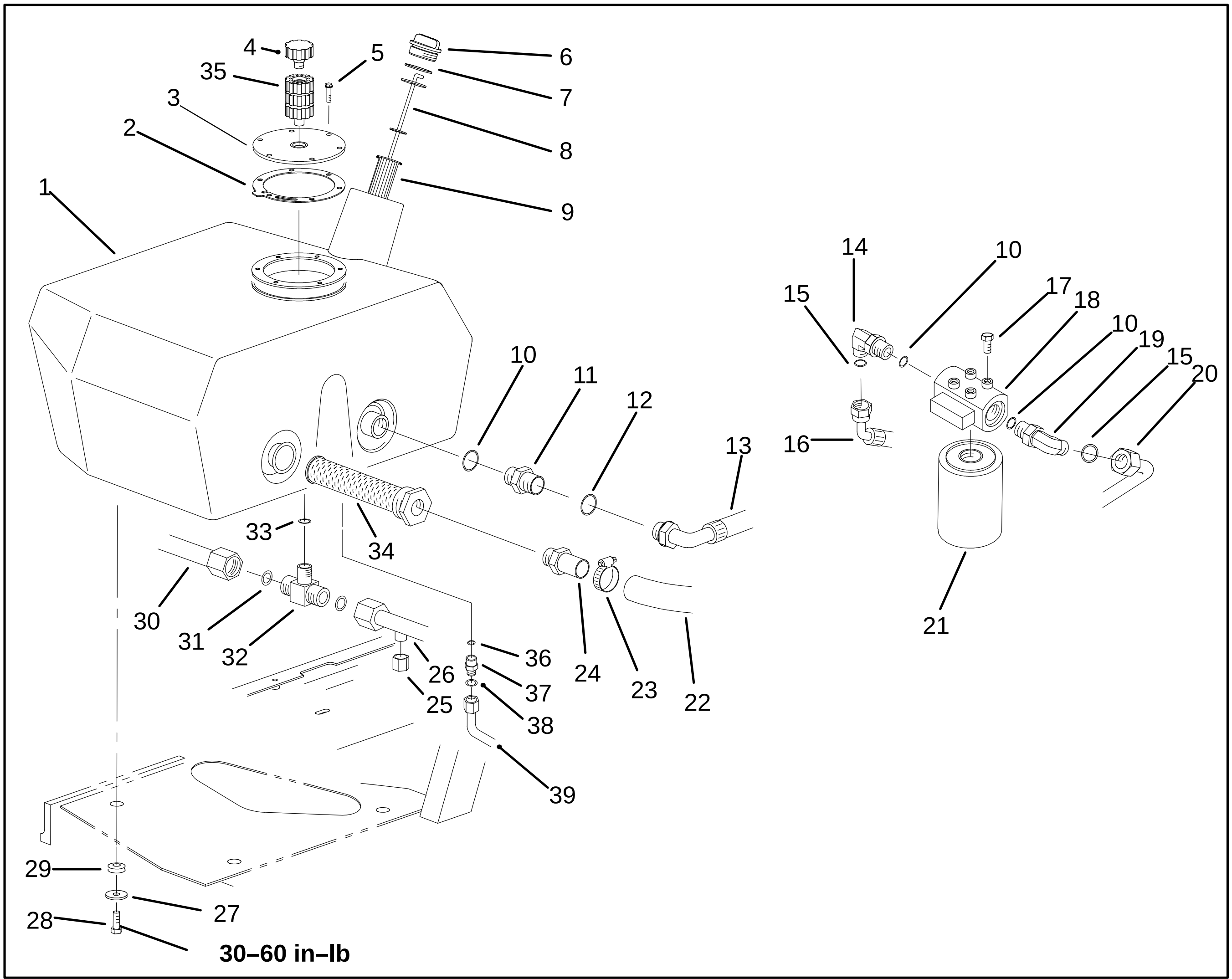


Figure 131

1. Hydraulic Tank	**14. Elbow 90° Fitting**	**27. Flat Washer**
2. Flange Gasket	**15. O–Ring**	**28. Hex Hd. Flange Screw**
3. Tank Cover	**16. Filter Hose**	**29. Grommet**
4. Air Breather	**17. Screw**	**30. RH Motor Tube**
5. Hex Hd. Flange Screw	**18. Filter Head**	**31. O–Ring**
6. Plastic Plug	**19. Hydraulic 90° Fitting**	**32. Tee Fitting**
7. O–Ring	**20. Filter Hose**	**33. O–Ring**
8. Dipstick	**21. Element**	**34. Suction Strainer**
9. Screen Filter	**22. Suction Hose**	**35. Breather Adapter**
10. O–Ring	**23. Clamp**	**36. O–Ring**
11. Hydraulic Fitting	**24. Hose Fitting**	**37. Adapter**
12. O–Ring	**25. Fitting Cap**	**38. O–Ring**
13. Return Hose	**26. Drain Tube**	**39. Return Steering Tube**

Inspecting Reservoir Parts

1. Clean filler screen, suction screen and reservoir with clean solvent (Fig. 103).

2. Inspect reservoir for leaks, cracks or other damage.

3. Replace hoses or fittings if worn or leaking.

4. Replace breather with new part.

Flushing the Hydraulic System

IMPORTANT: Flush the hydraulic system any time there is a severe component failure or the system is contaminated (oil appears milky or black or contains metal particles).

IMPORTANT: Flush hydraulic system when changing from petroleum base hydraulic fluid, such as Mobil 424, to biodegradable fluid, such as Mobil EAL 224H. Operate machine under normal operating conditions for at least four (4) hours before draining.

1. Lower cutting units, stop engine, engage parking brake and remove key from ignition switch.

2. Drain the system, including cylinders, hoses and tube lines while system is warm.

3. Inspect and clean reservoir (see Inspecting Reservoir Parts).

4. Clean area around filter mounting area. Remove and discard filter. Make sure filter mounting surface is clean. Apply hydraulic oil to gasket on new filter. Fill filter with hydraulic fluid. Screw filter on until gasket contacts mounting plate, then tighten filter one–half turn.

5. Fill hydraulic reservoir. NOTE: Use biodegradable fluid, such as Mobil EAL 224H, for this step if you are changing to this type of fluid. Use only hydraulic fluids specified (see Specifications section of this chapter). Other fluids could cause system damage.

6. Disconnect fuel stop solenoid electrical connector to prevent engine from starting.

7. Turn ignition key switch to engage starter for ten (10) seconds to prime pump. Repeat this procedure again.

8. Connect fuel stop solenoid electrical connector.

9. Start engine and let idle at low speed for minimum of two (2) minutes.

10. Increase engine speed to high idle for minimum of one (1) minute under no load.

11. Turn steering wheel fully left and right several times.

12. Raise and lower cutting units several times.

13. Shut off engine and check for hydraulic oil leaks. Check oil level in hydraulic reservoir and add correct oil if necessary.

14. Operate the machine for two (2) hours under normal operating conditions.

15. If the flushing fluid shows any signs of contamination, or if you are changing to biodegradable fluid, do steps 1 – 13 again.

16. Assume normal operation and follow recommended maintenance intervals.

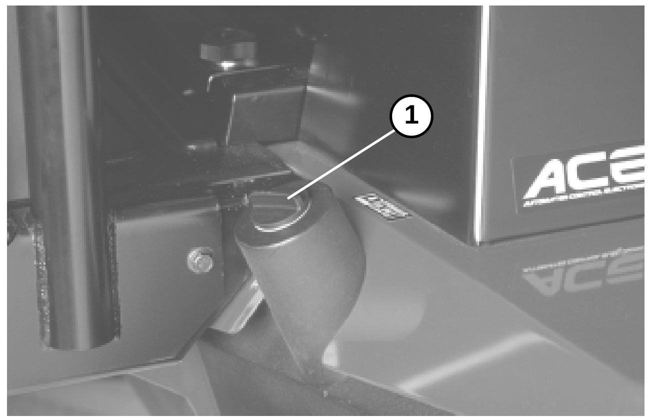


Figure 132

1. Hydraulic reservoir

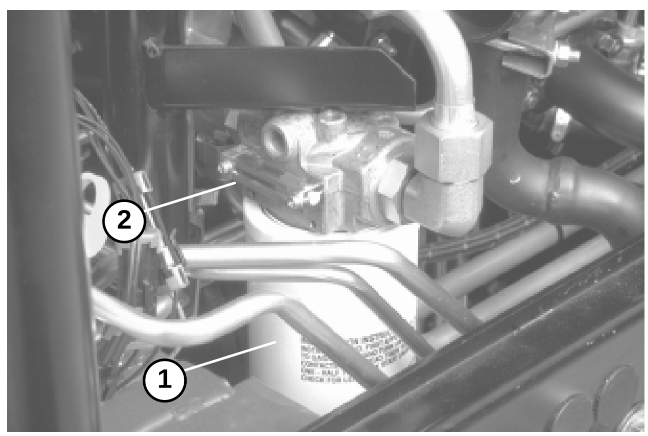


Figure 133

1. Hydraulic filter
2. Condition indicator

Steering Valve (93–5165 or 94–9950)

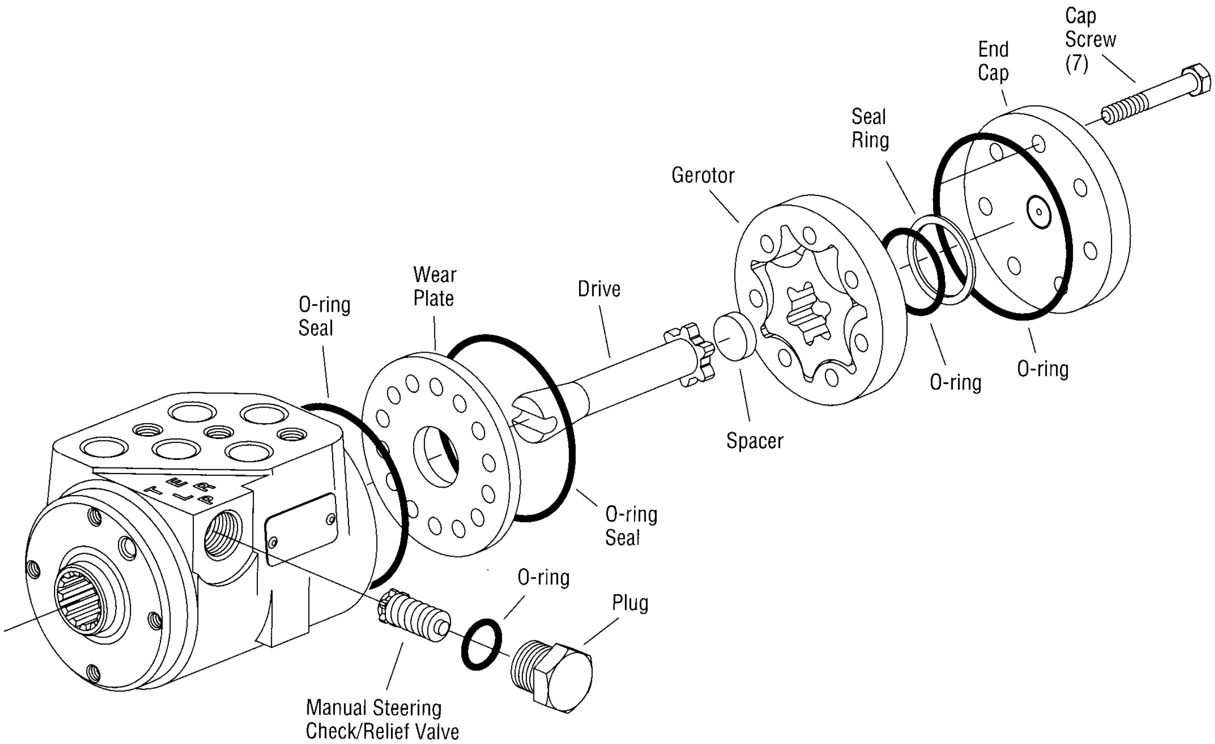


Figure 134

Before Disassembly

Cleanliness is extremely important when repairing steering control units. Work in a clean area. Before disconnecting the hydraulic lines, clean the port area of the steering control unit. Before disassembly, drain the oil, then plug the ports and thoroughly clean the exterior. During repairs, always protect machined surfaces.

1. Remove the seven capscrews and disassemble the steering control unit as shown (Fig. 134).

2. Remove the plug and manual steering check valves.

Hydraulic System

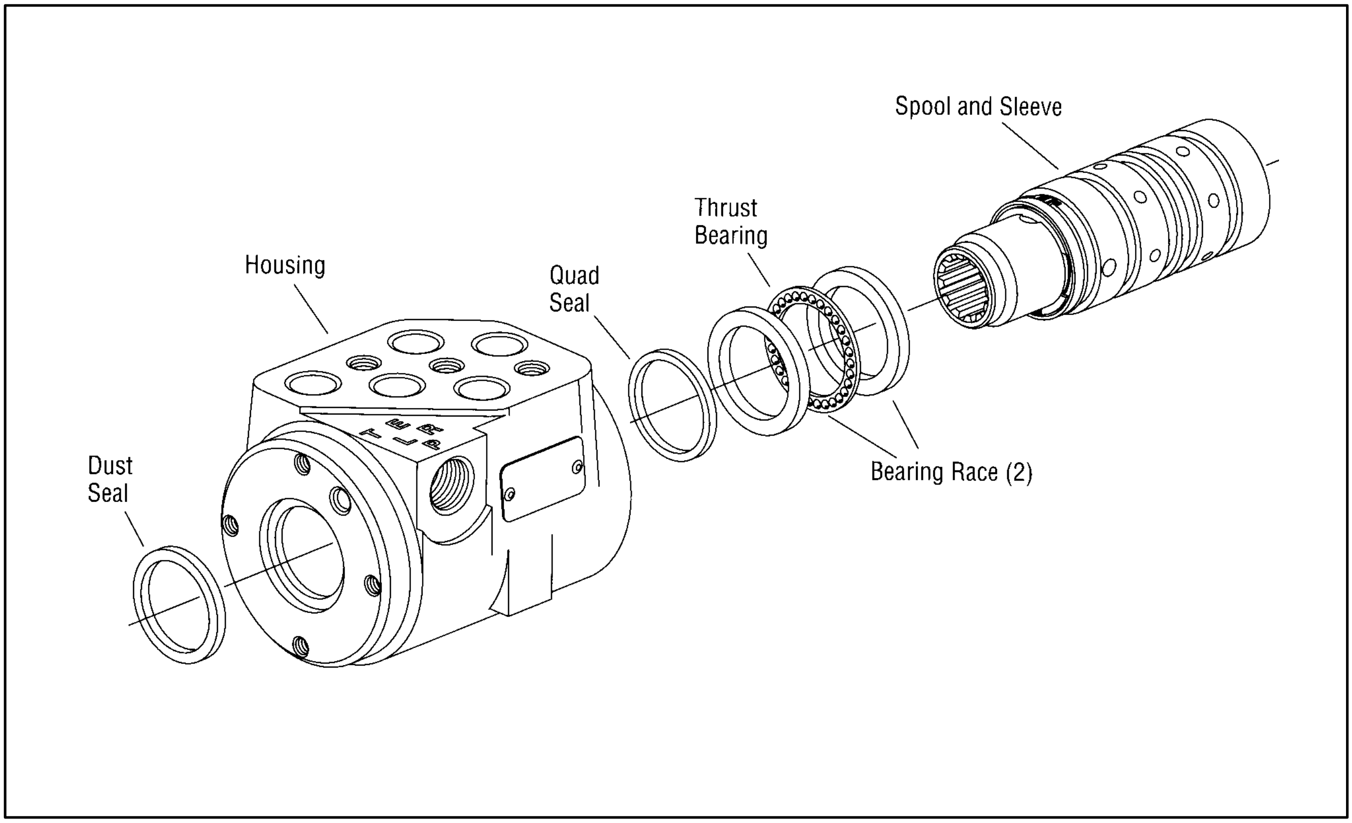


Figure 135

3. Slide the spool and sleeve from the housing (Fig. 135).

4. Remove the trust bearing and bearing races.

5. Remove the quad seal.

6. Use a small blade screwdriver to carefully pry the dust seal from the housing. Be careful to not damage the dust seal seat.

7. Remove the pin that holds the spool and sleeve together (Fig. 136).

8. Carefully slide the spool out of the sleeve. The springs and retaining ring will stay with the spool as it is removed.

9. Remove the retaining ring and springs.

CAUTION

The centering springs are under tension. Remove the retaining ring carefully.

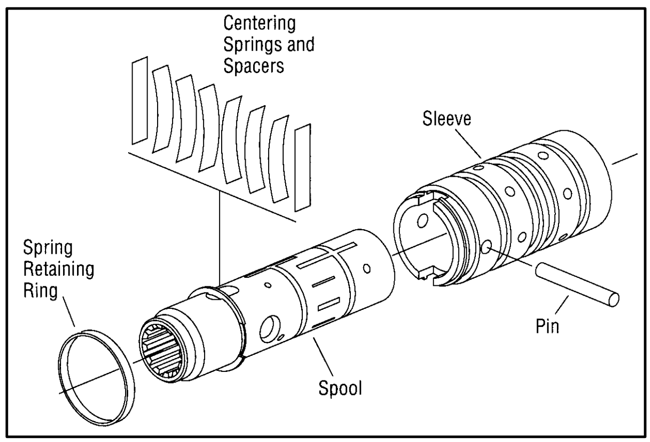


Figure 136

Reassembly

Check all mating surfaces. Replace any parts with scratches or burrs that could cause leakage. Wash all metal parts in clean solvent. Blow them dry with pressurized air. Do not wipe parts dry with paper towels or cloth. Lint in a hydraulic system will cause damage.

NOTE: Always use new seals when reassembling the steering control unit.

IMPORTANT: During reassembly, lubricate the new seals with petroleum jelly. Also lubricate machined surfaces and bearings with clean hydraulic fluid.

1. Install the quad seal:

   A. Put one of the bearing races and sleeve into the housing.

   B. Together, the housing and bearing race create a groove into which the quad seal will be installed.

   C. Hold the bearing race tightly against the input end of the housing by pushing on the gerotor end of the sleeve.

   D. Fit the quad seal into its seat through the input end of the housing. Be sure the seal is not twisted.

   E. Remove the sleeve and bearing race.

2. Lubricate and install the dust seal. See Figure 137 for correct seal orientation.

3. Install the centering springs in the spool (Fig. 136). It is best to install the two flat pieces first. Next, install the curved pieces, three at a time.

4. Fit the retaining ring over the centering springs.

5. Apply a light coating of clean hydraulic fluid to the spool and slide it into the sleeve. Be sure the centering springs fit into the notches in the sleeve.

6. Install the pin.

7. Apply a light coating of petroleum jelly to the inner edge of the dust and quad seals.

8. Put the thrust bearing and races into the housing. The thrust bearing goes between the two races (Fig. 135).

9. Apply a light coating of clean hydraulic fluid to the spool and sleeve assembly and slide it into the housing.

IMPORTANT: Do not damage the dust or quad seals.

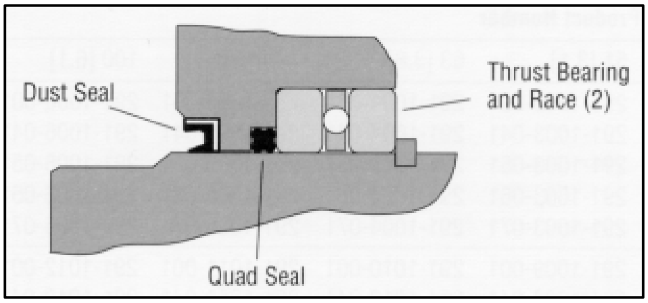


Figure 137

Hydraulic System

10. Clamp the housing in a vise (Fig. 138). Use just enough clamping force to hold the housing securely.

11. Lubricate and install a new o–ring seal in the groove in the housing.

12. Install the wear plate and align the holes in the wear plate with threaded holes in the housing.

NOTE: The holes in the wear plate are symmetrical.

13. Install the drive, making sure the slot in the drive engages the pin.

14. Lubricate and install a new o–ring seal in the groove in the wear plate.

15. Install the gerotor and align the screw holes.

16. Lubricate and install a new o–ring seal in the groove in the gerotor ring.

17. Lubricate and install a new o–ring and seal ring in the groove in the gerotor star.

18. Install the spacer.

19. Install the end cap and seven capscrews. Tighten the capscrews, in a crossing pattern, to a torque to 16 – 18 Nm (140 – 160 in–lb).

20. Remove the steering control unit from the vise.

21. Install the relief/check valve and plug. Use a new o–ring and tighten the plug to 17 Nm (150 in–lb).

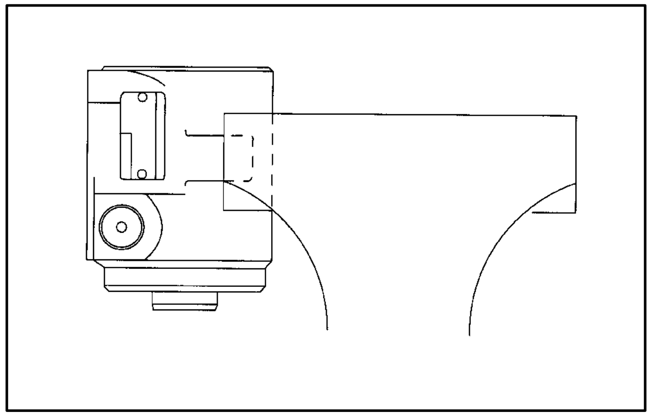


Figure 138

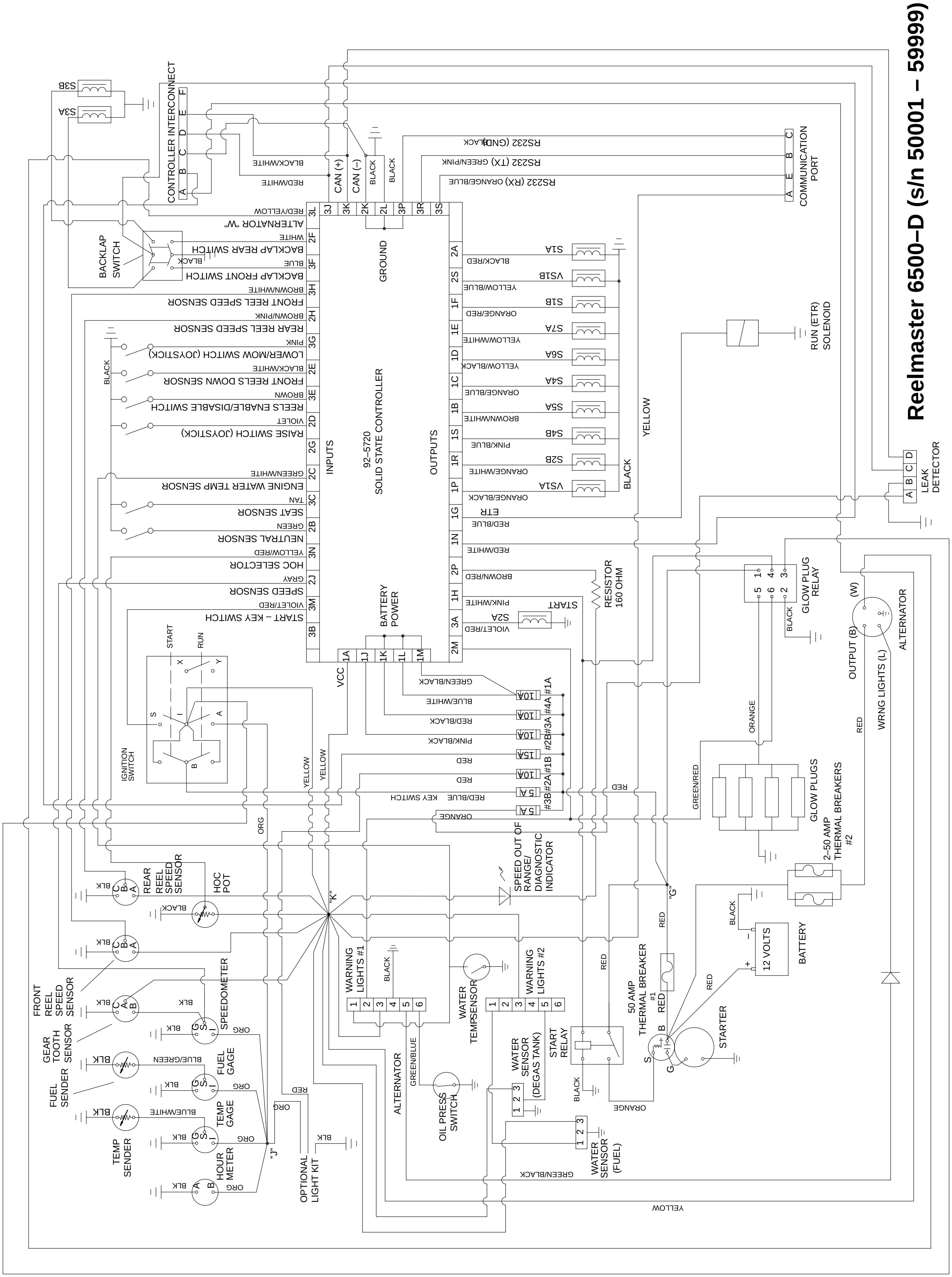
Chapter 5

Electrical System

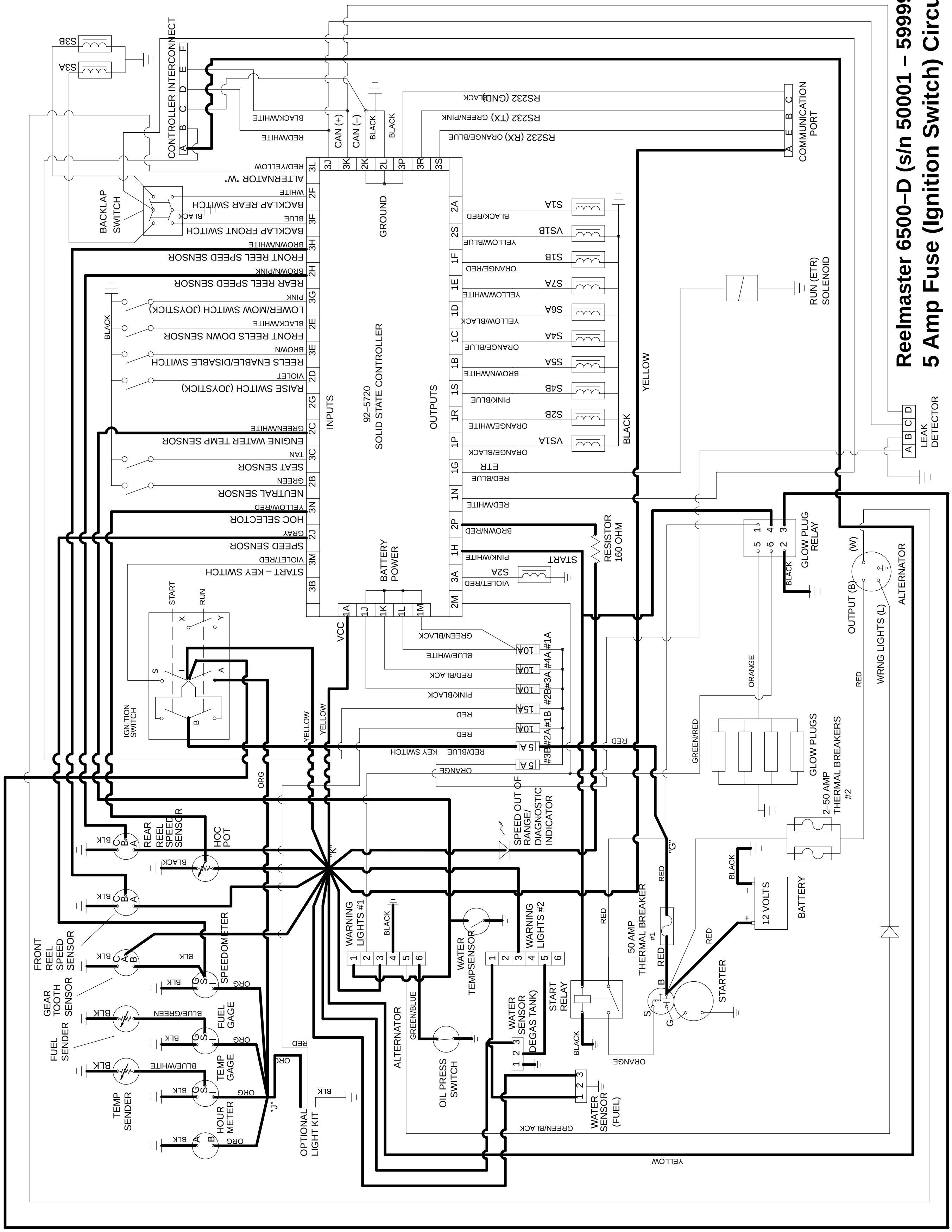
Table of Contents

Electrical System

Wiring Schematics (S/N 50001 – 59999)

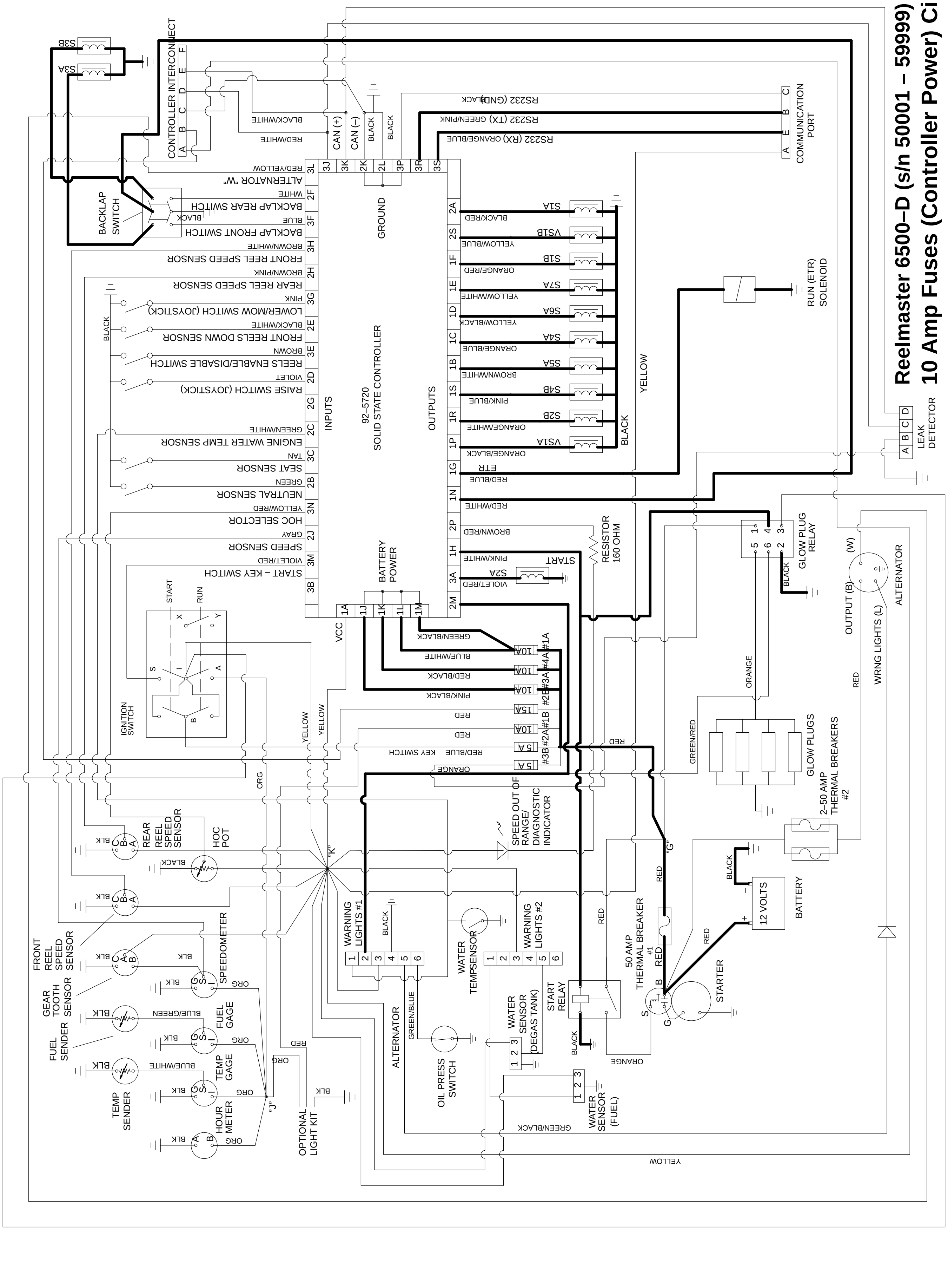


Reelmaster 6500–D (s/n 50001 – 59999) 5 Amp Fuse (Ignition Switch) Circuits

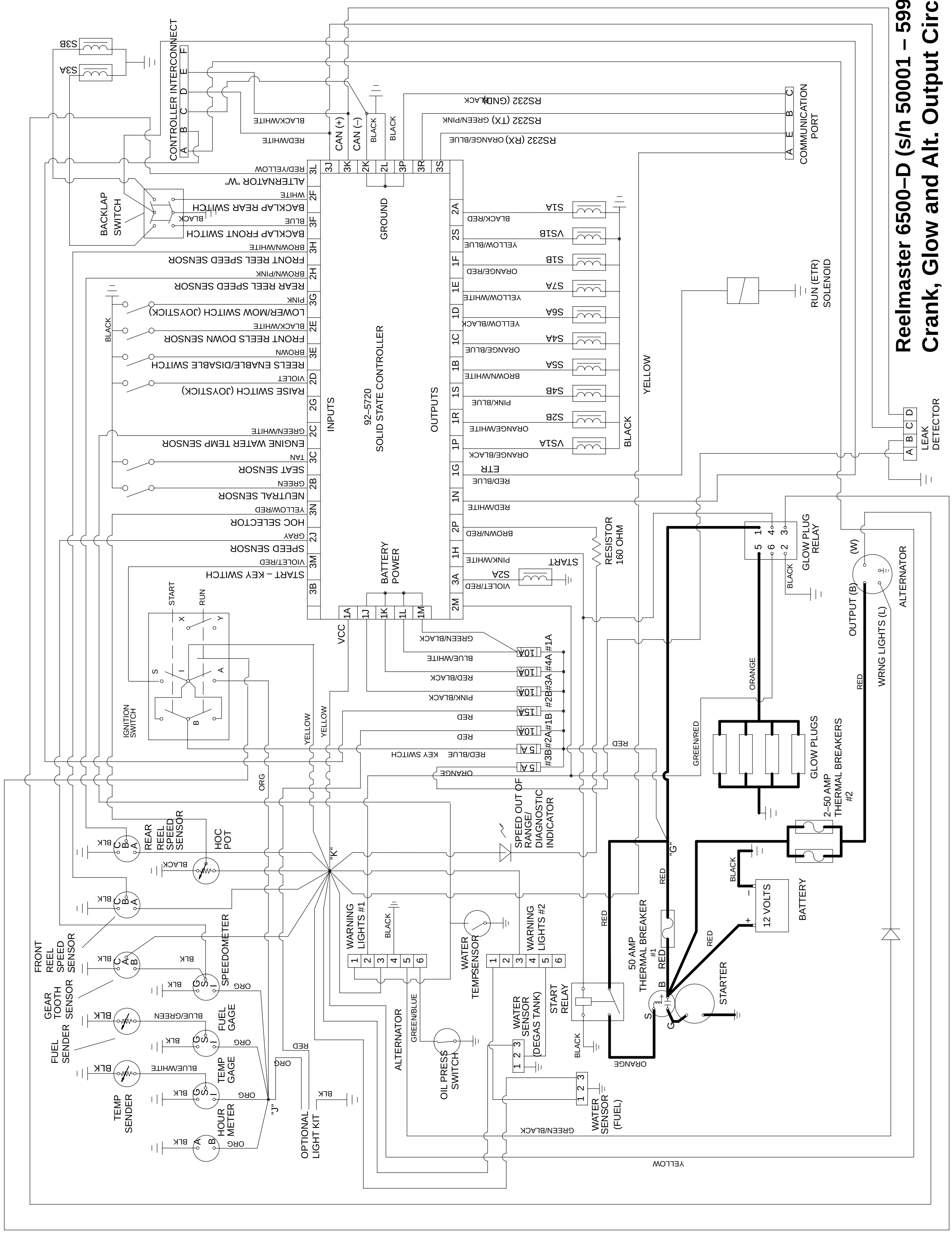


Electrical System

Reelmaster 6500–D (s/n 50001 – 59999)
10 Amp Fuses (Controller Power) Circuits

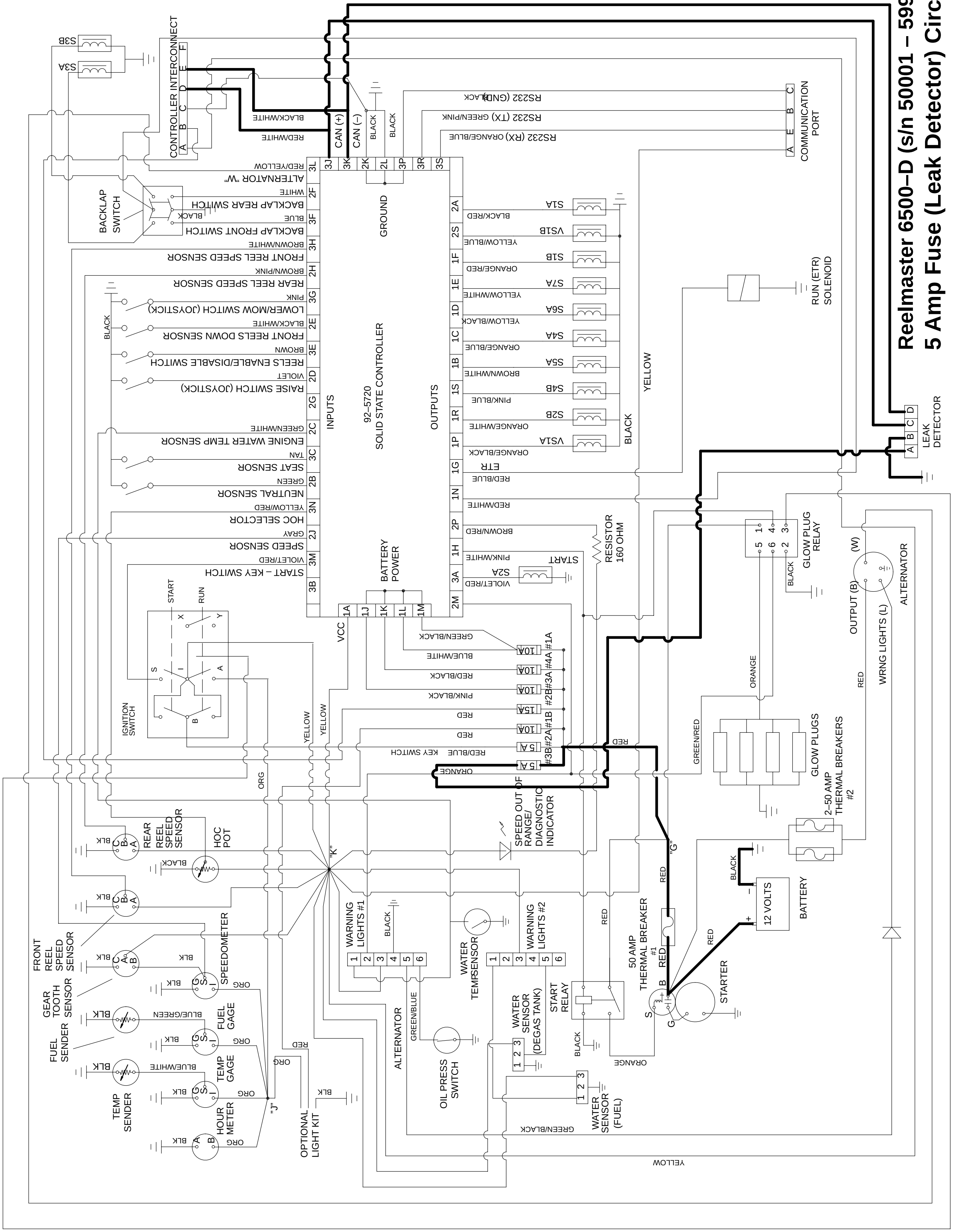


Reelmaster 6500–D (s/n 50001 – 59999) Crank, Glow and Alt. Output Circuits

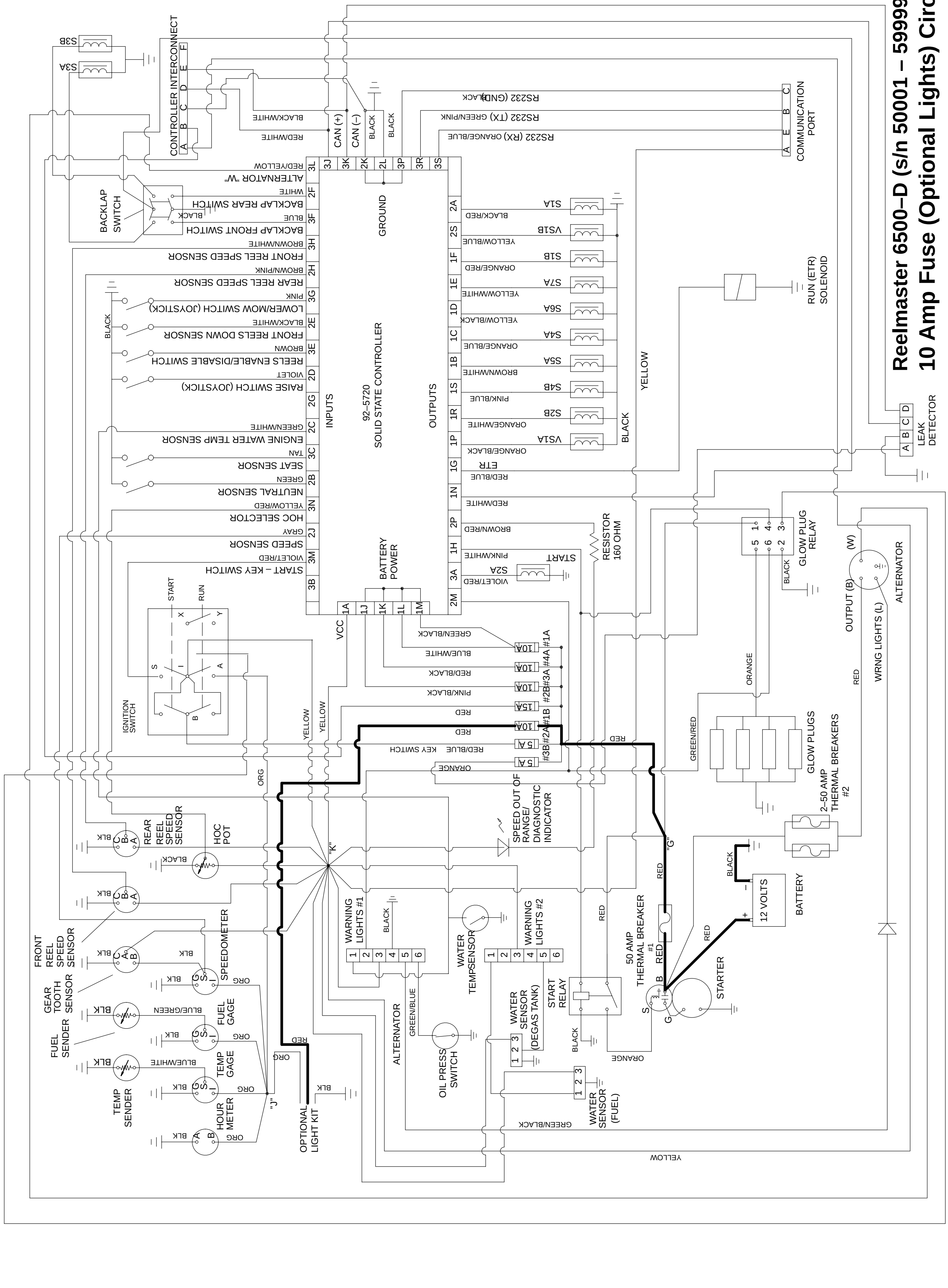


Electrical System

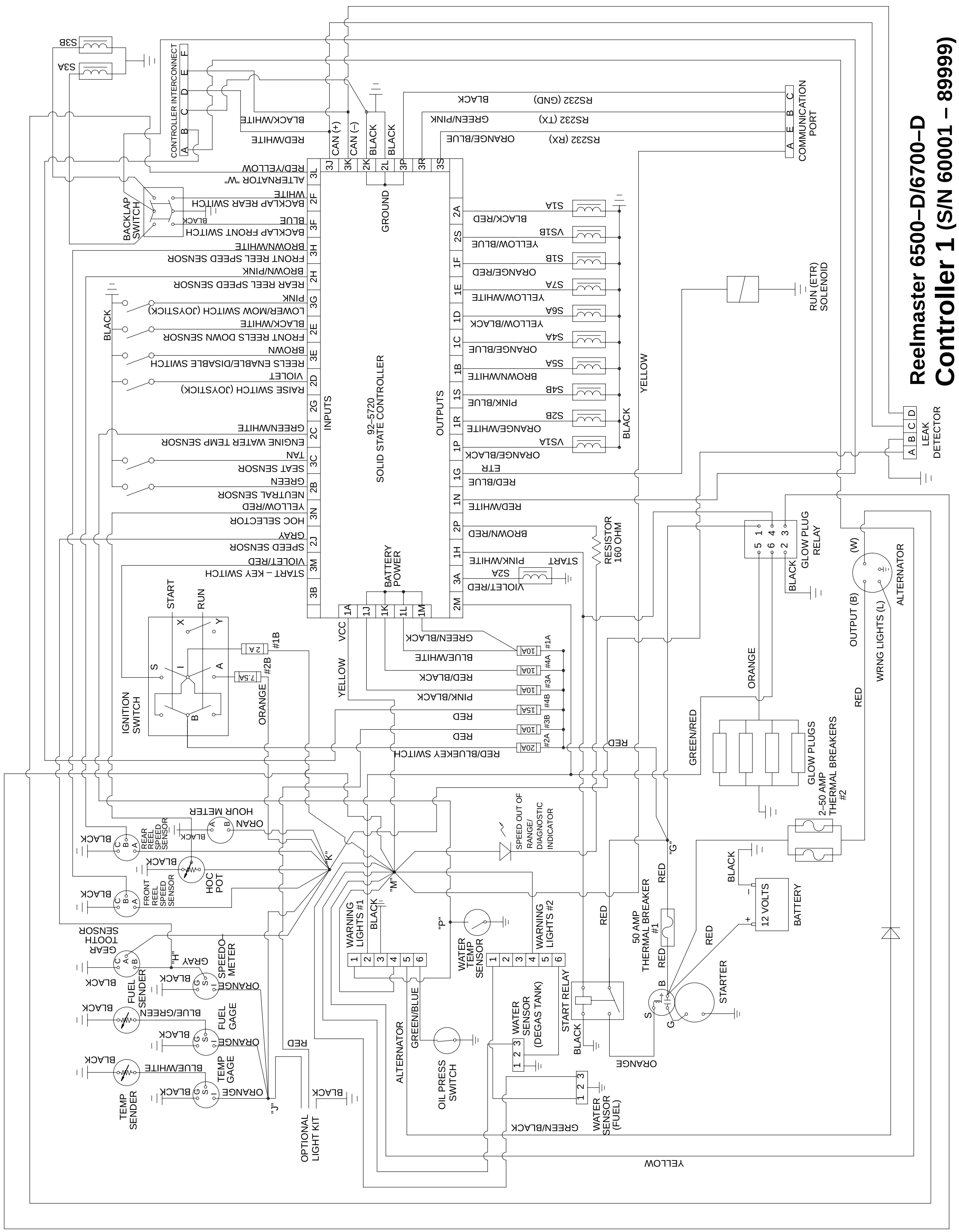
Reelmaster 6500–D (s/n 50001 – 59999)
5 Amp Fuse (Leak Detector) Circuits



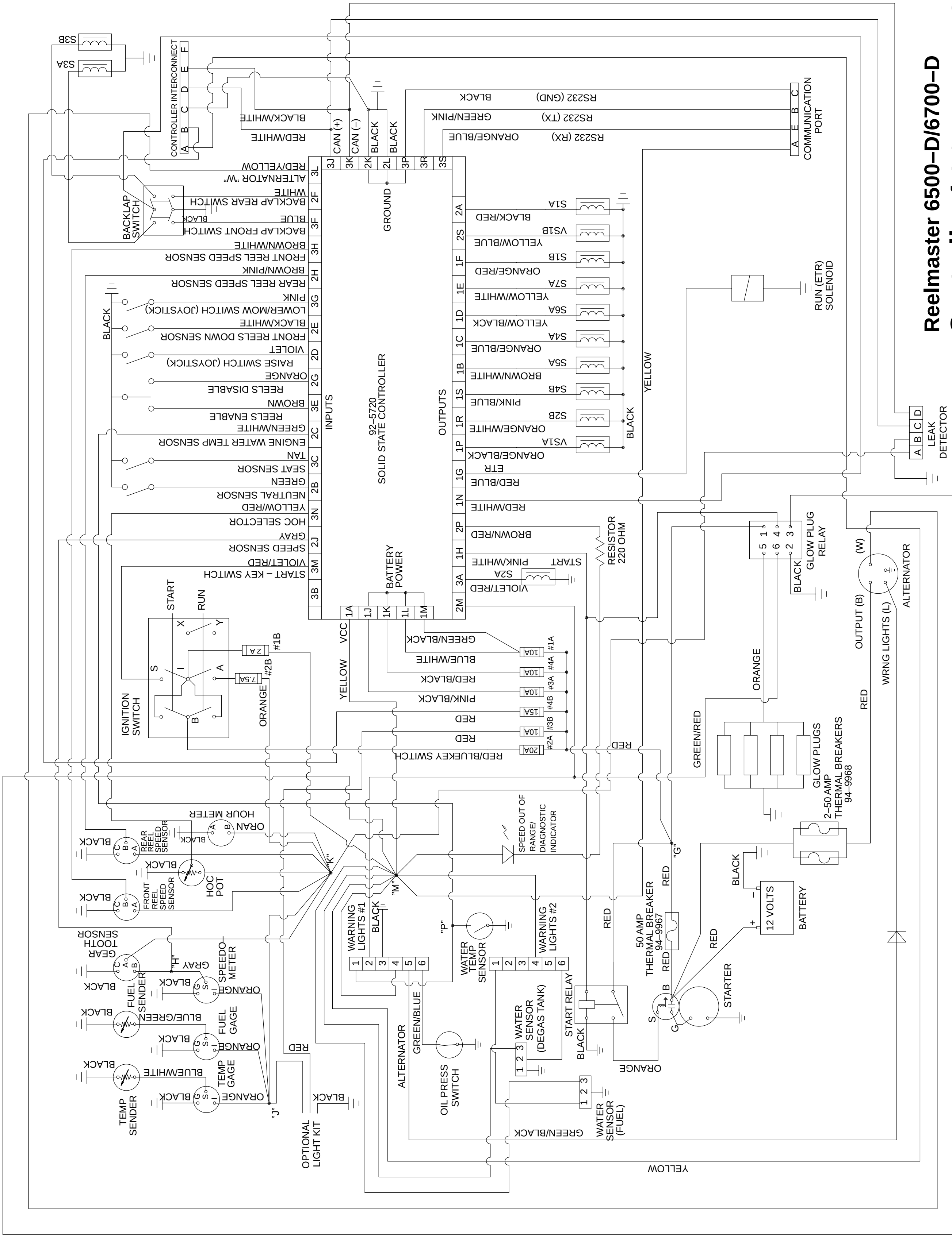
Reelmaster 6500–D (s/n 50001 – 59999) 10 Amp Fuse (Optional Lights) Circuit



Wiring Schematics (S/N 60001 & Up)

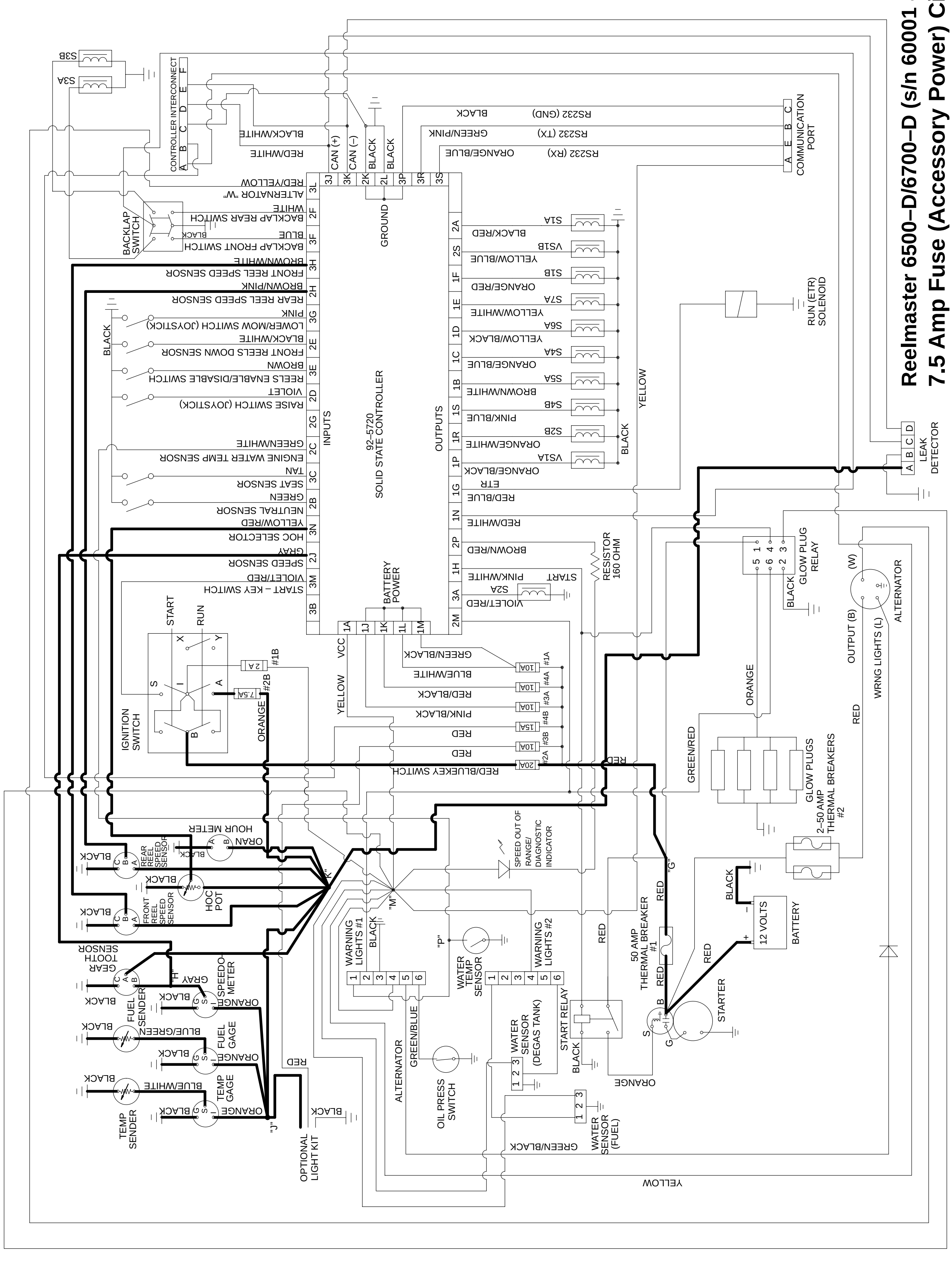


Reelmaster 6500–D/6700–D Controller 1 (S/N 90001 & Up)



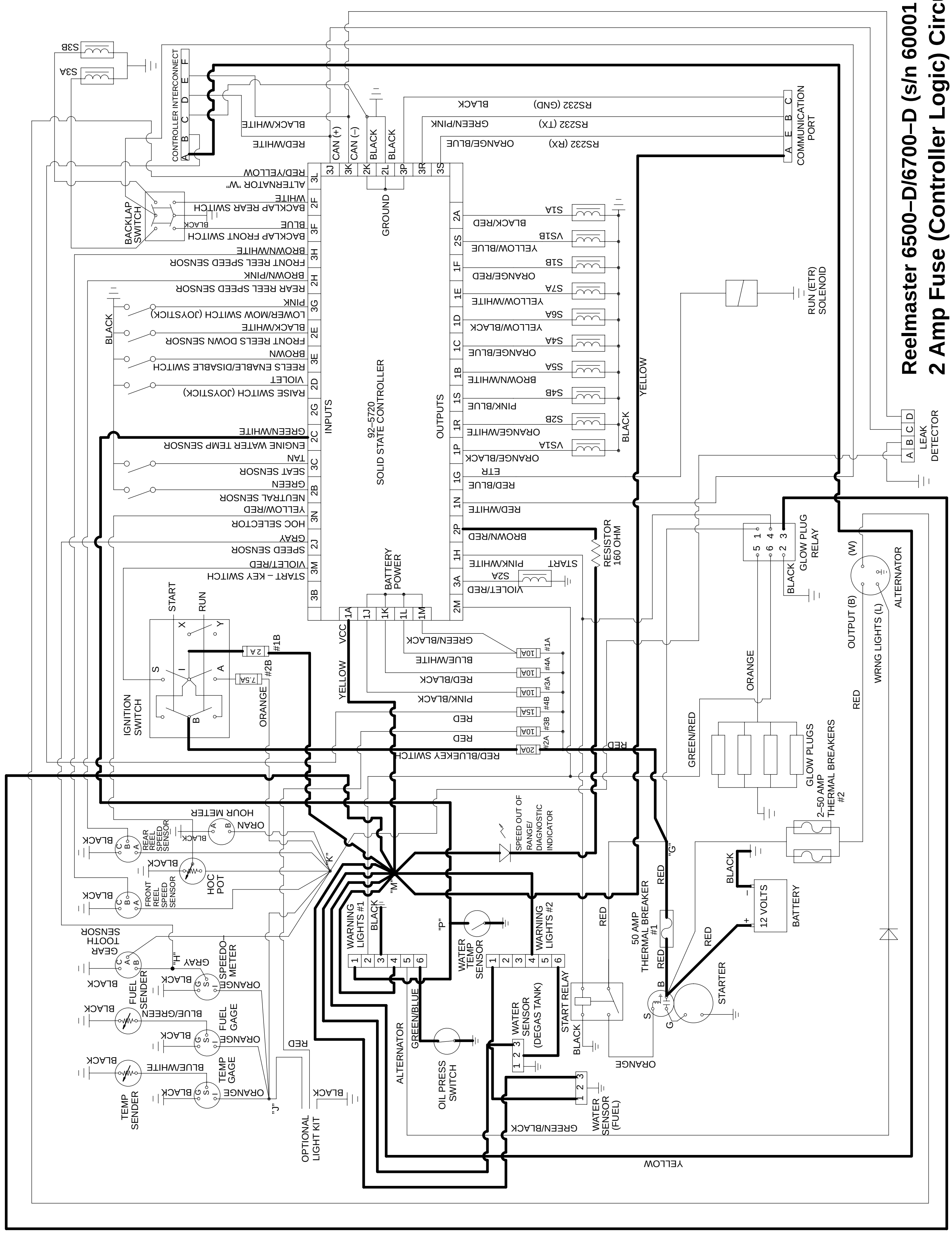
This page is intentionally blank.

Reelmaster 6500–D/6700–D (s/n 60001 & up)
7.5 Amp Fuse (Accessory Power) Circuits

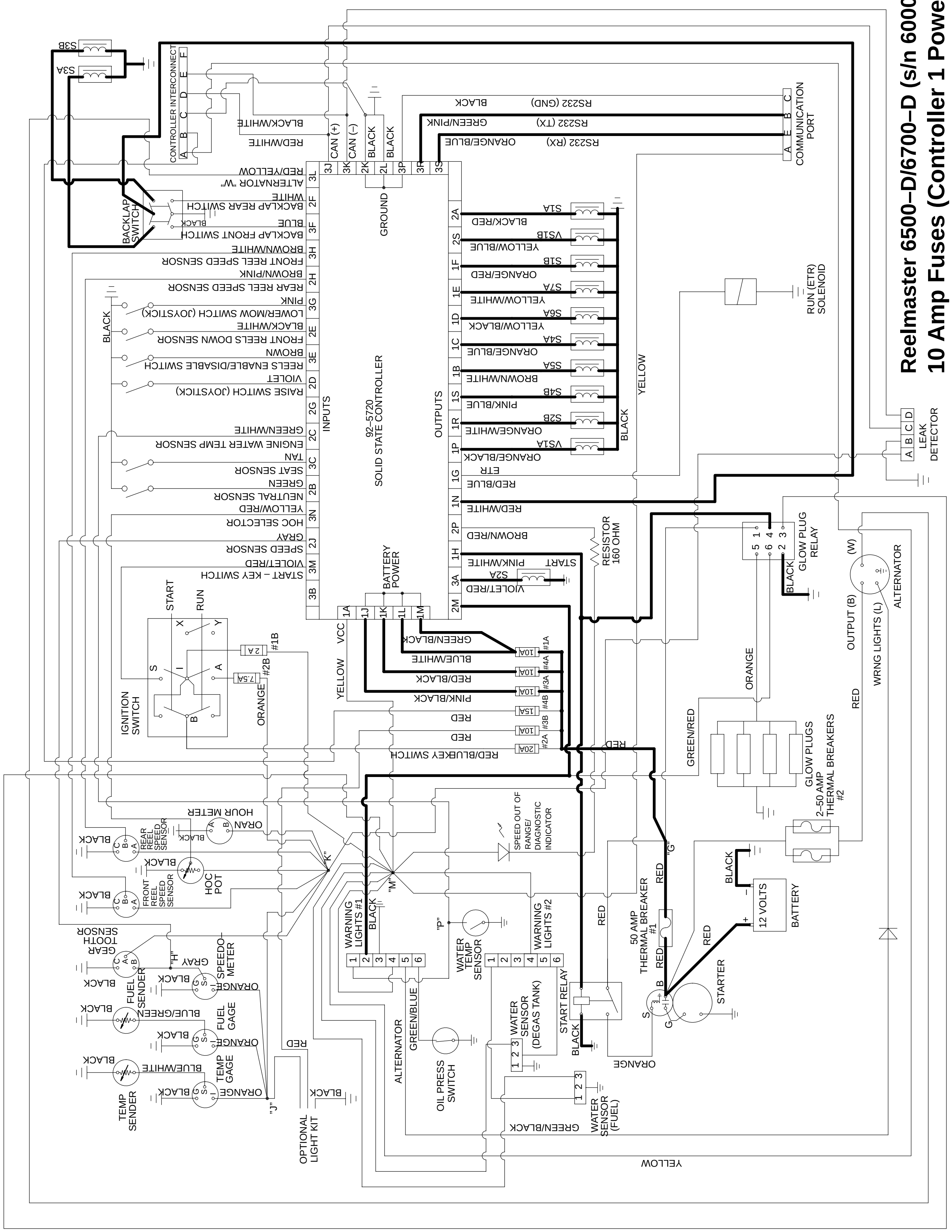


Electrical System

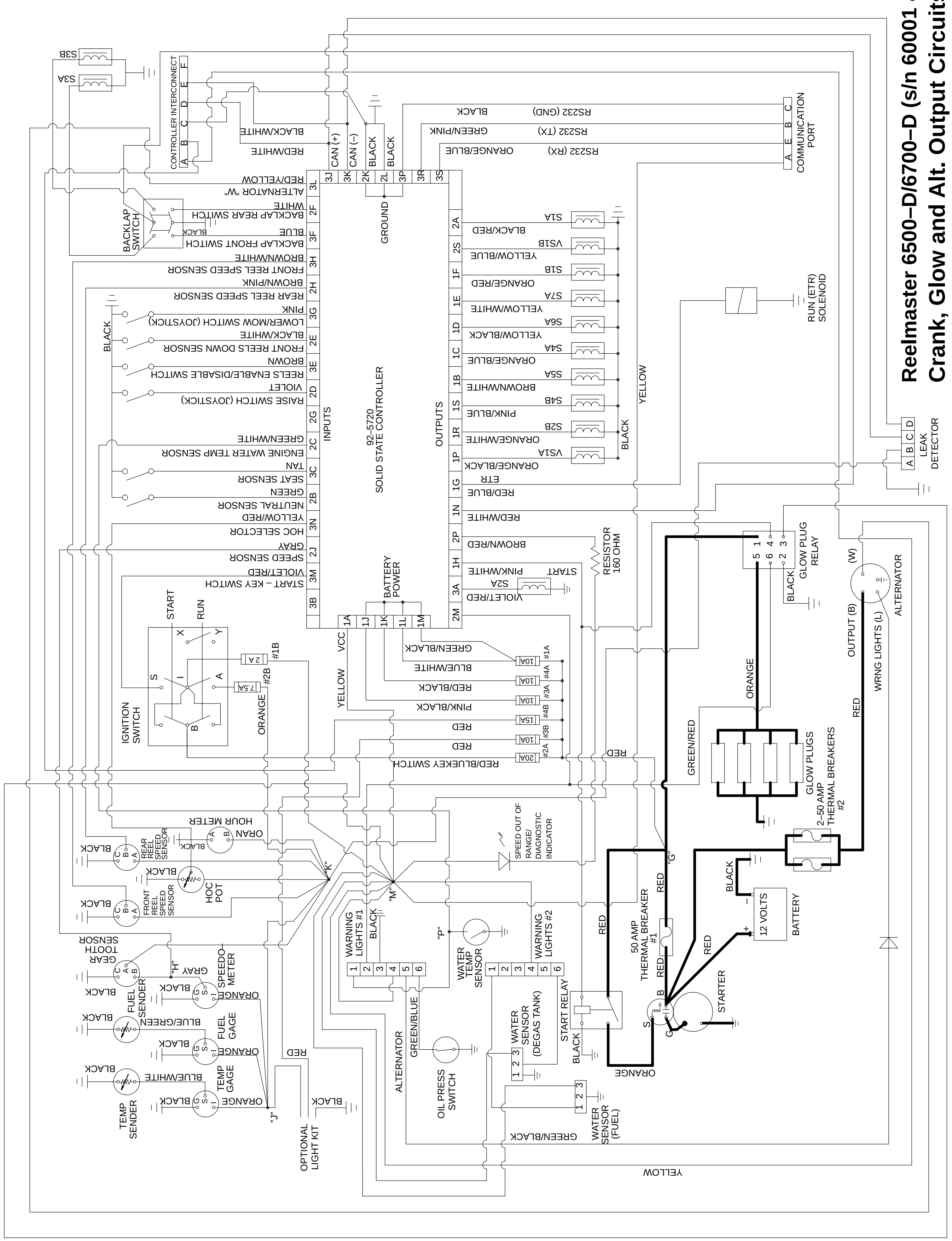
Reelmaster 6500–D/6700–D (s/n 60001 & up)
2 Amp Fuse (Controller Logic) Circuits



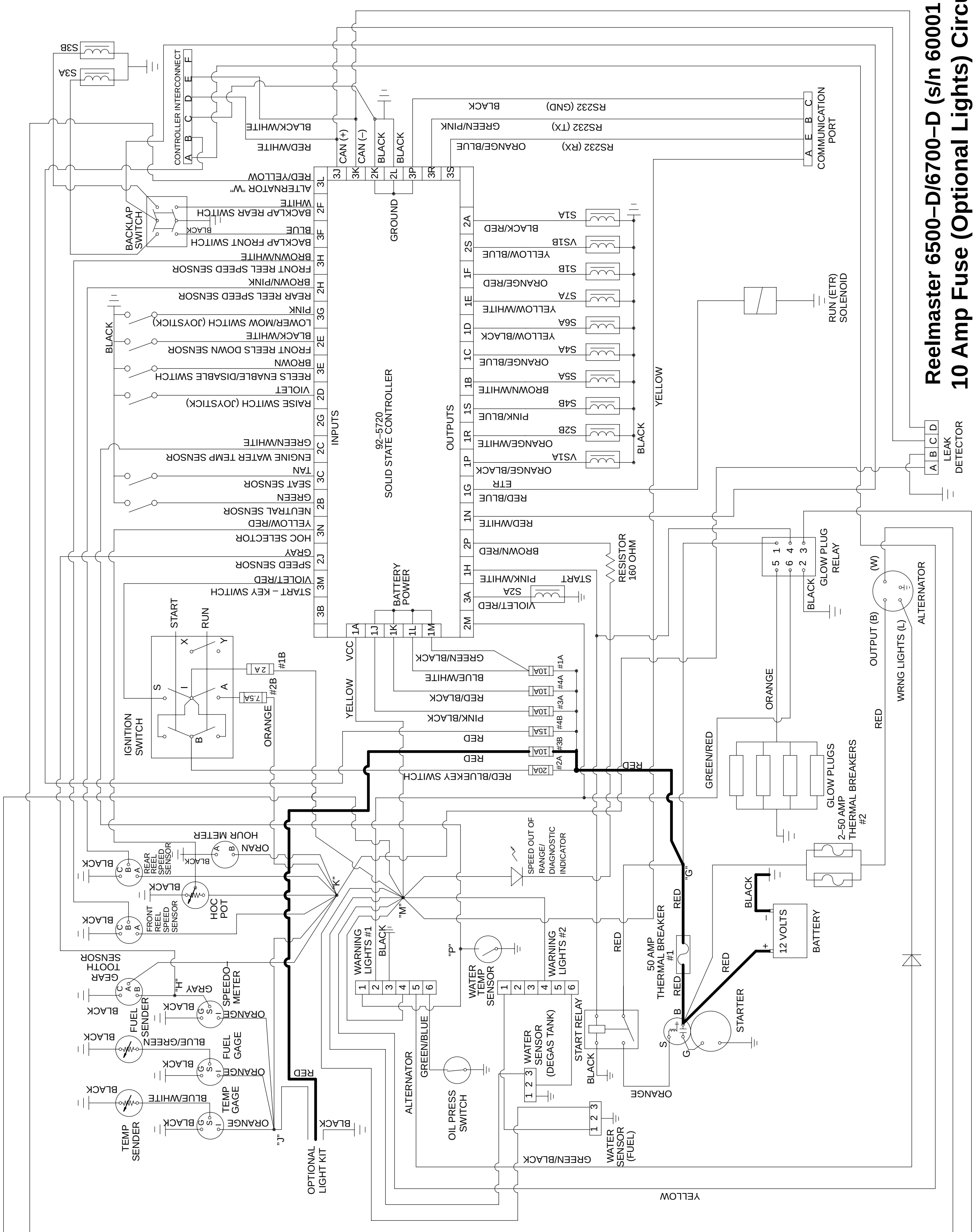
Reelmaster 6500–D/6700–D (s/n 60001 & up)
10 Amp Fuses (Controller 1 Power) Circuits



