2653 Professional Utility Mower

JOHN DEERE

TECHNICAL MANUAL

2653 Professional
Utility Mower

TM1533 (01JAN95) English

John Deere
Worldwide Commercial and
Consumer Equipment Division

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Replaces TM1533 (OCT94)

LITHO IN U.S.A.
ENGLISH

This technical manual is written for an experieced technician and contains sections that are specifically for this product. It is a part of a total product support program.

The manual is organized so that all the information on a particular system is kept together. The order of grouping is as follows:

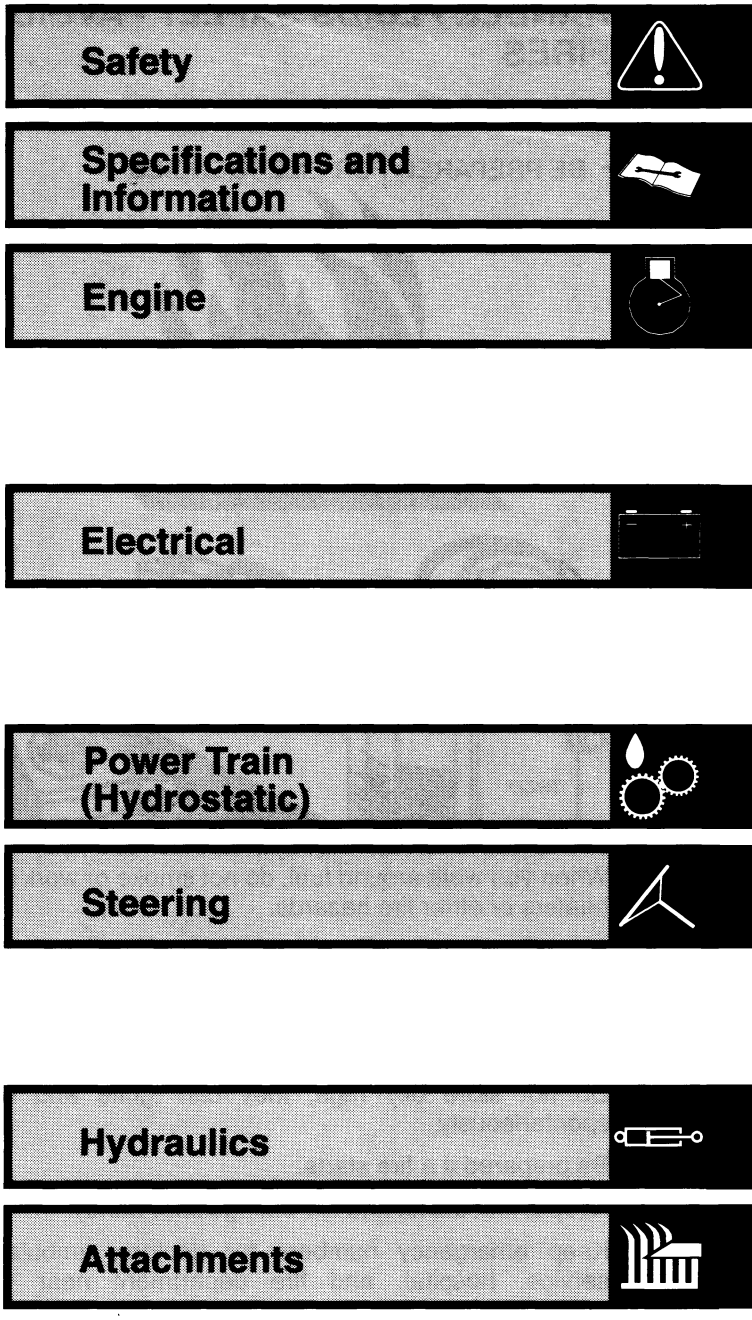
- Table of Contents
- Specifications
- Component Location
- Troubleshooting Diagram
- Theory of Operation
- Diagnostics
- Tests & Adjustments
- Assembly & Disassembly (Repair)

Note: Depending on the particular section or system being covered, not all of the above groups may be used.

Each section will be identified with a symbol rather than a number. The groups and pages within a section will be consecutively numbered.

All information, illustrations and specifications in this manual are based on the latest information available at the time of publication. The right is reserved to make changes at any time without notice.

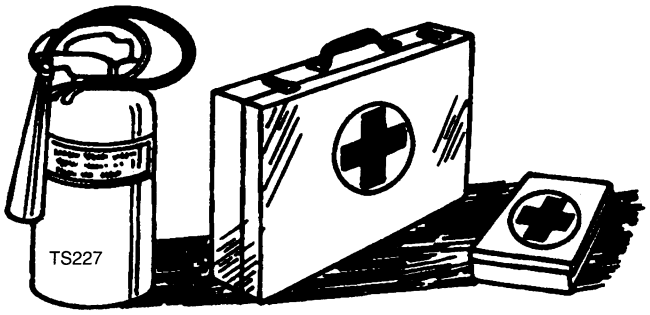
We appreciate your input on this manual. To help, there are postage paid post cards included at the back. If you find any errors or want to comment on the layout of the manual please fill out one of the cards and mail it back to us.



HANDLE FLUIDS SAFELY - AVOID FIRES

- **BE PREPARED FOR EMERGENCIES**


TS291


TS227

When you work around fuel, do not smoke or work near heaters or other fire hazards.

Store flammable fluids away from fire hazards. Do not incinerate or puncture pressurized containers.

Make sure machine is clean of trash, grease, and debris.

Do not store oily rags; they can ignite and burn spontaneously.

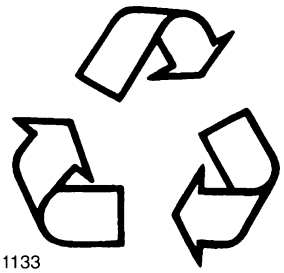
Be prepared if a fire starts.

Keep a first aid kit and fire extinguisher handy.

Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.

HANDLE CHEMICAL PRODUCTS SAFELY

TS1132


1133

Direct exposure to hazardous chemicals can cause serious injury. Potentially hazardous chemicals used with John Deere equipment include such items as lubricants, coolants, paints, and adhesives.

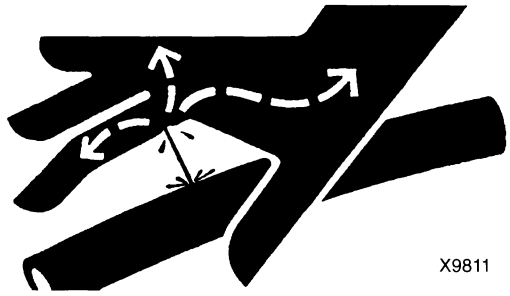
A Material Safety Data Sheet (MSDS) provides specific details on chemical products: physical and health hazards, safety procedures, and emergency response techniques. Check the MSDS before you start any job using a hazardous chemical. That way you will know exactly what the risks are and how to do the job safely. Then follow procedures and recommended equipment.

- **DISPOSE OF WASTE PROPERLY**

Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with John Deere equipment include such items as oil, fuel, coolant, brake fluid, filters, and batteries. Use leakproof containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them. Do not pour waste onto the ground, down a drain, or into any water source. Inquire on the proper way to recycle or dispose of waste from your local environmental or recycling center, or from your John Deere dealer.

USE CARE AROUND HIGH-PRESSURE FLUID LINES

- **AVOID HIGH-PRESSURE FLUIDS**


X9811

Escaping fluid under pressure can penetrate the skin causing serious injury.

Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

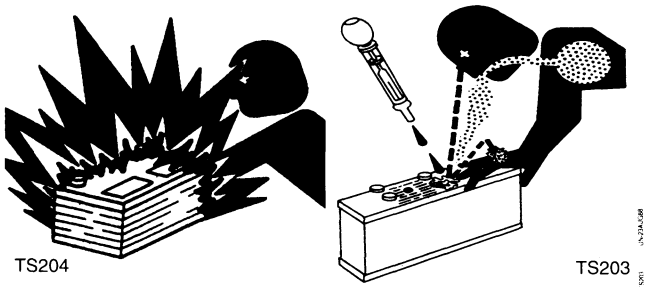
If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A.

- **AVOID HEATING NEAR PRESSURIZED FLUID LINES**


TS953

Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to yourself and bystanders. Do not heat by welding, soldering, or using a torch near pressurized fluid lines or other flammable materials. Pressurized lines can be accidentally cut when heat goes beyond the immediate flame area.

USE CARE IN HANDLING AND SERVICING BATTERIES


TS204 TS203

- **PREVENT BATTERY EXPLOSIONS**
  - Keep sparks, lighted matches, and open flame away from the top of battery. Battery gas can explode.
  - Never check battery charge by placing a metal object across the posts. Use a volt-meter or hydrometer.
  - Do not charge a frozen battery; it may explode. Warm battery to 16°C (60°F).

- **PREVENT ACID BURNS**
  - Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes.

- **Avoid acid burns by:**

1. Filling batteries in a well-ventilated area.
2. Wearing eye protection and rubber gloves.
3. Avoiding breathing fumes when electrolyte is added.
4. Avoiding spilling or dripping electrolyte.
5. Use proper jump start procedure.

- **If you spill acid on yourself:**

1. Flush your skin with water.
2. Apply baking soda or lime to help neutralize the acid.
3. Flush your eyes with water for 10_15 minutes.
4. Get medical attention immediately.

- **If acid is swallowed:**

1. Drink large amounts of water or milk.
2. Then drink milk of magnesia, beaten eggs, or vegetable oil.
3. Get medical attention immediately.

USE SAFE SERVICE PROCEDURES

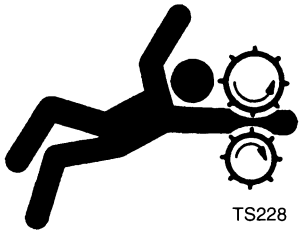
• WEAR PROTECTIVE CLOTHING

Wear close fitting clothing and safety equipment appropriate to the job.

Prolonged exposure to loud noise can cause impairment or loss of hearing. Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.

Operating equipment safely requires the full attention of the operator. Do not wear radio or music headphones while operating machine.

TS206



TS228

• SERVICE MACHINES SAFELY

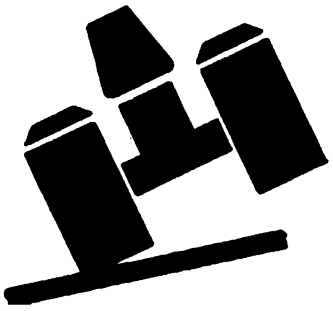
Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

Remove rings and other jewelry to prevent electrical shorts and entanglement in moving parts.

• USE PROPER TOOLS

Use tools appropriate to the work. Makeshift tools and procedures can create safety hazards. Use power tools only to loosen threaded parts and fasteners. For loosening and tightening hardware, use the correct size tools. **DO NOT** use U.S. measurement hand tools on metric fasteners. Avoid bodily injury caused by slipping wrenches. Use only service parts meeting John Deere specifications.

• PARK MACHINE SAFELY



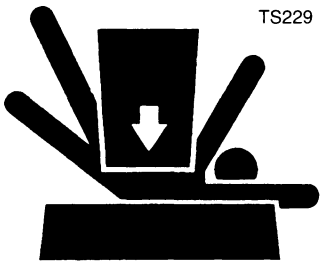
M46459

• Before working on the machine:

1. Lower all equipment to the ground.
2. Stop the engine and remove the key.
3. Disconnect the battery ground strap.
4. Hang a "DO NOT OPERATE" tag in operator station.

• SUPPORT MACHINE PROPERLY AND USE PROPER LIFTING EQUIPMENT

TS229



If you must work on a lifted machine or attachment, securely support the machine or attachment.

Do not support the machine on cinder blocks, hollow tiles, or props that may crumble under continuous load. Do not work under a machine that is supported solely by a jack. Follow recommended procedures in this manual.

Lifting heavy components incorrectly can cause severe injury or machine damage. Follow recommended procedure for removal and installation of components in the manual.

• WORK IN CLEAN AREA

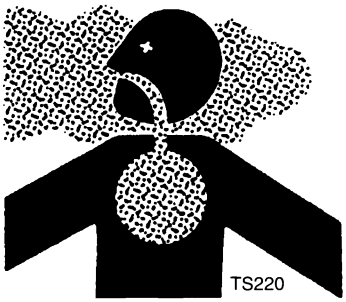
• Before starting a job

1. Clean work area and machine:
2. Make sure you have all necessary tools to do your job.
3. Have the right parts on hand.
4. Read all instructions thoroughly; do not attempt shortcuts.

- **ILLUMINATE WORK AREA SAFELY**

Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the machine. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.

- **WORK IN VENTILATED AREA**


TS220

Engine exhaust fumes can cause sickness or death. If it is necessary to run an engine in an enclosed area, remove the exhaust fumes from the area with an exhaust pipe extension.

If you do not have an exhaust pipe extension, open the doors and get outside air into the area.

- **REMOVE PAINT BEFORE WELDING OR HEATING**

Avoid potentially toxic fumes and dust. Hazardous fumes can be generated when paint is heated by welding, soldering, or using a torch. Do all work outside or in a well ventilated area. Dispose of paint and solvent properly. Remove paint before welding or heating: If you sand or grind paint, avoid breathing the dust. Wear an approved respirator. If you use solvent or paint stripper, remove stripper with soap and water before welding. Remove solvent or paint stripper containers and other flammable material from area. Allow fumes to disperse at least 15 minutes before welding or heating.

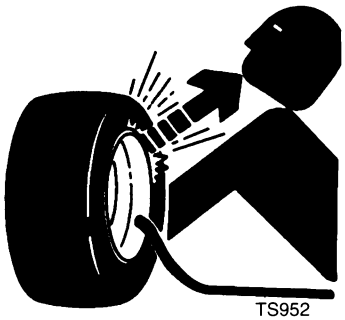
- **AVOID HARMFUL ASBESTOS DUST**

:Avoid breathing dust that may be generated when handling components containing asbestos fibers. Inhaled asbestos fibers may cause lung cancer.

Components in products that may contain asbestos fibers are brake pads, brake band and lining assemblies, clutch plates, and some gaskets. The asbestos used in these components is usually found in a resin or sealed in some way. Normal handling is not hazardous as long as airborne dust containing asbestos is not generated.

Avoid creating dust. Never use compressed air for cleaning. Avoid brushing or grinding material containing asbestos. When servicing, wear an approved respirator. A special vacuum cleaner is recommended to clean asbestos. If not available, apply a mist of oil or water on the material containing asbestos. Keep bystanders away from the area.

- **SERVICE TIRES SAFELY**


TS952

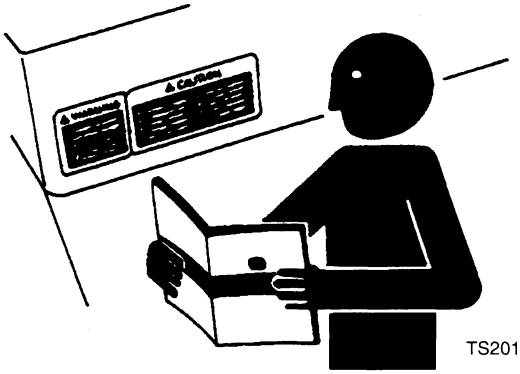
Explosive separation of a tire and rim parts can cause serious injury or death.

Do not attempt to mount a tire unless you have the proper equipment and experience to perform the job. Always maintain the correct tire pressure. Do not inflate the tires above the recommended pressure. Never weld or heat a wheel and tire assembly. The heat can cause an increase in air pressure resulting in a tire explosion. Welding can structurally weaken or deform the wheel.

When inflating tires, use a clip-on chuck and extension hose long enough to allow you to stand to one side and NOT in front of or over the tire assembly. Use a safety cage if available.

- Check wheels for low pressure, cuts, bubbles, damaged rims or missing lug bolts and nuts.

REPLACE SAFETY SIGNS



TS201

Replace missing or damaged safety signs. See the machine operator's manual for correct safety sign placement.

LIVE WITH SAFETY

TS231

Before returning machine to customer, make sure machine is functioning properly, especially the safety systems. Install all guards and shields.

CONTENTS

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SPECIFICATIONS & INFORMATION

Page

SPECIFICATIONS

ENGINE

ITEM	SPECIFICATION
Make	John Deere "K" Series
Model	FD620D
Horsepower	13.4 kW (18HP)

(For detailed engine specifications, see Engine Section)

MACHINE

Battery

Voltage	11.8-13.2 VDC
Reserve Capacity @ 25 Amps	80 min.
Cold Cranking Amps @ -18°C (0°F)	430 CCA

Capacities

Crankcase	
W/Filter	2.1 L (4.44 U.S. pt.)
W/O Filter	1.9 L (4.0 U.S. pt.)
Coolant	0.95 L (1 U.S. qt.)
Fuel Tank	28 L (7.4 U.S. gal)
Hydraulic Fluid Reservoir	15.1 L (4 U.S. gal)

Brakes

Type	Dual Disc (mechanical)15.2 cm (6 in.)

Wheels/Tires

Front	20 x 10 - 8
Steer	20 x 10 - 8
Mowing Speed	0 - 8 km (0 - 5 mph)
Transport Speed	0 - 13.7 km (0 - 8.5 mph)
Reverse Speed	0 - 4.8 km (0 - 3 mph)

INSTRUMENTATION

Engine Oil Pressure	Warning Light
Alternator	Warning Light
Hydraulic Oil Temperature	Warning Light
Engine Coolant Temperature	Warning Light
Hourmeter	Gauge

FUEL SYSTEM

Fuel	an antinock index of 87 or higher
Fuel Filter	Replaceable in-line filter
Fuel Pump	Electric

Weight and Dimensions

Wheel Base	140 cm (55 in.)
Tread Width	132 cm (52 in.)
Mowing Position Width	183 cm (72 in.)
Turning Radius uncut circle	50.8 cm (20 in.)
Vehicle Weight	703 kg (1550 lb.)
Full Fluids, no operator	748 kg (1650 lbs.)
Ground Clearance	7.6 cm (3 in.)

HYDRAULIC SYSTEM

Reservoir

Capacity	15.1 L (4 U.S. gal.)
Fluid Type	
Filtration	10 micron
Reel Circuit Pressure	20685 kPa (3000 psi)
Maximum Back Pressure	1034 kPa (150 psi
Maximum System Operating Temperature	93° C (200° F)

Steering & Lift System

Input Torque	
(Powered)	1.7-2.8 N•m @ 47.5 kPa Tank Pressure
	15-25 lb-in. @ 100 PSI Tank Pressure
(Non-Powered)	81.4 N•m (60 lb-ft.)
Rotation Limits	None

Reel Drive System

Reel Drive	Hydraulic
Pump	Gear
Reel Control Valves	Electro-hydraulic

Wheel Drive System

Drive Wheels	Front, with optional third (rear) wheel drive
Traction Drive	Hydrostatic, treadle pedal
Pump	Gear

MOWER

Number	3
Size	66 cm (26 in.) Floating Standard
Backlapping	(Optional) On Machine, Variable adjustment
Clip frequency	
5 blade cutting units	0.211/MPH
8 blade cutting units	0.132/MPH
Front Rollers	Optional, grooved or smooth
Reel diameter	17.8 cm (7 in.)
Bedknife or reel adjustment	Reel-to-bedknife
Height of cut	9.5 mm - 76 mm (3/8 - 3.00 in.)
Number of Blades	5 or 8

SAFETY INTERLOCKS

. . . . . Neutral Start switch
. . . . . Operator Presence switch
. . . . . Mow/transport switch
. . . . . Park Brake set switch

SERVICE RECOMENDATIONS

O-RING BOSS FITTINGS

Straight Fitting

1. Inspect O-ring boss seat for dirt or defects.
2. Lubricate O-ring with petroleum jelly. Place electrical tape over threads to protect O-ring. Slide O-ring over tape and into O-ring groove of fitting. Remove tape.
3. Tighten fitting to torque value shown on chart.

Angle Fitting

1. Back-off locknut (A) and back-up washer (B) completely to head-end (C) of fitting.
2. Turn fitting into threaded boss until back-up washer contacts face of boss.
3. Turn fitting head-end counterclockwise to proper index (maximum of one turn).
4. Hold fitting head-end with a wrench and tighten locknut and back-up washer to proper torque value.
5. Do not allow hoses to twist when tightening fittings.

TORQUE VALUE		
THREAD SIZE	N•m	lb-ft
3/8-24 UNF	8	6
7/16-20 UNF	12	9
1/2-20 UNF	16	12
9/16-18 UNF	24	18
3/4-16 UNF	46	34
7/8-14 UNF	62	46
1-1/16-12 UN	102	75
1-3/16-12 UN	122	90
1-5/16-12 UN	142	105
1-5/8-12 UN	190	140
1-7/8-12 UN	217	160

NOTE: Torque tolerance is ± 10%.

FLAT FACE O-RING SEAL FITTINGS

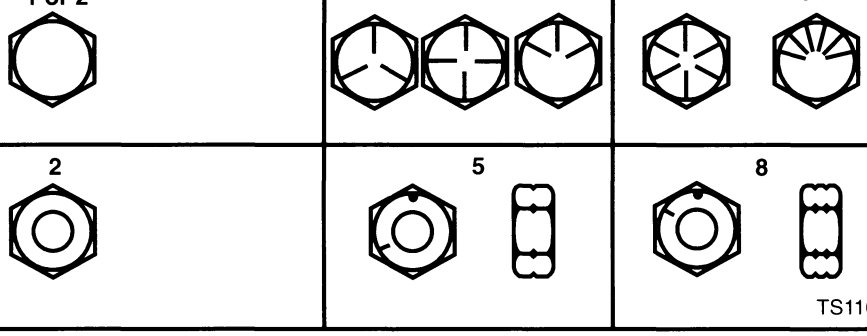
1. Inspect the fitting sealing surfaces. They must be free of dirt or defects.
2. Inspect the O-ring. It must be free of damage or defects.
3. Lubricate O-rings and install into groove using petroleum jelly to hold in place.
4. Push O-ring into the groove with plenty of petroleum jelly so O-ring is not displaced during assembly.
5. Index angle fittings and tighten by hand pressing joint together to ensure O-ring remains in place.
6. Tighten fitting or nut to torque value shown on the chart per dash size stamped on the fitting.

NOTE: Do not allow hoses to twist when tightening fittings.

FLAT FACE O-RING SEAL FITTING TORQUE							
NOMINAL TUBE O.D.		THREAD SIZE		SWIVEL NUT TORQUE		BULKHEAD NUT TORQUE	
(mm)	(in.)	DASH	(in.)	N•m	(lb-ft.)	N•m	(lb-ft.)
6.35	0.250	-4	9/16-18	16	12	5.0	3.5
9.52	0.375	-6	11/16-16	24	18	9.0	6.5
12.70	0.500	-8	13/16-16	50	37	17.0	12.5
15.88	0.625	-10	1-14	69	51	17.0	12.5
19.05	0.750	-12	1 3/16-12	102	75	17.0	12.5
22.22	0.875	-14	1 3/16-12	102	75	17.0	12.5
25.40	1.000	-16	1 7/16-12	142	105	17.0	12.5
31.75	1.250	-20	1 11/16-12	190	140	17.0	12.5
38.10	1.500	-24	2-12	217	160	17.0	12.5
NOTE: Torque tolerance is +15% -20%							

UNIFIED INCH BOLT AND CAP SCREW TORQUE VALUES

SAE Grade and Head Markings	No Marks	1 or 2[b]	5 5.1 5.2	8 8.2
SAE Grade and Nut Markings	No Marks	2	5	8



	Grade 1				Grade 2[b]				Grade 5, 5.1 or 5.2				Grade 8 or 8.2			
	Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]	
SIZE	Nm	lb-ft	Nm	lb-ft	Nm	lb-ft	Nm	lb-ft	Nm	lb-ft	Nm	lb-ft	Nm	lb-ft	Nm	lb-ft
1/4	3.7	2.8	4.7	3.5	6	4.5	7.5	5.5	9.5	7	12	9	13.5	10	17	12.5
5/16	7.7	5.5	10	7	12	9	15	11	20	15	25	18	28	21	35	26
3/8	14	10	17	13	22	16	27	20	35	26	44	33	50	36	63	46
7/16	22	16	28	20	35	26	44	32	55	41	70	52	80	58	100	75
1/2	33	25	42	31	53	39	67	50	85	63	110	80	120	90	150	115
9/16	48	36	60	45	75	56	95	70	125	90	155	115	175	130	225	160
5/8	67	50	85	62	105	78	135	100	170	125	215	160	215	160	300	225
3/4	120	87	150	110	190	140	240	175	300	225	375	280	425	310	550	400
7/8	190	140	240	175	190	140	240	175	490	360	625	450	700	500	875	650
1	290	210	360	270	290	210	360	270	725	540	925	675	1050	750	1300	975
1-1/8	470	300	510	375	470	300	510	375	900	675	1150	850	1450	1075	1850	1350
1-1/4	570	425	725	530	570	425	725	530	1300	950	1650	1200	2050	1500	2600	1950
1-3/8	750	550	950	700	750	550	950	700	1700	1250	2150	1550	2700	2000	3400	2550
1-1/2	1000	725	1250	925	990	725	1250	930	2250	1650	2850	2100	3600	2650	4550	3350

DO NOT use these values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only. Check tightness of fasteners periodically.

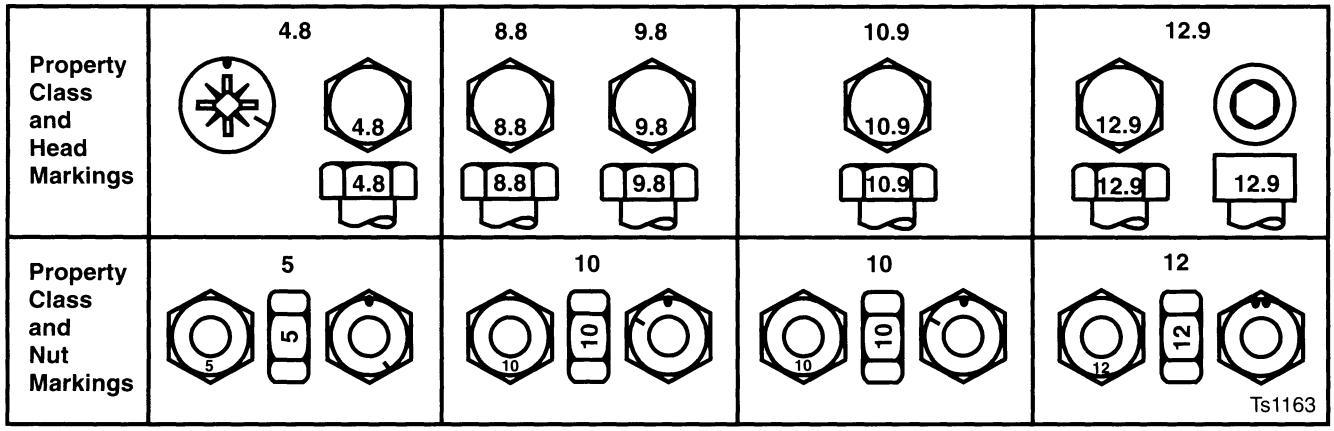
Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical grade.

Fasteners should be replaced with the same or higher grade. If higher grade fasteners are used, these should only be tightened to the strength of the original. Make sure fasteners threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

Tighten plastic insert or crimped steel-type lock nuts to approximately 50 percent of the dry torque shown in the chart, applied to the nut, not to the bolt head. Tighten toothed or serrated-type lock nuts to the full torque value.

[a] "Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated without any lubrication[b] Grade 2 applies for hex cap screws (not hex bolts) up to 152 mm (6-in.) long. Grade 1 applies for hex cap screws over 152 mm (6-in.) long, and for all other types of bolts and screws of any length.

METRIC BOLT AND CAP SCREW TORQUE VALUES



	Class 4.8				Class 8.8 or 9.8				Class 10.9				Class 12.9			
	Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]	
SIZE	Nm	lb-ft	Nm	lb-ft	Nm	lb-ft	Nm	lb-ft	Nm	lb-ft	Nm	lb-ft	Nm	lb-ft	Nm	lb-ft
M6	48	3.5	6	4.5	9	6.5	11	8.5	13	9.5	17	12	15	11.5	19	14.5
M8	12	8.5	15	11	22	16	28	20	32	24	40	30	37	28	47	35
M10	23	17	29	21	43	32	55	40	63	47	80	60	75	55	95	70
M12	40	29	50	37	75	55	95	70	110	80	140	105	130	95	165	120
M14	63	47	80	60	120	88	150	110	175	130	225	165	205	150	260	109
M16	100	73	125	92	190	140	240	175	275	200	350	225	320	240	400	300
M18	135	100	175	125	260	195	330	250	375	275	475	350	440	325	560	410
M20	190	140	240	180	375	275	475	350	530	400	675	500	625	460	800	580
M22	260	190	330	250	510	375	650	475	725	540	925	675	850	625	1075	800
M24	330	250	425	310	650	475	825	600	925	675	1150	850	1075	800	1350	1000
M27	490	360	625	450	950	700	1200	875	1350	1000	1700	1250	1600	1150	2000	1500
M30	675	490	850	625	1300	950	1650	1200	1850	1350	2300	1700	2150	1600	2700	2000
M33	900	675	1150	850	1750	1300	2200	1650	2500	1850	3150	2350	2900	2150	3700	2750
M36	1150	850	1450	1075	2250	1650	2850	2100	3200	2350	4050	3000	3750	2750	4750	3500

DO NOT use these values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only. Check tightness of fasteners periodically.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical grade.

Fasteners should be replaced with the same or higher grade. If higher grade fasteners are used, these should only be tightened to the strength of the original. Make sure fasteners threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

Tighten plastic insert or crimped steel-type lock nuts to approximately 50 percent of the dry torque shown in the chart, applied to the nut, not to the bolt head. Tighten toothed or serrated-type lock nuts to the full torque value.

[a] "Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated without any lubrication.

[b] Grade 2 applies for hex cap screws (not hex bolts) up to 152 mm (6-in.) long. Grade 1 applies for hex cap screws over 152 mm (6-in.) long, and for all other types of bolts and screws of any length.

GASOLINE SPECIFICATIONS

⚠ CAUTION:

Handle fuel with care, it is highly flammable. DO NOT refuel machine:

- **Indoors. Always fill fuel tank outdoors.**
- **While you smoke.**
- **When machine is near and open flame or sparks.**
- **When engine is running. STOP engine.**
- **When engine is hot. Allow it to cool.**

Help prevent fires:

- **Fill fuel tank only to bottom of filler neck.**
- **Clean oil, grease and dirt from machine.**
- **Clean up spilled fuel immediately.**
- **Do not store machine with fule in tank in a building where fumes may reach an open flame or spark.**

To prevent fire and explosion caused by static electric discharge while you fill tank:

- **Use approved, non-metal fuel container.**
- **When using a funnel, MAKE SURE it is PLASTIC.**
- **Avoid using a funnel which has a metal screen or filter.**

IMPORTANT: To avoid engine damage:

- DO NOT mix oil with gasoline
- Use only clean oil and fuel
- Use clean approved containers and funnels.
- Store oil and fuel in an area protected from dust, moisture and other contamination.

Unleaded fuel is recommended because it burns cleaner and leaves less unburned deposits in engine combustion chamber. Regular leaded gasoline with an anti-knock index of 87 or higher may be used.Use of gasohol is acceptable as long as the ethyl alcohol blend does not exceed 11 percent. Unleaded gasohol is preferred over leaded gasohol.

Fill fuel tank at end of each day's operation. Fill only to bottom of filler neck. *Fuel Tank Capacity.20 L (5.3 gal)*

FUEL STORAGE

Keep fuel in a clean container in a protected area. Water and sediment must be removed before fuel gets to the engine. Do not use deicers to remove water from fuel. Do not depend on fuel filters to remove water.

If possible, install a water separator at the storage tank outlet.

IMPORTANT: Keep all dirt, scale, water or other foreign material out of fuel.

If transporter is either stored or used during the winter, add TY6295 John Deere Gasoline Storage Stabilizer or an equivalent to the fuel. Follow directions on can.

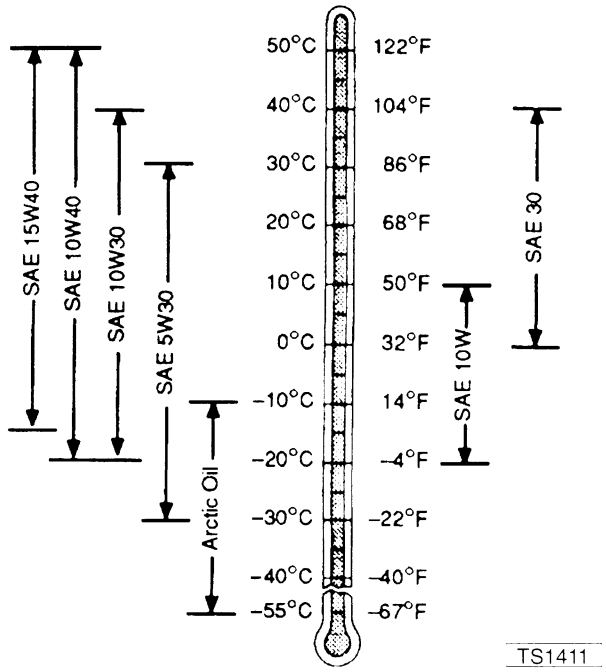
LUBRICANT SPECIFICATIONS

ENGINE OIL

Use oil viscosity based on the expected air temperature range during the period between oil changes.

The following oil is preferred:

- John Deere PLUS-4®



Other oils may be used if they meet one of the following:

- API Service Classification SG
- API Service Classification SF
- CCMC Specification G4

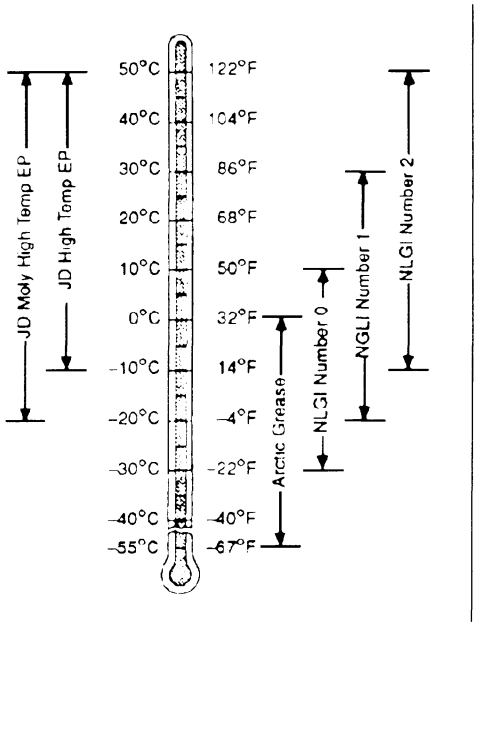
Oils meeting Military Specification MIL-L-46167B may be used as arctic oils.

GREASE

Use grease based on the expected air temperature range during the service interval.

The following greases are preferred:

- John Deere MOLY HIGH TEMPERATURE EP GREASE
- John Deere HIGH TEMPERATURE EP GREASE
- John Deere GREASE-GARD™



Other greases may be used if they meet one of the following:

- SAE Multipurpose EP Grease with a maximum of 5% molybdenum disulfide.
- SAE Multipurpose EP Grease

Greases meeting Military Specification MIL-G-10924F may be used as arctic grease.

ANTI-CHATTER TRANSMISSION/ HYDRAULIC OIL

NOTE: This transmission is filled with John Deere Hy-Gard™ (J20C) Transmission and Hydraulic oil at the factory. DO NOT mix oils.

This transmission is equipped with wet disk brakes. To avoid chatter, use only John Deere HY-GARD™ (J20C or J20D) Transmission/Hydraulic Oil. It is specifically formulated to minimize wet brake chatter, and to provide maximum protection against mechanical wear, corrosion, and foaming.

DO NOT use type "F" automatic transmission fluid.

Use J20C Transmission/Hydraulic Oil when ambient operating temperatures are **above** -18° C. (0° F.).

Use J20D Low Viscosity HY-Gard Transmission/ Hydraulic Oil when ambient operating temperatures are **below** -18° C. (0° F.).

ALTERNATIVE LUBRICANTS

Conditions in certain geographical areas outside the United States and Canada may require different lubricant recommendations than these printed in this manual or the operator's manual. Consult with your John Deere Dealer, or Sales Branch to obtain the alternative lubricant recommendations.

SYNTHETIC LUBRICANTS

Synthetic lubricants may be used in John Deere equipment if they meet the applicable performance requirements (industry classification and/or military specification) as shown earlier in this group.

The recommended temperature limits and service or oil change intervals should be maintained as shown in the operator's manual.

Avoid mixing different brands, grades, or types of oil. Oil manufacturers blend additive in their oils to meet certain specifications and performance requirements. Mixing different oils can interfere with the proper functioning of these additives and degrade lubricant performance.

OIL FILTERS

Filtration of oils is critical to proper lubrication. Always change filters regularly.

Use filters meeting John Deere performance specification.

LUBRICANT STORAGE

This machine can operate at top efficiency only if clean lubricants are used.

Use clean containers to handle all lubricants. Store them in an area protected from dust, moisture, and other contamination. Store drums on their sides.

ENGINE COOLANT

Use ethylene glycol base coolant. These coolants usually have labels stating "For Automobile and Light Duty Service." These products are also often labeled for use in aluminum engines. Check container label before using.

IMPORTANT: To prevent engine damage, DO NOT use pure antifreeze or more than 50% antifreeze in the cooling system. DO NOT mix or add any other type additives to the cooling system.

Mix approximately 50 percent antifreeze with 50 percent distilled or deionized water. This mixture will provide freeze protection to -34° F (-37 ° C).

Certain geographical areas may require lower temperature protection. See the label on your antifreeze container or consult your John Deere dealer to obtain the latest information and recommendations.

The recommended antifreeze provides:

- Adequate heat transfer.
- Corrosion-resistant environment within the cooling system.
- Compatibility with cooling system hose and seal material.
- Protection during cold and hot weather operations.

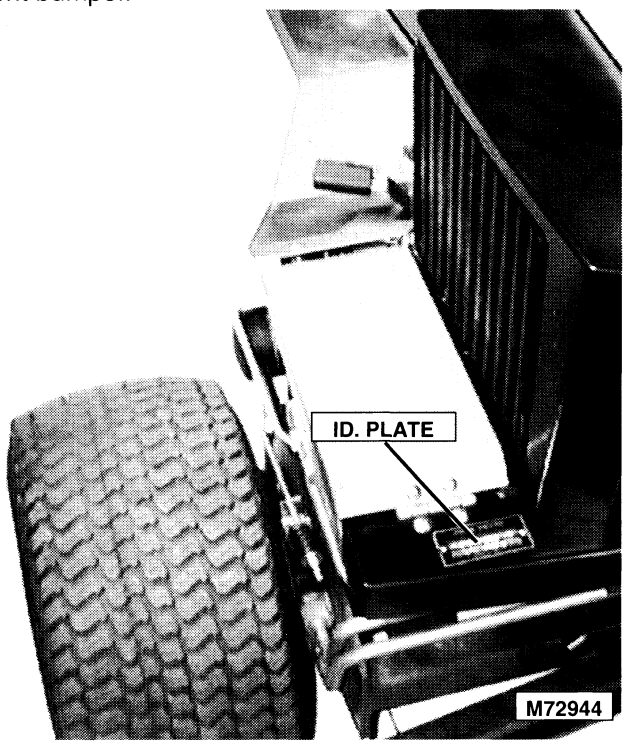
SERIAL NUMBER LOCATION

When ordering parts or submitting a warranty claim, it is IMPORTANT that you include the mower product identification number and the component serial numbers.

The location of the 2653 Professional Utility Mower Identification number is shown below.

MOWER IDENTIFICATION NUMBER

The Mower Identification Number is located on the right front bumper.



NOTES:

CONTENTS

SPECIFICATIONS

GENERAL ENGINE SPECIFICATIONS:

Engine

Make	Kawasaki
Model	FD620D
Type	Gasoline
Horsepower	13.4 kW (18HP)
Cylinders	2
Cycles	4
Bore	76 mm (2.99 in.)
Stroke	68 mm (2.66 in.)
Displacement	585 cc (35.7 cu-in.)

REPAIR SPECIFICATIONS:

Rocker Arm

Minimum Shaft O.D.	11.95 mm (0.470 in.)
Maximum Bearing I.D.	12.07 mm (0.475 in.)
Adjusting Nut Torque	9 N•m (79 lb-in.)

Push Rod

Maximum Bend	0.80 mm (0.031 in.)
Runnout	0.80 mm (0.03 in.)

Valves and Springs

Valve Clearance	0.25 mm (.010 in.)
Spring Free Length	29.70 mm (1.170 in.)
Minimum Valve Stem O.D.	
Intake	0.94 mm (0.234 in.)
Exhaust	5.92 mm (0.233 in.)
Maximum Valve Guide I.D.	6.05 mm (0.238 in.)
Maximum Valve Stem Bend	0.03 mm (0.001 in.)
Standard Valve Seating Surface	0.5 -1.10 mm (.020-.043 in.)
Valve Seating Width Tolerance	2.0 mm (0.08 in.)
Valve Seat and Face Angle	45^{o}
Minimum Valve Margin	0.60 mm (0.024 in.)
Valve Narrowing Angle	30^{o}

Cylinder Head

Cylinder Head Flatness	0.06 mm (.002 in.)
Compression (Min.)	1171 kPa (170 psi)
Cap Screw Torque In Sequence	
Initial Torque	13 N•m (115 lb-in.)
Final Torque	21 N•m (186 lb-in.)
Spark Plug Torque	20 N•m (177 lb-in.)

Flywheel

Flywheel Nut Torque	108 N•m (80 lb-ft.)
Sheave Half Cap Screw	15 N•m (130 lb-in.)

Camshaft

Minimum End Journals	25.21 mm (.993 in.)
Minimum Lobe O.D.	
Intake	25.21 mm (0.993 in.)
Exhaust	25.46 mm (1.002 in.)
Maximum Cover and Crankcase Bearing I.D.	16.07 mm (.633 in.)

Piston

Maximum Ring Groove Clearance	
Top Ring	0.15 mm (.006 in.)
Second Ring	0.12 mm (.005 in.)
Oil Ring	Not Measured
Ring Thickness (Top, Second)	1.12 mm (0.044 in.)
Maximum Ring End Gap (Top, Second)	1.20 mm (.050 in.)
Oil Ring	1.5 mm (0.06 in.)
Minimum Pin O.D.	16.98 mm (.668 in.)
Maximum Pin Bore I.D.	17.04 mm (.671 in.)
Piston O.D.(measured at 11 mm (.433 in.) from bottom of piston skirt)	75.935-75.95 mm (2.989-2.99 in.)
Piston-to-Cylinder Bore Clearance	0.030-.170 mm (.00118-.00670 in.)

Connecting Rod

Maximum Crankshaft Bearing I.D.	34.06 mm (1.341 in.)
Maximum Piston Pin Bearing I.D.	17.05 mm (.671 in.)
End-Cap Screw Torque	21 N•m (186 lb-in.)

Crankshaft

Minimum Side Journal O.D.	33.91 mm (1.335 in.)
Minimum Connecting Rod Journal	33.93 mm (1.336 in.)
Maximum T.I.R.	.05 mm (.002 in.)

Plain Bearings

Maximum Crankcase Cover I.D.	34.07 mm (1.341 in.)
Maximum Crankcase I.D.	34.11 mm (1.343 in.)

Cylinder Bore

Standard I.D.	75.98-76 mm(2.994-2.995 in.)
Maximum I.D.	76.07 mm (2.997 in.)
Out of Round	0.056 mm (0.0022 in.)

Cylinder Oversize Diameter

.25 mm	76.21-76.23 mm (3.002-3.003 in.)
.50 mm	76.46-76.48 mm (3.012-3.013 in.)
.75 mm	6.71-76.73 mm (3.022-3.023 in.)

Oil Pump

Minimum Rotor Shaft O.D.	0.92 mm (.430 in.)
Maximum Rotor Shaft Bearing I.D.	11.07 mm (.436 in.)
Minimum Outer Rotor O.D.	40.43 mm (1.592 in.)
Minimum Outer Rotor Bearing I.D.	40.80 mm (1.606 in.)
Minimum Valve Spring Free Length	19.50 mm (.770 in.)

Governor

Governor Arm Nut Torque	8 N•m (72 lb-in.)

Crankcase

Cover Cap Screw Torque . . . . . 21 N•m (186 lb-in.)
Drain Plug Torque . . . . . 23 N•m (204 lb-in.)

Intake Manifold

Cap Screw Torque . . . . . 6 N•m (53 Lb-in.)

Sheave /Half

Cap Screw Torque . . . . . 15 N•m (130 lb-in.)

Thermostat

Begin Opening Temperature . . . . . 65° C (148° F)
Fully Open Temperature. . . . . 80° C (176° F)

Water Pump

Minimum Shaft O.D.. . . . . 9.94 mm (0.391 in.)
Maximum Pump and Crankcase Housing Bore I.D.. . . . . 10.09 mm (0.397 in.)
Cap Screw Torque . . . . . 8 N•m (70 lb-in.)
Crankcase Cover Cap Screw Torque. . . . . 21 N•m (186 lb-in.)

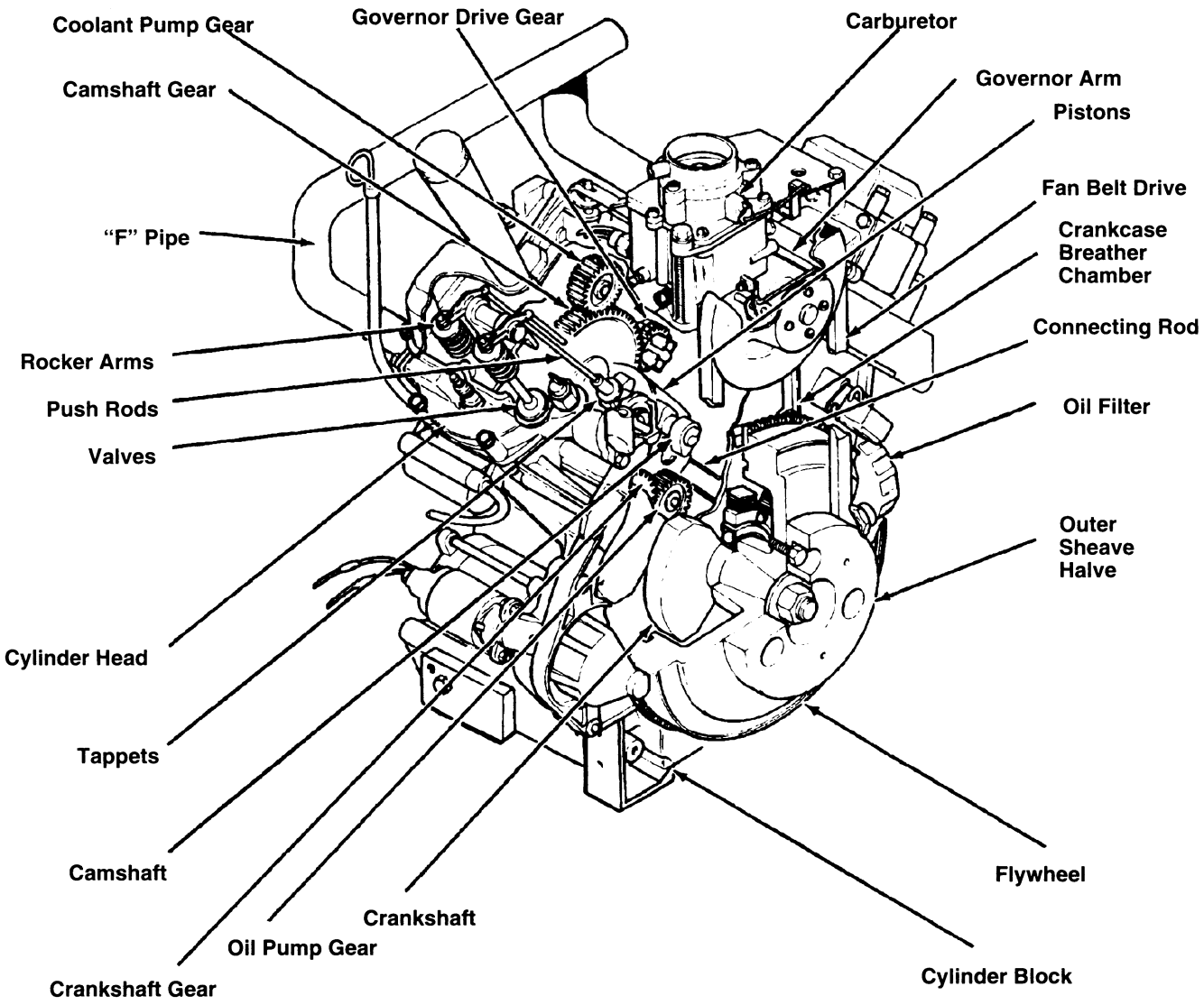
Ignition System

Type . . . . . Transistor Controlled
Pulsers . . . . . 85-270 ohms/Resistance
Ignition Coils
Primary Resistance . . . . . 3.4-4.6 ohms
Secondary Resistance . . . . . 10.4-15.5 K ohms

ENGINE AND COMPONENT TEST SPECIFICATIONS:

Compression . . . . . 1171 kPa (170 psi)
Thermo Switch . . . . . From off to on at 108°-114° C (226°-237° F)
. . . . . From on to off at 101°-107° C (214°-225° F)
. . . . . ON: Continuity
. . . . . OFF: Infinity

COMPONENT LOCATION



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TROUBLESHOOTING

Problem or Symptom / Check or Solution	Engine cranks but will not start	Loss of power	Engine runs erratically	Engine misses at high rpm	Engine misses at low rpm	Excessive fuel consumption	Excessive oil consumption	Engine backfires	Engine knocks	Coolant leakage	Engine overheats	Engine RPM Low Or Engine Stalls
Weak or faulty spark plug	●	●	●		●							
Faulty high tension leads	●	●			●							
Faulty igniter	●	●			●	●			●			
Faulty ignition coil	●	●			●							
Faulty pulser coil	●	●			●			●				
No fuel in tank (contaminated)	●		●						●			
Fuel shut-off solenoid	●											
Defective fuel pump	●		●	●								
Air being drawn in through a hole in the fuel line(s)	●	●	●						●			
Fuel shut-off valve closed	●											
Clogged fuel line or filter	●	●	●	●								
Fuel vent line clogged	●	●	●	●								
Vapor lock			●									
Improper use of choke	●					●						
Air filter restricted	●	●										
Defective breather valve		●					●					
Float level too high	●					●						
Worn piston/piston rings	●	●				●	●					
Stuck piston ring(s)	●	●				●	●					
Worn cylinder bore	●	●				●	●					

Problem or Symptom / Check or Solution	Engine cranks but will not start	Loss of power	Engine runs erratically	Engine misses at high rpm	Engine misses at low rpm	Excessive fuel consumption	Excessive oil consumption	Engine backfires	Engine knocks	Coolant leakage	Engine overheats	Engine RPM Low Or Engine Stalls
Cylinder head loose	●	●				●		●		●		
Worn valves or improper clearance	●	●			●	●						
Worn valve stem(s) or valve guide(s)							●					
Warped cylinder head	●	●						●				
Broken valve spring	●	●				●						
Defective head gasket	●	●						●		●		
Low oil level		●										
Too much oil in crankcase		●					●					
Carburetor out of adjustment		●	●	●	●	●		●	●			
Air/fuel passages clogged		●			●							
Carbon deposits in exhaust pipe/muffler		●										
Carbon deposits in combustion chamber		●							●			
Lack of coolant			●						●		●	
Governor linkage out of adjustment			●									
Faulty governor spring			●									
Governor gear assembly binding or broken			●									
Air being drawn through carburetor or intake manifold flanges					●				●			
Incorrect timing gear alignment					●							
Plugged oil ring groove							●					
Oil leakage along governor shaft							●					

Problem or Symptom / Check or Solution	Engine cranks but will not start	Loss of power	Engine runs erratically	Engine misses at high rpm	Engine misses at low rpm	Excessive fuel consumption	Excessive oil consumption	Engine backfires	Engine knocks	Coolant leakage	Engine overheats	Engine RPM Low Or Engine Stalls
Defective oil seal							●					
Drain-back hole in breather chamber plugged							●					
Incorrect oil viscosity							●					
Carburetor flange loose or leaking at gasket			●									
Carburetor body and throttle shaft worn			●									
Intake valve burned or sticking								●				
Excessive engine load									●		●	
Fan belt slippage											●	
Defective radiator hose or clamp										●	●	
Broken or missing fan shroud											●	
Defective radiator										●	●	
Cracked or porous casting										●	●	
Loose stud bolts and cap screw										●	●	
Engine overheating										●		
Damaged water pump seals										●	●	
Improperly installed gasket										●	●	
Improper or defective radiator cap										●	●	
Battery weak or discharged	●											
Hydro not neutralizing												●
Hydraulic load on engine												●

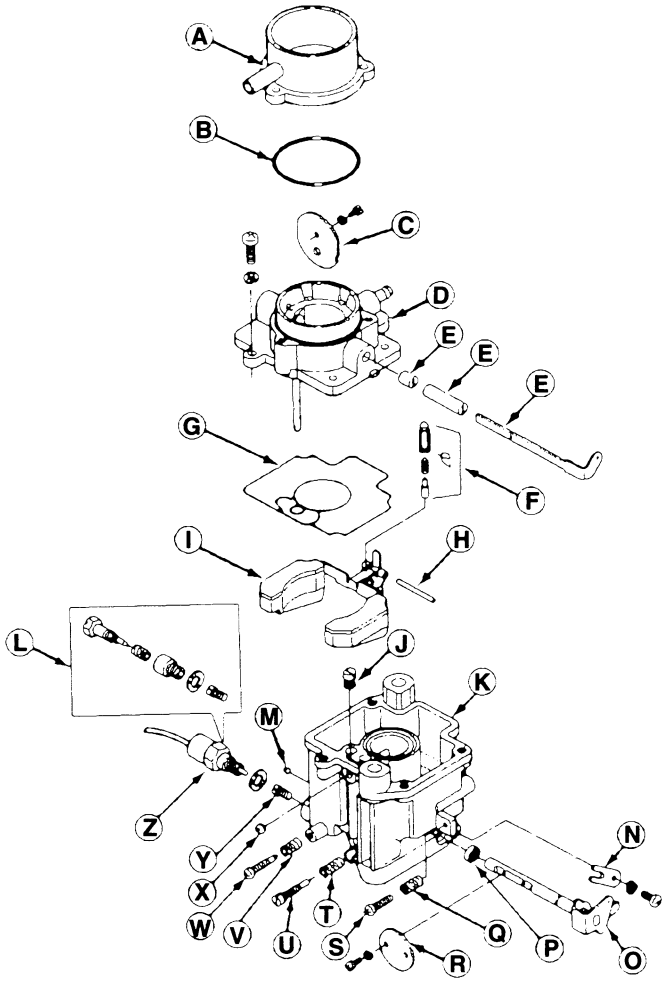
FUEL SYSTEM SERVICE

CARBURETOR REPAIR

⚠ CAUTION

Gasoline is extremely flammable. do not smoke. Always work in a ventilated area away from open flame or spark producing equipment, this includes equipment that utilizes pilot lights.

Refer to the illustration and the following steps for disassembly and assembly.



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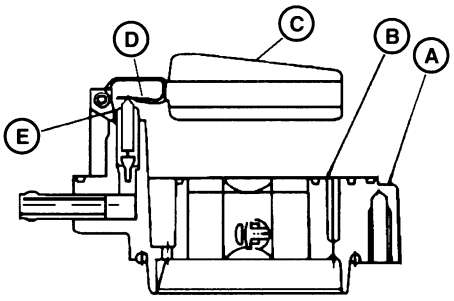
A - Air Horn
B - O-ring
C - Choke Plate
D - Air Horn
E - Choke Shaft Assembly
F - Needle Valve
G - Gasket
H - Float Pin
I - Float
J - Slow Idle Jet
K - Carburetor Body
L - Main Jet High Altitude Kit
M - Expansion Plug
N -Plate
O - Throttle Shaft
P - Bushing
Q - Spring
R - Throttle Valve
S - Idle Speed Screw
T - Spring
U - Idle Mixture Screw
V - Spring
W - Drain Screw
X - Expansion Plug
Y - Main Jet
Z - Fuel Shut-off Solenoid

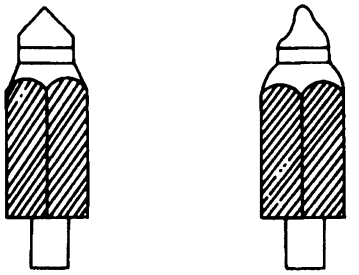
1. There are a number of plates in the carburetor that should not be removed.
2. Turn the idle mixture screw in and note the number of turns required to lightly seat it before removing it.

NOTE: If all rubber or plastic parts cannot be removed for cleaning, use a solvent, with a high flash point, that will not damage these parts when cleaning.

3. Remove rubber or plastic parts from the carburetor. Immerse all the carburetor metal parts in a carburetor cleaning solution.
4. Rinse the parts in water and dry with compressed air, do not use rags or paper to dry parts as lint can plug the tiny passages in the carburetor.
5. Inspect the carburetor body for damage. Ensure the sealing surfaces and flanges are smooth and free of nicks and burrs.
6. Turn the idle mixture screw in until lightly seated and back it out the same number of turns counted during disassembly.
7. Install the choke valve with the metering hole towards the fuel inlet joint of the carburetor.
8. Ensure the float pin extends the same distance on both sides of the float hinge bracket when reassembling the carburetor.
9. Ensure the throttle and choke valves move freely and that the shaft bosses are not elongated or worn. If shaft bosses have any of these conditions, replace the carburetor.
10. Inspect the inlet needle for wear or damage. The tip should be smooth, without any grooves, scratches or tears. If worn or damaged, replace the float assembly and carburetor body as a set.
11. Inspect the idle mixture screw for wear or damage, replace it if necessary.

FLOAT LEVEL ADJUSTMENT





1. Hold the air horn (A) upside down at eye level with the float assembly (C) installed.
2. Gently support the float with a finger and lower it slowly until the float arm tab (D) just touches the float valve needle (E).
3. The float lower surface should be parallel with the air horn mating surface (B).
4. If necessary, bend the float arm tab to adjust the float level.

FUEL SHUT-OFF SOLENOID TEST

1. Remove the fuel shut-off solenoid.
2. Connect a 12 VDC power source as shown.
3. Needle valve should pull in when test voltage is applied. If not, replace solenoid.

NOTE: It may be necessary to push the plunger in slightly in order for it to retract.

FUEL PUMP TEST

NOTE: Ensure battery is fully charged before testing the fuel pump.

1. Disconnect and plug the fuel line from the outlet side of the fuel pump.
2. Connect a fuel pressure gage to the outlet side of the fuel pump.
3. Turn the ignition switch to the run position and record the pressure reading. Turn the ignition switch off and disconnect the pressure gage.
4. Connect a hose to the fuel pump outlet and place the hose end in a graduated container.
5. Turn the ignition switch to the run position for thirty seconds, turn the ignition switch off and record the measurement.
6. Compare the readings to the specifications.
7. If readings do not meet the specifications, inspect the fuel lines, fuel filter, and fuel tank for restrictions or damage. Replace defective tank.