Reelmaster 6500–D/6700–D (s/n 60001 & up)
Crank, Glow and Alt. Output Circuits

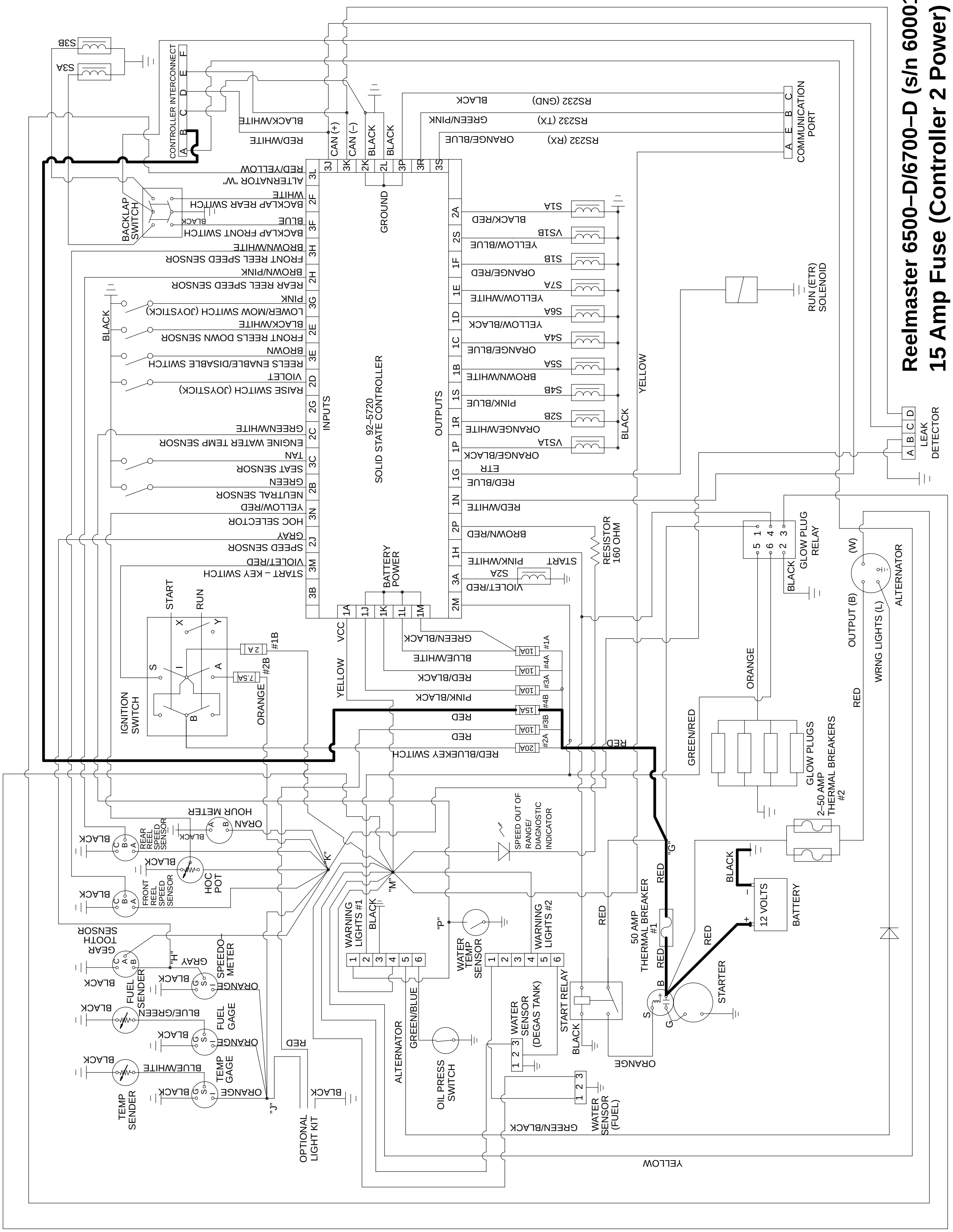


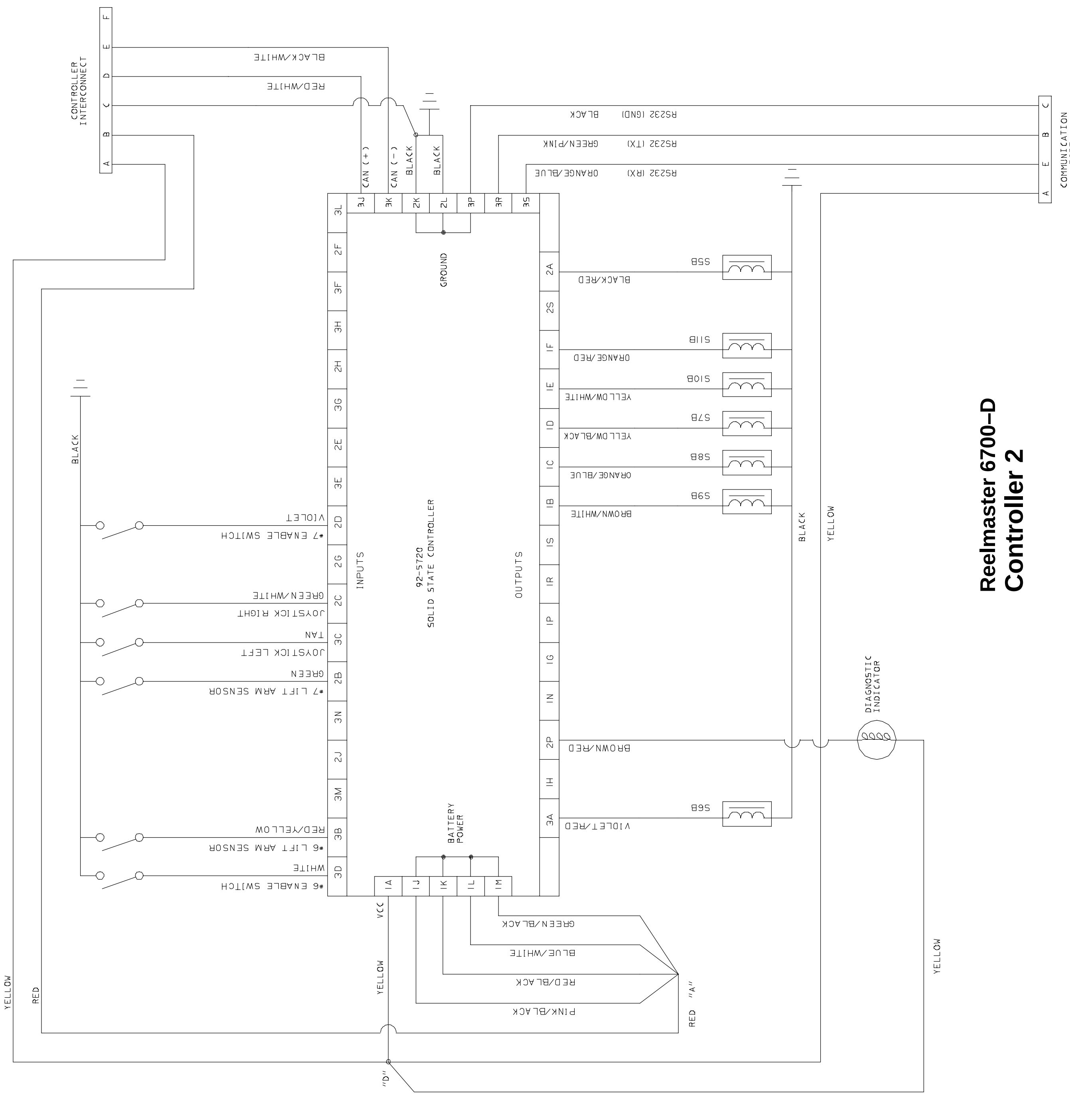
Reelmaster 6500–D/6700–D (s/n 60001 & up) 10 Amp Fuse (Optional Lights) Circuit



Electrical System

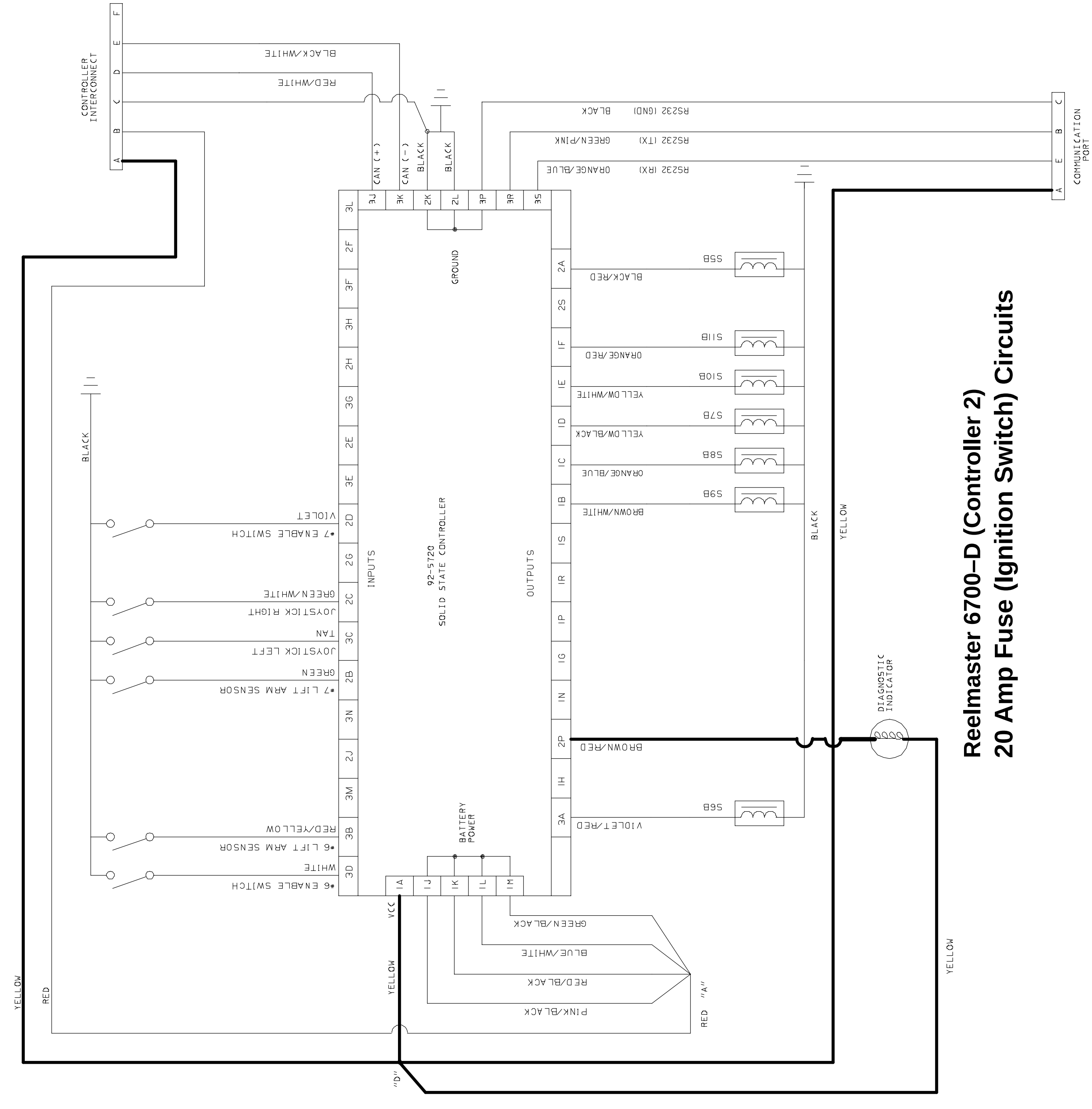
Reelmaster 6500–D/6700–D (s/n 60001 & up)
15 Amp Fuse (Controller 2 Power) Circuits





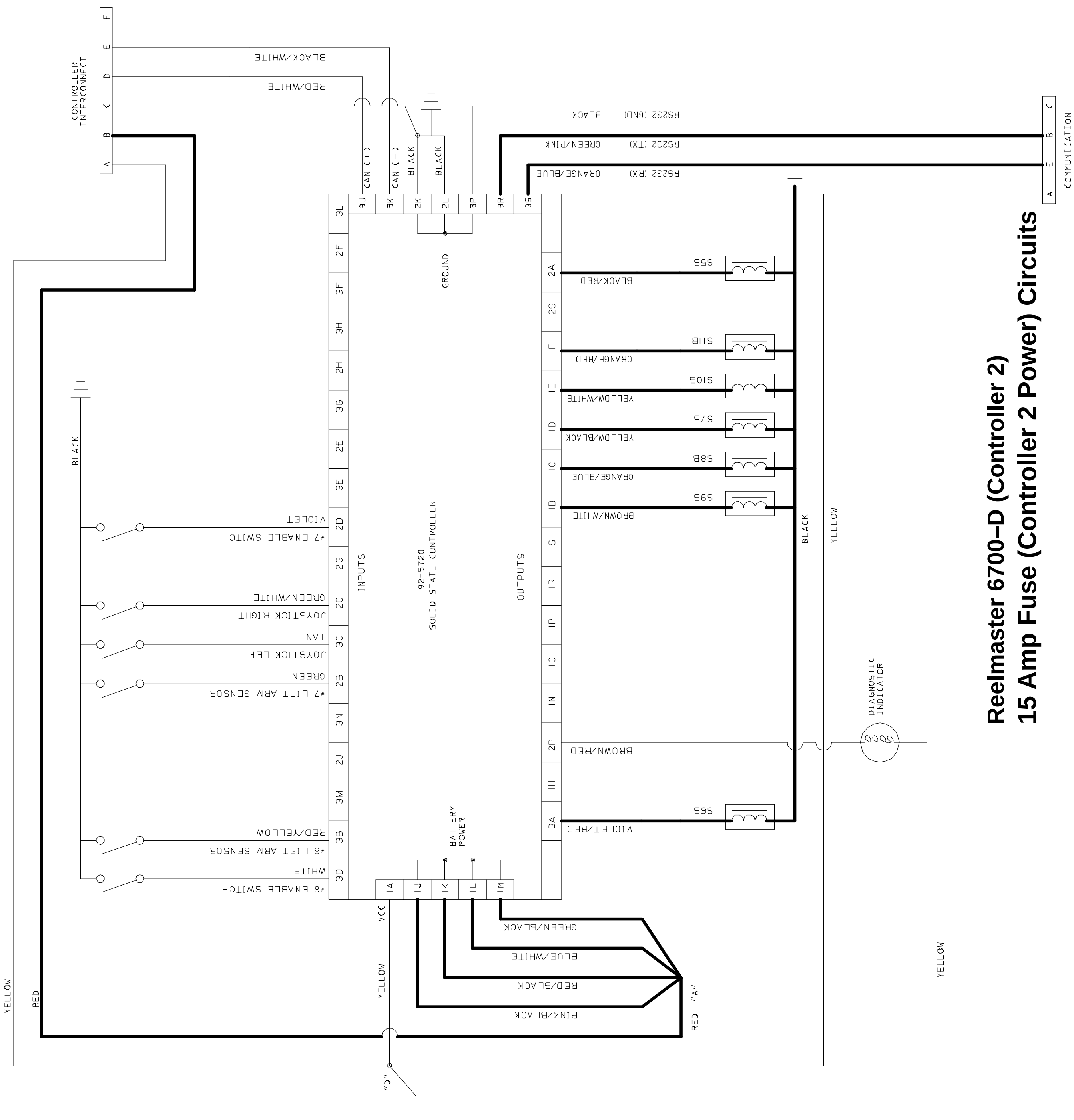
Reelmaster 6700–D
Controller 2

Electrical System

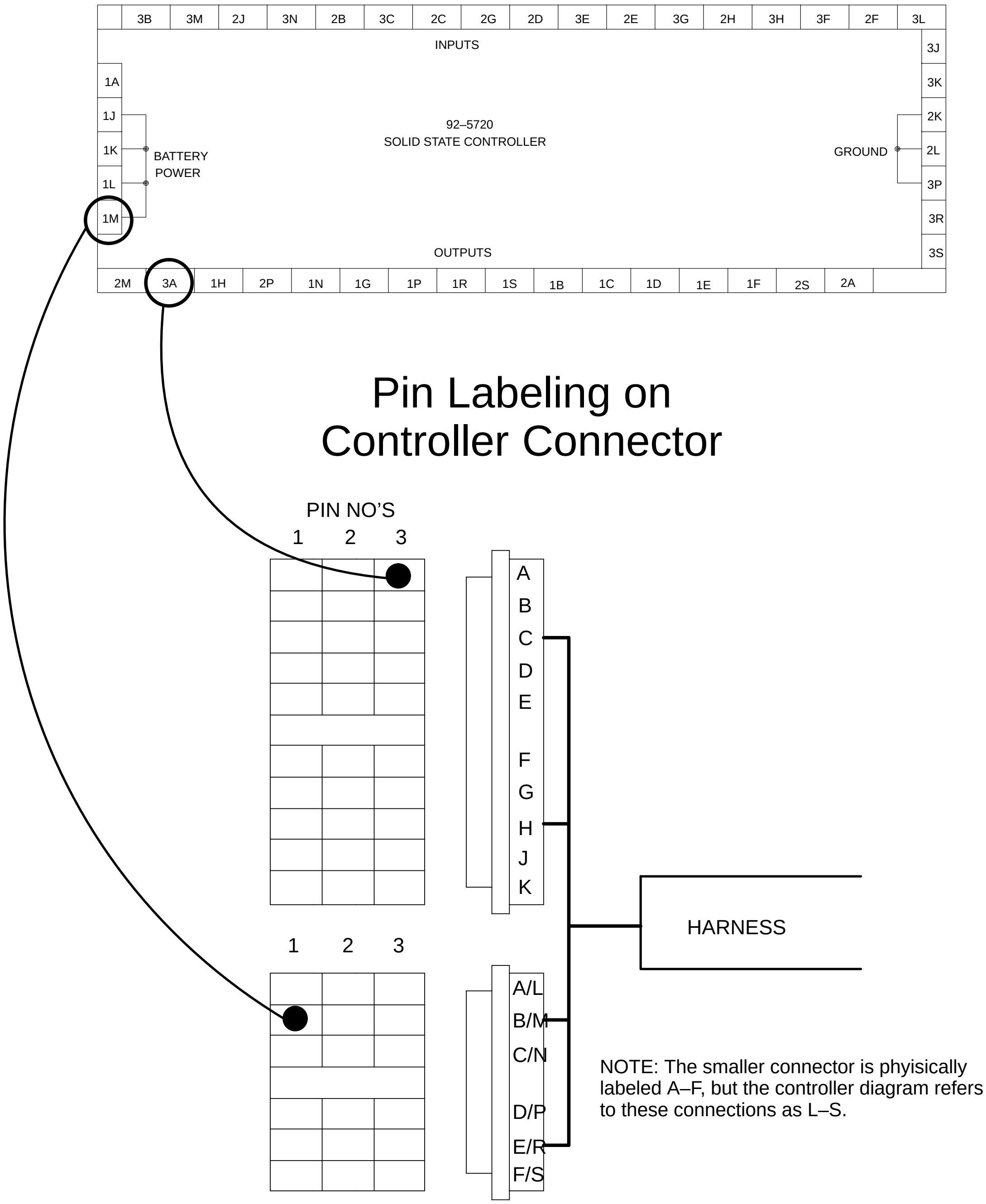


Reelmaster 6700–D (Controller 2)
20 Amp Fuse (Ignition Switch) Circuits

Reelmaster 6700–D (Controller 2)
15 Amp Fuse (Controller 2 Power) Circuits



Main Wire Harness Connector Diagram



Special Tools

Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*.

Some tools may be listed in the Parts Catalog for the Reelmaster 6500–D or 6700–D. Some tools may also be available from a local supplier.

Digital Multimeter

The meter can test electrical components and circuits for current, resistance, or voltage drop.

NOTE: Toro recommends the use of a DIGITAL mutlimeter when testing electrical circuits. The high impedance (internal resistance) of a digital meter will ensure that excess current is not allowed through the meter. Excess current can cause damage to a circuit that is not designed to carry it.

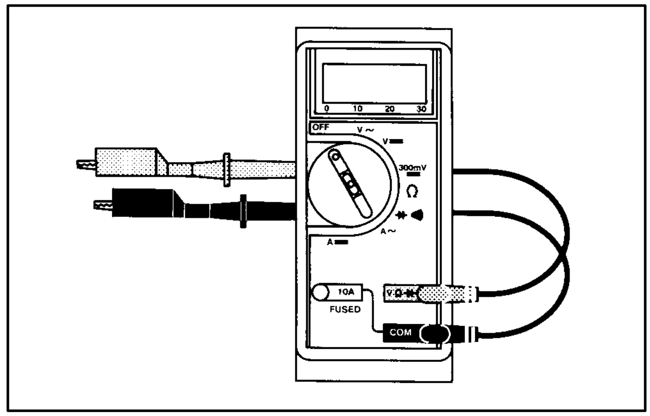


Figure 1

Inductive Ammeter (AC/DC Current Transducer – Hall Effect)

Use this tool, connected to a Digital multimeter for doing current draw tests. This tool can be useful when checking glow plug and starter circuits.

Skin–Over Grease

Special non–conductive grease which forms a light protective skin to help waterproof electrical switches and contacts.

Toro P/N **505–47** 8 oz. (.24 L) can

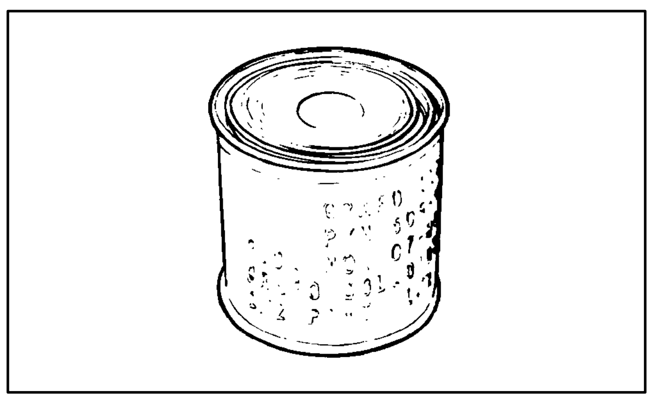


Figure 2

Toro Autotomated Control Electronics™ Diagnostic Tools

Diagnostic ACE™ Display

The diagnostic display (Fig. 3) is connected to the wiring harness connector located inside the R.H. console to help the user verfiy correct electrical functions of the machine.

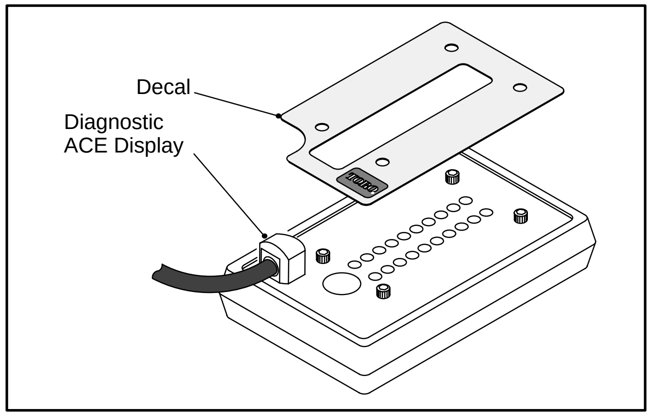


Figure 3

Data Log™ System

The data log system controller is connected to the wiring harness connector near the electronic control unit (ECU). This device can record machine data while it is in operation to help your Toro Distributor diagnose intermittent problems.

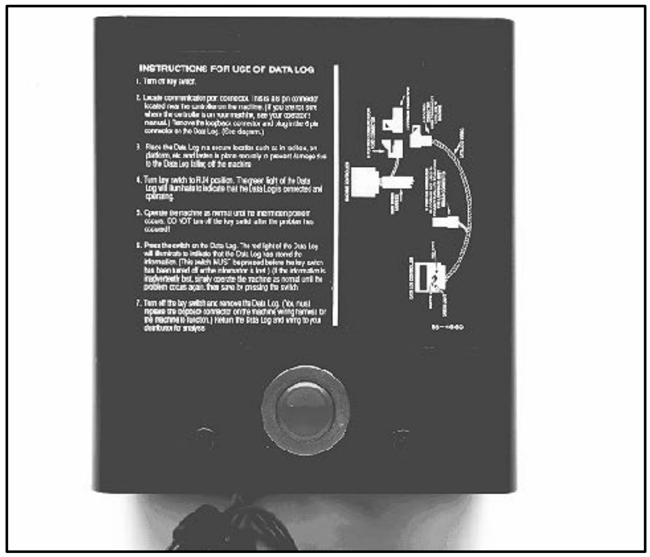


Figure 4

Troubleshooting

For all electrical problems, use of the Quick Reference Troubleshooting guide is recommended. Using the Diagnostic ACE Display allows you to quickly find the source of the electrical problem.

If the machine has any interlock switches by–passed, they must be reconnected for proper troubleshooting and safety.

Quick Reference Troubleshooting Guide (Reelmaster 6500–D)

Diagnostic Light (Reelmaster 6500–D)

The RM 6500–D and 6700–D is equipped with a diagnostic light which indicates if the electronic controller is functioning correctly. The diagnostic light is located on the steering tower panel. When the electronic controller is functioning correctly and the key switch is moved to the ON position, the controller diagnostic light will be illuminated for approximately 6 seconds. The light will not illuminate if the controller detects a malfunction in the electrical system.

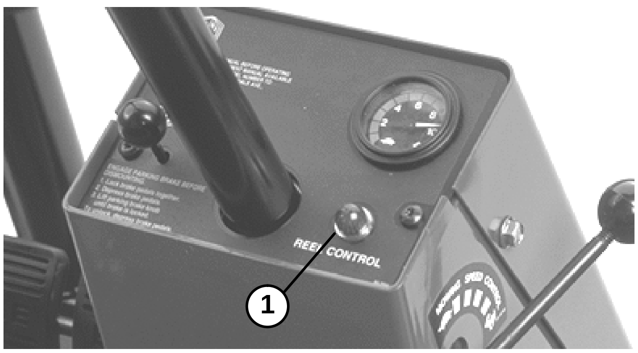


Figure 5

1. Electronic Controller Light

If the diagnostic light is not illuminated when the key switch is in the ON position, this indicates that the electronic controller is not operating. Possible causes are:

1. Loopback connector (under control panel cover) is not connected.
2. The electronic controller light is burned out.
3. Fuses are blown.
4. Not functioning correctly.

Check electrical connections, input fuses and diagnostic light bulb to determine malfunction. Make sure loopback connector is secured to wire harness connector.

Diagnostic ACE Display

The RM 6500–D is equipped with an electronic controller which controls most machine functions. The controller determines what function is required for various input switches (i.e. seat switch, key switch, etc.) and turns on the outputs to actuate solenoids or relays for the requested machine function.

For the electronic controller to control the machine as desired, each of the input switches, output solenoids and relays must be connected and functioning properly.

The Diagnostic ACE display is a tool to help the user verify correct electrical functions of the machine.

Checking Interlock Switches

The purpose of the interlock switches are to prevent the engine from cranking or starting unless the traction pedal is in NEUTRAL, the Enable / Disable switch is in DISABLE and the Lower Mow / Raise control is in the neutral position. In addition, the engine will stop when the traction pedal is depressed with operator off the seat.

CAUTION

THE INTERLOCK SWITCHES ARE FOR THE PROTECTION OF THE OPERATOR AND BYSTANDERS, AND TO ENSURE CORRECT OPERATION OF THE MACHINE, SO DO NOT BYPASS OR DISCONNECT THEM. CHECK OPERATION OF THE SWITCHES DAILY TO ASSURE INTERLOCK SYSTEM IS OPERATING. IF A SWITCH IS DEFECTIVE, REPLACE IT BEFORE OPERATING. DO NOT RELY ENTIRELY ON SAFETY SWITCHES – USE COMMON SENSE!

To verify interlock switch function:

1. Park machine on a level surface, lower the cutting units, stop the engine and engage the parking brake.

2. Open control panel cover. Locate wire harness and connector. Carefully unplug loopback connector from harness connector.

3. Connect the Diagnostic ACE display connector to the harness connector. Make sure correct overlay decal is positioned on Diagnostic ACE display.

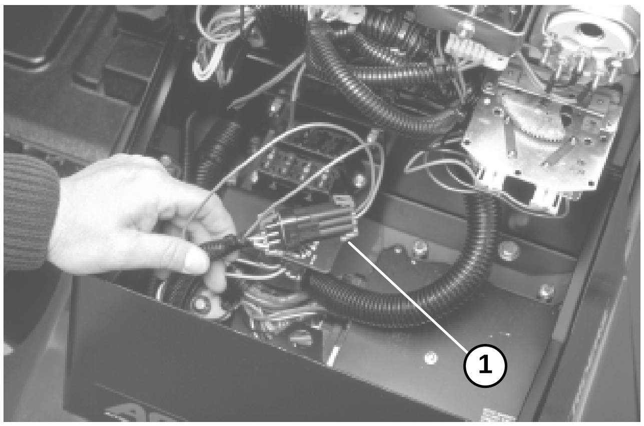


Figure 6

1. Wire Harness and Connectors

4. Turn the key switch to the ON position, but do not start machine.

NOTE: The red text on the overlay decal refers to input switches and the green text refers to outputs.

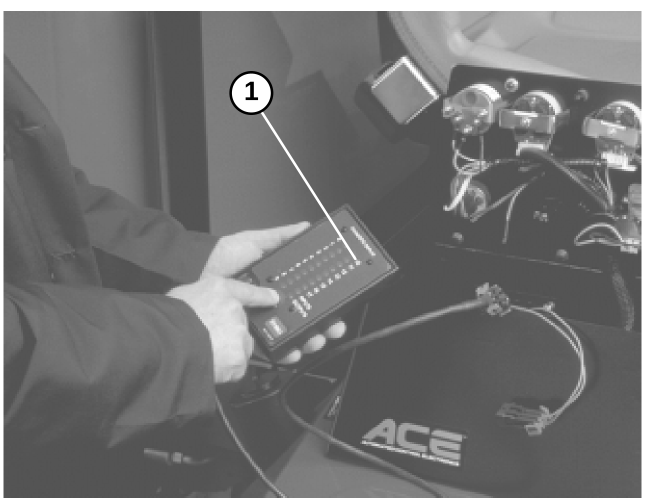


Figure 7

1. Diagnostic ACE

5. The "inputs displayed" LED, on lower right column of the Diagnostic ACE, should be illuminated. If "outputs displayed" LED is illuminated, press and release the toggle button, on Diagnostic ACE, to change LED to "inputs displayed". Do not hold button down.

6. The Diagnostic ACE will illuminate the LED associated with each of the inputs when that input switch is closed. Individually, change each of the switches from open to closed (i.e., sit on seat, engage traction pedal, etc.), and note that the appropriate LED on Diagnostic ACE will blink on and off when corresponding switch is closed. Repeat on each switch that is possible to be changed by hand.

7. If switch is closed and appropriate LED does not turn on, check all wiring and connections to switch and/or check switches with an ohm meter. Replace any defective switches and repair any defective wiring.

The Diagnostic ACE also has the ability to detect which output solenoids or relays are turned on. This is a quick way to determine if a machine malfunction is electrical or hydraulic.

To verify output function:

1. Park machine on a level surface, lower the cutting units, stop the engine and engage the parking brake.

2. Open control panel cover. Locate wire harness and connectors near controller. Carefully unplug loopback connector from harness connector. Set HOC selector knob to position "A".

3. Connect the Diagnostic ACE connector to the harness connector. Make sure correct overlay decal is positioned on Diagnostic ACE.

4. Turn the key switch to the ON position, but do not start machine.

NOTE: The red text on the overlay decal refers to input switches and the green text refers to outputs.

5. The "outputs displayed" LED, on lower right column of Diagnostic ACE, should be illuminated. If "inputs displayed" LED is illuminated, press the toggle button, on Diagnostic ACE, to change LED to "outputs displayed".

NOTE: It may be necessary to toggle between "inputs displayed" and "outputs displayed" several times to do the following step. To toggle back and forth, press toggle button once. This may be done as often as required. DO NOT HOLD BUTTON.

6. Sit on the seat and attempt to operate the desired function of the machine. The appropriate output LED's should illuminate to indicate that the ECU is turning on that function. (Refer to the list on page 21 to be certain of the specified output LED's).

NOTE: If any output LED is blinking, this indicates an electrical problem with that OUTPUT. Repair / replace defective electrical parts immediately. To reset a blinking LED, turn the key switch “OFF”, then back “ON”.

If no output LED’s are blinking, but the correct output LED’s do not illuminate, verify that the required input switches are in the necessary positions to allow that function to occur. Verify correct switch function.

If the output LED’s are on as specified, but the machine does not function properly, this indicates a non–electrical problem. Repair as necessary.

NOTE: Due to electrical system constraints, the output LED’s for “START”, “PREHEAT” and “ETR/ALT” may not blink even though an electrical problem may exist for those functions. If the machine problem appears to be with one of these functions, be certain to check the electrical circuit with a volt / ohm meter to verify that no electrical problem exists to these functions.

If each input switch is in the correct position and functioning correctly, but the output LED’s are not correctly illuminated, this indicates an ECU problem. If this occurs, contact your Toro Distributor for assistance.

IMPORTANT: The Diagnostic ACE display must not be left connected to the machine. It is not designed to withstand the environment of the machine’s every day use. When done using Diagnostic ACE, disconnect it from the machine and reconnect loopback connector to harness connector. Machine will not operate without loopback connector installed on harness. Store Diagnostic ACE in dry, secure location in shop, not on machine.

Quick Reference Troubleshooting Guide (Reelmaster 6700–D)

Diagnostic Lights

The RM 6700–D is equipped with two diagnostic lights which indicate if the electronic controllers are functioning correctly. The diagnostic light for the main (#1) controller is located on the steering tower panel. When the (#1) electronic controller is functioning correctly and the key switch is moved to the ON position, the controller diagnostic light will be illuminated for approximately 6 seconds. The light will not illuminate if the controller detects a malfunction in the electrical system. The diagnostic light for the secondary (#2) controller is located under the control panel, next to the Height–of–Cut selector knob. This green light should illuminate if the controller is functioning properly.

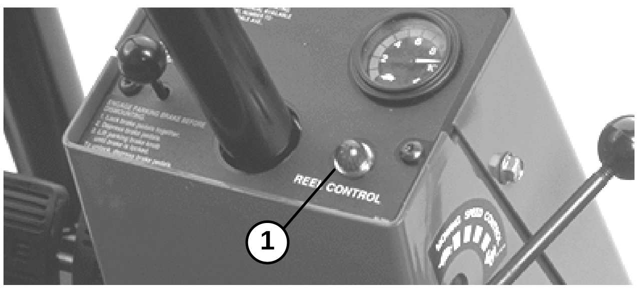


Figure 8
1. (#1) Electronic Controller Light

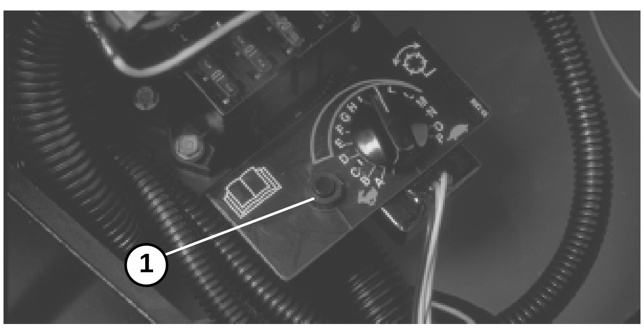


Figure 9
1. (#2) Electronic Controller Light

If the diagnostic light is not illuminated when the key switch is in the ON position, this indicates that the electronic controller is not operating. Possible causes are:

1. Loopback connector (under control panel cover) is not connected.
2. The electronic controller light is burned out.
3. Fuses are blown.
4. Electronic controller not functioning correctly.

Check electrical connections, input fuses and diagnostic light bulb to determine malfunction. Make sure loopback connector is secured to wire harness connector.

Diagnostic ACE Display

The RM 6700–D is equipped with two electronic controllers which control most machine functions. The controllers determine what function is required for various input switches (i.e. seat switch, key switch, etc.) and turns on the outputs to actuate solenoids or relays for the requested machine function.

For the electronic controllers to control the machine as desired, each of the input switches, output solenoids and relays must be connected and functioning properly. Electronic controller #1 controls the functions of the main five cutting units. Electronic controller #2 controls the functions of the two outer rear cutting units (#6 and #7).

The Diagnostic ACE display is a tool to help the user verify correct electrical functions of the machine.

Checking Interlock Switches

The purpose of the interlock switches are to prevent the engine from cranking or starting unless the traction pedal is in NEUTRAL, the Enable/ Disable switches are in DISABLE and the Lower Mow/Raise control is in the neutral position. In addition, the engine will stop when the traction pedal is depressed with operator off the seat.

CAUTION

THE INTERLOCK SWITCHES ARE FOR THE PROTECTION OF THE OPERATOR AND BYSTANDERS, AND TO ENSURE CORRECT OPERATION OF THE MACHINE, SO DO NOT BYPASS OR DISCONNECT THEM. CHECK OPERATION OF THE SWITCHES DAILY TO ASSURE INTERLOCK SYSTEM IS OPERATING. IF A SWITCH IS DEFECTIVE, REPLACE IT BEFORE OPERATING. DO NOT RELY ENTIRELY ON SAFETY SWITCHES – USE COMMON SENSE!

To verify interlock switch function:

1. Park machine on a level surface, lower the cutting units, stop the engine and engage the parking brake.

2. Open control panel cover. Locate wire harness and connectors #1, #2 and leak detector (if equipped). Connectors will have visible labels attached noting #1, #2 and leak detector (hydraulic cylinder symbol). Carefully unplug loopback connectors from harness connectors.

3. Connect the Diagnostic ACE display connectors to the correct harness connectors. Overlay decal #1 must be used on connection #1, overlay decal #2 must be used on connection #2 and leak detector overlay decal must be used on leak detector connection.

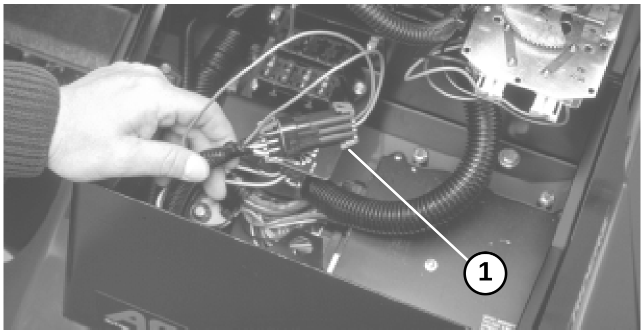


Figure 10
1. Wire Harness and Connectors

4. Turn the key switch to the ON position, but do not start machine.

Note: The red text on the overlay decal refers to input switches and the green text refers to outputs.

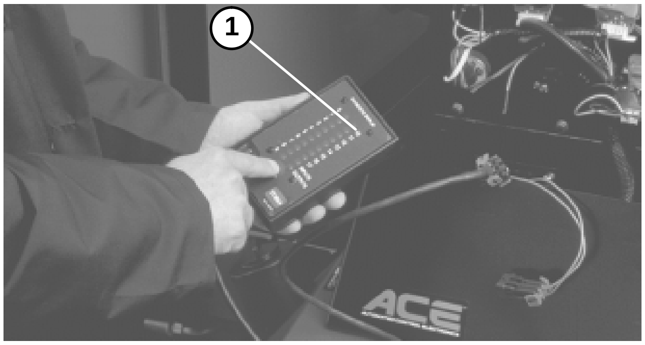


Figure 11
1. Diagnostic ACE

5. The "inputs displayed" LED, on lower right column of the Diagnostic ACE, should be illuminated. If "outputs displayed" LED is illuminated, press and release the toggle button, on Diagnostic ACE, to change LED to "inputs displayed". Do not hold button down.

6. The Diagnostic ACE will illuminate the LED associated with each of the inputs when that input switch is closed.
Individually, change each of the switches from open to closed (i.e., sit on seat, engage traction pedal, etc.), and note that the appropriate LED on Diagnostic ACE will blink on and off when corresponding switch is closed. Repeat on each switch that is possible to be changed by hand.

7. If switch is closed and appropriate LED does not turn on, check all wiring and connections to switch and/or check switches with an ohm meter. Replace any defective switches and repair any defective wiring.

The Diagnostic ACE also has the ability to detect which output solenoids or relays are turned on. This is a quick way to determine if a machine malfunction is electrical or hydraulic.

To verify output function:

1. Park machine on a level surface, lower the cutting units, stop the engine and engage the parking brake.

2. Open control panel cover. Locate wire harness and connectors #1 and #2 (Connectors will have visible labels attached noting #1 and #2). Set HOC selector knob to position "A".

3. Connect the Diagnostic ACE display connectors to the correct harness connectors. Overlay decal #1 must be used on connection #1 and overlay decal #2 must be used on connection #2.

4. Turn the key switch to the ON position, but do not start machine.

Note: The red text on the overlay decal refers to input switches and the green text refers to outputs.

5. The "outputs displayed" LED, on lower right column of Diagnostic ACE, should be illuminated. If "inputs displayed" LED is illuminated, press the toggle button, on Diagnostic ACE, to change LED to "outputs displayed".

Note: It may be necessary to toggle between "inputs displayed" and "outputs displayed" several times to do the following step. To toggle back and forth, press toggle button once. This may be done as often as required. DO NOT HOLD BUTTON.

6. Sit on the seat and attempt to operate the desired function of the machine. The appropriate output LED's should illuminate to indicate that the ECU is turning on that function. (Refer to the list on page 21 to be certain of the specified output LED's.

Note: If any output LED is blinking, this indicates an electrical problem with that OUTPUT. Repair / replace defective electrical parts immediately. To reset a blinking LED, turn the key switch "OFF", then back "ON".

If no output LED's are blinking, but the correct output LED's do not illuminate, verify that the required input switches are in the necessary positions to allow that function to occur. Verify correct switch function.

If the output LED's are on as specified, but the machine does not function properly, this indicates a non–electrical problem. Repair as necessary.

Note: Due to electrical system constraints, the output LED's for "START", "PREHEAT" and "ETR/ALT" may not blink even though an electrical problem may exist for those functions. If the machine problem appears to be with one of these functions, be certain to check the electrical circuit with a volt / ohm meter to verify that no electrical problem exists to these functions.

If each input switch is in the correct position and functioning correctly, but the output LED's are not correctly illuminated, this indicates an ECU problem. If this occurs, contact your Toro Distributor for assistance.

IMPORTANT: The Diagnostic ACE displays must not be left connected to the machine. It is not designed to withstand the environment of the machine's every day use. When done using Diagnostic ACE, disconnect them from the machine and reconnect loopback connectors to harness connectors. Machine will not operate without loopback connectors installed on harnesss. Store Diagnostic ACE in dry, secure location in shop, not on machine.

Fault Memory and Retrieval

If the Controller senses a **fault** on one of the **output solenoids**, it will flash the machines diagnostic Lamp (Reel Control lamp or green Diagnostic lamp under console) and store the fault into the Controllers (ECU) memory. The fault can then be retrieved and viewed with the Diagnostic ACE hand held tool or a lap top/PC at anytime. The Controller will store one (1) fault at a time and will not store another different fault until the first fault is cleared.

Retrieving Stored Faults

1. Rotate ignition key to **Off** position.
2. Connect the Hand held Diagnostic Tool to the desired Controller Loopback Connector (use the proper overlay).
3. Move the Joystick to the **Raise** position and hold.
4. Rotate ignition key to **On** position, and continue to hold the Joystick in **Raise** position until the top left Diagnostic Tool light comes on (approx. 2 seconds).
5. Release the Joystick to the center position.
6. Hand held Tool will now playback the fault retained in the Controller memory.

IMPORTANT: The display will show eight (8) individual records with the fault displayed on the 8th record. Each record will be displayed for 10 seconds. **Be sure to have the Diagnostic Tool display on Outputs** to see fault. The Problem circuit will be flashing. Records will repeat until key is turned off. Unit will not start in this mode.

Clearing the Fault Memory
(Diagnostic Tool not required)

1. Rotate ignition key to **Off** position.
2. Turn Backlap Switch to the **Front** or **Rear** Backlap position.
3. Turn the Reel Control Switch to **Enable** position.
4. Move the Joystick to the **Raise** position and hold.
5. Turn the ignition key to **On**, and continue to hold the Joystick in the **Raise** position until the Reel Control Lamp starts to flash (approx. 2 seconds).
6. Release the Joystick and turn the Key **Off**. **Memory is now cleared.**
7. Turn the Backlap Switch to **Off** and Enable Switch to **Disable** position.

Leak Detector Operation

The TurfDefender™ is an electronic hydraulic fluid leak detection device that fits inside the hydraulic tank of your machine. It is a pressure based system which requires a sealed hydraulic tank to function properly. Very small changes to the oil level in the sealed tank result in a large movement of the leak detector's internal float. The TurfDefender's internal microprocessor analyzes the float movement and determines if there is a leak in the system.

- Turn ignition key to "ON" position start the system. The system will reset itself whenever the ignition key is moved to "OFF" position. Wait 5 seconds, then move key to "ON" position to restart the system.
- When machine is started, the alarm will give one short beep to indicate that everything is operating properly. If the alarm makes no noise at all, it should be checked by a mechanic.
- If the alarm gives 4 short beeps it means a system problem has been detected and it should be checked by a mechanic. The 4 beep pattern will continue for approximately 1–1/2 minutes, then stop, unless the ignition key is moved to "OFF" position.

Note: The low or high oil level 4 beep signal may occur if machine is started on a slope. Move machine to a level surface, move ignition key to "OFF" position, wait 5 seconds, then move key to "ON" position to restart the system.

- If the alarm gives long continuous beeps while mowing and shuts off the cutting units, it means that a leak has been detected. On the Reelmaster traction unit, the red light on the steering console will also blink indicating the Reelmaster ECU has shut off the cutting unit's.

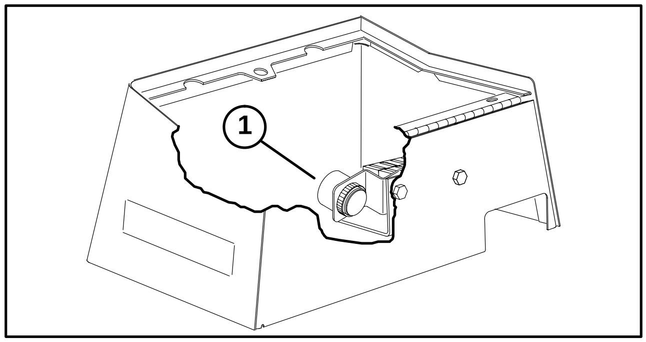


Figure 11a
1. Alarm

Checking Leak Detector Operation

The operation of the TurfDefender™ should be checked if any of the following conditions occur:

Note: The hand held Diagnostic ACE can be used to identify many of the problems.

a. No beeps are heard when ignition switch is turned "ON".

b. Any time the machine gives a series of 4 short beeps.

Note: The Diagnostic ACE may have to be connected before shutting off the ignition key in order to identify the problem.

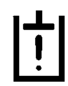
WARNING

To identify some problems, engine may have to be running. To guard against possible personal injury, engage parking brake and keep hands, feet, face and other parts of the body away from moving parts.

c. False alarms are observed.

1. Park machine on a level surface and engage the parking brake.

2. Open control panel cover. Locate leak detector harness loopback connector with hydraulic symbol tag. Carefully unplug loopback connector from harness connector.



3. Connect the Diagnostic ACE display connector to the correct harness loopback connector. Install TurfDefender overlay decal (supplied with leak detector kit) onto Diagnostic ACE .

4. The ignition key switch must be turned to the "ON" position.

Note: Red text on the overlay decal refers to inputs and green text refers to outputs.

5. The red "Inputs displayed" LED (Light Emitting Diode), on lower right column of the Diagnostic ACE, should be illuminated. If green "Outputs displayed" LED is illuminated, press and release the toggle button, on

Electrical System

Diagnostic ACE, to change LED to “Inputs displayed”. Do not hold button down.

If TurfDefender is functioning normally:

1. When the “Inputs displayed” LED is lit, the actual Float position (1 or 2 LED’s on left row) and “Oil level OK” LED – should be displayed.

2. Press toggle button until green “Outputs displayed” LED is lit. “Valve ON”, “data line” and ”self diagnostic”LED’s should be lit steadily. “Alarm ON” LED may be displayed temporarily (about 5 seconds).

Note: If “data line” or ”self diagnostic” LED’s are blinking, there is a problem in the system.

If No beeps are heard:

1. Check alarm wires to make sure they are not disconnected, broken or “+” and “–” reversed.

2. Make sure TurfDefender 4–pin connector is plugged in.

3. Make sure TurfDefender 5 amp fuse (fuse block “B”, slot #3) is not blown.

4. Toggle “outputs displayed” on Diagnostic ACE display.

- Alarm open circuit (LED blinking): Check / replace TurfDefender alarm or wires.
- Alarm short circuit (LED blinking): Check / replace TurfDefender alarm or wires.

If 4 beeps are heard:

The most common cause for a 4 beep signal is from an improper oil level reading. Make sure machine is on a level surface when checking oil level. Since oil level will vary with temperature, it is best to check when cool.

1. When toggling “input”, a LED should display any of the following problems diagnosed by the TurfDefender:

- Oil level low: Position machine on a level surface and fill to proper level.
- Oil level high: Position machine on a level surface and remove excess oil until proper level is attained.
- Oil too hot: Allow machine to cool and clean any debris from oil cooler.
- Air leak in system: Assure tank cap is tight or check for leak in tank.

Note: Only large air leaks can be detected by hand held Diagnostic ACE. A leak down test is required to identify small air leaks. Consult your Authorized Toro Distributor for assistance.

2. When toggling “output” a LED should display any of the following problems diagnosed by the TurfDefender:

- Valve open circuit (LED blinking): Check / replace TurfDefender electric solenoid valve or wires.
- Valve short circuit (LED blinking): Check / replace TurfDefender electric solenoid valve or wires.
- Self diagnostic LED Blinking: Internal circuit failure in TurfDefender. Consult your Authorized Toro Distributor for assistance.
- Data Line LED Blinking: Problem with communications between machine and leak detector; or problem with wires. Consult your Authorized Toro Distributor for assistance.

Note: If machine must be operable with leak detector disabled, unplug leak detector 4–pin connector from 4–pin connector of main harness. Do not unplug leak detector alarm.

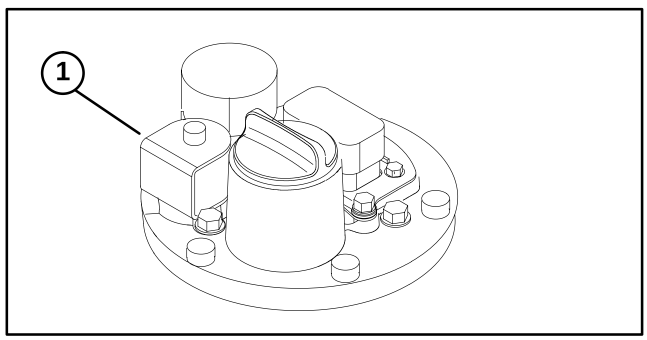


Figure 11b
1. Electric solenoid valve

If false alarms are observed:

1. Oil level may be low causing air to be drawn out of system. Check oil level.

2. Extremely hard left turns can cause oil to slosh to the right, exposing suction line and purging air out of system. Normal maneuvering should not cause this condition.

3. Air leak in system. Check to make sure cap is securely on tank. Contact your local authorized Toro Distributor for further assistance with air leak problem.

4. To check for a system problem, install hand held Diagnostic ACE, toggle input/output and check for any problems previously discussed.

Note: The system will reset itself whenever the ignition key is turned to “OFF” position. The hand held Diagnostic ACE must be connected and observed during a false alarm. Once the ignition key is turned to “OFF” position, the TurfDefender will reset itself.

5. Your Authorized Toro Distributor has equipment to analyze system problems. Sometimes a “false leak detect” can occur when the TurfDefender erroneously concludes that a hydraulic leak has occurred. The TurfDefender continually monitors several independent functions to determine if an oil leak is occurring. These functions are influenced by various external factors such as ambient temperature, variations between machines, and machine operating practices. Machine operation in cool ambient temperatures (below 50^{o} F) and/or short pass cross–cutting practices may trigger potential false alarms. If “false leak detects” are suspected, your Toro Distributor can adjust the calibration between the Turfdefender and tractor Controller (ECU).

IMPORTANT: The Diagnostic ACE displays must not be left connected to the machine. It is not designed to withstand the environment of the machine’s every day use. When done using Diagnostic ACE, disconnect them from the machine and reconnect loopback connectors to harness connectors. Machine will not operate without loopback connectors installed on harnesss. Store Diagnostic ACE in dry, secure location in shop, not on machine.

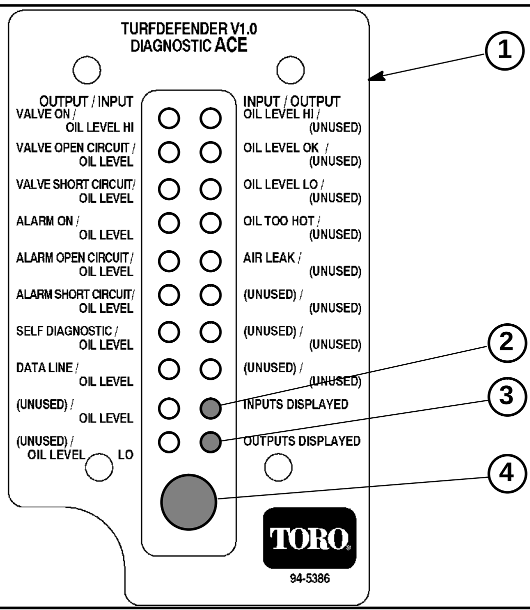


Figure 11c

Diagnostic ACE Display Functions

1. Overlay decal (English shown)
2. "Inputs Displayed" LED (Red)
3. "Outputs Displayed" LED (Green)
4. Toggle button

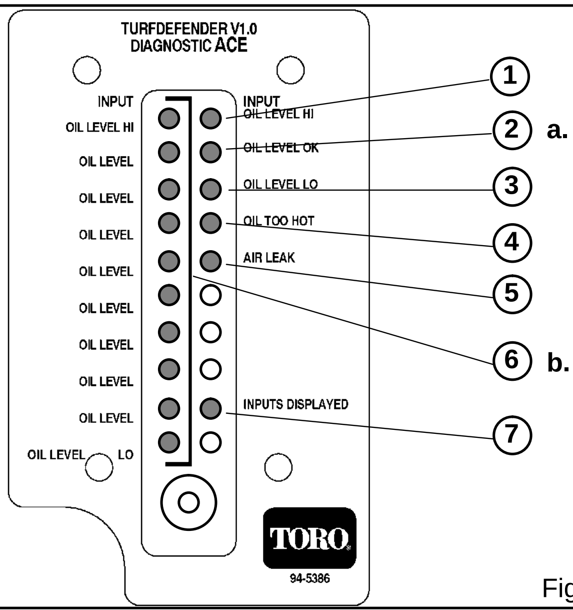


Figure 11d

Using "Inputs Displayed" (Red Text)

1. LED lit if oil level is too high
2. LED lit if oil level is OK
3. LED lit if oil level is too low
4. LED lit if oil is too hot
5. LED lit if system air leak has been detected
6. One or two LED's lit displaying relative position of the Turfdefender's internal float.
7. "Inputs Displayed" LED "ON" (Red)

Normal Operation:

a. "Oil Level OK" LED lit
b. 1 or 2 LED's lit on left column

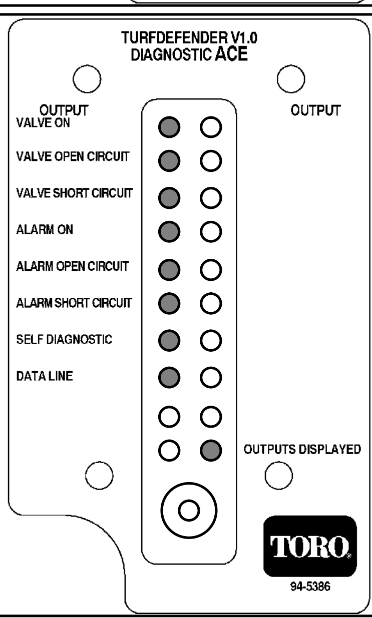


Figure 11e

Using "Outputs Displayed" (Green Text)

Normal Operation:

a. "Valve ON" LED lit steadily
b. "Self Diagnostic" LED lit steadily
c. "DATA LINE" LED lit steadily
d. "Alarm ON" LED lit temporarily

Problem Diagnosed:

The appropriate LED will blink to identify the problem

Turf Defender Troubleshooting Guide

The following is a quick guide to the most common problems likely to be encountered. The hand–held Diagnostic ACE is helpful for identifying specific problems

4–beep faults are occurring:

Oil level is incorrect	Check tank dipstick on a level surface
Machine started on a slope (oil level error)	Try again on a level surface, add oil as required
TurfDefender or ECU loopback unplugged	Reconnect
Solenoid valve unplugged	Reconnect
Hydraulic tank cap is loose	Tighten

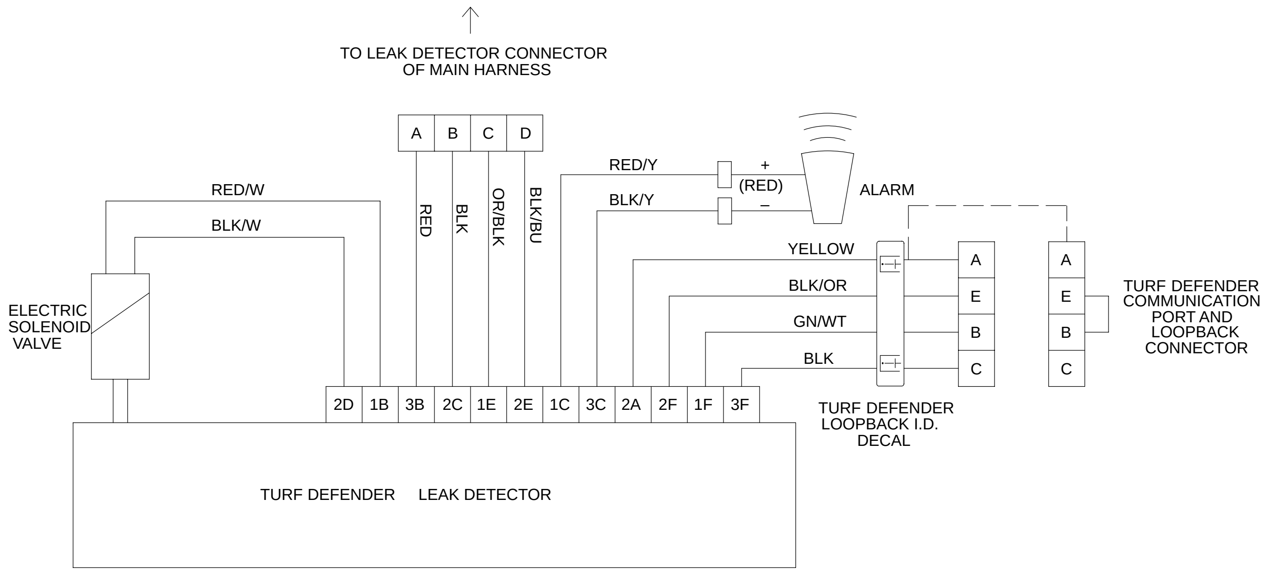
False–alarms (continuous beeps but no leak) are occurring:

Hydraulic tank cap is loose	Tighten
Operator is making severe left turns	Slow down while turning
Oil level is near the “ADD” mark	Add oil to “FULL” mark
Operator jiggles traction while waiting	Leave pedal in Neutral while waiting
Solenoid valve not sealing	Check if loose; replace if defective

No beep occurs at start–up:

Alarm wires are reversed or disconnected	Connect red to “+”, black to “–”
TurfDefender 4–pin connector is unplugged	Reconnect
TurfDefender fuse is blown	Replace

Electrical Schematic–Leak Detector



This page is blank.

Understanding the Controllers

Controller #1 (Primary)
Functions:
- Main controller for both the RM6500 and RM6700.
- Contains primary logic program.
- Manages all functions of machine safety, sequencing of cutting units and clip control.
- "Supervisor" for the RM6700 controller #2.
- Connected to other controller and/or leak detector by the CAN bus (communication lines between devices).

Fault Identification / Operator Warning:
- Flashing reel control lamp (red) on steering tower.

Diagnostics:
- Do troubleshooting by connecting one of the following devices to the loopback connector:
  – Diagnostic ACE (with the correct overlay).
  – TOROPC and a personal computer.
  – Data Log.

Controller #2 (Secondary) – RM6700–D Only
Functions:
- Manages the functions of #6 and #7 cutting units ONLY.
- Needs approval from controller #1 before executing an operator request.
- Same part number as controller #1, but requires a different software program (on TOROPC disk).
- Connected to other controller and/or leak detector by the CAN bus.

Fault Identification / Operator Warning:
- Flashing reel control lamp (red) on steering tower **and/or** diagnostic lamp (green) under control console.

Diagnostics:
- Do troubleshooting by connecting one of the following devices to the loopback connector:
  – Diagnostic ACE (with the correct overlay).
  – TOROPC and a personal computer.
  – Data Log.

Turf Defender Leak Detector
Functions:
- Warns operator of hydraulic leak with an audible alarm.
- Internal temperature sensor detects if oil is too hot and compensates for oil cool down.
- Drop in retrofit for most existing machines.

Fault Identification / Operator Warning:
- Alerts operator to several potential problems with audible "beeps" and/or by cutting unit shut down.

Diagnostics:
- Do troubleshooting by connecting one of the following devices to the loopback connector:
  – Diagnostic ACE (with the correct overlay).
  – TOROPC and a personal computer.

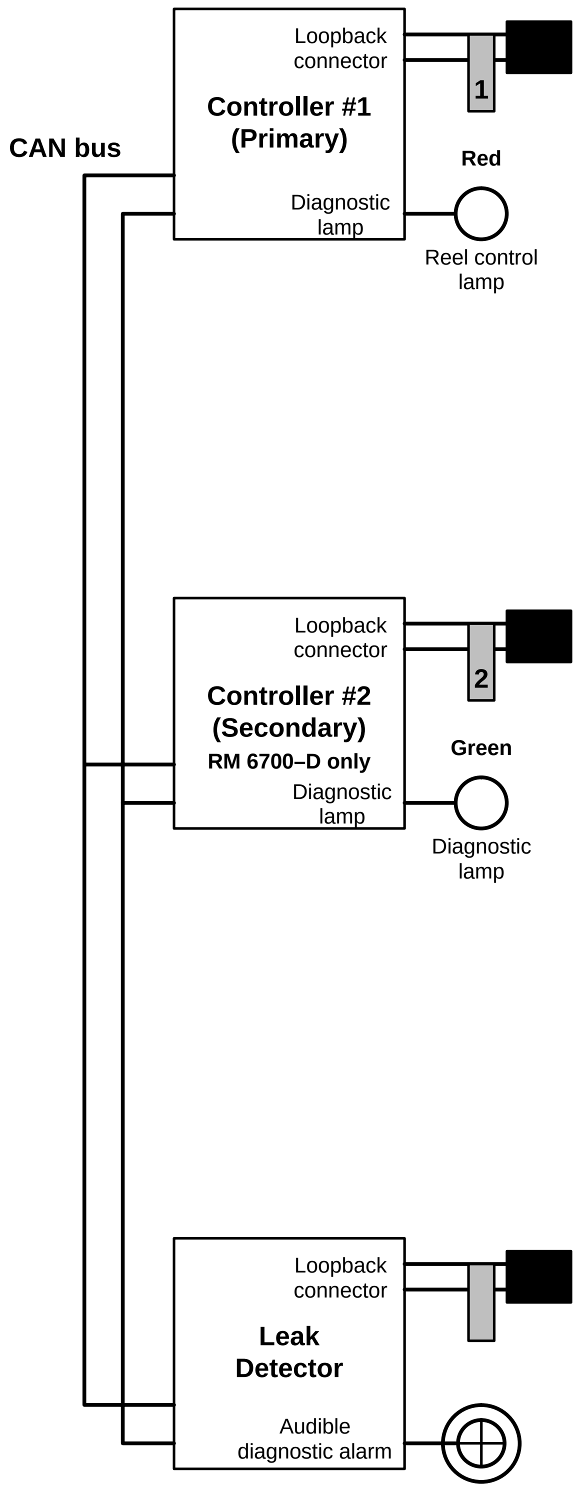


Figure 12

Understanding the Diagnostic Lamps

Controller #1 (Primary) Fault Identification / Operator Warning

The reel control lamp (red) on the steering tower will stay ON with no flashing if:

1. The glow plugs are on.
2. Operator mowing too slow or too fast for proper ClipAce control.
3. Defective reel speed sensor (reels engaged).
4. Defective traction unit speed sensor (reels engaged – cannot sense ground speed).

The reel control lamp (red) on the steering tower will flash ON and OFF if:

1. Number of reel blades is not programmed at set–up (reels will backlap but not run forward).
2. Programmed speed limit (LIMITMPH) has been exceeded (reels will also shut off).
3. Controller senses an OUTPUT fault (open or shorted condition) with controller #1 or controller #2 (RM6700 only – see next section).
4. Controller shut down reels during backlap (Controller sensed a reel speed of less than 50 RPM).

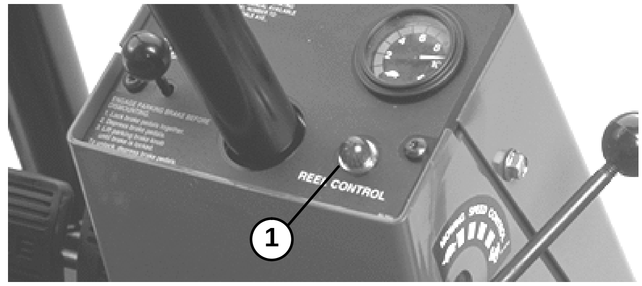


Figure 13
1. Reel control lamp (Controller #1)

Controller #2 (Secondary) Fault Identification / Operator Warning (RM6700–D only)

The diagnostic lamp (green) under the control console will stay steady if:

1. Controller #2 program is successfully loaded (from #1) and read to operate (all O.K.).

A flashing reel control lamp (red) on steering tower AND a flashing diagnostic lamp (green) under control console indicates:

1. Controller #2 senses an OUTPUT fault (open or shorted condition).

NO reel control lamp (red) on steering tower AND a flashing diagnostic lamp (green) under control console indicates:

1. Program fault with controller #1.
2. Possible fault with the CAN bus (wiring problem – no communication between controllers).

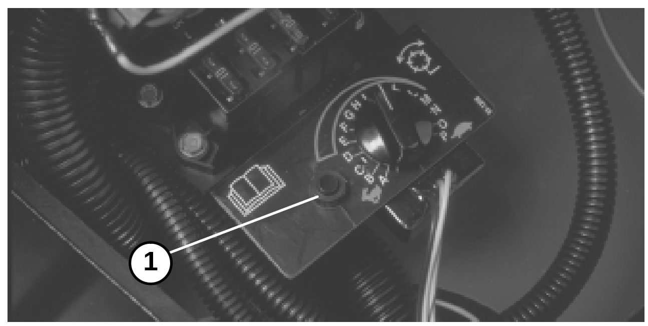


Figure 14
1. (#2) Electronic Controller Light

Turf Defender Leak Detector

The audible alarm indicates:

1. ONE short beep at start–up. Detector has completed internal test and is operating properly.
2. FOUR short beeps. Detector is indicating a problem such as:
   – Low oil.
   – Air leak.
   – Internal problem.
   – Oil overheat.
3. LONG beeps and reels shut off. Leak has been detected.

Starting Problems

All Electrical and Gauges Are Dead

Cause	Correction
Low battery charge.	Charge battery. Replace battery if it will not hold a charge.
Thermal circuit breaker No. 1 open.	Find cause for open circuit breaker and correct. Circuit breaker will reset automatically after it has cooled.
Key switch fuse open.	Check fuse and replace if fuse is open. If fuses burn out often, find and correct cause. NOTE: If auxiliary lights are added, this fuse must be replaced with a 15A fuse.
Faulty key switch wiring.	Repair wiring.
Faulty key switch.	Test key switch and replace if necessary.

Starter Solenoid Clicks, But Start Will Not Crank

Cause	Correction
Low battery charge.	Charge battery. Replace battery if it will not hold a charge.
Loose or corroded battery cables. Loose or correded 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 solenoid.

Nothing Happens When Start Attempt is Made

Cause	Correction
Faulty ignition (key) switch or wiring.	Test switch and replace if faulty. Correct wiring problem if necessary.
Traction neutral switch circuit open	Check traction control linkage and adjust or repair.
Short circuit or open circuit between controller and start relay.	Check wiring and repair if necessary.
Start relay fault.	Test relay and replace if necessary.
Wiring between start relay and starter faulty.	Check wiring and repair if necessary.
Start solenoid faulty.	Test start solenoid and replace if necessary.

Engine Starts, But Dies When Ignition Switch Is Released From Start Position

Cause	Correction
Run solenoid faulty.	Replace run solenoid.
Run solenoid wiring faulty.	Repair wiring.
Faulty high engine water temperature shut–down switch (engine not overheated) or wiring.	Check switch and wiring and replace or repair if necessary.

Starter Cranks But Engine Will Not Start

Cause	Correction
Engine not cranking fast enough.	Check battery and cable connections. Charge battery. Replace battery if it won't hold accept a charge. Repair wiring if necessary.
Run solenoid faulty.	Replace run solenoid.
Problem is not electrical.	See Troubleshooting section of Chapter 3 – Engine.

Starter Cranks, But Should Not When Traction Pedal Is Depressed

Cause	Correction
Traction neutral switch circuit closed.	Check traction neutral switch adjustment and adjust if faulty. Test traction neutral switch and replace if faulty. Check traction neutral switch wiring and repair if faulty.

General Run and Transport Problems

Engine Continues To Run, But Should Not, When Ignition Key Is Off

Cause	Correction
Engine fuel lever or run solenoid stuck in “on” position.	Check operation of run solenoid and adjust or replace if necessary. Make sure fuel stop lever moves without sticking and repair if necessary.
Ignition switch faulty.	Replace ignition switch.

Engine Continues To Run, But Should Not, When Traction Pedal Is Engaged With No Operator On Seat

Cause	Correction
Seat switch circuit is closed.	Check seat plate hinges and seat support pin and repair if faulty. Check for water soaked seat cushion. Test seat switch and replace if faulty. Check seat switch wiring and repair if faulty.
Traction neutral switch circuit closed.	Check traction neutral switch adjustment and adjust if faulty. Test traction neutral switch and replace if faulty. Check traction neutral switch wiring and repair if faulty.

Engine Kills During Operation, But Restarts

Cause	Correction
Seat switch circuit open.	Instruct operator to sit back in seat during operation. Operate machine slower when operating in rough terrain. Check seat plate hinges and seat support pin and repair if faulty Test seat switch and replace if faulty. Check seat switch wiring and repair if faulty.
Engine overheated.	

Engine Kills When Traction Pedal Is Depressed

Cause	Correction
Seat lifting off seat switch.	Instruct operator to sit back in seat during operation. Check seat plate hinges and seat support pin and repair if faulty
Seat switch circuit open.	Test seat switch and replace if faulty. Check seat switch wiring and repair if faulty.

Battery Does Not Charge

Cause	Correction
Alternator belt slipping.	Adjust belt tension.
Faulty wiring.	Check and repair wiring.
Malfunctioning alternator.	Repair or replace alternator.
Faulty battery.	Replace battery.

Cutting Unit Operation Problems

See Quick Reference Troubleshooting Guide in this section and Troubleshooting section of Chapter 4 – Hydraulic System.

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 60° to 100° F. The ignition key should be off and all accessories turned off. Connect the positive (+) Volt meter lead to the positive battery post and the negative (–) Voltmeter lead the the negative battery post.

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
12.6 V (or higher)	Fully charged (100%)
12.4 V	75% charged
12.2 V	50% charged
12.0 V	25% charged

NOTE: Regulated voltage will increase to approximately 13.5 Volts when the engine is running.

Charging System Test

This is a simple test used to determine if a Charging system is functioning. It will tell you if the charging system has an output, but not how much (amps) or what it is capable of.

Tool required: Digital Multimeter – DC volts setting.

Test instructions: Connect the positive (+) multimeter test lead on the positive Battery Post, and negative (–) lead on the negative Battery Post. Leave test leads connected and start engine and run at 2000 RPM minimum. Test results should be:

At least 1 volt over Open Circuit test results.	
Example: Open Circuit Test results	= 12.5v
Charging System Test results	= 13.5v
Difference	= +1.0 v

Voltage Drop Testing

This is a simple test that should be used to locate excess resistance in an electrical circuit.

Tool required: Digital Multimeter – DC volts setting.

Test instructions: Connect the positive (+) multimeter test lead to the power side (or most positive) of the component, circuit or connection. Connect the negative (–) multimeter test lead to the ground side (or least positive) of the component, circuit or connection. Turn on the circuit to be tested and read the voltage. Remember – when performing voltage drop tests the circuit must be complete and activated to locate the resistance!

Voltage Drop Specifications (Maximums)

High Amperage Circuits (>20 A.)	Low Amperage Circuits (<20 A.)
.4 volt feed side	.2 volt feed side
.4 volt ground side	.2 volt ground side

Glow Plug System Test

This is a fast, simple test that can help you determine a Glow Plug system's integrity and operation. The test should be run anytime hard starting (cold) is encountered on a diesel engine equipped with a Glow system. Remember – there are 2 types of Glow Plug systems that Toro uses:

1. Systems with resistors (Glow Plug Indicators) in series (Reelmaster 450/4500–D, Groundsmaster 325–D, etc.)

2. Systems without resistors (**Reelmaster 6500–D/ 6700–D**, Reelmaster 3500–D, Groundsmaster 455–D, Reelmaster 5100/5300–D, etc.)

Tool(s) required: Digital Multimeter and/or inductive Ammeter (AC/DC Current Transducer).

Test instructions: Properly connect inductive Ammeter to the multimeter (refer to manufacturer's instructions). Set multimeter on Volts scale. With the key off (or Glow Switch in off position), place the inductive Ammeter around the main glow plug power supply wire(s) and read meter prior to activating Glow system. Adjust Meter to read zero (if applicable). Cycle the Glow Plug system at least two times (per instructions in Operator's Manual) and record the final results.

Typical specifications for systems without resistors:

# of Glow Plugs	Amps Draw (10%)
2	20 Amps
3	30 Amps
4	40 Amps
Individual Glow Plug resistance (all models) – .3–.4 Ohms (cold)	

Starting System Test

This is an excellent test to use when a "slow crank/no start" problem is encountered. It will tell you if the problem is due to an electrical open, short or high resistance in the starter circuit.

NOTE: The Battery condition and state of charge must checked before testing the starter system.

Tool(s) required: Digital Multimeter and/or Inductive Ammeter (AC/DC Current Transducer).

Test instructions: Properly connect inductive Ammeter to the multimeter (refer to manufacturers instructions). Set multimeter on Volts scale. With the key off place the inductive Ammeter around the main negative (–) Battery Cable and read meter prior to activating the Starter system. Adjust Meter to read zero (if applicable). Crank the engine for at least 3 seconds and record the results. Typical Starter System Draw for the Reelmaster 6500–D and 6700–D is **230 Amps at 65°F**.

If current draw is significantly higher than listed – check for shorted condition. If current draw is significantly lower than listed – check for high resistance.

Component Identification and Testing

For all electrical problems, use of the Quick Reference Troubleshooting guide is recommended. Using the Diagnostic ACE Display allows you to quickly find the source of the electrical problem.

This section will define given components, and the tests that can be performed on those components, when those parts are disconnected from the electrical system.

For accurate resistance and/or continuity checks, electrically disconnect the component being tested from the circuit (e.g. unplug the clutch 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

The ignition (key) switch has three positions (OFF, START and RUN). The terminals are marked as shown. The circuitry of the ignition switch is shown in the chart. With the use of a continuity tester, the switch functions may be tested to determine whether all circuits are being completed while the key is moved to each position.

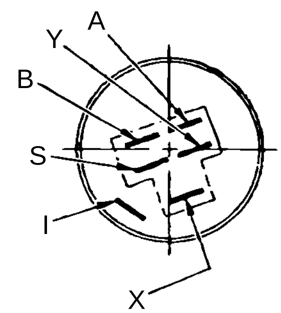


Figure 15

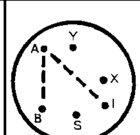
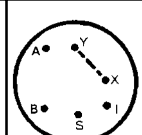
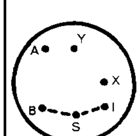
POSITION	CONTINUITY AMONG TERMINALS	OTHER CIRCUITS MADE
1. OFF	NONE	NONE
2. RUN	 B+A+I	 X+Y
3. START	 B+S+I	NONE

Figure 16

Electronic Control Unit (ECU)

The Toro electronic control unit (ECU) senses the condition of various switches, such as the seat switch, cutting unit down switches, traction neutral switch, etc., and directs power output to allow certain machine functions, such as engine run, cutting units engage, etc.

Because of the solid state circuitry built into the controller, there is no method to test it directly. The controller may be damaged if an attempt is made to test it with an electrical test device, such as a volt–ohm meter.

IMPORTANT: Before welding on the machine, disconnect both battery cables from the battery, disconnect both wire harness connectors from the electronic control unit and disconnect the terminal connector from the alternator to prevent damage to the electrical system.

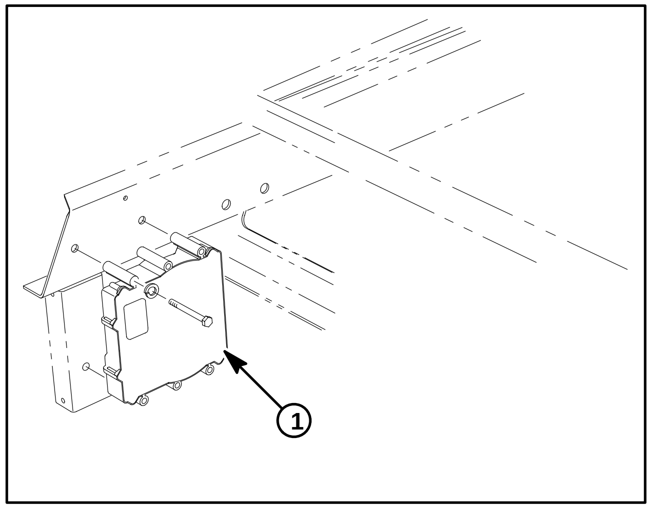


Figure 17

1. Electronic Control Unit
(Located behind access panel below seat)

Seat Switch

The seat switch is a proximity type, normally open (NO) reed switch that closes when the operator is on the seat. With the operator on the seat, the magnet on the bottom of the seat activates the reed switch causing it to close and complete the circuit.

1. Raise the seat to get access to the seat switch wiring connector.

2. Disconnect the seat switch wiring connector and install a continuity tester or ohm meter between the two leads of the seat switch.

3. Lower the seat. The continuity tester should show no continuity.

NOTE: Make sure the compression spring holds the seat up off the seat switch when there is no operator on the seat.

4. Have the operator sit on the seat, slowly depressing the seat switch magnet. The continuity tester should show continuity as the seat approaches the bottom of its travel.

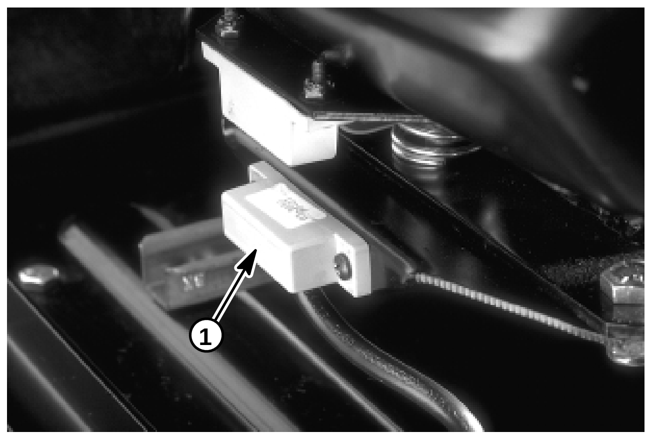


Figure 18

1. Seat switch

Traction Neutral Switch

The traction switch is normally closed and opens when traction pedal is depressed in either direction. The switch is located on the right side of the hydrostatic transmission.

Test the switch by disconnecting the wires from the switch terminals and connecting a continuity tester across the two terminals that had wires connected to them. With the engine turned off, slowly push the traction pedal in a forward and reverse direction while watching the continuity tester. There should be indications that the traction switch is opening and closing. Allow the traction pedal to return to neutral. There should be continuity across the terminals. (See Replacing the Traction Switch in the Repairs section of this chapter for replacement and adjustment procedures.)

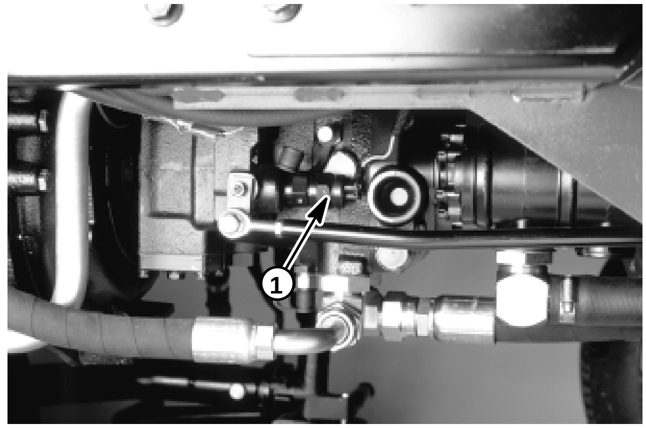


Figure 19

1. Traction (neutral) switch

Cutting Unit Down Sensor(s)

The cutting unit down switch is a normally open (NO) reed switch located on the left front lift arm that closes when the lift arm is in the lowered position. As the lift arm is lowered a magnet in the lift arm causes the reed switch to close and complete the circuit.

NOTE: The Reelmaster 6700–D also has sensors on each rear outboard lift arm (for #6 and #7 cutting units).

1. Disconnect the switch wire connector and install a continuity tester or ohm meter between the two leads of the switch.

2. With the lift arm in the lowered position the tester should show continuity. With the lift arm in the raised position, the tester should show no continuity.

NOTE: When the Enable/Disable switch is in the ENABLE position, the controller uses inputs from this switch to turn the cutting units on and off. When raising the cutting units with the Enable/Disable switch in ENABLE, the cutting units lift part way to a “turn around” position.

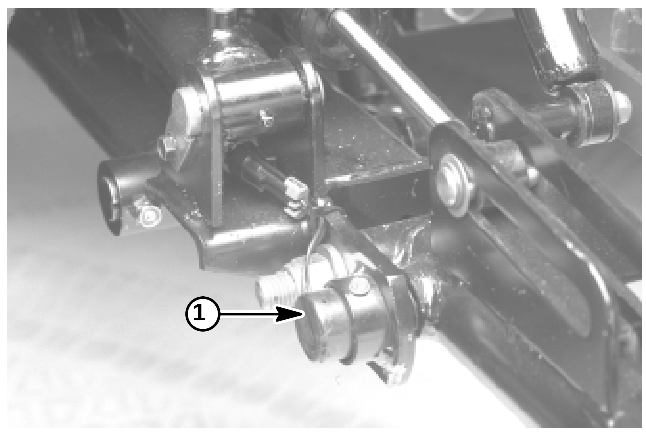


Figure 20

1. Cutting unit down switch

Lower–Mow/Raise Switches (Joystick)

Each switch is normally open and closes when the joystick is moved.

Test each switch by disconnecting the wiring connector from the switch and connecting a continuity tester across the two terminals of the switch being tested.

Testing

With the engine turned off, move the joystick, then allow it to return to neutral while watching the continuity tester. There should be indications that the switch is opening and closing. With the joystick in the neutral position there should be no continuity across the terminals.

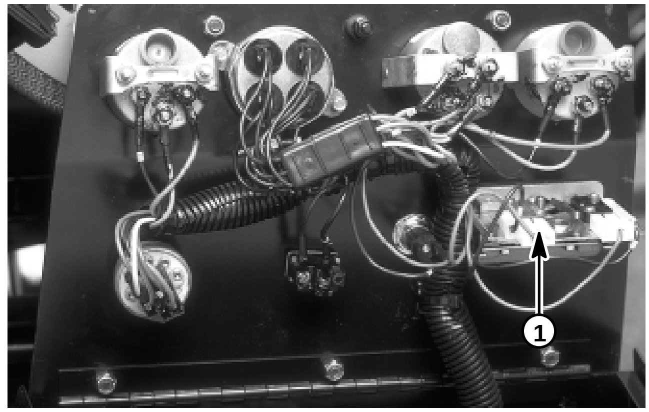


Figure 21
(Reelmaster 6500–D shown)

1. Joystick with switches

Enable/Disable Switch(es)

Test the Enable/Disable switch by disconnecting the wires from the switch and connecting a continuity tester across the terminals of the switch.

With the switch in the DISABLE position, the tester should show no continuity. With the switch in the ENABLE position, the tester should show continuity.

NOTE: The Reelmaster 6700–D has three (3) switches.

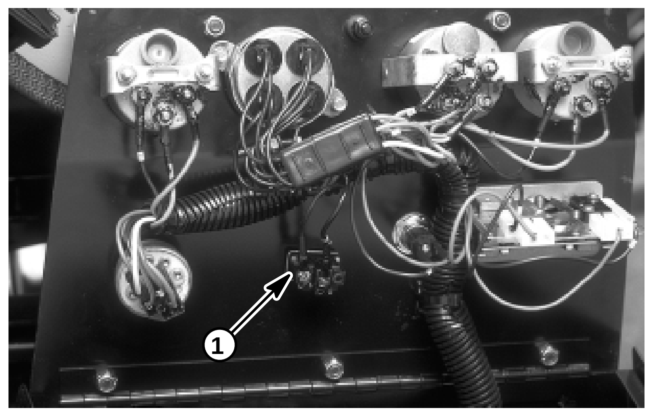


Figure 22
(Reelmaster 6500–D shown)

1. Enable/Disable switch

Backlap Switch

The Backlap switch is a three–way switch. Test the switch by disconnecting the wires and connecting a continuity tester across terminals of switch.

With the switch OFF, the tester should show no continuity across terminals 4 – 5 or 5 – 6.

With the switch in the FRONT position (toward keyway), tester should show continuity across terminals 4 and 5.

With the switch in the REAR position (away from keyway), tester should show continuity across terminals 5 and 6.

Terminals on switch	Wire color
1	(Not used)
2	(Not used)
3	(Not used)
4	Blue
5	Black
6	White

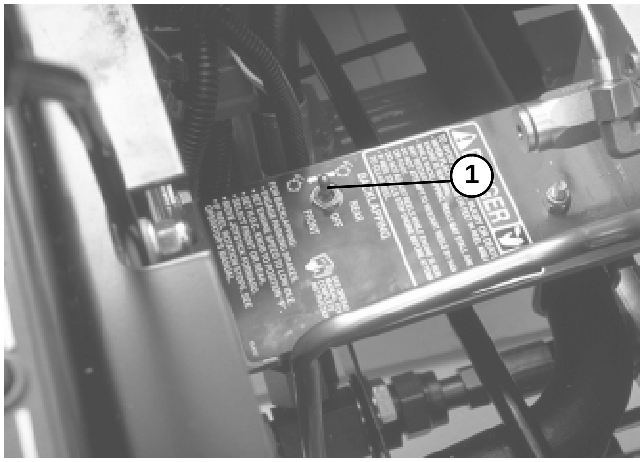


Figure 23

1. Backlap switch

Start Relay

To test the relay, 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.

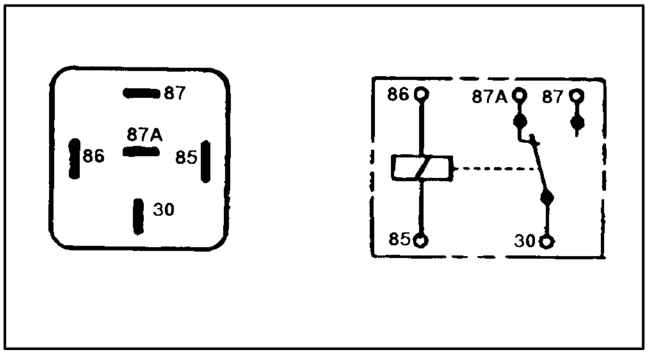


Figure 24

Electrical System

Glow Relay and Glow Plugs

1. Attach an amp meter to glow plug circuit. Turn ignition switch to ON. Meter may have an initial reading as high as 100 amps.

A. If amp meter shows a reading for 5 to 12 seconds, the glow relay is operating. If there is no reading, go to step 2.

B. Turn ignition switch OFF, then ON again. A reading of 48 amps should be observed. Go to step 3.

2. To test the circuit.

A. Check with a test light at buss bar connection for glow plugs at cylinder head. Turn the ignition switch ON. If the light glows, power is being supplied from glow relay. If light does not glow check wiring or relay.

B. Check relay with a test light connected at terminal #5 on relay (glow plugs connection). Turn ignition switch ON. If the light glows, the power relay is working. If the light does not glow, check for power to relay by moving to terminal #1 (power from battery). If the light glows, check for power from ignition switch by moving to terminal #3.

3. Glow plug test:

A. Warm up the glow plugs by cycling the glow system two times, then check for total draw of all four (4) glow plugs:

if draw is 48 amps all four (4) are OK.
if draw is 36 amps, then one (1) is faulty.
if draw is 24 amps, then two (2) are faulty.
if draw is 12 amps, then three (3) are faulty.
if draw is 0 amps, then all are faulty.
if draw is more than 48 amps (60 to 100 amps) there is a short in one or more of the glow plugs (see Glow Plugs in Testing section of Chapter 3 – Engine.)

NOTE: The glow relay has a built in temperature sensor and timer. Battery voltage is always available at terminal #1. When voltage is sensed at terminal #3 (ignition switch turned to ON) power is directed to terminals #5 (glow plugs) and #6 (glow indicator light). At 68°F (20°C) the glow indicator light will turn off after 5 seconds, then the glow plugs will turn off after 12 seconds. At 32°F (0°C) the glow indicator light will turn off after 10 seconds, then the glow plugs will turn off after 18 seconds.

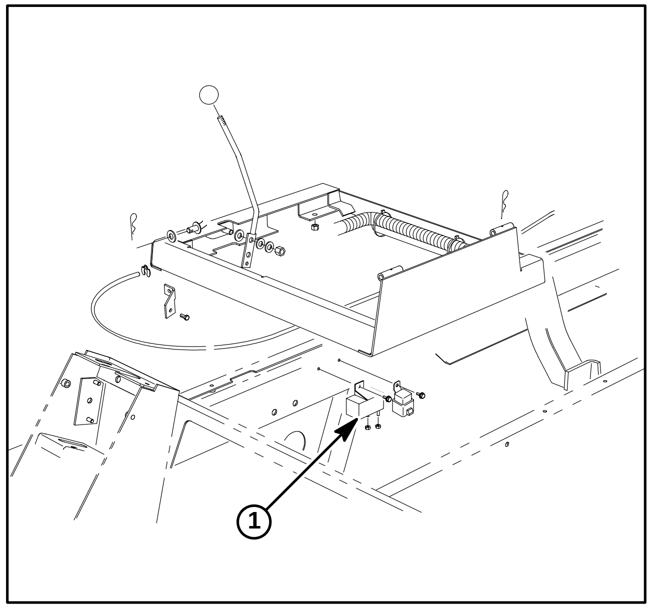


Figure 25

1. Glow relay

Fuel Stop (ETR) Solenoid

This engine has an energize-to-run (ETR) fuel stop solenoid. The solenoid will stop injector pump fuel delivery with any electrical failure in the RUN circuit.

1. Disconnect the wire from the solenoid.

2. Remove the solenoid from the injector pump.

3. Connect a 12 volt battery so that a wire from positive (+) battery terminal is connected to switch terminal. Touch a wire from the negative (–) battery terminal to solenoid body. The plunger should retract.

NOTE: You can also test operation without removing the solenoid from the injector pump. Listen for an audible “click” as the solenoid extends and retracts while doing step 3 of the above procedure. This will not show if the solenoid is fully extending and retracting.

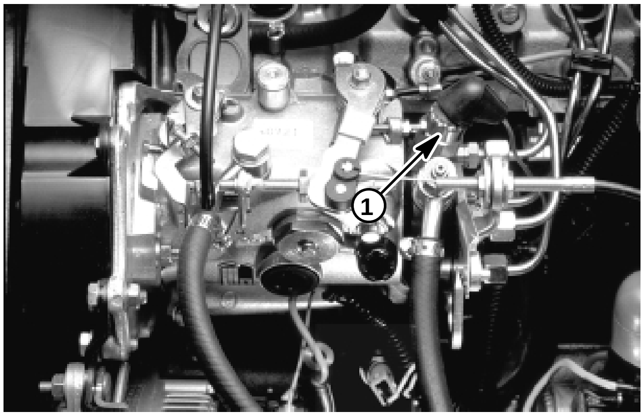


Figure 26

1. Fuel stop (ETR) solenoid

Engine Oil Pressure Switch

The switch is normally closed (NC) and opens with pressure.

The switch opens at approximately 8 psi.

1. Turn ignition key switch ON. Oil pressure lamp should be on.

If lamp is not on:

1. Disconnect wire from switch and touch wire to a good ground, such as the engine block.

2. If lamp comes on, replace switch.

3. If lamp does not come on check wiring between lamp and switch for continuity.

If lamp is on with engine running:

1. Shut off engine immediately.

2. Check switch by disconnecting wire 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 for 30 psi minimum at 1500 rpm. If engine pressure is good, replace switch. If engine pressure is low, DO NOT operate the engine.

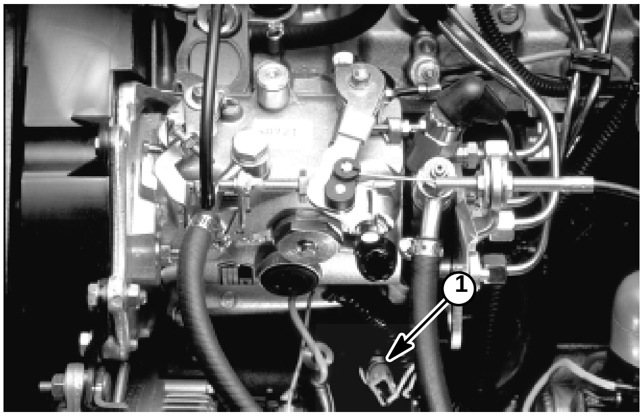


Figure 27

1. Engine oil pressure switch

Indicator Lights and Gauges

Reel Control and Diagnostic Lamps

See **Quick Reference Troubleshooting Guide** in Troubleshooting section for explanation of diagnostic functions.

The REEL CONTROL lamp should come ON when the cutting units are operating with the machine not moving. When the light is ON, it indicates that the machine is being operated in a way in which the automatic reel speed control cannot obtain the desired clip.

Test the lamps by disconnecting the wires and applying 12 V.D.C. between the lamp wiring terminals.

Oil Pressure Light

Oil pressure lamp should come on when the ignition key switch is in the RUN position with the engine not running or if the oil pressure switch closes during operation – oil pressure below 7 psi (0.5 kg/cm^2).

Test the lamp by grounding the wire that is connected to the oil pressure switch. The light should come on when the wire is grounded (with the key switch on and engine not running).

Charge Light

The charge light should come on when the ignition key switch is in the RUN position with the engine not running or if the charging circuit is not operating properly during operation.

Glow Light

The glow light should be on when the ignition switch is in the ON position. The glow system runs off of a timer relay.

Temperature Light

The temperature light should come on only if the high temperature shut–down switch has stopped the engine – coolant temperature above 225° F (108°C).

Test the lamp by grounding the wire that is connected to the high temperature shut–down switch. The light should come on when the wire is grounded.

Water in Fuel Light

Indicates water in fuel system. Switch is located on fuel filter/water separator.

Lower Water Level Light

Indicates coolant level is low. Switch is located on degassing tank.

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.

Temperature Gauge, Fuel Level Gauge and Speedometer

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.

Fuel Gauge Sender

Disconnect wire and remove the fuel gauge sender from the fuel tank.

Install an ohm meter between the terminal and base.

With arm completely down (empty position), resistance should be 240–260 ohms.

With arm completely up (full position), resistance should be 29–34 ohms.

NOTE: Bend float arm, if necessary, to get proper gauge reading for a 1/2 full tank.

CAUTION

Make sure the sending unit is completely dry (no fuel on it) before testing. Perform test away from fuel tank to prevent an explosion or fire from sparks.

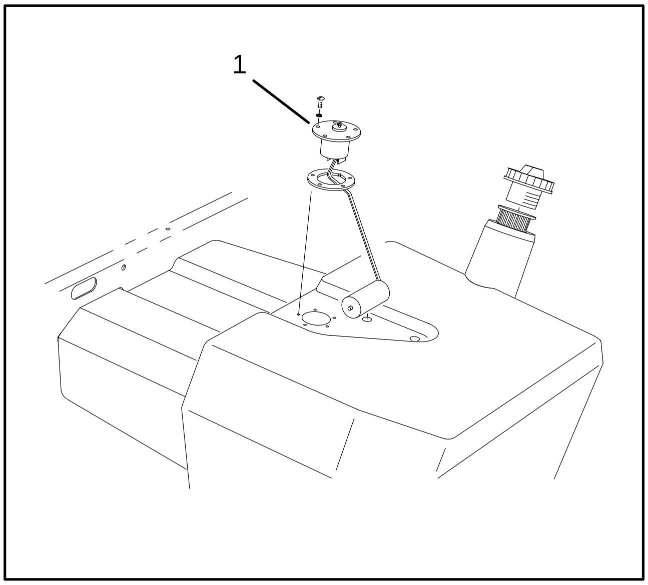


Figure 28

1. Fuel gauge sender

Valve Block Solenoids

1. Disconnect the wire connector.

2. Connect a 12 volt battery so the positive (+) battery terminal is connected to colored solenoid lead. Connect the negative (–) battery terminal to black lead. The valve spool should retract completely as 12 V.D.C. is applied between leads.

3. If valve spool does not retract check for binding or damage in valve.

4. If valve operates smoothly, but does not retract when 12 V.D.C. is applied to solenoid leads, replace solenoid coil.

5. If valve still does not retract after replacing solenoid coil, replace the valve.

NOTE: To do a quick test without removing solenoid valve, hold a screwdriver to top of affected valve. When solenoid is energized, screw driver should be attracted to valve stem, due to magnetism from energized solenoid. This test will not identify a sticking valve spool.

Solenoid coil resistance:

20 Watt solenoid:	7.2 Ohms (± 10%) at 77°F (25°C)
28 Watt solenoid:	5.1 Ohms (± 10%) at 77°F (25°C)

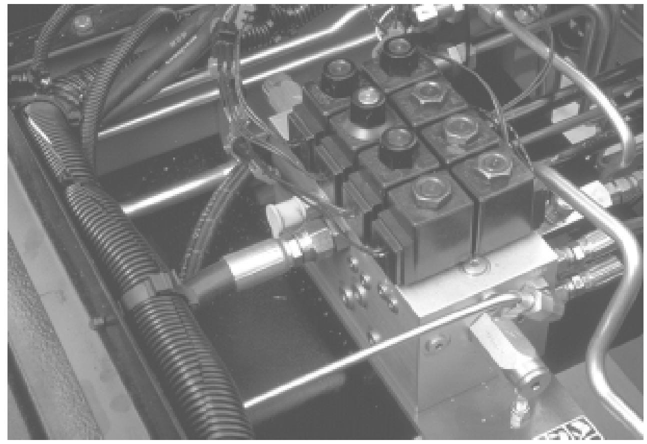


Figure 29
Front valve block

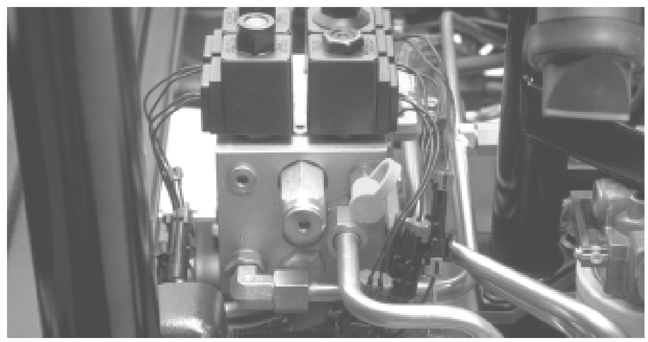


Figure 30
Rear valve block
(Reelmaster 6500–D shown)

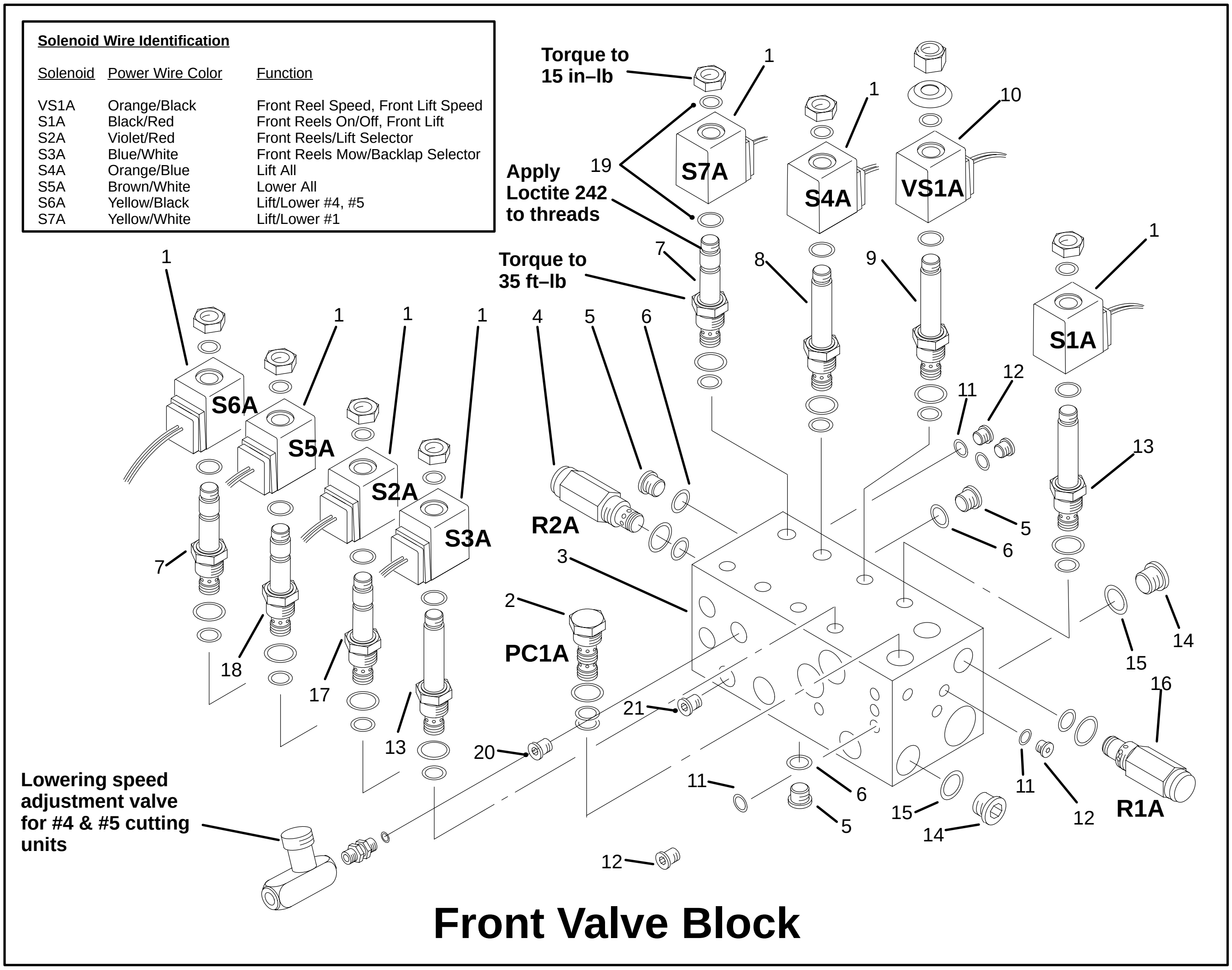
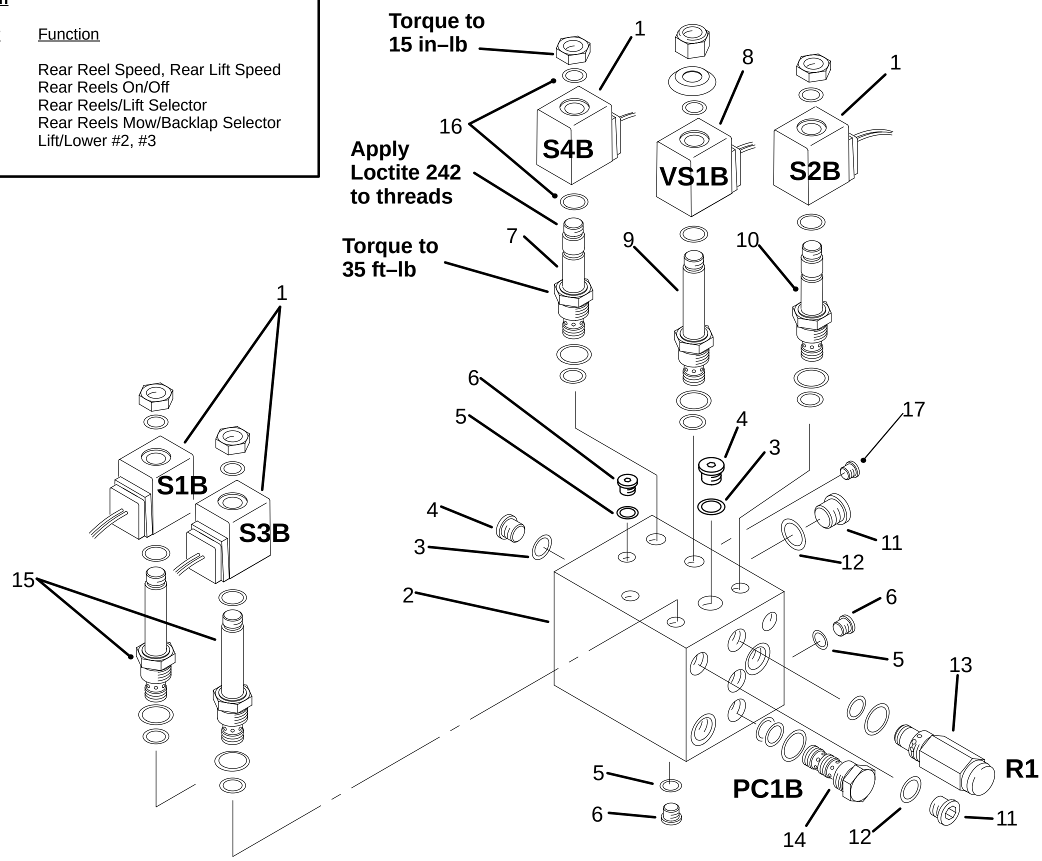


Figure 31

1. Solenoid – 20 Watt
2. Pilot check cartridge
3. Front manifold block
4. Relief cartridge – 2300 PSI
5. Plug
6. Cartridge – N.C.
7. Cartridge – N.C. (2)
8. Cartridge
9. Cartridge – N.O.
10. Solenoid – 28 Watt
11. O–ring
12. Plug
13. Cartridge – N.O. poppet
14. Plug
15. O–ring
16. Relief cartridge – 3000 PSI
17. Cartridge – N.O. poppet
18. Cartridge – N.C. poppet
19. Seal
20. Orifice (.060)
21. Orifice (.040)

Solenoid Wire Identification

Solenoid	Power Wire Color	Function
VS1B	Yellow/Blue	Rear Reel Speed, Rear Lift Speed
S1B	Orange/Red	Rear Reels On/Off
S2B	Orange/White	Rear Reels/Lift Selector
S3B	White/Orange	Rear Reels Mow/Backlap Selector
S4B	Pink/Blue	Lift/Lower #2, #3



Rear Valve Block (RM6500–D)

Figure 32

1. **Solenoid – 20 Watt**
2. **Rear Manifold Block**
3. **O–ring**
4. **Plug**
5. **O–ring**
6. **Plug**
7. **Cartridge – N.C. Spool**
8. **Solenoid – 28 Watt**
9. **Cartridge – No Flow**
10. **Cartridge – N.C. Poppet**
11. **Plug**
12. **O–ring**
13. **Relief cartridge – 3000 PSI**
14. **Pilot check cartridge**
15. **Cartridge – N.O. poppet(2)**
16. **Solenoid seal**
17. **Orifice (.040)**

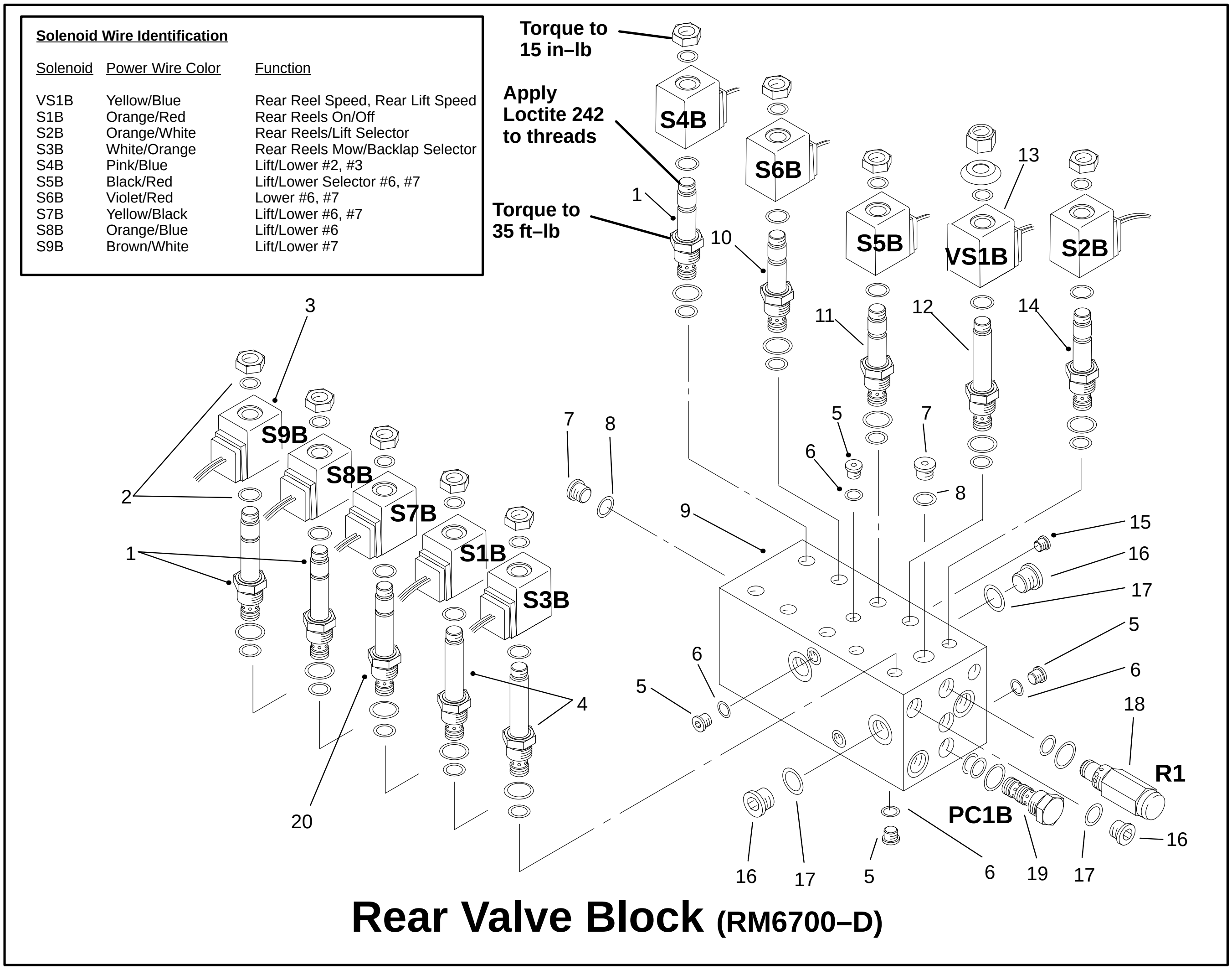


Figure 33

1. Cartridge – N.C. spool (3)
2. Seal
3. Solenoid – 20 Watt
4. Cartridge – N.O. poppet (2)
5. Plug
6. O–ring
7. Plug
8. O–ring
9. Rear manifold block
10. Cartridge – N.C. poppet
11. Cartridge – W/2P
12. Cartridge – No flow
13. Solenoid – 28 Watt
14. Cartridge – N.C. poppet
15. Orifice (.040)
16. Plug
17. O–ring
18. Relief cartridge – 3000 psi
19. Cartridge – N.O. poppet
20. Cartridge – 3W2P pull

#6 and #7 Reel On/Off Solenoids

1. Disconnect the wire connector.

2. Connect a 12 volt battery so the positive (+) battery terminal is connected to colored solenoid lead. Connect the negative (–) battery terminal to black lead. The valve spool should retract completely as 12 V.D.C. is applied between leads.

3. If valve spool does not operate properly check for binding or damage to valve.

4. If valve moves smoothly, but does not engage when 12 V.D.C. is applied to solenoid leads, replace solenoid coil.

5. If valve still does not operate after replacing solenoid coil, replace the valve.

Solenoid coil resistance:
3.5 Ohms (± 10%) at 77°F (25°C)

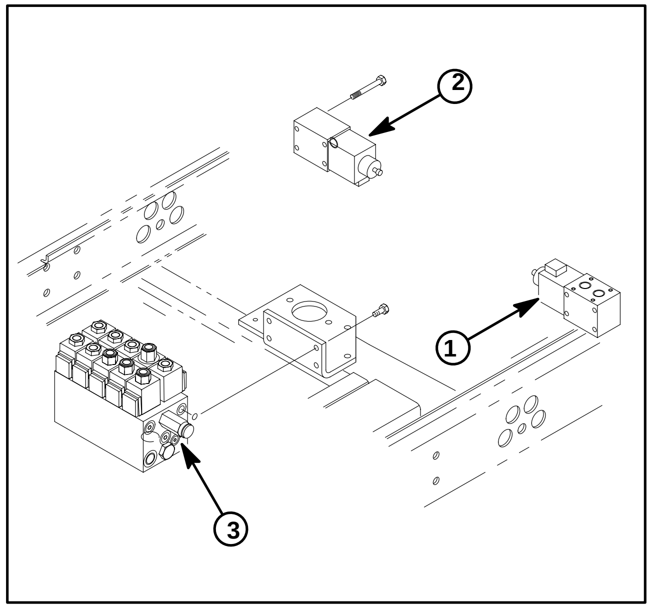


Figure 34
(Located on frame rails)

1. #6 reel solenoid (S10)
2. #7 reel solenoid (S11)
3. Rear valve block

Height of Cut Selector (Potentiometer)

The HOC selector can be tested with the Diagnostic ACE Display tool.

1. Make sure key switch is OFF.

2. Connect Diagnostic ACE Display tool to controller loop–back connector – primary controller on RM6700–D. (See Troubleshooting section for more information.)

3. Remove overlay decal from Diagnostic ACE Display tool so numbers 0 to 17 next to lamps are visible.

4. Raise seat and set Backlap switch to FRONT backlap position.

5. Set Enable/Disable switch to DISABLE position.

6. Hold Lower/Mow–Raise lever in RAISE position and turn ignition key switch to ON. Release Lower/Mow–Raise lever.

8. Slowly turn HOC selector. LED's on Diagnostic ACE Display tool will show how ECU is interpreting HOC selector. LED labeled "0" should be illuminated when knob is pointed to "A", and LED labeled "15" should be illuminated when knob is pointed to "P". It is not necessary for knob to line up with letters on decal for machine to function normally.

9. Turn key switch OFF and disconnect Diagnostic ACE Display tool. Connect loop–back connector.

NOTE: The HOC selection potentiometer is factory calibrated. If the HOC selection potentiometer must be replaced for any reason, the new potentiometer will need to be calibrated in order to assure the correct clip is delivered. If the potentiometer is not calibrated correctly, the delivered clip may be as much as 2 or 3 settings different from the desired setting. This calibration must be done by your Toro distributor.

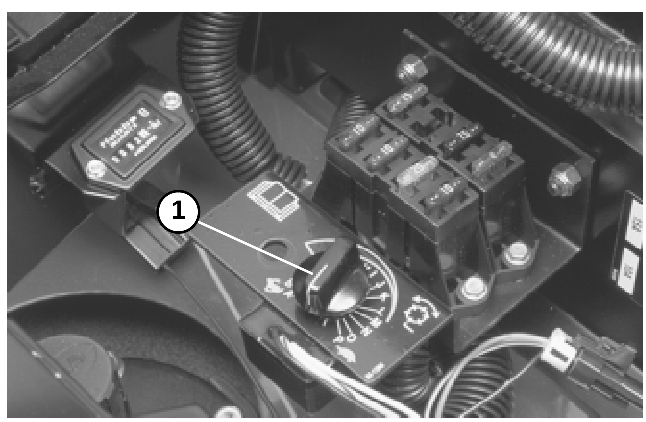


Figure 34a
1. H.O.C. Selector Knob

Battery Service

IMPORTANT: To prevent damage to the electrical components, do not operate the engine with the battery cables disconnected.

Keep the terminals and entire battery case clean. To clean the battery, wash the entire case with a solution of baking soda and water. Rinse with clear water. Do not get the soda solution into the battery because damage to the battery will result. Coat the battery posts and cable connectors with skin–over grease, or petroleum jelly to prevent corrosion.

Check for loose battery hold–downs. A loose battery may crack or cause the container to wear and leak acid.

Check the electrolyte solution to make sure the level is above the plates. 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.

CAUTION

Do not charge a frozen battery because it can explode and cause injury. Let the battery warm to 60F° (15.5° C) before connecting to a charger.

Charge the battery in a well–ventilated place so that gases produced while charging can dissipate. Since the gases are explosive, keep open flame and electrical spark away from the battery; do not smoke. Nausea may result if the gases are inhaled. Unplug the charger from the electrical outlet before connecting or disconnecting the charger leads from the battery posts.

Electrolyte Specific Gravity

Fully charged: 1.250 – 1.280
Discharged: less than 1.240

Battery Specifications

BCI Group 24 Battery:
650 Amp Cranking Performance at 0° F (–18° C)
+105 min. Reserve Capacity at 80° F (27°C)

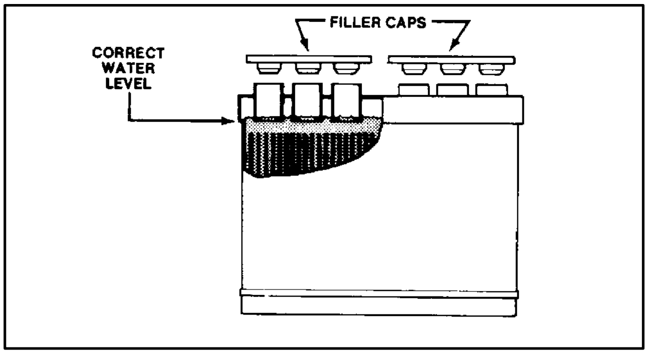


Figure 35

Fuses

Fuses are located below the control panel.

NOTE: It is not always possible to see if a fuse is faulty. It is recommended that you check for faulty fuses with a continuity tester; not visually.

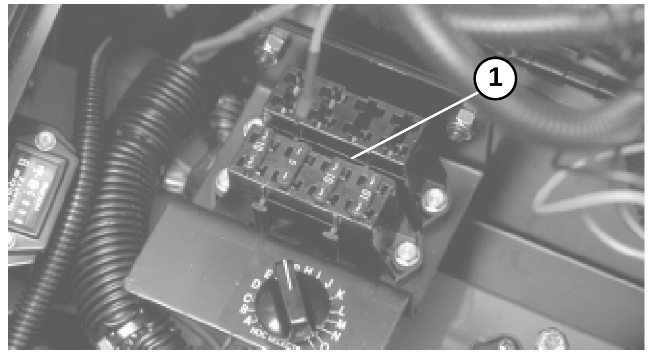


Figure 36

1. Fuses

IMPORTANT
USE CORRECT FUSES. WRONG FUSES CAN CAUSE DAMAGE TO CONTROLLER AND VOID WARRANTY.

OPTIONAL LIGHTS	CONTROLLER POWER (1)
10A	10A
CONTROLLER POWER (2)	IGNITION SWITCH
15A	5A
LEAK DETECTOR	CONTROLLER POWER
5A	10A
OPEN	CONTROLLER POWER
	10A

93-7596

Reelmaster 6500–D
(S/N 50001 – 59999)

IMPORTANT
USE CORRECT FUSES. WRONG FUSES CAN CAUSE DAMAGE TO CONTROLLER AND VOID WARRANTY.

CONTROLLER LOGIC	CONTROLLER POWER (1)
2A	10A
ACCESSORY POWER	IGNITION SWITCH
7.5A	20A
OPTIONAL LIGHTS	CONTROLLER POWER (1)
10A	10A
CONTROLLER POWER (2)	CONTROLLER POWER (1)
15A	10A

94-6348

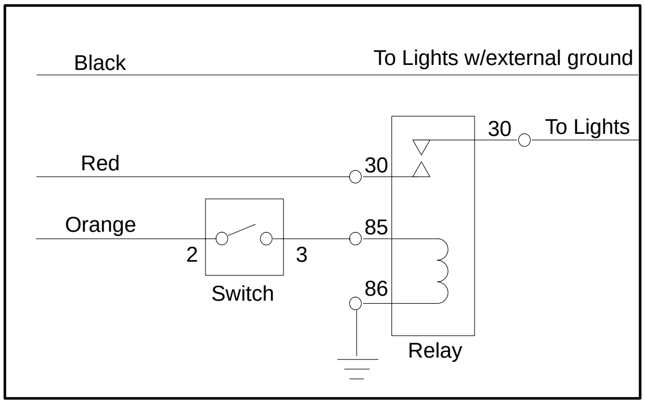
Reelmaster 6500–D/6700–D
(S/N 60001 & UP)

Figure 37

Installing Optional Lighting

IMPORTANT: If optional lighting is to be added to the traction unit, use the following schematic and part numbers to prevent damage to the traction unit's electrical system.

SCHEMATIC FOR OPTIONAL LIGHTING



Switch*

Toro Part No. 75–1010
Honeywell Part No. 1TL1–2

Relay

Toro Part No. 70–1480
Bosch Part No. 0–332–204

Black, red and orange wires are located in control console.

Add 10 Amp fuse to fuse block at location shown

*** Punch out in control panel provided for switch installation**

Hydraulic Valve Block Solenoid Coil Replacement

1. Remove solenoid coil:

A. Remove nut from solenoid.

B. Remove solenoid coil and o–ring at each end of solenoid coil.

NOTE: There are two different solenoid coils used on the hydraulic valve blocks. Cartridge valves VS1A and VS1B use 28 Watt coils. All other valves use 20 Watt coils. Make sure you use the correct replacement solenoid.

2. Install solenoid coil:

A. Make sure there is an o–ring installed at each end of the coil.

B. Apply “Loctite 242” or equivalent to threads of stem tube before installing nut.

C. Tighten nut to a torque of 15 in–lb. Over–tightening may damage the coil or cause the solenoid valve to malfunction.

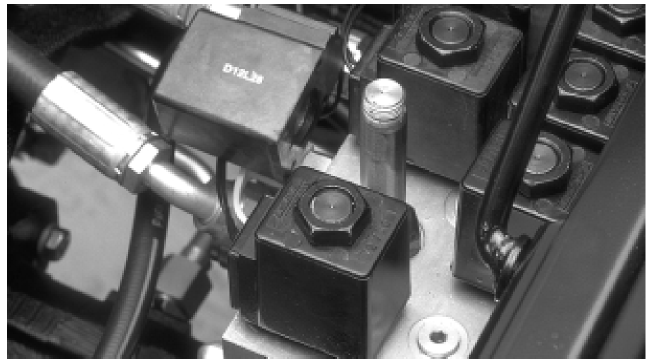


Figure 38

#6 and #7 Reel On/Off Solenoid Coil Replacement

1. Remove solenoid coil:

A. Disconnect the electrical connector

B. Remove the coil nut.

C. Remove coil assembly.

2. Install solenoid coil:

A. Install the new coil assembly.

B. Apply “Loctite 242” or equivalent to threads of stem tube before installing nut.

C. Tighten nut to a torque of 15 in–lb. Over–tightening may damage the coil or cause the solenoid valve to malfunction.

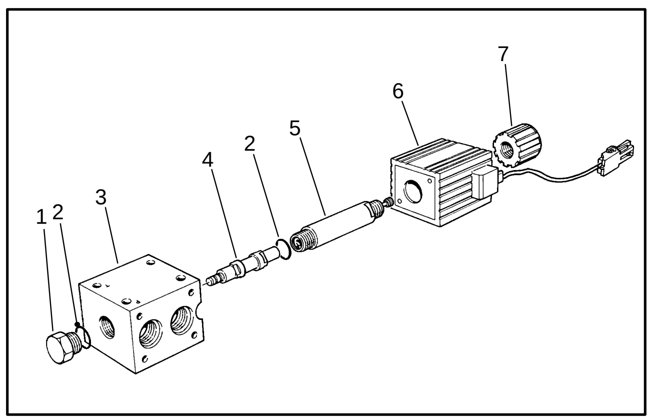


Figure 39

1. Adapter assembly
2. O–ring
3. Valve
4. Spool
5. Tube assembly
6. Coil assembly
7. Coil nut

Speedometer Sensor Installation

NOTE: It is recommended that this procedure be done with the motor removed from the machine.

1. Thread locknut onto speed sensor to allow full exposure of sensor threads.

2. Center a motor piston with the center of the sensor port (see Sensor Port View below). NOTE: If the motor is on the machine use a tool to feel when a motor piston is in the center of the sensor port.

3. Lubricate O–ring on sensor.

4. Thread sensor into port until sensor contacts piston. Motor output shaft must rotate freely 360°.

5. Turn sensor out (counter–clockwise) until sensor orientation grooves are at a right angle + 3° to motor centerline, then back out sensor one full turn or 360°. Hold sensor at this position and tighten locknut to a torque of 75 – 125 in–lb (8.5 – 14.1 Nm).

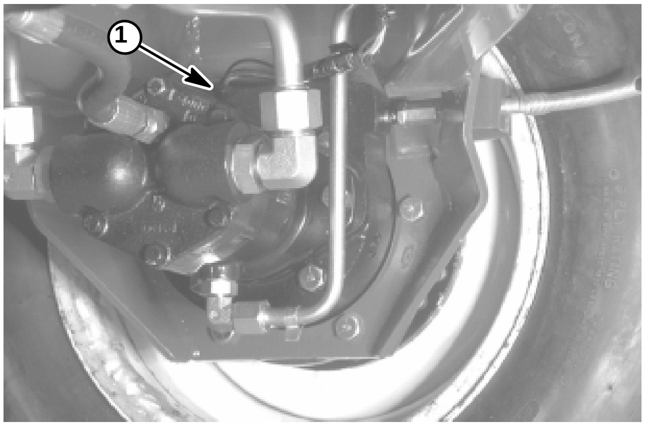


Figure 40

1. Speedometer sensor

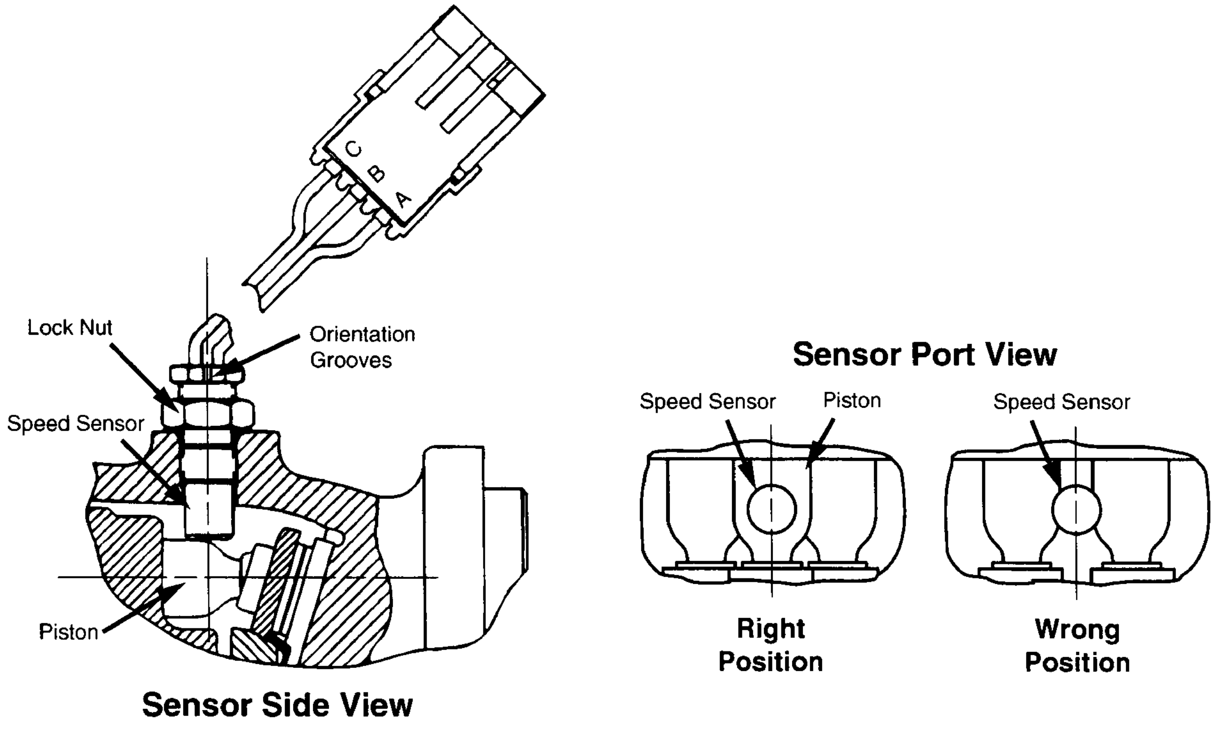


Figure 41

Reel Speed Sensor Installation

See Cutting Unit Installation in Repairs section of Chapter 7 – Cutting Units.

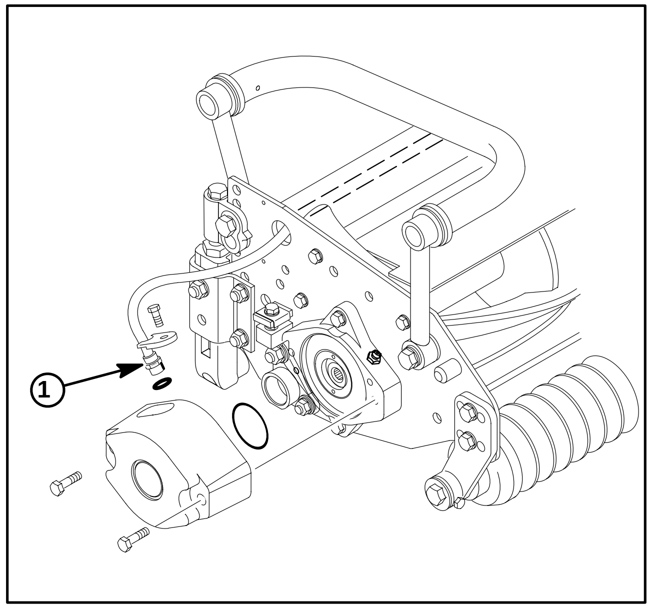


Figure 42

1. Reel speed sensor

Traction Neutral Switch Installation

See Servo Control in Repairs section of Chapter 4 – Hydraulic System.

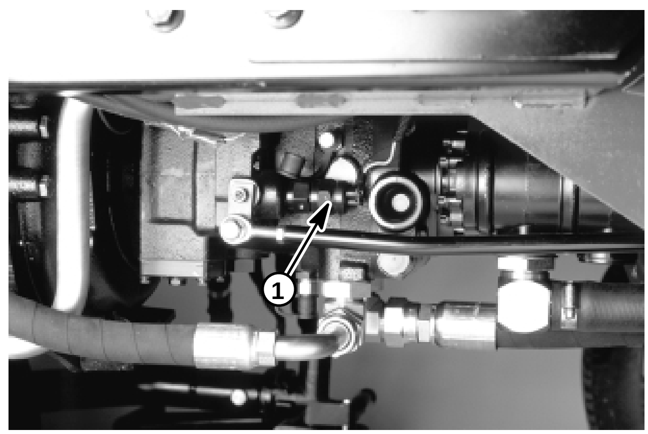


Figure 43

1. Traction (neutral) switch

Chapter 6

Axles, Planetaries and Brakes

Table of Contents

Axles, Planetaries and Brakes

Specifications

Item	Specification
Front wheel lug nut torque	45–55 ft–lb
Rear wheel lug nut torque	85–100 ft–lb
Steering cylinder bolt torque	100–125 ft–lb
Rear wheel toe–in	.25”
Tire pressure	15–20 psi, front and rear
Brake pedal free travel	.12”
Planetary brake housing, and wheel motor mounting cap screw torque	75–85 ft–lb
Planetary gear drive oil System gear lube capacity each wheel	SAE 85W–140 wt. gear lube 16 oz. (incl. brakes)
Rear axle lubricant (4WD) System gear lube capacity	SAE 85W–140 wt. gear lube 80 oz.

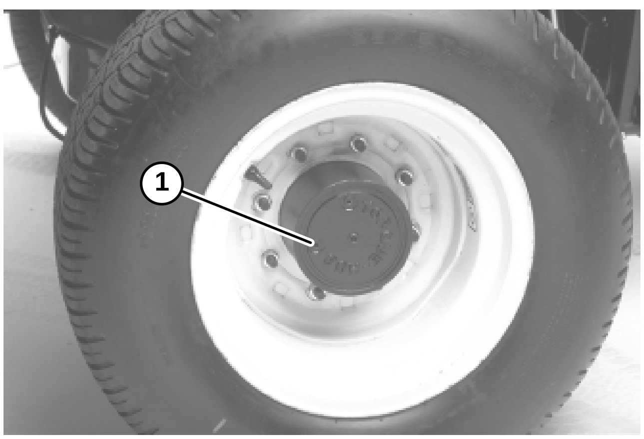


Figure 1

1. Check/Drain Plug

Check with machine on a level surface and check/ drain plug at either three or nine o’clock position.

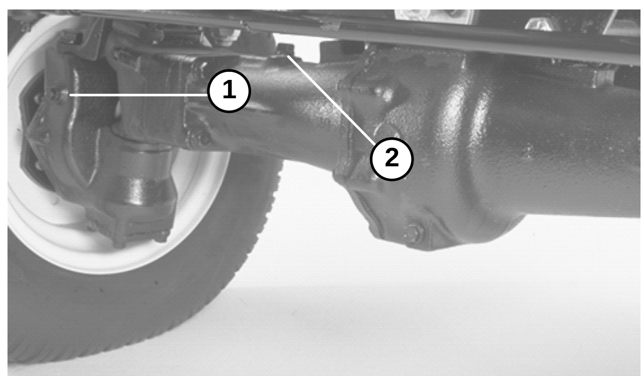


Figure 2

1. Check Plug 2. Fill Plug

Special Tools

Order special tools from the TORO SPECIALS TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS).

Rear 4WD Axle Tools

TOR4038 – Differential Case Gauge

Used to determine the number of shims required between the 4WD rear axle differential housing.

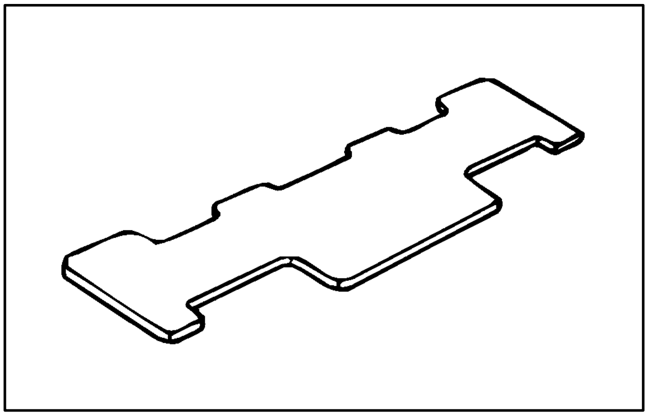


Figure 3

TOR4039 – Pilot Bushing Driver

Used to install the pilot bushing into ends of 4WD rear axle.

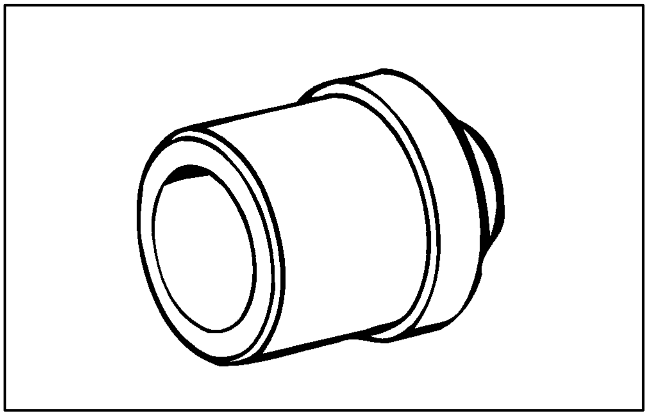


Figure 4

TOR4040 – Pinion Nut Tool

Used to remove or install the pinion (sleeve) nut on the 4WD rear axle.

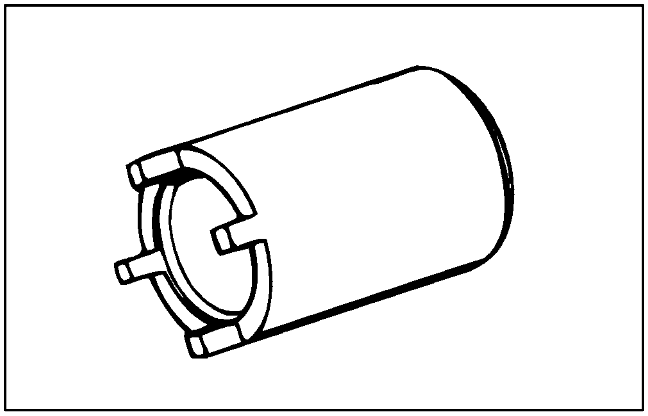


Figure 5

TOR4041 – Bevel Gear Remover

Used to separate the bevel gears from their shafts in the ends of the 4WD rear axle.

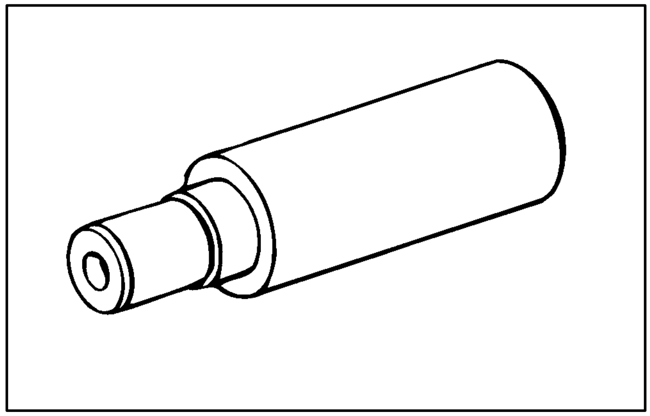


Figure 6

TOR4042 – Pinion Gauge

Used to determine the number of shims required to properly position the 4WD rear axle pinion.

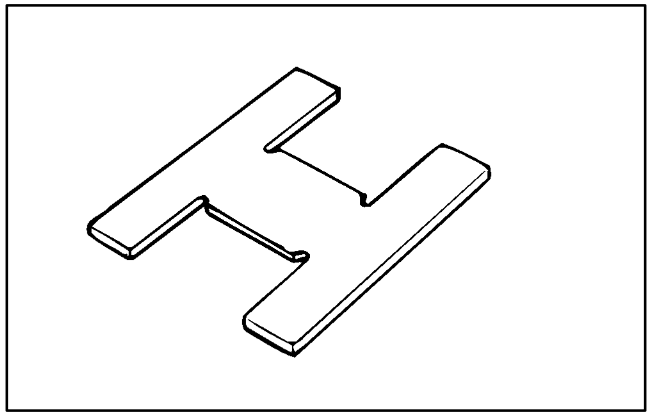


Figure 7

TOR4043 – Oil Seal Installation Tool

Used to install the oil seals in the ends of the 4WD rear axle.

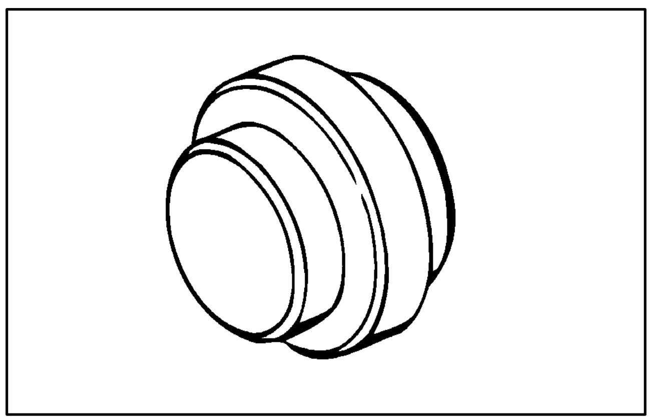


Figure 8

Adjustments

Service Brake Adjustment

Adjust the service brakes when there is more than 1 inch of "free travel" of the brake pedal, or when the brakes do not work effectively. Free travel is the distance the brake pedal moves before braking resistance is felt.

1. Disengage locking pin from brake pedals so both pedals work independently of each other.

2. To reduce free travel of brake pedals, tighten the brakes – loosen front nut on threaded end of brake cable. Then tighten rear nut to move cable backward until brake pedals have 1/2 to 1 inch of free travel. Tighten front nuts after brakes are adjusted correctly.

NOTE: Each brake cable should be loose and require 1/8 inch movement from floor plate opening to start movement of cable at clevis end.

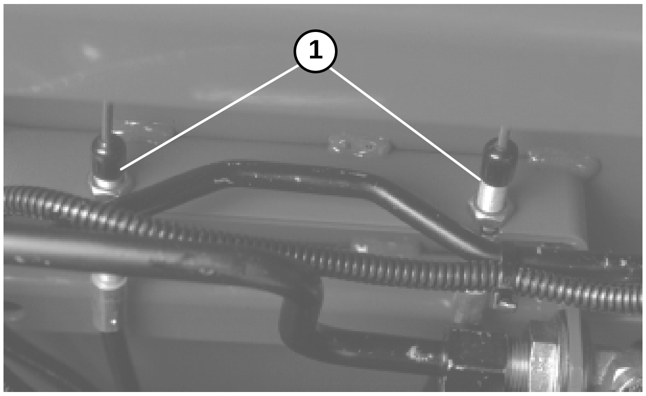


Figure 9

1. Brake Cables

Rear Wheel Toe–in

After every 800 operating hours or annually, check rear wheel toe–in.