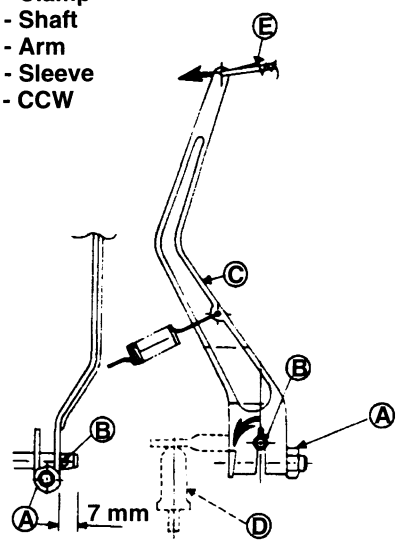
SPECIFICATIONS

Fuel pressure19 kPa (2.76 psi)
Fuel Flow180 ml/30 seconds

GOVERNOR ARM ADJUSTMENT

1. Remove air cleaner assembly.

A - Clamp
B - Shaft
C - Arm
D - Sleeve
E - CCW



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2. Loosen the clamp nut (A) on the governor arm (C) enough to move the governor shaft (B).
3. Turn the governor arm counterclockwise (E) to fully open the throttle valve and hold it there.
4. Rotate the governor shaft (B) fully counterclockwise and tighten the clamp nut (A) on the governor arm.
5. Ensure the governor shaft extends approximately **7 mm** from the governor arm.V

IDLE MIXTURE SCREW *(PILOT SCREW)* AND IDLE SPEED ADJUSTMENT

IMPORTANT: Do not turn the idle adjustment screw in too far or the carburetor body will be damaged requiring replacement.

1. Stop the engine.
2. Turn the idle mixture screw in until lightly seated.
3. Back the idle mixture screw out **1 3/4 turns.**
4. Start the engine and allow it to reach normal operating temperature. (Ensure there is no load applied to the engine)
5. Position the throttle lever to the idle position.
6. Hold the throttle lever on the carburetor in the closed position and adjust the idle speed to **1400 ±100 rpm.**
7. Slowly turn the idle mixture screw in or out until the engine speed reaches the highest rpm. Turn the idle mixture screw out an additional **1/4 turn.**
8. Turn the idle mixture screw to adjust the idle to **1550 ± 100 rpm.**

FAST IDLE SPEED ADJUSTMENT

NOTE: Fast idle speed adjustment should be made after the idle speed adjustment is performed.

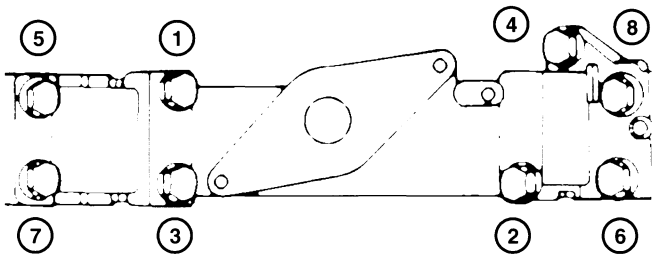
1. Start the engine and allow it to reach normal operating temperature.
2. Position the throttle lever to the fast idle position.
3. Loosen the two control panel mounting bolts just enough to move the control panel assembly
4. Carefully move the control panel to obtain **3600 ± 75 rpm**, tighten the control panel mounting bolts.

HIGH ALTITUDE OPERATION

High altitude performance can be improved by installing a smaller diameter main jet in the carburetor and readjusting the idle speed and idle mixture screws to specified rpm.

INTAKE MANIFOLD SERVICE

1. Remove the carburetor and governor control panel.
2. Drain coolant.



3. Loosen manifold bolts **1/4 turn** at a time in sequence shown until all bolts are loose.
4. Visually inspect manifold passages for corrosion or deposits and clean as necessary.
5. Inspect the manifold for cracks or a porous casting.
6. If cracks are present, replace the manifold.

NOTE: Before installing the manifold, install the cylinder heads and tighten the head bolts in sequence to half the rated torque value.

7. Install the intake manifold and tighten the bolts in sequence, (see numbers 1-8 in above artwork) in two steps to a final torque of **6 N•m (26 lb-in.).**
8. Tighten the cylinder head bolts to **21 N•m (15 lb-ft.).**

COOLING SYSTEM SERVICE

Notes About Coolant:

- **Always use coolants that are compatable with aluminum engines.**
- **Always use a soft or distilled water to mix with the coolant, hard water causes scale accumulation in the water passages that will severely reduce cooling efficiency.**
- **If white flakes appear in the radiator or overflow tank, suspect corrosion of the aluminum parts in the engine or cooling system. Flush and renew coolant.**
- **If coolant is brown in color, suspect rusting of iron or steel parts in the cooling system. Flush and renew coolant.**

COOLING SYSTEM PRESSURE TEST

IMPORTANT: Do not exceed 102.7 kpa (14.9 psi) during pressure test.

1. Remove the radiator cap. Wet the sealing surface on a suitable pressure tester and install it on the radiator filler neck.
2. Build up pressure in the system slowly until pressure reaches **60 kPa (8.7 psi).**
3. Watch the pressure gauge for at least 6 seconds. If the pressure holds steady, the system is all right. If the pressure drops, look for external signs of leakage. If no external leaks are found, check the engine oil for drops of coolant. If coolant is found in the engine oil, suspect faulty cylinder head gaskets.
4. Wet the radiator cap sealing surface with water and install on a suitable pressure tester.
5. Build up pressure to **60 kPa (8.7 psi).** Pressure must hold for at least 6 seconds. Now test the cap for the following relief pressures. Replace the cap if it fails any of these tests.Cap Relief Pressure

Pressure valve:
73.3 - 102.7 kPa(910.6 - 14.9 psi)
Vacuum Valve:
. . . . . 4.90 kPa (0.71 psi) (vacuum)

COOLING SYSTEM FLUSHING

IMPORTANT: Use only flushing agents that are compatable with aluminum engines.

- **Carefully follow the instructions supplied by the manufacturer of the cleaning product.**

WATER PUMP SERVICE

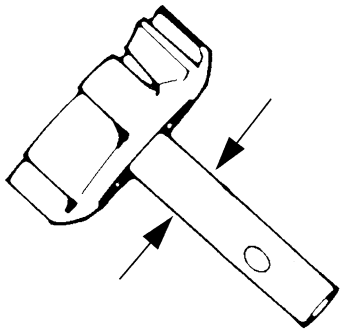
PUMP PARTS INSPECTION

- **Clean all metal parts in solvent and dry with compressed air.**
- **Clean all rubber and plastic parts with a mixture of detergent and water.**
- **Inspect the pump housing for damage. Mating surfaces should be smooth and free of burrs and nicks.**
- **Check the pump mechanical seal for damage. If damaged, coolant will leak from the pump body. Replace if necessary.**

- **Inspect the impeller for missing blades and corrosion. Measure the impeller shaft at several points with a micrometer, minimum shaft diameter is 9.935 mm (0.3911 in.). If damage or wear is noted, replace all internal pump parts.**

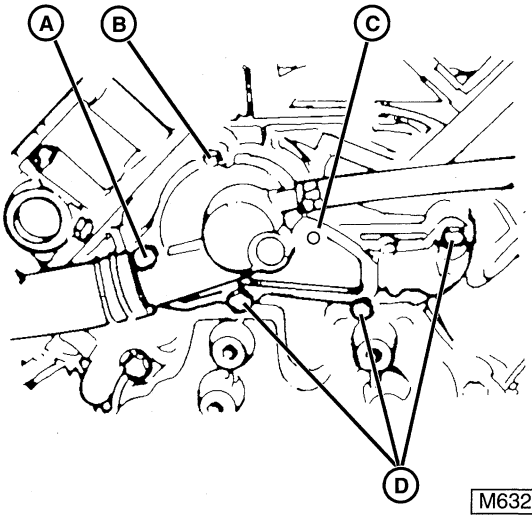
WATER PUMP INSTALLATION

NOTE: Ensure water pump gear meshes with cam gear when aligning the pump for installation.



M63225

1. Use a new gasket and position the pump onto the engine.
2. Install water pump bolts in positions shown and torque to **21 N•m (15 lb-ft.)** in two steps.



M63226

Bolt Dimensions.

A. Bolt M675 mm (2.95 in.)
B. Bolt M665 mm (2.56 in.)
C. Bolt M870 mm (2.76 in.)
D. Bolt M645 mm (1.77 in.)

COOLING FAN AND FAN BELT

- **The only service on the cooling fan is to be sure the fan blades are not deformed and are not contacting the fan shroud.**
- **Replace the fan shroud if broken, inadequate cooling will result if the shroud is broken or missing.**
- **For fan belt tension, see page 3-16.**

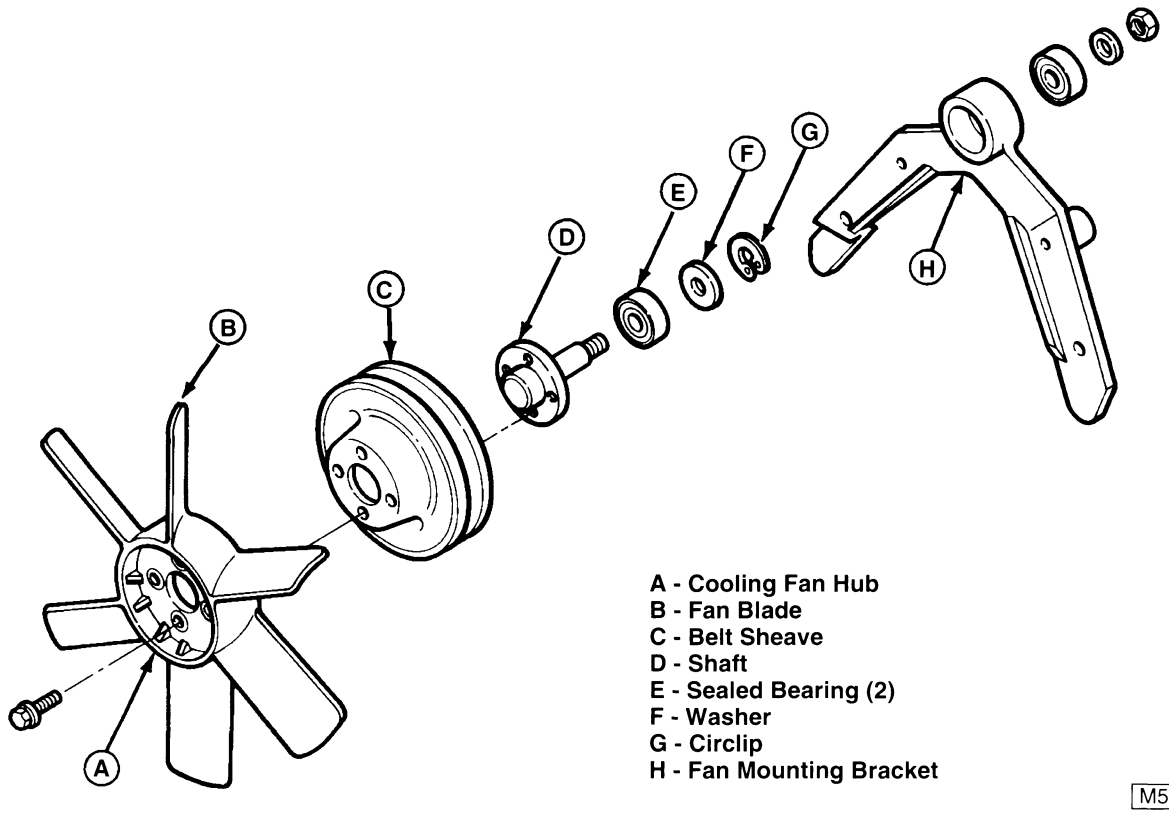
FAN BEARING REMOVAL

⚠ CAUTION

Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well ventilated area. Plan a safe handling procedure to avoid burns.

IMPORTANT: Do not remove the bearing unless it is defective. Once it is removed, it must be replaced.

1. Unscrew the fan shaft nut and remove the shaft and washer.
2. Rotate the bearing slowly with a finger, if any roughness or free-play is felt, the bearing must be replaced.
3. To remove the bearing, heat in hot oil, **150° C (302° F).**
4. Place the bearing housing on a bench (bearing side up) and remove the bearing..



A - Cooling Fan Hub
B - Fan Blade
C - Belt Sheave
D - Shaft
E - Sealed Bearing (2)
F - Washer
G - Circlip
H - Fan Mounting Bracket

M53994

FAN BEARING INSTALLATION

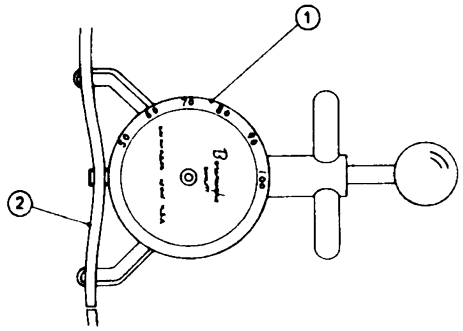
1. Coat the bearing surfaces with a light coat of engine oil.
2. Use a bearing driver and press in the fan side bearing **(flush with the housing).**
3. Install the opposite side bearing with a bearing driver until it contacts the stop (snap ring).
4. Install the fan shaft, washer and nut, torque to **20 N•m (14.5 lb-ft.)**

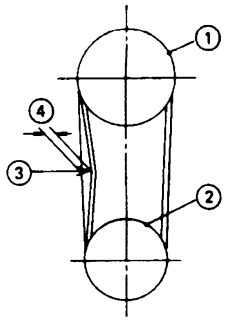
BELT TENSION ADJUSTMENT

1. Measure the belt tension with a gauge, or, if a gauge is not available, measure the slack in the belt using the following table as a guide.

Belt Tension Service Limit

Belt Tension	Belt Deflection
25 kg (55 lb)	12 mm (0.47 in.)
40 kg (88 lb)	9 mm (0.35 in.)
18 kg (40 lb)	17 mm (0.67 in.)



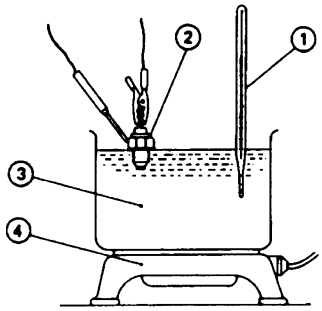


M72914

2. Install or remove shims as required to obtain the proper tension.

NOTE: When tightening the sheave hub, rotate the fan in both directions to avoid pinching the belt.

THERMO SWITCH INSPECTION



M56497

1. Using an ohmmeter, test the connections listed below. Replace the switch if it fails any of these tests.

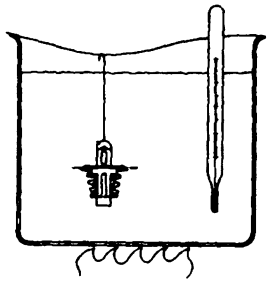
NOTE: The switch (2) and thermometer (1) must not touch the sides (3) or bottom (4) of the container

Thermo Switch Connections

Rising Temperature
. . . . . From off to on at 108 - 114° C (226 - 237° F)
Falling Temperature
. . . . . From on to off at 101 - 107° C (214 - 225° F)
ON:. . . . . Continuity
OFF:. . . . . Infinity

THERMOSTAT TEST

1. Inspect the thermostat at room temperature, if the valve is open, replace it.



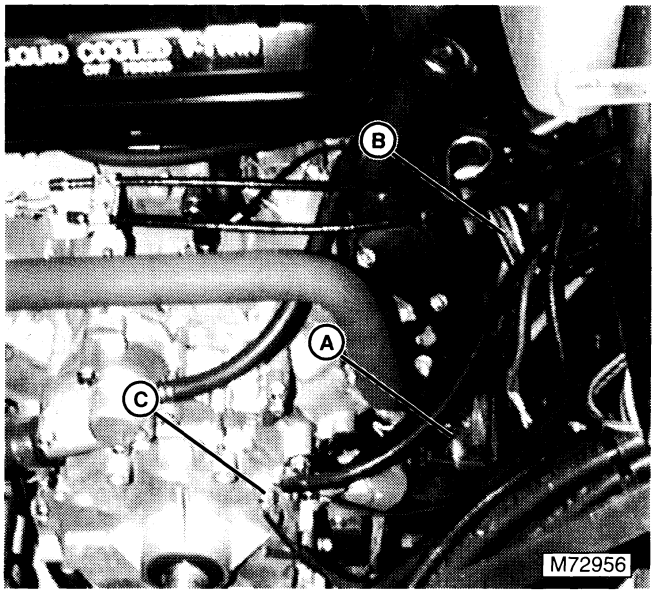
M56498

2. Suspend the thermostat and an accurate thermometer in a container filled with water.
3. Using a heat source, gradually raise the temperature of the water while gently stirring the water.
4. The thermostat should begin opening at **63° - 66° C (145° - 150° F)** and should be fully open at **80° C (176° F).**
5. If the thermostat fails any of these tests, replace it.

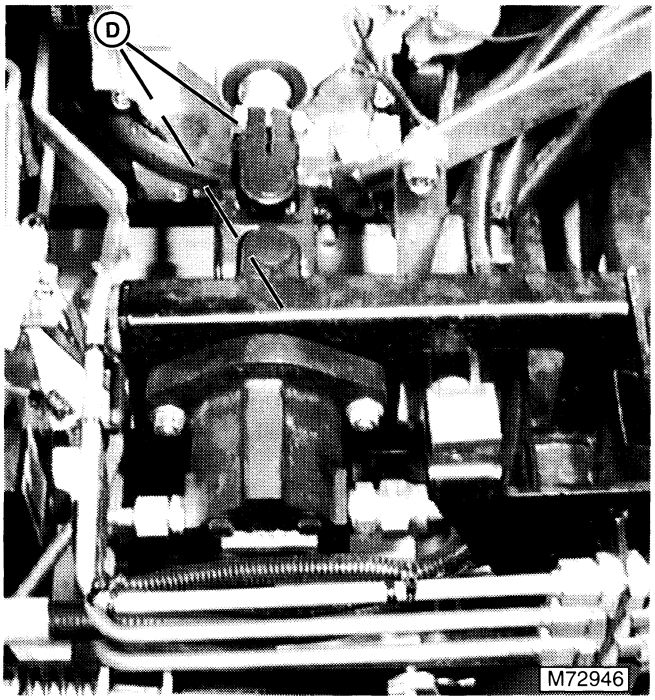
ENGINE SERVICE

REMOVAL

1. Disconnect the battery by removing the NEG(-) cable first.
2. Drain coolant from the radiator, and remove hoses.
3. Remove radiator.
4. Disconnect and plug the fuel line coming from the fuel tank to the carburetor.



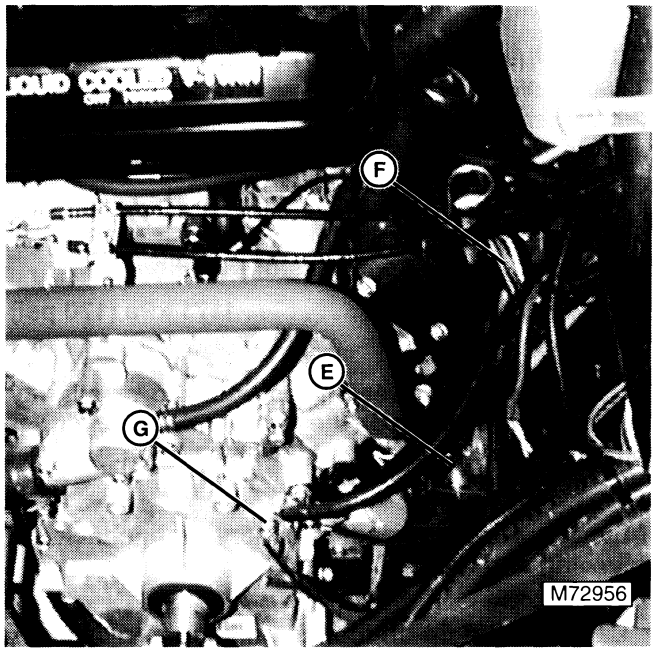
5. Mark for reinstallation disconnect all electrical leads from starter (A).
6. Disconnect engine electrical harness (B).
7. Disconnect ground wires from engine block (C).
8. Disconnect engine choke and throttle cable.



9. Loosen both bolts (D) at reel pump drive shaft U-joint, and slide the U-joint towards the engine.
10. Disconnect hydro U-joint at engine sheave.
11. Remove muffler.
12. Remove four bolts securing engine to vehicle frame.

INSTALLATION

1. Secure engine to vehicle frame with four bolts. Torque to 18 N·m (160 lb-in.)
2. Reconnect hydro U-joint to engine sheave, torque to 35 N·m (27 lb-ft.).
3. Reconnect reel pump U-joint to engine output shaft, torque both both bolts (D) to 35 N·m (27 lb-ft.)



4. Reconnect all electrical leads at starter (E).
5. Reconnect engine electrical harness (F).
6. Reconnect ground wires from engine block (G).
7. Reconnect engine choke and throttle cable.
8. Install radiator, reconnect hoses and fill radiator with equal amounts of anti-freeze and water.
9. Install muffler.
10. Reconnect the battery starting with the POS (+) lead first.

CYLINDER HEADS, VALVES AND PISTONS

COMPRESSION TEST

IMPORTANT: Position spark plugs as far as possible from cylinder head opening to avoid igniting the fuel entering the combustion chamber that is not being tested. Engine must be at full operating temperature, carburetor throttle plate must be blocked open, battery must be fully charged and both spark plugs must be removed and grounded before performing this test.

1. Install the compression tester (JDM59) in one of the spark plug holes.
2. Using the starter motor, crank engine through five compression strokes and record reading.
3. Repeat step on the other cylinder.

Minimum Cylinder Compression Reading

..... 1171 kPa (170 psi)

If the compression reading is equal to or slightly higher than specified, the piston rings, cylinder and valves are probably in good condition.

If the compression reading is very high, check the following and repeat the test:

- **Carbon build-up on the piston head and cylinder head. Remove carbon.**
- **Cylinder head gasket too thin. Remove and replace with proper gasket.**
- **Valve guides and piston rings - rapid carbon accumulation in the combustion chamber may be caused by worn valve guides and/or worn piston oil rings. This may be indicated by blue exhaust smoke.**

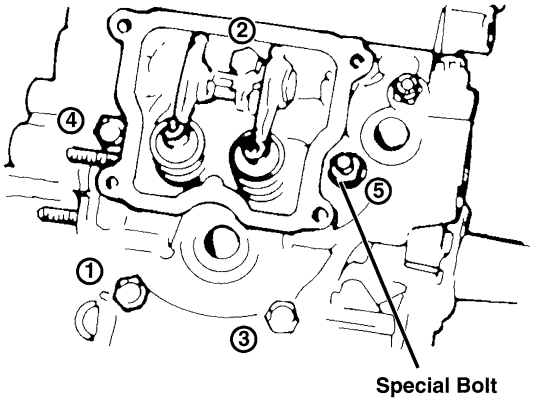
If compression is lower than the minimum specified, check the following:

- **Gas leakage around the cylinder head - replace the damaged gasket and check the cylinder head for warpage.**
- **Burned valve seat.**
- **Improper valve clearance.**
- **Piston/cylinder wear, piston seizure.**
- **Piston ring, piston ring groove.**

CYLINDER HEAD SERVICE

Removal

1. Loosen the cylinder head bolts 1/4 turn at a time, in the sequence shown, to avoid warping the cylinder head.



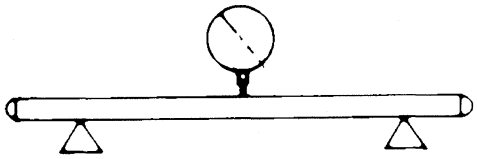
M72915

2. Make note of the special bolt location for reinstalling the cylinder head.
3. Mark the push-rods so they can be reinstalled in there original position during assembly.

PUSH ROD INSPECTION

1. Place the push rod on V-blocks and measure runnout. If runnout exceeds the service limit, replace the push rod.

Push Rod Runnout..... 0.8 mm (0.03 in.)



M50044

CYLINDER HEAD DISASSEMBLY

NOTE: Note the position of all valve mechanism parts so they can be reinstalled in their original position.

1. Remove the circlips from the rocker arm shafts and push the shafts out the same side the circlip was removed from.
2. Remove the spring retainers by applying pressure with your thumbs and sliding the retainer over to a side hole on the retainer.
3. Remove the stem seals and bottom spring retainers.

CYLINDER HEAD CLEANING AND INSPECTION

NOTE: Use tools that will not gouge or damage the cylinder head.

1. Scrape the head to remove carbon deposits or use a de-carboning agent. Clean the head with a suitable solvent and dry with compressed air.
2. Lay a straight edge along the sealing surface of the head and measure the warpage with a thickness gauge at several different points. If warpage exceeds the service limit, repair or replace the cylinder head.

Cylinder Head Warpage
. . . . . 0.06 mm (0.002 in.)

3. Check the cylinder head for cracks.

NOTE: Many cracks cannot be detected visually. Cylinder head may need to be taken to a qualified engine repair shop.

4. Clean and measure the diameter of the rocker arm shaft with a micrometer at several points.If the outside diameter exceeds the service limit, replace the shaft.

Rocker Shaft Outside Diameter
. . . . . .11.949 mm (0.4704 in.)

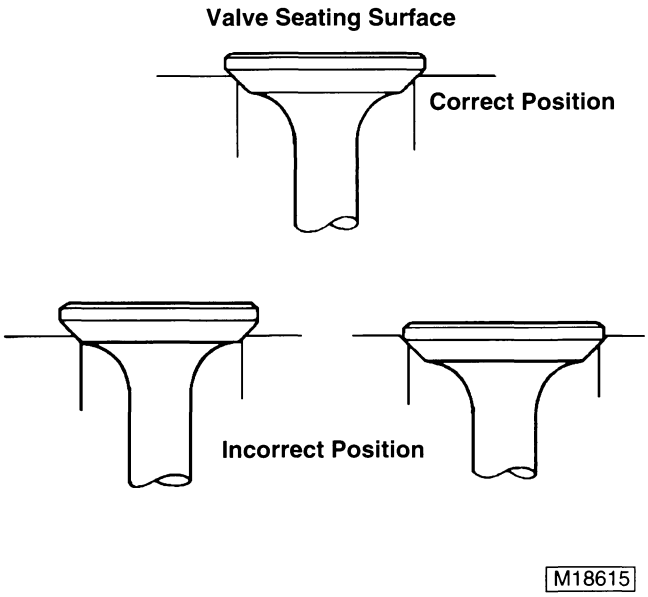
5. Clean and inspect the rocker arm where it contacts the push rod and valve stem. If the contact points are worn or damaged, replace the rocker arm.
6. Measure the inside diameter of the rocker arm bearing at several points using a dial bore gauge or inside micrometer. If the diameter is more than the service limit, replace the rocker arm.

Rocker Arm Inside Diameter
. . . . . 12.074 mm (0.474 in.)

7. Measure the valve guide inside diameter in three places down the length of the guide with a small bore gauge, if the measurement is more than the service limit, replace the cylinder head.

NOTE: Ensure all carbon deposits are removed from valve guide before taking any measurements.

Valve Guide Inside Diameter
Intake: . . . . . 6.045 mm (0.2379 in.)
Exhaust: . . . . . 6.055 mm (0.2384 in.)

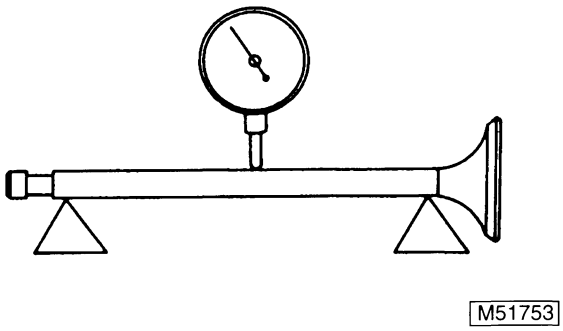


8. Inspect the valve seats for damage. If the seats are warped or distorted beyond reconditioning, replace the cylinder head.
9. Check the valve seating pattern for the correct width and evenness all the way around. Repair if necessary.

Valve Seating Width
. . . . . 0.5 - 1.1 mm (0.02 - 0.043 in.)

10. Clean and measure the valve stem at three points along the length of the stem. If not within specification, replace the valve.

Valve Stem Diameter
Intake: . . . . . 5.945 mm (0.2341 in.)
Exhaust: . . . . . 5.925 mm (0.2332 in.)



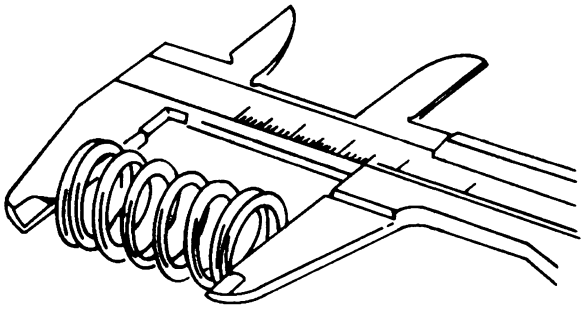
11. Place the valve on V-blocks and measure the runnout, if not within specifications, replace the valve.

Valve Stem Runnout . . . . . 0.05 mm (0.002 in.)

12. Measure the valve head thickness (valve margin). If not within specification, replace the valve.

Valve Margin . . . . . 0.6 mm (0.024 in.)

13. If grinding the valve and valve seat is necessary, follow the tool manufacturer's instructions carefully. Lap the valves after grinding with lapping compound and recheck the valve seating surface for correct width and evenness of the seating pattern.