1. Measure center–to–center distance (at axle height) at front and rear of steering tires. Front measurement must be 1/4 in. less than rear measurement.

2. To adjust, loosen clamps at both ends of tie rods.

3. Rotate tie rod to move front of tire inward or outward.

4. Tighten tie rod clamps when adjustment is correct.

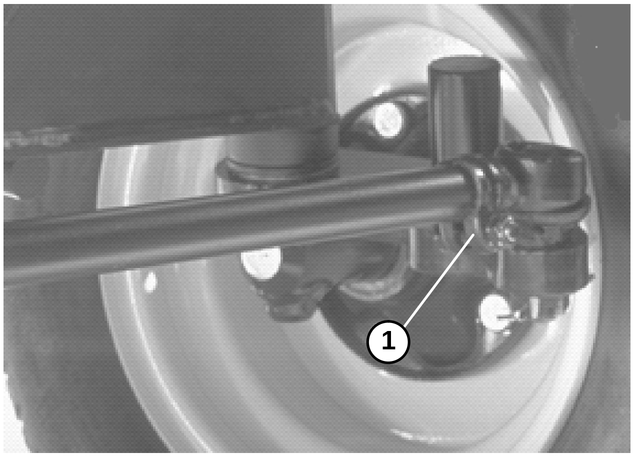


Figure 10

1. Tie Rod Clamps

Axles, Planetaries and Brakes

Rear Wheel Bearing Service (2WD)

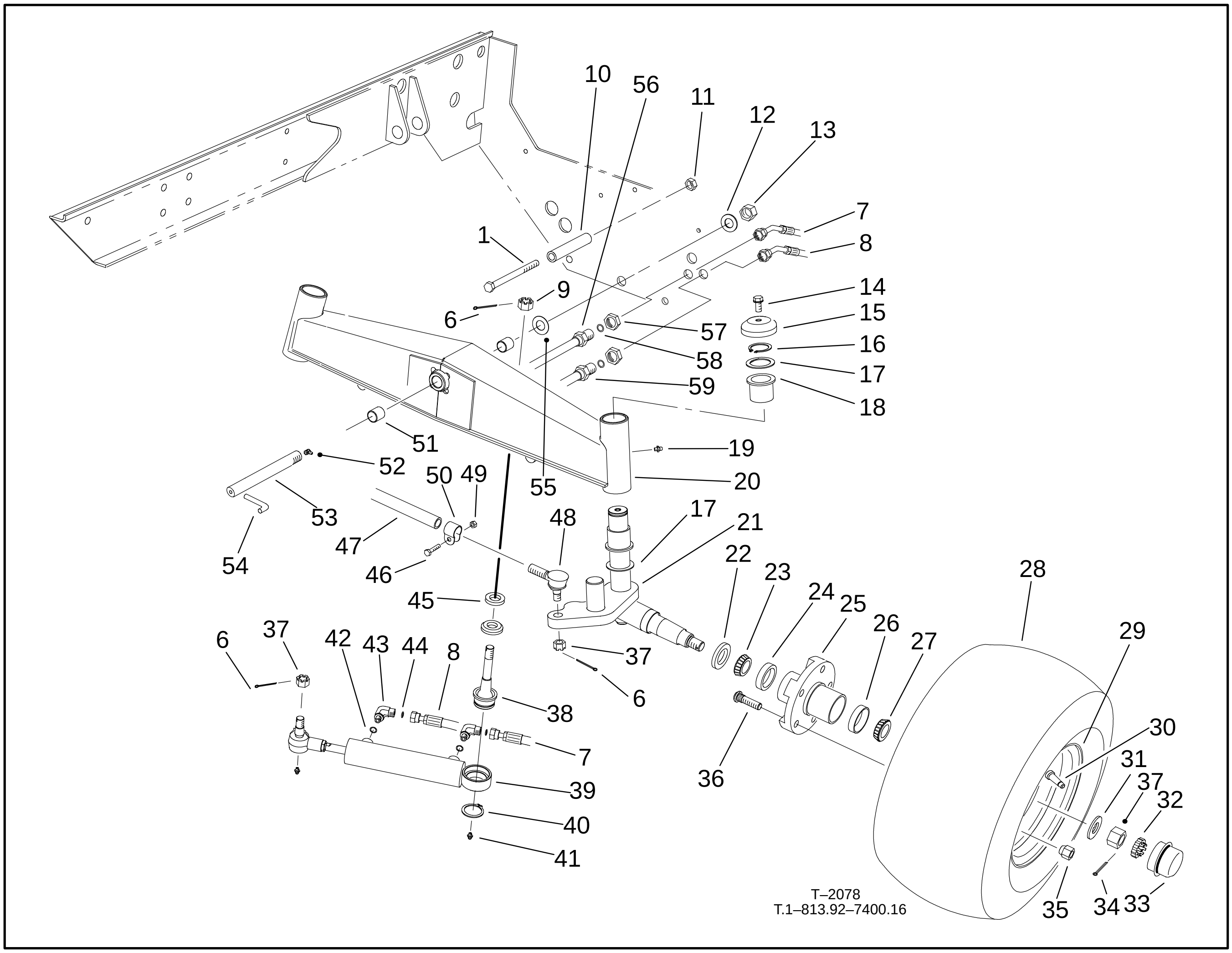


Figure 11

1. Cap Hex Hd. Screw
6. Cotter Pin
7. Hose Assembly
8. Hose Assembly
9. Hex Slotted Nut
10. Axle Stop
11. Lock Nut
12. Flat Washer
13. Lock Nut
14. Hex Hd. Flange Screw
15. Spindle Cap
16. Retaining Ring
17. Thrust Washer
18. Flange Bushing
19. Grease Fitting
20. Rear Axle Assembly
21. LH Spindle WA.
22. Inner Seal
23. Bearing Cone
24. Bearing Cup
25. Hub Assembly
26. Bearing Cup
27. Bearing Cone
28. Tire
29. Wheel
30. Valve Stem
31. Tab Washer
32. Retainer
33. Hub Cap
34. Cotter Pin
35. Lug Nut
36. Drive Stud
37. Jam Nut
38. Ball Joint
39. Cylinder Assembly
40. Retaining Ring
41. Grease Fitting
42. O–Ring
43. Hydraulic 90° Fitting
44. O–Ring
45. Ball Joint Spacer
46. CAp Hex Hd. Screw
47. Tie Rod Assembly
48. LH Ball Joint
49. Lock Nut
50. Clamp Assembly
51. Sleeve Bushing
52. Grease 90° Fitting
53. Pivot Axle Pin
54. Stop Pin
55. Thrust Washer
56. Steering Rear Tube Assembly
57. Bulkhead Lock Nut
58. O–Ring
59. Steering Rear Tube Assembly

Disassemble, clean, repack and adjust the rear wheel bearings after each 800 hours of operation. 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. Slightly loosen the wheel lug nuts. 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. Remove the wheel.

2. Remove the hubcap from the end of the wheel spindle.

3. Remove the cotter pin, retainer, jam nut, and washer. Slide the hub off of the spindle shaft.

4. Pull the seal out of the hub.

5. Remove the bearing cones from both sides of the hub assembly. 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 hub assembly, press new ones into the hub until they seat against the shoulder.

7. Pack bearing cones with grease. Install one bearing cone into the cup on inboard side of the hub assembly. Lubricate the inside of the new lip seal and press it into the hub assembly.

IMPORTANT: The lip seal must be pressed in so it is flush with the end of the hub.

8. Pack inside of hub assembly with some grease (not full). Install remaining bearing cone into the bearing cup.

9. Slide the hub onto the spindle shaft and secure it in place with the tab washer, jam nut, and retainer. DO NOT tighten the nut or install the cotter pin.

10. Adjust preload on the wheel bearings.

A. Tighten the jam nut to 75 – 80 in–lb (86 – 270 Kg–cm) while turning the hub to seat the bearings and remove all end play.

B. Loosen the jam nut until it is away from the tab washer and the hub has end play. Tighten the jam nut to 15 – 20 in–lb (17 – 23 Kg–cm) while rotating the hub.

C. Put the retainer over the jam nut. If the cotter pin hole is not aligned with a retainer slot, remove the retainer and re–orient it until alignment occurs.

D. Insert the cotter pin. Bend both legs of the cotter pin and tap out of the way. Install the cap.

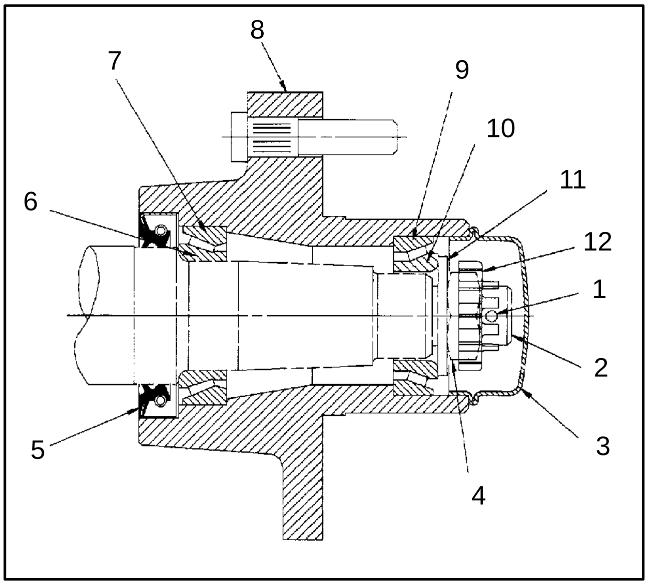


Figure 12

1. Cotter pin	**7. Inner bearing cup**
2. Spindle	**8. Wheel hub**
3. Cap	**9. Outer bearing cup**
4. Washer	**10. Outer bearing cone**
5. Seal	**11. Washer**
6. Inner bearing cone	**12. Retainer**
	13. Jam nut

Axles, Planetaries and Brakes

Planetary Wheel Drive Service

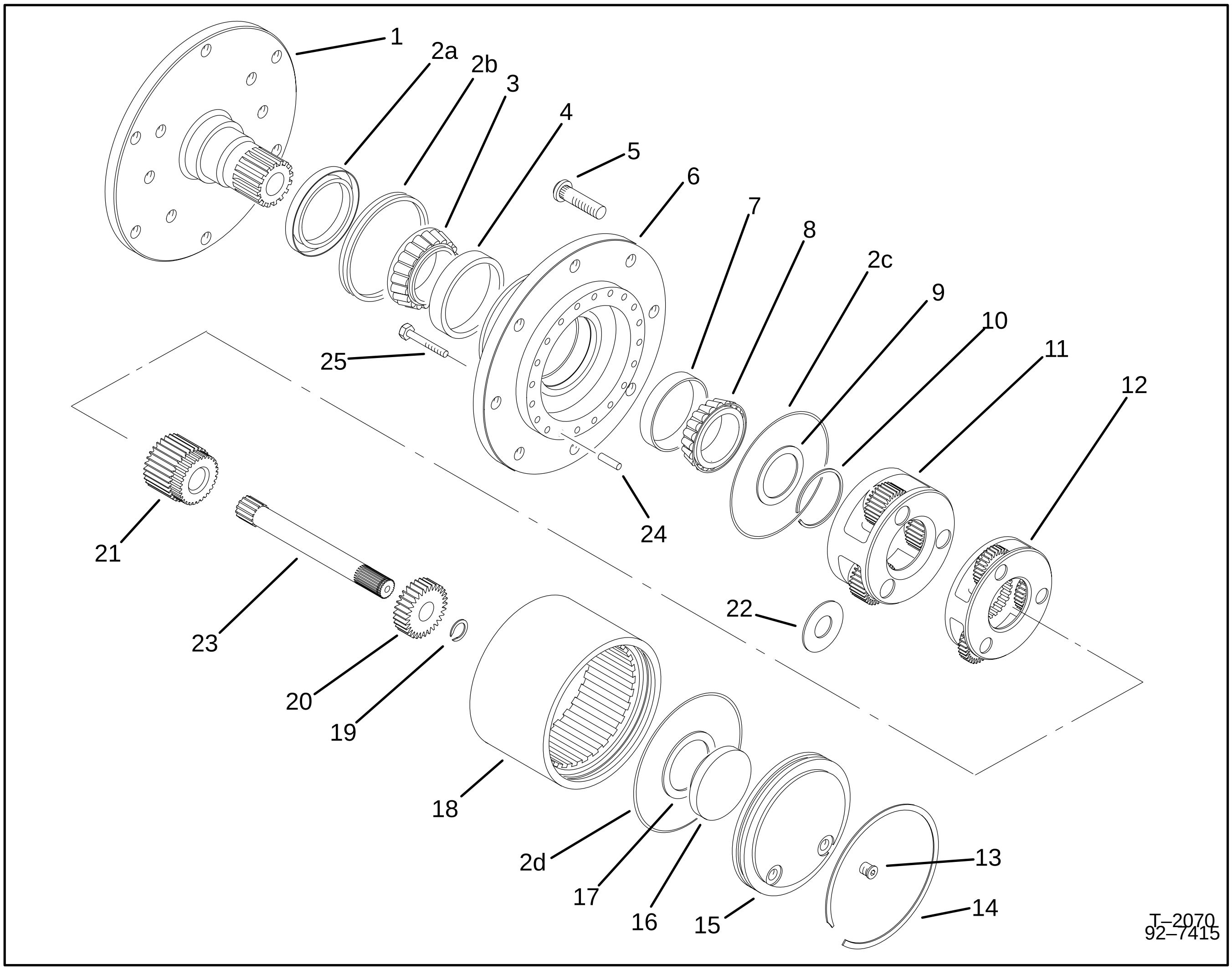


Figure 13

1. Spindle	**9. Thrust washer**	**17. Thrust washer**
2. Seal kit	**10. Retaining ring**	**18. Ring gear**
3. Bearing cone	**11. Secondary carrier assembly**	**19. Retaining ring**
4. Bearing cup	**12. Primary carrier assembly**	**20. Sun gear**
5. Wheel stud	**13. Pipe plug**	**21. Sun gear**
6. Housing	**14. Retaining ring**	**22. Thrust washer**
7. Bearing cup	**15. Cover plate**	**23. Input shaft**
8. Bearing cone	**16. Input spacer**	**24. Dowel pin**
		25. Screw

Disassembly of the Planetary Wheel Drive

1. Remove retaining ring (14).

2. Remove cover plate. (15).

3. Remove spacer (16) and washer (17).

4. Remove sun gear and input shaft assembly (19, 20 and 23).

5. Remove primary carrier assembly (12).

6. Remove sun gear (21).

7. Remove secondary carrier assembly (11). NOTE: Washer (22) is inside carrier assembly.

NOTE: Steps 8 –12 are necessary only if inspecting or replacing bearings and/or seals.

8. Remove capscrews (25) and remove ring gear (18).

9. Remove retaining ring (10) and thrust washer (9).

10. Use a puller to remove spindle (1) from housing (6). Remove bearing cone (8).

11. Remove and discard all seals.

12. If bearings will be replaced, use a puller to remove bearing cone (3) from spindle. Remove bearing cups (4 and 7) from housing (6).

Assembly of the Planetary Wheel Drive

NOTE: Use a new seal kit when assembling planetary wheel drive.

1. Clean parts in solvent. Inspect parts for damage or excessive wear and replace as necessary.

2. Install lip seal (2a) to spindle (1).

3. Press bearing cups (4 and 7) into housing (6).

4. Press bearing cone (3) onto spindle (1).

5. Install seal (2b) to housing (6). Assemble housing (6) to spindle (1). Make sure seals are installed correctly (Fig. 13a).

6. Press bearing cone (8) onto spindle and secure with thrust washer (9) and retaining ring (10).

7. Install seal (2c), then assemble ring gear (18) to housing (6) with capscrews (25).

8. Install secondary carrier assembly (11).

9. Install sun gear (21).

10. Install primary carrier assembly (12).

11. Assemble input shaft and sun gears (19, 20 and 23). Install input shaft assembly.

12. Install thrust washer (17) and input spacer (16).

13. Install seal (2d), then install cover (15). Secure cover with retaining ring (14).

14. Check operation of planetary wheel drive before installing on the tractor.

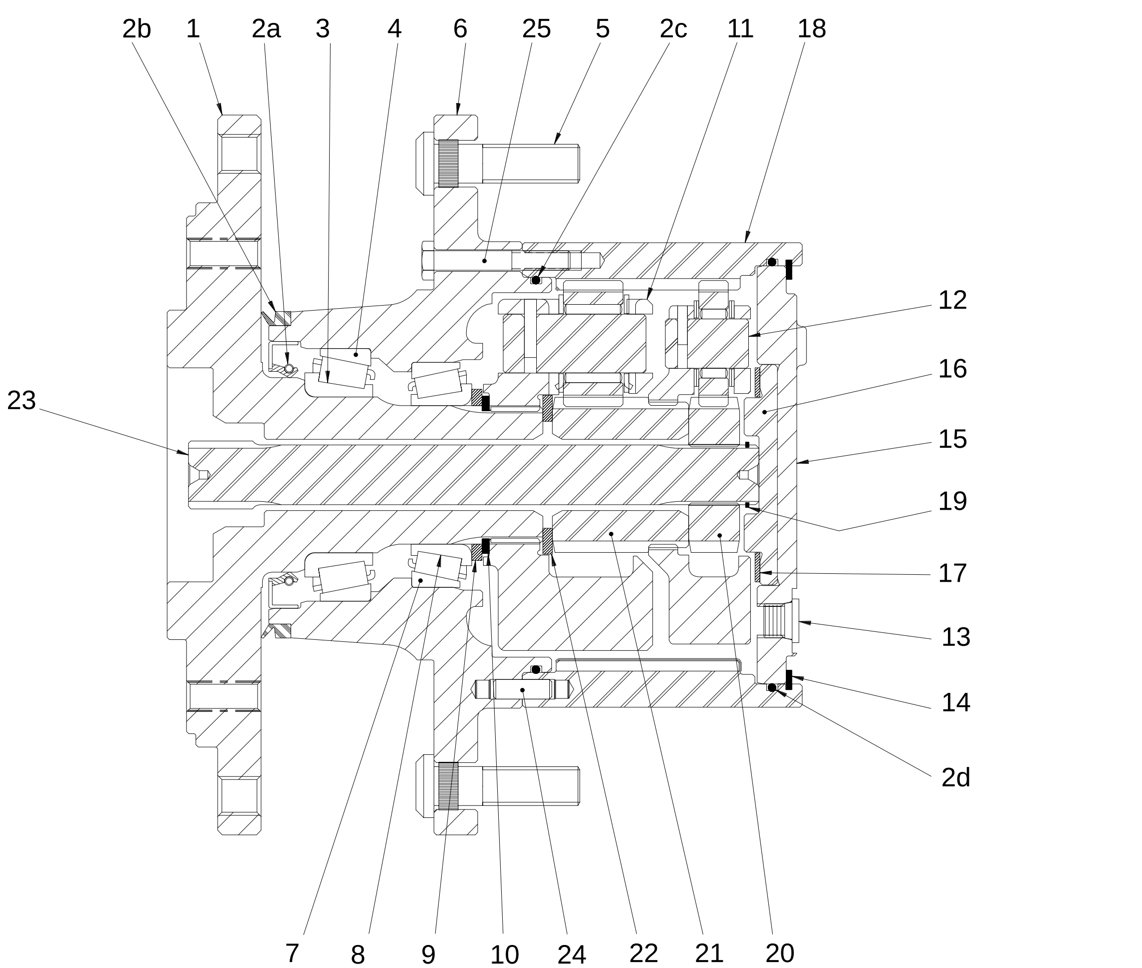


Figure 13a

Brake Service

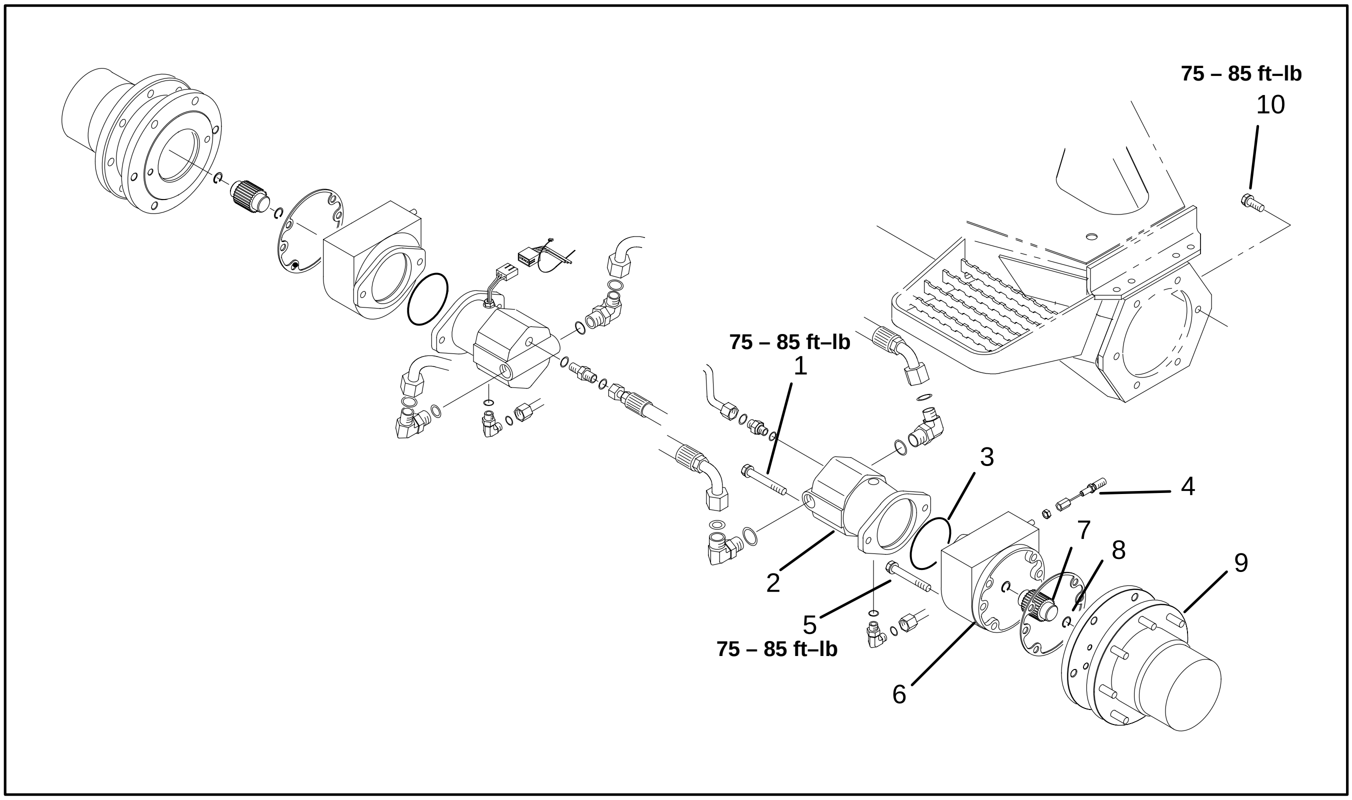


Figure 14

1. Capscrew
2. Wheel motor
3. O–ring
4. Brake cable
5. Flange head capscrew
6. Brake assembly
7. Splined shaft
8. Retaining ring
9. Planetary wheel drive
10. Flange head capscrew

Remove Brake Assembly (Fig. 14)

1. Drain oil from planetary wheel drive (9) and brake assembly (6).

2. Jack up front of machine and support with jack stands.

3. Remove wheel.

4. Remove wheel motor (2) (see **Removing Hydraulic System Components** in Repairs section of Chapter 4 – Hydraulic System).

5. Disconnect brake cable (4) from pull rod on brake.

6. Remove flange head capscrews (5) securing brake assembly to frame; be careful not to drop splined shaft as brake assembly is removed.

7. Remove splined shaft (7).

8. Do brake inspection and repair as shown on next page.

Install Brake Assembly (Fig. 14)

1. Install splined shaft (7) into brake assembly.

2. Install brake assembly onto frame, aligning splined shaft with input shaft on planetary wheel drive.

3. Install flange head screws (5) to secure brake assembly to frame. Tighten screws in a crossing pattern to a torque of 75 – 85 ft–lb.

4. Install brake cable (4)to pull rod on brake assembly.

5. Install new o–ring (3) on wheel motor (2). Install wheel motor and tighten capscrews (1) to a torque of 75 – 85 ft–lb.

6. Make sure drain plug is installed in bottom of brake assembly. Fill planetary wheel drive with SAE 85W–140 gear lube. Capacity is approximately 16 oz. per wheel (both planetary drive and brake housing).

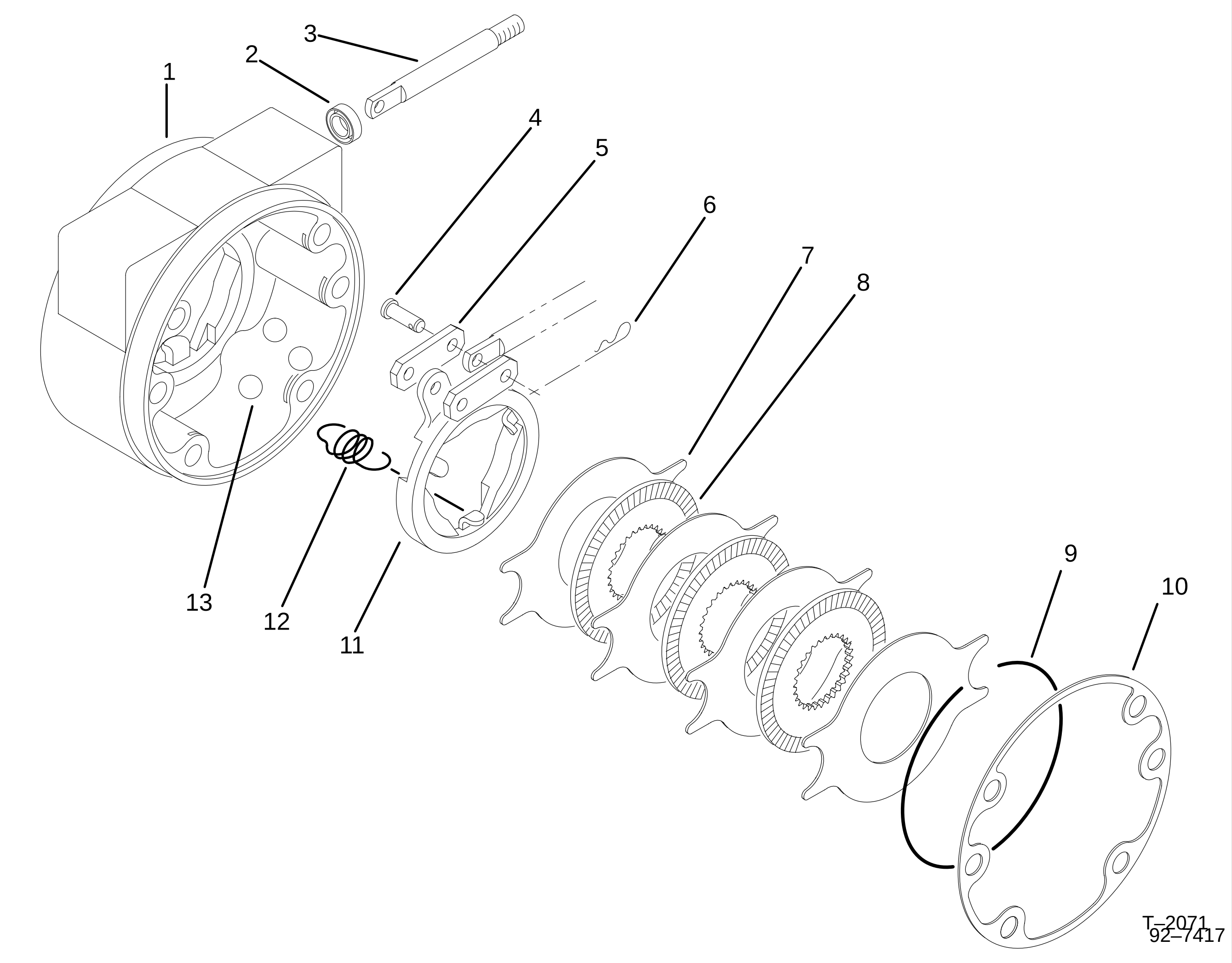


Figure 15

1. LH Brake Housing	**6. Hair Cotter Pin**	**11. Actuator**
2. Seal	**7. Stationary Disc**	**12. Extension Spring**
3. Pull Rod	**8. Rotating Disc**	**13. Ball**
4. Clevis Pin	**9. Retaining Ring**	
5. Link	**10. Gasket**	

Brake Inspection and Repair (Fig. 15)

1. Scrape gasket material (10) off of brake housing and planetary wheel drive mounting surfaces.

2. Remove retaining ring (9).

3. Remove stationary discs (7) and rotating discs (8).

4. Remove springs (12).

5. Remove actuator assembly (11, 6, 5, 4, 3).

6. Remove balls (13).

7. Wash parts in cleaning solvent.

8. Inspect parts for wear or damage.

9. Reverse steps 2 – 6 to assemble brakes, installing new parts as necessary. Install a new seal (2).

10. Use a new gasket (10) when installing brake assembly.

Rear 4WD Axle Service

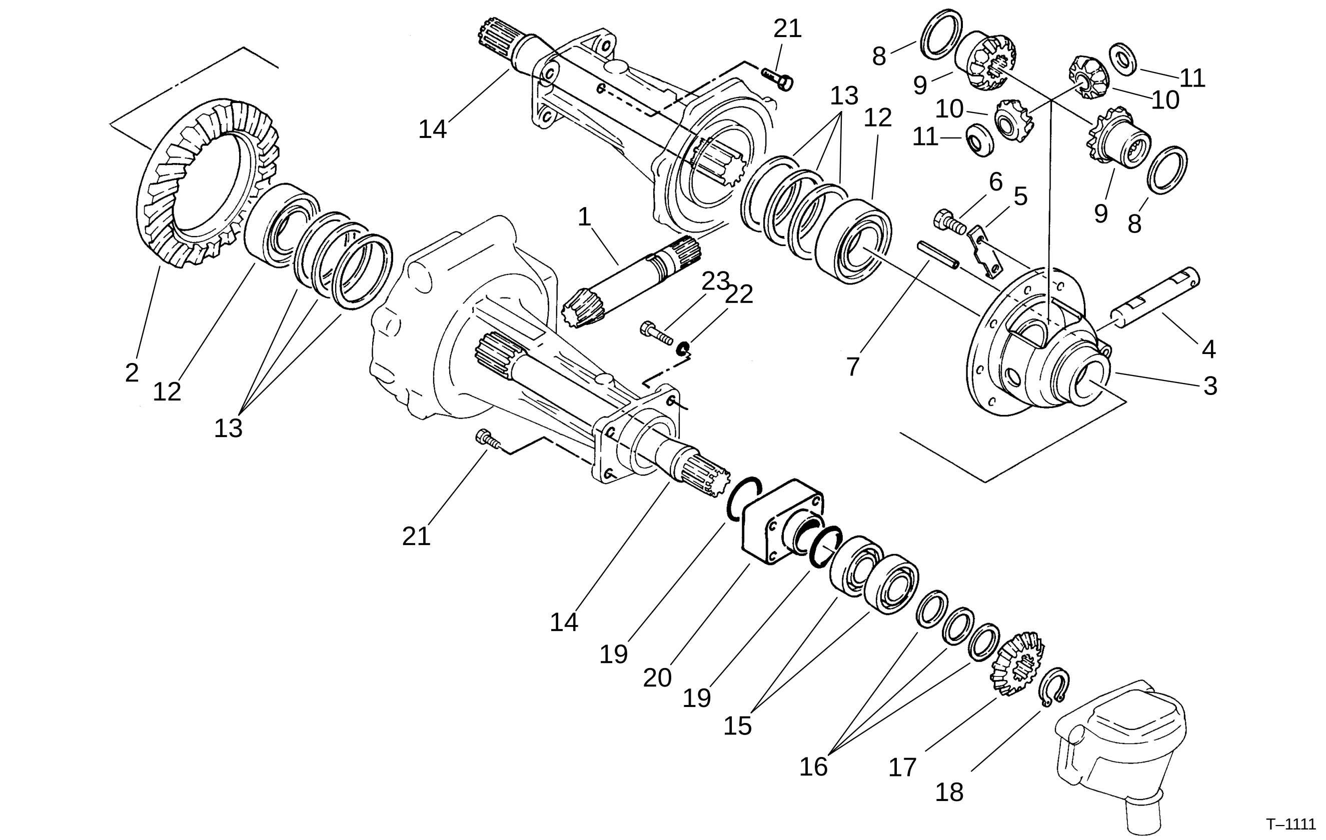


Figure 16

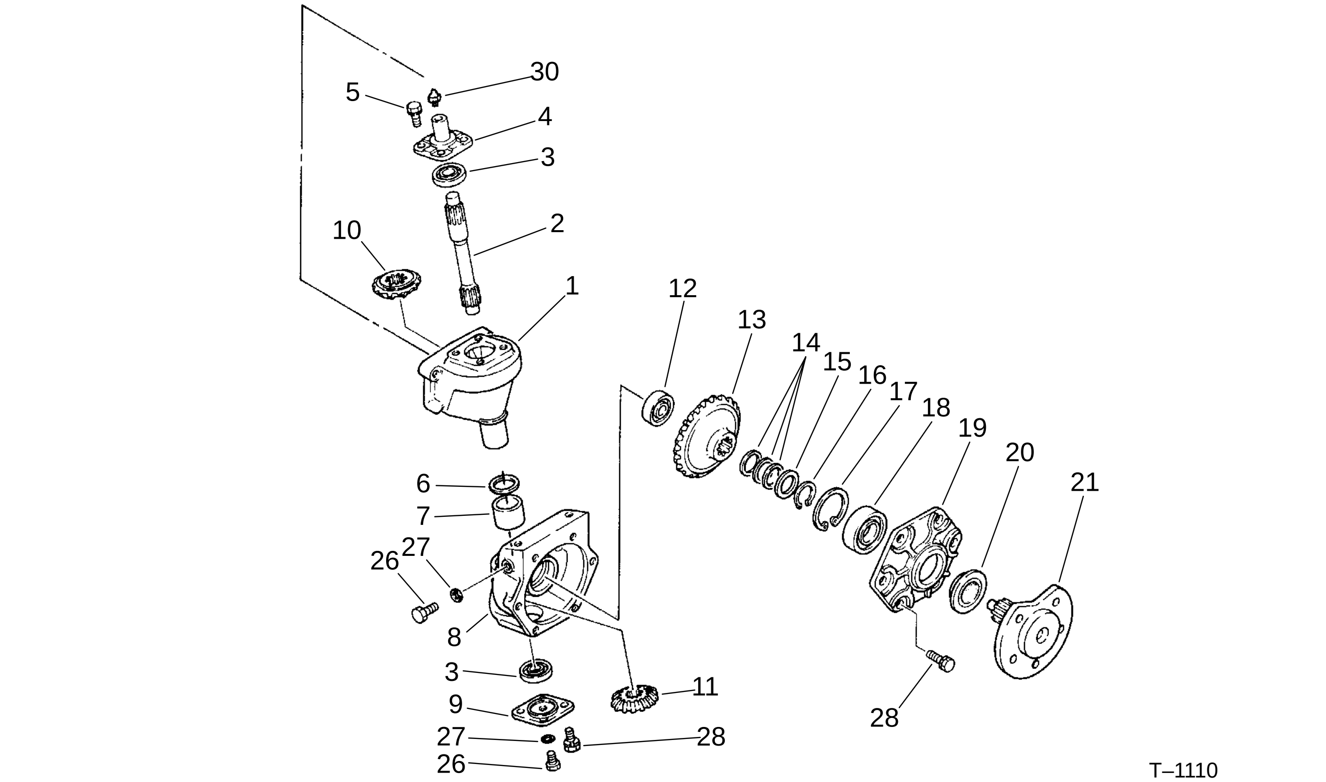


Figure 17

Disassembly

The two gear cases, right and left can be removed from the housing without requiring the entire axle to be disassembled.

1. Remove tie rod by disconnecting rod end ball joint on each end. Disconnect hydraulic cylinder rod end from drag link arm.

2. Remove bolts (Fig. 16, Item 23 and 21) securing gear case to axle housing and pull gear case complete with final drive case.

NOTE: Of four (4) bolts securing the gear case, the one on the bottom right side (viewed from center of axle) is a reamer bolt (Item 21).

Disassembling Final Drive Case

1. Remove bearing holder (Fig. 17, Item 19) from final drive case. The holder will come out together with the wheel shaft (Item 21).

2. Pull draglink arm or tie rod arm off final drive case. Be sure to recover the thrust washer.

3. Remove the bolts securing top cover (Item 4) to gear case and remove the cover to expose the top end of final drive shaft (Item 2). Use special tool TOR4041 to drive lightly on the exposed shaft end so that the final drive case will slide off the gear case.

4. Remove bottom cover (Item 9) from final drive case to expose bottom end of shaft. Use special tool TOR4041 to drive the shaft out and take out the 15T bevel pinion (Item 11).

Disassembling Wheel Shaft

1. Use a gear puller to draw the bevel gear (Item 13) and ball bearing (Item 12) off wheel shaft.

2. Remove shaft from bearing holder by lightly tapping on the shaft.

3. Remove retaining ring (Item 17) from holder and remove bearing outer race and oil seal (Item 20).

Figure 18

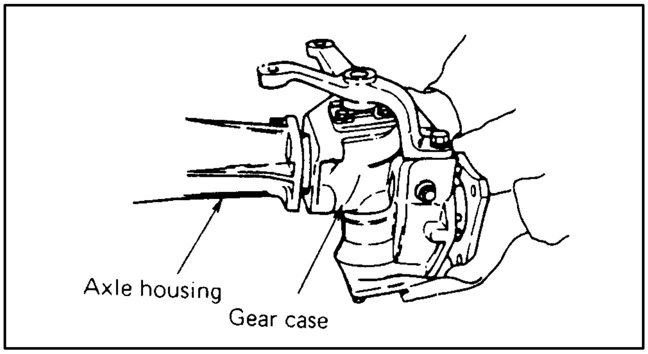


Figure 19

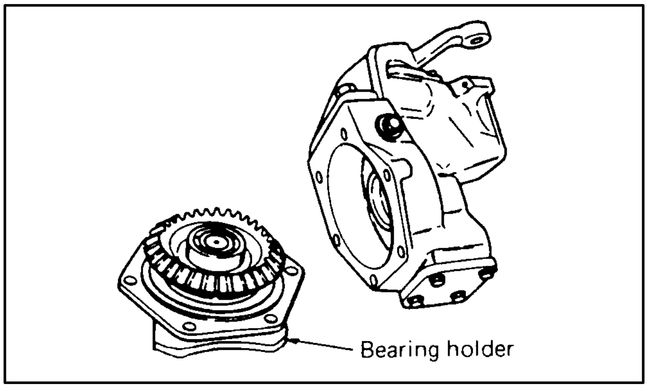


Figure 20

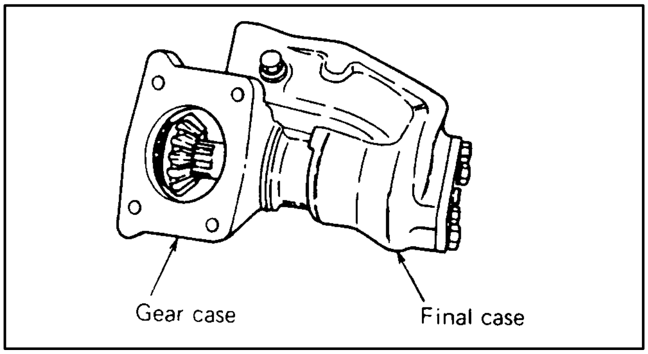


Figure 21

Axles, Planetaries and Brakes

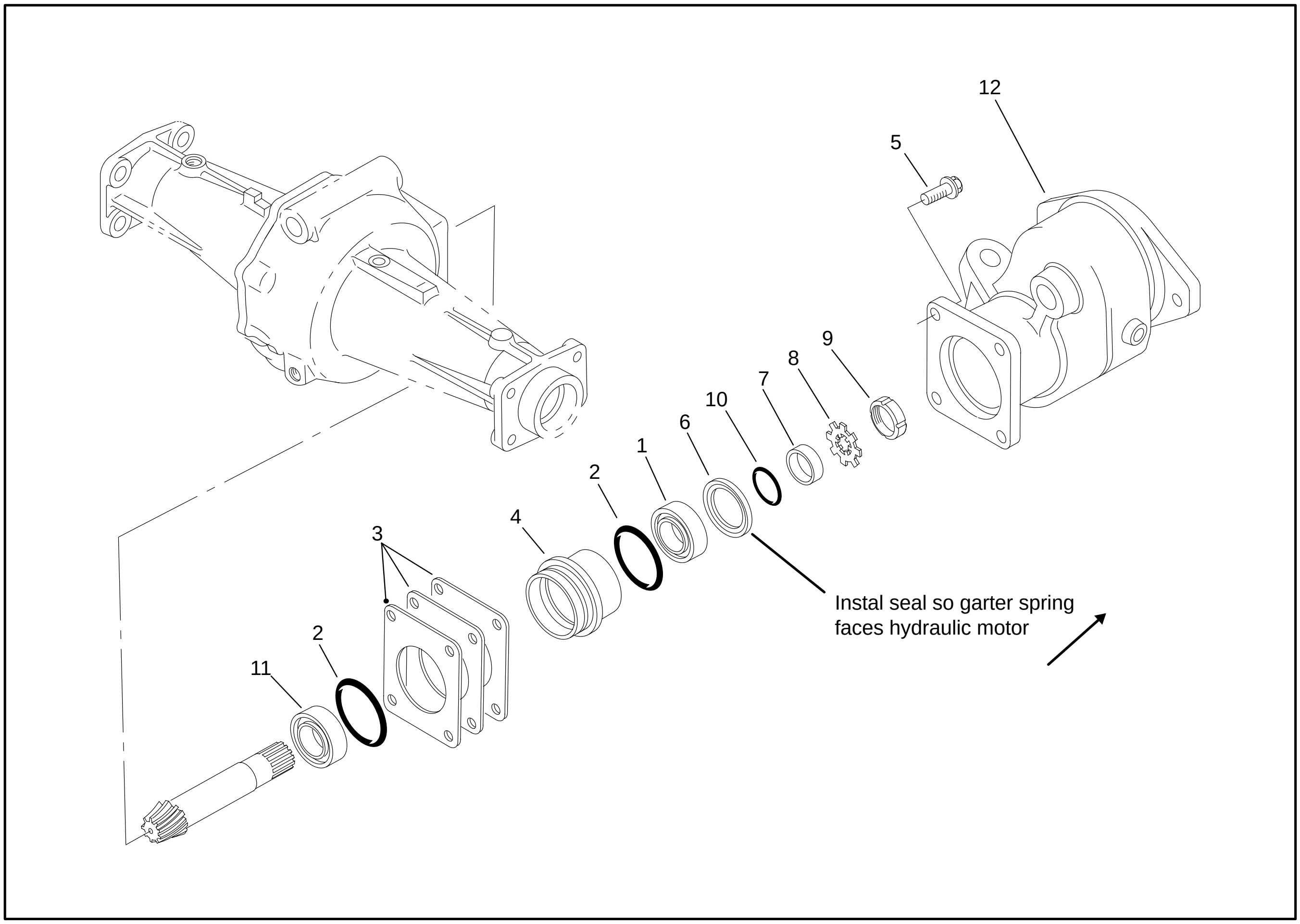


Figure 22

1. Bearing	**6. Oil Seal**	**11. Bearing**
2. O–Ring	**7. Bushing**	**12. Adapter**
3. Shim	**8. Washer**	**13. Nut**
4. Sleeve	**9. Locknut**	**14. Stud Bolt**
5. Bolt	**10. O–Ring**	**15. Washer**

Disassembling Axle Housing

1. Remove axle from machine before disassembling:

A. Jack up rear of machine and support from frame with jack stands.

B. Remove wheels from axle.

C. Remove hydraulic motor. Do not disconnect hydraulic lines from motor.

D. Support axle with a jack, then remove axle pivot pin to separate axle from frame.

E. Pull axle out from under machine and put on a work bench.

F. Be sure to account for thrust washers between axle pivot and frame.

2. Remove bolts (Fig. 22, Item 5) securing adapter to axle housing and remove adapter.

3. Separate axle housing by removing bolts.

4. Pull out differential shaft (Fig. 16, Item 14) from housing (B).

5. Remove differential gear assembly (Fig. 16, Items 3–11) from axle housing (A).

6. Pull out differential shaft from housing (A).

Disassembling Sleeve Assembly

1. Remove sleeve (Item 4) from adaptor case. Straighten tab washer (Fig. 22, Item 8) and use special tool TOR4040 to remove sleeve (lock) nut (Item 9).

2. Use a press or tap lightly on shaft end to force pinion shaft out of case.

3. Remove oil seal (Item 6) and bearings (Item 1 and 11) as necessary.

Inspection

Clean the disassembled parts by washing in cleaning solvent. Inspect gears and pinions to be sure their teeth are in good condition. Check to be sure that each bearing rotates smoothly. Examine housings for cracks.

Reassembly

Replace damaged or worn parts as necessary. Oil or grease the surfaces of rotating or sliding parts before assembling. Grease oil seals and o–rings before installing.

Assembling Pinion Shaft

1. Fit two outer races of tapered roller bearings into sleeve, positioning each race as shown.

2. Fit inner race of tapered roller bearing to gear side of pinion shaft, pushing it all the way against the pinion shoulder.

3. Insert pinion shaft into sleeve. Fit other inner race to shaft. Install o–ring and oil seal bushing. Pinion shaft is now securely installed inside the sleeve.

4. Grease oil seal and install it between sleeve and bushing, making outer end face flush with mating face of sleeve. Install seal with garter spring facing toward hydraulic motor.

5. Install tab washer and lock nut. Tighten lock nut with special tool TOR4040 to specified preload on bearings.

Pinion shaft bearing preload	0.04 ~ 0.06 kg–m (0.29 ~ 0.43 ft-lb)

NOTE: Make sure pinion shaft has no end play when checking bearing preload.

6. After obtaining specified preload, secure lock nut by bending tab washer.

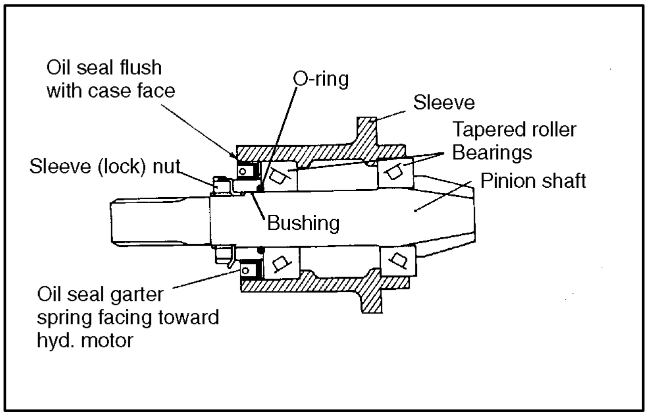


Figure 23

Adjusting Pinion Shaft Cone Center

“Cone Center” is the distance from the mating face of axle housing to end face of pinion. This distance can be increased or decreased by installing removing shims.

Cone center specification	43 ± 0.05mm (1.69 ± 0.002 in.)

Shim stock for this adjustment is available in the following thicknesses:

Thickness	Part No.
Shim set	77-4010
0.1 mm (0.004 in.)	76-7410
0.2 mm (0.008 in.)	76-7420
0.4 mm (0.016 in.)	77-7430

Using gauge TOR4042 for cone center adjustment, determine the required thickness of shim by proceeding as follows:

1. Apply grease to o–rings. Install o–rings to sleeve, then install sleeve assembly into adapter case.

2. Put gauge alternately on pinion shaft and select the shim so that with the short gauge, a clearance will occur between the gauge end and case face, but with the long gauge, a similar clearance will occur between the gauge and pinion end face.

3. Apply grease to o–ring and fit to mating face of sleeve. Attach adapter case to axle housing (A) and secure by tightening bolts to proper torque.

Adapter bolt torque	2.5 ~ 3.0 kg–m (18 ~ 22 ft-lb)

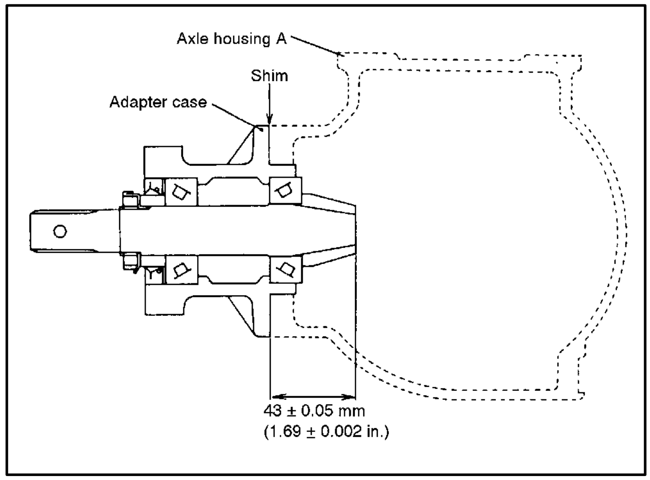


Figure 24

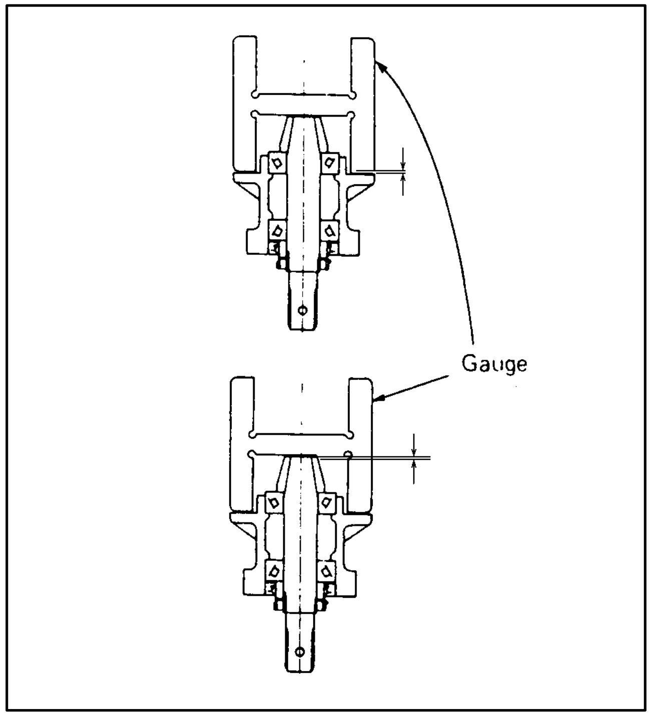


Figure 25

Adjusting Backlash

Backlash specification	0.25 ~ 0.35 mm (0.010 ~ 0.014 in.)

Adjust shim thickness (between bearing housing of axle housing (A) and bearing) to get specified backlash. Shim stock for this adjustment is available in these thicknesses:

Thickness	Part No.
Shim set	77-4000
0.1 mm (0.004 in.)	76-7290
0.2 mm (0.008 in.)	76-7300
0.4 mm (0.016 in.)	77-7310

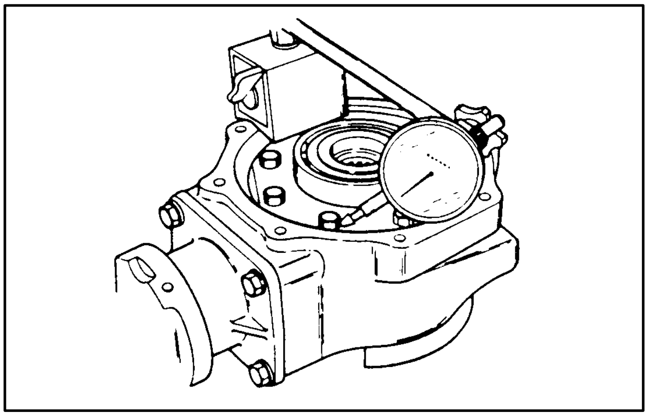


Figure 26

Shim Between Differential and Axle Housing (B)

After obtaining specified backlash, determine amount of shims needed:

1. Put gauge TOR4038 on axle housing (A) and read clearance (a) between ball bearing and gauge.

2. Select from shim stock (shown above for backlash adjustment) to match clearance (a).

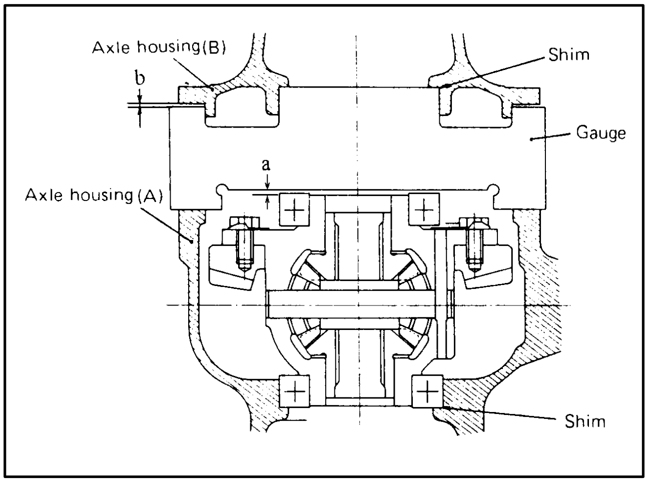


Figure 27

Axles, Planetaries and Brakes

Assembling Axle Housing

1. Coat mating faces of two housings (A) and (B) with sealant and attach selected shim to face of housing (B). Put the two housings together and fasten them by tightening bolts to following torque value:

Torque specification	2.5 ~ 3.0 kg–m (18 ~ 22 ft-lb)

2. Fit ball bearings to out end of each differential shaft, then mount pinion (14T) and retain pinion by installing circlip. The ball bearings have a groove cut in the end faces of the inner and outer races. Be sure to position the bearing to its grooved end is on inner side as shown.

3. Install o–rings to spacers. Insert differential shafts through spacers then install differential shaft and spacer to each axle housings.

Assembling Gear Case and Final Case

1. Use tool TOR4039 to install bushing into final case.

2. Grease oil seal and use tool TOR4043 to carefully fit it to final case, making sure the seal is properly aligned.

NOTE: The steel part of this oil seal is so thin that the seal can distort at the time of installation.

3. Insert final drive shaft into gear case, bringing its large diameter end to top side and fitting pinion (14T) onto splined end. Install inner race of upper tapered roller bearing as shown.

4. Fit bearing out race into gear case. Apply sealant to mating face of holder and secure to case by tightening bolts to following torque value:

Torque specification	2.5 ~ 3.0 kg–m (18 ~ 22 ft-lb)

NOTE: Be sure to wrap each bolt with sealing tape before installation.

5. Attach final case to gear case while fitting pinion (15T) onto splined end of shaft.

6. Install tapered roller bearing. Apply sealant to mating face of cover and secure cover to final case. Tighten bolts to above listed torque value:

7. Wrap drain plug with sealing tape and install in bottom cover.

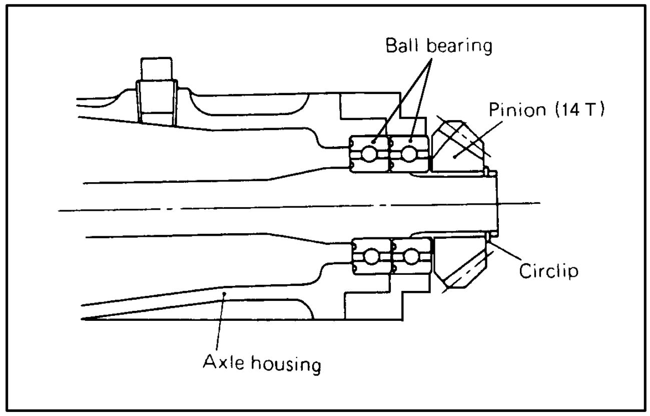


Figure 28

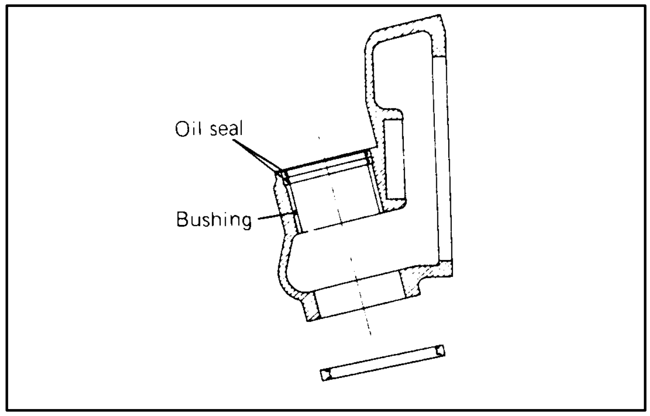


Figure 29

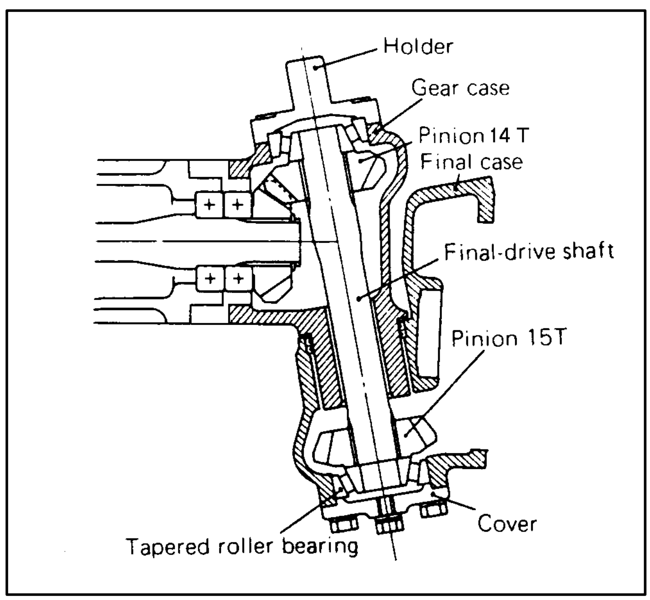


Figure 30

Installing Drag Link and Tie Rod Arm

1. Carefully insert bushing into arm.

2. Put arm into position over holder, fitting it to final case and secure to case with bolts.

3. Check thrust clearance. Proper thrust clearance is 0 to 0.2 mm (0.008in.). If necessary reduce clearance to specification by shimming. Shim stock for this adjustment is available in the following thicknesses:

Thickness	Shim Part No. TIE ROD ARM	Part No. DRAG LINK ARM
Shim set	77-4050	77-4040
0.8 mm (0.03 in.)	76-7820	76-7700
1.0 mm (0.04 in.)	76-7970	76-7760
1.2 mm (0.05 in.)	76-7980	76-7780
1.4 mm (0.055 in.)	76-7990	76-7790

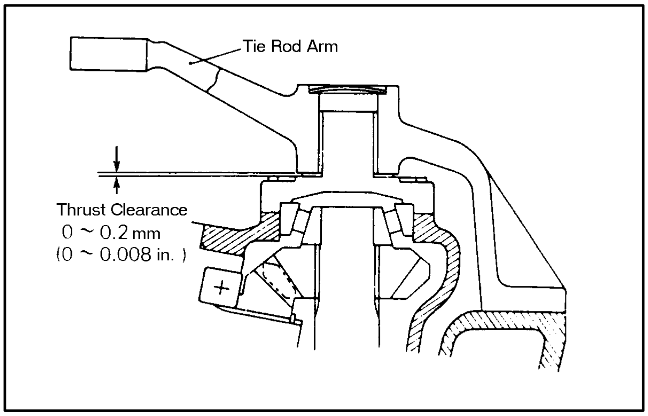


Figure 31

4. After selecting required shim, remove the arm. Apply multi–purpose lithium base grease to OD part of holder. Install holder on arm with shim and secure to final case by tighten reamer bolts to following torque value:

Torque specification	8.5 ~ 9.5 kg–m (61 ~ 69 ft-lb)

Installing Gear Case Assembly to Axle Housing

1. To check backlash between pinions (14T) — one on final drive shaft and one on differential shaft — temporarily fit gear case to axle housing and tighten two bolts diametrically opposite. DO NOT use black reamer bolt for this temporary assembly.

2. Install a dial indicator to final case, putting gauge spindle to tooth on pinion (15T pinion on bottom end of final drive shaft). Take a backlash reading.

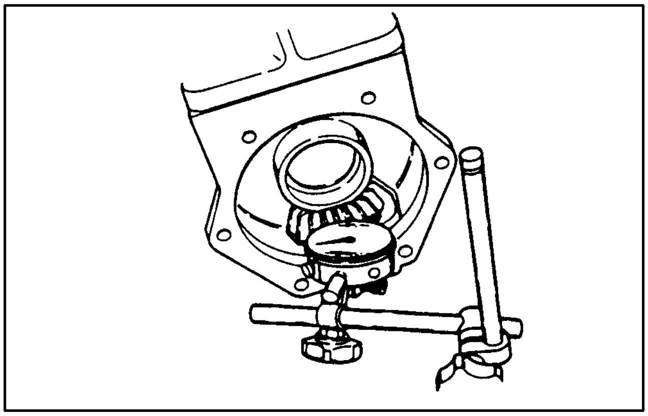


Figure 32

Pinion (14T) backlash	0.2 ~ 0.4 mm (0.008 ~ 0.016 in.)

3. If reading is outside of specified range, remove gear case and adjust shim between pinion (14T) on differential shaft and ball bearing. Shim stock for this adjustment is available in the following thicknesses:

Thickness	Part No.
Shim set	77-4020
0.1 mm (0.004 in.)	76-7520
0.2 mm (0.008 in.)	76-7530
0.4 mm (0.016 in.)	77-7540

Axles, Planetaries and Brakes

4. After obtaining proper pinion backlash, grease o–ring and fit it to mating face of axle housing. Secure gear case to housing by tightening bolts to the following torque value:

Torque specification	5.0 ~ 6.0 kg–m (36 ~ 43 ft-lb)

Reassembling Wheel Shaft

1. Grease oil seal and fit it to bearing holder.

2. Insert shaft into holder. Install ball bearing and retain bearing by installing circlip.

3. Mount bevel gear (29T) on splined end of shaft.

4. Fit bearing holder (complete with shaft and bevel gear) to final case and temporarily secure it bolting. Leave bolts lightly tightened.

NOTE: Inner ball bearing is left out at this time.

5. Check backlash between bevel gear (29T) and pinion (15T) by installing dial indicator on tip of wheel shaft. Adjust shim between bevel gear (29T) and ball bearing if reading is outside of specification:

Pinion (29T) backlash	0.2 ~ 0.4 mm (0.008 ~ 0.016 in.)

Shim stock for this adjustment is available in the following thicknesses:

Thickness	Part No.
Shim set	77-4030
0.1 mm (0.004 in.)	76-7890
0.2 mm (0.008 in.)	76-7900
0.4 mm (0.016 in.)	77-7910

6. After obtaining proper backlash, remove bearing holder. Apply Locitite 680 (or equivalent) to inner race bore of bearing. Press inner race of bearing onto wheel shaft and clean off excess Loctite. Install outer portion of bearing. Apply sealant to mating face of final case and attach holder. Tighten bolts to following torque value:

Torque specification	2.5 ~ 3.0 kg–m (18 ~ 22 ft-lb)

7. Use a torque wrench as shown to check final case for torque required to turn it around gear case and make sure that no more than 0.03 kg–m (0.22 ft–lb) is required.

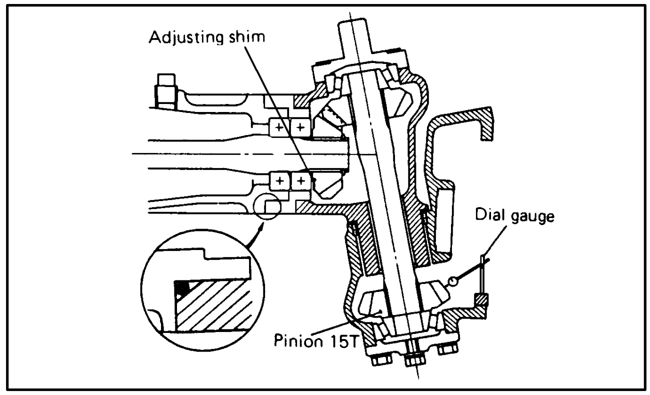


Figure 33

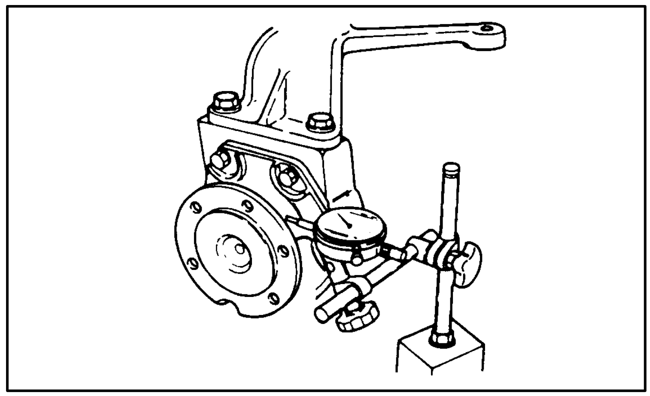


Figure 34

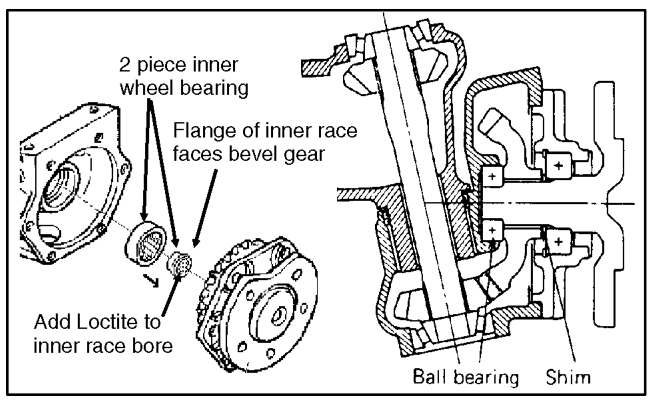


Figure 35

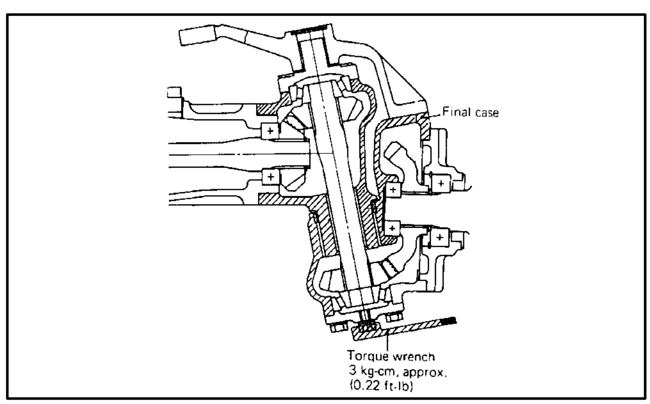


Figure 36

Installing Axle on Machine

1. Support axle under machine with a jack.

2. Install axle pivot pin to secure axle to frame. Make sure to install thrust washers between axle pivot and frame.

3. Install hydraulic motor to adaptor housing.

4. Install wheels to axle. Tighten wheel bolts to a torque of 85 – 100 ft–lb.

5. Fill axle with SAE 80–90W EP gear lube. Lubricant capacity is approximately 80 oz. (2.5 U.S. qt.).

6. Check rear wheel toe–in and adjust if necessary.

Rear wheel toe-in	.25 in.

Model 03853
Model 03854
Model 03856

Chapter 7

Cutting Units

Table of Contents

Cutting Units
03853, 03854, 03856

Specifications

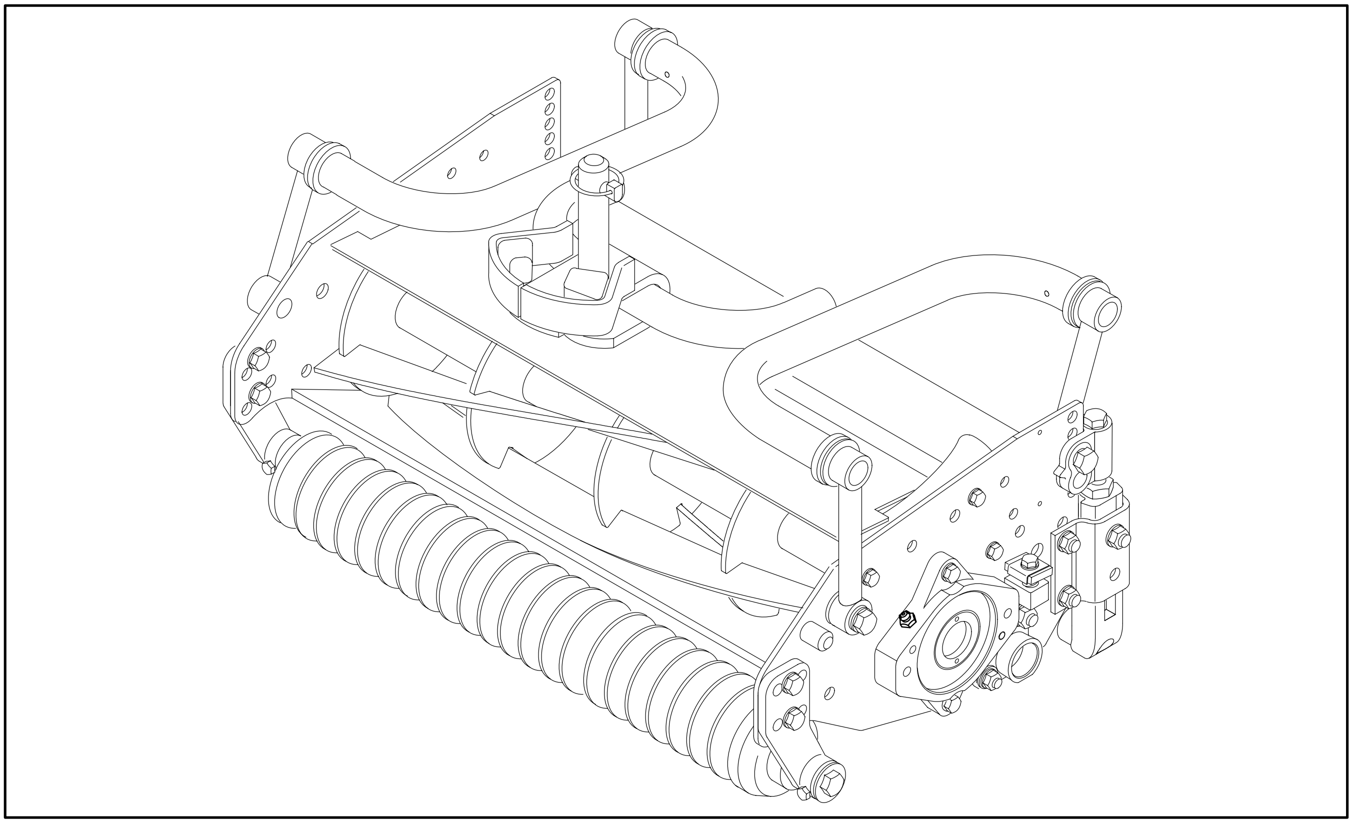


Figure 1

REEL CONSTRUCTION: Fairway reels. All welded. 5 or 11 blades.

HEIGHT OF CUT RANGE:
5 Blade – 3/4" to 1–1/4"
7 Blade – 1/2" to 1–1/8"
11 Blade – 3/8" to 3/4"

REEL DIAMETER: 7 in.

POWER: Reel motors feature quick disconnect for removal or installation onto cutting unit. Cutting units can be driven from either end.

HEIGHT–OF–CUT & ROLLER ADJUSTMENT: Height–of–cut adjustment is made at the rear roller with quick locating pin and/or threaded micro–adjustment. Front roller position is adjustable to 3 locations to set cutting unit attitude.

BEDKNIFE AND BEDBAR ADJUSTMENT: Single point adjustment mechanism.

CLIP FREQUENCY: .375" – 1.25". Reel speed automatically adjusts to maintain proper clip. Reel speed is continuously calculated based on the current forward speed and the pre–set reel type and height of cut.

ROLLERS:
Front rollers: 3" diameter Wiehle rollers. Replacement 3'' diameter full rollers, Part No. 93–3040, are available for the front position.
Rear rollers: 2.5" diameter full rollers. All rollers use the same heavy duty ball bearings with two conventional single lip seals and a Toro labyrinth seal to provide four sealing surfaces to protect the bearings.

ROLLER SCRAPER KITS:
Front Roller Scraper Kit, P/N 93–2967.
Rear Roller Scraper Kit, P/N 93–2962.

Special Tools

Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*.

Some tools may have been supplied with your machine or available as TORO parts. Some tools may also be available from a local supplier.

Gauge Bar Assembly

Use gauge bar to verify height of cut.

Toro P/N **59–7900**

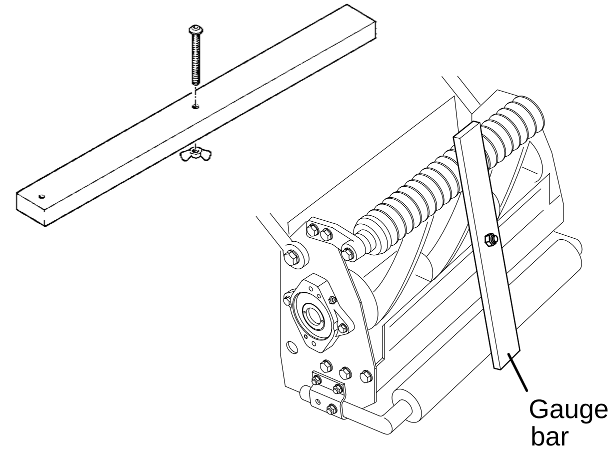


Figure 2

Handle Assembly – TOR299100

For applying lapping compound to cutting units while keep hands a safe distance from the rotating reel.

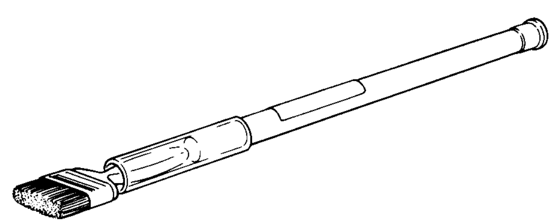


Figure 3

Cutting Units
03853, 03854, 03856

Bedknife Screw Tool – TOR510880

This screwdriver–type bit is made to fit Toro bedknife attaching screws. Use this bit with a torque wrench to secure the bedknife to the bedbar. Make sure bedbar threads are clean and use new screws. Tighten screws to a torque of 250 – 300 in.lb. (288 – 345 KgCm) starting in the middle of the bedknife as shown in figure 5.

NOTE: Remove all rust, scale and corrosion from bedbar surface before installing bedknife.

DO NOT use and air impact wrench with this tool.

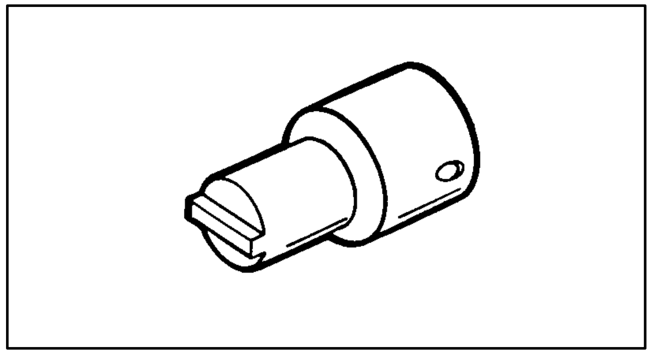


Figure 4

Reel Drive Shaft – TOR4074

Use reel drive shaft for rotating cutting reel when hydraulic motor is removed (backlapping or sharpening).

NOTE: This tool is included in Cutting Unit Tool Kit TOR4070.

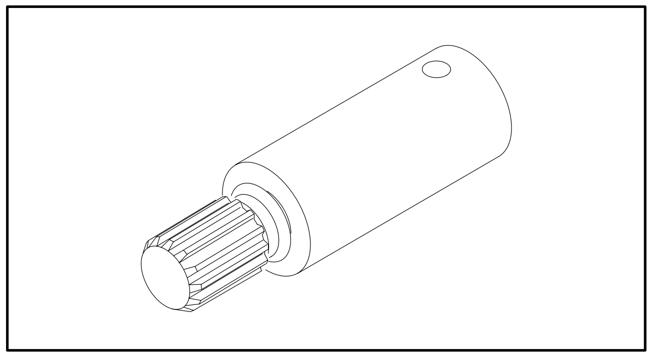


Figure 5

Cutting Unit Tool Kit –TOR4070

This tool kit includes special tools required for rebuilding the cutting unit and cutting unit drive motor on the Reelmaster 6500–D and 6700–D.

TOR4064	Spanner Wrench
TOR4065	Inner Oil Seal Installer
TOR4066	Bearing Installer
TOR4067	Shaft Support Tool
TOR4068	Inner Seal Installer
TOR4869	Outer Seal Installer
TOR4071	Outer Oil Seal Installer
TOR4072	Reel Motor Shaft Seal Protector
TOR4073	Handle
TOR4074	Spline Insert Tool

Figure 6

Troubleshooting

There are a number of factors that can contribute to unsatisfactory quality of cut, some of which may be turf conditions. Turf conditions such as excessive thatch, “sponginess” or attempting to cut off too much grass height may not always be overcome by adjusting the machine. It is important to remember that the lower the height of cut, the more critical these factors are.

Remember that the “effective” or actual height of cut depends on cutting unit weight and turf conditions. Effective height of cut will be different than the bench set height of cut.

Factors That Can Affect Quality of Cut

Factor	**Possible Problem/Correction**
1. Reel speed and ground speed.	Make sure HOC Selector is set to correct position (A – P) for height of cut and number of reel blades. Slow down or speed up if Reel Control lamp comes on. Make sure controller is programmed for correct cutting unit model (5, 7 or 11 blade) All reels should rotate at same speed (within 100 RPM). All cutting units should have equal bedknife to reel contact. If checking RPM, do not run reel to long without cutting grass, or bedknife and/or reel may overheat and “rifle”. See other items under Troubleshooting in Chapter 4 – Hydraulic System and Chapter 5 – Electrical System.
3. Tire pressure.	Check and inflate to specification if necessary. Must be equal in two front tires and two rear tires. NOTE: Correct tire size and inflation pressure is important on 4WD model to prevent scuffing of turf.
3. Reel bearing condition.	Replace bearings if worn or damaged. Do not over–tighten bearing retainer nut.
4. Reel and bedknife sharpness.	Reel and/or bedknife that has rounded cutting edges or “rifling” cannot be corrected by tightening bedknife to reel contact. Grind reel to remove taper and/or rifling (grooved or wavy appearance). Grind bedknife to sharpen and/or remove rifling. (Most common cause of rifling is bedknife to reel contact that is too tight.) NOTE: New bedknife must be ground or backlapped after installing on bedbar.

Factor	Possible Problem/Correction
5. Bedknife to reel adjustment.	Check bedknife to reel contact daily. Bedknife must have light contact all across reel. No contact will cause cutting edges to become dull. Excessive contact accelerates wear; quality of cut may be adversely affected. Adjust so you paper can be pinched between reel and bedknife without tearing when inserted from the front, and cuts cleanly when inserted at a right angle (along entire length of bedknife). Slightly dull cutting edges may be corrected by backlapping, Excessively dull cutting edges must be corrected by grinding the reel and bedknife.
6. Front roller position.	Make sure front rollers on all cutting units are level and in the same position. Mount front roller brackets in one of three positions to set cutting unit attitude.
7. Rear roller parallel to reel.	Rear roller must be leveled so it is parallel with the reel before setting height of cut.
8. Height of cut.	Make sure all cutting units are set at same height of cut. Set with rear roller – must be equal at both ends of roller.
9. Roller scraper adjustment.	Install and/or adjust front and rear roller scrapers if grass clippings build up on rollers.
10. Stability of bedbar.	Check bedbar end bushings, adjuster pivot bushings and nylon flanged bushings for wear or damage. Check adjustment knob to make sure detent holds adjustment.
11. Number of reel blades.	Use cutting unit model with correct number of blades for clip frequency and optimum quality of cut range (see Specifications).
12. Cutting unit alignment and ground following.	Check lift arms and cutting unit pivot linkages for wear, damage or binding.
13. Roller condition.	All rollers should rotate freely. Replace bearings if they are worn, damaged, or have excessive radial play.

Set–up and Adjustments

IMPORTANT: Toro strongly recommends the use of a leveling plate when setting–up or adjusting any reel type cutting unit. The leveling plate will help to ensure accurate and consistent adjustments.

Note: Right and left ends of cutting unit is determined by standing in the operator's position (Fig. 7).

Use the following sequence to set–up and adjust each cutting unit:

1. Check each end of the reel for grease. Grease should be visibly evident in the reel bearings and internal splines of reel shaft.

2. Insure that all nuts and bolts are securely fastened.

3. Make sure 4 bar link suspension operates freely and does not bInd when moved back and forth.

4. Adjust bedknife to reel.

5. Adjust and level front and rear rollers.

6. Set height–of–cut.

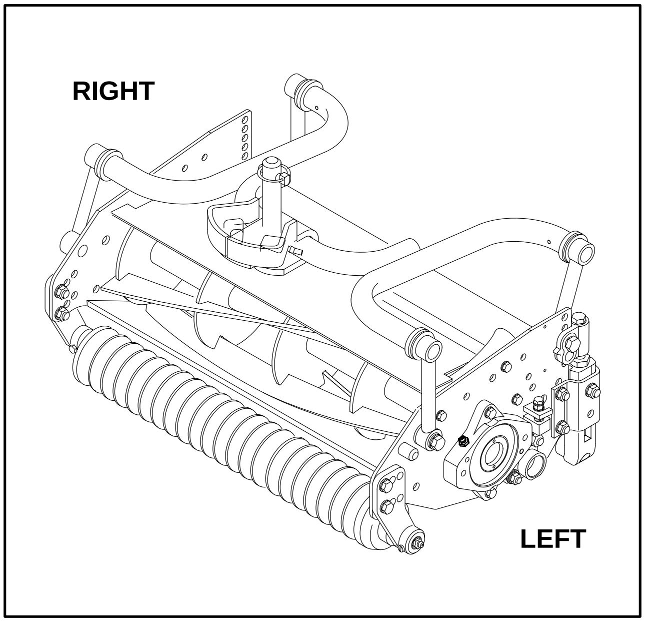


Figure 7

Bedknife to Reel Adjustment

1. A 19 mm (3/4 inch) wrench will be needed to rotate bedknife adjustment knob. Each notch on the knob will move the bedknife .0005 inches (.013 mm) (Fig. 6).

2. On either end of reel, insert a long strip of dry newspaper between reel and bedknife. While slowly rotating reel into bedknife, turn bedknife adjusting knob clockwise, one click at a time until paper is pinched lightly, which results in a slight drag when paper is pulled.

3. Check for light contact at other end of reel using paper. If light contact is not evident, proceed to next step.

4. Slightly loosen (2) locknuts securing pivot hub to left sideplate.

5. Rotate pivot hub adjusting screw until a slightly larger gap exists between reel blades and bed knife on left end than on right end.

6. On right end of reel, insert a long strip of dry newspaper between reel and bedknife. While slowly rotating reel into bedknife, turn bedknife adjusting knob clockwise, one click at a time until paper is pinched lightly, which results in a slight drag when paper is pulled.

7. Rotate pivot hub adjusting screw until the gap between reel blades and bedknife is equal on both ends.

8. Tighten locknuts securing pivot hub to left sideplate and verify adjustment.

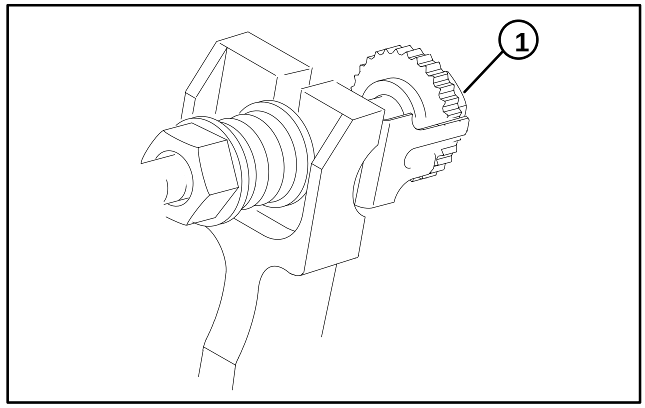


Figure 8

1. **Bedknife adjusting knob**

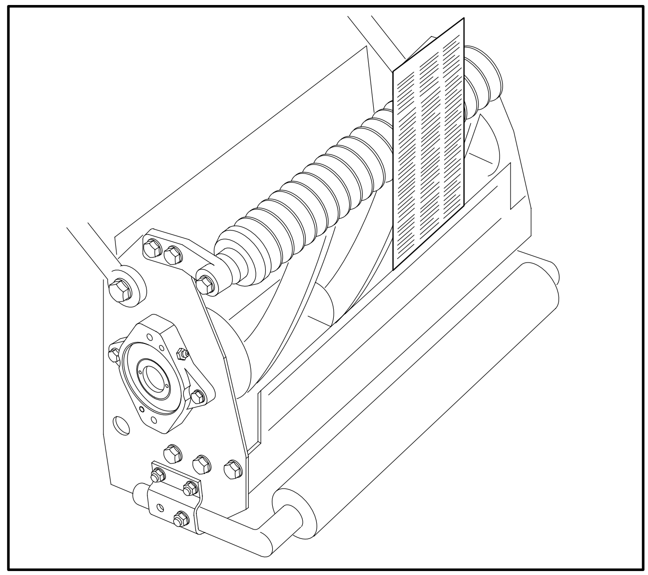


Figure 9

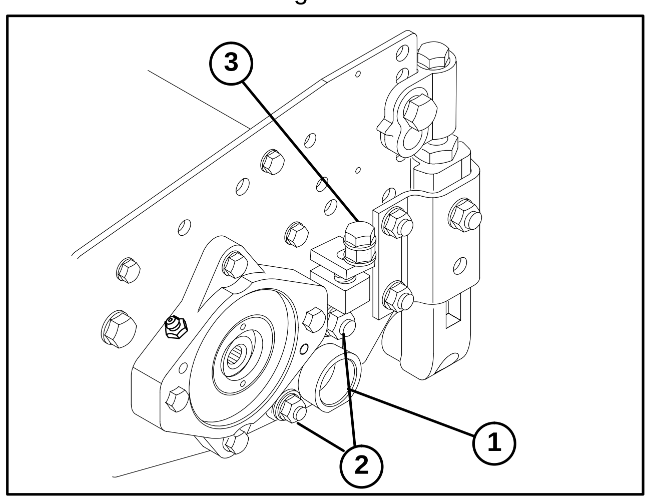


Figure 10

1. **Pivot hub**
2. **Pivot hub locknuts**
3. **Pivot hub adjusting screw**

Front Roller Adjustment and Leveling

Note: Cutting units are shipped from the factory with the front roller mounted in the “C” position. The best cutting unit attitude is dependent on turf conditions and desired results. Experience in your conditions will determine the best setting to use.

ROLLER POSITION	APPLICATION
A	**Very Aggressive Mowing**
B	**Aggressive Mowing**
C	**Less Aggressive Mowing**

When setting–up a cutting unit, or if repositioning or installing a front roller to the cutting unit, proceed as follows:

1. Position cutting unit on a flat level surface (leveling plate).

2. Position a 1/2” (13mm) or thicker bar under the reel blades and against the cutting edge of the bedknife. **Make sure bar covers the full length of reel blades.** Rear roller should not contact surface.

3. Make sure capscrews and locknuts securing front roller brackets to side plates are loose.

4. Make sure capscrews securing front roller to front roller brackets are loose.

5. Rock cutting unit forward (on reel blades and steel bar) until front roller contacts flat surface. Reel blades and bedknife must maintain contact with bar.

6. **Make sure both ends of roller are in contact with level surface.** Use a piece of paper to check to see if any gap exists between roller ends and flat surface.

7. Tighten front roller bracket mounting nuts to 27–35 ft–lbs. **Do not tighten capscrews.** Make sure roller brackets do not move and both ends of roller remain in contact with level surface.

8. Tighten front roller mounting capscrews to 13–27 ft–lbs.

9. Re–check roller contact with paper to insure roller has not changed position and is parallel with the reel and bedknife.

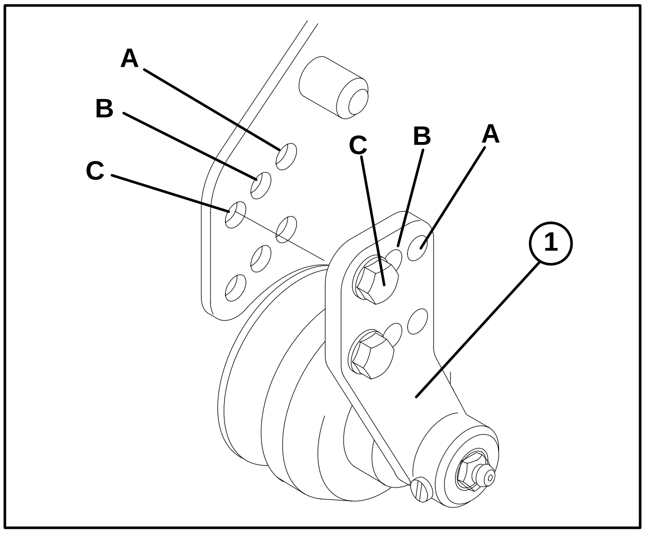


Figure 11
1. Roller bracket

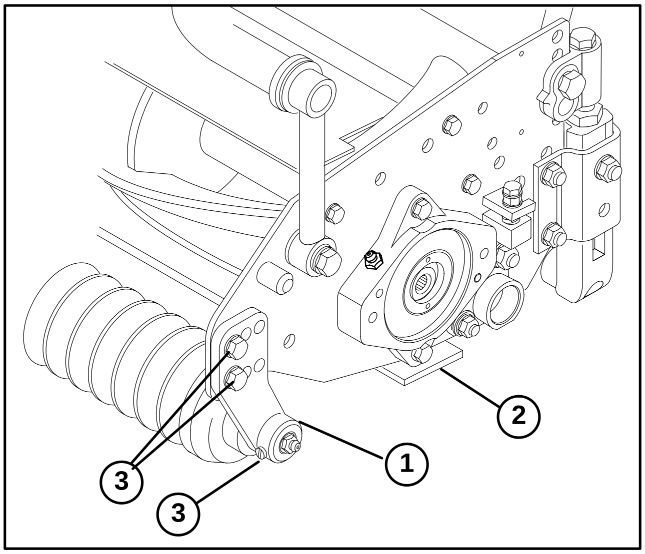


Figure 12
1. Front roller bracket
2. 1/2” Steel bar
3. Loosen capscrews & nuts

Cutting Units
03853, 03854, 03856

Height of Cut

The Height–of–Cut adjustment is made by moving the rear roller up or down, **after adjusting and leveling the front roller**. This can be done by using the adjusting screw or quick height–of–cut locating pin (Fig. 13 & 13).

Note: To ensure accuracy, initial rear roller set–up should be performed on a leveling plate .

1. Select proper rear roller position holes for desired height–of–cut (Fig. 13 & 15).

Note: If final height–of–cut settings other than those shown in figure 15 are desired, select the set of position holes closest to desired height–of–cut. Use top capscrews (Fig. 13) to adjust to final setting.

2. Position cutting unit on a flat level surface (leveling plate).

3. Depending on which front roller position is selected, adjust capscrew on top of each rear roller bracket to attain approximate distance (Dimension X) between support and bracket (Fig. 13 & 13).

4. Continue to adjust top capscrews slightly to level rear roller if required.

5. Tighten retainer nut securing roller bracket to angle bracket.

6. Verify desired height–of–cut using gauge bar.

Note: Once cutting unit has been properly set–up (leveled and parallel), height–of–cut can be quickly changed by changing the quick height–of–cut pin location.

Figures 13 & 15 show the height–of–cut settings which can be achieved by installing the the quick height–of–cut pin in the different hole combinations.

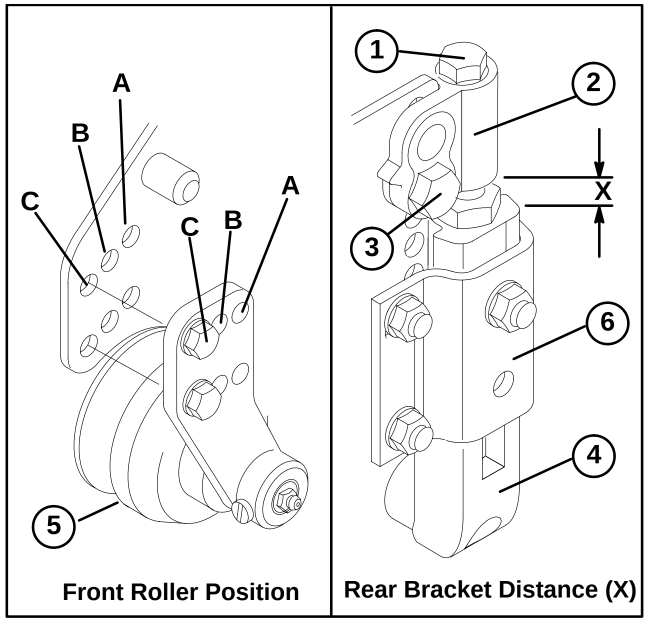


Figure 13

1. **Height–of–cut adjusting capscrew**
2. **Height–of–cut support**
3. **Quick height–of–cut pin**
4. **Roller bracket**
5. **Front roller**
6. **Angle bracket**

Front Roller Position	**(Dimension X, Fig. 13)** Distance between brackets
A	**15/16” (24mm)**
B	**5/8” (16mm)**
C	**1/2” (13mm)**

Figure 14

REAR ROLLER POSITIONS

Height –of–Cut	**Height–of–Cut Hole In Support**		**Side Plate Hole**					
	Upper	**Lower**	**1**	**2**	**3**	**4**	**5**	**6**
3/8” (9mm)	**X**		**X**					
1/2” (13mm)		**X**			**X**			
5/8” (16mm)	**X**			**X**				
3/4” (19mm)		**X**				**X**		
7/8” (22mm)	**X**				**X**			
1” (25mm)		**X**					**X**	
1–1/8” (28mm)	**X**					**X**		
1–1/4” (31mm)		**X**						**X**

Figure 15

Verify Height of Cut

1. On gauge bar, set head of screw to desired Height–of–Cut. This measurement is from bar face to underside of screw head.

2. Place the bar across the front and rear rollers and adjust the rear roller up or down until the underside of screw head engages the bedknife edge. Do this on both ends of reel.

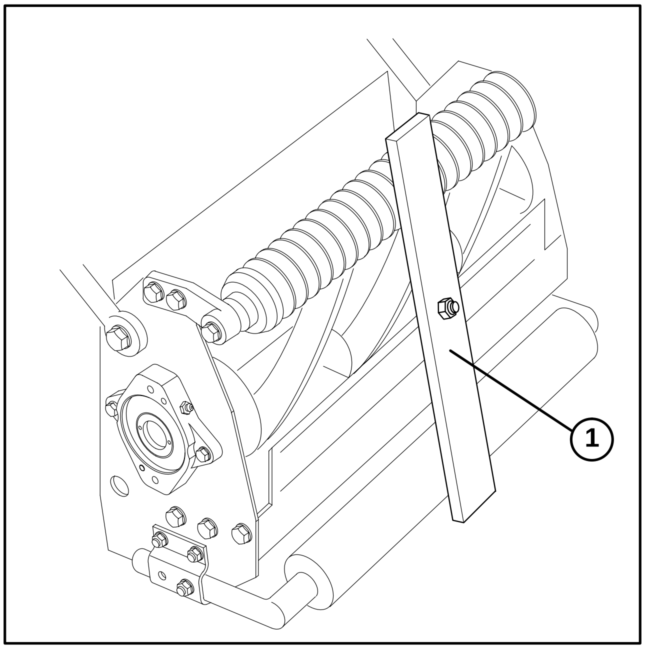


Figure 16

1. Gauge bar

Grass Shield and Fin Adjustment

Adjust grass shield and/or shield fin angle for desired grass clippings dispersion.

1. Position cutting unit on a flat level surface.

2. To adjust fins, unhook and move front mounting tab to the straight ahead or angled position slot. Set fins to prevent windrowing of clippings. Windrowing can occur due to the helix of the reel or when clippings are discharged onto frame members or tires.

3. To change grass shield angle, loosen flange head capscrew securing shield to left side plate, move shield to desired angle and tighten screw.

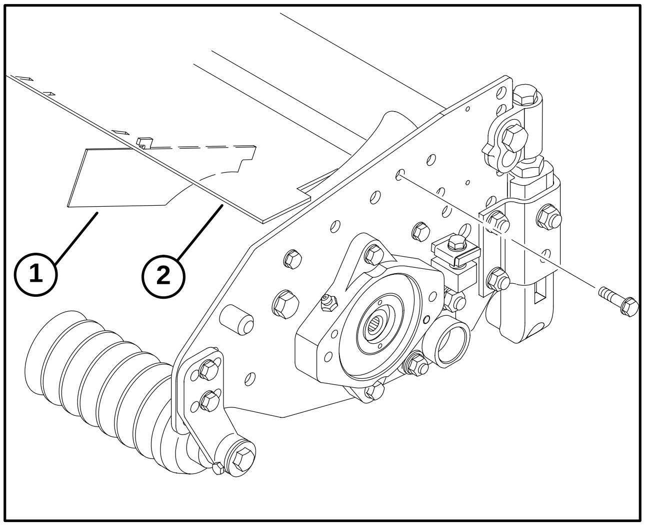


Figure 17

1. Shield fin
2. Grass shield

Backlapping

Note: See traction unit Operator’s Manual for complete operating instructions.

Note: Lapping is not intended to be a reconditioning process to correct severely nicked or rounded blades, rifling or taper. If, after 5 minutes of lapping, the edge is not restored, it is time to grind the reel.

DANGER

TO AVOID PERSONAL INJURY OR DEATH:
- **Never place hands or feet in reel area while engine is running.**
- **While backlapping, reels may stall and then restart.**
- **Do not attempt to restart reels by hand or foot.**
- **Do not adjust reels while engine is running.**
- **If reel stalls, stop engine before attempting to clear reel.**

Note: Backlap either the front cutting units together or the rear ones together.

1. Position machine on a clean, level surface, lower the cutting units, stop the engine, engage the parking brakes, move enable/disable switch to disable position and remove key from ignition switch.

2. Unlock and raise seat to expose controls.

3. Make initial reel to bedknife adjustments appropriate for backlapping on all cutting units. Start engine and set engine to low idle speed.

4. Set reel speed control to Position P. Select either front or rear on backlap switch to determine which units to backlap.

5. Move enable / disable switch to enable position. Move lower mow / raise lever forward to start backlapping operation on designated reels.

6. Apply lapping compound with long handled brush supplied with machine.

CAUTION

Be careful when lapping the reel because contact with the reel or other moving parts can result in personal injury.

7. To make an adjustment to the cutting units while backlapping, Turn reels OFF by moving Lower mow / Raise lever REARWARD, Move Enable / Disable switch to DISABLE and turn engine OFF. After adjustments have been completed, repeat steps 3–6.

8. Repeat procedure for remaining cutting units.

9. When backlap operation is completed, return backlap switch to OFF, set reel speed controls to desired mowing setting and wash all lapping compound off cutting units.

Note: Additional instructions and procedures on Backlapping are available in the TORO Sharpening Reel & Rotary Mowers Manual Form No. 80–300PT.

NOTE: For a better cutting edge, run a file across the front face of the bedknife when the lapping operation is completed. This will remove any burrs or rough edges that may have built up on the cutting edge.

Bedbar Removal and Installation

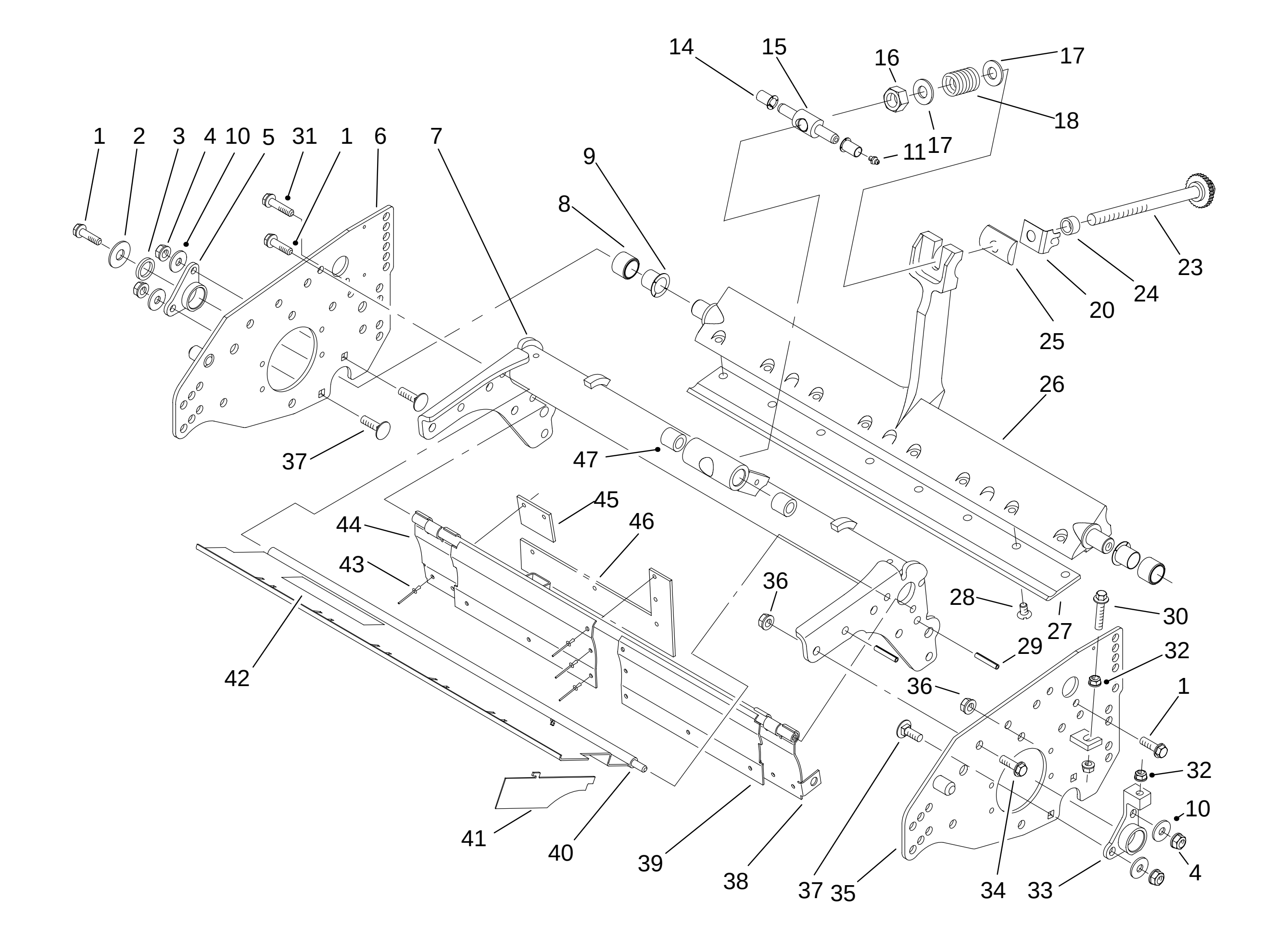


Figure 18

Remove Bedbar

1. Loosen bedknife adjusting knob to loosen bedknife to reel contact.

2. Loosen locknut on bedknife adjuster assembly and disengaging adjuster from bedbar. NOTE: On early production cutting units there is no slot in bedbar for disengaging bedknife adjuster from the bedbar; you must completely unscrew adjuster assembly from pivot on cutting unit frame.

3. Remove bedbar leveling screw and spring from L.H. side of cutting unit.

4. Remove fasteners securing L.H. and R.H. bedbar pivot hubs to frame.

5. Remove bedbar assembly.

6. Remove capscrew, washer and quad ring from R.H. end of bedbar.

7. Remove R.H. and L.H. pivot hubs from bedbar.

8. Sharpen or replace bedknife as necessary (see Bedknife Replacement and Grinding).

Install Bedbar

1. Inspect bedbar end bushings and flange bushings for wear and replace if necessary.

2. Install R.H. and L.H. pivot hubs onto bedbar.

3. Install quad ring, washer and capscrew to R.H. end of bedbar.

4. Install bedbar onto cutting unit and secure pivot hubs to frame with fasteners removed in step 4 above.

5. Install bedbar leveling capscrew and spring to L.H. side of cutting unit.

6. Install bedknife adjusting knob assembly. Tighten locknut to compress spring to dimension shown.

7. Adjust bedknife to reel (see Bedknife to Reel Adjustment).

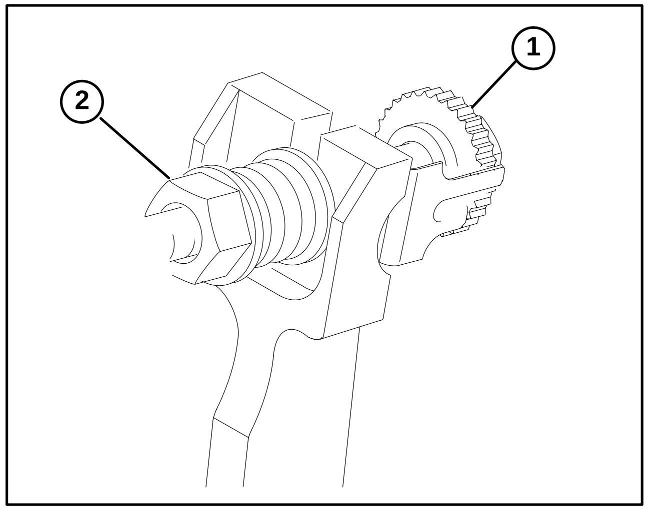


Figure 19

1. **Bedknife adjusting knob**
2. **Locknut**

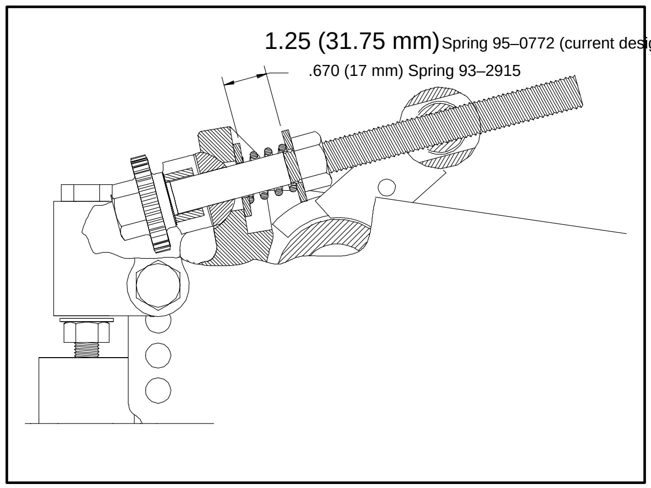


Figure 20

Bedknife Replacement and Grinding

1. Remove bedbar from cutting unit.

2. Remove bedknife screws and remove bedknife.

3. Remove all rust, scale and corrosion from bedbar surface before installing new bedknife.

4. Install new bedknife:

A. Make sure bedbar threads are clean.

B. Use new screws. Apply anti–seize lubricant to screw threads before installing.

C. Tighten screws to a torque of 250 – 300 in.lb. (288 – 345 KgCm) working from the center toward each end of the bedbar. DO NOT use an impact wrench.

5. Since there can be variations in the mounting surface of the bedbar, a new bedknife will not be perfectly flat after it is installed. Because of this, it is necessary to backlap or grind a new bedknife after installing it to the bedbar. Follow the existing angle that was ground into the bedknife and grind only enough to make sure the top surface is true.

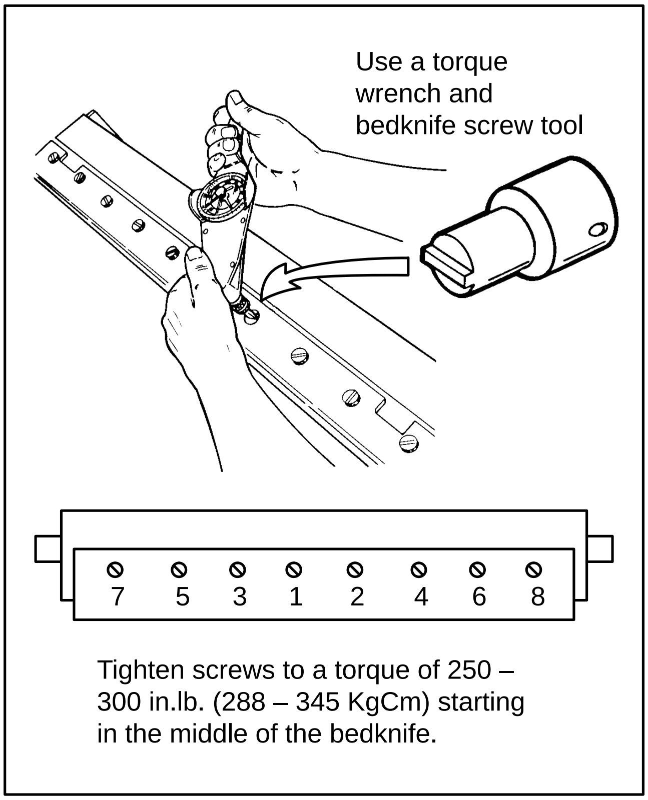


Figure 21

Regrinding Bedknife

Remove bedbar / bedknife assembly from cutting unit before attempting to regrind a used bedknife. Keep the bedknife fastened to the bedbar when grinding.

Note: When grinding, be careful to not overheat the bedknife. Remove small amounts of material with each pass of the grinder.

Bedknife Regrinding Specifications	
Relief Angle	5°
Relief Angle Range	3° – 6°
Front Angle	15°
Front Angle Range	13° – 17°

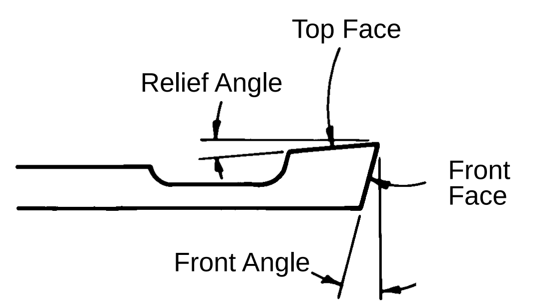


Figure 22

Preparing Reel for Grinding

1. Check to make sure reel bearings are in good condition and properly adjusted before grinding the reel. Make sure the cutting unit frame and roller brackets are true and not bent or damaged from impacts with trees, posts or cart path edges.

2. Remove bedbar assembly.

3. Remove parts as necessary to mount the cutting unit in the grinder (e.g. front roller, brackets). Follow the ginding equipment manufactuer's instructions for mounting the cutting unit.

Note: The cutting unit must be aligned so the grinding wheel will travel parallel to the reel shaft. This will result in the the reel being ground to the desired cylinder shape.

Note: When grinding, be careful to not overheat the reel blades. Remove small amounts of material with each pass of the grinder.

4. After completing the grinding process, do a complete set–up and adjustment procedure.

Reel Grinding Specifications	
Nominal Reel Diameter	7″ (178 mm)
Service Limit Reel Diameter	6.2″ (158 mm)
Blade Relief Angle	30°
Relief Angle Range	20° – 40°
Blade Land Width	.060″ (1.5 mm)
Land Width Range	.050″ – .090″ (1.3 – 2.3 mm)
Service Limit Reel Taper	.060″ (1.5 mm)

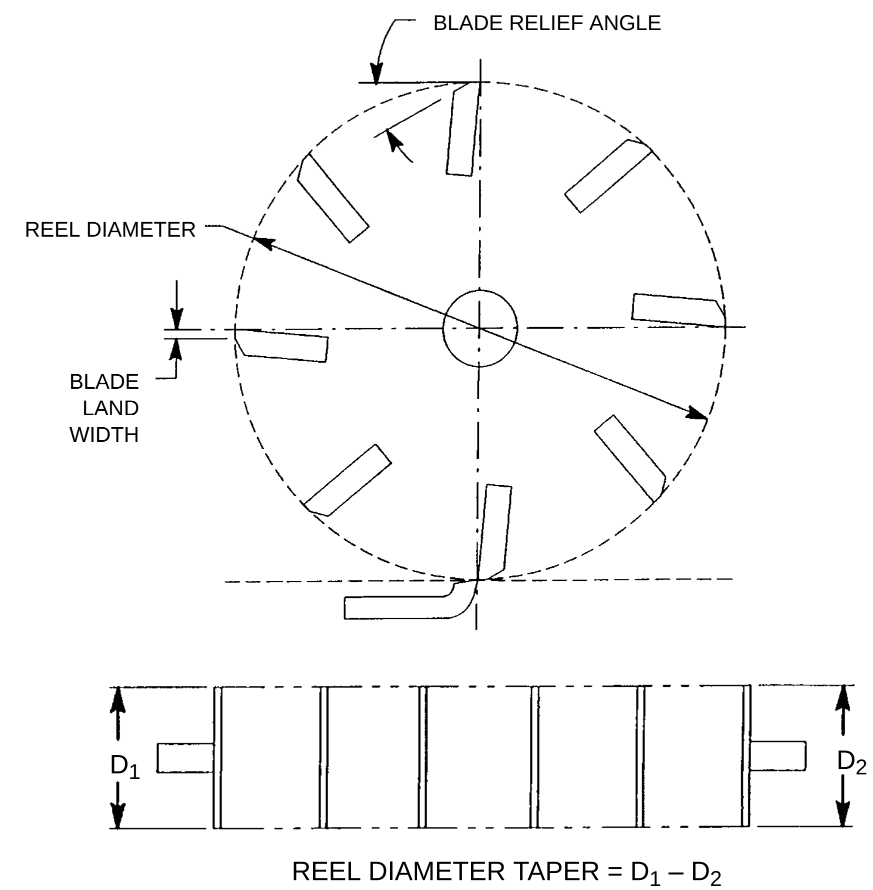


Figure 23

Reel Removal and Bearing Replacement

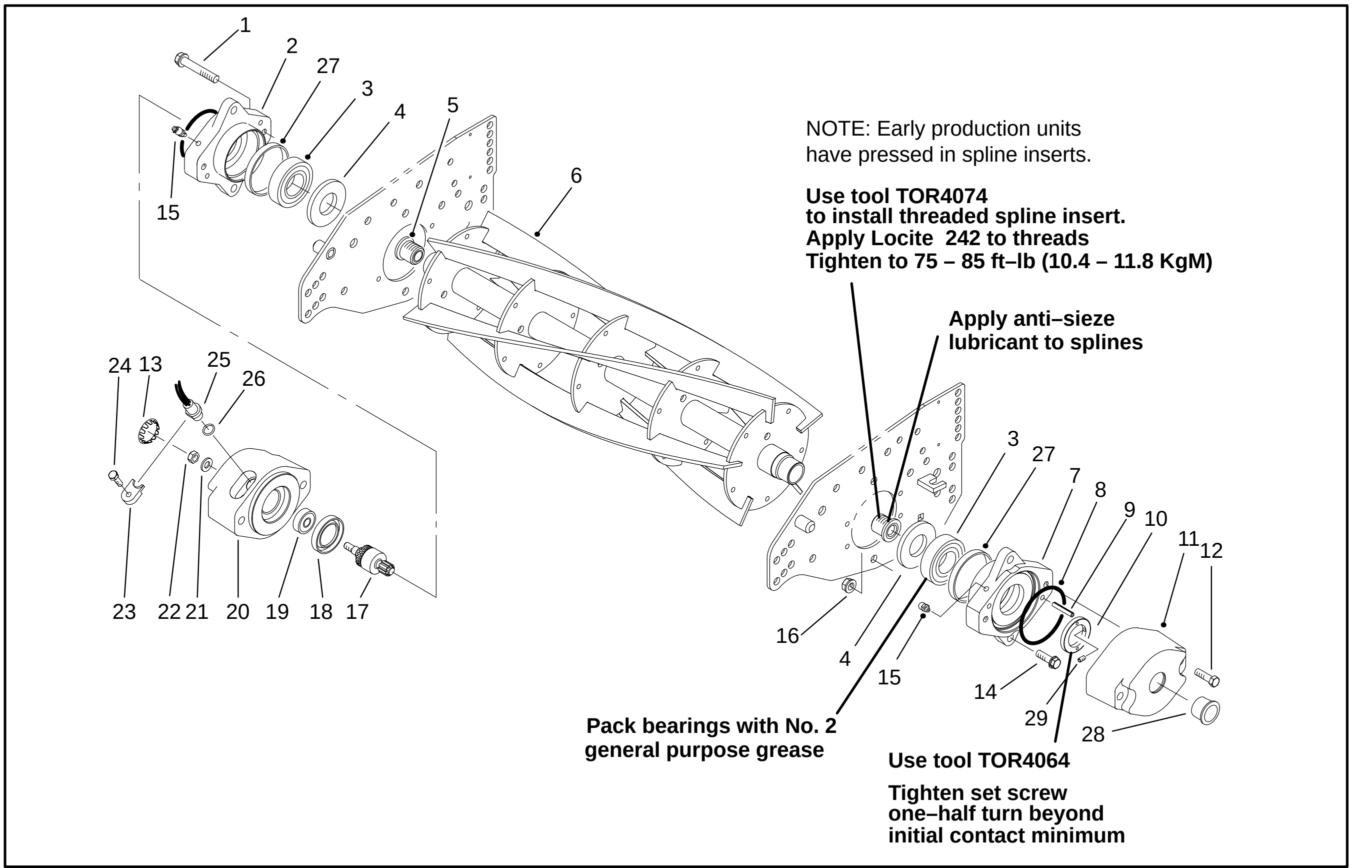


Figure 24

1. Screw
2. R.H. bearing housing
3. Bearing
4. Grease seal
5. Threaded insert
6. Reel assembly
7. L.H. Bearing housing
8. O–ring
9. Roll pin
10. Bearing adjustment nut
11. End weight
12. Screw
13. Cap plug
14. Screw
15. Grease fitting
16. Lock nut
17. Shaft magnet assembly
18. Outer seal
19. Bearing
20. End weight housing
21. Flat washer
22. Lock nut
23. Clamp
24. Screw
25. Speed sensor
26. O–ring
27. Bearing ring
28. Plug
29. Set screw

Remove Reel

1. Remove weight from cutting unit. If equipped with a speed sensor, remove shaft magnet after removing weight and sensor.

2. Remove bedbar assembly.

3. Remove front roller assembly.

4. Remove bearing adjustment nut from L.H. bearing housing.

5. Use a hammer and punch to drive out roll pins from L.H. bearing housing. Remove L.H. bearing housing. It is not necessary to remove the R.H. bearing housing.

6. Remove reel.

Inspect Reel

1. Replace reel if diameter has decreased to the service limit (see Reel Grinding Specifications).

2. Replace reel if blades are bent or cracked.

3. Inspect reel shaft splined inserts and replace if worn or damaged. Two different styles of reel and splined inserts were manufactured:

A. Early cutting units had a pressed in spline insert. The splined insert can be pressed out by using a long rod inserted through the reel shaft tube.

B. The current design uses threaded inserts, installed with thread locking compound (Loctite 242 or equivalent). One side is L.H. threads and the other R.H. threads (R.H. has identification groove on outer surface of flange). To remove or install threaded spline inserts, use tool TOR4074. Before installing, apply Loctite 242 or equivalent to threads and tighten to a torque of 75 – 85 ft–lb (10.4 – 11.8 KgM)

4. Inspect bearings and seals. To replace seals and bearings:

A. Use a bearing puller tool to remove the bearings. To prevent damage to bearings, pull on the inner bearing race. Remove the seals. NOTE: If bearing is removed, the seal should be replaced.

B. Install new seals on the reel shaft. Make sure seals are installed square to shaft.

C. Pack bearings with No. 2 general purpose grease before installing. Install bearings on reel shaft by pressing on the inner bearing race.

Install Reel

1. Set cutting unit frame in a vertical position so R.H. bearing housing is down. Install reel into R.H. bearing housing.

2. Install L.H. bearing housing. Install roll pins.

3. Hit end of reel shaft with a brass hammer to make sure that R.H. reel bearing is seated on shoulder of R.H. bearing housing.

NOTE: If bearing adjustment nut does not have a set screw, replace it with 95–2793 Reel Bearing Retainer and 3245–42 Set Screw. If reinstalling adjustment nut that does not have a set screw, clean threads on bearing adjustment nut, and apply Loctite 271 or equivalent to nut before installing.

4. Install bearing adjustment nut and tighten with special spanner wrench TOR4064 until contact is made with the bearing and reel end play is removed. NOTE: Over–tightening can cause early bearing failure. Tighten set screw to secure bearing adjustment nut. Tighten set screw one–half turn beyond initial contact minimum.

5. Install front roller assembly.

6. Install bedbar assembly.

7. Apply anti–seize lubricant to splines on splined couplers.

8. Install shaft magnet if this cutting unit is to be equipped with a speed sensor.

9. Install weight assembly.

Roller and Frame Service

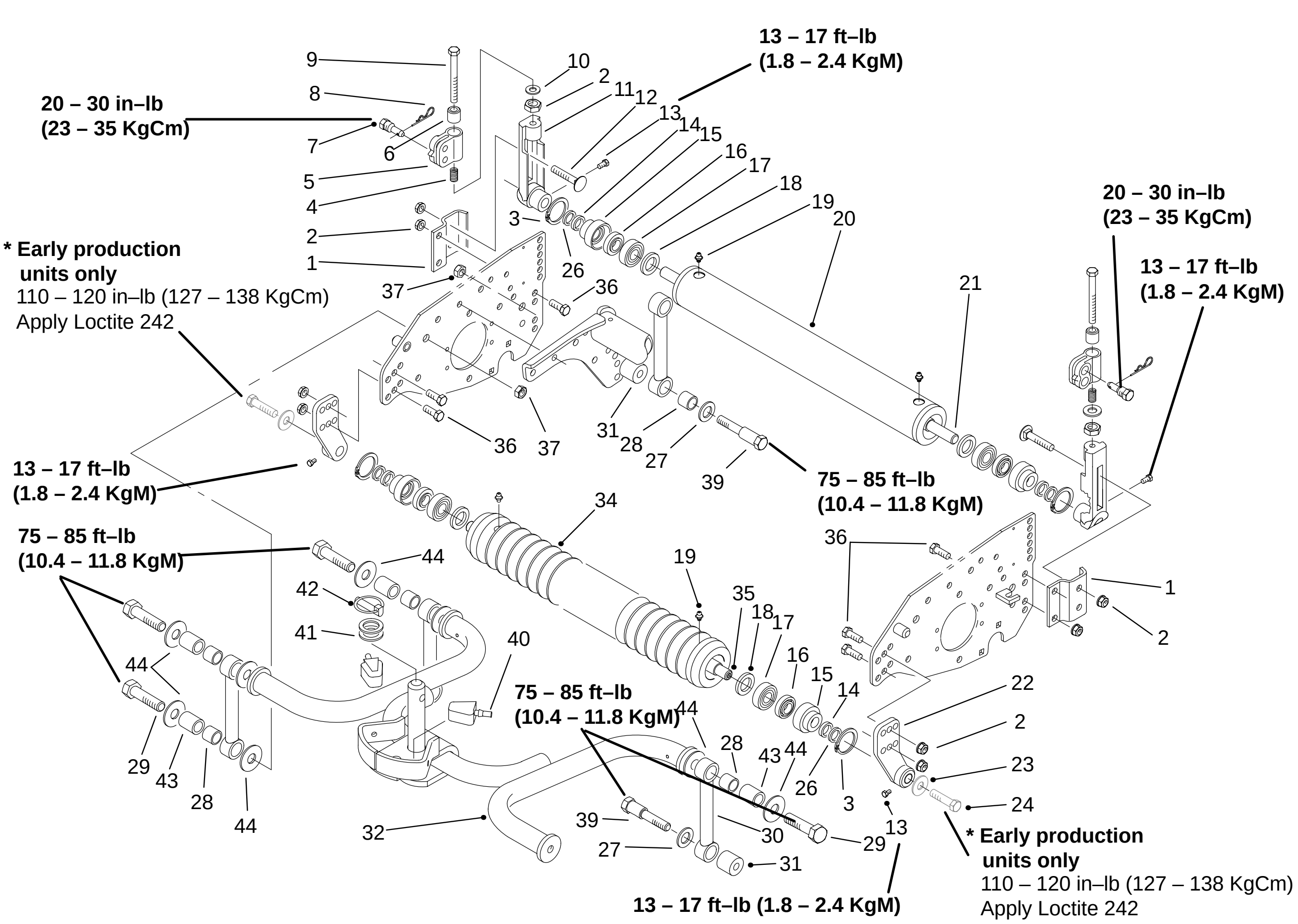


Figure 25

1. Angle bracket
2. Lock nut
3. Snap ring
4. HOC compression spring
5. Rear HOC support
6. Spacer
7. HOC pin
8. Hair pin cotter
9. Screw
10. Special washer
11. Rear HOC bracket
12. Carriage screw
13. Screw
14. Oil seal
15. Outer seal
16. Inner seal
17. Ball bearing
18. Oil seal
19. Grease fitting
20. Rear roller tube assembly
21. Rear roller shaft
22. Front L.H. HOC bracket
23. Belleville washer
24. Screw
26. Roller washer
27. Washer
28. Bushing
29. Bolt
30. 4 bar link
31. Spacer
32. 4 bar frame
34. Wiehle roller
35. Wiehle roller shaft
36. Screw
37. Lock nut
38. Front R.H. HOC bracket
39. Shoulder bolt
40. Bumper
41. Flat washer
42. Lynch pin
43. Spacer link
44. Hardened washer

Cutting Units

Roller Bearing and Seal Replacement

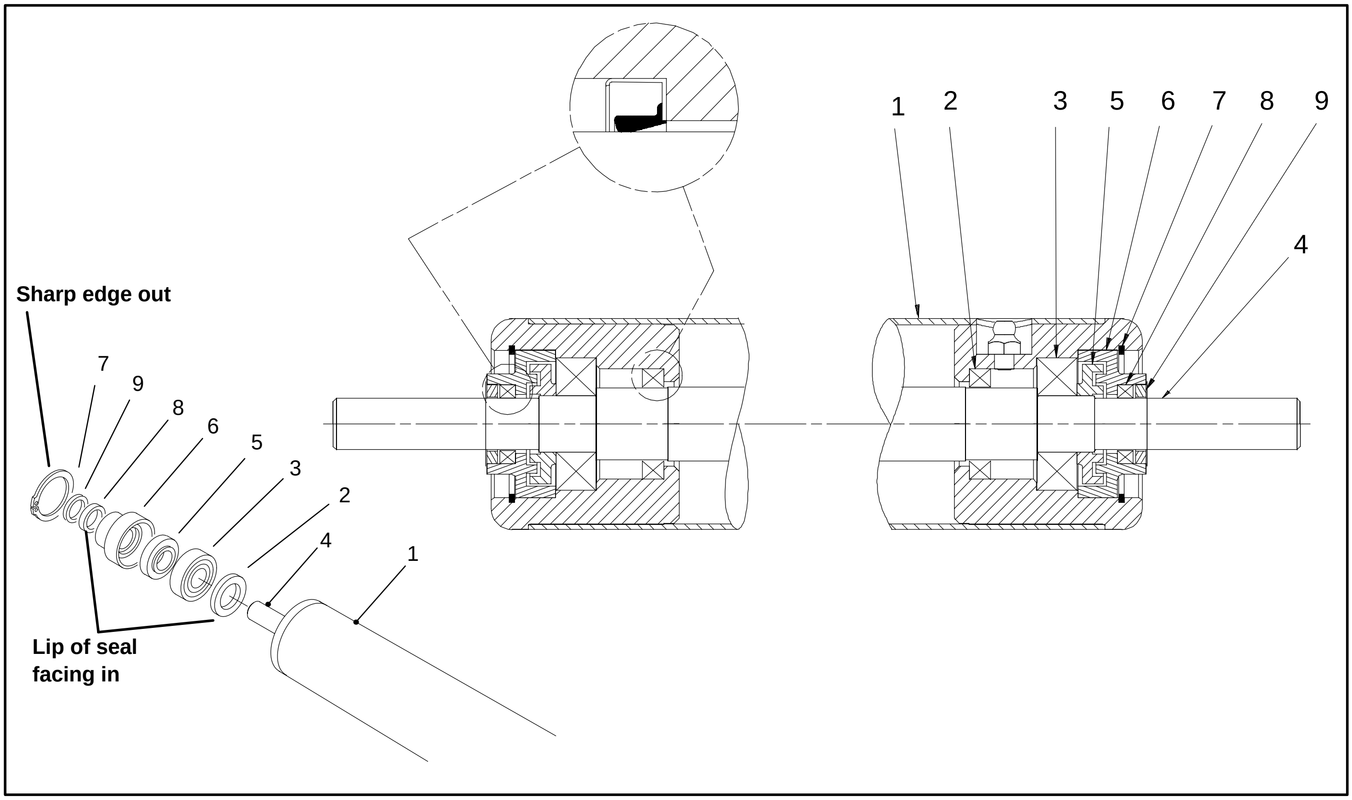


Figure 26

1. Roller	**4. Roller shaft**	**7. Retaining ring**
2. Inner oil seal	**5. Inner seal**	**8. Outer oil seal**
3. Bearing	**6. Outer seal**	**9. Washer**

NOTE: Bearing and seal configurations are the same for both the front and rear rollers.

Remove Seals and Bearings

1. Remove retaining ring from both ends of roller.

2. Hit end of roller shaft with a soft face hammer to remove seals and bearing from one end of roller. Hit other end of roller shaft to remove seals and bearing from other end of roller. Be careful not to drop roller shaft.

3. Discard seals and bearings.

Install New Seals and Bearings

NOTE: A soft face hammer can be used with the special tools to assemble the roller, however use of a press is recommended.

1. Use installation tool TOR4065 and handle TOR4073 to install inner oil seal into each end of roller.

2. Install bearings:

A. Use tool TOR4066, handle TOR4073 to install bearing into one end of roller.

B. Install roller shaft from opposite end of roller. Be carefull not to damage the inner oil seals.

C. Put roller in a vertical position and support shaft and bearing with tool TOR4067.

D. Use tool TOR4067 to install second bearing.

3. Use tool TOR4068 to install inner seal.

4. Use tool TOR4069 to install outer seal

5. Install retaining ring.

6. Use tool TOR4071 to install outer oil seal.

7. Use tool TOR4067 to install washer.

8. Put opposite end of roller facing up and support bottom end with tool TOR4067. Repeat steps 3 – 7.

9. Use a hand operated grease grease gun and No. 2 general purpose lithium base grease to lubricate bearings until grease appears at washer. Wipe off excess grease.

Cutting Unit Installation

Cutting unit models 03854 and 03856 can be installed at any of the five mounting locations on the traction unit. Figure 17 shows the orientation of the hydraulic drive motor for each of the five locations. For any of the locations requiring the motor to be mounted on the right end of the cutting unit, install a counter weight on the left end of the cutting unit. For the locations requiring the motor to be mounted on the left end, install a counter weight on the right end of the cutting unit.

NOTE: Counterweights with speed sensors must be on cutting units to be mounted in the front center and left rear positions on the tractor.

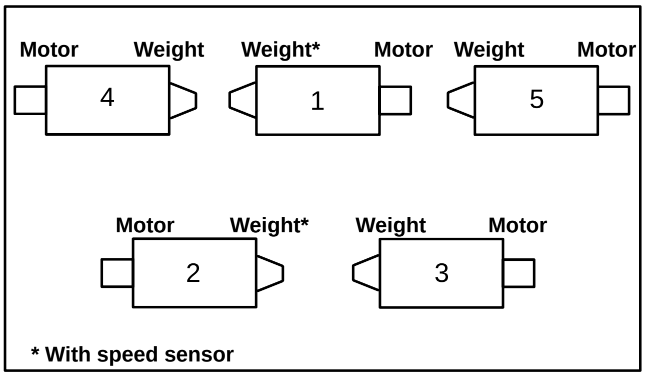


Figure 27

1. Lubricate and install a large O–ring into bearing housing groove on each end of cutting unit (Fig. 28 & 30).

Note: Before installing cutting unit motors or counterweights with speed sensors, lubricate internal splines of cutting unit reels shafts with grease.

2. Install a counter weight onto appropriate end of each cutting unit with capscrews provided (Fig. 28).

3. Install shims as required on pivot shaft of each cutting unit carrier frame (Fig. 29). Use enough shims (0 to 2) to remove any vertical play, but still allow free rotation when lynch pin (5) is installed.

4. Insert the pivot shaft of the carrier frame into the mounting hole at the end of the pivot knuckle (Fig. 29).

5. Guide the pivot knuckle in place between the two rubber centering stops on the carrier frame (Fig. 29).

6. Insert the lynch pin into the cross hole on the pivot shaft (Fig. 29). (If pin does not fit, remove one of the shims from the pivot shaft.)

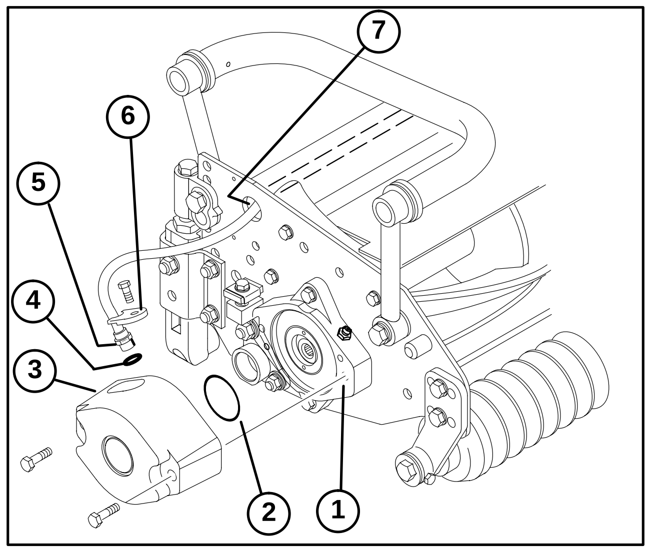


Figure 28

1. Bearing housing
2. O–ring–large
3. Counterweight
4. O–ring –small
5. Speed sensor
6. Speed sensor holder
7. Frame tube

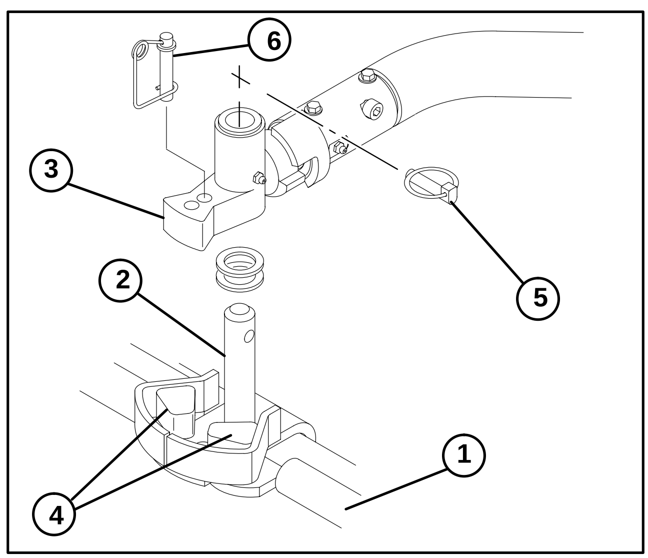


Figure 29

1. Carrier frame
2. Pivot shaft
3. Pivot knuckle
4. Centering stops
5. Lynch pin
6. Steering pin

7. Mount the motor to the drive end of the cutting unit and secure with two capscrews provided (Fig. 30).

8. On front center and left rear cutting units, plug speed sensor wire harness connector into traction unit wire harness connector.

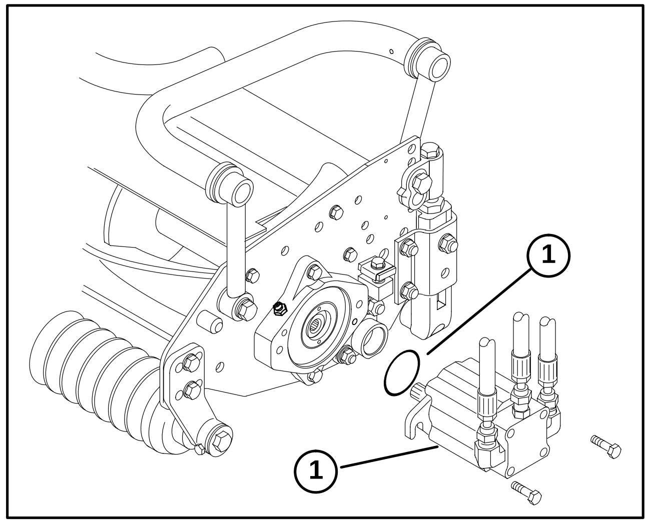


Figure 30
1. Motor
2. O–ring

9. On motor side of cutting unit, insert speed sensor end of harness into frame tube and route to counterweight.

10. Install small O–ring onto speed sensor and insert sensor into hole in counterweight.

11. Secure sensor to counterweight with a sensor holder and a M6 x 20 mm capscrew.

12. Insert steering pin into either front or rear mounting hole on pivot knuckle, using one of the following locations (Fig. 15):

Rear Mounting Hole–Keeps cutting unit in straight line.

Front Mounting Hole–Allows cutting unit to steer itself as traction unit turns.

13. Hook wire around bottom of pin.

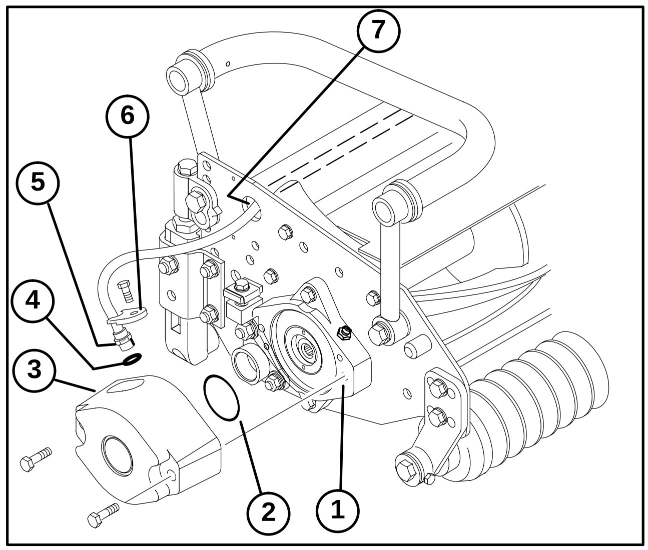


Figure 31
1. Bearing housing
2. O–ring–large
3. Counterweight
4. O–ring –small
5. Speed sensor
6. Speed sensor holder
7. Frame tube

Greasing Bearings, Bushings and Pivot Points

Each cutting unit has (6) grease fittings (Fig. 32) that must be lubricated regularly with No. 2 General Purpose Lithium Base Grease.

The grease fitting locations and quantities are: reel bearings (2) and front and rear rollers (2 ea.)

IMPORTANT: Lubricating cutting units immediately after washing helps purge water out of bearings and increases bearing life.

1. Wipe each grease fitting with a clean rag.

2. Apply grease until pressure is felt against handle.

IMPORTANT: Do not apply too much pressure or grease seals will be permanently damaged.

3. Wipe excess grease away.

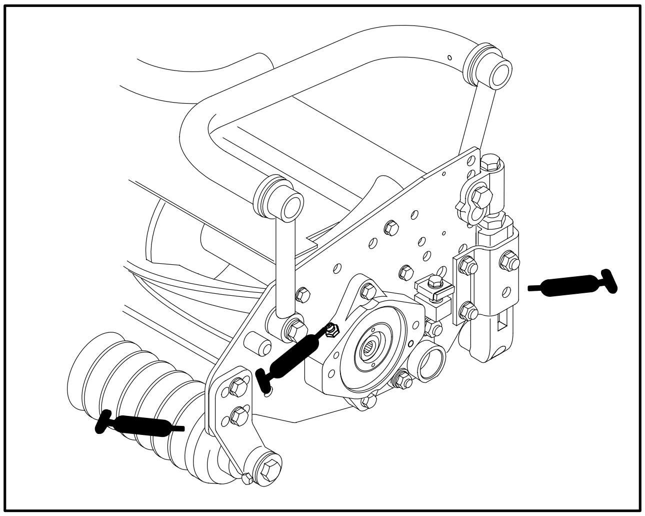


Figure 32

Cutting Units

Model 03857, S/N 80001–80301
Model 03858, S/N 80001–81418
Model 03859, S/N 80001–81992

Chapter 8

Cutting Units

Table of Contents

Specifications

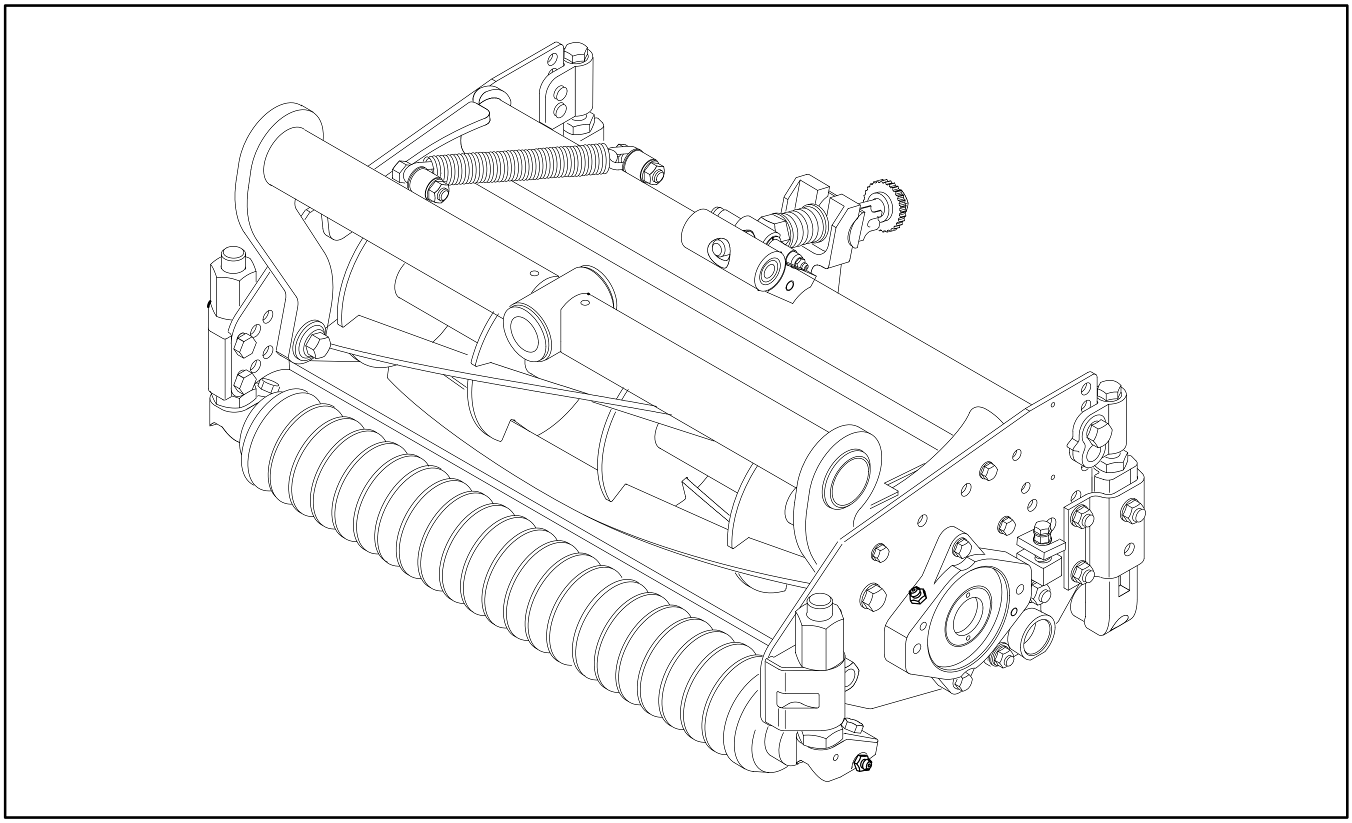


Figure 1

REEL CONSTRUCTION: Fairway reels. All welded. 5, 7 or 11 blades.