M50036

14. Inspect the valve spring for pitting, rust and burrs. Measure the spring free length, replace if necessary.

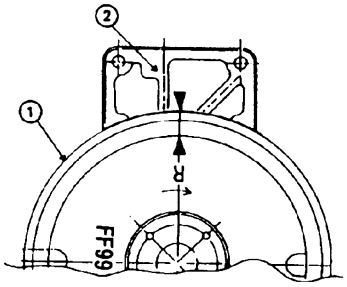
Valve Spring Free Length . . . . . 29.70 mm (1.17 in.)

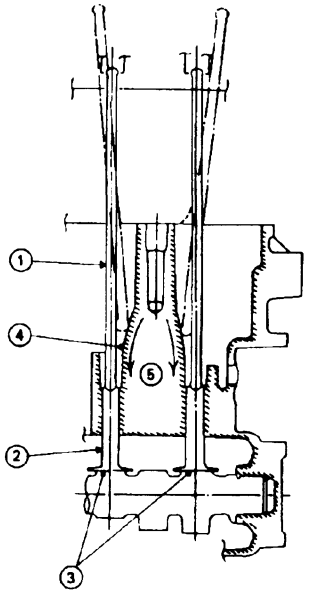
15. Apply clean engine oil to all the contact surfaces and assemble the cylinder head.

Installation

IMPORTANT: Use a torque wrench when tightening the cylinder head bolts.

NOTE: Handle the head gaskets carefully to avoid removing the sealing agents from the surface during handling.





M72916

1. Turn the flywheel (1) clockwise to align the (R) over the timing mark (2), visually check to ensure the cam lobes are at their lowest position, if not, turn the flywheel 360° and align the timing marks again.
2. Install the push-rods in their original positions by sliding them down the inside wall of the crankcase and positioning the push rod on the tappet.

NOTE: Torque should be applied in 3 N•m (27 lb-in.) increments.

3. Tighten the cylinder head bolts to half the required torque. Install the intake manifold before applying a final torque of 21 N•m (186 lb-in.).

VALVE CLEARANCE ADJUSTMENT

NOTE: Valve repairs require readjusting the valve clearance.

1. Turn the crankshaft to align the number 1 or 2 cylinder to Top Dead Center (TDC) of the compression stroke. (described above)
2. Loosen the locknut and valve clearance adjusting screw for the cylinder aligned on TDC.
3. Insert a **0.25 mm (0.01 in.)** thickness gauge between the adjusting screw and the valve stem, tighten the adjusting screw until the thickness gauge begins to bind. (use a sweeping motion with the thickness gauge while tightening the adjusting screw)
4. Hold the adjusting screw in position while tightening the locknut. (Do Not overtighten)
5. Align the other cylinder on TDC and repeat the above steps.

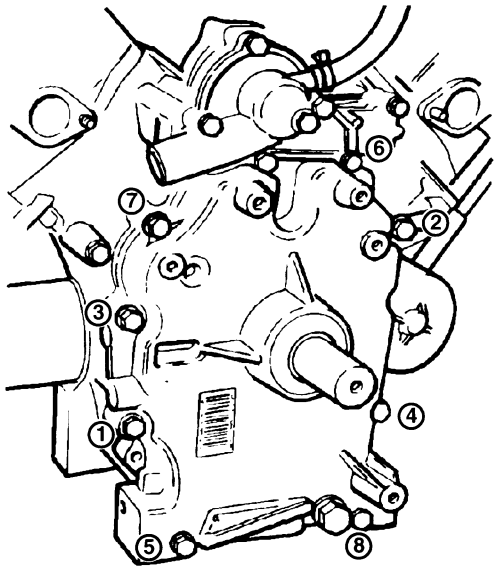
CRANKCASE SERVICE

COVER REMOVAL

Remove the Following:

Muffler
Air Cleaner
Carburetor
Throttle Control Panel
Radiator
Radiator Hoses, Bypass Tube
Water Pump Assembly
Cooling Fan and Brackets
Cylinder Head Assemblies
Oil Filter
Intake Manifold
Flywheel
Stator Coil
Pulser Coils
Ignition Coils
Igniter
Starter Motor
Igniter and Bracket
Oil Drip Tray

1. Unscrew the mounting bolts in the order shown and remove the crankcase cover from the crankcase.



NOTE: There are two knock pins on the crankcase mating surface. A wooden or plastic mallet may be used to gently tap loose the cover.

COVER INSPECTION

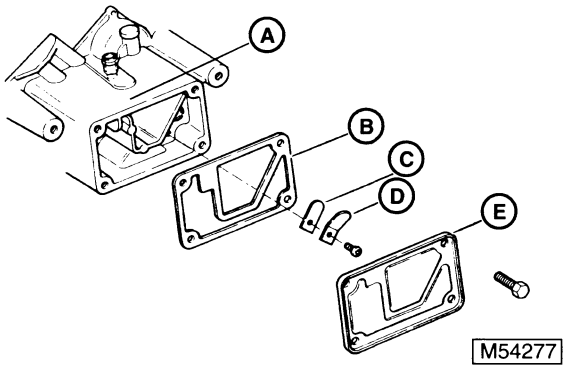
2. Clean the cover with a suitable solvent and dry with compressed air.
3. Measure the inside diameter of the PTO shaft bearing at several points. If the measurement is not within serviceable limits, replace the cover.

PTO Shaft Bearing Inside Diameter
Service Limit: . . . . . 34.066 mm (1.3412 in.)

4. Measure the inside diameter of the camshaft bearing on the crankcase cover at several points. Replace the crankcase cover if measurement is out of serviceable limits.

Camshaft Bearing Inside Diameter
Service Limit: . . . . . 16.068 mm (0.6326 in.)

OIL BREATHER SERVICE



M54277

A - Drain Hole
B - Gasket
C - Reed Valve
D - Back Plate
E - Cover

Inspect the reed valve for breakage, hairline cracks or distortion, replace if necessary.

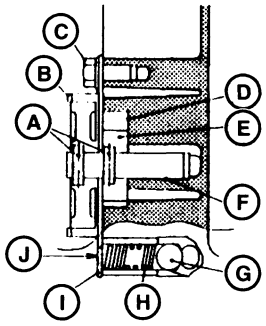
- Inspect the back plate for damage or a rough contact surface, replace if necessary.
- Inspect the valve seating surface for damage, repair if necessary.

OIL PUMP SERVICE

OIL PRESSURE SWITCH TEST

NOTE: Ensure oil level has been checked prior to performing this test.
Engine must be at normal operating temperature to assure accurate test results.

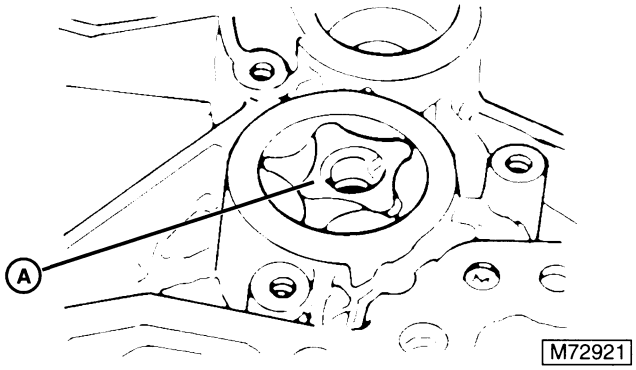
1. Remove the oil pressure switch and install a direct reading oil pressure gauge.
2. Run the engine at fast idle and observe pressure reading.
3. If the oil pressure is not **276 kPa (40 psi) (minimum),** inspect the oil pump and relief valve for defects.
4. If the oil pressure circuit has been tested and the oil pressure limits are at the minimum specified, a Low oil pressure light, when the engine is operating, indicates a defective pressure switch.



M72918

A- Pins
B- Pump Gear
C- Mounting Bolts
D- Outer Rotor
E- Inner Rotor
F- Pump Shaft
G- Relief Valve Ball
H- Spring
I- Pump Cover Plate
J- 6 mm Dia. Hole

1. Visually inspect the pump gear, inner rotor and cover plate. If there is any sign of uneven wear or damage, replace them.



M72921

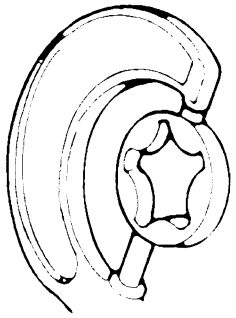
2. Check the clearance (A) between the inner and outer rotor with a feeler gauge. Measure the clearance between the high point of the inner rotor and the high point of the outer rotor. If the measurement exceeds the service limit, replace both rotors as a set.

Inner and Outer Rotor Clearance
Service Limit: . . . . . 0.3 mm (0.012 in.)

Measure the outside diameter of the outer rotor with a micrometer at several points. If the rotor diameter is less than the service limit, replace both rotors as a set.

Outer Rotor Diameter
Service Limit: . . . . . 40.470 mm (1.5933 in.)

0



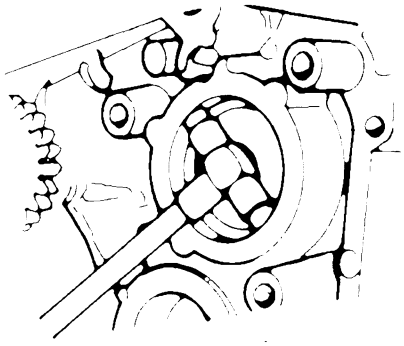
M72919

3. Measure the thickness of the outer rotor at several points. If measurement is less than the service limit, replace both rotors as a set.

Outer Rotor Thickness
Service limit:. . . . . 9.830 mm (0.3870 in.)

4. Measure the inside diameter of the pump housing at several points. If the inside diameter is more than the service limit, replace the cover.

Pump Housing Inside Diameter
Service Limit . . . . . 40.801 mm (1.6063 in.)



M72920

5. Measure the depth of the pump housing at several points. If the measurement exceeds the service limit, replace the cover.

Pump Housing Depth
Service limit:. . . . . 10.230 mm (0.4028 in.)

6. Measure the inside diameter of the pump shaft bearing at several points. If the inside diameter is more than the service limit, replace the cover.

Inside Diameter of Pump Shaft Bearing
Service Limit: . . . . . .11.072 mm (0.4359 in.)

7. Measure the outside diameter of the pump shaft at several points. If the diameter is less than the service limit, replace the pump shaft.

Pump Shaft Diameter
Service Limit: . . . . . 10.923 mm (0.4300 in.)

8. Visually inspect the relief valve spring, steel ball and valve seat in the cover. Remove any varnish deposits with a suitable solvent. If the ball is deformed or has any rough spots that could prevent a perfect seal, replace the valve parts.

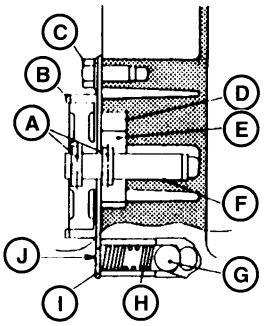
M72922

9. Measure the valve spring free length. If the free length is less than the service limit, replace the valve spring.

Valve Spring Free Length
Service Limit: . . . . . 19.50 mm (0.77 in.)

OIL PUMP INSTALLATION

1. Fill the rotor housing with engine oil for initial lubrication.
2. Install the relief valve ball and spring and then the pump parts assembly (ensure the 6 mm dia. hole in the cover plate is aligned with the center of the relief valve).

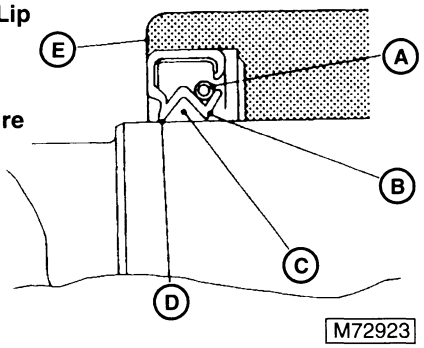


M72918

A- Pins
B- Pump Gear
C- Mounting Bolts
D- Outer Rotor
E- Inner Rotor
F- Pump Shaft
G- Relief Valve Ball
H- Spring
I- Pump Cover Plate
J- 6 mm Dia. Hole

3. Remove the crankshaft oil seal and press in a new seal with the spring loaded lip towards the inside of the engine and flush with the flange surface.

A- Spring Loaded Lip
B- Lip Seal
C- Dust Lip
D- Flange Surface
E- High Temperature Grease

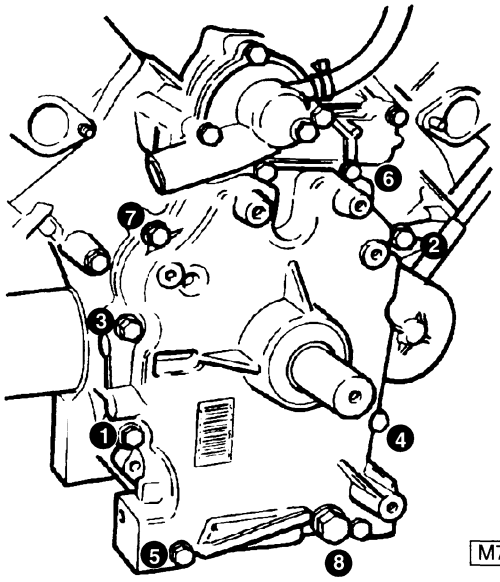


M72923

4. Pack the space between the seal lip and the dust lip with high temperature grease.
5. Ensure the cam gear meshes with the governor gear and the oil pump gear meshes with the crank gear when installing the cover.

IMPORTANT: Do Not force the cover into position.

6. Install the gasket, cover and mounting bolts. Torque mounting bolts in sequence to **21 N•m (15 lb-ft.).**



M72917

CAMSHAFT SERVICE

NOTE: See Crankcase Cover before starting this procedure.

1. Align the punch mark on the crank gear with the projection on the cam gear.
2. Turn the crankcase upside down to let the tappets fall away from the cam lobes.
3. Pull the camshaft out of the crankcase.

Inspection

4. Inspect the camshaft gear for pitting, fatigue cracks, burrs or evidence of improper tooth contact. Replace the shaft if necessary.
5. Inspect the cam lobes for wear, uneven contact or burrs. Replace the shaft if necessary.
6. Measure the height of each cam lobe. Replace the camshaft if measurements are less than the service limit.

Cam Lobe Height
Service Limit: . . . . . .IN. 25.21 mm (0.993 in.)
. . . . . EX. 25.46 mm (1.002 in.)

7. Measure both camshaft journals at several points. If the journal diameter is less than the service limit, replace the camshaft.

PTO Side Journal Diameter
Service Limit: . . . . . 15.907 mm (0.6263 in.)

Flywheel Side Journal Diameter
Service Limit: . . . . . 15.917 mm (0.6267 in.)

8. Measure the inside diameter of the camshaft bearing at several points. Replace the crankcase if the diameter exceeds the service limit.

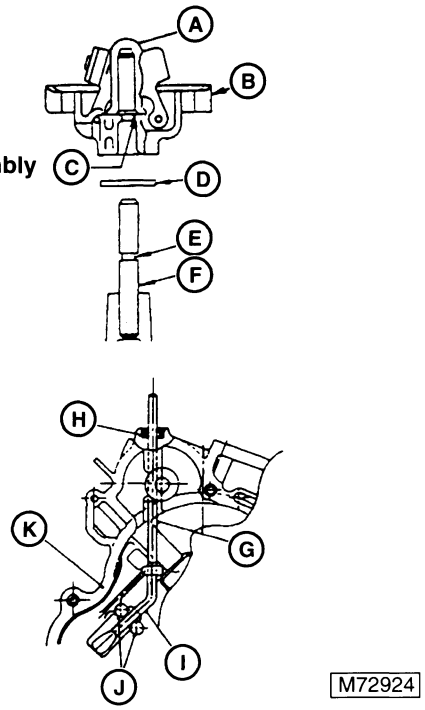
Camshaft Bearing Inside Diameter
Service Limit: . . . . . 16.068 mm (0.6326 in.)

GOVERNOR SERVICE

IMPORTANT: Do not remove governor or governor shaft unless damaged. Removal damages the assembly

1. Remove camshaft

A- Sleeve
B- Governor Assembly
C- Inner Flange
D-Thrust Washer
E- Groove
F- Shaft
G- Governor Shaft
H- Oil Seal
I- Shaft Arm
J- Projections
K- Crankcase



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2. Use two suitable screwdrivers to pry the flyweights from the shaft. Do Not damage the crankcase sealing surfaces.
3. Unscrew the governor arm clamp nut and remove

the governor arm.

4. Turn the governor shaft **1/4 turn** clockwise to remove the shaft.
5. Inspect shaft seal for wear or damage, replace if necessary.
6. Press seal in (lip towards inside of engine) and **1.0 mm (0.04 in.)** below the crankcase surface.
7. Install the governor shaft by properly positioning it between the two projections (4) on the crankcase.

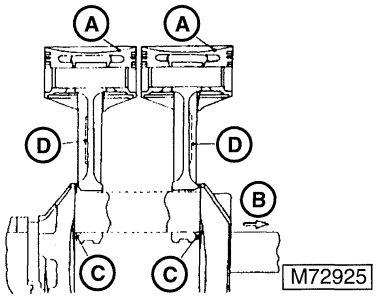
NOTE: Install sleeve into governor and install as an assembly.

8. Push the assembly onto the shaft until it snaps into place. Check the assembly for freedom of movement.

PISTONS AND CYLINDERS SERVICE

REMOVAL AND CLEANING

A- Match Marks
B- Flywheel Side
C- Large Chamfers
D- Raised Letters (MADE IN JAPAN)



IMPORTANT: Note location of the arrow match mark on the piston head in relation to made in japan on the connecting rod. no. 1 piston is opposite no.2. Keep parts together as a set.

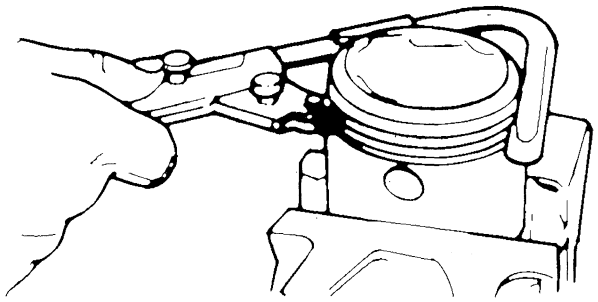
1. Turn the crankshaft to expose the connecting rod end caps. Mark the end caps for reassembly in the same position as removed.
2. Remove carbon and/or ridge from the top of the cylinder bore with a suitable ridge remover and remove the piston and connecting rod through the top of the cylinder bore.

NOTE: Withdraw the piston pin from the same side as the piston pin retaining ring is removed from.

3. Remove the piston pin retaining ring and pin.
4. Scrape the carbon off the piston without damaging the piston surfaces.

IMPORTANT: Be careful not to widen the ring grooves when cleaning. Damaged grooves will require piston replacement.

5. Clean the ring grooves with a suitable ring groove cleaner.



PISTON INSPECTION

Analyzing Piston and Ring Wear:

Rings of the wrong size or rings having improper end gaps will not conform to the shape of the cylinder. This results in high oil consumption and excessive blow-by.

Ring end gaps should be staggered on the piston during installation. End gaps in alignment can cause oil consumption and blow-by.

Light scuffing or scoring of both rings and piston occurs when unusually high friction and combustion temperatures approach the melting point of the piston material.

When this condition exists, it is due to one or more of the following probable causes.

- Engine overheating
- lack of cylinder lubrication
- Improper combustion
- Wrong bearing or piston clearance
- Too much oil in crankcase causing fluid friction

The engine operating at abnormally high temperatures may cause varnish, lacquer or carbon deposits to form in the piston grooves making the rings stick. When this happens, excessive oil consumption and blow-by will occur.

Engine overheating is usually the result of one or more of these conditions.

- Overloading
- Incorrect ignition timing
- Lean fuel mixture
- Lack of coolant
- Incorrect oil
- Low oil supply
- Stale fuel

Vertical scratches across the piston rings are due to an abrasive in the engine. Abrasives may be airborne, may have been left in the engine during overhaul or may be loose lead and carbon deposits.

When this condition exists, check for one or more of the following causes.

- Damaged, collapsed or improperly installed air cleaner
- Loose connection or damaged gasket between air cleaner and carburetor
- Intake manifold leak
- Leak around carburetor throttle shaft or choke shaft
- Failure to remove abrasives from cylinder
- Air entering through breather tube

Dirt in the oil will cause scratches on the oil control ring resulting in high oil consumption.

Oil control ring inner spacer wear or distortion may result in one of these conditions.

- High oil consumption
- Increased deposits in combustion chamber
- Sticking compression rings

Detonation, commonly called pre-ignition, carbon knock, spark knock, pinging or timing knock, is an uneven ignition of the fuel/air mixture across the combustion chamber. Severe damage to pistons valves and cylinder heads can result from detonation. The following is a list of possible causes for detonation.

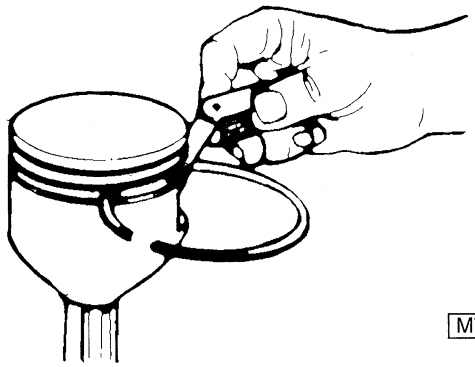
- Lean fuel mixture
- Low octane fuel
- Advanced ignition timing
- Incorrect spark plug (wrong heat range)
- Broken spark plug
- Sharp edges on valves or in combustion chamber
- Overloading
- Higher than normal compression (a result of excessive deposits in the combustion chamber
- Incorrect cylinder head or milling of cylinder head (resulting in high compression)

Improper ring contact or piston contact with the cylinder wall can result from incorrect rod or piston alignment, and /or a bent connecting rod. Diagonal wear patterns and excessive wear on the ring grooves are evidence of this condition. This problem will cause:

- Rapid piston wear
- Uneven piston wear
- Excessive oil consumption
- Catastrophic engine failure

A broken piston pin retaining ring can cause severe damage in the combustion chamber. Common causes are:

- Misaligned or bent connecting rod
- Excessive crankshaft end-play
- Crankshaft journal taper
- Weak retaining rings
- Incorrectly installed retaining rings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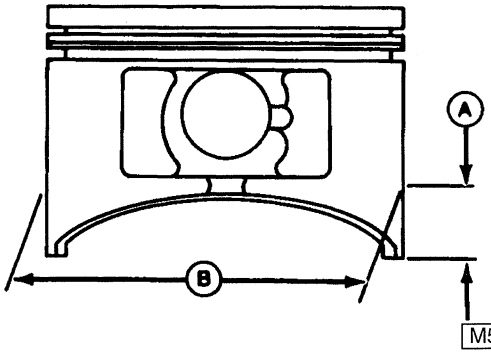
6. Measure the top and second ring groove clearance by inserting a new piston ring in the groove at several locations and measuring the gap between the ring and the ring land with a thickness gauge. Replace the piston if the gap exceeds the service limit.

Piston/Ring Groove Clearance

Top . . . . . 0.15 mm (0.006 in.)
Second . . . . . 0.12 mm (0.005 in.)

NOTE: The oil ring is a three piece assembled ring. It is too difficult to measure the ring groove clearance, visually inspect only.



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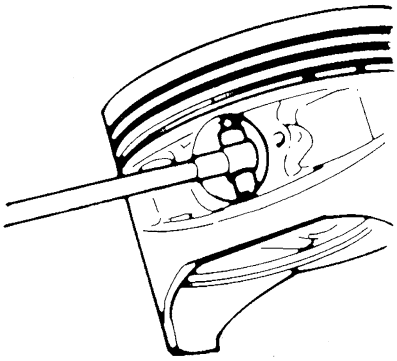
7. Measure the outside diameter (B) of the piston 11 mm (0.43 in.) (A) up from the bottom of the piston at a right angle to the direction of the piston pin hole. If the measurement is less than the service limit, replace the piston.

Piston Diameter
Service Limit: . . . . . 75.875 mm (2.9872 in.)

8. Measure the inside diameter of the piston pin hole at several locations using a dial bore gauge. If not within service limits, replace the piston.



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Piston Pin Hole Inside Diameter
Service Limit: . . . . . 17.041 mm (0.6709 in.)

9. Measure the inside diameter of the small end of the connecting rod at several points. If the inside hole is more than the service limit, replace the connecting rod.

Connecting Rod Small End Inside Diameter
Service Limit: . . . . . 17.051 mm (0.6713 in.)

10. Measure the diameter of the piston pin at several points with a micrometer. If the outside diameter is less than the service limit, replace the piston pin.

Piston Pin Outside Diameter
Service Limit: . . . . . 16.975 mm (0.6683 in.)

11. Measure the ring thickness at several points around the ring. If any ring is not within the service limits, replace the entire set of rings.

Piston Ring Thickness

Top. . . . . 1.12 mm (0.044 in.)
Second . . . . . 1.12 mm (0.044 in.)

12. Deglaze the cylinder bore with a rigid hone, 220 to 300 grit stone. Use hone according to the hone manufacturer's recommendations to obtain a 40° - 60° crosshatch pattern.

IMPORTANT: Do Not use solvents to remove the abrasives from the cylinder wall.

13. Use hot soapy water to wash the cylinder and rinse with clean water. Wipe dry with a clean, lint free white cloth until the cloth shows no sign of discoloration. Apply clean engine oil to the cylinder after cleaning.
14. Position each ring (one at a time) near the bottom of the cylinder bore, use a piston to square the ring in the cylinder.

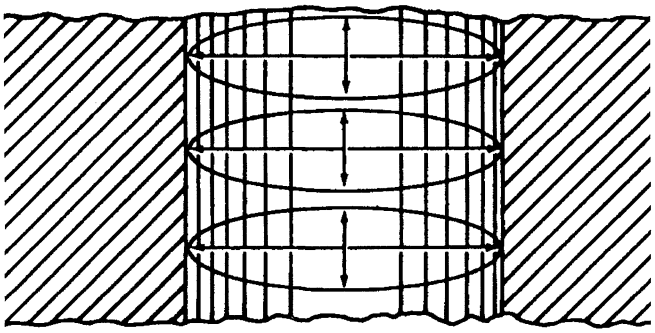
IMPORTANT: Piston ring end gap must be checked, even when using new rings.

15. Measure the end gap between the ends of the ring. If the end gap is greater than the service limit, replace the entire set of rings or, if new, obtain the proper size rings.

Piston Ring End Gap

. . . . . Top, second1.2 mm (0.05 in.)
. . . . . Oil1.5 mm (0.06 in.)

16. Measure the cylinder bore parallel with the crankshaft at right angles to the crankshaft. Measure at the top, middle and bottom of the ring travel.
17. Replace the crankcase or rebore the cylinder if it is not within service limits.



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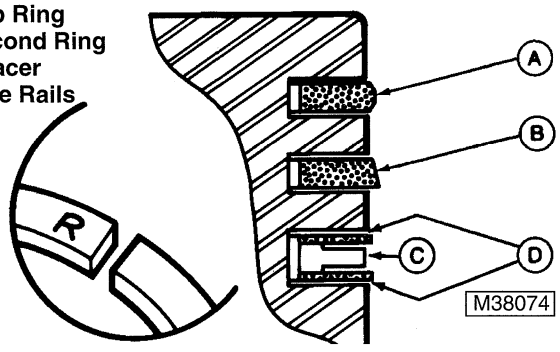
Cylinder Bore Specifications

Standard . . . . . 75.98 - 76.00 mm (2.994 - 2.995 in.)
Wear Limit. . . . . 76.07 mm (2.997 in.)
0.50 mm. . . . . .76.500 mm (3.0118 in.)
Wear Limit. . . . . 76.567 mm (3.0144 in.)

PISTON RING INSTALLATION

IMPORTANT: Ensure the piston has been properly cleaned and inspected and the correct size rings and pistons are obtained before accomplishing this procedure.

A - Top Ring
B - Second Ring
C - Spacer
D - Side Rails



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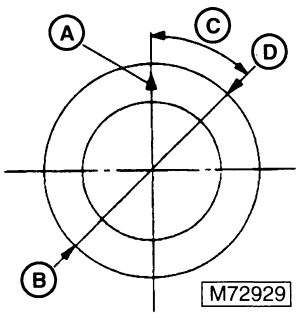
1. Install the spacer (C) in the oil ring groove first and ensure the spacer ends butt together.
2. Install the steel rails (D) above and below the spacer with the end gaps positioned 180° apart.
3. Install the chrome-plated top ring and second ring with the "N" mark facing up. Align the piston and ring end gaps as shown. SEE NEXT PAGE.

A- Arrow Match Mark
B- Top Ring End Gap, Upper Side Rail End Gap
C- 45°
D- Second Ring End Gap, Lower Side Rail End Gap



CYLINDER BORING

NOTE: Always resize to exactly 0.25 mm (0.01 in.),or 0.5 mm (0.02 in.), or 0.75 mm (0.03 in.) over the standard bore size. if this is done accurately, the stock oversize rings and pistons will fit perfectly and the proper clearance will be maintained.
Resizing the cylinder bore can be done by a reliable repair shop or by using a drill press and honing tool.
Use the stone recommended by the hone manufacturer to produce the correct cylinder wall finish.

1. Machine bore the cylinder first to the initial bore diameter and use a hone to finish bore the cylinder.

NOTE: Be sure to use the correct stone and ensure it is serviceable.

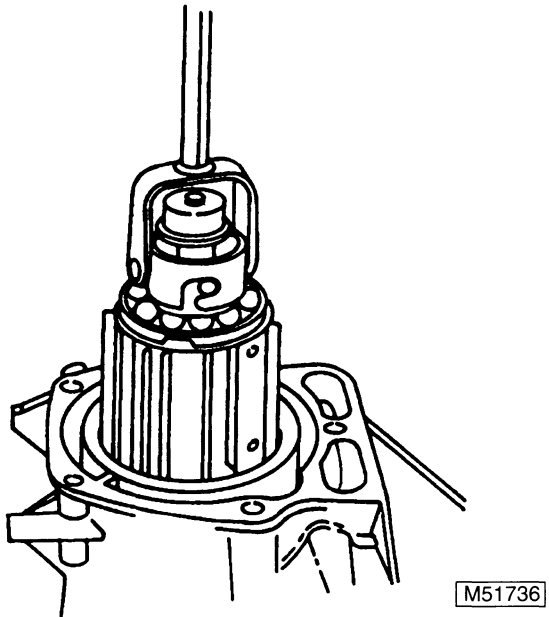
Initial Bore Diameter

Oversize	Bore Diameter
0.50 mm	76.480 - 76.460 mm (3.0110 - 3.0102 in.)

Final Bore Diameter

Oversize	Bore Diameter
0.50 mm	76.500 - 76.480 mm (3.0118 - 3.0110 in.)

2. Clean the cylinder to remove burrs and any pieces of gasket that may be left after removing the head gasket.
3. Securely anchor the cylinder to the drill press table.
4. Align the center of the cylinder bore to the press center. Set the press to operate at 200 - 250 rpm.
5. Connect the hone to the drive shaft and set the stop on the drill press so the hone can only extend 20 - 25 mm (3/4 - 1.0 in.) above the top or below the bottom of the cylinder bore.



6. Rotate the adjusting nut (knob) on the hone until the stone just contacts the cylinder wall at the narrowest point. (if the hone cannot be turned by hand, it is too tight and must be loosened)
7. Ensure that the hone and cylinder centers are aligned with the drill press and driveshaft centers. Pour honing oil inside the cylinder while honing. Start the drill press and move the hone up and down approximately 20 cycles per minute
8. Check the diameter of the cylinder often during the honing process.
9. Hone the cylinder until it is about **0.007 - 0.009 mm (0.0003 - 0.0004 in.)** larger to allow for shrinkage when the cylinder cools.

IMPORTANT: Do Not use solvents to remove the abrasives from the cylinder wall.

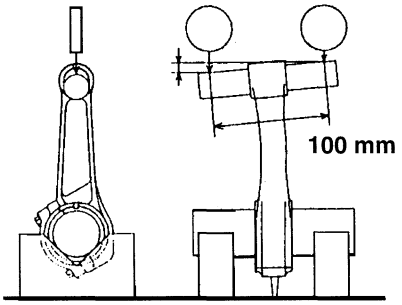
10. Use hot soapy water to wash the cylinder and rinse with clean water. Wipe dry with a clean, lint free white cloth until the cloth shows no sign of discoloration. Apply clean engine oil to the cylinder after cleaning.

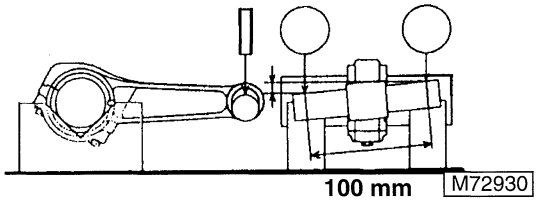
CONNECTING ROD BEND AND TWIST INSPECTION

1. Select an arbor of the same diameter as the connecting rod big end, insert it and place the arbor on V-blocks that rest on a surface plate.
2. Select an arbor (100 mm long) and the same size as the piston pin.
3. With the arbors installed and the connecting rod held vertically, measure the difference in height of the small end arbor above the surface plate over a 100 mm length to determine the amount of bend in the

connecting rod. If the connecting rod bend exceeds the service limit, the connecting rod must be replaced.

Connecting Rod Bend
Service Limit: . . . . . 0.15/100 mm (0.006/3.94 in.)





4. With the big end still on the V-blocks, hold the connecting rod horizontally and measure the amount that the small end arbor varies from being parallel with the surface plate over a 100 mm length of the arbor to determine the amount of connecting rod twist.

Connecting Rod Twist
Service Limit: . . . . . 0.15/100 mm (0.006/3.94 in.)

5. Measure the connecting rod big end width, if the measurement is less than the service limit, replace the connecting rod.

Connecting Rod Big End Width
Service Limit: . . . . . 21.20 mm (0.83 in.)

6. Assemble the connecting rod and end cap and torque to 21 N•m (186 lb-in.).
7. Measure the inside diameter of the big end at several points. If the measurement is larger than the service limit, replace the connecting rod.

Connecting Rod Big End Inside Diameter
Service Limit: . . . . . 34.055 mm (1.3407 in.)

CRANKSHAFT INSPECTION

1. Measure the crankpin journal at several points (A). If the measurement is less than the service limit, replace the crankshaft.

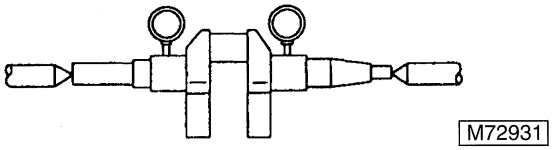
Crank Pin Outside Diameter
Service Limit: . . . . . 33.297 mm (1.3357 in.)

2. Measure the crank pin width (C). If the measurement exceeds the service limit, replace the crankshaft.

Crank Pin Width
Service Limit: . . . . . 44.5 mm (1.75 in.)

3. Set the crankshaft in alignment jig or on V-blocks. Place a dial gauge on both bearing journals.
4. Turn the crankshaft slowly and record the highest and lowest dial gauge readings. The difference between the highest and lowest readings (TIR), is the amount of runnout.
5. If the measurement exceeds the service limit, replace the crankshaft.

Crankshaft Runnout
Service Limit: . . . . . 0.05 mm (0.002 in.)

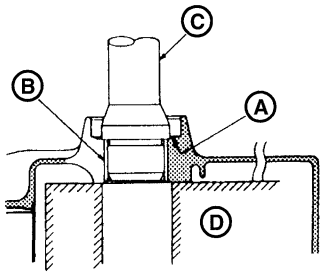


6. Measure the inside diameter of the crankshaft journal bearing at several points. Replace the journal bearing if the inside diameter is more than the service limit.

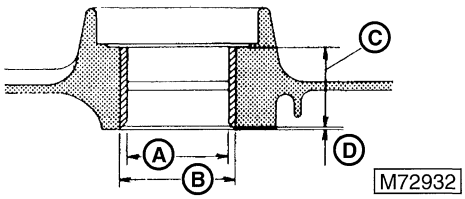
Crankshaft Bearing Journal inside Diameter
Service Limit: . . . . . .34.114 mm (1.3431 in.)

Journal Bushing Replacement

1. The service bushing is to be reinstalled using a bushing tool as shown.
2. Coat the bushing and flange surface with a light film of oil, Press in the new bushing flush with the flange surface.
3. No finish reaming is required.



A- Flange Surface
B- New



4. To Design a Bushing Tool

Bushing Inside Diameter (MIN)
. . . . . 33.997 mm (1.3385 in.)
Housing Inside Diameter (MIN)
. . . . . 38.0 mm (1.4961 in.)
Bushing Width
. . . . . 26.0 mm (1.02 in.)
Bushing Counter Sunk
. . . . . 1.0 mm (0.04 in.)

CRANKSHAFT, CONNECTING ROD AND CAMSHAFT INSTALLATION

IMPORTANT: Ensure your work area is clean, dirt in an engine will shorten the life expectancy and result in expensive repairs. Use "lint free" shop rags and have plenty of clean engine oil available when assembling the engine.

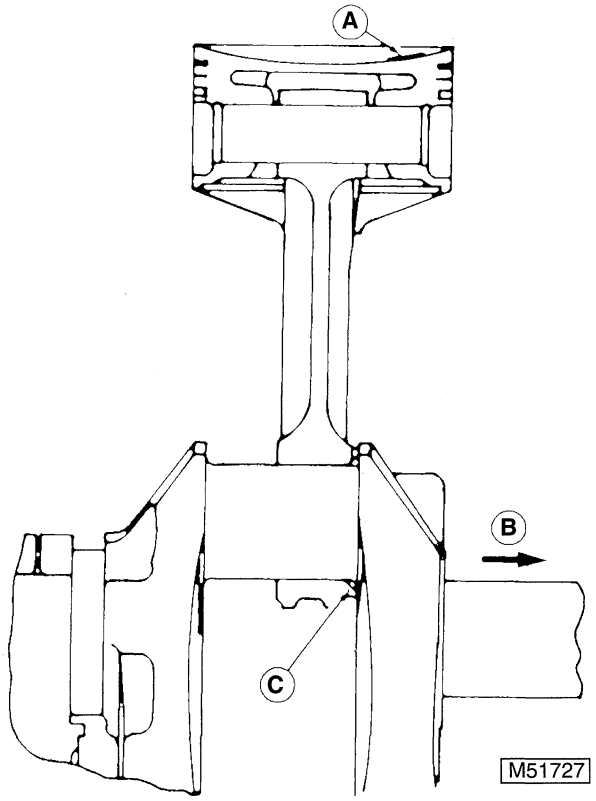
CRANKSHAFT INSTALLATION

1. Pack high temperature grease into the oil seal of the crankcase.
2. Apply engine oil to the journal and bearing.
3. Carefully insert the crankshaft flywheel end into the main bearing and oil seal being careful not to damage the oil seal.
4. Install the crankshaft woodruff key into the crankshaft taper.

CONNECTING ROD ASSEMBLY AND INSTALLATION

IMPORTANT: Never re-use piston pin snap-rings. Removal weakens and deforms them.

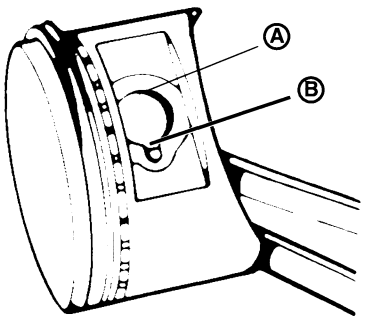
1. Apply engine oil to the piston pins and assemble the pistons to the connecting rods as follows.



- Align the arrow match mark on the No. 1 piston head with the raised letters (MADE IN JAPAN) on the connecting rod.
- Align the arrow match mark on the No.2 piston head with the opposite letters (MADE IN JAPAN) on the connecting rod.

NOTE: Compress piston pin snap-rings just enough to install it and no more.

2. Install piston pin snap-rings. ensure the snap-ring opening (A) does not coincide with the notch (B) in the edge of the piston pin hole.



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3. Apply engine oil to the piston skirt and the cylinder bore.

NOTE: Compress piston rings just enough to install the pistons and no more. Lightly tap the piston with a plastic mallet.

4. Using a piston ring compressor, insert the piston and connecting rod into the cylinder (Arrow match mark (A) facing the flywheel (B) side).
5. Apply a light film of oil to cap bearing surface and cap screws. Install connecting rod cap with chamfer (C) facing crank web. Tighten cap screws alternately to 21 N•m (186 lb-in.).

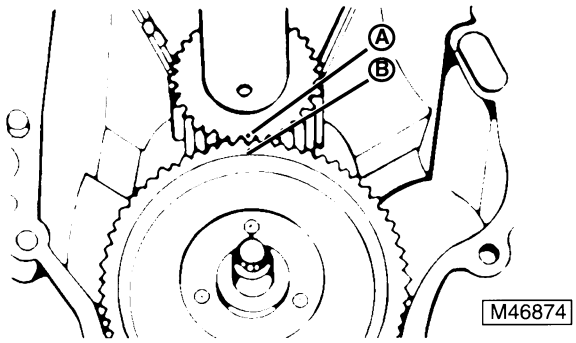
TAPPET AND CAMSHAFT INSTALLATION

1. Lubricate and install tappets in their original positions.

Apply Engine Oil To The Following

- Tappet Journal
- Camshaft Journal
- Cam Lobe Surface
- Camshaft Gear

2. Install camshaft and align the punch mark on the crank gear with the projection on the camgear.



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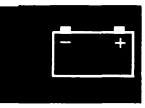


SPECIFICATIONS

Voltage

Unregulated	26 VAC @ 3400 rpm
Regulated	12.2-14.7 VDC @ 3400 rpm

Amperage

Regulated	15 Amps @ 3400 rpm

Ignition System

Type	Transistor Controlled
Pulsers	85-270 ohms/Resistance
Ignition Coils	
Primary Resistance	3.4-4.6 ohms
Secondary Resistance	10.4-15.5 K ohms

Battery

Voltage	11.8-13.2 VDC
Reserve Capacity @ 25 Amps	80 min.
Cold Cranking Amps @ -18^{O}C (0^{O}F)	430 CCA

Electric Starter

Minimum Brush Length	6 mm (.240 in.)
Maximum No-load Starter Draw	30 Amps at 6000 rpm (min)
Starter Draw (Loaded)	72 Amps

THEORY OF OPERATION INFORMATION

The theory of operation stories divide the electrical system into individual circuits by function. Each circuit is isolated from the main wiring schematic and only shows the components that are used in it. The story contains information on function, operating conditions, and theory of operation. The circuit schematics are drawn with the components in the operating position, with the power, or battery positive, into them across the top and the ground, or battery negative, across the bottom.

DIAGNOSTIC INFORMATION

The diagnostic procedures is used to test the complete circuit regardless of the problem or complaint. Select a symptom or system from the quick check or troubleshooting chart and follow the test procedures under that heading.

The diagnostic procedure lists:

- Test conditions
- Test sequence
- Test location
- Normal reading
- Check or test to perform if reading is not normal

When performing the test or check, be sure to set your machine up to the test conditions listed and follow the sequence carefully. The middle **"NORMAL"** column gives the reading or condition that should be obtained when performing the test or check. If the results of the test or check are not normal, perform the test, check, or adjustment listed in the third **"IF NOT NORMAL"** column to repair the malfunction. The detailed tests or adjustments referred to in the **"IF NOT NORMAL"** column are located at the end of that group. The system diagram that accompanies each test procedure is drawn to resemble machine components. The key number on the art matches the number in the **"TEST LOCATION"** column and the arrow points to the exact point the test is to be made.

COMMON CIRCUIT TESTS

Shorted Circuit:

A shorted circuit may result in the wrong component operating (i.e. improper wire-to-wire contact). To test for a shorted or improperly wired circuit:

1. Turn component switch ON.
2. Start at the controlling switch of the component that should not be operating.
3. Follow the circuit and disconnect wires at connectors until component stops operating.
4. Shorted or improper connections will be the last two wires disconnected.

High Resistance or Opened Circuit:

High resistance or open circuits usually result in slow, dim or no component operation (i.e. poor, corroded, or disconnected connections). Voltage at the component will be low when the component is in operation. To test for high resistance and open circuits:

1. Check all terminals and grounds of the circuit for corrosion.
2. If terminals are not corroded or loose, the problem is in the component or wiring.

Grounded Circuit:

Grounded circuits usually result in no component operation or a blown fuse.

WIRE COLOR CHART

WIRE COLOR ABBREVIATION	WIRE COLOR
Blu	Blue
Blu/Blk	Blue/Black
Blu/Red	Blue/Red
Blk	Black
Blk/Wht	Black/White
Blk/Yel	Black/Yellow
Brn	Brown
Brn/Wht	Brown/White
Brn/Yel	Brown/Yellow
Clr	Clear
Dk Blu	Dark Blue
Dk Brn/Lt Grn	Dark Brown/Light Green
Dk Brn/Red	Dark Brown/Red
Dk Brn/Yel	Dark Brown/Yellow
Dk Grn	Dark Green
Grn	Green
Grn/Wht	Green/White
Gry	Gray
Lt Blu	Light Blue
Lt Grn	Light Green
Org	Orange
Org/Wht	Orange/White
Pnk	Pink
Pur	Purple
Pur/Blk	Purple/Black
Pur/Wht	Purple/White
Red	Red
Red/Blk	Red/Black
Red/Blu	Red/Blue
Red/Wht	Red/White
Red/Yel	Red/Yellow
Tan	Tan
Wht	White
Wht/Blk	White/Black
Wht/Blu	White/Blue
Wht/Red	White/Red
Yel	Yellow
Yel/Blk	Yellow/Black
Yel/Red	Yellow/Red
Yel/Wht	Yellow/White

READING ELECTRICAL SCHEMATICS

The schematic is made up of individual circuits laid out in a sequence of related functions. It is formatted with all power wires (A) across the top and all ground wires (B) across the bottom. Current flow is generally from top to bottom through each circuit and component. All components are shown in the OFF position. The diagram does not list connector (C) information unless needed to avoid confusion. If the connector is shown, the number next to it is the terminal pin location (D) in the connector.

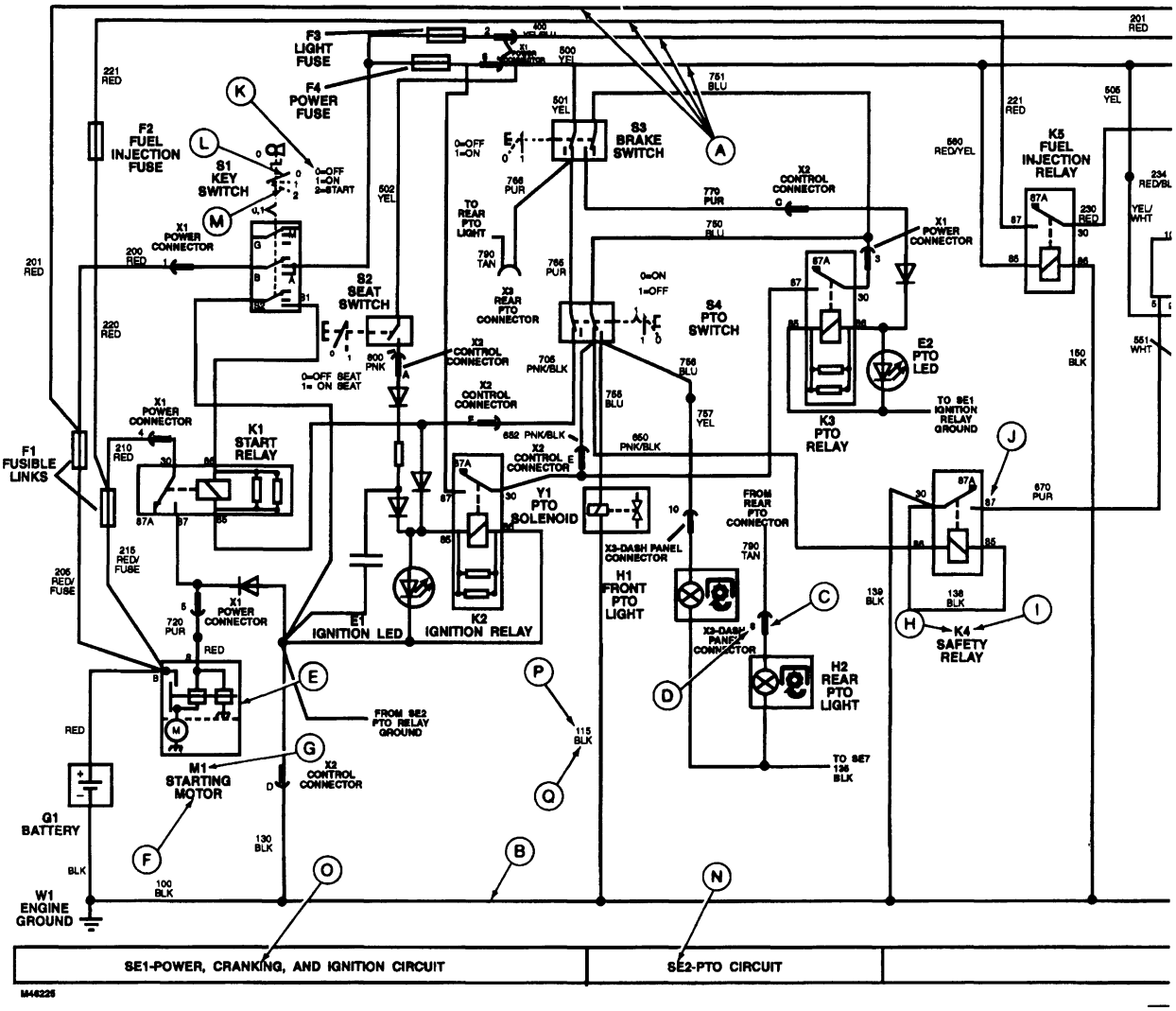
Each component is shown by a symbol (E), its name (F), and an identification code (G). The identification code contains a device identifying letter (H) and number (I).

The identifying letter is always the same for a specific component, but the identifying numbers are numbered consecutively from upper left to lower right. The terminal designation (J) is placed directly outside the symbol next to the connecting wire path. Switch positions (K) are also placed directly outside the symbol. The solid line (L) shows the position the switch is currently in and dash lines (M) represent other switch positions.

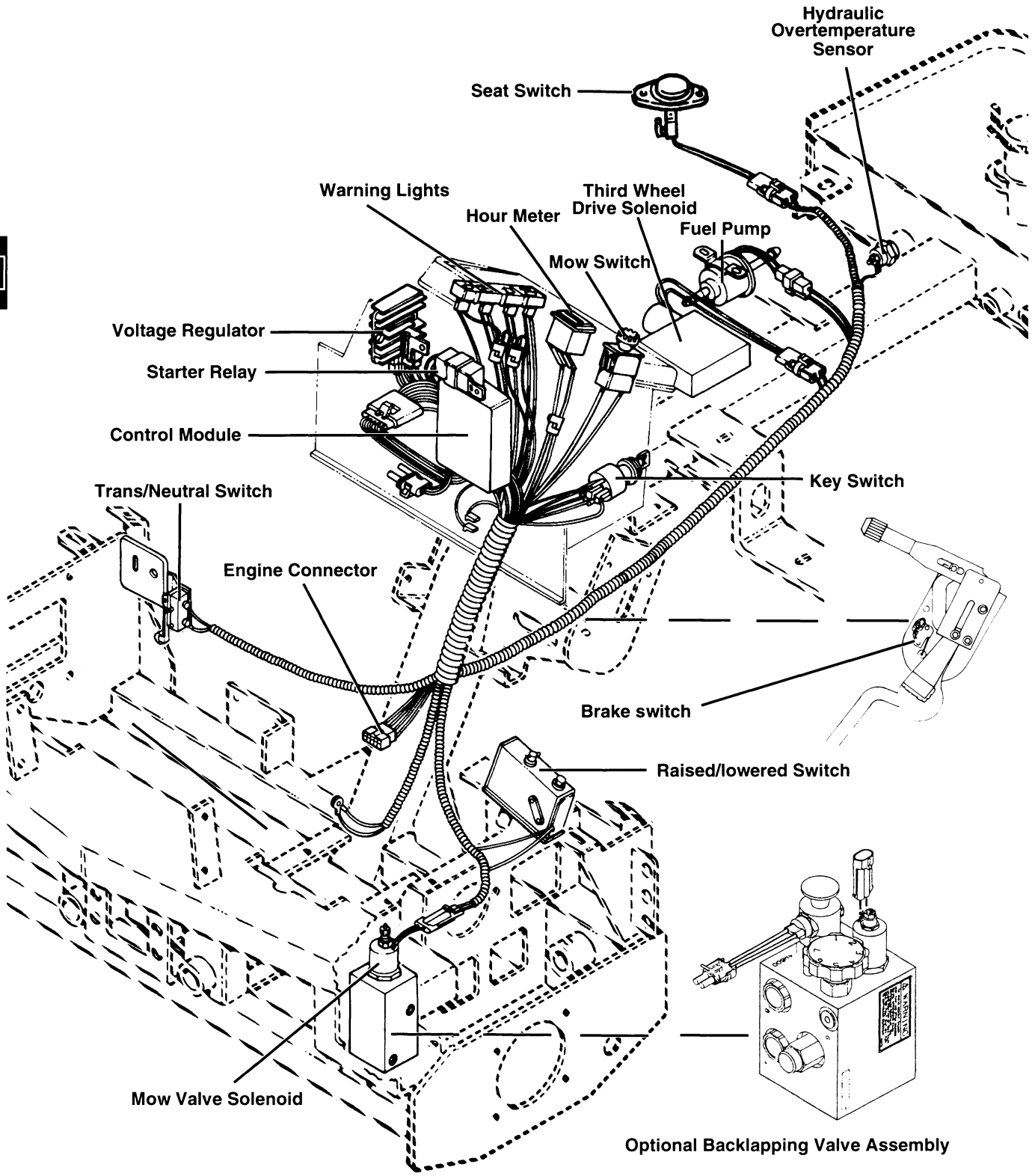
Each circuit is identified at the bottom of the drawing by a section number (N) and section name (O).

The circuit number (P) and wire color (Q) of the wires are shown directly next to the wire path.

The same component name and identification code are used consistently on all diagrams in this section. Components can be easily cross-referenced.



COMPONENT LOCATION



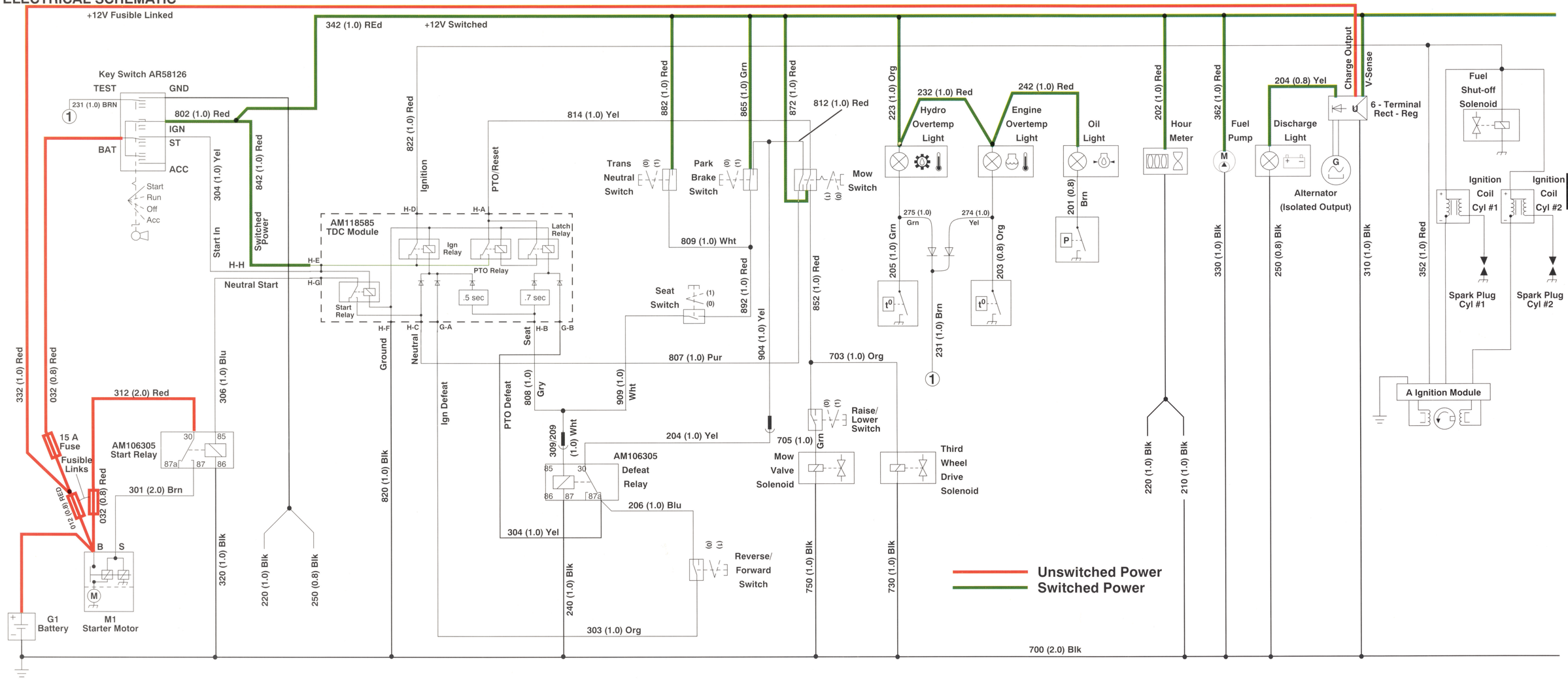
M72860

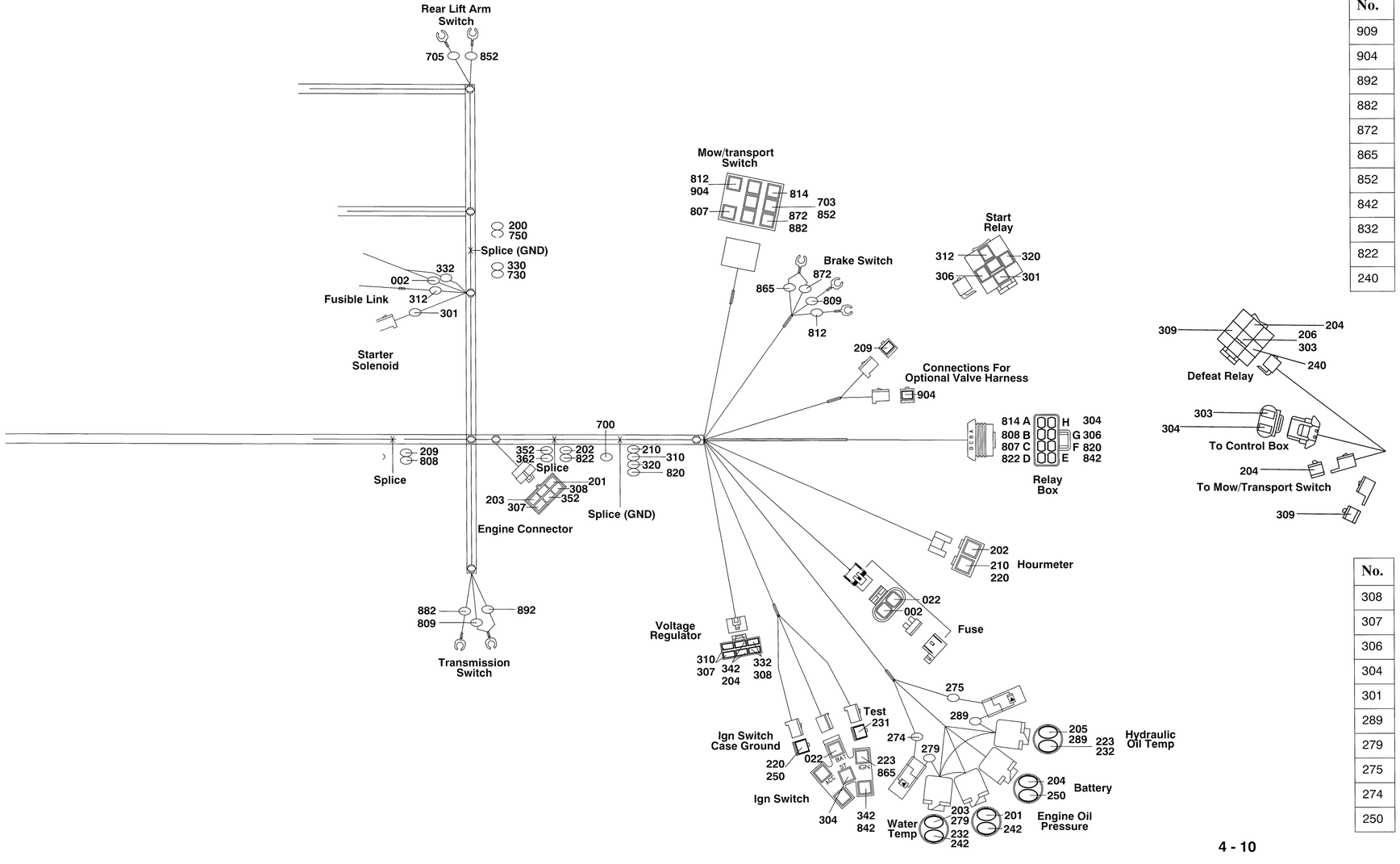
TROUBLESHOOTING

Problem or Symptom / Check or Solution	Engine Will Not Crank	Engine Cranks But Will Not Start	Engine Stops When Mow Switch Is Engaged During Backlapping	Cutting Units Will Not Operate During Backlapping	Engine Stops When Parking Brake Is Released	Battery Warning Light Illuminated During Fast Idle Operation	Coolant Overtemperature Light Does Not Illuminate When Starting	Hydro Ovetemperature Light Does Not Illuminate When Starting	Cutting Units Will Not Operate	Third Wheel Drive Not Operating	Engine Cranks Slowly	Starter Rotates But Does Not Turn Engine	Starter Rotates With Ignition Switch "Off"	Loss Of Power	Engine Misses At Low rpm
Transmission Not In Neutral Or Trans/ neutral Switch Is Defective	●														
Park Brake Not Set Or Park Brake Switch Is Defective	●		●	●											
Mow Switch Is On Or Mow Switch Is Defective	●														
Control Module Start Relay Defective	●														
Start Relay Defective	●														
Starter Motor Defective	●	●				●					●				
Control Module Ignition Relay Defective		●													
Loose Or Dirty Electrical Connections	●	●	●	●	●	●	●	●	●	●	●				
Fusible Link Defective	●														
15 Amp Fuse Defective	●														
Micro Switch On Forward/reverse Knob Defective				●											
Mow Switch Or Wiring Defective			●							●					