HEIGHT OF CUT RANGE:
5 Blade – 3/4” to 1–1/2”
7 Blade – 1/2” to 1–1/8”
11 Blade – 3/8” to 3/4”

Note: Use bedknife Part No. 93–9774 for height–of–cuts below 1/2”.

REEL DIAMETER: 7 in.

POWER: Reel motors feature quick disconnect for removal or installation onto cutting unit. Cutting units can be driven from either end.

HEIGHT–OF–CUT & ROLLER ADJUSTMENT: Height–of–cut adjustment is made at the rear roller with quick locating pin and/or threaded micro–adjustment. Front roller position is adjustable to set cutting unit attitude.

BEDKNIFE AND BEDBAR ADJUSTMENT: Single point adjustment mechanism.

CLIP FREQUENCY: .375” – 1.25”. Reel speed automatically adjusts to maintain proper clip. Reel speed is continuously calculated based on the current forward speed, reel type (number of blades) and height of cut.

ROLLERS:
Front rollers: 3” diameter Wiehle rollers. Optional 3” diameter full rollers, Part No. 93–3040, are available for the front position.
Rear rollers: 2.5” diameter full rollers. All rollers use the same heavy duty ball bearings with two conventional single lip seals and a Toro labyrinth seal to provide four sealing surfaces to protect the bearings.

ROLLER SCRAPER KITS:

Front Roller Scraper	Part No. 95–7729
Rear Roller Scraper Kit	Part No. 98–7996 (1 per kit)

Special Tools

Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*.

Some tools may have been supplied with your machine or available as TORO parts. Some tools may also be available from a local supplier.

Gauge Bar Assembly

Use gauge bar to verify height of cut and bedknife attitude.

Toro P/N **98–1852**

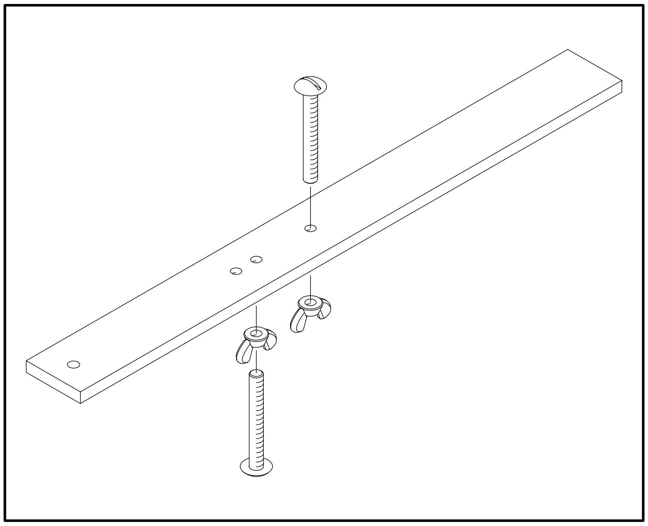


Figure 2

Handle Assembly – TOR299100

For applying lapping compound to cutting units while keep hands a safe distance from the rotating reel.

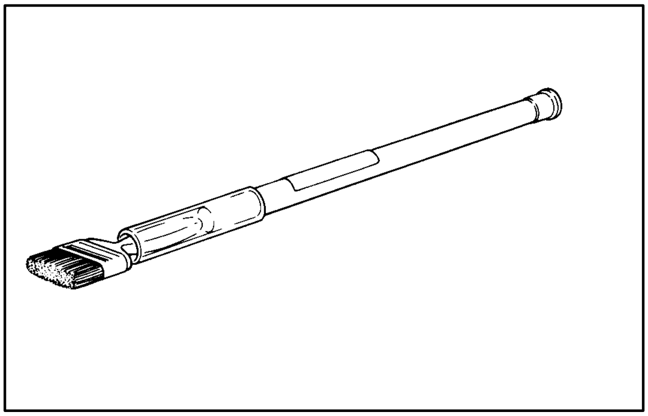


Figure 3

Bedknife Screw Tool – TOR510880

This screwdriver–type bit is made to fit Toro bedknife attaching screws. Use this bit with a torque wrench to secure the bedknife to the bedbar. Make sure bedbar threads are clean and use new screws. Tighten screws to a torque of 250 – 300 in.lb. (288 – 345 KgCm) starting in the middle of the bedknife as shown in figure 5.

NOTE: Remove all rust, scale and corrosion from bedbar surface before installing bedknife.

DO NOT use and air impact wrench with this tool.

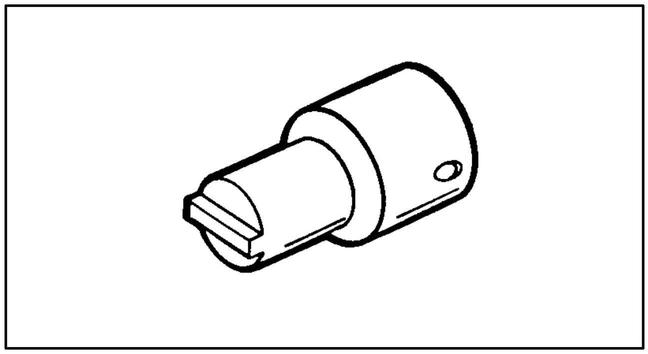


Figure 4

Reel Drive Shaft – TOR4074

Use reel drive shaft for rotating cutting reel when hydraulic motor is removed (backlapping or sharpening).

NOTE: This tool is included in Cutting Unit Tool Kit TOR4070.

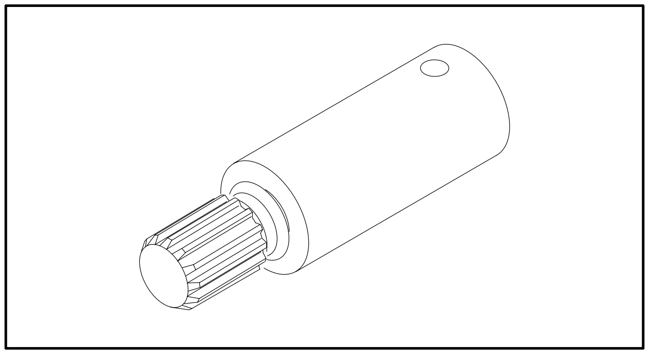


Figure 5

Cutting Unit Tool Kit –TOR4070

This tool kit includes special tools required for rebuilding the cutting unit and cutting unit drive motor on the Reelmaster 6500–D and 6700–D.

TOR4064	Spanner Wrench
TOR4065	Inner Oil Seal Installer
TOR4066	Bearing Installer
TOR4067	Shaft Support Tool
TOR4068	Inner Seal Installer
TOR4869	Outer Seal Installer
TOR4071	Outer Oil Seal Installer
TOR4072	Reel Motor Shaft Seal Protector
TOR4073	Handle
TOR4074	Spline Insert Tool

Figure 6

Troubleshooting

There are a number of factors that can contribute to unsatisfactory quality of cut, some of which may be turf conditions. Turf conditions such as excessive thatch, “sponginess” or attempting to cut off too much grass height may not always be overcome by adjusting the machine. It is important to remember that the lower the height of cut, the more critical these factors are.

Remember that the “effective” or actual height of cut depends on cutting unit weight and turf conditions. Effective height of cut will be different than the bench set height of cut.

Factors That Can Affect Quality of Cut

Factor	Possible Problem/Correction
1. Reel speed and ground speed.	Make sure HOC Selector is set to correct position (A – P) for height of cut and number of reel blades. Slow down or speed up if Reel Control lamp comes on. Make sure controller is programmed for correct cutting unit model (5, 7 or 11 blade) All reels should rotate at same speed (within 100 RPM). All cutting units should have equal bedknife to reel contact. If checking RPM, do not run reel to long without cutting grass, or bedknife and/or reel may overheat and “rifle”. See other items under Troubleshooting in Chapter 4 – Hydraulic System and Chapter 5 – Electrical System.
3. Tire pressure.	Check and inflate to specification if necessary. Must be equal in two front tires and two rear tires. NOTE: Correct tire size and inflation pressure is important on 4WD model to prevent scuffing of turf.
3. Reel bearing condition.	Replace bearings if worn or damaged. Do not over–tighten bearing retainer nut.
4. Reel and bedknife sharpness.	Reel and/or bedknife that has rounded cutting edges or “rifling” cannot be corrected by tightening bedknife to reel contact. Grind reel to remove taper and/or rifling (grooved or wavy appearance). Grind bedknife to sharpen and/or remove rifling. (Most common cause of rifling is bedknife to reel contact that is too tight.) NOTE: New bedknife must be ground or backlapped after installing on bedbar.

Factor	Possible Problem/Correction
5. Bedknife to reel adjustment.	Check bedknife to reel contact daily. Bedknife must have light contact all across reel. No contact will cause cutting edges to become dull. Excessive contact accelerates wear; quality of cut may be adversely affected. Adjust so you paper can be pinched between reel and bedknife without tearing when inserted from the front, and cuts cleanly when inserted at a right angle (along entire length of bedknife). Slightly dull cutting edges may be corrected by backlapping, Excessively dull cutting edges must be corrected by grinding the reel and bedknife.
6. Front roller position.	Make sure front rollers on all cutting units are in the same position Make sure rollers are adjusted so bedknife has proper attitude for height of cut setting and turf conditions.
7. Rear roller parallel to reel.	Rear roller must be leveled so it is parallel with the reel before setting height of cut.
8. Height of cut.	Make sure all cutting units are set at same height of cut. Set with rear roller – must be equal at both ends of roller.
9. Roller scraper adjustment.	Install and/or adjust front and rear roller scrapers if grass clippings build up on rollers.
10. Stability of bedbar.	Check bedbar end bushings, adjuster pivot bushings and nylon flanged bushings for wear or damage. Check adjustment knob to make sure detent holds adjustment.
11. Number of reel blades.	Use cutting unit model with correct number of blades for clip frequency and optimum quality of cut range (see Specifications).
12. Cutting unit alignment and ground following.	Check lift arms and cutting unit pivot linkages for wear, damage or binding.
13. Roller condition.	All rollers should rotate freely. Replace bearings if they are worn, damaged, or have excessive radial play.

Set–up and Adjustments

IMPORTANT: Toro strongly recommends the use of a leveling plate when setting–up or adjusting any reel type cutting unit. The leveling plate will help to ensure accurate and consistent adjustments.

Note: Right and left ends of cutting unit is determined by standing in the operator's position (Fig. 7).

After the cutting unit is unboxed, use the following procedures to assure the cutting units are adjusted properly.

1. Check each end of the reel for grease. Grease should be visibly evident in the reel bearings and internal splines of reel shaft.

2. Insure that all nuts and bolts are securely fastened.

3. Make sure carrier frame suspension operates freely and does not bInd when moved back and forth.

4. Adjust bedknife to reel.

5. Adjust and level front and rear rollers.

6. Set height–of–cut.

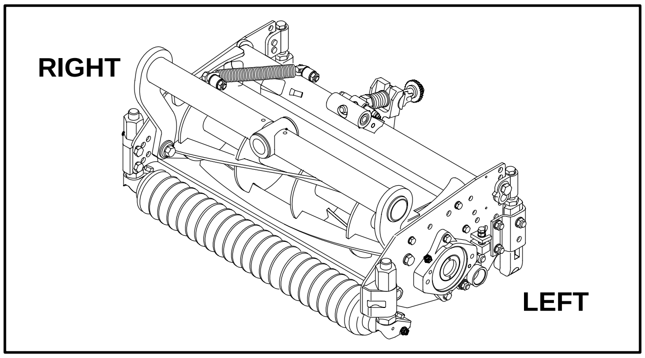


Figure 7

Bedknife to Reel Adjustment

1. A 19 mm (3/4 inch) wrench will be needed to rotate bedknife adjustment knob. Each notch on the knob will move the bedknife .0005 inches (.013 mm) (Fig. 8).

2. Tip cutting unit rearward to gain access to reel and bedknife (Fig. 9).

3. On either end of reel, insert a long strip of dry newspaper between reel and bedknife. While slowly rotating reel into bedknife, turn bedknife adjusting knob clockwise, one click at a time until paper is pinched lightly, which results in a slight drag when paper is pulled.

4. Check for light contact at other end of reel using paper. If light contact is not evident or if a gap exists, the bedknife is not parallel to reel. Proceed to steps 5 thru 9.

5. Slightly loosen (2) locknuts securing pivot hub to left sideplate (Fig. 10).

6. Rotate pivot hub adjusting screw until a slightly larger gap exists between reel blades and bed knife on left end than on right end (Fig. 10).

7. On right end of reel, insert a long strip of dry newspaper between reel and bedknife. While slowly rotating reel towards bedknife, turn bedknife adjusting knob clockwise, one click at a time until paper is pinched lightly, which results in a slight drag when paper is pulled.

8. Rotate pivot hub adjusting screw until the gap between reel blades and bedknife is equal on both ends.

9. Tighten locknuts securing pivot hub to left sideplate and verify adjustment.

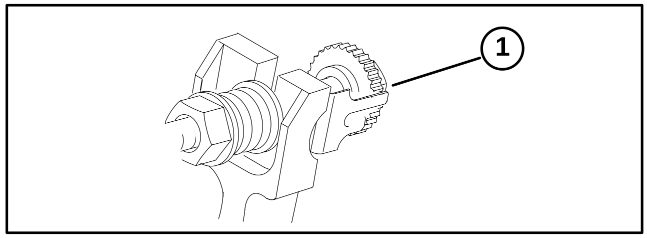


Figure 8

1. Bedknife adjusting knob

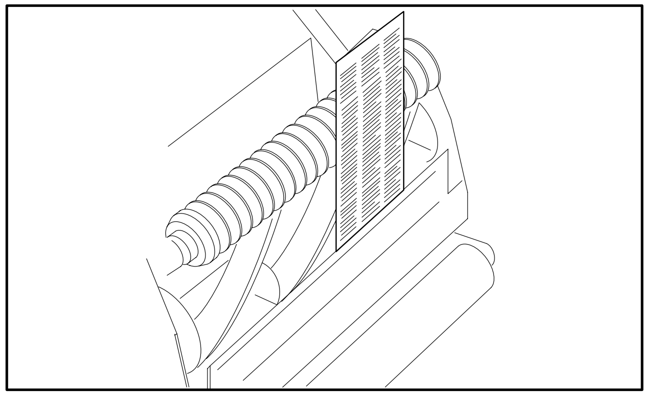


Figure 9

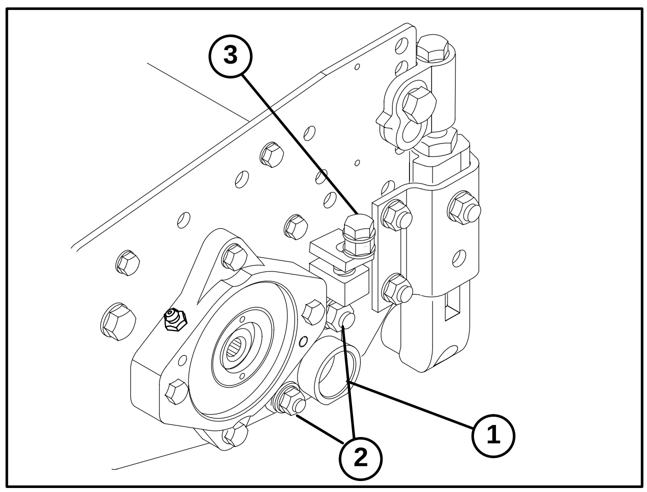


Figure 10

1. Pivot hub
2. Pivot hub locknuts
3. Pivot hub adjusting screw

Cutting Unit Set–up Guide

Adjustable front and rear brackets allow infinite adjustment of cuffing unit ”attitude”. Attitude refers to the angle of the knife relative to the ground. Attitude has a significant impact on the performance of the cutting unit. All cutting units on a given machine must be set to the same attitude.

In general, less aggressive attitudes are more appropriate for lower heights of cut while, higher heights of cut may require more aggressive attitudes. An angle that is too flat will allow the bedbar or other parts of the reel to drag in the turf causing tufting or marks. Minimum recommended angle is 2 degrees.

The ”best” cutting unit attitude is dependent on turf conditions and desired results. Cutting unit attitude may need to be adjusted throughout the cutting season to allow for various turf conditions. Experience with the cutting unit on the turf will determine the best setting to use. Wear of the bedknife and reel will result in changes to cutting unit attitude which must be compensated for during setup and adjusted throughout the life of the cutting unit.

The charts below give approximate dimensions for setting up a new cutting unit to 6 degrees. Changes can be made from this setting based on observed results in the turf.

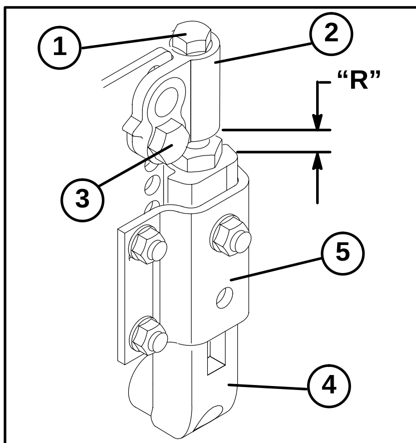
Note: If final height–of–cut settings other than those shown in chart are desired, select the set of position holes closest to desired height–of–cut. Use top capscrews to adjust to final setting.

Note: Set initial rear height–of–cut approximately 3/16” lower for ease of adjustment.

Desired Height of Cut	Rear Support Hole		Rear Cutting Unit Side Plate Hole						**Rear Thread Distance “R”	Front Roller Thread Distance “F”
	Upper	Lower	1	2	3	4	5	6		
*3/8” (9.5mm)	X		X						.53” (13.5mm)	.55” (13.9mm)
*1/2” (12.7mm)	X		X						.56” (14.2mm)	.36” (9.1mm)
5/8” (15.9mm)	X		X						.69” (17.5mm)	.24” (6.1mm)
3/4” (19.0mm)		X			X				.54” 13.7mm)	.11” (2.8mm)
7/8” (22.2mm)		X			X				.67” (17.0mm)	.00” (0.0mm)
1” (25.4mm)	X			X					.52” (13.2mm)	–.14” (–3.6mm)
1–1/8” (28.6mm)	X			X					.65” (16.5mm)	–.26” (–6.6mm)
1–1/4” (31.8mm)		X				X			.51” (12.9mm)	–.38” (–9.7mm)
1–3/8” (34.9mm)		X				X			.63” (16.0mm)	–.51” (–12.9mm)
1–1/2” (38.1mm)	X				X				.49” (12.5mm)	–.64” (–16.3mm)

***** Optional Low Cut Bedknife (Part No. 93–9774) is required for height–of–cut below 1/2” (12.7mm).

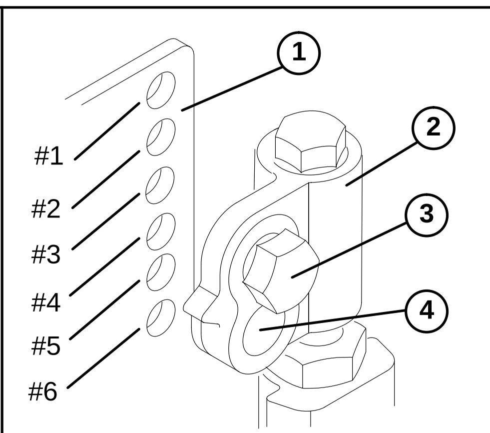
****** Rear thread distance is 3/16” (4.8mm) shorter for initial set–up.



REAR BRACKET DISTANCE (R)

Figure 11

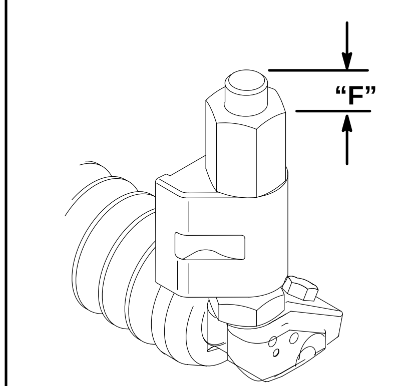
1. **Height–of–cut adjusting capscrew**
2. **Height–of–cut support**
3. **Quick height–of–cut pin**
4. **Roller bracket**
5. **Angle bracket**



QUICK HEIGHT–OF–CUT PIN HOLES

Figure 12

1. **Side plate**
2. **Height–of–cut support**
3. **Upper hole**
4. **Lower hole**



FRONT BRACKET DISTANCE (F)

Figure 13

Preliminary Height of Cut and Front Roller Adjustment

When setting–up a cutting unit, or if repositioning or installing a front or rear roller to the cutting unit, proceed as follows:

1. Verify reel to bedknife contact before setting height–of–cut.

2. Select initial front roller bracket setting and rear roller position holes for desired height–of–cut (Fig. 11, 12 & CHART).

3. Position cutting unit on a flat level surface (leveling plate).

4. Position a 1/2” (13mm) or thicker bar under the reel blades and against the cutting edge of the bedknife. **Make sure bar covers the full length of reel blades.** Rear roller should not contact surface (Fig. 14).

5. Rock cutting unit forward (on reel blades and steel bar) until front roller contacts flat surface. Reel blades and bedknife must maintain contact with bar.

6. **Adjust front brackets until both ends of roller are in contact with level surface.** Use a piece of paper or visually check to see if any gap exists between roller ends and flat surface.

7. Tighten top and bottom nuts of front roller brackets to 55–65 ft–lbs.

8. Re–check roller contact with paper to insure roller has not changed position and is parallel with the reel and bedknife.

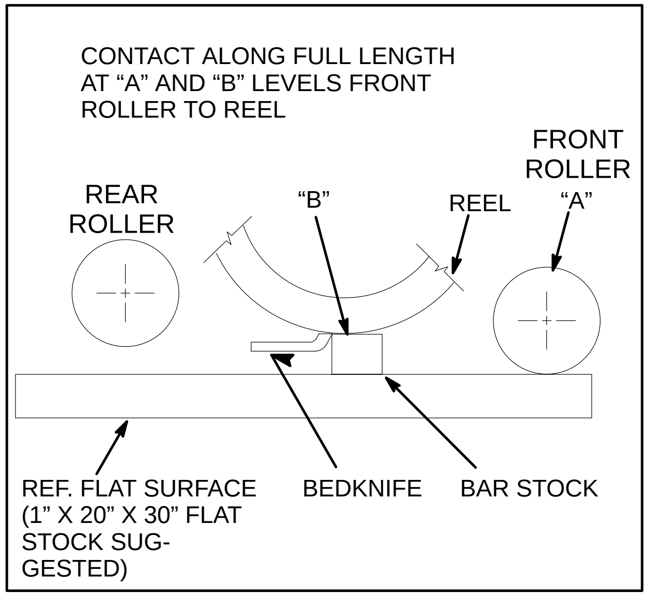


Figure 14

Final Height of Cut Adjustment

1. Using a gauge bar, Toro part no. 98–1852 or equivalent (Fig. 15), set head of screw to desired Height–of–Cut. This measurement is from bar face to underside of screw head.

2. Place gauge bar across front and rear rollers. Verify at each end (Fig. 16). Adjust as required.

IMPORTANT: Set properly, front and rear rollers will contact gauge bar and screw head will be snug over bedknife cutting edge when checked at both ends of the reel.

If an adjustment to attain the desired height–of–cut or attitude is required, either front or rear roller may be adjusted. Re–check leveling, with a piece of paper and leveling plate, after adjustments are complete.

IMPORTANT: Each reel must be set consistently. Minor differences in either height–of–cut or attitude between cutting units may result in inconsistent quality of cut.

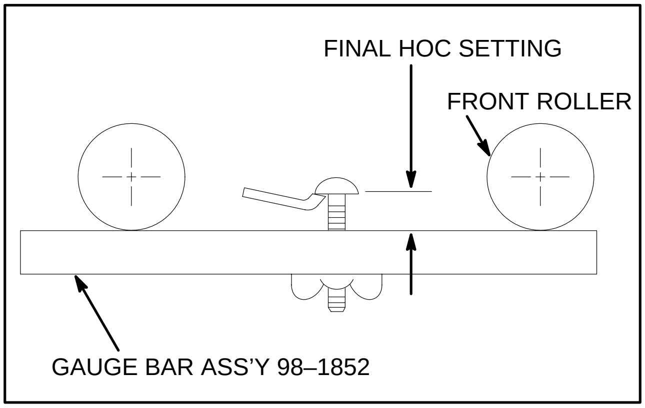


Figure 15

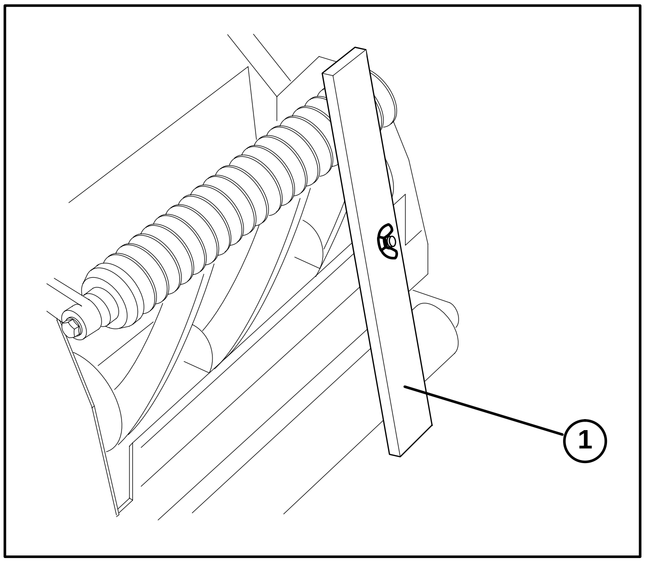


Figure 16

1. Gauge bar

Grass Shield and Fin Adjustment

Adjust grass shield and/or shield fin angle for desired grass clippings dispersion. For best dispersion under most conditions

1. Position cutting unit on a flat level surface.

2. To adjust fins, unhook and move front mounting tab to the straight ahead or angled position slot.

3. To change grass shield angle, loosen flange head capscrew (Fig. 17) securing shield to left side plate, move shield to desired angle and tighten screw.

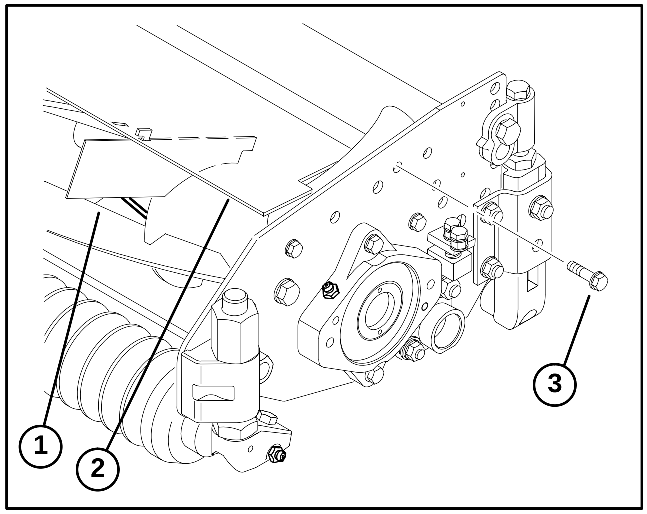


Figure 17

1. **Shield fin**
2. **Grass shield**
3. **Capscrew**

Rear Shield Adjustment

Under most conditions, best dispersion is attained when rear shield is closed (front discharge).
When conditions are heavy or wet, rear shield may be opened.

1. To open rear shield, loosen flange head capscrews securing shield to each side plate, rotate shield to open position and tighten screws.

Lift Chain Adjustment

The chain connecting carrier frame to cutting unit controls the amount of fore–aft rotation available, as well as the amount of ground clearance in transport and turn around. The chain has a total of 13 links. The chain is factory adjusted at the eleventh link, which will work well for most fairways.

On rougher ground, chain may be shortened to allow for more ground clearance. To allow greater rotation for areas with many contours, lengthen chain.

Note: The position of the screw within the link will affect the chain length.

Cutting Unit Attitude Adjustment (2 Screw Gauge Bar)

The cutting unit attitude may be adjusted or verified using a gauge bar, Toro part no. 98–1852. which has two screws and three hole locations. The second screw is used in the inner hole to set or verify cutting attitude. Adjust as follows:

1. Set front screw height to final height–of–cut setting (Fig. 18).

2. Set rear screw, distance “B”, lower than front setting (Fig. 18).

.20” (5.3mm)	8°
.15” (3.8mm)	6°
.09” (2.3mm)	4°
.04” (1.0mm)	2°

3. Place gauge bar across front and rear rollers. Front screw head should fit snugly over edge of bedknife and end of rear screw should contact bottom of bedknife (Fig. 19 & 20). Front and rear rollers should contact gauge bar. Verify attitude at each end.

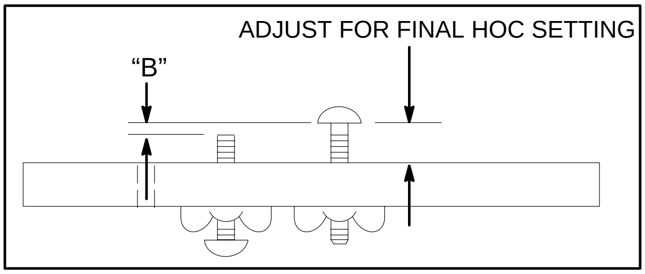


Figure 18

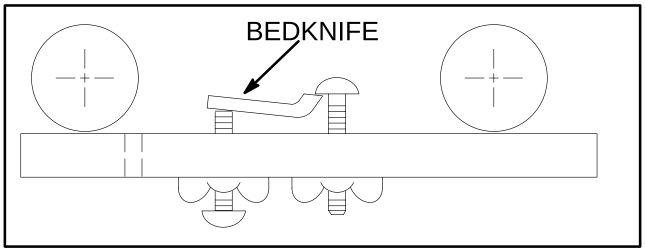


Figure 19

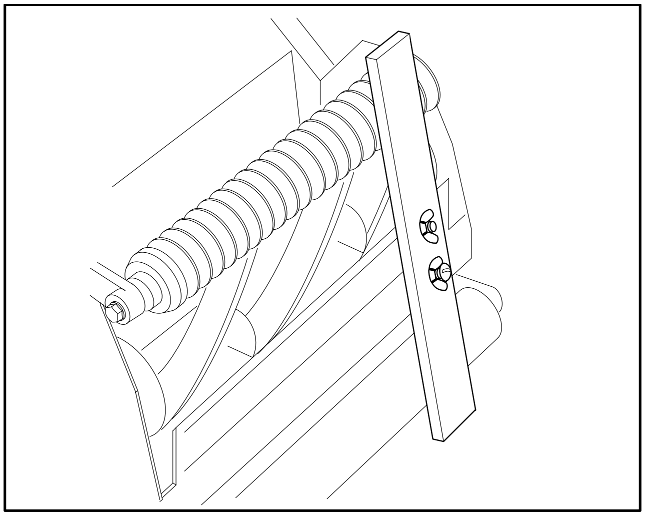


Figure 20

Alternate Adjustments

Tractors are setup at the factory appropriately for most fairway mowing applications.

The following adjustments are available for fine–tuning of the machine to the application:

Adjusting Cutting Unit Stop Chains

The lift chain of the cuttings units may be lengthened or shortened to adjust for either ground following or ground clearance of the cutting units. Refer to the cutting unit operator manual for adjusting procedure.

Adjusting the Travel of the Front Three Cutting Units

Additional downward travel of the front three cutting units may be desirable in highly contoured locations. If any of the front three cutting units lift off the ground when cresting a "hill", the front carrier frame may be lowered by removing mounting bolts and repositioning frame in the bottom set of holes in the main frame.

Backlapping

DANGER

REELS MAY STALL WHILE BACKLAPPING. DO NOT ATTEMPT TO RESTART REELS BY HAND OR TOUCH REELS WHILE BACKLAPPING. STOP ENGINE AND TURN H.O.C. KNOB ONE POSITION TOWARD "A".

Note: When backlapping, the front units all operate together, and the rear units operate together.

1. Position the machine on a level surface, lower the cutting units, stop the engine, engage the parking brake, and move the Enable/Disable switch to disable position.

2. Unlock and raise the seat to expose controls.

3. Open control cover and turn the H.O.C. selection knob to position "P".

Note: Backlapping speed may be increased by moving the H.O.C. selection knob toward to "A". Each position will increase speed approximately 60 rpm. After changing selector, wait 30 seconds for the system to respond to the new speed target.

4. Make initial reel to bedknife adjustments appropriate for backlapping on all cutting units which are to be backlapped.

5. Start engine and run at <u>idle</u> <u>speed</u>.

DANGER: To avoid personal injury, never place hands or feet in reel area while engine is running. Changing engine speed while backlapping may cause reels to stall. Never change engine speed while backlapping. Only backlap at idle engine speed. Never attempt to turn reels by hand or foot while engine is running.

6**.** Select either front or rear on the backlap switch to determine whether front or rear reels will be backlapped.

DANGER: To avoid personal injury, be certain that you are clear of the cutting units before proceeding.

7. Move Enable/Disable switch to Enable position. Move Lower Mow / Lift control forward to start back–lapping operation on designated reels.

8. Apply lapping compound with a long handle brush (Toro Part No. 29–9100). Never use a short handled brush.

9. If reels stall or become erratic while backlapping, the reel control light will begin to blink and the reels will turn off. If this occurs, turn the H.O.C. selection knob one position closer to "A". Then, toggle the Enable/Disable switch to the disable position followed by the enable position. To resume backlapping, move the Lower Mow / Lift control lever forward.

10. To make an adjustment to the cutting units while backlapping, turn reels OFF by moving the Lower Mow/ Raise lever rearward; move the Enable/Disable switch to Disable and turn the engine OFF. After adjustments have been completed, repeat steps 5 – 9.

11. Repeat procedure for all cutting units to be backlapped.

12. When backlap operation has been completed, return the backlap switch to OFF, lower seat and wash all lapping compound off cutting units. Adjust cutting unit reel to bedknife as needed.

IMPORTANT: If the backlap switch is not returned to OFF position after backlapping, the cutting units will not raise or function properly.

Bedbar Removal and Installation

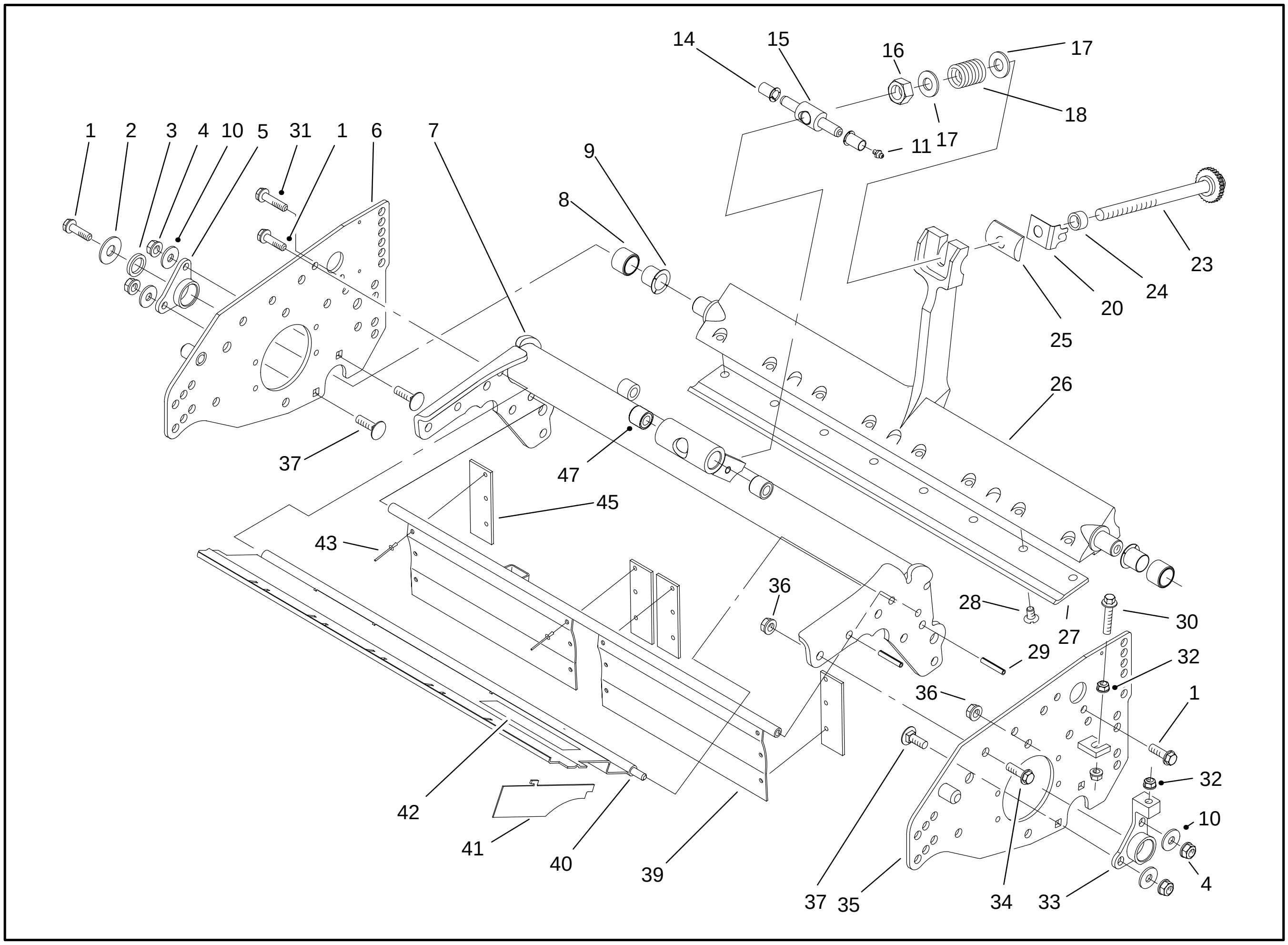


Figure 21

1. Screw
2. Washer
3. Quad ring
4. Lock nut
5. R.H. pivot hub
6. R.H. side plate
7. Reel frame
8. Bushing assembly
9. Flange bushing
10. Flat washer
11. Grease fitting
14. Plastic bushing
15. Adjustment screw pivot
16. Lock nut
17. Washer
18. Compression spring
19. Spring arm
23. Bedbar adjuster assembly
24. Adjuster spacer
25. Bedbar adjustment pivot
26. Bedbar
27. Bedknife
28. Special screw
29. Roll pin
30. Screw
31. Screw
32. Flange nut
33. L.H. pivot hub
34. Screw
35. L.H. side plate
36. Lock nut
37. Carriage screw
39. Rear grass shield
40. Grass shield assembly
41. Grass shield deflector
42. Decal – Danger
43. Rivet
45. Side flap
47. Bushing

Remove Bedbar

1. Loosen bedknife adjusting knob to loosen bedknife to reel contact.

2. Loosen locknut on bedknife adjuster assembly and disengaging adjuster from bedbar.

3. Remove bedbar leveling screw from L.H. side of cutting unit.

4. Remove fasteners securing L.H. and R.H. bedbar pivot hubs to frame.

5. Remove bedbar assembly.

6. Remove capscrew, washer and quad ring from R.H. end of bedbar.

7. Remove R.H. and L.H. pivot hubs from bedbar.

8. Sharpen or replace bedknife as necessary (see Bedknife Replacement and Grinding).

Install Bedbar

1. Inspect bedbar end bushings and flange bushings for wear and replace if necessary.

2. Install R.H. and L.H. pivot hubs onto bedbar.

3. Install quad ring, washer and capscrew to R.H. end of bedbar.

4. Install bedbar onto cutting unit and secure pivot hubs to frame with fasteners removed in step 4 above.

5. Install bedbar leveling capscrew and nuts to L.H. side of cutting unit.

6. Install bedknife adjusting knob assembly. Tighten locknut to compress spring to dimension shown.

7. Adjust bedknife to reel (see Bedknife to Reel Adjustment).

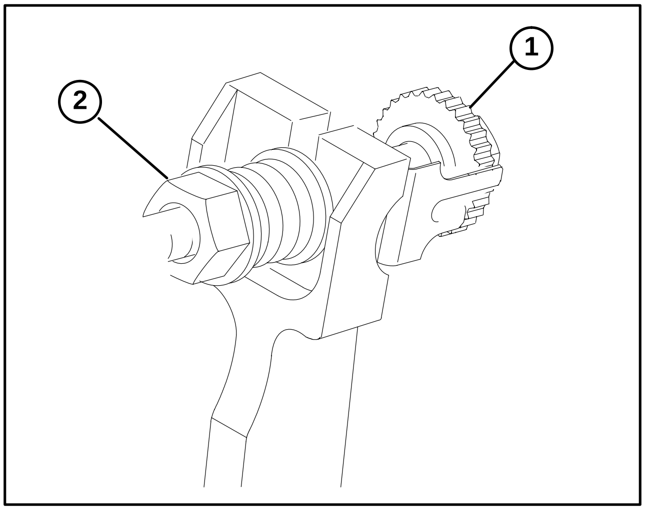


Figure 22

1. **Bedknife adjusting knob**
2. **Locknut**

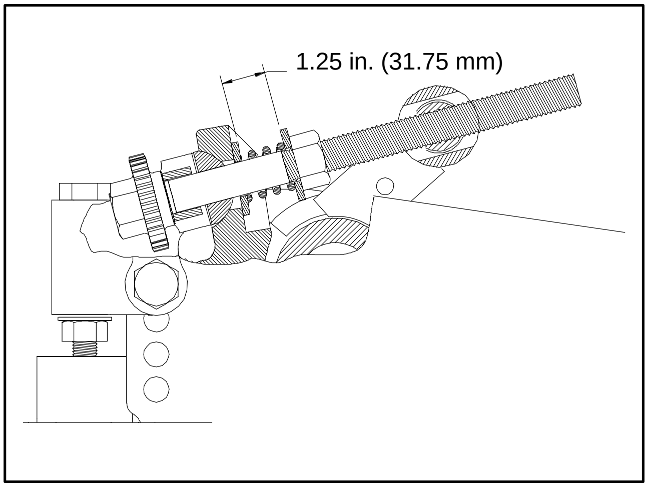


Figure 23

Bedknife Replacement and Grinding

1. Remove bedbar from cutting unit.

2. Remove bedknife screws and remove bedknife.

3. Remove all rust, scale and corrosion from bedbar surface before installing new bedknife.

4. Install new bedknife:

A. Make sure bedbar threads are clean.

B. Use new screws. Apply anti–seize lubricant to screw threads before installing.

C. Tighten screws to a torque of 250 – 300 in.lb. (288 – 345 KgCm) working from the center toward each end of the bedbar. DO NOT use an impact wrench.

5. Since there can be variations in the mounting surface of the bedbar, a new bedknife will not be perfectly flat after it is installed. Because of this, it is necessary to backlap or grind a new bedknife after installing it to the bedbar. Follow the existing angle that was ground into the bedknife and grind only enough to make sure the top surface is true.

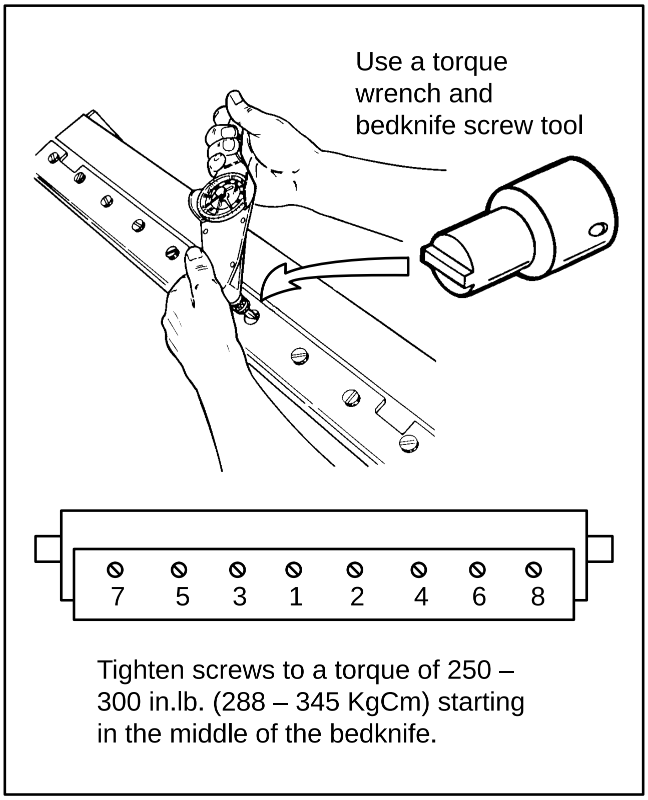


Figure 24

Regrinding Bedknife

Remove bedbar / bedknife assembly from cutting unit before attempting to regrind a used bedknife. Keep the bedknife fastened to the bedbar when grinding.

Note: When grinding, be careful to not overheat the bedknife. Remove small amounts of material with each pass of the grinder.

Bedknife Regrinding Specifications	
Relief Angle	5°
Relief Angle Range	3° – 6°
Front Angle	15°
Front Angle Range	13° – 17°

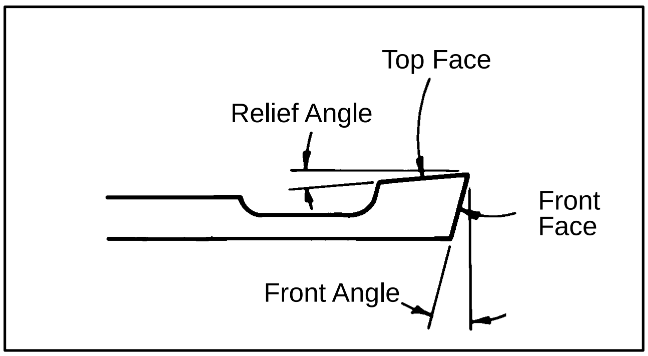


Figure 25

Preparing Reel for Grinding

1. Check to make sure reel bearings are in good condition and properly adjusted before grinding the reel. Make sure the cutting unit frame and roller brackets are true and not bent or damaged from impacts with trees, posts or cart path edges.

2. Remove bedbar assembly.

3. Remove parts as necessary to mount the cutting unit in the grinder (e.g. front roller, brackets). Follow the ginding equipment manufactuer's instructions for mounting the cutting unit.

Note: The cutting unit must be aligned so the grinding wheel will travel parallel to the reel shaft. This will result in the the reel being ground to the desired cylinder shape.

Note: When grinding, be careful to not overheat the reel blades. Remove small amounts of material with each pass of the grinder.

4. After completing the grinding process, do a complete set–up and adjustment procedure.

Reel Grinding Specifications	
Nominal Reel Diameter	7″ (178 mm)
Service Limit Reel Diameter	6.2″ (158 mm)
Blade Relief Angle	30°
Relief Angle Range	20° – 40°
Blade Land Width	.060″ (1.5 mm)
Land Width Range	.050″ – .090″ (1.3 – 2.3 mm)
Service Limit Reel Taper	.060″ (1.5 mm)

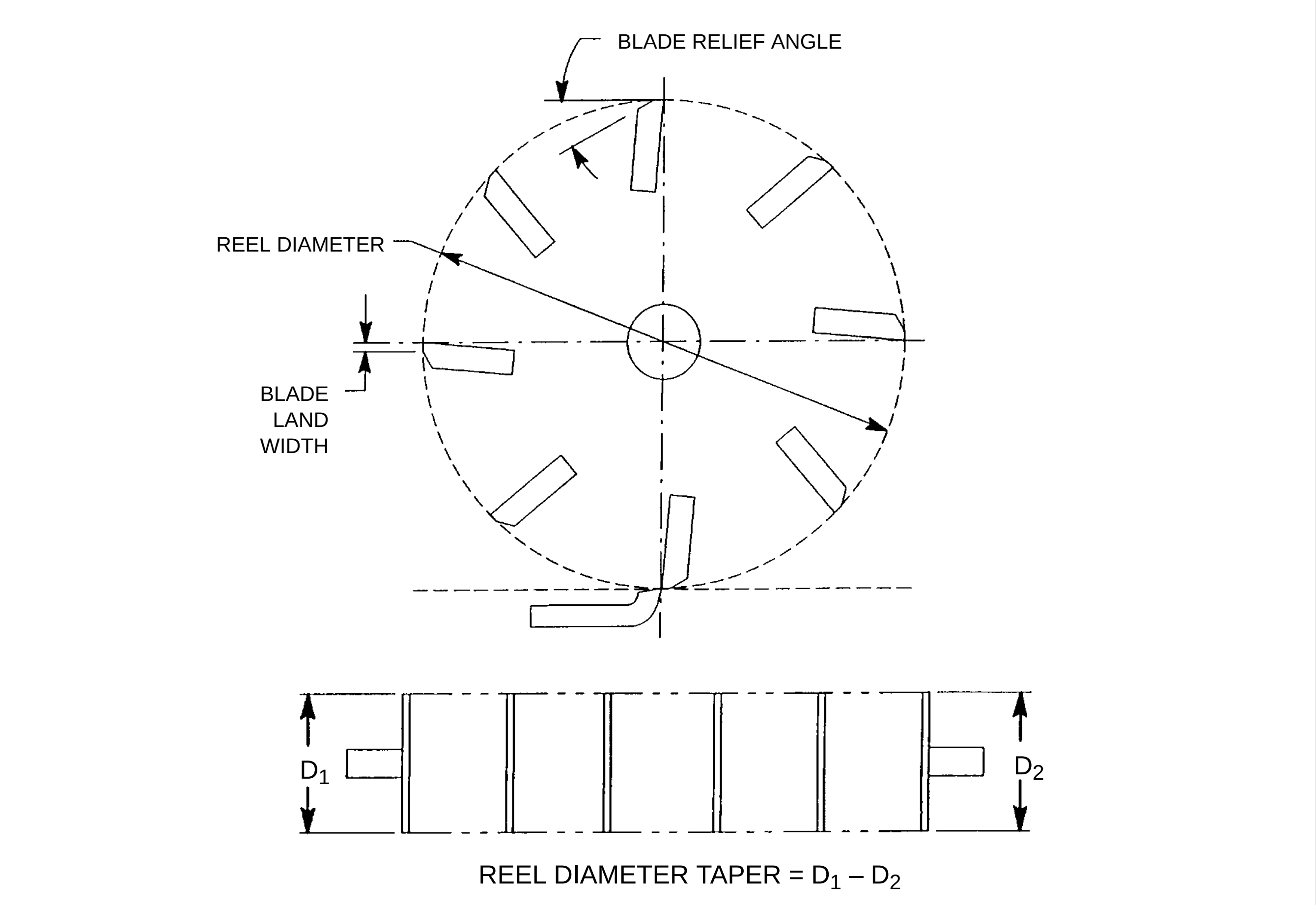


Figure 26

Cutting Units
03857, 03858, 03859

Reel Removal and Bearing Replacement

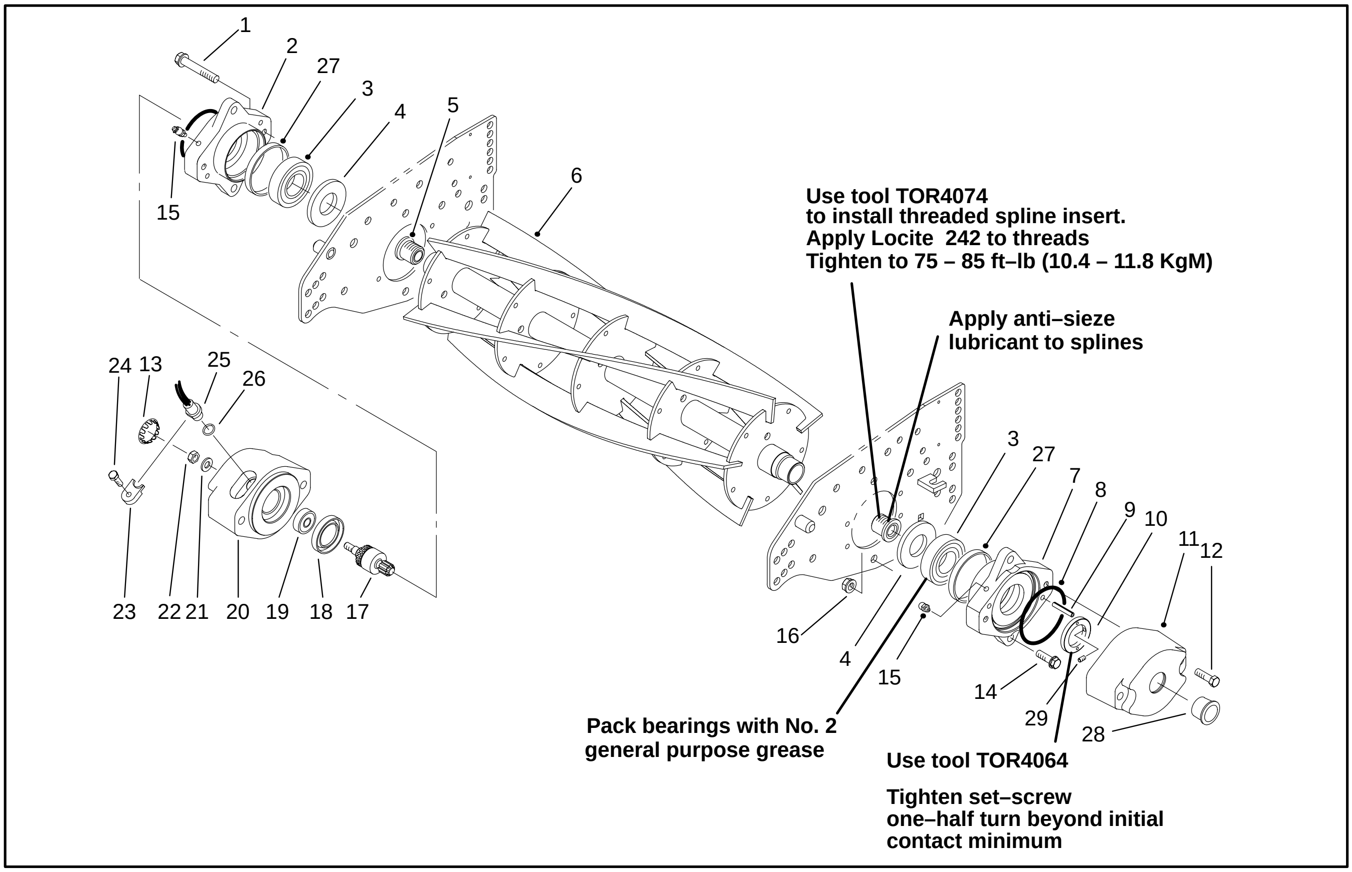


Figure 27

1. Screw
2. R.H. bearing housing
3. Bearing
4. Grease seal
5. Threaded insert
6. Reel assembly
7. L.H. Bearing housing
8. O–ring
9. Roll pin
10. Bearing adjustment nut
11. End weight
12. Screw
13. Cap plug
14. Screw
15. Grease fitting
16. Lock nut
17. Shaft magnet assembly
18. Outer seal
19. Bearing
20. End weight housing
21. Flat washer
22. Lock nut
23. Clamp
24. Screw
25. Speed sensor
26. O–ring
27. Bearing ring
28. Plug
29. Set screw

Remove Reel

1. Remove weight from cutting unit. If equipped with a speed sensor, remove shaft magnet after removing weight and sensor.

2. Remove bedbar assembly.

3. Remove front roller assembly.

4. Loosen set screw and remove bearing adjustment nut from L.H. bearing housing.

5. Use a hammer and punch to drive out roll pins from L.H. bearing housing. Remove L.H. bearing housing. It is not necessary to remove the R.H. bearing housing.

6. Remove reel.

Inspect Reel

1. Replace reel if diameter has decreased to the service limit (see Reel Grinding Specifications).

2. Replace reel if blades are bent or cracked.

3. Inspect reel shaft splined inserts and replace if worn or damaged.

The threaded inserts are installed with thread locking compound (Loctite 242 or equivalent). One side is L.H. threads and the other R.H. threads (R.H. has identification groove on outer surface of flange). To remove or install threaded spline inserts, use tool TOR4074. Before installing, apply Loctite 242 or equivalent to threads and tighten to a torque of 75 – 85 ft–lb (10.4 – 11.8 KgM)

4. Inspect bearings and seals. To replace seals and bearings:

A. Use a bearing puller tool to remove the bearings. To prevent damage to bearings, pull on the inner bearing race. Remove the seals. NOTE: If bearing is removed, the seal should be replaced.

B. Install new seals on the reel shaft. Make sure seals are installed square to shaft.

C. Pack bearings with No. 2 general purpose grease before installing. Install bearings on reel shaft by pressing on the inner bearing race.

Install Reel

1. Set cutting unit frame in a vertical position so R.H. bearing housing is down. Install reel into R.H. bearing housing.

2. Install L.H. bearing housing. Install roll pins.

3. Hit end of reel shaft with a brass hammer to make sure that R.H. reel bearing is seated on shoulder of R.H. bearing housing.

4. Install bearing adjustment nut and tighten with special spanner wrench TOR4064 until contact is made with the bearing and reel end play is removed. NOTE: Over–tightening can cause early bearing failure. Tighten set screw to secure bearing adjustment nut. Tighten set screw one–half turn beyond initial contact minimum.

5. Install front roller assembly.

6. Install bedbar assembly.

7. Apply anti–seize lubricant to splines on splined couplers.

8. Install shaft magnet if this cutting unit is to be equipped with a speed sensor.

9. Install weight assembly.

Roller and Frame Service

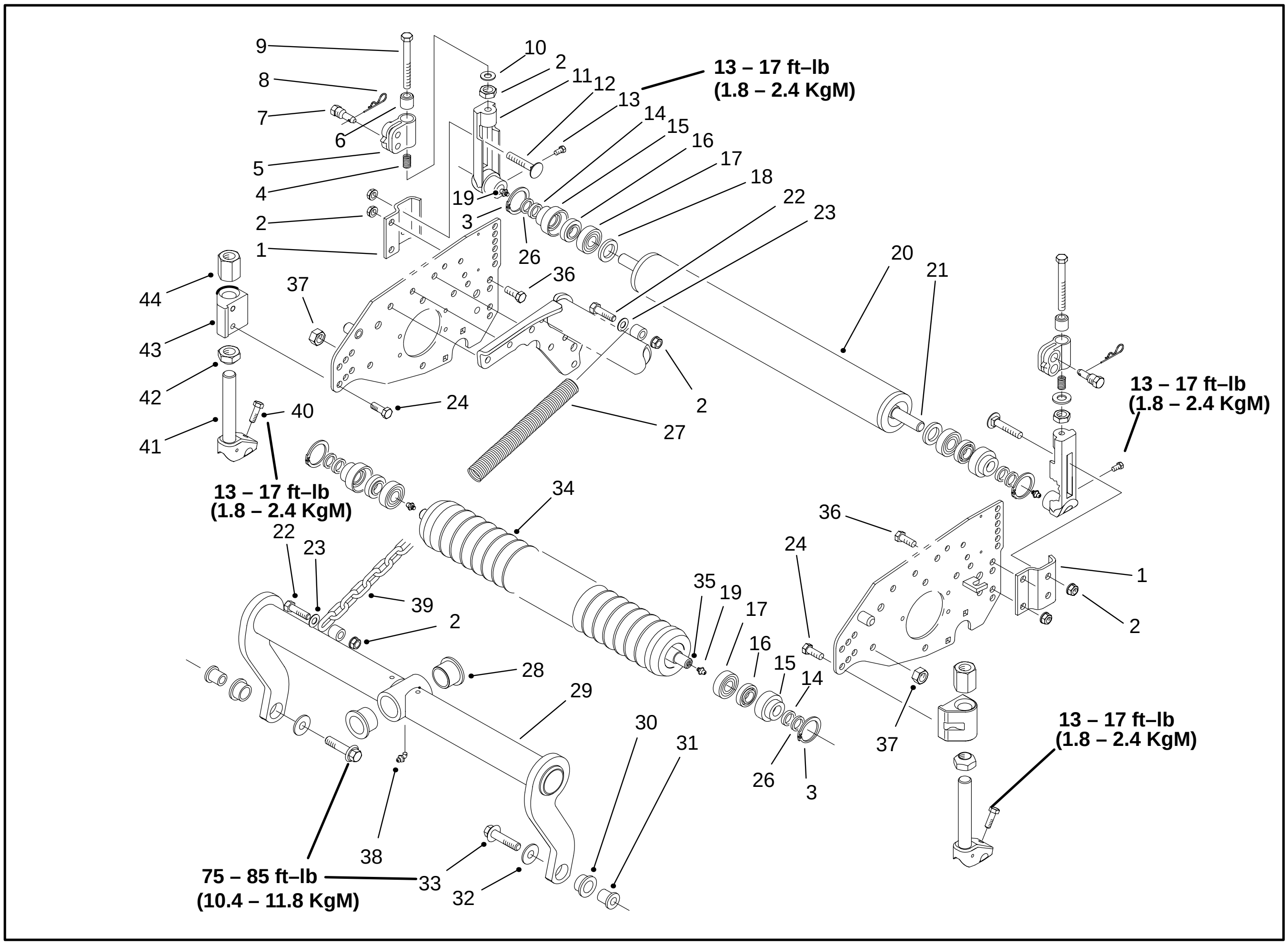


Figure 28

1. Angle bracket
2. Lock nut
3. Snap ring
4. HOC Compression Spring
5. Rear HOC support
6. Spacer
7. HOC pin
8. Hair pin cotter
9. Hex screw
10. Special washer
11. Rear HOC bracket
12. Carriage screw
13. Hex screw
14. Oil seal
15. Outer seal
16. Inner seal
17. Ball bearing
18. Oil seal
19. Grease fitting
20. Rear roller tube ass'y
21. Rear roller shaft
22. Hex screw
23. Flat washer
24. Hex screw
26. Roller washer
27. Chain cover
28. Special bushing
29. Carrier frame ass'y
30. Bushing
31. Frame spacer
32. Hardened washer
33. Bolt
34. Wiehle roller
35. Wiehle roller shaft
36. Hex screw
37. Lock nut
38. Grease fitting
39. Chain
40. Hex screw
41. Support rod ass'y
42. Special nut
43. HOC bracket
44. Special long nut

Roller Bearing and Seal Replacement

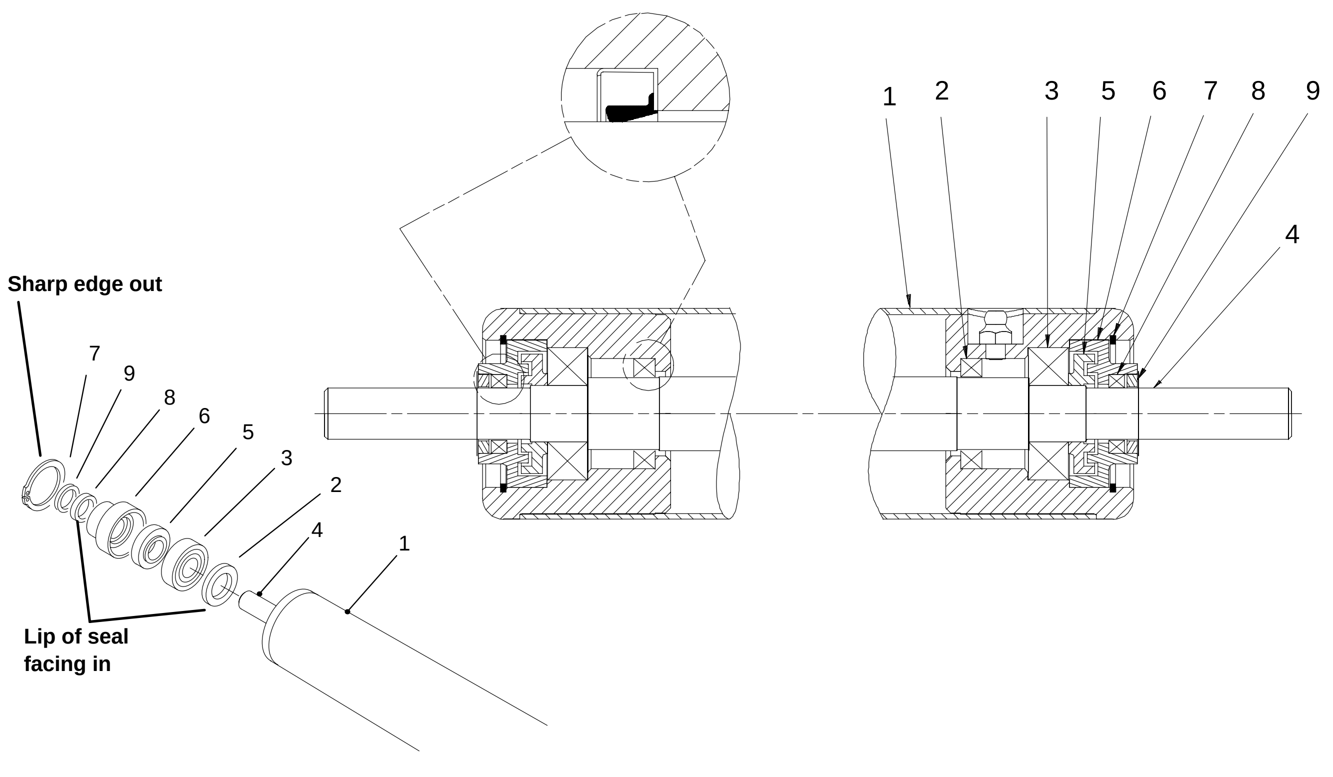


Figure 29

1. Roller	**4. Roller shaft**	**7. Retaining ring**
2. Inner oil seal	**5. Inner seal**	**8. Outer oil seal**
3. Bearing	**6. Outer seal**	**9. Washer**

NOTE: Bearing and seal configurations are the same for both the front and rear rollers.

Remove Seals and Bearings

1. Remove retaining ring from both ends of roller.

2. Hit end of roller shaft with a soft face hammer to remove seals and bearing from one end of roller. Hit other end of roller shaft to remove seals and bearing from other end of roller. Be careful not to drop roller shaft.

3. Discard seals and bearings.

Install New Seals and Bearings

NOTE: A soft face hammer can be used with the special tools to assemble the roller, however use of a press is recommended.

1. Use installation tool TOR4065 and handle TOR4073 to install inner oil seal into each end of roller.

2. Install bearings:

A. Use tool TOR4066, handle TOR4073 to install bearing into one end of roller.

B. Install roller shaft from opposite end of roller. Be carefull not to damage the inner oil seals.

C. Put roller in a vertical position and support shaft and bearing with tool TOR4067.

D. Use tool TOR4067 to install second bearing.

3. Use tool TOR4068 to install inner seal.

4. Use tool TOR4069 to install outer seal

5. Install retaining ring.

6. Use tool TOR4071 to install outer oil seal.

7. Use tool TOR4067 to install washer.

8. Put opposite end of roller facing up and support bottom end with tool TOR4067. Repeat steps 3 – 7.

9. Use a hand operated grease grease gun and No. 2 general purpose lithium base grease to lubricate bearings until grease appears at washer. Wipe off excess grease.

Cutting Unit Installation

Cutting unit models 03857, 03858, and 03859 can be installed at any of the five mounting locations on the traction unit. Figure 1 shows the orientation of the hydraulic drive motor for each of the five locations. For any of the locations requiring the motor to be mounted on the right end of the cutting unit, install a counter weight on the left end of the cutting unit. For the locations requiring the motor to be mounted on the left end, install a counter weight on the right end of the cutting unit.

Two of the counter weights provided with the tractor include reel speed sensor assemblies. These need to be installed on cutting units to be mounted in the front center and left rear positions on the tractor.

Note: Counter weight mounting capscrews are shipped installed on the right bearing housing of the cutting units. The capscrews on left bearing housing are to be used for securing the hydraulic motor.

1. Remove cutting units from cartons. Assemble and adjust per Cutting Unit Operator's Manual.

2. Remove protective plugs from each end of cutting unit.

3. Lubricate and install a large O–ring into bearing housing groove on each end of cutting unit (Fig. 31 & 33).

Note: Before installing cutting unit motors or counterweights with speed sensors, lubricate internal splines of cutting unit reels shafts with grease.

4. Install a counter weight onto appropriate end of each cutting unit with capscrews provided (Fig. 31).

5. Thoroughly grease the cutting unit reel bearings prior to installation on the traction unit. Grease should be evident at the inboard reel seals. Refer to Cutting Unit Operator's Manual for greasing procedure.