Problem or Symptom / Check or Solution	Engine Will Not Crank	Engine Cranks But Will Not Start	Engine Stops When Mow Switch Is Engaged During Backlapping	Cutting Units Will Not Operate During Backlapping	Engine Stops When Parking Brake Is Released	Battery Warning Light Illuminated During Fast Idle Operation	Coolant Overtemperature Light Does Not Illuminate When Starting	Hydro Ovetemperature Light Does Not Illuminate When Starting	Cutting Units Will Not Operate	Third Wheel Drive Not Operating	Engine Cranks Slowly	Starter Rotates But Does Not Turn Engine	Starter Rotates With Ignition Switch "Off"	Loss Of Power	Engine Misses At Low rpm
Defeat Relay Defective			●												
Seat Switch Defective					●										
Park Brake Switch Defective	●				●										
Test Circuit Defective							●	●							
Rear Lift Arm Switch Defective									●						
Mow Valve Solenoid Defective									●						
Third Wheel Drive Solenoid Defective										●					
Battery Weak Or Discharged	●	●									●				
Defective Starter Solenoid	●														
Defective Ignition Switch	●														
Engine Defective Or Seized	●										●				
Incorrect Starter Alignment												●			
Faulty Clutch															
Faulty Pinion Return Mechanism													●		
Worn Pinion Or Ring Gear												●			

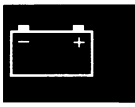
ELECTRICAL SCHEMATIC





No.
909
904
892
882
872
865
852
842
832
822
240

No.
308
307
306
304
301
289
279
275
274
250



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THEORY AND DIAGNOSIS

CRANKING CIRCUIT OPERATION:

Function:

To energize the starter solenoid and engage the starter motor.

Operating Conditions:

To crank the engine, the following conditions must be met:

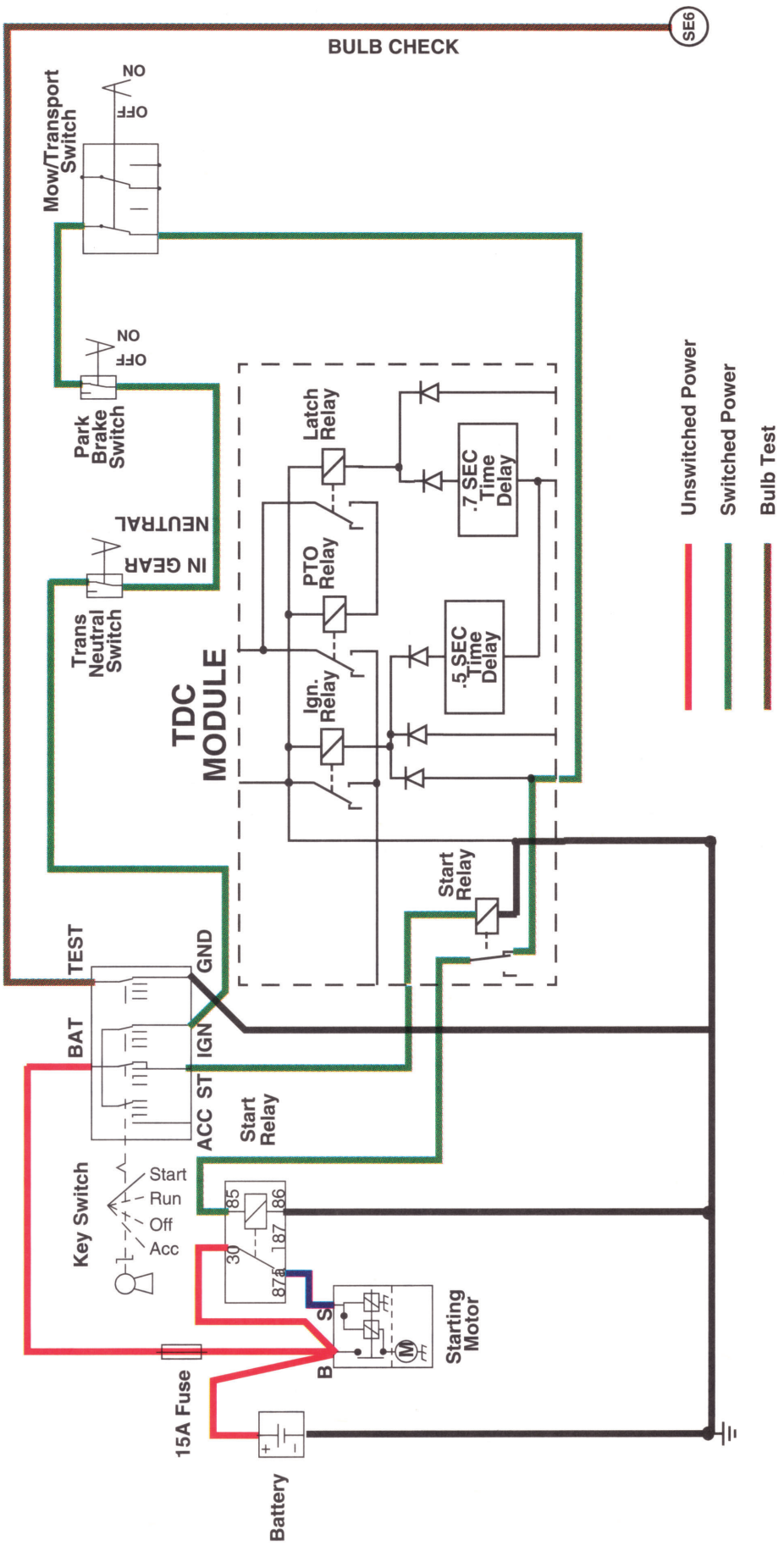
- Key switch in the START position.
- Travel pedal must be in NEUTRAL position.
- Mow switch must be in the OFF position.
- Parking brake ON.

Theory of Operation:

The battery is connected to a tie point at the starter, the key switch is also connected to the same tie point through a 15 amp fuse. When the key switch is turned to the START position, the starter relay, located inside the TDC module is energized. 12 V switched power is also available at the transmission neutral switch through the ignition switch in the START or RUN position. If the transmission is in NEUTRAL, voltage flows to the park brake switch. With the park brake engaged, voltage flows through the mow switch (OFF position) to the main contacts of the starter relay inside the TDC module.

Voltage then flows through the main contacts of the starter relay, that is already energized from the key switch and energizes the starter solenoid. This allows voltage coming directly from the battery to energize the starter motor and crank the engine.

NOTE: In addition to the cranking circuit, a bulb check circuit for the Hydro overtemp and Engine coolant overtemp lights is completed when the key switch is in the START position.


SE6
BULB CHECK
Mow/Transport Switch
NO
OFF
Park Brake Switch
NEUTRAL
IN GEAR
Trans Neutral Switch
TDC MODULE
Latch Relay
.7 SEC Time Delay
PTO Relay
.5 SEC Time Delay
Ign. Relay
Start Relay
TEST
GND
BAT
IGN
ACC
ST
Start Relay
Key Switch
Start
Run
Off
Acc
85
86
30
87
87a
S
B
Starting Motor
15A Fuse
Battery
Unswitched Power
Switched Power
Bulb Test
CRANKING CIRCUIT

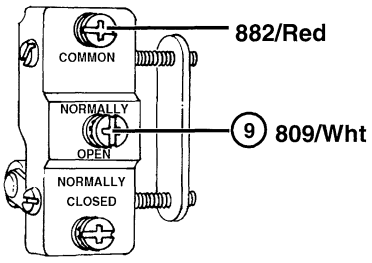
CRANKING CIRCUIT TEST POINTS

Test Conditions:

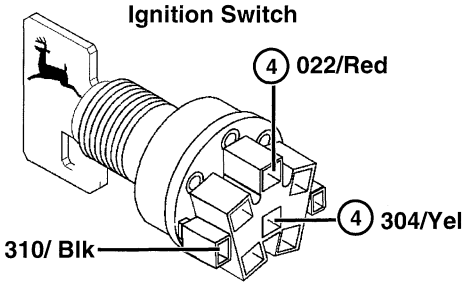
- Mow switch "OFF"
- Ignition switch "START"
- Park brake engaged
- Transmission in Neutral

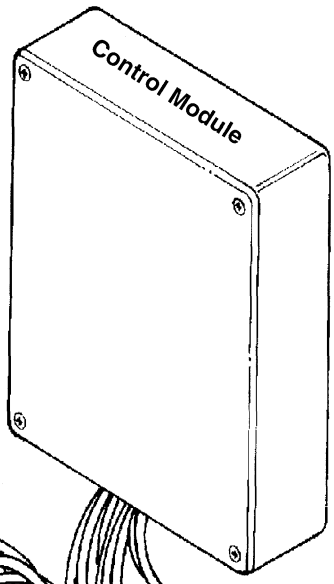
Test/Check Point	Normal	If Not Normal
1. Starter positive terminal	11.8 - 13.2 volts	Check battery connections and test battery
2. Fuse	11.8 - 13.2 volts	Test 032/Red, fusible link, and 002/ Red and fuse connections
3. Fuse	11.8 - 13.2 volts	Replace fuse
4. Ignition switch	11.8 - 13.2 volts	Test 022/red
5. Ignition switch	11.8 - 13.2 volts	Check ignition switch connections/ Replace switch
6. Control module	11.8 - 13.2 volts	Test 304/Yel to the start switch
7. Mow switch	11.8 - 13.2 volts	Ensure mow switch is OFF, test switch, test 812/Red between the mow switch and the park brake switch
8. Park brake switch	11.8 - 13.2 volts	Adjust or repair brake switch, test 809/Wht between the brake switch and the trans/neutral switch
9. Trans/neutral switch	11.8 - 13.2 volts	Adjust or repair trans/neutral switch. test 882/Red to the mow switch and 872/red to the brake switch and 865/Grn to the key switch.
10. Control module	11.8 - 13.2 volts	Test 820/Blk connections, if good, replace module with a known good module and test again
11. Start relay	11.8 - 13.2 volts and a clicking sound when ignition switch is placed to "START"	If no voltage is present, test 306/ Blu, if voltage is present and no clicking sound is heard, test 320/Blk and relay.
12. Start relay	11.8 - 13.2 volts	Test 012/Red, fusible link, and 312/ Red
13. Start relay	11.8 - 13.2 volts	Test or replace relay
14. Starter solenoid	11.8 - 13.2 volts	Test 301 BRN

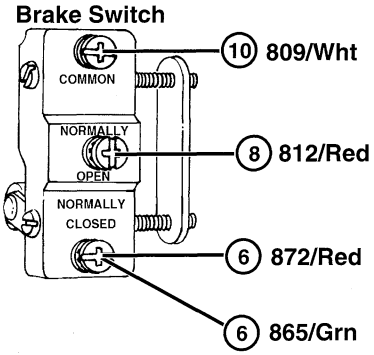
NOTE: These tests do not determine if ground connections are defective. To test the ground connections, connect the POS terminal of a voltmeter to the POS terminal of the battery and connect the NEG terminal of the voltmeter to the ground terminals. Battery voltage should be indicated, if not, test the ground wire, splice points and grounding points on the frame. Repair as necessary.

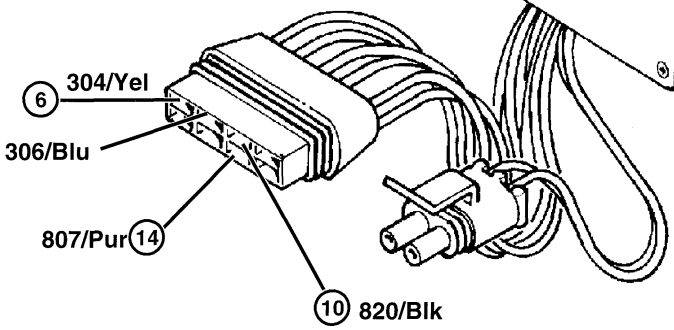


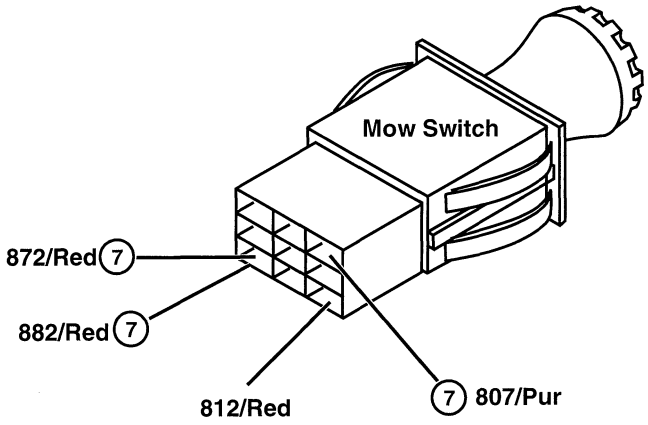
Transmission Neutral Switch

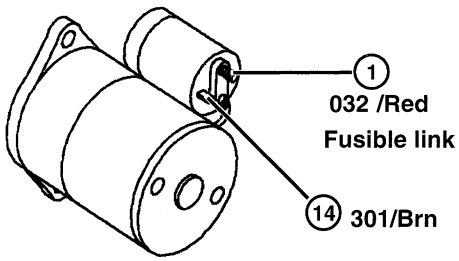


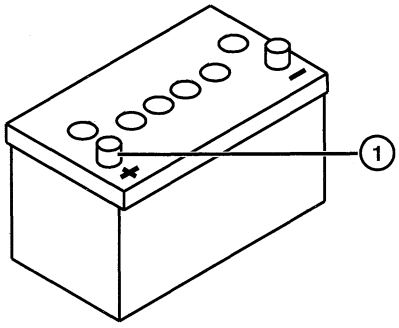


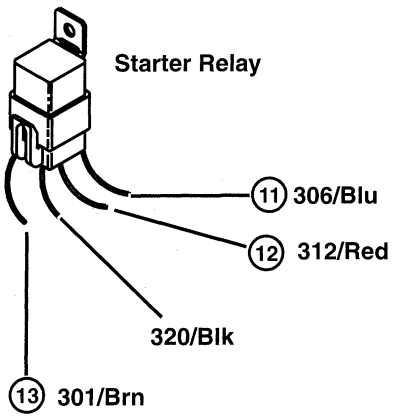


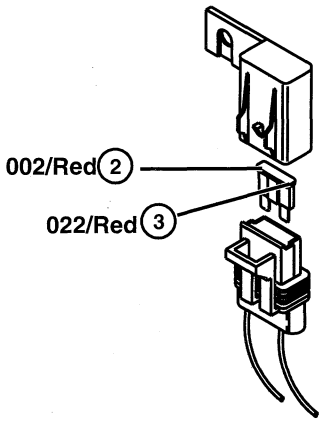












IGNITION (RUN) CIRCUIT OPERATION - OPERATOR ON SEAT

Function:

With an operator on the seat, allows the engine to run after it has cranked (starter disengaged).

Operating Conditions:

For the engine to continue to run, the following conditions must be met:

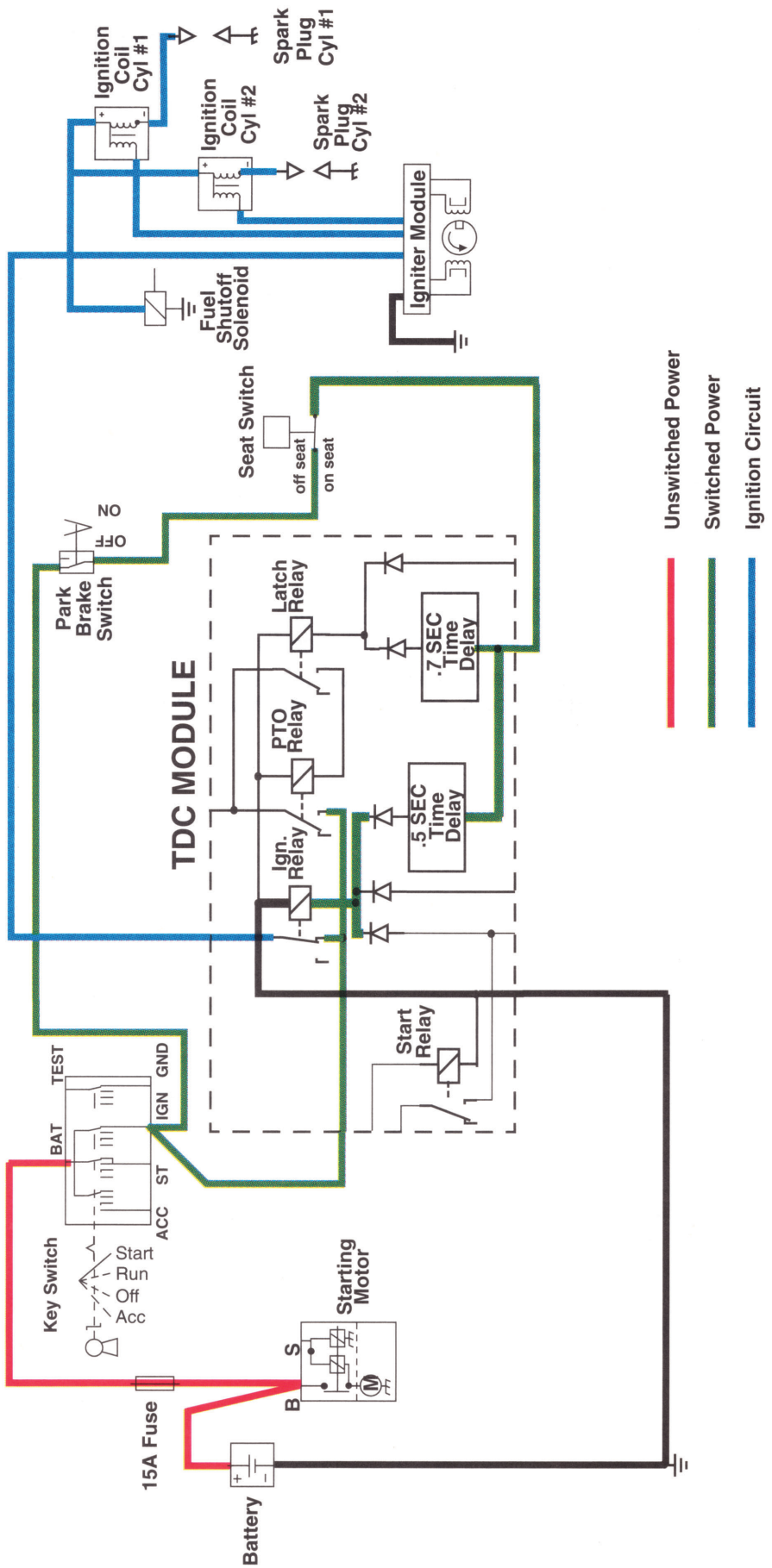
- Key switch in the RUN position.
- Operator on seat and parking brake OFF or operator on seat and travel pedal in NEUTRAL.

Theory of Operation:

With the key switch in the RUN position and operator on the seat, voltage flows from the Key Switch through the transmission neutral switch (NEUTRAL), the seat switch (operator on seat) and into the TDC Module. voltage then flows through a .5 sec. delay timer and energizes the Ignition Relay.

If the transmission is in gear, voltage flows from the Key Switch through the park brake switch (OFF), the seat switch (operator on seat) and into the TDC Module. Voltage then flows through a .5 sec. delay timer and energizes the Ignition Relay.

Either situation allows voltage coming from the key switch to flow through the main contacts of the ignition relay and to the igniter module, ignition coils, and fuel shutoff solenoid creating spark and providing fuel flow, allowing the engine to run.



IGNITION (RUN) CIRCUIT - OPERATOR ON SEAT

IGNITION (RUN) CIRCUIT OPERATION - OPERATOR OFF SEAT

Function:

With an operator off the seat, allows the engine to run after it has cranked (starter disengaged).

Operating Conditions:

NOTE: These conditions are separate from the backlapping mode of operation.

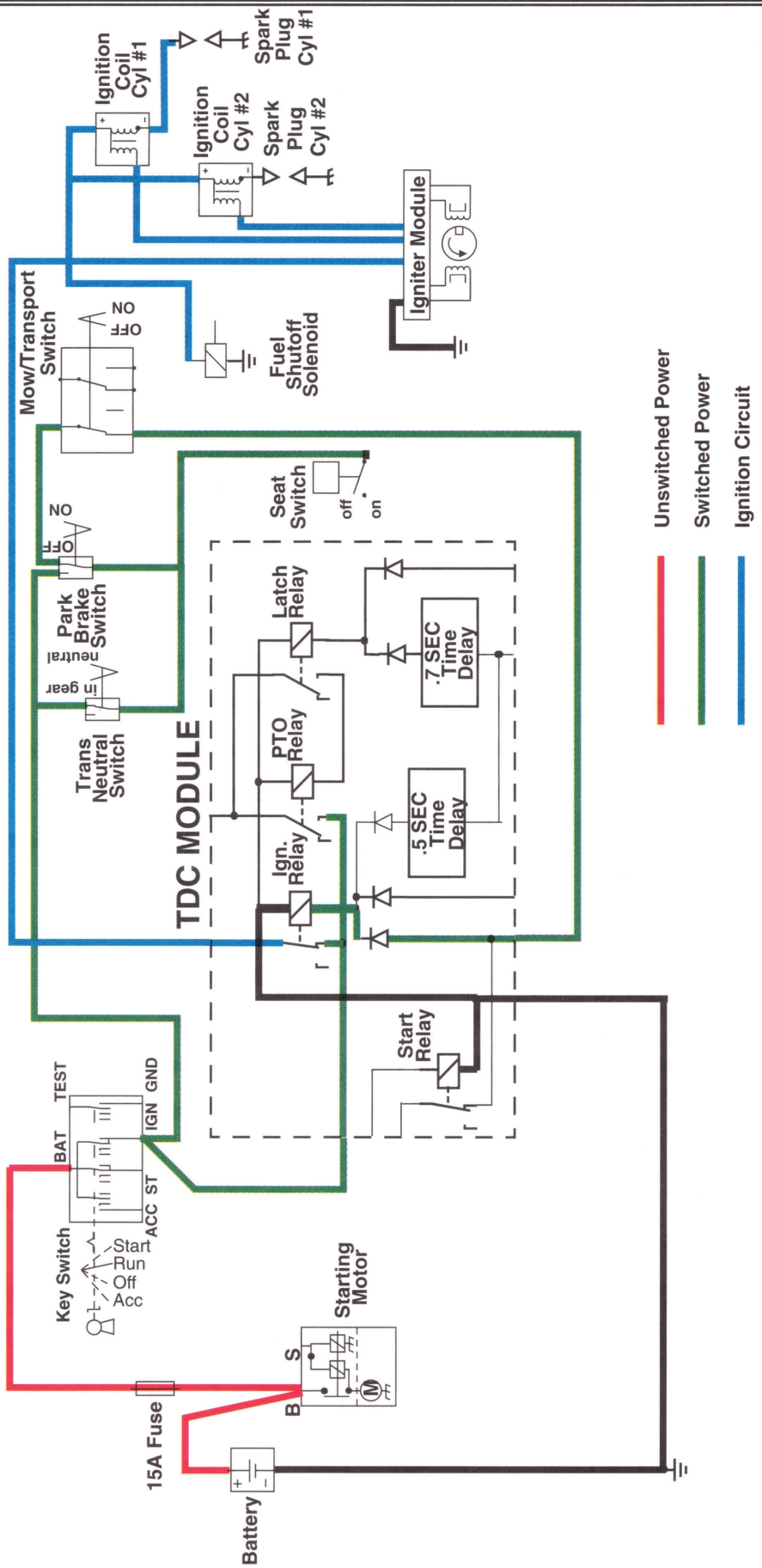
For the engine to continue to run, the following conditions must be met:

- Key switch in the RUN position.
- Travel pedal must be in NEUTRAL position.
- Mow switch must be in the OFF position.
- Operator off seat and parking brake ON.

Theory of Operation:

With the key switch in the RUN position and operator off the seat, voltage flows from the key switch through the transmission neutral switch, the park brake switch (ON) and mow switch (OFF). Voltage then flows into the TDC module, by-passing the .5 second time delay and activating the ignition relay.

This creates a path for the voltage coming from the key switch to pass through the main contacts of the ignition relay and on to the ignition module, ignition coils, and the fuel shutoff solenoid creating spark and providing fuel flow, allowing the engine to run.