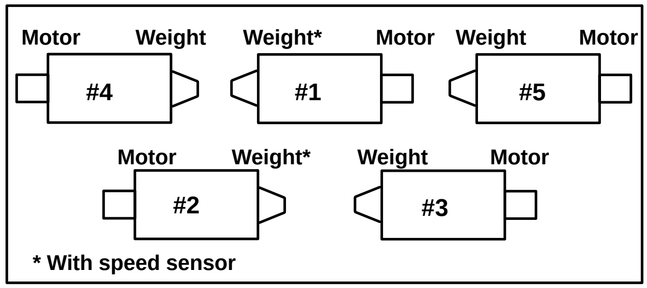


Figure 30

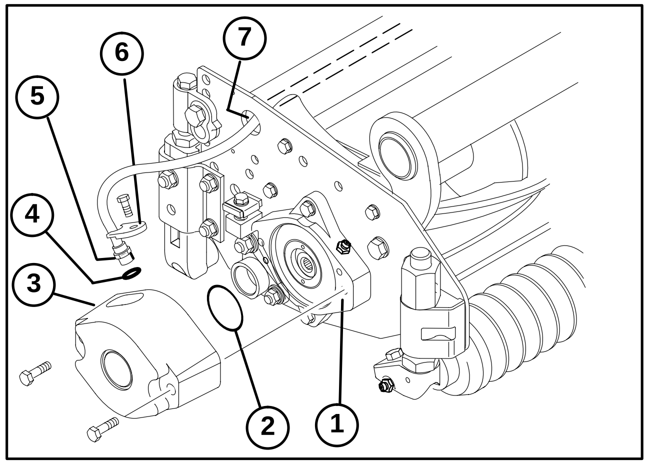


Figure 31

1. Bearing housing
2. O–ring–large
3. Counterweight
4. O–ring –small
5. Speed sensor
6. Speed sensor holder
7. Frame tube

6. Insert a thrust washer onto horizontal shaft of pivot knuckle as shown in figure 32.

7. Insert the horizontal shaft of the pivot knuckle into the mounting tube of the carrier frame (Fig. 32).

8. Secure pivot knuckle to carrier frame with a thrust washer, flat washer and a flange head capscrew (Fig. 32).

9. Insert a thrust washer onto vertical shaft of pivot knuckle (Fig. 32).

10. Insert the vertical shaft of the pivot knuckle into lift arm pivot hub (Fig. 32). Guide the pivot knuckle in place between the two rubber centering bumpers in the under side of the lift arm steering plate.

11. Insert the lynch pin into the cross hole on the pivot knuckle shaft (Fig. 32).

12. Mount the motor to the drive end of the cutting unit and secure with two capscrews provided (Fig. 33).

13. On front center and left rear cutting units, plug speed sensor wire harness connector into traction unit wire harness connector.

14. On motor side of cutting unit, insert speed sensor end of harness through cutting unit rear frame tube and route to counterweight.

15. Install small O–ring onto speed sensor and insert sensor into hole in counterweight (Fig. 31).

16. Secure sensor to counterweight with a sensor holder and a M6 x 20 mm capscrew (Fig. 31).

17. Insert steering pin into one of the following pivot knuckle mounting locations (Fig. 32):

Rear Mounting Hole–Keeps cutting unit locked in straight a line.

Front Mounting Hole–Allows cutting unit to steer itself as traction unit turns.

18. Hook spring wire around bottom of steering pin (Fig. 32).

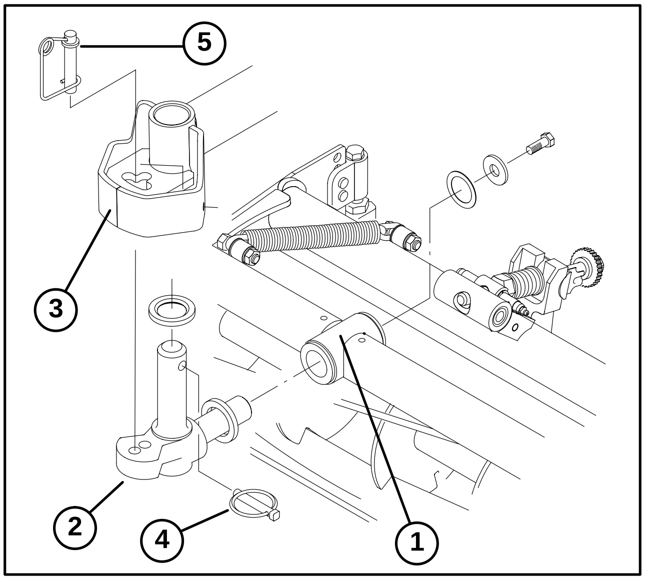


Figure 32

1. Carrier frame
2. Pivot knuckle
3. Lift arm steering plate
4. Lynch pin
5. Steering pin

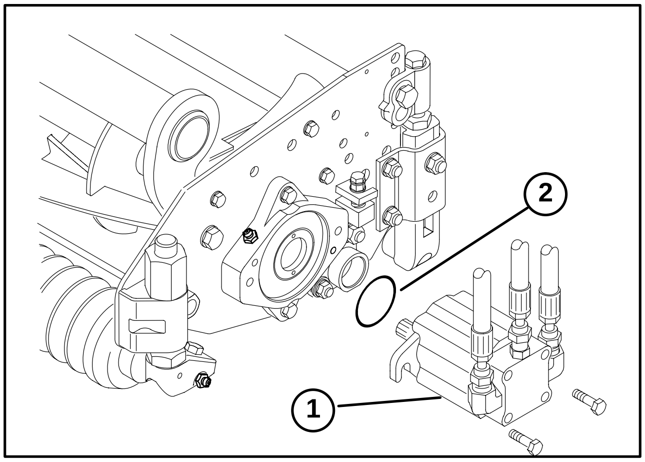


Figure 33

1. Motor
2. O–ring

Greasing Bearings, Bushings and Pivot Points

IMPORTANT: Lubricating cutting units immediately after washing helps purge water out of bearings and increases bearing life.

Each cutting unit has (6) grease fittings (Fig. 34) that must be lubricated regularly with No. 2 General Purpose Lithium Base Grease.

The grease fitting locations shown in figure 34 are for each side of cutting unit.

IMPORTANT: Lubricating cutting units immediately after washing helps purge water out of bearings and increases bearing life.

1. Wipe each grease fitting with a clean rag.

2. Apply grease until pressure is felt against handle.

3. Wipe excess grease away.

Note: Apply grease to reel bearing cavities until a small amount is evident at the inboard reel seal.

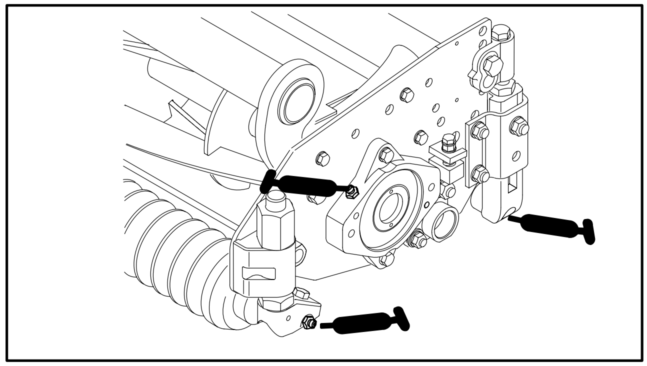


Figure 34

Model 03857, S/N 80302 & Up
Model 03858, S/N 81419 & Up
Model 03859, S/N 81993 & Up

Chapter 8.1

Cutting Units

Table of Contents

Specifications

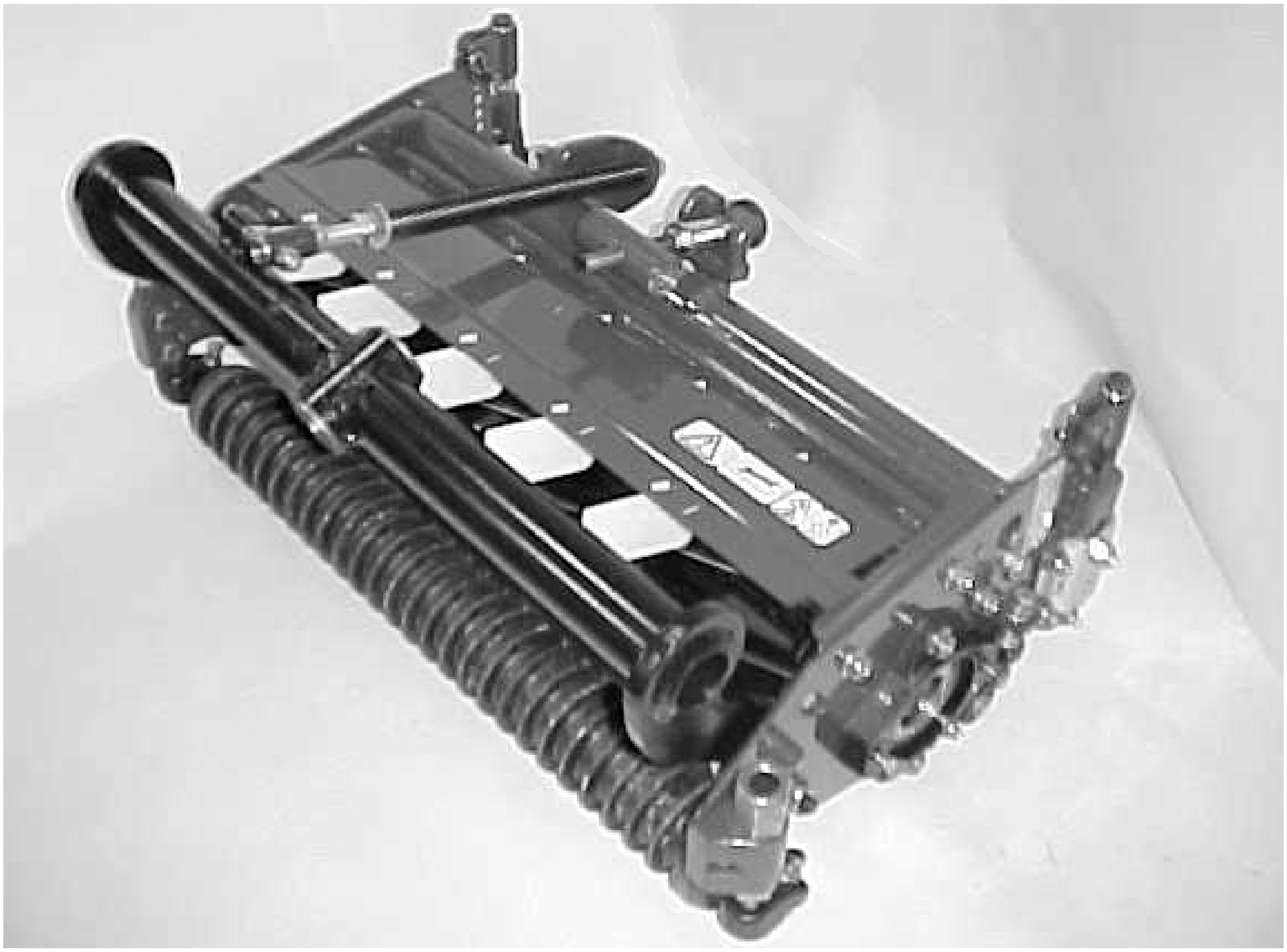


Figure 1

Reel Construction: Fairway reels. All welded. 5, 7 or 11 blades.

Height Of Cut Range:
5 Blade – 3/4” to 1–1/2” (19–38 mm)
7 Blade – 1/2” to 1–1/8” (13–29 mm)
11 Blade – 3/8” to 3/4” (10–19 mm)

NOTE: Use bedknife Part No. 93–9774 for height–of–cuts below 1/2” (13 mm).

Reel Diameter: 7 in. (178 mm)

Power Attachment: Reel motors feature quick disconnect for removal or installation onto cutting unit. Cutting units can be driven from either end.

Height–of–cut & Roller Adjustment: Height–of–cut adjustment is made at the rear roller with quick locating pin and/or threaded micro–adjustment. Front roller position is adjustable to set cutting unit attitude.

Bedknife And Bedbar Adjustment: Single point adjustment (SPA) mechanism.

Clip Frequency: .375” – 1.25” (10–32 mm).

Automatic Clip Control: The Reelmaster 6000D Series Traction Unit is equipped with an electronic controller which is programmed to achieve automatic clip control.
As the traction unit speed varies, the controller will automatically adjust the hydraulic flow to the reel motors to vary reel speed and maintain proper clip.
For proper clip, the controller needs to know what cutting units are installed (5, 7 or 11 blade) and the height–of–cut.
NOTE: Refer to Traction Unit Operator’s Manual for proper set–up procedure.

Rollers: Front roller is a 3” (76 mm) diameter cast Wiehle roller. Rear roller is a 3” (76 mm) diameter steel full roller. Both rollers use the same heavy duty ball bearings with two conventional single lip seals and a Toro labyrinth seal to provide four sealing surfaces to protect the bearings.

Special Tools

Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*.

Some tools may have been supplied with your machine or available as TORO parts. Some tools may also be available from a local supplier.

Gauge Bar Assembly

Use gauge bar to verify height of cut and cutting unit attitude.

Toro P/N **98–1852**

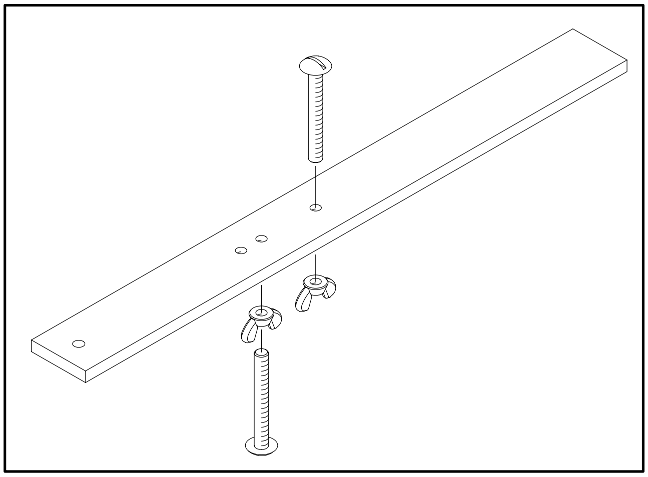


Figure 2

Angle Indicator

Use angle indicator to measure and set cutting unit attitude.

Toro P/N **99–3503**

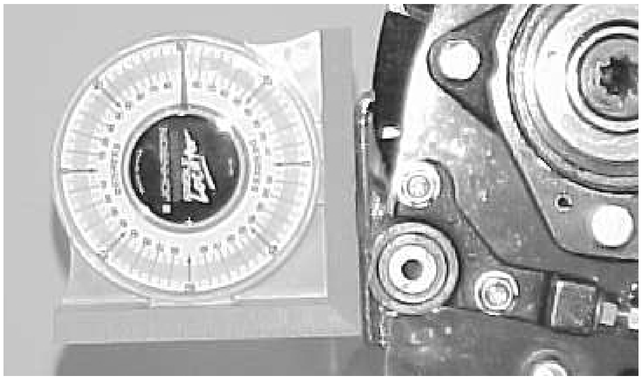


Figure 3

Handle Assembly TOR299100

For applying lapping compound to cutting units while keep hands a safe distance from the rotating reel.

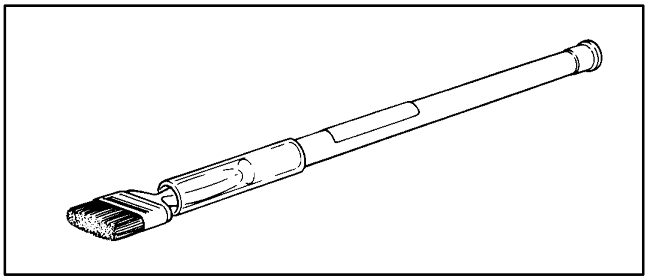


Figure 4

Bedknife Screw Tool TOR510880

This screwdriver–type bit is made to fit Toro bedknife attaching screws. Use this bit with a torque wrench to secure the bedknife to the bedbar. Make sure bedbar threads are clean and use new screws. Tighten screws to a torque of 250 – 300 in.lb. (288 – 345 KgCm) starting in the middle of the bedknife as shown in figure 5.

NOTE: Remove all rust, scale and corrosion from bedbar surface before installing bedknife.

DO NOT use and air impact wrench with this tool.

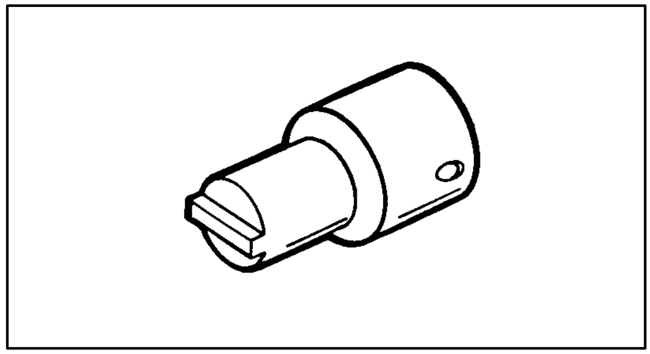


Figure 5

Reel Drive Shaft TOR4074

Use reel drive shaft for rotating cutting reel when hydraulic motor is removed (backlapping or sharpening).

NOTE: This tool is included in Cutting Unit Tool Kit TOR4070.

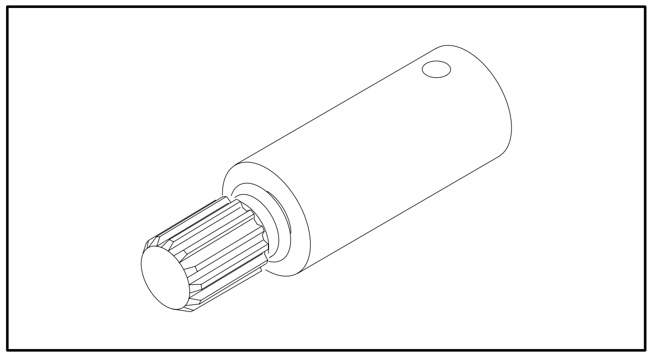


Figure 6

Cutting Unit Tool Kit TOR4070

This tool kit includes special tools required for rebuilding the cutting unit and cutting unit drive motor on the Reelmaster 6500–D and 6700–D.

TOR4064	Spanner Wrench
TOR4065	Inner Oil Seal Installer
TOR4066	Bearing Installer
TOR4067	Shaft Support Tool
TOR4068	Inner Seal Installer
TOR4869	Outer Seal Installer
TOR4071	Outer Oil Seal Installer
TOR4072	Reel Motor Shaft Seal Protector
TOR4073	Handle
TOR4074	Spline Insert Tool

Figure 7

Troubleshooting

There are a number of factors that can contribute to unsatisfactory quality of cut, some of which may be turf conditions. Turf conditions such as excessive thatch, “sponginess” or attempting to cut off too much grass height may not always be overcome by adjusting the machine. It is important to remember that the lower the height of cut, the more critical these factors are.

Remember that the “effective” or actual height of cut depends on cutting unit weight and turf conditions. Effective height of cut will be different than the bench set height of cut.

Factors That Can Affect Quality of Cut

Factor	Possible Problem/Correction
1. Reel speed and ground speed.	Make sure HOC Selector is set to correct position (A – P) for height of cut and number of reel blades. Slow down or speed up if Reel Control lamp comes on. Make sure controller is programmed for correct cutting unit model (5, 7 or 11 blade) All reels should rotate at same speed (within 100 RPM). All cutting units should have equal bedknife to reel contact. If checking RPM, do not run reel to long without cutting grass, or bedknife and/or reel may overheat and “rifle”. See other items under Troubleshooting in Chapter 4 – Hydraulic System and Chapter 5 – Electrical System.
3. Tire pressure.	Check and inflate to specification if necessary. Must be equal in two front tires and two rear tires. NOTE: Correct tire size and inflation pressure is important on 4WD model to prevent scuffing of turf.
3. Reel bearing condition.	Replace bearings if worn or damaged. Do not over–tighten bearing retainer nut.
4. Reel and bedknife sharpness.	Reel and/or bedknife that has rounded cutting edges or “rifling” cannot be corrected by tightening bedknife to reel contact. Grind reel to remove taper and/or rifling (grooved or wavy appearance). Grind bedknife to sharpen and/or remove rifling. (Most common cause of rifling is bedknife to reel contact that is too tight.) NOTE: New bedknife must be ground or backlapped after installing on bedbar.

Factor	**Possible Problem/Correction**
5. Bedknife to reel adjustment.	Check bedknife to reel contact daily. Bedknife must have light contact all across reel. No contact will cause cutting edges to become dull. Excessive contact accelerates wear; quality of cut may be adversely affected. Adjust so you paper can be pinched between reel and bedknife without tearing when inserted from the front, and cuts cleanly when inserted at a right angle (along entire length of bedknife). Slightly dull cutting edges may be corrected by backlapping, Excessively dull cutting edges must be corrected by grinding the reel and bedknife.
6. Front roller position.	Make sure front rollers on all cutting units are in the same position Make sure rollers are adjusted so bedknife has proper attitude for height of cut setting and turf conditions.
7. Rear roller parallel to reel.	Rear roller must be leveled so it is parallel with the reel before setting height of cut.
8. Height of cut.	Make sure all cutting units are set at same height of cut. Set with rear roller – must be equal at both ends of roller.
9. Roller scraper adjustment.	Install and/or adjust front and rear roller scrapers if grass clippings build up on rollers.
10. Stability of bedbar.	Check bedbar end bushings, adjuster pivot bushings and nylon flanged bushings for wear or damage. Check adjustment knob to make sure detent holds adjustment.
11. Number of reel blades.	Use cutting unit model with correct number of blades for clip frequency and optimum quality of cut range (see Specifications).
12. Cutting unit alignment and ground following.	Check lift arms and cutting unit pivot linkages for wear, damage or binding.
13. Roller condition.	All rollers should rotate freely. Replace bearings if they are worn, damaged, or have excessive radial play.

Set–up and Adjustments

IMPORTANT: To insure proper setting of height–of–cut, these procedures must be followed in this order:

A. Adjusting (Parallel) Bedknife To Reel

B. Setting Cutting Unit Attitude

C. Leveling Front Roller

D. Finalizing Height–of–Cut

IMPORTANT: Each cutting unit must be set consistently. Minor differences in either 1) Height–of–Cut, 2) Attitude, 3) Bedknife Wear or 4) Reel Blade Wear, between cutting units, may result in negative after cut appearance.

NOTE: The cutting unit has been set at the factory at 5/8" (16mm) height–of–cut and with a cutting unit attitude of 2 degrees. Also, the bedknife has been backed off from the reel to prevent shipping damage. Verify setting to ensure changes did not occur during shipment.

When doing set–up and adjustments:

1. Check each end of the reel for grease. Grease should be visibly evident in the reel bearings and internal splines of reel shaft.

2. Insure that all nuts and bolts are securely fastened.

3. Make sure carrier frame suspension operates freely and does not bind when moved back and forth.

NOTE: Right and left ends of cutting unit is determined by standing with the rear roller in front of you (Fig. 8).

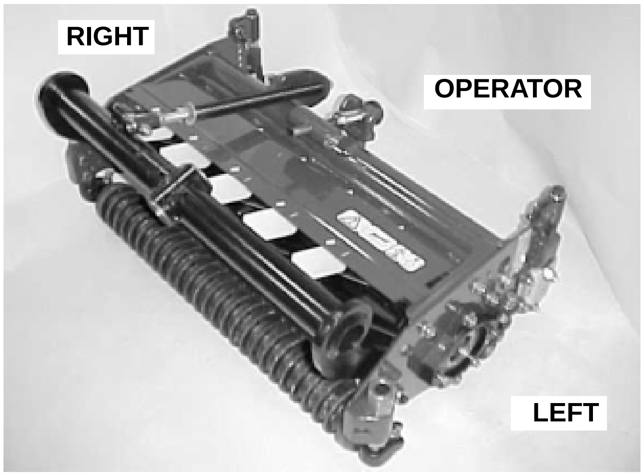


Figure 8

A. Adjusting (Parallel) Bedknife to Reel

IMPORTANT: The reel and bedknife must be parallel to insure the cutting unit cuts grass across the bedknife, and the reel and bedknife wear evenly.

NOTE: Toro recommends light contact between the reel and bedknife. However, for dry and/or sparse conditions a .001–.002" (.03–.05 mm) clearance may be required to prevent heat buildup which can cause uneven wear in the reel and bedknife.

NOTE: A 3/4 inch (19 mm) wrench is needed to rotate bedknife adjustment knob. Each notch on the knob will move the bedknife 0.0005 inches (.013 mm) closer to the reel (Fig. 9).

1. Rotate cutting unit backwards to gain access to reel and bedknife (Fig. 10).
2. While slowly rotating the reel in the mowing direction, turn the bedknife adjusting knob clockwise until you hear light contact between the reel and bedknife.

3. Insert a 1" wide news piece of newspaper perpendicular to the bedknife, and then rotate the reel slowly in the mowing direction to see if the reel cuts the paper - do this on both ends of the bedknife (Fig. 10).

4. If paper is cut on both ends, the bedknife is parallel to the reel. If not proceed to steps 5 thru 8.

NOTE: If reel makes contact on both sides of bedknife but still does not cut paper, cutting unit may need to be backlapped (refer to Backlapping) and/or reel and bedknife may need to be reground (refer to Toro manual for Sharpening Reel and Rotary Mowers, Form No. 80–300PT).

5. Loosen the pivot hub lock nuts to allow movement of the pivot hub (Fig. 11).

6. If paper was not cut on the left side: loosen the bottom adjusting nut on the pivot hub, then turn the top adjusting nut clockwise to pull the pivot hub up. **OR** If paper was not cut on the right side: loosen the top adjusting nut on the pivot hub, then turn the bottom adjusting nut counterclockwise to push the pivot hub down (Fig. 11).

NOTE: To reduce thread play, always tighten the bottom adjusting nut last.

7. Recheck reel to bedknife contact on both ends of the bedknife, and repeat step 6 as necessary.

NOTE: Reel to bedknife contact may become too tight or too loose after previous adjustment, therefore, turn bedknife adjustment knob, accordingly, for light contact.

8. Retighten pivot hub lock nuts.

NOTE: Recheck if paper cuts on both ends, to insure the bedknife did not move when re–tightening the pivot hub lock nuts.

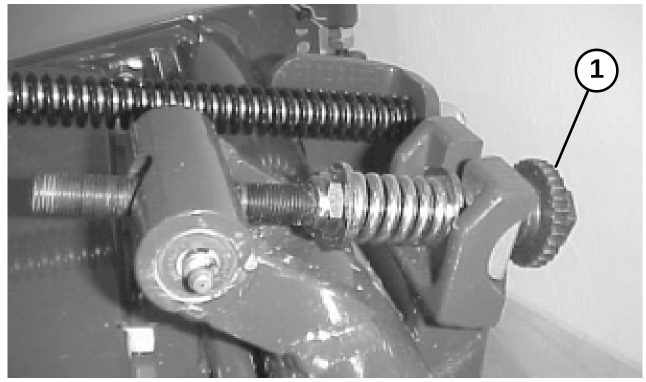


Figure 9

1. **Bedknife adjusting knob**

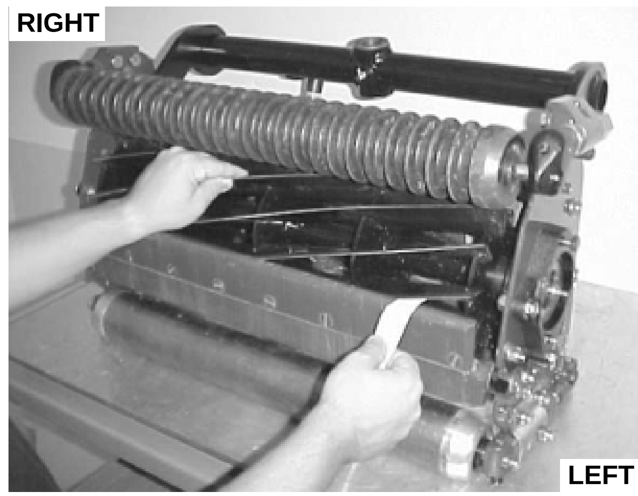


Figure 10

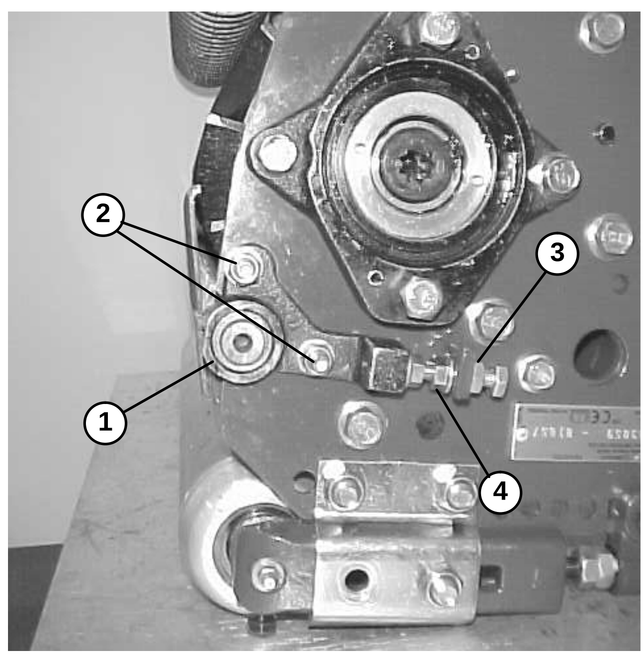


Figure 11

1. Pivot hub
2. Pivot hub locknuts
3. Top adjusting nut
4. bottom adjusting nut

B. Setting Cutting Unit Attitude – New Cutting Units

IMPORTANT: Cutting unit "attitude" has a significant impact on the performance of the cutting unit. Attitude refers to the angle of the knife relative to the ground (Fig. 12). Adjustable front and rear brackets allow for variable adjustment of cutting unit attitude within the height–of–cut range. All cutting units on a given machine must be set to the same attitude, if not - after cut appearance will be negatively affected.

The best cutting unit attitude is dependent on your turf conditions and desired results. Experience with the cutting unit on your turf will determine the best setting to use. Cutting unit attitude can be adjusted throughout the cutting season to allow for various turf conditions.

In general, less aggressive attitudes (example: 2 degrees) are more appropriate for warm season grasses while cool season grasses may require more aggressive attitudes (example: 6 degrees). More aggressive attitudes cut more grass off by allowing the spinning reel to pull more grass up into the bedknife. An angle that is too flat (attitude less than 1 degree) may allow the bedbar or other parts of the cutting unit to drag in the turf causing tufting. Therefore, minimum recommended attitude is 1 degree.

For setting consistent cutting unit attitude, Toro strongly recommends using a two–screw gauge bar, Toro part no. 98–1852 (Fig. 13). The first screw is set for height–of–cut, and the second screw is set for cutting unit attitude. The second screw setting is an easy method of transferring cutting unit attitude to all cutting units on a machine.

NOTE: The third hole is not used for RM6000 cutting units.

SETTING ATTITUDE FOR NEW CUTTING UNITS:

Table 1 lists dimensions for setting up a new cutting unit with attitudes of 2, 4, 6 and 8 degrees.

NOTE: The second screw setting will change throughout the life of the bedknife and reel due to wear – **even if the height–of–cut is not changed.** Therefore, after initial set up use **Checking and Adjusting Attitude for Used Cutting Unit** procedure.

1. Using a two–screw gauge bar, Toro part no. 98–1852, set first screw to desired Height–of–Cut. This setting is from the bar face to the underside of the screw head (Fig. 13).

2. Set the Front Bracket Height "B" using the approximate dimension given by **Table 1**. This measurement is between bottom surface of middle casting and top surface of rod casting (Fig. 14).

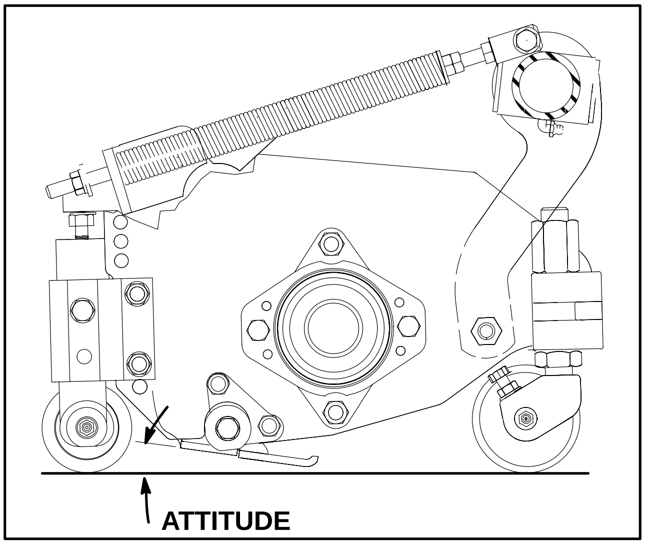


Figure 12

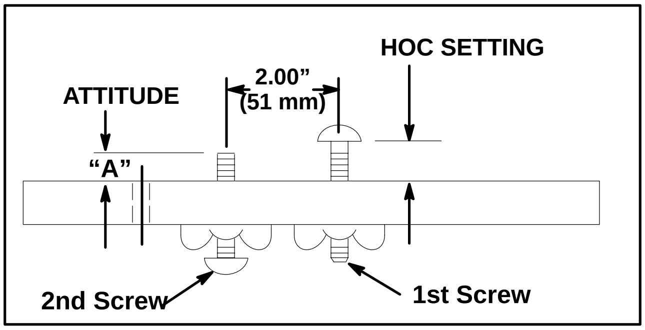


Figure 13

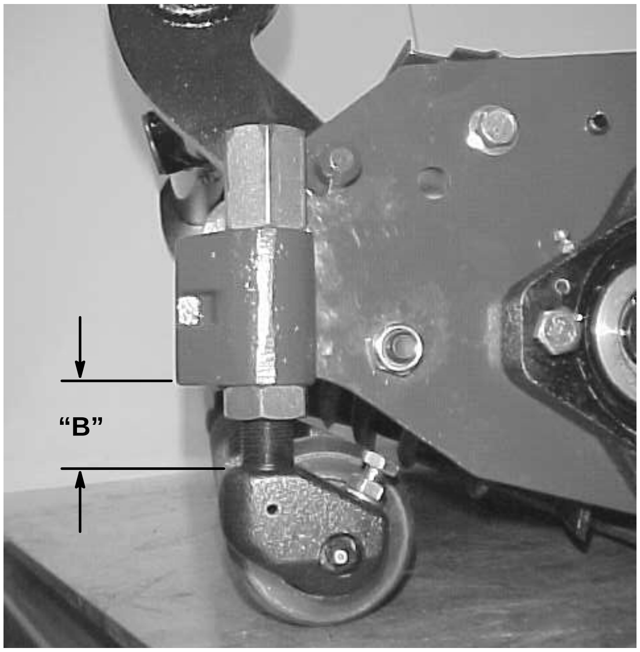


Figure 14

Table 1 – New Cutting Unit Set–up Guide

Desired Height–of–Cut (HOC)		Desired Attitude	2nd Screw “A” (Fig. 17)		Front Roller “B” (Fig. 14)		Rear Support Bracket Hole (Fig. 15)	Side Plate Hole (Fig. 15)	
(in)	**(mm)**	**(degrees)**	**(in)**	**(mm)**	**(in)**	**(mm)**	**(location)**	**(location)**	
0.375	**(10)**	2*	0.180	4.6	0.901	22.9	Bottom	1st	
		4*	0.231	5.9	0.696	17.7	Bottom	1st	
		6*	–	–	–	–	–	–	
		8*	–	–	–	–	–	–	
0.500	**(13)**	2*	0.299	7.6	1.020	25.9	Bottom	1st	
		4*	0.356	9.0	0.820	20.8	Bottom	2nd	
		6*	0.414	10.5	0.621	15.8	Bottom	2nd	
		8*	–	–	–	–	–	–	
		2	0.228	5.8	1.109	28.2	Bottom	1st	
		4	0.285	7.2	0.909	23.1	Bottom	1st	
		6	0.342	8.7	0.707	18.0	Bottom	2nd	
		8	–	–	–	–	–	–	
0.625	**(16)**	2	**0.353**	**9.0**	**1.233**	**31.3**	**Bottom**	**1st**	**– Factory Setting**
		4	0.410	10.4	1.034	26.3	Bottom	2nd	
		6	0.467	11.9	0.832	21.1	Bottom	2nd	
		8	–	–	–	–	–	–	
0.750	**(19)**	2	0.478	12.1	1.358	34.5	Bottom	1st	
		4	0.535	13.6	1.158	29.4	Bottom	2nd	
		6	0.592	15.0	0.957	24.3	Top	1st	
		8	0.650	16.5	0.756	19.2	Top	1st	
0.875	**(22)**	2	0.603	15.3	1.482	37.6	Bottom	2nd	
		4	0.660	16.8	1.283	32.6	Bottom	2nd	
		6	0.717	18.2	1.082	27.5	Top	1st	
		8	0.775	19.7	0.881	22.4	Bottom	3rd	
1.000	**(25)**	2	0.728	18.5	1.606	40.8	Bottom	2nd	
		4	0.785	19.9	1.408	35.8	Top	1st	
		6	0.842	21.4	1.207	30.7	Bottom	3rd	
		8	0.900	22.9	1.006	25.6	Bottom	3rd	
1.125	**(29)**	2	0.853	21.7	1.731	44.0	Bottom	2nd	
		4	0.910	23.1	1.533	38.9	Top	1st	
		6	0.967	24.6	1.332	33.8	Bottom	3rd	
		8	1.025	26.0	1.131	28.7	Top	2nd	
1.250	**(32)**	2	0.978	24.8	1.855	47.1	Bottom	2nd	
		4	1.035	26.3	1.657	42.1	Top	1st	
		6	1.092	27.7	1.457	37.0	Bottom	3rd	
		8	1.150	29.2	1.256	31.9	Top	2nd	
1.375	**(35)**	2	1.103	28.0	1.980	50.3	Top	1st	
		4	1.160	29.5	1.782	45.3	Bottom	3rd	
		6	1.217	30.9	1.582	40.2	Top	2nd	
		8	1.275	32.4	1.381	35.1	Top	2nd	
1.500	**(38)**	2	1.228	31.2	2.104	53.4	Top	1st	
		4	1.285	32.6	1.907	48.4	Bottom	3rd	
		6	1.342	34.1	1.707	43.4	Top	2nd	
		8	1.400	35.6	1.506	38.3	Top	4th	
1.625	**(41)**	2	–	–	–	–	–	–	
		4	1.410	35.8	2.032	51.6	Top	2nd	
		6	1.427	36.2	1.832	46.5	Bottom	4th	
		8	1.525	38.7	1.631	41.4	Bottom	4th	
1.750	**(45)**	2	–	–	–	–	–	–	
		4	1.535	39.0	2.156	54.8	Top	2nd	
		6	1.592	40.4	1.957	49.7	Bottom	4th	
		8	1.650	41.9	1.756	44.6	Top	3rd	

***** Optional Low Cut Bedknife, Toro part no. 93–9774, is required for height–of–cut below 0.500” (13 mm).

NOTE: For front roller distances (“B”) greater than 1.5” (38 mm) switch long and short adjusting nut locations for better support (Fig. 14).

3. Set the rear support bracket and side plate using the approximate dimensions given by **Table 1**. The rear support bracket is either in the top or bottom location, and the side plate location can be in holes 1 thru 4, with 1 being the top hole (Fig. 15).

4. With the cutting unit rotated vertical, place gauge bar across front and rear rollers. The first screw head should fit snugly over edge of bedknife and the end of second screw should contact bottom of bedknife (Fig. 16). If there is a gap between the front roller and the gauge bar, lower the front roller until it contacts the gauge bar. Verify front roller (attitude) at each end of the bedknife.

NOTE: At this time leave a small gap between the rear roller and gauge bar.

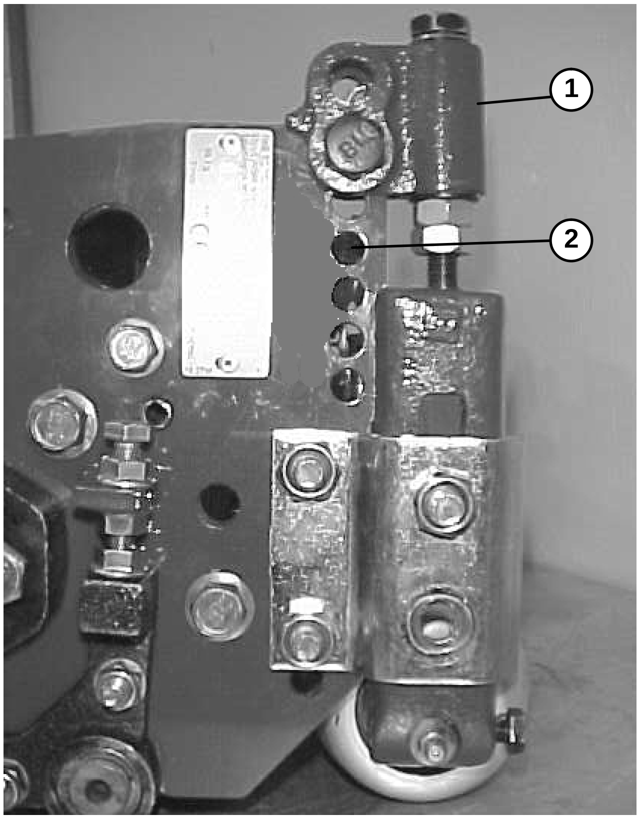


Figure 15

1. **Rear support bracket**
2. **Side plate holes**

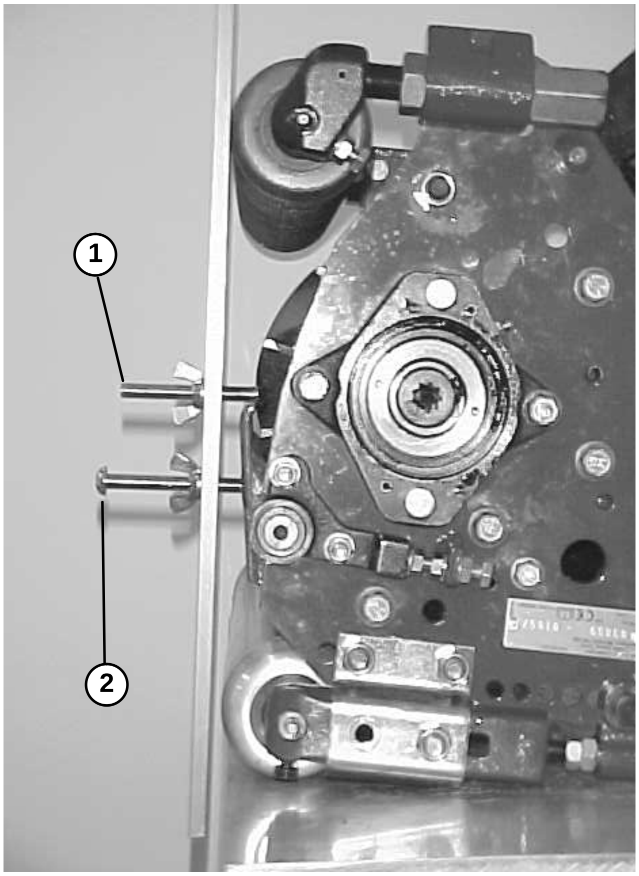


Figure 16

1. **1st screw**
2. **2nd screw**

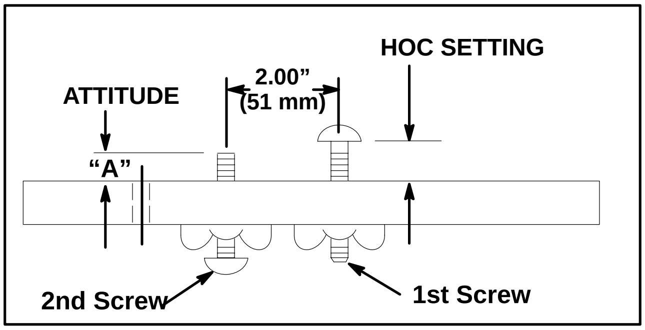


Figure 17

B. Checking or Adjusting Attitude – Used Cutting Units

NOTE: As a starting point for adjusting cutting unit attitude, the cutting unit may be set up using the dimensions from **TABLE 1.** However, because of wear on the bedknife and reel, either the First or Second Method must be used to insure the correct setting of the attitude.

FIRST METHOD (Angle Indicator):

1. Rotate cutting unit backwards to gain access to reel and bedknife.

2. Place an angle indicator, Toro part no. 99–3503, on the bedknife and record the bedknife angle (Fig. 18).

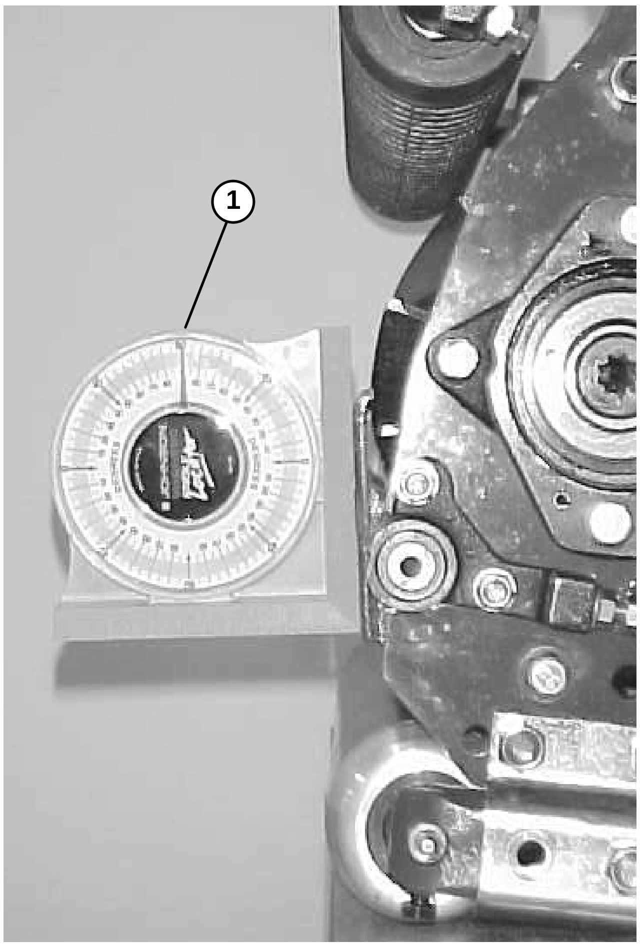


Figure 18
1. Bedknife angle

3. Using a two–screw gauge bar, Toro part no. 98–1852, set first screw to desired height–of–cut.

4. Place the gauge bar across front and rear rollers. The first screw head needs to fit snugly over edge of the bedknife,while the gauge bar contacts the front roller (Fig. 19).

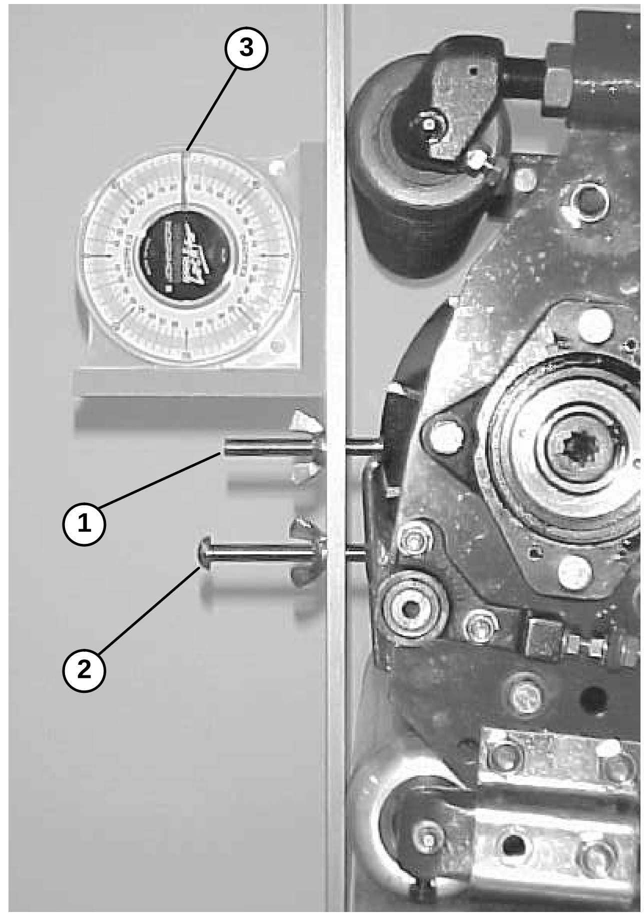


Figure 19
1. 1st screw
2. 2nd screw
3. Gauge bar angle

NOTE: The rear roller does not have to contact the gauge bar.

5. Place an angle indicator on the gauge bar and record the gauge bar angle (Fig. 19).

6. **Bedknife Angle (step 2)**
   – **<u>Gauge Bar Angle (step 5)</u>**
   = Cutting Unit Attitude (degrees)

7. Adjust the front roller to your desired cutting unit attitude.

NOTE: Moving the front roller down will decrease your cutting unit attitude, while moving the front roller up will increase cutting unit attitude.

8. Set the second screw to transfer your desired cutting unit attitude to the remaining cutting units on the machine.

SECOND METHOD (Screw Height Difference) :

1. Rotate cutting unit backwards to gain access to reel and bedknife.

2. Using a two–screw gauge bar, Toro part no. 98–1852, set first screw to desired Height–of–Cut.

3. Place the gauge bar across front and rear rollers. The first screw head needs to fit snugly over edge of the bedknife, while the gauge bar contacts the front roller (Fig. 20).

NOTE: The rear roller does not have to contact the gauge bar.

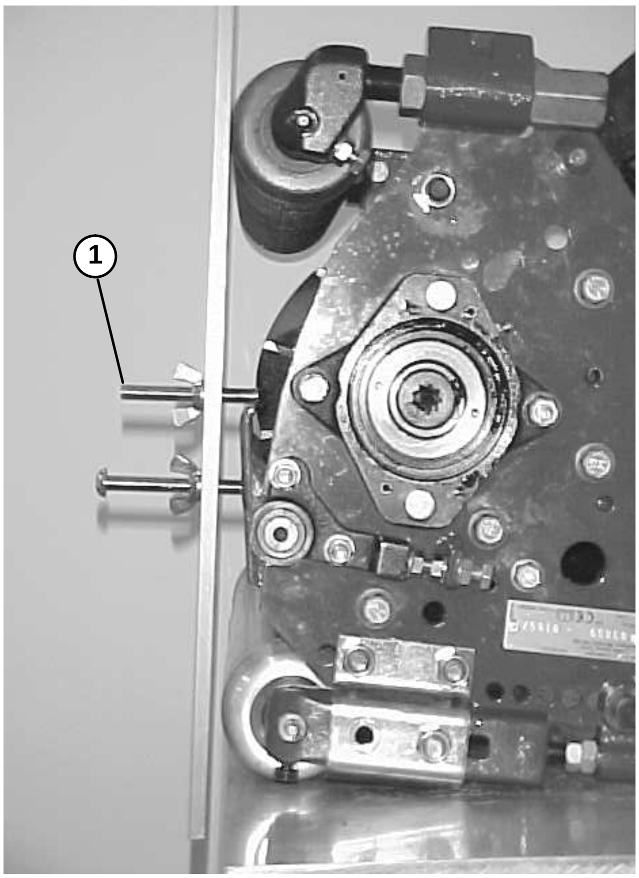


Figure 20

1. 1st screw

4. Switch first screw on gauge bar so both screw heads are pointed in the same direction (Fig. 21).

5. Place two–screw gauge bar on bedknife so both screws contact bedknife while gauge bar contacts front and rear rollers (Fig. 21).

NOTE: Both screws must contact flat surface of bedknife.

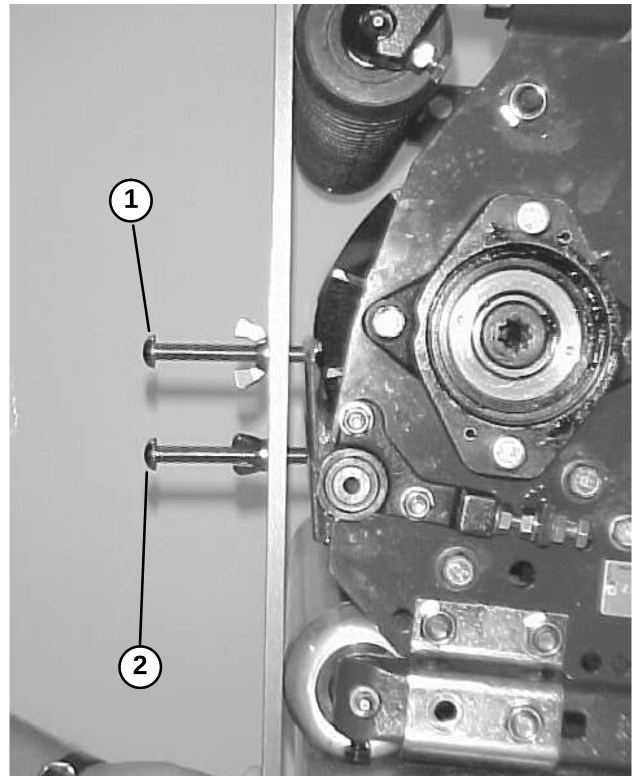


Figure 21

1. 1st screw
2. 2nd screw

6. Using a vernier caliper measure the height of first and second screw. This measurement is from the bar face to the end of the screw (Fig. 22).

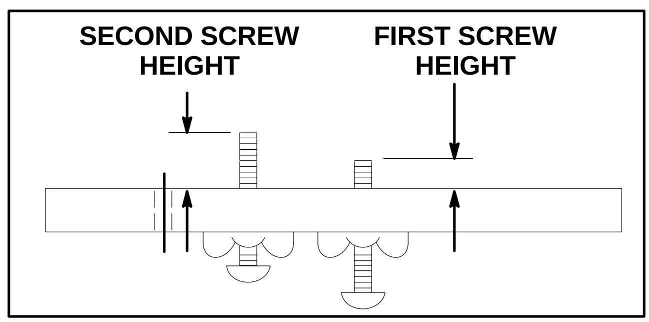


Figure 22

7. **Second Screw Height**
   – **<u>First Screw Height</u>**
   = **Screw Height Difference**

8. Using **Table 2,** adjust the second screw to your desired cutting unit attitude.

TABLE 2 - USED CUTTING UNIT SET UP GUIDE

Attitude (degrees)	Screw Height Difference (in)	(mm)
1	0.028	0.72
2	0.057	1.44
3	0.085	2.16
4	0.114	2.89
5	0.142	3.61
6	0.171	4.34
7	0.200	5.07
8	0.228	5.80

9. Put 1st screw back to the normal position (screw head hooks over bedknife) and set to desired height of cut (Fig. 20)

10. Place the gauge bar across front and rear rollers. While the first screw head fits snugly over edge of the bedknife and the second screw contacts the bedknife, adjust the front roller until contacts the gauge bar (Fig. 20).

11. Use your gauge bar to set cutting unit attitude to the remaining cutting units on the machine.

C. Leveling Front Roller

IMPORTANT: Toro strongly recommends the use of a leveling plate when setting–up or adjusting any reel type cutting unit. The leveling plate will help to ensure accurate and consistent adjustments. Contact your local Toro Distributor to order a leveling plate.

1. Position cutting unit on a flat surface.

2. Position a 1/2" (13 mm) or thicker bar under the reel blades and against the cutting edge of the bedknife. **Make sure bar covers the full length of reel blades.** Rear roller should not contact surface (Fig. 23).

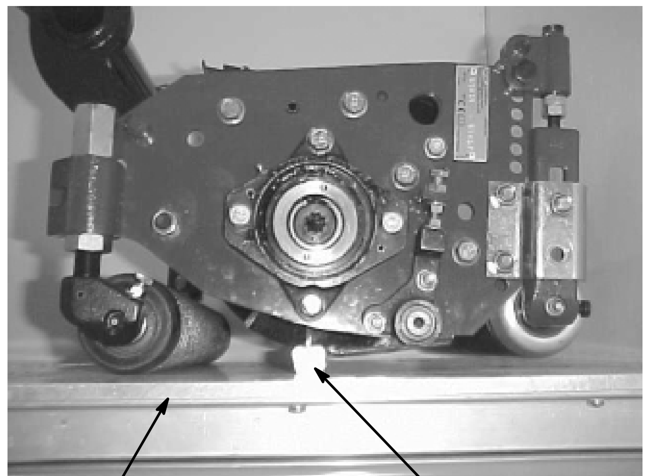
3. Rock cutting unit forward (on reel blades and steel bar) until front roller contacts flat surface. Reel blades and bedknife must maintain contact with bar (Fig. 23).

4. **Adjust front brackets until both ends of roller are in contact with level surface.** Use a piece of newspaper or visually check to see if any gap exists between roller ends and flat surface (Fig. 24).

5. Tighten top and bottom nuts of front roller brackets to 55–65 ft–lbs. (75–88 N•m).

6. Re–check roller contact with newspaper to insure roller has not changed position and is parallel with the reel and bedknife.

CONTACT ALONG FULL LENGTH OF FRONT ROLLER AND REEL BLADE LEVELS FRONT ROLLER TO REEL



REF. FLAT SURFACE (1" X 20" X 30" FLAT STOCK SUGGESTED)

BAR STOCK (1" X 3/4" STOCK SUGGESTED)

Figure 23

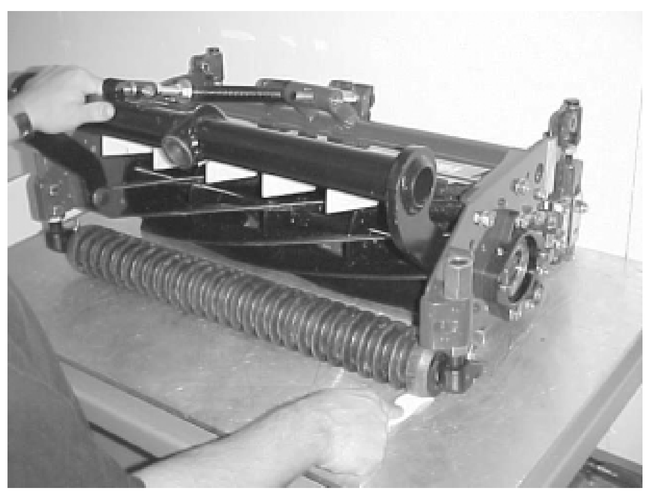


Figure 24

D. Finalizing Height–of–Cut

IMPORTANT: Adjusting (Parallel) bedknife to reel, setting cutting unit attitude, and leveling the front roller must be completed before finalizing height of cut.

1. Using a two–screw gauge bar, Toro part no. 98–1852, set first screw to desired Height–of–Cut. This setting is from the bar face to the underside of the screw head (Fig. 25).

2. With the cutting unit rotated backwards, place gauge bar across front and rear rollers. First screw head should fit snugly over edge of bedknife and the end of second screw should contact bottom of bedknife (Fig. 26). Verify rear roller (height of cut) at each end of the bedknife.

NOTE: Second screw height was determined in section B. Setting Cutting Unit Attitude.

3. If there is a gap between the rear roller and the gauge bar, or if the rear roller will not let you put the gauge bar on the bedknife, proceed as follows:

4. Loosen lock nuts on rear side brackets (Fig. 27).

5. To reduce thread play, turn rear adjusting screw clockwise until a slight gap exists between the rear roller and gauge bar. Then turn rear adjusting screw counter-clockwise until rear roller contacts the gauge bar. After adjustment, verify gauge bar contacts rear roller on both ends of the bedknife.

NOTE: Make sure gauge bar is in contact with front roller at all times to keep correct cutting unit attitude.

6. Slide gauge bar towards the end of the cutting unit to remove. Gauge bar can now be utilized to set remaining cutting units on machine.

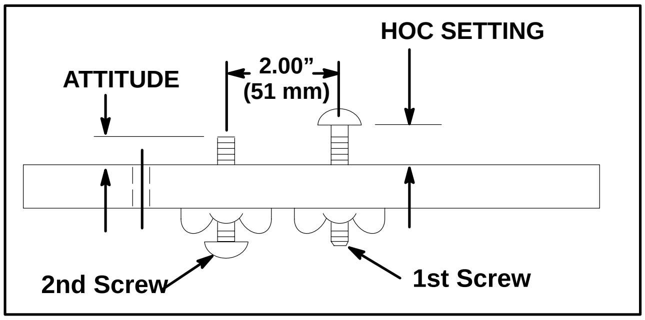


Figure 25

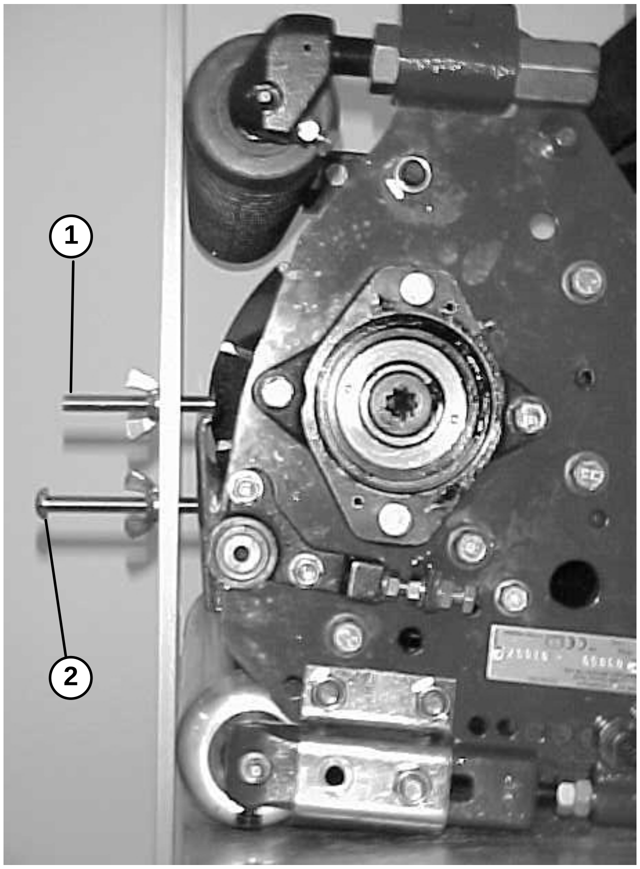


Figure 26
1. 1st screw
2. 2nd screw

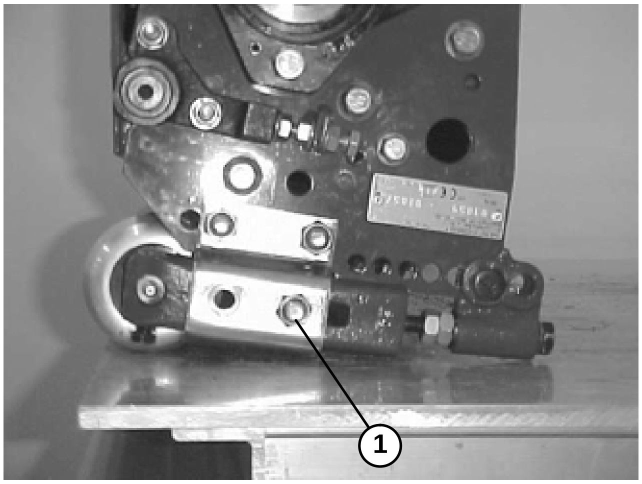


Figure 27
1. Locknut (both sides)

Front Shield and Fins Adjustment

Adjust front shield and/or shield fin angle for desired grass clippings dispersion.

1. Position cutting unit on a flat level surface.

2. To adjust fins (Fig. 28), unhook and move front mounting tab to the straight ahead or angled position slot.

3. To change front shield angle, loosen flange head capscrew securing shield to right side plate, move shield to desired angle and tighten screw.

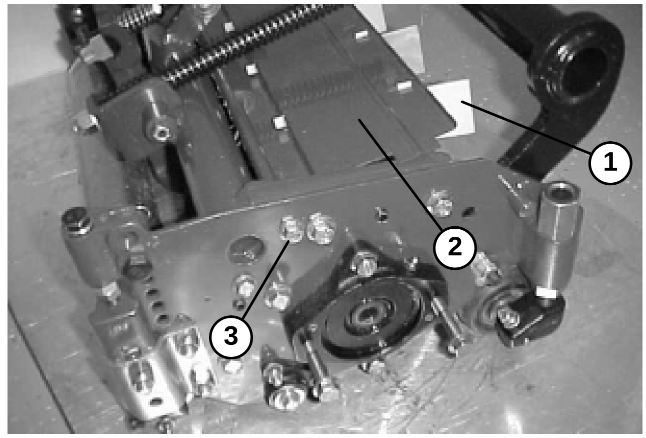


Figure 28

1. **Shield fin**
2. **Front grass shield**
3. **Front capscrew location**

Rear Shield Adjustment

Under most conditions, best dispersion is attained when rear shield is closed (front discharge).
When conditions are heavy or wet, rear shield may be opened.

1. To open rear shield (Fig. 29), loosen flange head capscrew securing shield to left side plate, rotate shield to open position and tighten capscrew.

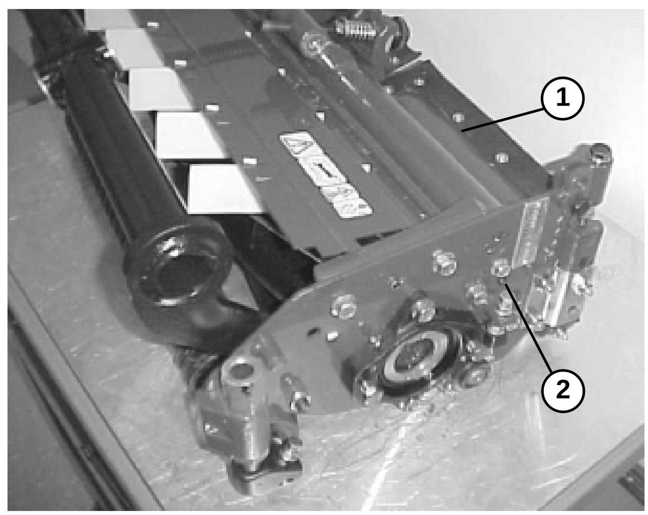


Figure 29

1. **Rear grass shield**
2. **Rear capscrew**

Turf Compensation Spring Adjustment

The Turf Compensation Spring (Fig. 30), connecting carrier frame to cutting unit, controls the amount of fore–aft rotation available, as well as the amount of ground clearance in transport and turn around.

The Turf Compensation Spring also transfers weight from the front to rear roller. This helps to reduce a wave pattern in the turf, also known as bobbing.

IMPORTANT: Make spring adjustments with cutting unit mounted to traction unit and lowered to shop floor. Refer to Traction Unit Operator's Manual for mounting instructions.

1. Tighten lock nut on rear of spring rod until the gap (C) between rear of spring bracket and front of washer is 1" (26 mm) (Fig. 30).

2. Tighten hex nuts on front end of spring rod until the compressed length (A) of spring is 8" (203 mm) (Fig. 30).

NOTE: When cutting rough or undulating turf, increase compressed length (A) of spring to 8–1/2" (216 mm) and gap (C) between rear of spring bracket and front of washer to 1–1/2" (39 mm) (Fig. 30).

NOTE: As compressed spring length (A) DECREASES, weight transfer from front roller to rear roller INCREASES and carrier frame/cutting unit rotation angle (B) DECREASES.

NOTE: As gap (C) between spring bracket and washer INCREASES, cutting unit ground clearance DECREASES and carrier frame/cutting unit rotation angle (B) INCREASES.

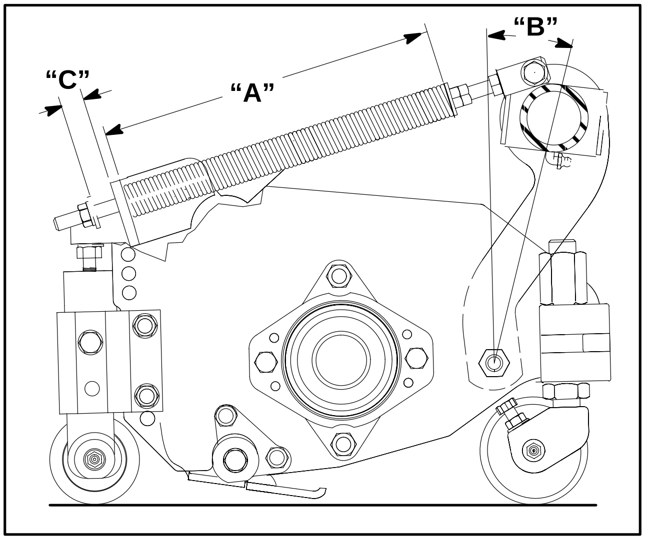


Figure 30

Reel Bearing Adjustment

To insure long life of the reel bearings, periodically check if reel end play exits. The reel bearings can be checked and adjusted as follows:

1. Loosen reel to bedknife contact by turning the bedknife adjusting knob counter–clockwise until no contact exists.

2. Hold on to the reel shaft and try to move the reel assembly side to side.

3. If end play exists, proceeded as follows:

A. Loosen set screw securing bearing adjusting nut to bearing housing located on the left side of the cutting unit.

B. Using a spanner wrench, slowly tighten the reel bearing adjustment nut until no end play of the reel exists. If adjusting nut does not eliminate reel end play, replace reel bearings.

NOTE: Reel bearings do not require pre–load. Over tightening reel bearing adjuster nut will damage reel bearings.

C. Retighten set screw securing bearing adjusting nut to bearing housing.

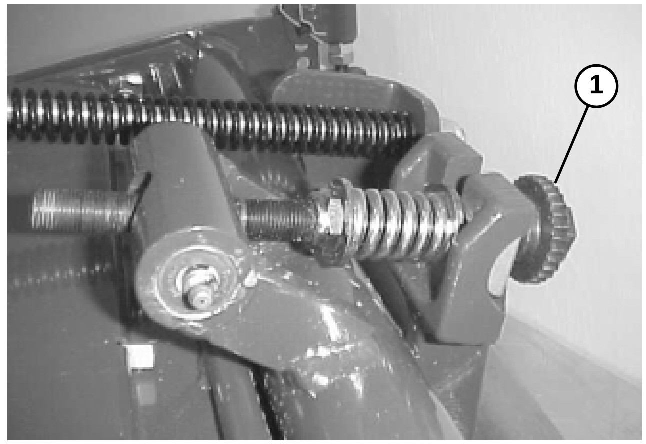


Figure 31
1. Bedknife adjusting knob

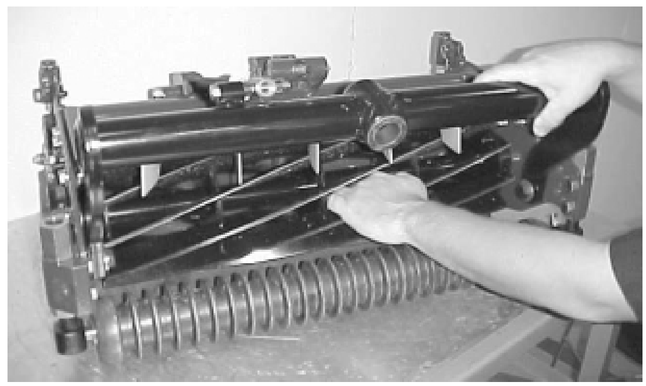


Figure 32

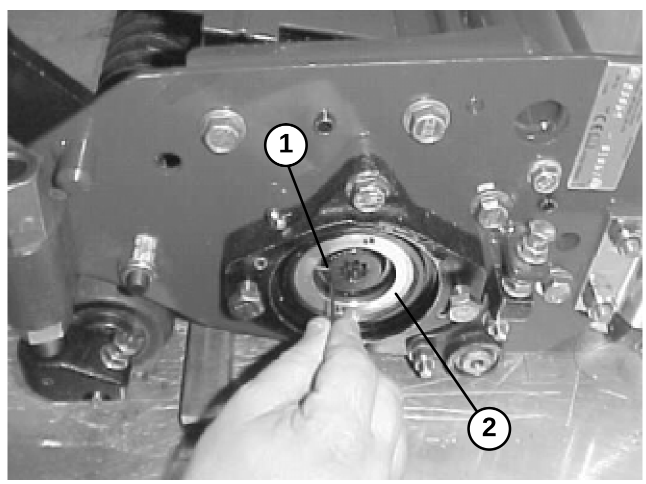


Figure 33
1. Set screw
2. Bearing adjusting nut

SPA (Single Point Adjustment) Spring

If single point adjustment assembly (Fig. 41) is removed for servicing, make sure spring is compressed to a length of 1.25” (32 mm). This adjustment is attained by tightening nut on SPA knob shaft.