IGNITION (RUN) CIRCUIT - OPERATOR OFF SEAT

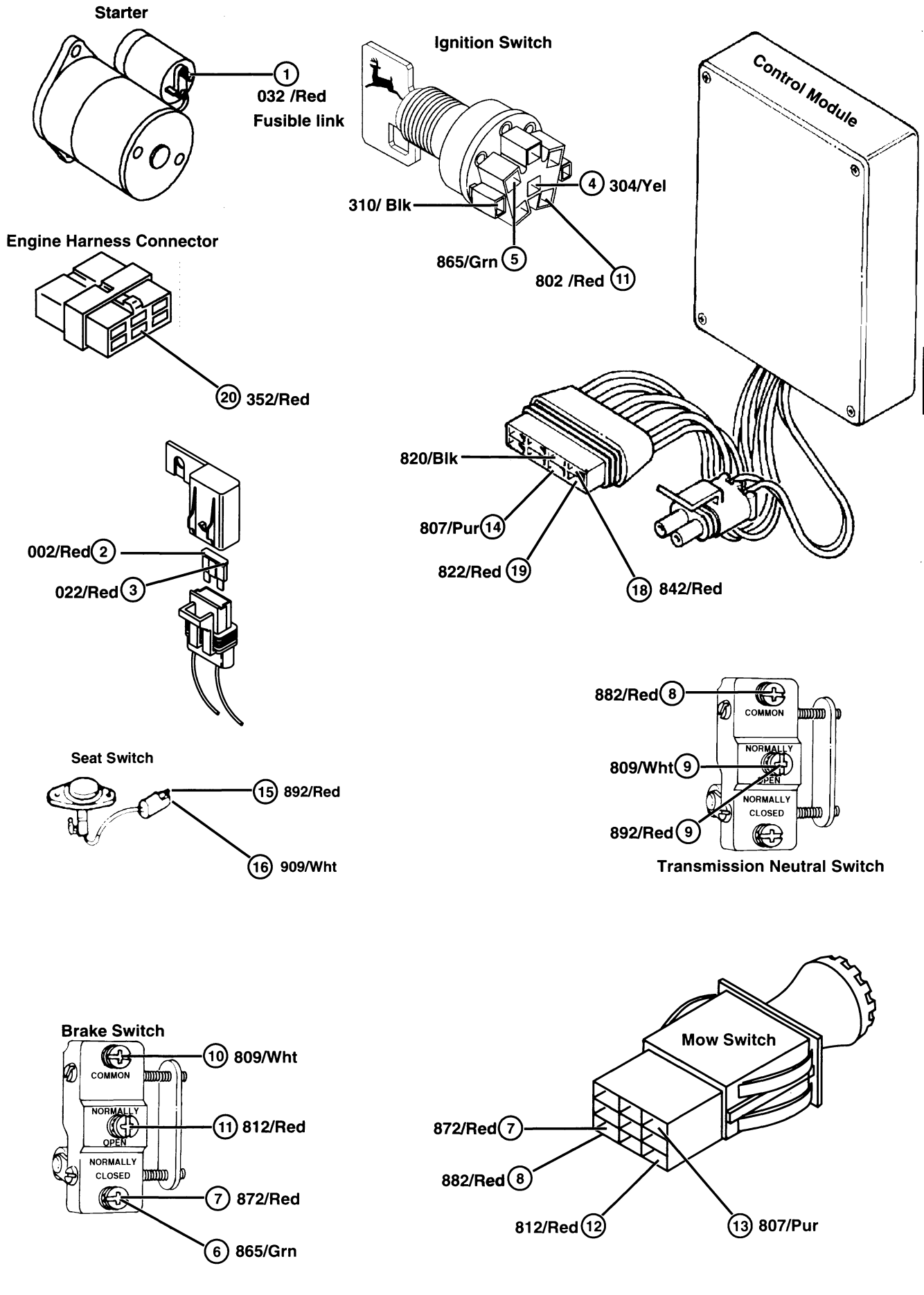
IGNITION CIRCUIT TEST

Test Conditions:

- Engine cranks
- Park brake engaged
- Operator off seat
- Battery fully charged
- Transmission in NEUTRAL
- Ignition switch in RUN position

Test/Check Point	Test/Check Point	Test/Check Point
1. Starter positive terminal	11.8 - 13.2 volts	Check battery connections and test battery
2. Fuse	11.8 - 13.2 volts	Test 032/Red, fusible link, and 002/Red and fuse connections
3. Fuse	11.8 - 13.2 volts	Replace fuse
4. Ignition switch	11.8 - 13.2 volts	Test 022/Red
5. Ignition switch	11.8 - 13.2 volts	Check ignition switch connections/Replace switch
6. Brake switch	11.8 - 13.2 volts	Test 865/Grn
7. Mow switch	11.8 - 13.2 volts	Test 872/Red
8. Transmission neutral switch	11.8 - 13.2 volts	Test 882/Red
9. Transmission neutral switch	11.8 - 13.2 volts	Adjust switch and retest/Test or replace switch
10. Brake switch	11.8 - 13.2 volts	Test 809/Wht
11. Brake switch	11.8 - 13.2 volts	Adjust switch and retest/Test or replace switch
12. Mow switch	11.8 - 13.2 volts	Test 812/Red
13. Mow switch	11.8 - 13.2 volts	Ensure switch is OFF/Test or replace switch
14. Control module	11.8 - 13.2 volts	Test 807/Pur
15. Seat switch	11.8 - 13.2 volts	Test 892/Red
16. Seat switch (depressed)	11.8 - 13.2 volts	Replace switch
17. Control module	11.8 - 13.2 volts	Test 808/Gry and 909/Wht
18. Control module	11.8 - 13.2 volts	Test 802/Red and 842/Red
19. Control Module	11.8 - 13.2 volts	Test or replace control module
20. Engine harness connector	11.8 - 13.2 volts	Test 822/Red and 352/Red

NOTE: These tests do not determine if ground connections are defective. To test the ground connections, connect the POS terminal of a voltmeter to the POS terminal of the battery and connect the NEG terminal of the voltmeter to the ground terminals. Battery voltage should be indicated, if not, test the ground wire, splice points and grounding points on the frame. Repair as necessary.


Starter
1
032 /Red
Fusible link
Ignition Switch
4 304/Yel
310/ Blk
865/Grn 5
802 /Red 11
Control Module
Engine Harness Connector
20 352/Red
820/Blk
807/Pur 14
822/Red 19
18 842/Red
002/Red 2
022/Red 3
882/Red 8
COMMON
809/Wht 9
NORMALLY OPEN
NORMALLY CLOSED
892/Red 9
Transmission Neutral Switch
Seat Switch
15 892/Red
16 909/Wht
Brake Switch
10 809/Wht
COMMON
NORMALLY OPEN
11 812/Red
NORMALLY CLOSED
7 872/Red
6 865/Grn
Mow Switch
872/Red 7
882/Red 8
812/Red 12
13 807/Pur

IGNITION CIRCUIT TEST CONTINUED

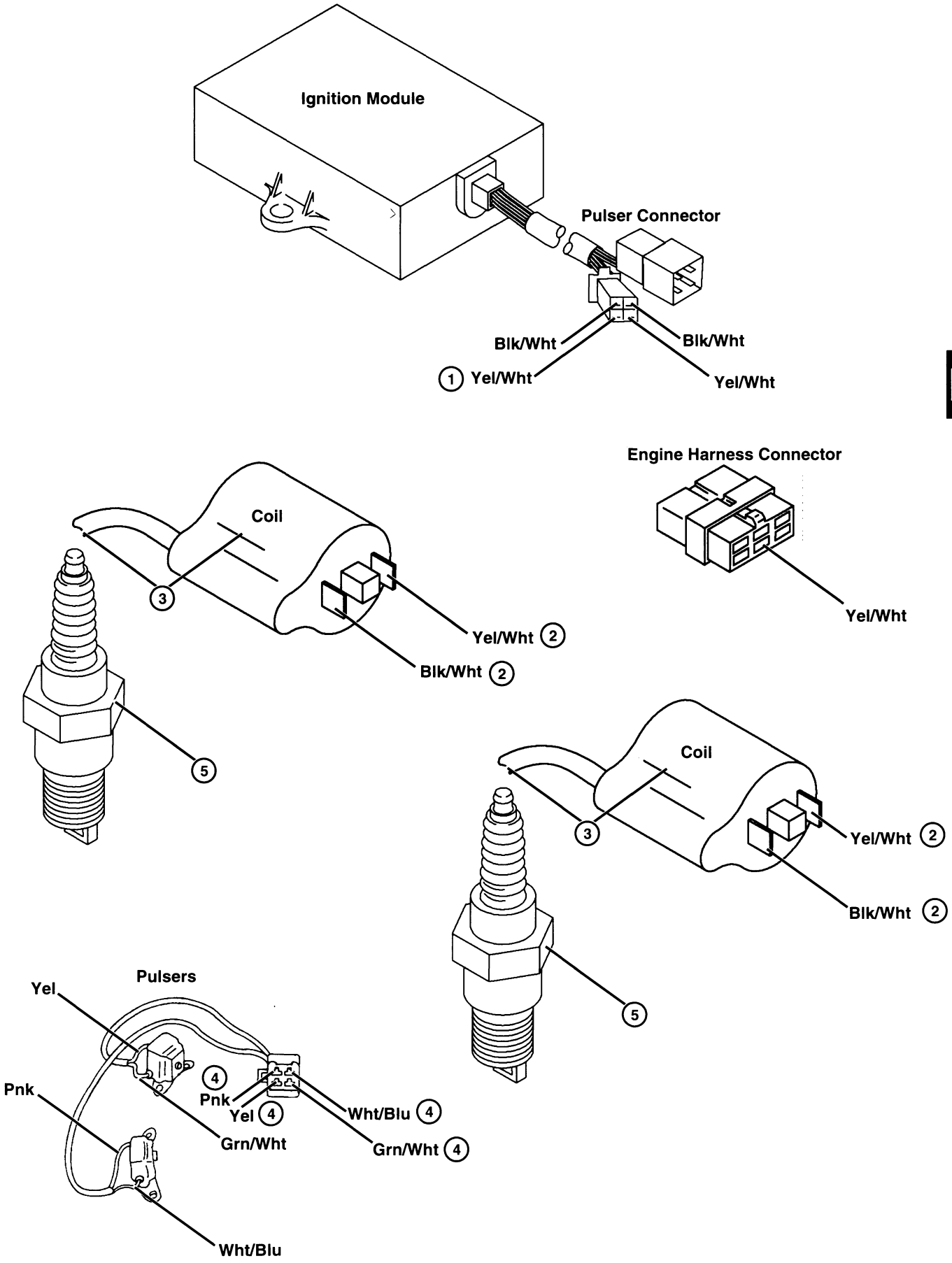
NOTE: The Ignition module is very sensitive to the type of meter used to measure resistance. Due to the variations in the meters, the best way to determine if the ignition module is defective is to replace the questionable module with a known good module.

Test Conditions:

Engine cranks
Park brake engaged
Operator off seat
Battery fully charged
Transmission in NEUTRAL
Ignition switch in RUN position

Test/Check Point	Normal	If Not Normal
1. Ignition module	11.8 - 13.2 volts	Test YEL/WHT from module to connector
2. Ignition coils	Primary resistance = 3.4 - 4.6 ohms	Replace coil
3. Ignition coils	Secondary resistance = 10.4 - 15.5 K ohms	Replace coil
4. Pulsers	Resistance = 85 - 270 ohms	Replace pulser
5. Spark plugs	Hot blue spark	Replace plugs

NOTE: These tests do not determine if ground connections are defective. To test the ground connections, connect the POS terminal of a voltmeter to the POS terminal of the battery and connect the NEG terminal of the voltmeter to the ground terminals. Battery voltage should be indicated, if not, test the ground wire, splice points and grounding points on the frame. Repair as necessary.


Ignition Module
Pulser Connector
Blk/Wht
Blk/Wht
1 Yel/Wht
Yel/Wht
Engine Harness Connector
Yel/Wht
Coil
3
Yel/Wht 2
Blk/Wht 2
5
Coil
3
Yel/Wht 2
Blk/Wht 2
5
Pulsers
Yel
Pnk
4
Pnk
Yel 4
Grn/Wht
Wht/Blu 4
Grn/Wht 4
Wht/Blu

MOW CIRCUIT (3 WHEEL DRIVE)

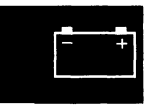
Function:

To allow reels to turn and, at the same time, engage the Third Wheel Drive (if so equipped with Third Wheel Drive option).

Operating Conditions:

To engage the reels (mow circuit) and the 3 wheel drive, the following conditions must be met:

- Key switch in the RUN position.
- Park brake disengaged (OFF).
- Mow switch (OFF) initially, then (ON).
- Operator on seat.
- Reels in LOWERED position.

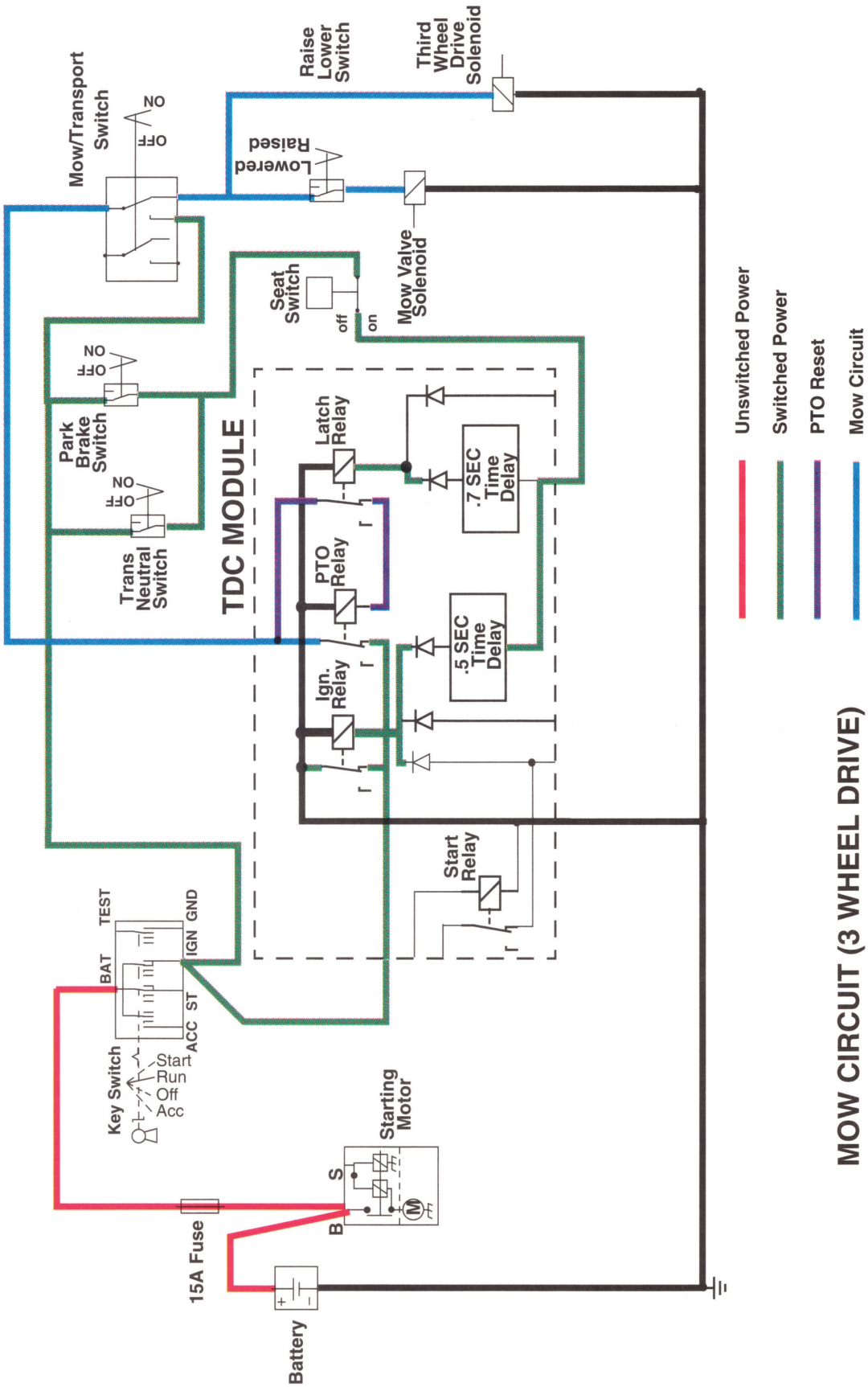


Theory of Operation:

With the Key Switch in the run position, voltage flows from the key switch, through the park brake switch (OFF) and to the seat switch. With the operator on the seat, voltage flows into the TDC Module and through the time delays to energize the latch relay and keep the ignition relay energized. At this time voltage from the mow switch (OFF POSITION), is also standing-bye at the main contacts of the latch relay waiting for the latch relay to be energized.

With the latch relay energized, voltage can now pass through the mow switch (OFF POSITION) through the main contacts of the latch relay and energize the PTO relay inside the TDC module.

At this time the mow switch can be turned ON. Now voltage from the key switch passes through the main contacts of the PTO relay in the TDC module, through the mow switch (ON POSITION), continues to the raise/lower switch (LOWERED) and energizes the mow valve solenoid. Voltage from the mow switch energizes the third wheel drive solenoid also.



MOW CIRCUIT (3 WHEEL DRIVE)

MOW SWITCH CIRCUIT TEST "ENGAGED"

Test Conditions:

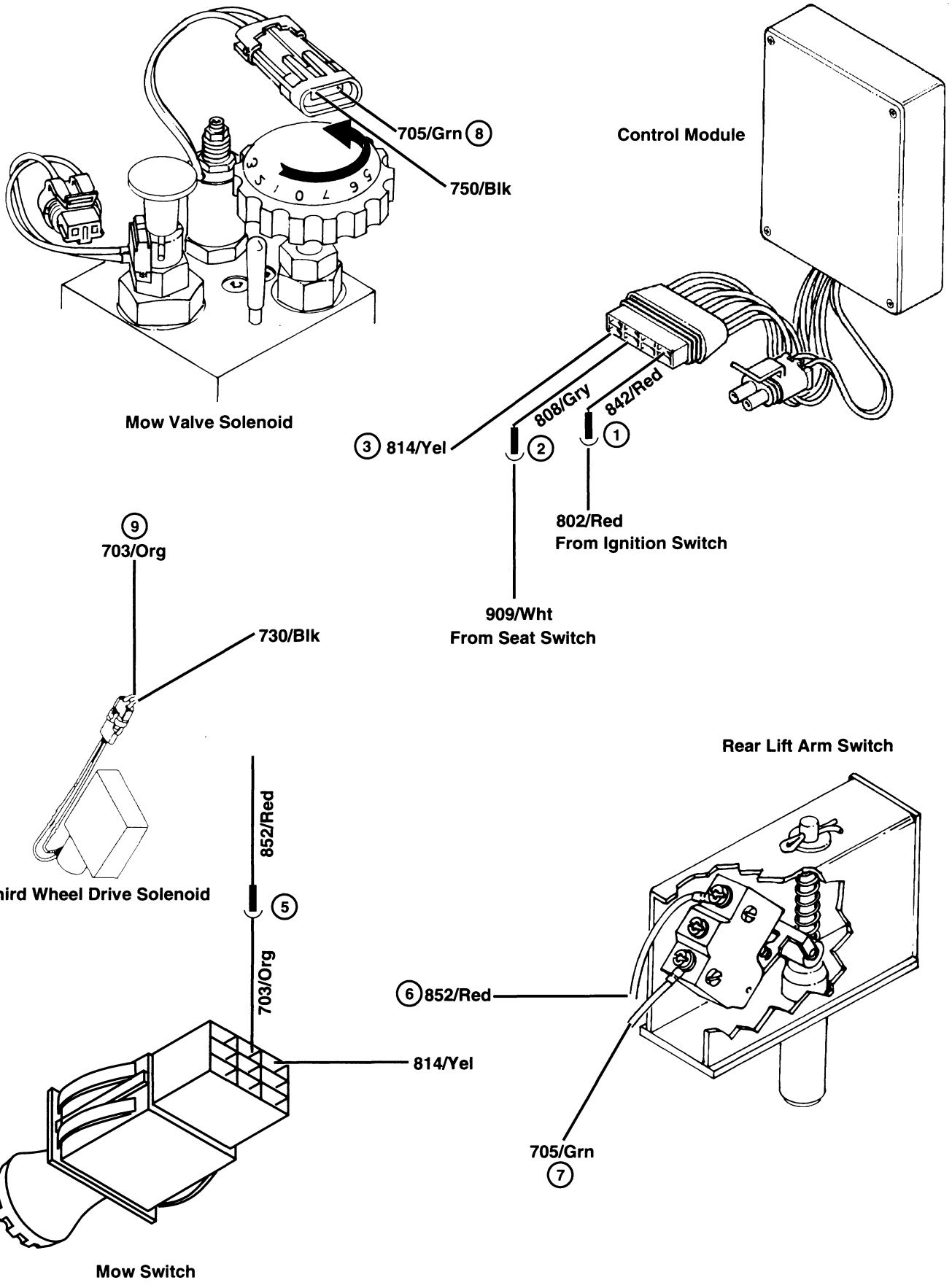
Park brake on
Ignition switch "RUN"
Operator on seat

NOTE: To test the mow switch in the "OFF" position, refer to Cranking Circuit Test.

Transmission in NEUTRAL
mow switch "ON"
Cutting units lowered

Test/Check Point	Normal	If Not Normal
1. Control module	11.8 - 13.2 volts	Test 842/Red and 802/Red
2. Control module	11.8 - 13.2 volts	Test 808/Gry and 909/Wht
3. Control module	11.8 - 13.2 volts	Test or replace control module
4. Mow switch	11.8 - 13.2 volts	Test 814/Yel
5. Mow switch	11.8 - 13.2 volts	Ensure mow switch is "ON", test or replace mow switch
6. Rear lift arm switch	11.8 - 13.2 volts	Test 852/Red
7. Rear lift arm switch	11.8 - 13.2 volts	Adjust or replace switch
8. Mow valve solenoid	11.8 - 13.2 volts	Test 705/Grn
9. Third wheel drive solenoid	11.8 - 13.2 volts	Test 703/Org

NOTE: These tests do not determine if ground connections are defective. To test the ground connections, connect the POS terminal of a voltmeter to the POS terminal of the battery and connect the NEG terminal of the voltmeter to the ground terminals. Battery voltage should be indicated, if not, test the ground wire, splice points and grounding points on the frame. Repair as necessary.


705/Grn (8)
750/Blk
Mow Valve Solenoid
Control Module
(3) 814/Yel
808/Gry
(2)
842/Red
(1)
802/Red
From Ignition Switch
909/Wht
From Seat Switch
(9)
703/Org
730/Blk
Third Wheel Drive Solenoid
852/Red
(5)
703/Org
814/Yel
Mow Switch
Rear Lift Arm Switch
(6) 852/Red
705/Grn
(7)

BACKLAPPING CIRCUIT - OPERATOR OFF SEAT

Function:

Allows the mow circuit to be energized for backlapping operations.

Operating Conditions:

To engage the reels (mow circuit) for backlapping, the following conditions must be met:

- Key switch in the RUN position.
- Travel pedal in NEUTRAL.
- Park brake engaged (ON).
- Mow switch (OFF) initially, then (ON).
- Operator off seat.
- Reels in LOWERED position.
- Forward/reverse switch in REVERSE position.

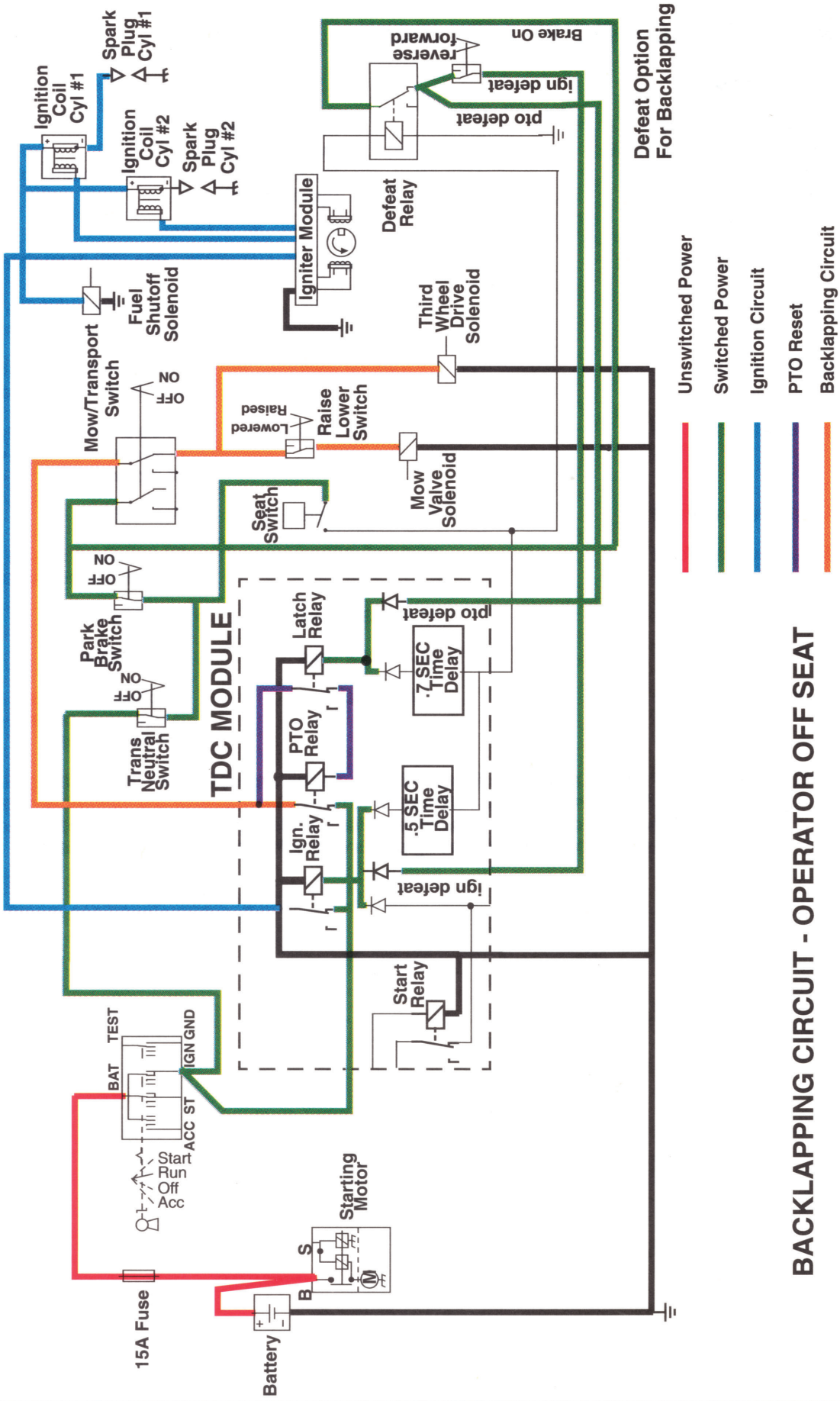
Theory Of Operation:

With the key switch in the RUN position, voltage travels through the trans neutral switch (NEUTRAL), the park brake switch (BRAKE ON) and stands-bye at the forward/reverse switch. At this time voltage from the mow switch (OFF POSITION), is also standing-bye at the main contacts of the latch relay, waiting for the latch relay to be energized.

With the operator off the seat, the defeat relay is de-energized, allowing voltage from the brake switch to keep the latch relay energized and provide voltage through the forward/reverse switch (REVERSE) to energize the Ignition relay.

With the latch relay energized, voltage can now pass through the mow switch (OFF POSITION) through the main contacts of the latch relay and energize the PTO relay inside the TDC module.

At this time the mow switch can be turned ON. Now voltage from the key switch passes through the main contacts of the PTO relay in the TDC module, through the mow switch (ON POSITION), continues through the raise/lower switch (LOWERED) and energizes the mow valve solenoid.


Spark Plug Cyl #1
Ignition Coil Cyl #1
Ignition Coil Cyl #2
Spark Plug Cyl #2
Brake On
reverse forward
ign defeat
pto defeat
Defeat Option For Backlapping
Defeat Relay
Igniter Module
Fuel Shutoff Solenoid
Third Wheel Drive Solenoid
Mow/Transport Switch
ON
OFF
Lowered
Raised
Raise Lower Switch
Mow Valve Solenoid
Seat Switch
Park Brake Switch
Trans Neutral Switch
TDC MODULE
Latch Relay
.7 SEC Time Delay
PTO Relay
.5 SEC Time Delay
Ign. Relay
Start Relay
TEST
BAT
IGN
GND
ACC
ST
Start
Run
Off
Acc
Starting Motor
S
B
15A Fuse
Battery
Unswitched Power
Switched Power
Ignition Circuit
PTO Reset
Backlapping Circuit
BACKLAPPING CIRCUIT - OPERATOR OFF SEAT

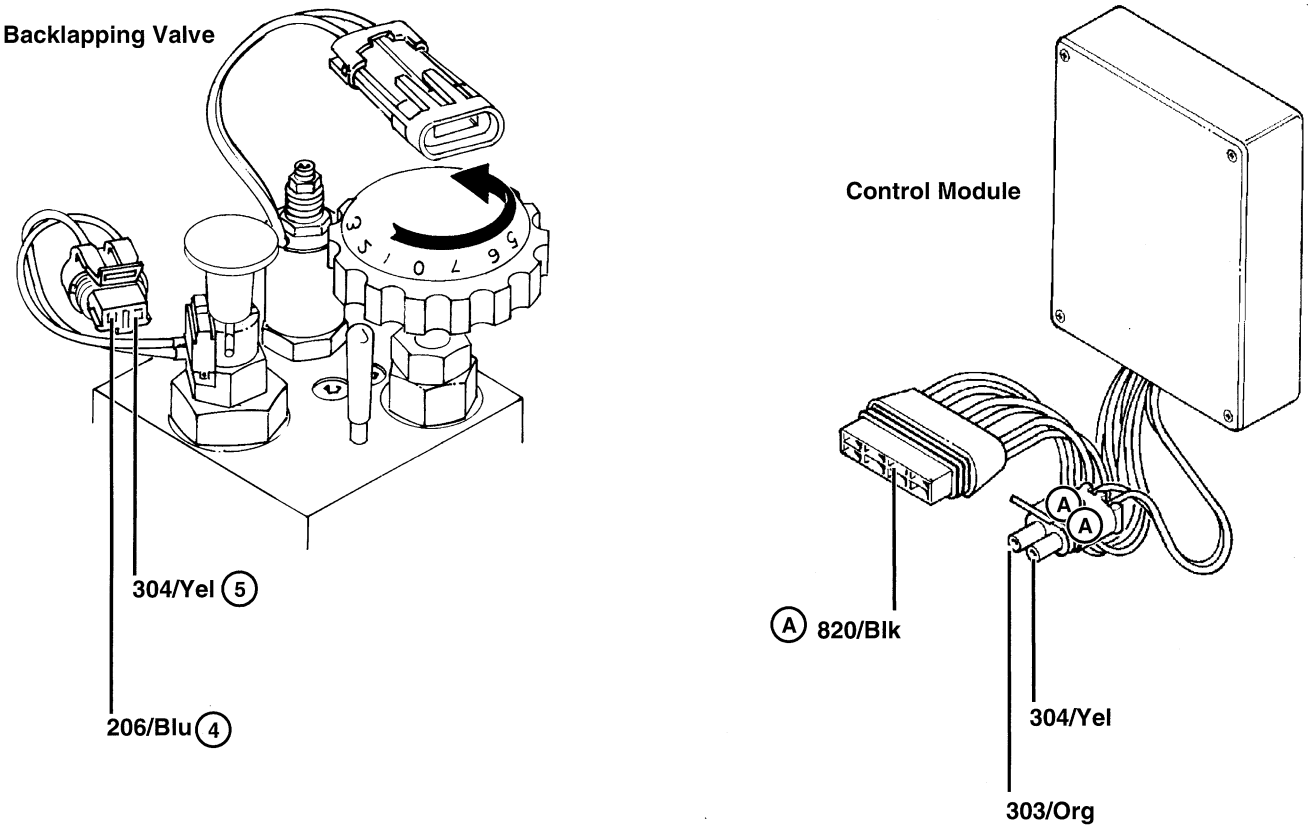
BACKLAPPING CIRCUIT TEST (DEFEAT OPTION)

Test Conditions:

Ignition switch "RUN"
Transmission in NEUTRAL
Mow switch "ON"
Park brake on
Operator off seat
Backlapping valve "Pulled up and rotated for backlapping"

Test/Check Point	Normal	If Not Normal
1. Mow Switch	11.8 - 13.2 volts	Ensure transmission is in NEUTRAL and park brake is on
2. Defeat Relay	11.8 - 13.2 volts	Check connector between 904/Yel and 204/Yel and wires
3. Defeat Relay	11.8 - 13.2 volts	Ensure operator is not sitting on seat or seat switch is not depressed Test or replace relay
4. Backlapping Valve	11.8 - 13.2 volts	Test 206/Blu
5. Backlapping Valve	11.8 - 13.2 volts	Ensure Backlapping valve is pulled up and rotated, replace switch
6. Control Module	11.8 - 13.2 volts	Test 304/Yel
7. Control Module	11.8 - 13.2 volts	Test 303/Org
8. Defeat Relay	No voltage	If voltage is present, ensure operator is not sitting on seat or seat switch is not depressed

NOTE: These tests do not determine if ground connections are defective. To test the ground connections, connect the POS terminal of a voltmeter to the POS terminal of the battery and connect the NEG terminal of the voltmeter to the ground terminals. Battery voltage should be indicated, if not, test the ground wire, splice points and grounding points on the frame. Repair as necessary.