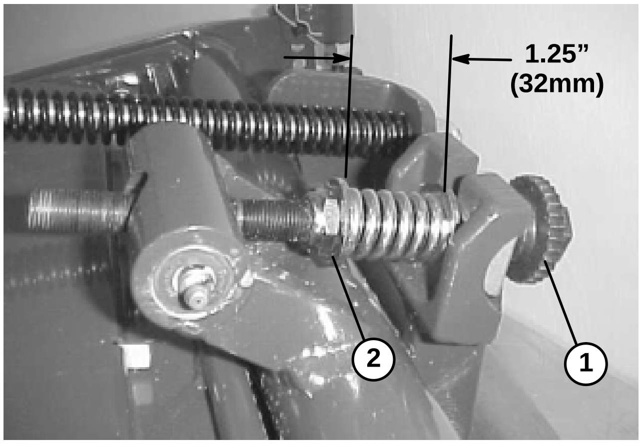


Figure 34

1. **Single point adjust assembly**
2. **Adjusting nut**

Cutting Unit Lowering Rate Adjustment (Outer front cutting units only – #4 and #5

The cutting unit lift circuit is equipped with a adjustable valve to ensure the front cutting units lower evenly. Adjust as follows:

1. Run traction unit until operating temperature is reached.

2. Locate valve under seat.

3. Loosen setscrew on valve. Rotate valve clockwise to slow down drop rate of front outside cutting units.

4. Verify lift rate adjustment by raising and lowering cutting units several times. Readjust as required.

5. After desired lift rate is attained, tighten set screw to lock adjustment.

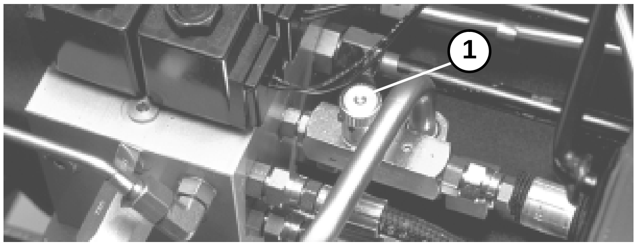


Figure 35

1. Cutting unit adjustment valve

Lifted Height of Outer Front Cutting Units (Enable Position)

The turnaround height of the front outer cutting units (#4 & #5) may be increased to provide additional ground clearance on contoured fairways. Contact your distributor for assistance.

Travel of Front Three Cutting Units

Additional downward travel of the front three cutting units may be desirable in highly contoured locations. If any of the front three cutting units lift off the ground when cresting a “hill”, the front carrier frame may be lowered by removing mounting bolts and repositioning frame in the bottom set of holes in the main frame (Fig. 36). Contact your distributor for assistance.

Note: Moving the carrier frame down will decrease the amount of clearance between the cutting units and the ground in turnaround and transport positions and may require adjusting the lift chain length on the cutting unit.

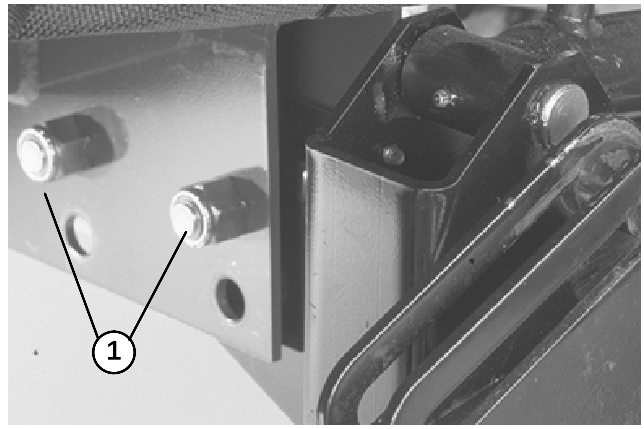


Figure 36
1. Carrier frame mounting bolts

Backlapping

DANGER

REELS MAY STALL WHILE BACKLAPPING. DO NOT ATTEMPT TO RESTART REELS BY HAND OR TOUCH REELS WHILE BACKLAPPING. STOP ENGINE AND TURN H.O.C. KNOB ONE POSITION TOWARD "A".

NOTE: When backlapping, the front units all operate together, and the rear units operate together.

1. Position the machine on a level surface, lower the cutting units, stop the engine, engage the parking brake, and move the Enable/Disable switch to disable position.

2. Unlock and raise the seat to expose controls.

3. Open control cover and turn the H.O.C. selection knob to position "P" (Fig. 37).

NOTE: Backlapping speed may be increased by moving the H.O.C. selection knob toward "A". Each position will increase speed approximately 60 rpm. After changing selector, wait 30 seconds for the system to respond to the new speed target.

4. Make initial reel to bedknife adjustments appropriate for backlapping on all cutting units which are to be backlapped.

5. Start engine and run at idle speed.

DANGER: To avoid personal injury, never place hands or feet in reel area while engine is running. Changing engine speed while backlapping may cause reels to stall. Never change engine speed while backlapping. Only backlap at idle engine speed. Never attempt to turn reels by hand or foot while engine is running.

6. Select either front or rear on the backlap switch to determine whether front or rear reels will be backlapped.

DANGER: To avoid personal injury, be certain that you are clear of the cutting units before proceeding.

7. Move Enable/Disable switch to Enable position. Move Lower Mow / Lift control forward to start back–lapping operation on designated reels.

8. Apply lapping compound with a long handle brush (Toro Part No. 29–9100). Never use a short handled brush (Fig. 38).

9. If reels stall or become erratic while backlapping, the reel control light will begin to blink and the reels will turn off. If this occurs, turn the H.O.C. selection knob one position closer to "A". Then, toggle the Enable/Disable switch to the disable position followed by the enable position. To resume backlapping, move the Lower Mow / Lift control lever forward.

10. To make an adjustment to the cutting units while backlapping, turn reels OFF by moving the Lower Mow/ Raise lever rearward; move the Enable/Disable switch to Disable and turn the engine OFF. After adjustments have been completed, repeat steps 5 – 9.

11. Backlap until a small burr develops across the entire front edge of the bedknife.

12. Repeat procedure for all cutting units to be backlapped.

13. When backlap operation has been completed, return the backlap switch to OFF, lower seat and wash all lapping compound off cutting units. Adjust cutting unit reel to bedknife as needed.

IMPORTANT: If the backlap switch is not returned to OFF position after backlapping, the cutting units will not raise or function properly.

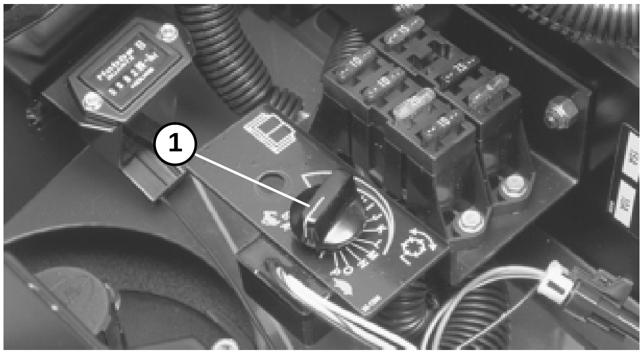


Figure 37

1. H.O.C. Selector Knob

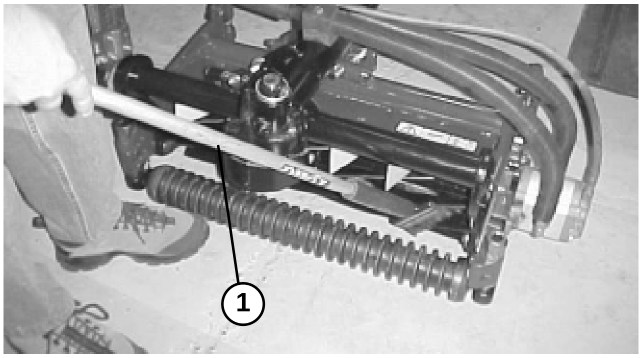


Figure 38

1. Long handle brush

Bedbar Removal and Installation

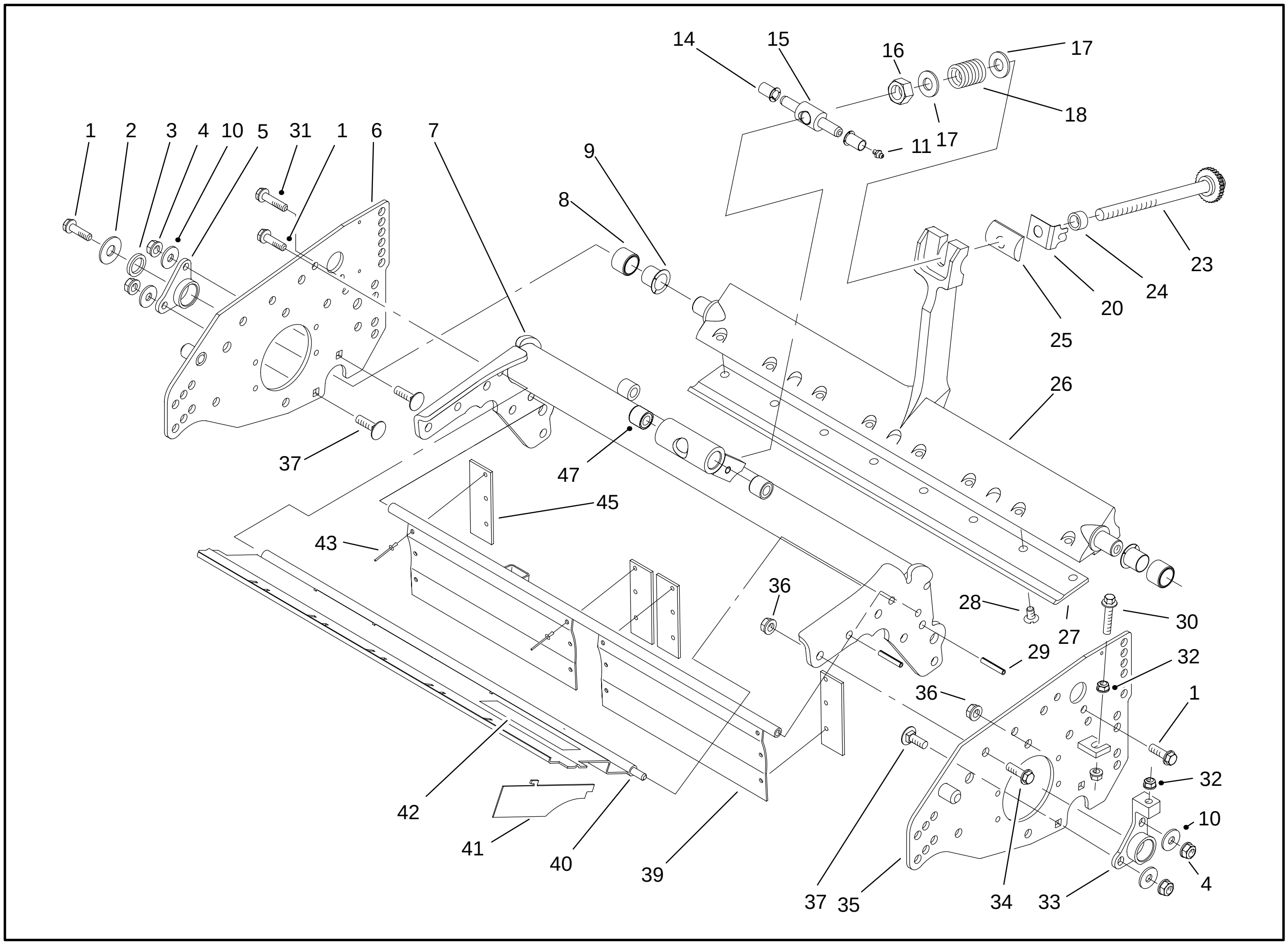


Figure 39

1. Screw	**16. Lock nut**	**32. Flange nut**
2. Washer	**17. Washer**	**33. L.H. pivot hub**
3. Quad ring	**18. Compression spring**	**34. Screw**
4. Lock nut	**19. Spring arm**	**35. L.H. side plate**
5. R.H. pivot hub	**23. Bedbar adjuster assembly**	**36. Lock nut**
6. R.H. side plate	**24. Adjuster spacer**	**37. Carriage screw**
7. Reel frame	**25. Bedbar adjustment pivot**	**39. Rear grass shield**
8. Bushing assembly	**26. Bedbar**	**40. Grass shield assembly**
9. Flange bushing	**27. Bedknife**	**41. Grass shield deflector**
10. Flat washer	**28. Special screw**	**42. Decal – Danger**
11. Grease fitting	**29. Roll pin**	**43. Rivet**
14. Plastic bushing	**30. Screw**	**45. Side flap**
15. Adjustment screw pivot	**31. Screw**	**47. Bushing**

Remove Bedbar

3. Loosen bedknife adjusting knob to loosen bedknife to reel contact.

4. Loosen locknut on bedknife adjuster assembly and disengaging adjuster from bedbar.

5. Remove bedbar leveling screw from L.H. side of cutting unit.

6. Remove fasteners securing L.H. and R.H. bedbar pivot hubs to frame.

7. Remove bedbar assembly.

8. Remove capscrew, washer and quad ring from R.H. end of bedbar.

9. Remove R.H. and L.H. pivot hubs from bedbar.

10. Sharpen or replace bedknife as necessary (see Bedknife Replacement and Grinding).

Install Bedbar

1. Inspect bedbar end bushings and flange bushings for wear and replace if necessary.

2. Install R.H. and L.H. pivot hubs onto bedbar.

3. Install quad ring, washer and capscrew to R.H. end of bedbar.

4. Install bedbar onto cutting unit and secure pivot hubs to frame with fasteners removed in step 4 above.

5. Install bedbar leveling capscrew and nuts to L.H. side of cutting unit.

6. Install bedknife adjusting knob assembly. Tighten locknut to compress spring to dimension shown.

7. Adjust bedknife to reel (see Bedknife to Reel Adjustment).

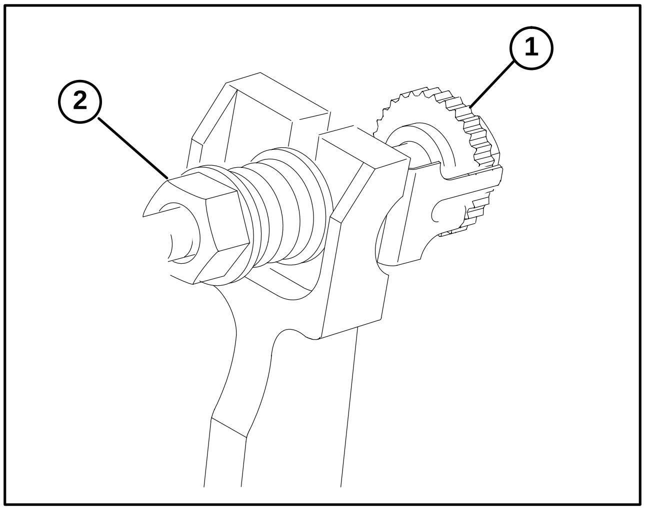


Figure 40

1. **Bedknife adjusting knob**
2. **Locknut**

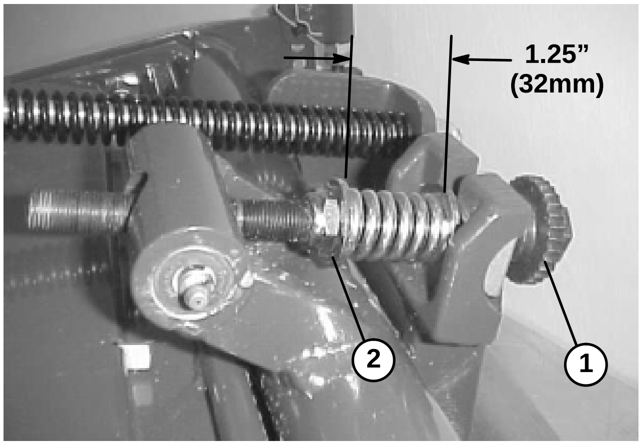


Figure 41

1. **Single point adjust assembly**
2. **Adjusting nut**

Bedknife Replacement and Grinding

1. Remove bedbar from cutting unit.

2. Remove bedknife screws and remove bedknife.

3. Remove all rust, scale and corrosion from bedbar surface before installing new bedknife.

4. Install new bedknife:

   A. Make sure bedbar threads are clean.

   B. Use new screws. Apply anti–seize lubricant to screw threads before installing.

   C. Tighten screws to a torque of 250 – 300 in.lb. (288 – 345 KgCm) working from the center toward each end of the bedbar. DO NOT use an impact wrench.

5. Since there can be variations in the mounting surface of the bedbar, a new bedknife will not be perfectly flat after it is installed. Because of this, it is necessary to backlap or grind a new bedknife after installing it to the bedbar. Follow the existing angle that was ground into the bedknife and grind only enough to make sure the top surface is true.

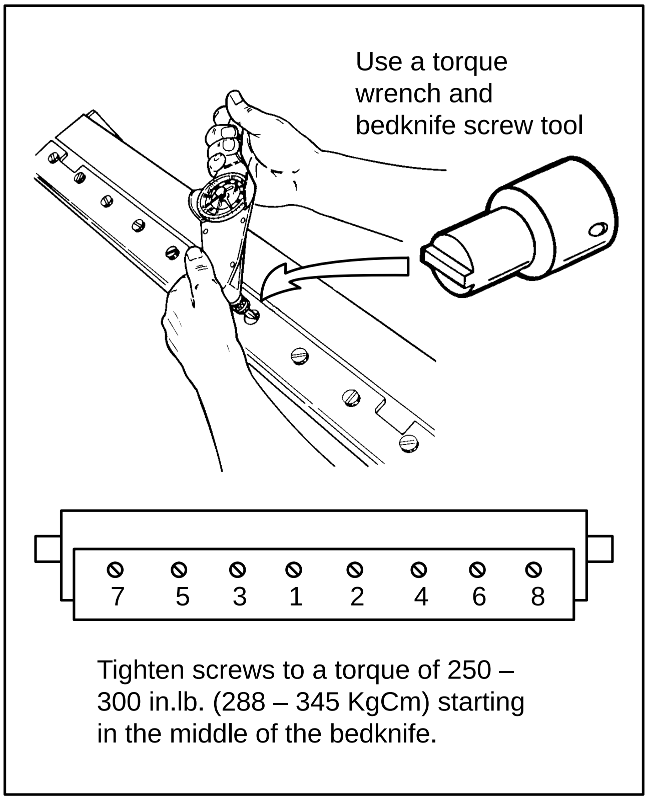


Figure 42

Regrinding Bedknife

Remove bedbar / bedknife assembly from cutting unit before attempting to regrind a used bedknife. Keep the bedknife fastened to the bedbar when grinding.

Note: When grinding, be careful to not overheat the bedknife. Remove small amounts of material with each pass of the grinder.

Bedknife Regrinding Specifications	
Relief Angle	5°
Relief Angle Range	3° – 6°
Front Angle	15°
Front Angle Range	13° – 17°

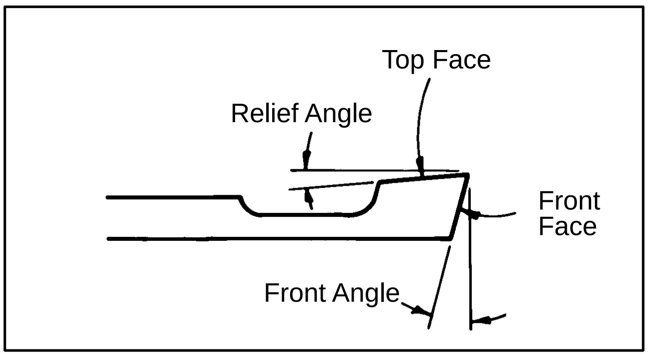


Figure 43

Preparing Reel for Grinding

1. Check to make sure reel bearings are in good condition and properly adjusted before grinding the reel. Make sure the cutting unit frame and roller brackets are true and not bent or damaged from impacts with trees, posts or cart path edges.

2. Remove bedbar assembly.

3. Remove parts as necessary to mount the cutting unit in the grinder (e.g. front roller, brackets). Follow the ginding equipment manufactuer's instructions for mounting the cutting unit.

Note: The cutting unit must be aligned so the grinding wheel will travel parallel to the reel shaft. This will result in the the reel being ground to the desired cylinder shape.

Note: When grinding, be careful to not overheat the reel blades. Remove small amounts of material with each pass of the grinder.

4. After completing the grinding process, do a complete set–up and adjustment procedure.

Reel Grinding Specifications	
Nominal Reel Diameter	7″ (178 mm)
Service Limit Reel Diameter	6.2″ (158 mm)
Blade Relief Angle	30°
Relief Angle Range	20° – 40°
Blade Land Width	.060″ (1.5 mm)
Land Width Range	.050″ – .090″ (1.3 – 2.3 mm)
Service Limit Reel Taper	.060″ (1.5 mm)

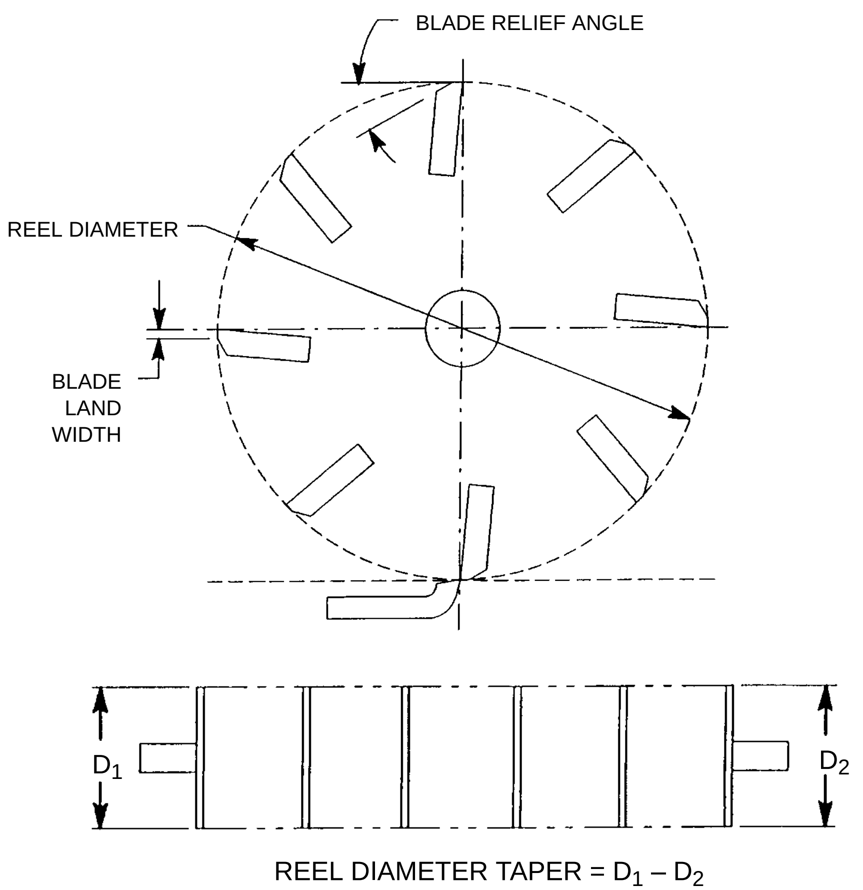


Figure 44

Reel Removal and Bearing Replacement

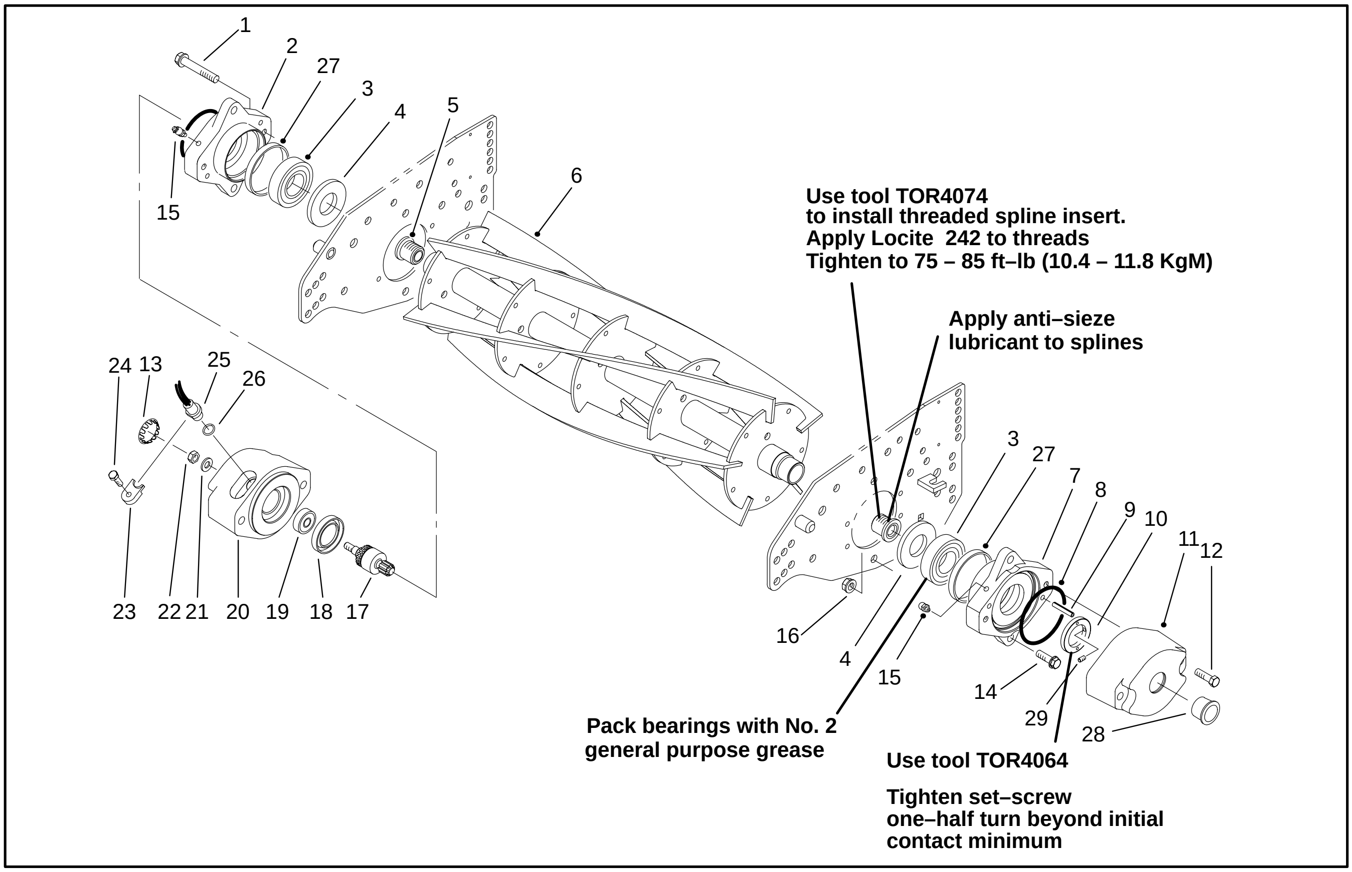


Figure 45

1. Screw
2. R.H. bearing housing
3. Bearing
4. Grease seal
5. Threaded insert
6. Reel assembly
7. L.H. Bearing housing
8. O–ring
9. Roll pin
10. Bearing adjustment nut
11. End weight
12. Screw
13. Cap plug
14. Screw
15. Grease fitting
16. Lock nut
17. Shaft magnet assembly
18. Outer seal
19. Bearing
20. End weight housing
21. Flat washer
22. Lock nut
23. Clamp
24. Screw
25. Speed sensor
26. O–ring
27. Bearing ring
28. Plug
29. Set screw

Remove Reel

1. Remove weight from cutting unit. If equipped with a speed sensor, remove shaft magnet after removing weight and sensor.

2. Remove bedbar assembly.

3. Remove front roller assembly.

4. Loosen set screw and remove bearing adjustment nut from L.H. bearing housing.

5. Use a hammer and punch to drive out roll pins from L.H. bearing housing. Remove L.H. bearing housing. It is not necessary to remove the R.H. bearing housing.

6. Remove reel.

Inspect Reel

1. Replace reel if diameter has decreased to the service limit (see Reel Grinding Specifications).

2. Replace reel if blades are bent or cracked.

3. Inspect reel shaft splined inserts and replace if worn or damaged.

The threaded inserts are installed with thread locking compound (Loctite 242 or equivalent). One side is L.H. threads and the other R.H. threads (R.H. has identification groove on outer surface of flange). To remove or install threaded spline inserts, use tool TOR4074. Before installing, apply Loctite 242 or equivalent to threads and tighten to a torque of 75 – 85 ft–lb (10.4 – 11.8 KgM)

4. Inspect bearings and seals. To replace seals and bearings:

A. Use a bearing puller tool to remove the bearings. To prevent damage to bearings, pull on the inner bearing race. Remove the seals. NOTE: If bearing is removed, the seal should be replaced.

B. Install new seals on the reel shaft. Make sure seals are installed square to shaft.

C. Pack bearings with No. 2 general purpose grease before installing. Install bearings on reel shaft by pressing on the inner bearing race.

Install Reel

1. Set cutting unit frame in a vertical position so R.H. bearing housing is down. Install reel into R.H. bearing housing.

2. Install L.H. bearing housing. Install roll pins.

3. Hit end of reel shaft with a brass hammer to make sure that R.H. reel bearing is seated on shoulder of R.H. bearing housing.

4. Install bearing adjustment nut and tighten with special spanner wrench TOR4064 until contact is made with the bearing and reel end play is removed. NOTE: Over–tightening can cause early bearing failure. Tighten set screw to secure bearing adjustment nut. Tighten set screw one–half turn beyond initial contact minimum.

5. Install front roller assembly.

6. Install bedbar assembly.

7. Apply anti–seize lubricant to splines on splined couplers.

8. Install shaft magnet if this cutting unit is to be equipped with a speed sensor.

9. Install weight assembly.

Roller and Frame Service

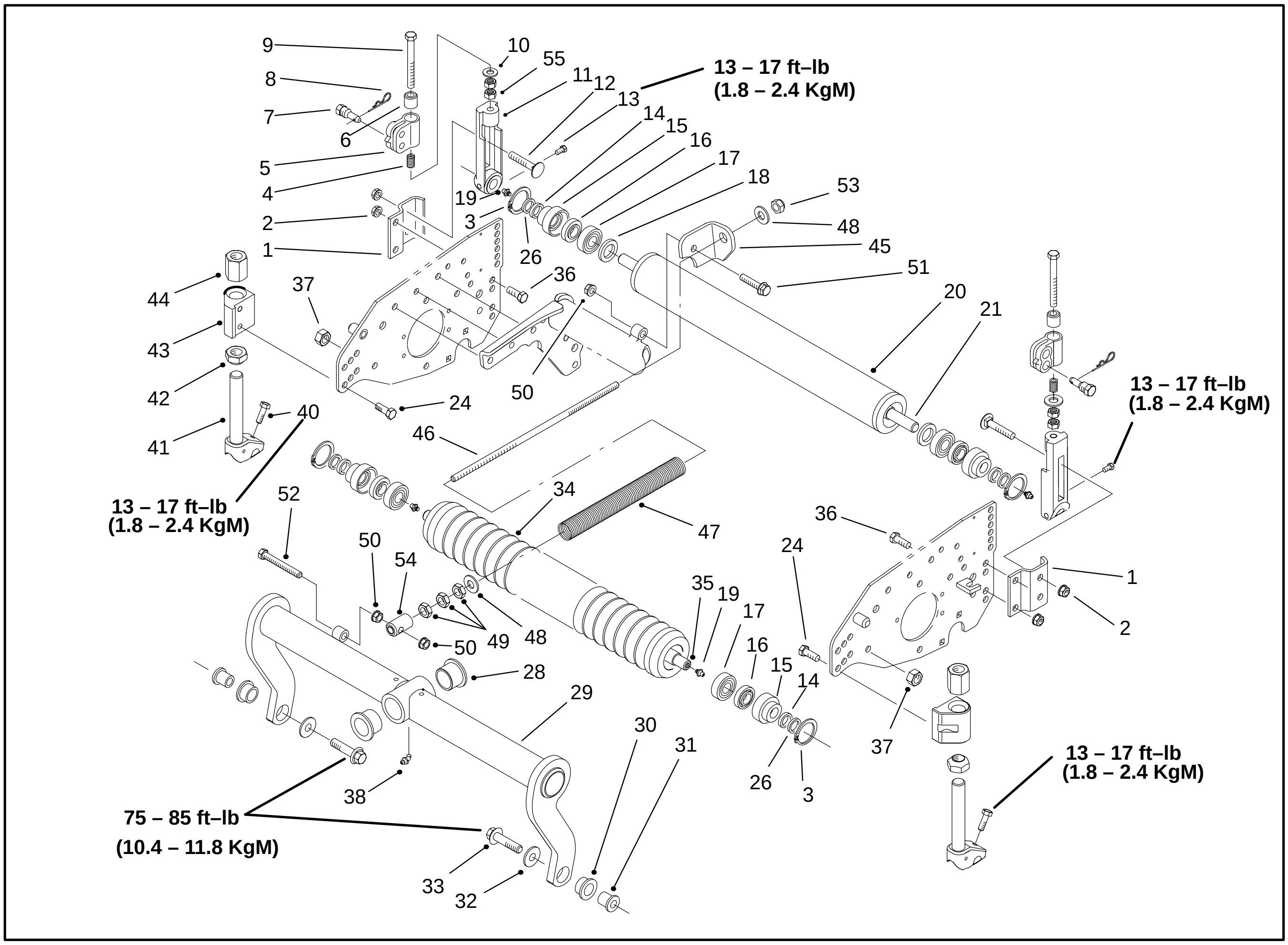


Figure 46

1. Angle bracket
2. Lock nut
3. Snap ring
4. HOC compression spring
5. Rear HOC spacer
6. Spacer
7. HOC pin
8. Hair pin cotter
9. Hex screw
10. Special washer
11. Rear HOC spacer
12. Carriage screw
13. Hex screw
14. Oil seal
15. Outer seal
16. Inner seal
17. Ball bearing
18. Oil seal
19. Grease fitting
20. Rear roller assy.
21. Rear roller shaft
24. Hex screw
26. Roller washer
28. Special bushing
29. Carrier frame assy.
30. Bushing
31. Frame spacer
32. Hardened washer
33. Bolt
34. Wiehle roller
35. Wiehle roller shaft
36. Hex screw
37. Lock nut
38. Grease fitting
40. Hex screw
41. Support rod assy.
42. Special nut
43. HOC bracket
44. Special long nut
45. Spring bracket
46. Spring rod
47. Compression spring
48. Hardened washer
49. Hex nut

Roller Bearing and Seal Replacement

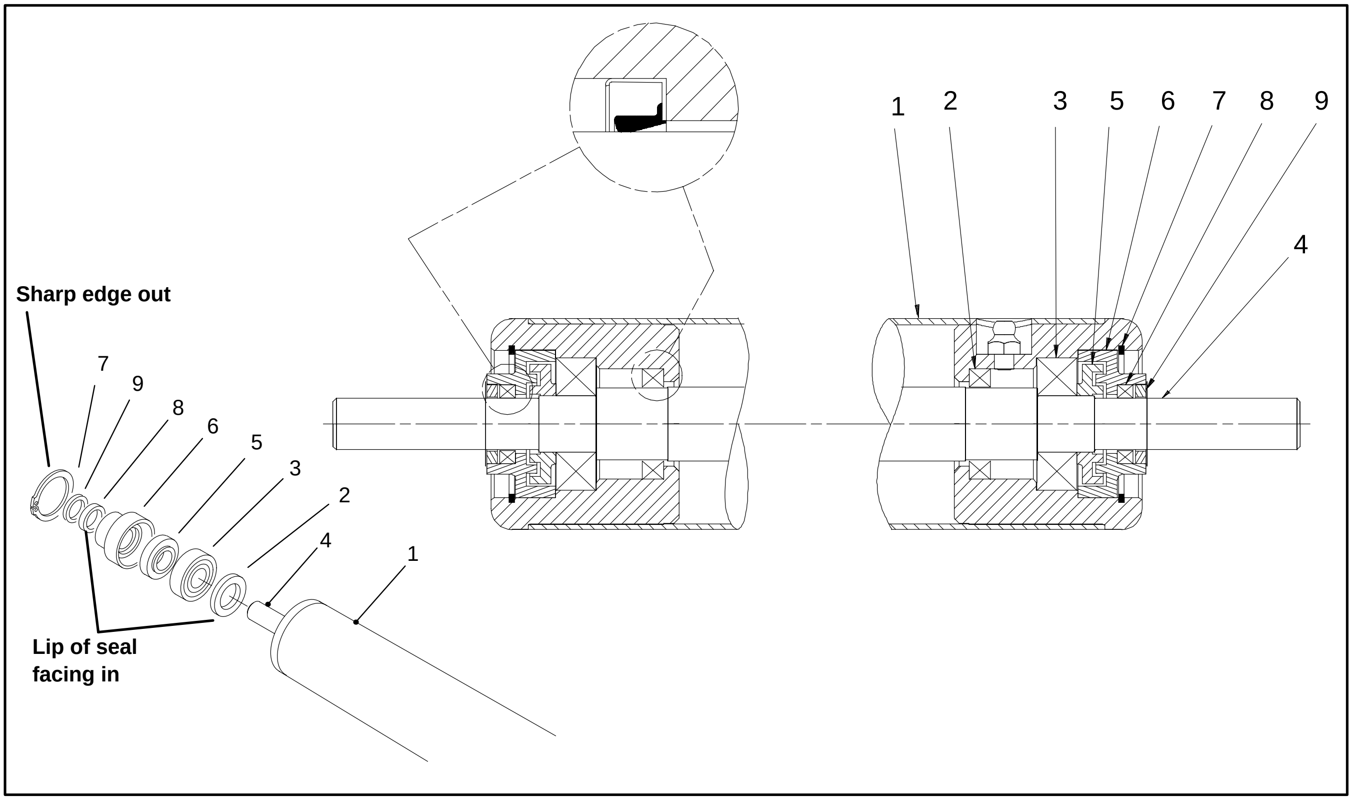


Figure 47

1. Roller	**4. Roller shaft**	**7. Retaining ring**
2. Inner oil seal	**5. Inner seal**	**8. Outer oil seal**
3. Bearing	**6. Outer seal**	**9. Washer**

NOTE: Bearing and seal configurations are the same for both the front and rear rollers.

Remove Seals and Bearings

1. Remove retaining ring from both ends of roller.

2. Hit end of roller shaft with a soft face hammer to remove seals and bearing from one end of roller. Hit other end of roller shaft to remove seals and bearing from other end of roller. Be careful not to drop roller shaft.

3. Discard seals and bearings.

Install New Seals and Bearings

NOTE: A soft face hammer can be used with the special tools to assemble the roller, however use of a press is recommended.

1. Use installation tool TOR4065 and handle TOR4073 to install inner oil seal into each end of roller.

2. Install bearings:

A. Use tool TOR4066, handle TOR4073 to install bearing into one end of roller.

B. Install roller shaft from opposite end of roller. Be carefull not to damage the inner oil seals.

C. Put roller in a vertical position and support shaft and bearing with tool TOR4067.

D. Use tool TOR4067 to install second bearing.

3. Use tool TOR4068 to install inner seal.

4. Use tool TOR4069 to install outer seal

5. Install retaining ring.

6. Use tool TOR4071 to install outer oil seal.

7. Use tool TOR4067 to install washer.

8. Put opposite end of roller facing up and support bottom end with tool TOR4067. Repeat steps 3 – 7.

9. Use a hand operated grease grease gun and No. 2 general purpose lithium base grease to lubricate bearings until grease appears at washer. Wipe off excess grease.

Cutting Unit Installation

IMPORTANT: All Reelmaster 6000 Series must have the on–board controller (ECU) configured for the installed cutting units, otherwise the cutting unit drive circuits will not function. Refer to configuration instructions in this manual.

Cutting unit models 03857, 03858, and 03859 can be installed at any of the five mounting locations on the traction unit. Figure 46 shows the orientation of the hydraulic drive motor for each of the five locations. For any of the locations requiring the motor to be mounted on the right end of the cutting unit, install a counter weight on the left end of the cutting unit. For the locations requiring the motor to be mounted on the left end, install a counter weight on the right end of the cutting unit.

Two of the counter weights provided with the tractor include reel speed sensor assemblies. These need to be installed on cutting units to be mounted in the front center and left rear positions on the tractor.

Note: Counter weight mounting capscrews are shipped installed on the right bearing housing of the cutting units. The capscrews on left bearing housing are to be used for securing the hydraulic motor.

1. Remove cutting units from cartons. Assemble and adjust per Cutting Unit Operator's Manual.

2. Remove protective plugs from each end of cutting unit.

3. Lubricate and install a large O–ring into bearing housing groove on each end of cutting unit (Fig. 49 & 50).

Note: Before installing cutting unit motors or counterweights with speed sensors, lubricate internal splines of cutting unit reel shafts with grease.

4. Install a counter weight onto appropriate end of each cutting unit with capscrews provided (Fig. 49).

5. Thoroughly grease the cutting unit reel bearings prior to installation on the traction unit. Grease should be evident at the inboard reel seals. Refer to Cutting Unit Operator's Manual for greasing procedure.

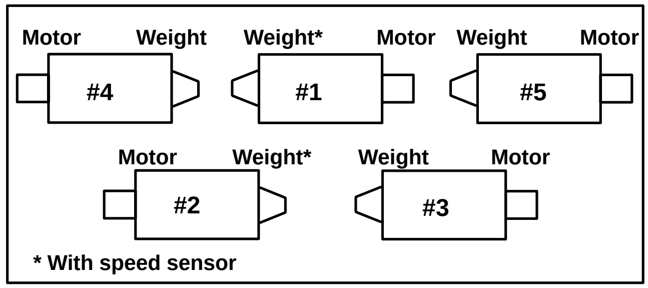


Figure 48

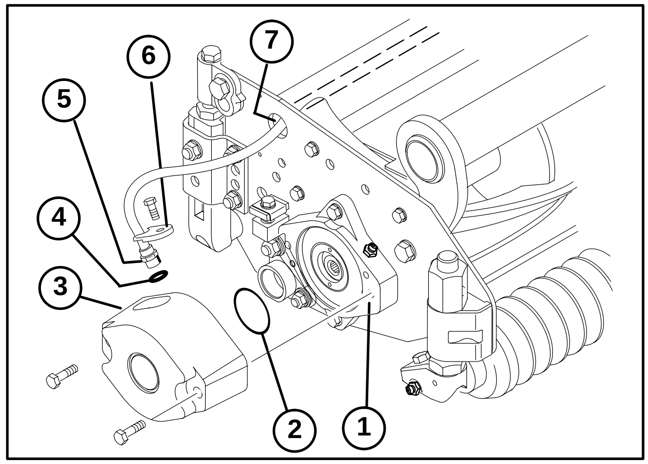


Figure 49

1. Bearing housing
2. O–ring–large
3. Counterweight
4. O–ring –small
5. Speed sensor
6. Speed sensor holder
7. Frame tube

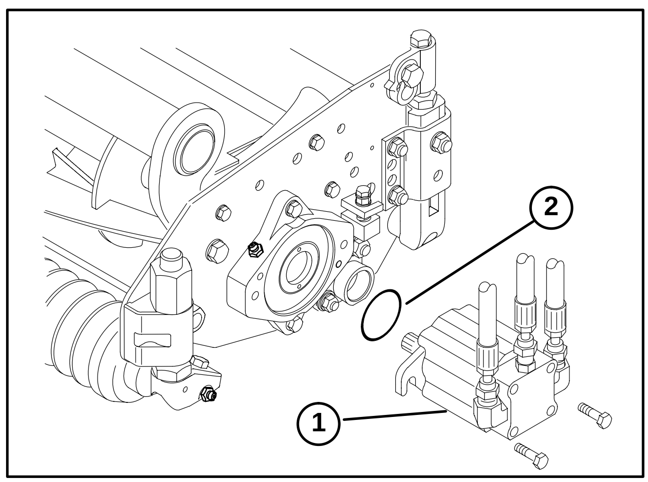


Figure 50

1. Motor
2. O–ring

6. Insert a thrust washer onto horizontal shaft of pivot knuckle as shown in figure 51.

7. Insert the horizontal shaft of the pivot knuckle into the mounting tube of the carrier frame (Fig. 51).

8. Secure pivot knuckle to carrier frame with a thrust washer, flat washer and a flange head capscrew (Fig. 51).

9. Insert a thrust washer onto vertical shaft of pivot knuckle (Fig. 51).

10. Insert the vertical shaft of the pivot knuckle into lift arm pivot hub (Fig. 51). Guide the pivot knuckle in place between the two rubber centering bumpers in the under side of the lift arm steering plate.

11. Insert the lynch pin into the cross hole on the pivot knuckle shaft (Fig. 51).

12. Mount the motor to the drive end of the cutting unit and secure with two capscrews provided (Fig. 50).

13. On front center and left rear cutting units, plug speed sensor wire harness connector into traction unit wire harness connector.

14. On motor side of cutting unit, insert speed sensor end of harness through cutting unit rear frame tube and route to counterweight.

15. Install small O–ring onto speed sensor and insert sensor into hole in counterweight (Fig. 49).

16. Secure sensor to counterweight with a sensor holder and a M6 x 20 mm capscrew (Fig. 49).

17. If fixed cutting unit position is required, insert steering pin into pivot knuckle mounting hole (Fig. 51)

18. Hook spring wire around bottom of steering pin (Fig. 51).

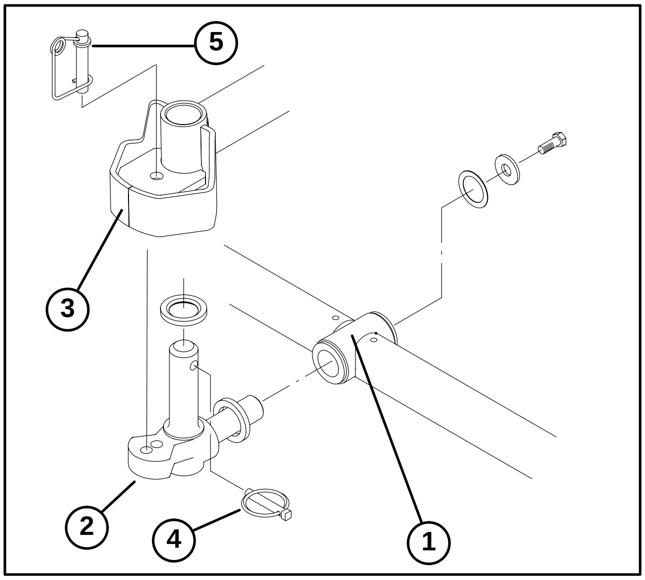


Figure 51

1. Carrier frame
2. Pivot knuckle
3. Lift arm steering plate
4. Lynch pin
5. Steering pin

Cutting Unit Selection

The Controller must be programmed with the Blade configuration (number of Blades) on the installed cutting units in order for the ClipAce™ feature to operate properly. If the Blade configuration is not set, the cutting units will not operate in the mow position.

IMPORTANT: Do not sit in the seat. Closed Seat Switch will void this procedure!

1. Rotate ignition key to **Off** position.

2. Connect the Hand held Diagnostic Tool to the Controller Loopback Connector (remove overlays).

3. Turn the Reel Control Switch to **Enable** position.

4. Move the Joystick to the **Lower** position and hold.

5. Turn ignition key to **On** position and continue to hold the Joystick in the **Lower** position until the Reel Control Lamp starts to flash (2 seconds).

6. Release the Joystick to the center position. Reel Control Lamp will now be on steady.

7. Toggle Diagnostic Tool to display **Outputs**.

8. Cycle the Joystick to the **Lower** position once for each blade on the installed cutting units (e.g. 5 times for 5 blades, 8 times for 8 blades, etc..). **Wait for Reel Control Lamp to come back on before each cycle.** Hand held Diagnostic Tool will display the number of times the Joystick has been cycled.

9. Turn Reel Control Switch to the **Disable** position. Reel Control Lamp will now flash the number of blades the Controller has been programmed for, then go out. The Hand held Tool will also display the Blade configuration programmed.

10. Turn the key **Off** and disconnect Diagnostic Tool. Reconnect Loopback Connector. **Blade configuration is now set.**

Note: Skip step 8 when verifying Blade configuration in the field.

Greasing Bearings, Bushings and Pivot Points

IMPORTANT: Lubricating cutting units immediately after washing helps purge water out of bearings and increases bearing life.

Each cutting unit has (7) grease fittings that must be lubricated regularly with No. 2 General Purpose Lithium Base Grease.

The lubrication points are front roller (2), rear roller (2), reel bearing (2), and bedknife adjuster.

1. Wipe each grease fitting with a clean rag.
2. Apply grease until pressure is felt against handle.
3. Wipe excess grease away.

Note: Apply grease to reel bearing cavities until a small amount is evident at the inboard reel seal.

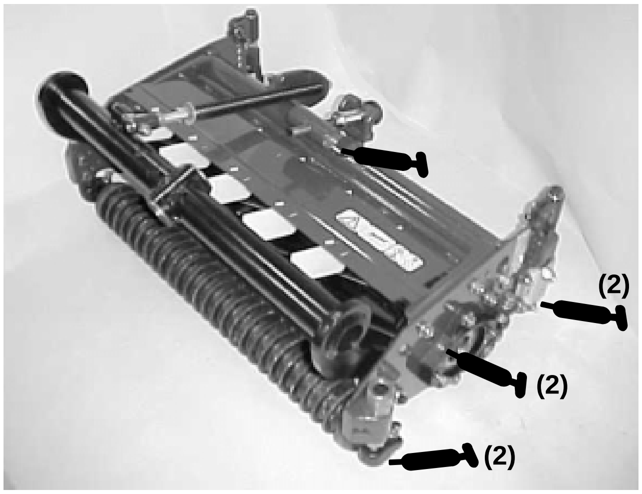


Figure 52

Chapter 9

Wire Harness Diagram

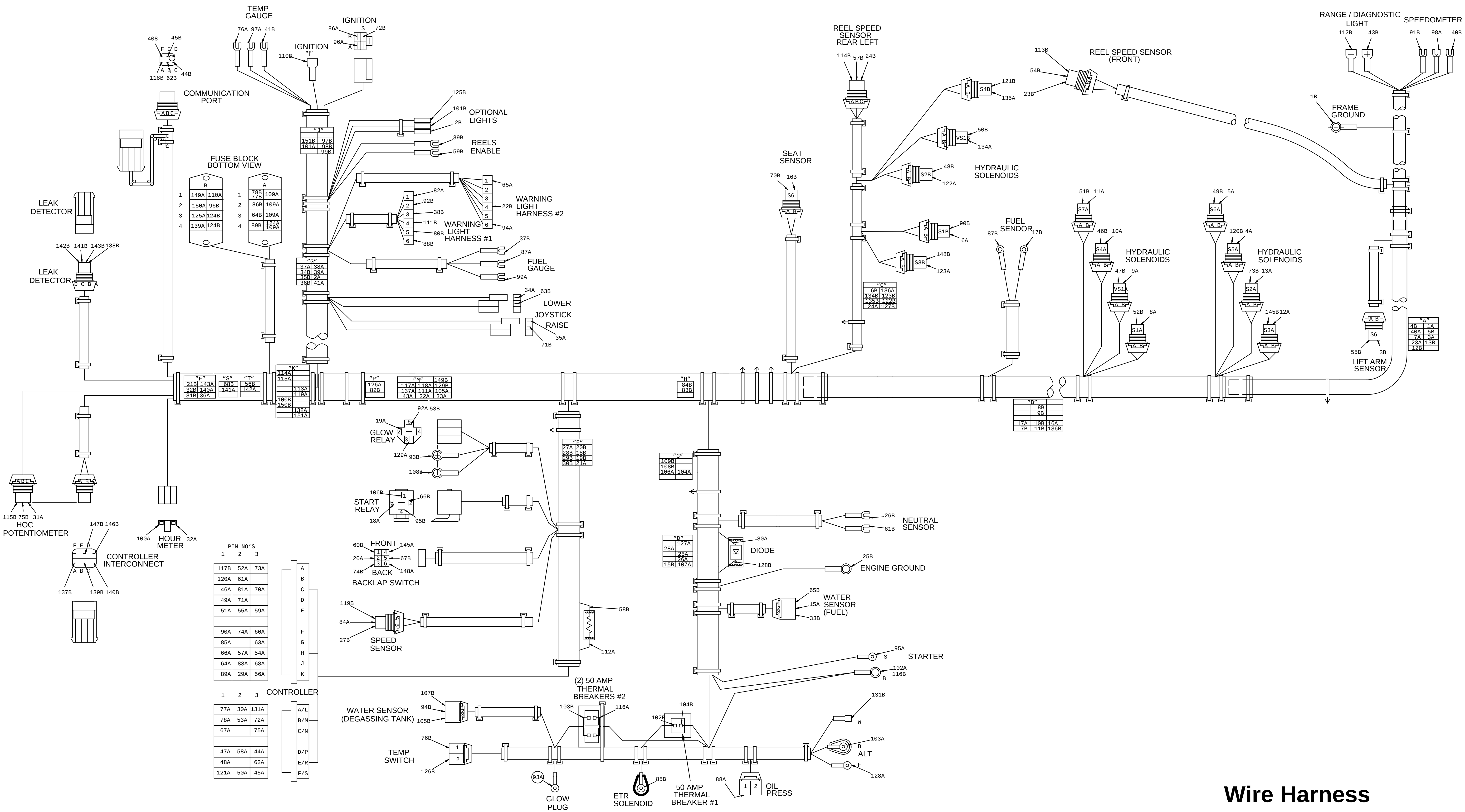
Wire Harness

Table of Contents

WIRE NO.	COLOR	CONNECTOR LOCATION A	CONNECTOR LOCATION B
1	BLACK	HARNESS GROUND SPLICE A	GROUND TO FRAME
2	BLACK	HARNESS GROUND SPLICE G	OPTIONAL LIGHTS
3	BLACK	HARNESS GROUND SPLICE A	LIFT ARM SENSOR – FRONT
4	BLACK	HYD. SOLENOID S5A	HARNESS GROUND SPLICE A
5	BLACK	HYD. SOLENOID S6A	HARNESS GROUND SPLICE A
6	BLACK	HYD. SOLENOID S1B	HARNESS GROUND SPLICE C
7	BLACK	HARNESS GROUND SPLICE A	HARNESS GROUND SPLICE B
8	BLACK	HYD. SOLENOID S1A	HARNESS GROUND SPLICE B
9	BLACK	HYD. SOLENOID VS1A	HARNESS GROUND SPLICE B
10	BLACK	HYD. SOLENOID S4A	HARNESS GROUND SPLICE B
11	BLACK	HYD. SOLENOID S7A	HARNESS GROUND SPLICE B
12	BLACK	HYD. SOLENOID S3A	HARNESS GROUND SPLICE A
13	BLACK	HYD. SOLENOID S2A	HARNESS GROUND SPLICE A
14	Not Used		
15	BLACK	WATER SENSOR (FUEL)	HARNESS GROUND SPLICE D
16	BLACK	HARNESS GROUND SPLICE B	SEAT SENSOR
17	BLACK	HARNESS GROUND SPLICE B	FUEL SENDER
18	BLACK	STARTER RELAY 5	HARNESS GROUND SPLICE E
19	BLACK	GLOW RELAY #2	HARNESS GROUND SPLICE E
20	BLACK	BACKLAP SWITCH	HARNESS GROUND SPLICE E
21	BLACK	HARNESS GROUND SPLICE E	HARNESS GROUND SPLICE F
22	YELLOW	HARNESS POWER SPLICE M	LIGHT CLUSTER #2
23	BLACK	HARNESS GROUND SPLICE A	FRONT REEL SPEED SENSOR
24	BLACK	HARNESS GROUND SPLICE C	REAR REEL SPEED SENSOR
25	BLACK	HARNESS GROUND SPLICE D	ENGINE GROUND
26	BLACK	HARNESS GROUND SPLICE D	NEUTRAL SENSOR
27	BLACK	HARNESS GROUND SPLICE E	SPEEDOMETER SENSOR
28	BLACK	HARNESS GROUND SPLICE D	HARNESS GROUND SPLICE E
29	BLACK	CONTROLLER (K2)	HARNESS GROUND SPLICE E
30	BLACK	CONTROLLER (A/L 2)	HARNESS GROUND SPLICE E
31	BLACK	HOC POTENTIOMETER	HARNESS GROUND SPLICE F
32	BLACK	HOUR METER	HARNESS GROUND SPLICE F
33	YELLOW	HARNESS POWER SPLICE M	WATER SENSOR (FUEL)
34	BLACK	JOYSTICK LOWER	HARNESS GROUND SPLICE G
35	BLACK	JOYSTICK RAISE	HARNESS GROUND SPLICE G
36	BLACK	HARNESS GROUND SPLICE F	HARNESS GROUND SPLICE G
37	BLACK	HARNESS GROUND SPLICE G	FUEL GAUGE
38	BLACK	HARNESS GROUND SPLICE G	LIGHT CLUSTER #1
39	BLACK	HARNESS GROUND SPLICE G	REEL ENABLE SWITCH (#2 on S/N 90001 & Up)
40	BLACK	HARNESS GROUND SPLICE A	SPEEDOMETER
41	BLACK	HARNESS GROUND SPLICE G	TEMPERATURE GAUGE – G
42	Not Used		
43	YELLOW	HARNESS POWER SPLICE M	RANGE LIGHT
44	BLACK	CONTROLLER (D/P 3)	COMMUNICATION PORT GND
45	ORANGE / BLUE	CONTROLLER (F/S 3)	COMMUNICATION PORT R
46	ORANGE / BLUE	CONTROLLER (C1)	HYD. SOLENOID S4A
47	ORANGE / BLACK	CONTROLLER (D/P 1)	HYD. SOLENOID VS1A
48	ORANGE / WHITE	CONTROLLER (E/R 1)	HYD. SOLENOID S2B
49	YELLOW / BLACK	CONTROLLER (D1)	HYD. SOLENOID S6A
50	YELLOW / BLUE	CONTROLLER (F/S 2)	HYD. SOLENOID VS1B
51	YELLOW / WHITE	CONTROLLER E1	HYD. S0LENOID S7A
52	BLACK / RED	CONTROLLER A2	hYD. SOLENOID S1A
53	GREEN / BLUE	CONTROLLER (B/M 2)	GLOW RELAY #6
54	BROWN / WHITE	CONTROLLER (H3)	FRONT REEL SPEED SENSOR
55	BLACK / WHITE	CONTROLLER (E2)	LIFT ARM SENSOR
56	BLACK / WHITE	CONTROLLER (K3) (CAN –)	HARNESS CAN – SPLICE
57	BROWN / PINK	CONTROLLER (H2)	REAR REEL SPEED SENSOR
58	BROWN / RED	CONTROLLER (D/P 2)	RESISTOR
59	BROWN	CONTROLLER (E3)	REELS ENABLE SWITCH (#3 on S/N 90001 & Up)
60	BLUE	CONTROLLER (F3)	BACKLAP SWITCH (FRONT)
61	GREEN	CONTROLLER (B2)	NEUTRAL SENSOR
62	GREEN / PINK	CONTROLLER (E/R 3)	COMMUNICATION PORT T
63	PINK	CONTROLLER (G3)	JOYSTICK LOWER
64	PINK / BLACK	CONTROLLER (J1)	FUSE BLOCK – FUSE A3
65	BLUE	LIGHT CLUSTER #2	WATER SENSOR (FUEL)
66	PINK / WHITE	CONTROLLER (H1)	STARTER RELAY 2

67	RED / WHITE	CONTROLLER (C/N 1)	BACKLAP SWITCH
68	RED / WHITE	CONTROLLER (J3) (CAN +)	HARNESS CAN + SPLICE
69	Not Used		
70	TAN	CONTROLLER (C3)	SEAT SWITCH
71	VIOLET	CONTROLLER (D2)	JOYSTICK RAISE
72	VIOLET / RED	CONTROLLER (B/M 3)	KEY START (S)
73	VIOLET / RED	CONTROLLER (A3)	HYD. SOLENOID S2A
74	WHITE	CONTROLLER (F2)	BACKLAP SWITCH (REAR)
75	YELLOW / RED	CONTROLLER (C/N 3)	HOC POTENTIOMETER
76	BLUE / WHITE	TEMPERATURE GAUGE – S	TEMPERATURE SENSOR
77	BLUE / WHITE	CONTROLLER (A/L 1)	FUSE BLOCK – FUSE A1
78	GREEN / BLACK	CONTROLLER (B/M 1)	FUSE BLOCK – FUSE A1
79	Not Used		
80	GREEN / BLACK	DIODE	LIGHT CLUSTER #1
81	GREEN / WHITE	CONTROLLER (C2)	HARNESS SPLICE P
82	GREEN / WHITE	LIGHT CLUSTER #1	HARNESS SPLICE P
83	GRAY	CONTROLLER (J2)	SPEEDOMETER SPLICE H
84	GRAY	SPEEDOMETER SENSOR	SPEEDOMETER SPLICE H
85	RED / BLUE	CONTROLLER (G1)	ETR SOLENOID
86	RED / BLUE	IGNITION – B	FUSE BLOCK – FUSE A2
87	BLUE / GREEN	FUEL GAUGE	FUEL SENDER
88	GREEN / BLUE	OIL PRESSURE SWITCH	LIGHT CLUSTER #1
89	RED / BLACK	CONTROLLER (K1)	FUSE BLOCK – FUSE 4
90	ORANGE / RED	CONTROLLER (F1)	HYD. SOLENOID S1B
91	GRAY	SPEEDOMETER SPLICE H	SPEEDOMETER – S
92	ORANGE / RED	GLOW RELAY #6	LIGHT CLUSTER #1
93	ORANGE	GLOW PLUG	GLOW RELAY #5
94	BLUE	LIGHT CLUSTER #2	WATER SENSOR (DEGAS TANK)
95	ORANGE	STARTER – S	START RELAY 4
96	ORANGE	IGNITION – A	FUSE BLOCK – FUSE B2
97	ORANGE	TEMPERATURE GAUGE	HARNESS POWER SPLICE J
98	ORANGE	SPEEDOMETER – I	HANRESS POWER SPLICE J
99	ORANGE	FUEL GUAGE – I	HARNESS POWER SPLICE J
100	ORANGE	HOUR METER (+)	HARNESS POWER SPLICE K
101	ORANGE	HARNESS POWER SPLICE J	OPTIONAL LIGHTS
102	RED	STARTER – B	THERMAL BREAKER 1
103	RED	ALTERNATOR – B	THERMAL BREAKER 2
104	RED	HARNESS POWER SPLICE G	THERMAL BREAKER 1
105	YELLOW	HARNESS POWER SPLICE M	WATER SENSOR (DEGAS TANK)
106	RED	HARNESS POWER SPLICE G	START RELAY 1
107	BLACK	HARNESS POWER SPLICE D	WATER SENSOR (DEGAS TANK)
108	RED	GLOW PLUG RELAY #1	HARNESS POWER SPLICE G
109	RED	FLUSE BLOCK – FUSE A1–4	HARNESS POWER SPLICE G
110	YELLOW	FUSE BLOCK – FUSE B1	IGNITION – I
111	YELLOW	HARNESS POWER SPLICE M	LIGHT CLUSTER #1
112	BROWN / RED	RESISTOR	RANGE LIGHT
113	ORANGE	HARNESS POWER SPLICE K	FRONT REEL SPEED SENSOR
114	ORANGE	HARNESS POWER SPLICE K	REAR REEL SPEED SENSOR
115	ORANGE	HARNESS POWER SPLICE K	HOC POTENTIOMETER
116	RED	THERMAL BREAKER 2	STARTER B
117	YELLOW	HARNESS POWER SPLICE K	CONTROLLER (A1)
118	YELLOW	HARNESS POWER SPLICE M	COMMUNICATION PORT
119	ORANGE	HARNESS POWER SPLICE K	SPEEDOMETER SENSOR
120	BROWN / WHITE	CONTROLLER (B1)	HYD. SOLENOID S5A
121	PINK / BLUE	CONTROLLER (F/S 1)	HYD. SOLENOID S4B
122	BLACK	HYD. SOLENOID S2B	HARNESS GROUND SPLICE C
123	BLACK	HYD. SOLENOID S3B	HARNESS GROUND SPLICE C
124	RED	FUSE BLOCK FUSE A4	FUSE BLOCK FUSE B1–4
125	RED	FUSE BLOCK B3	OPTIONAL LIGHTS
126	GREEN / RED	HARNESS SPLICE P	TEMP SWITCH 2
127	BLACK	HARNESS GROUND SPLICE D	HARNESS GROUND SPLICE C
128	GREEN / BLACK	ALTERNATOR – F	DIODE
129	YELLOW	GLOW RELAY #3	HARNESS POWER SPLICE M
130	Not Used		
131	RED / YELLOW	CONTROLLER (A/L 3)	ALTERNATOR – W
132	Not Used		
133	Not Used		

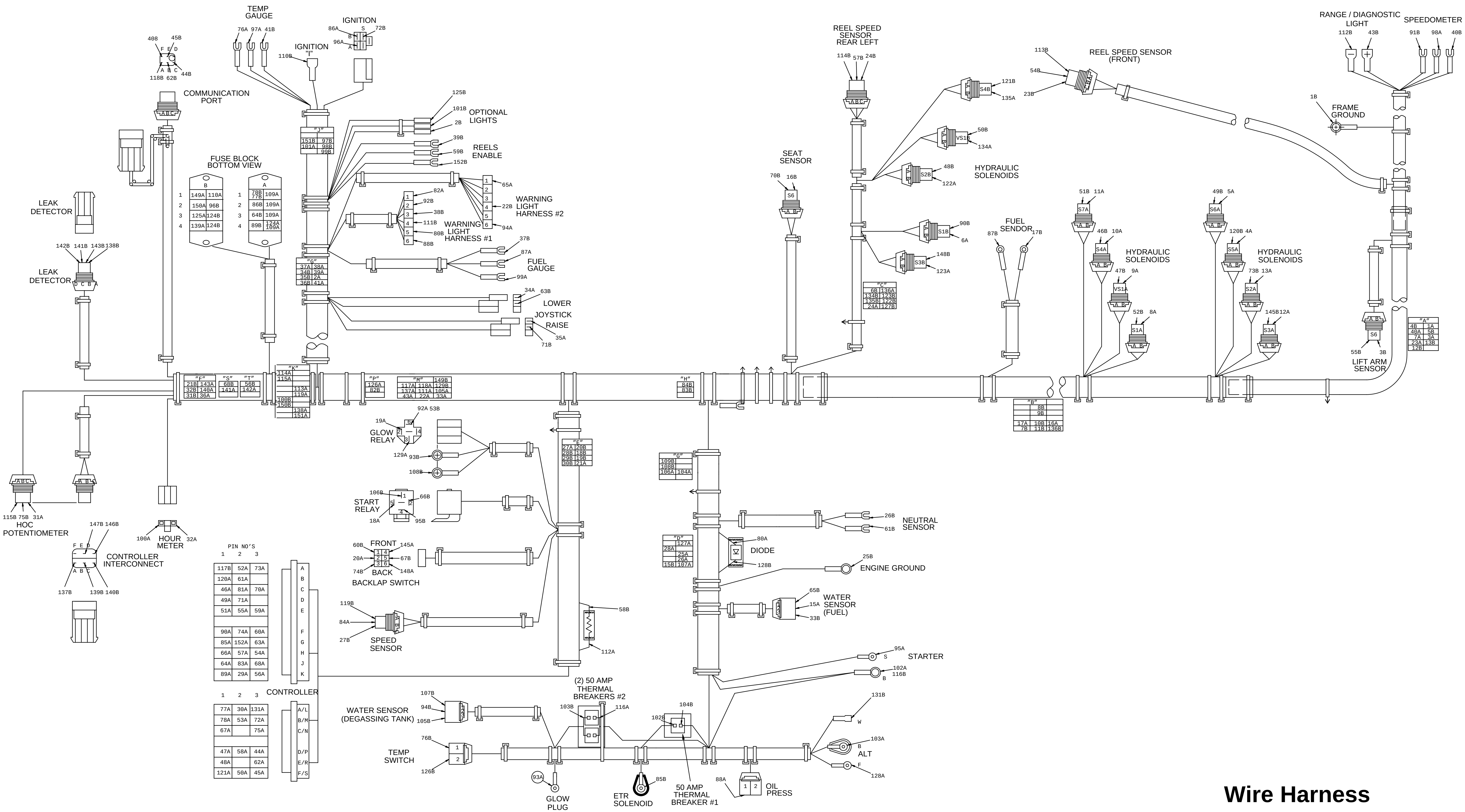
134	BLACK	HYD. SOLENOID VS1B	HARNESS GROUND SPLICE C
135	BLACK	HYD. SOLENOID S4B	HARNESS GROUND SPLICE C
136	BLACK	HARNESS GROUND SPLICE C	HARNESS GROUND SPLICE B
137	YELLOW	HARNESS GROUND SPLICE M	CONTROLLER INTERCONNECT
138	ORANGE	HARNESS POWER SPLICE K	LEAK DETECTOR
139	RED	FUSE BLOCK FUSE B4	CONTROLLER INTERCONNECT
140	BLACK	HARNESS GROUND SPLICE F	CONTROLLER INTERCONNECT
141	RED / WHITE	HARNESS CAN + SPLICE	LEAK DETECTOR
142	BLACK / WHITE	HARNESS CAN – SPLICE	LEAK DETECTOR
143	BLACK	HARNESS GROUND SPLICE F	LEAK DETECTOR
144	Not Used		
145	BLUE / WHITE	BACKLAP SWITCH	HYD. SOLENOID S3A
146	RED / WHITE	HARNESS CAN + SPLICE	CONTROLLER INTERCONNECT
147	BLACK / WHITE	HARNESS CAN – SPLICE	CONTROLLER INTERCONNECT
148	WHITE / ORANGE	BACKLAP SWITCH	HYD. SOLENOID S3B
149	YELLOW	FUSE BLOCK FUSE B1	HARNESS POWER SPLICE M
150	ORANGE	FUSE BLOCK FUSE B2	HARNESS POWER SPLICE K
151	ORANGE	HARNESS POWER SPLICE K	HARNESS POWER SPLICE J
152 (s/n 90001 & Up)	ORANGE	CONTROLLER 2G	ENABLE SWITCH #1



Wire Harness

Reelmaster 6500–D/6700–D

S/N 60001 – 89999



Wire Harness

Reelmaster 6500–D/6700–D

S/N 90001 & Up