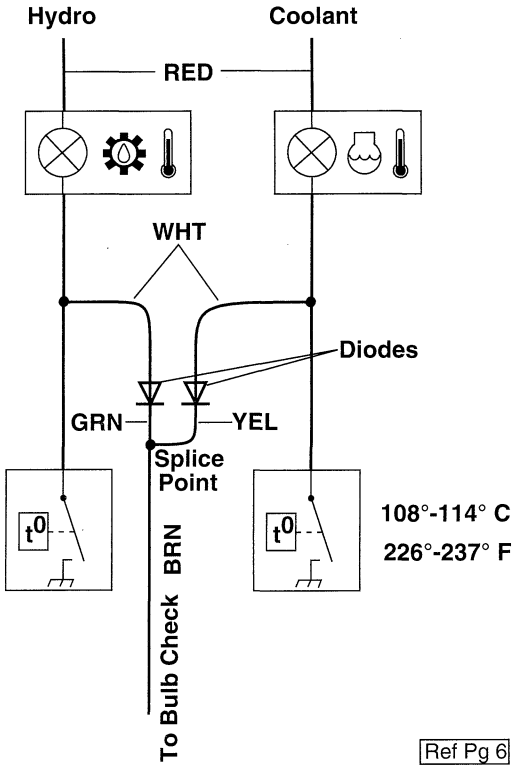

Backlapping Valve
304/Yel (5)
206/Blu (4)
Control Module
(A) 820/Blk
304/Yel
303/Org
Defeat Relay
(3) 206/Blu & 303/Org
(2) 204/Yel
904/Yel
240/Blk
(8)
309/Wht
209/Wht
(1)
Mow Switch

CHASSIS TESTS & ADJUSTMENTS

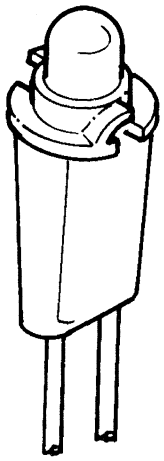
Refer to the Engine section to troubleshoot and repair the Starting, Ignition and Charging Systems.

Hydro/Engine Over-temperature Indicating Lights

NOTE: If both indicators illuminate at the same time, except for in the START position, test the diodes, located near the bulb receptacles, for proper operation.,



1. To test the continuity of the Hydraulic and Coolant Overtemperature circuit, position the ignition switch to the START position and observe the indicator lights for illumination.
2. If both indicator lights illuminate, the circuit is good and no further tests are needed.
3. If only one indicator light illuminates, test or replace the bulb and try again. If the bulb still fails to illuminate, check for battery current at the bulb receptacle (red wire) with the ignition switch in the RUN position. Repair or replace wiring or bulb receptacle as needed. If current is being supplied to the indicator light, follow the Green wire (for the Hydraulic temperature light) or the Yellow wire (for the Coolant temperature light) to a splice point and look for a open in the wire before or at the splice point.

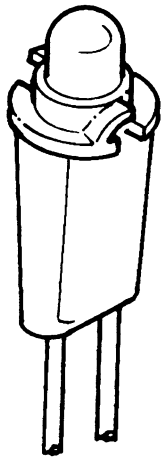


M56510

4. If neither indicator bulb illuminates, remove the diode, plugged into the wiring harness near the indicator bulb receptacle, and ground the Green wire (for the Hydraulic circuit) or the Yellow wire (for the coolant circuit). Place the Ignition switch to the START position and observe the indicator light for illumination. If the light illuminates, check the wiring to the ignition switch to ground for an open circuit. Repair the wiring or replace the ignition switch as necessary.

ENGINE LOW OIL PRESSURE LIGHT CIRCUIT TEST

1. To test the indicator light circuit for continuity, remove the power lead at the oil pressure switch and ground it. Position the ignition switch to the RUN position and observe the indicator light for illumination.
2. If the indicator light illuminates, the warning circuit, from the battery to the switch, is good. Refer to the engine section to test the oil pressure switch and if necessary, the engine lubrication system for proper operation.

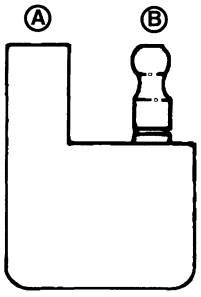


M56510

3. If the indicator light fails to illuminate, check for battery current at the bulb receptacle, if current is available at the receptacle, replace the indicator bulb and repeat the test.
4. If the indicator light fails to illuminate, inspect the wiring and engine connector for an open circuit, repair or replace as necessary.
5. If no current is available at the bulb receptacle, check for illumination of the water temperature indicator light by placing the ignition switch to the START position. If the water temperature light illuminates, inspect the power lead from the water temperature indicator to the oil pressure indicator for a faulty connection. Repair or replace as necessary.

DIODE TEST

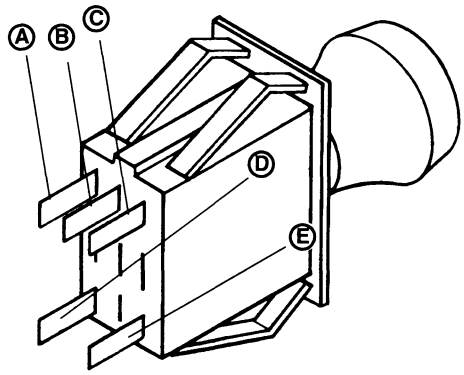
1. Remove the diode from the electrical harness.



M56502

2. Using an ohmmeter connect the black test lead to A and the red test lead to B and check continuity.
3. Reverse the test leads and check continuity.
4. If continuity is noted in both steps, the diode is defective and must be replaced.
5. If continuity is noted in step 2 and not in step 3, the diode is good.

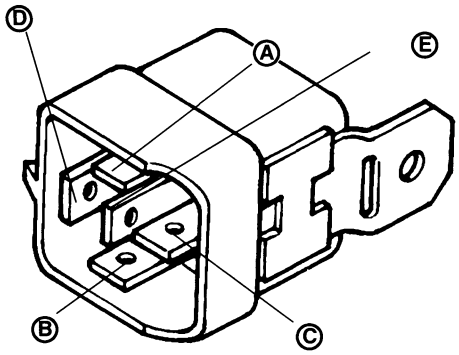
MOW SWITCH TEST



M72863

1. Remove the mow switch and perform the following tests with an ohmmeter.
2. With the mow switch OFF (pushed in), check for continuity between (A and C) and (D and E).
3. With the mow switch ON (pulled out), check for continuity between (B and C).
4. If the mow switch fails any of these tests, replace it.

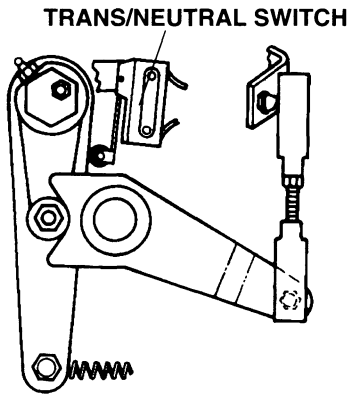
START AND DEFEAT RELAY TESTS



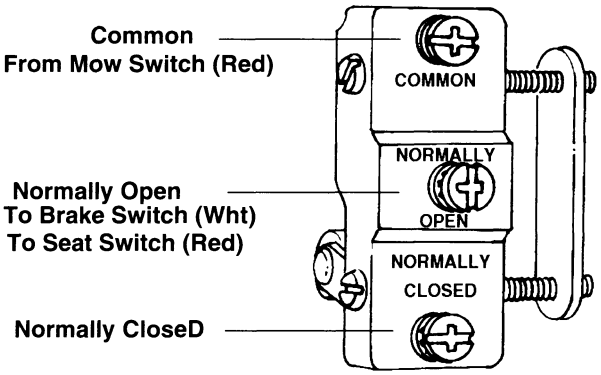
M56509

1. Using a 12V battery and test leads, connect the battery POS (+) lead to terminal (A) and the battery NEG (-) lead to terminal (B).
2. With the relay energized, check for continuity between (C) and (D) terminals.
3. Replace the relay if it fails this test.
4. Remove the battery test leads and check for continuity between (C) and (E).

TRANS/NEUTRAL SWITCH TEST



M72870

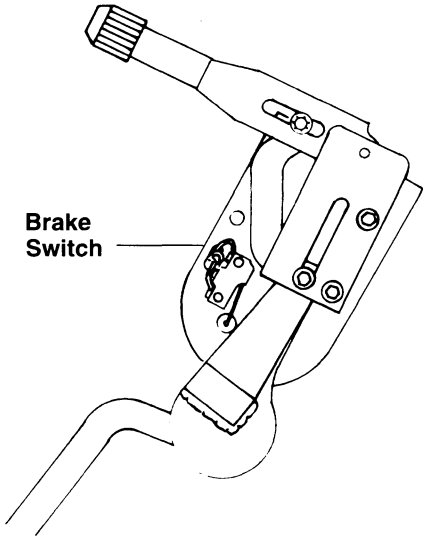


M56501

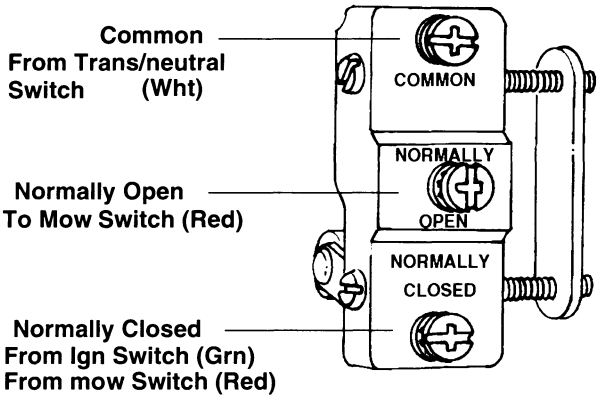
NOTE: The Trans/Neutral switch terminals used are Common and Normally open. Failure to use the proper connections will result in improper operation.

1. Remove the switch and inspect the roller for flat spots and freedom of movement. Lubricate the roller or replace the switch if flat spots are found.
2. Connect an ohmmeter to the Common and Normally open contacts of the switch.
3. There should be no continuity with the lever arm released.
4. Actuate the lever arm. Continuity should be indicated when the lever arm reaches the midway point of full travel and should indicate continuity until the lever arm is released. Replace the switch if it fails this test.
5. See Transmission Neutral adjustment in the Hydrostatic Transmission Section to adjust the switch.

PARK BRAKE SWITCH TEST



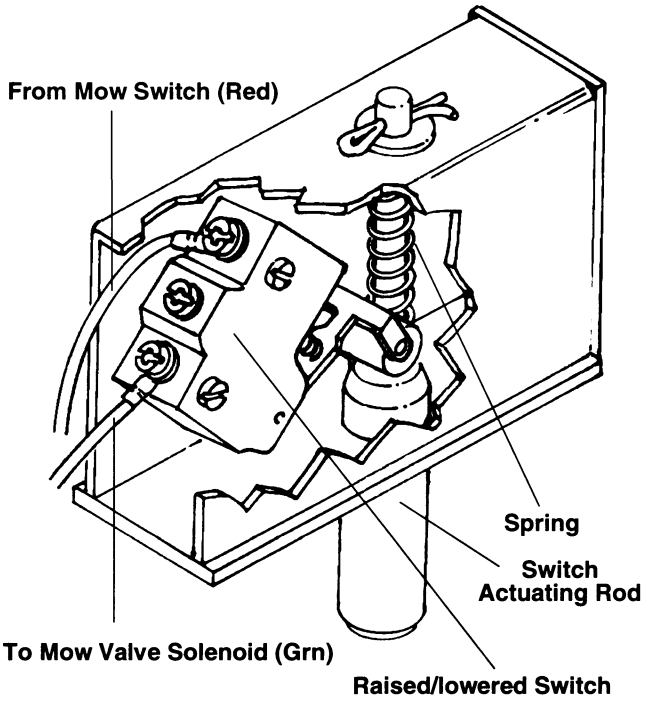
M56505



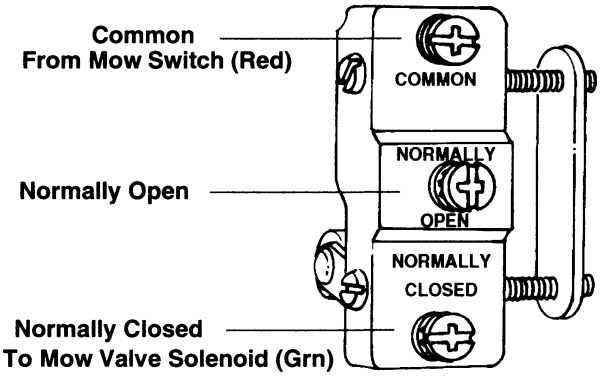
M56501

1. Remove the switch and inspect the roller for flat spots and freedom of movement. Lubricate the roller or replace the switch if flat spots are found.
2. To test the Brake switch, disconnect the wires from the terminals of the switch.
3. Using an ohmmeter, place the (+) lead of the ohmmeter on the Common switch terminal and the (-) lead on the Normally Open terminal. The ohmmeter should not have continuity until the switch is actuated to the midway point of full travel. Continuity should be indicated until the lever is released.
4. Place the (-) lead from the ohmmeter on the Normally Closed terminal of the switch. Continuity should be indicated until the switch is actuated to the midway point of full travel. Continuity should not be indicated until the lever is released.

LOWERED/RAISED SWITCH TEST



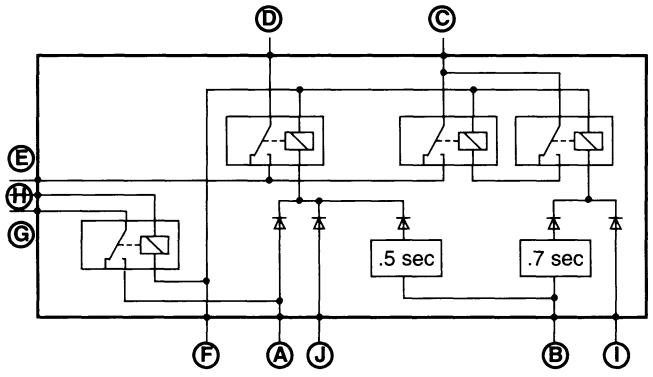
M56506



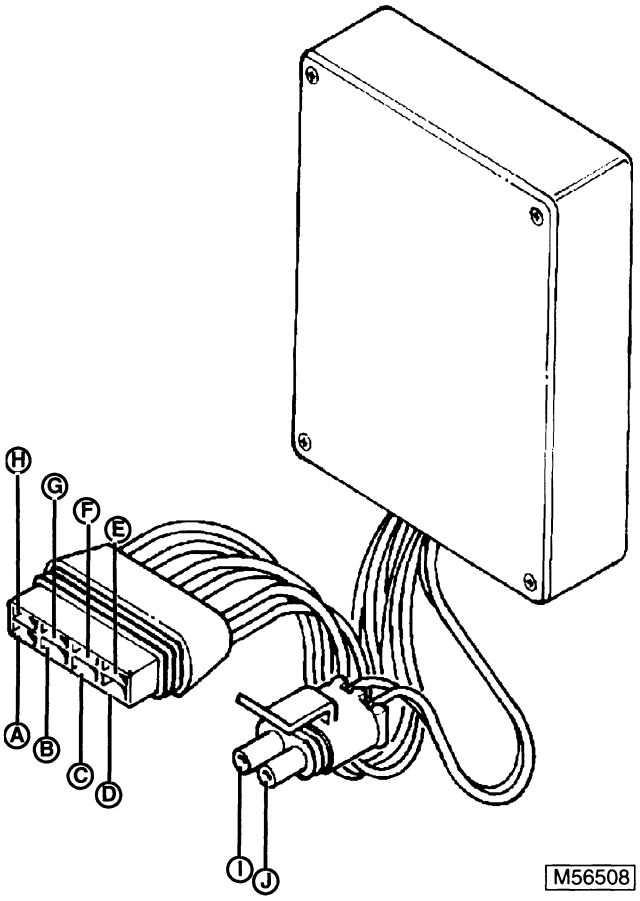
M56501

1. Remove the switch and inspect the roller for flat spots and freedom of movement. Lubricate the roller or replace the switch if flat spots are found. Inspect the switch actuating rod for freedom of movement and the spring for wear.
2. To test the Raised/Lowered switch, disconnect the wires from the terminals of the switch.
3. Place the (+) lead of the ohmmeter on the Common terminal of the switch and the (-) lead of the meter on the Normally Closed terminal of the switch. Continuity should be indicated until the switch is actuated to the midway point of full travel. Continuity should not be indicated until the switch is released.

CONTROL MODULE TESTS



Ref Pg 6



M56508

COLOR CODES:

A-YEL	F-BLK
B-GRY	G-BLU
C-PUR	H-YEL
D-RED	I-YEL
E-RED	J-ORG

Tools Needed:

- Two, 12V Batteries
- Ohmmeter
- 12V Test Light

Control Module, Start Relay

1. Remove the control module for bench testing.
2. Connect an ohmmeter to terminals (A, G).
   - No continuity
3. Connect battery POS (+) lead to terminal (H). Connect battery NEG (-) to terminal(F).
   - Continuity at terminals (A, G).
4. If the Control Module fails any of these tests, replace it.

Control Module, Ign Relay

1. Connect an ohmmeter to terminals (E, D).
   - No continuity
2. Connect the battery NEG (-) lead to terminal (F) and, one at a time, connect the battery POS (+) lead to terminals (A, J, and B).
   - Continuity at terminals (E, D) with a .5 second release delay when the battery POS (+) lead is disconnected from terminal (B).
3. If the Control Module fails any of these tests, replace it.

Control Module, Latch Relay, PTO Relay

1. Using two 12V batteries, connect both battery NEG (-) leads to terminal (F).
2. Connect one of the battery POS (+) leads to terminal (C).
3. Ground the test light lead to terminal (F) and test for voltage at terminal (E).
   - No voltage.
4. Connect the second battery POS (+) lead, one at a time, to terminals (I, B). Test for voltage at terminal (E).
   - Voltage at terminal (E) with a .7 second release delay when voltage is removed from terminal (B).
5. If the Control Module fails any of these tests, replace it.

ENGINE ELECTRICAL SERVICE

Item	Standard	Service Limit
Charging System:		
Regulated output voltage	Battery voltage to 15 VDC	~
Alternator stator coil resistance	0.11 to 0.18 Ohms	~
Unregulated stator output	~	26 VAC/3000 rpm
Regulator resistance	See charging system	
Ignition System:		
Coil air gap	0.3 to 1.2 mm (0.012 to 0.05 in.) (not adjustable)	~
Coil resistance	85 to 270 Ohms	~
Igniter resistance	See ignition system	~
Primary winding resistance	3.4 to 4.6 Ohms	~
Secondary winding resistance	10.4 to 15.6 k/Ohms	~
Spark plug	NGK BMR4A	~
Plug gap	0.6 to 0.7 mm (0.024 to 0.028 in.)	~
Electric Starter System:		
Carbon brush length	10 mm (0.394 in.)	6.0 mm (0.24 in.)
Commutator groove depth	0.5 to 0.8 mm (0.02 to 0.031 in.)	0.2 mm (0.008 in.)
Commutator diameter	28 mm (1.102 in.)	2.7 mm (1.06 in.)
Commutator runnout	~	0.4 mm (0.016 in.)

CHARGING SYSTEM OPERATIONAL INSPECTION

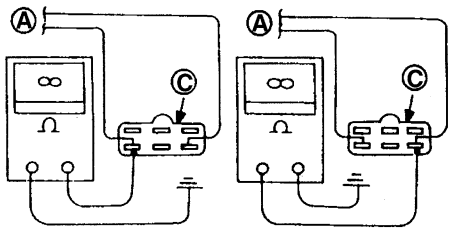
NOTE: Always check battery condition before condemning other parts of the charging system. The battery must be fully charged in order to conduct accurate charging system tests.

1. Start the engine and allow it to reach normal operating temperature.
2. Connect a voltmeter across the battery terminals.
3. The readings should show nearly battery voltage at slow engine speeds and should rise as the engine speed increases not to exceed 15 VDC.
4. If the readings do not rise as the engine speed increases, the regulator is defective or the alternator output is insufficient for the loads.

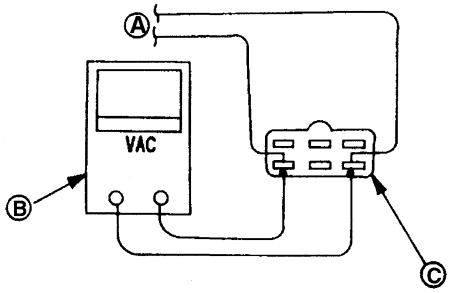
STATOR UNREGULATED OUTPUT TEST

1. Disconnect the Engine wiring harness at the 6-point connector and connect an AC voltmeter to the stator pins.
2. Start the engine and run it at 3000 RPM. Voltage reading should be a minimum of **26 VAC**. If unregulated voltage is less than specified, check the stator coil resistance. If the stator coil resistance is good, replace the rotor.

A - To Stator **B - Ohm Meter**
C - 6P Connector



Stator Pin and Ground (Infinite Ohm)



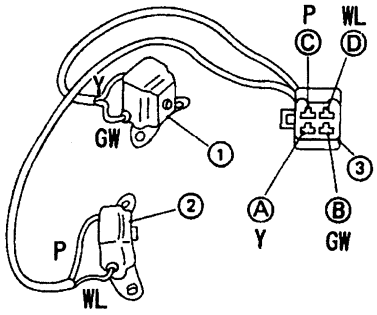
Unregulated Stator Output, 26 VAC/3000 RPM

M72871

PULSER COIL RESISTANCE TEST

1. Connect an ohmmeter to the points shown and read the resistance. If the resistance is not as specified, replace the pulser coil.

Resistance Between
[A and B] . . . . . 85 - 270 Ohms
[C and D] . . . . . 85 - 270 Ohms

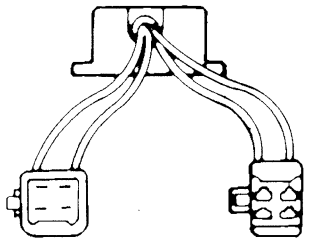


M72872

Wire Color

Y - Yellow **P - Pink**
GW - Green/White **WL - White/Blue**

IGNITER MODULE TEST



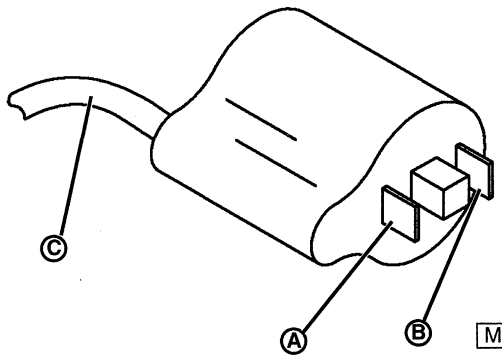
M46872

NOTE: The Ignition module is very sensitive to the type of meter used to measure resistance. Due to the variations in the meters, the best way to determine if the ignition module is good is to replace the questionable module with a known good module. If the new ignition module does not solve the problem, other ignition components are at fault.

IGNITION COIL INSPECTION

1. Remove the ignition coil from the engine.
2. Remove the plug cap from the high tension lead.
3. Connect the test leads to the points shown and read the resistance. If the resistance values are not as specified, replace the ignition coil.

Resistance Between
[A and B] . . . . . 3.4 - 4.6 Ohms
[A and C] . . . . . 1.4 - 15.6 K Ohms



M72867

STARTER SERVICE

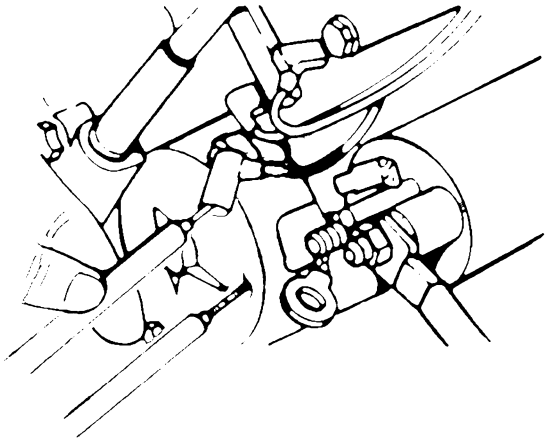
STARTER SOLENOID AND CIRCUIT TEST

⚠ CAUTION

Ensure transmission is in neutral and place blocks in front and behind wheels to prevent vehicle from moving.

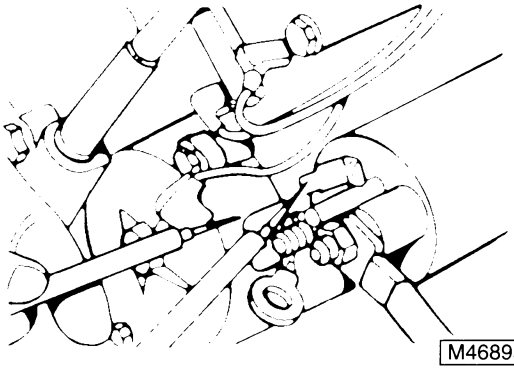
NOTE: Ensure battery has been load-tested and is fully charged.
Ensure battery connections are clean and tight and cables are not frayed or damaged.

1. Disconnect the starter switch terminal lead from the solenoid.



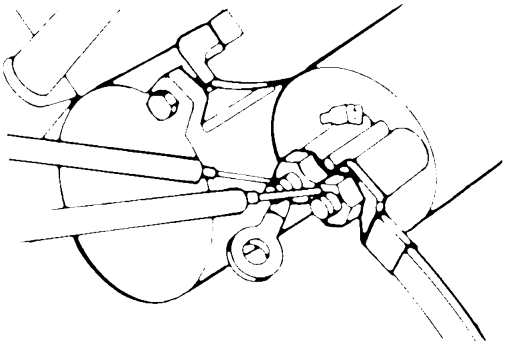
M46896

2. With a meter set at the 25VDC position, measure the voltage at the lead with the starter switch in the START position.
3. If the meter reads battery voltage, the circuit is good, if not, inspect the wiring to and from the ignition switch for damage or breaks. Test the switch for proper operation.



M46895

4. Measure the resistance between the solenoid starter terminal and ground with a meter set at Rx1. Resistance should be 0 or close to it, if not replace the solenoid.
5. Disconnect the starter lead from the starter solenoid and keep it away from the solenoid.



M46898

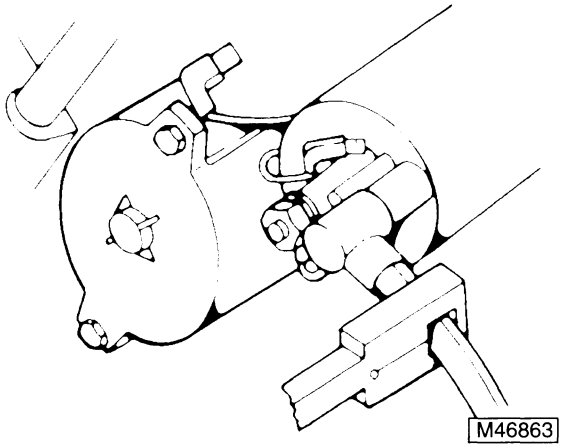
6. Use a multimeter, set at Rx1, and connect it across the large terminal leads of the solenoid.
7. Turn the ignition switch to the Start position and read the meter. The resistance should be 0, a clicking sound should be heard and the pinion gear should engage the flywheel, if not replace the solenoid. If all tests are good, test the starter motor.

STARTER MOTOR TEST

Special Tools

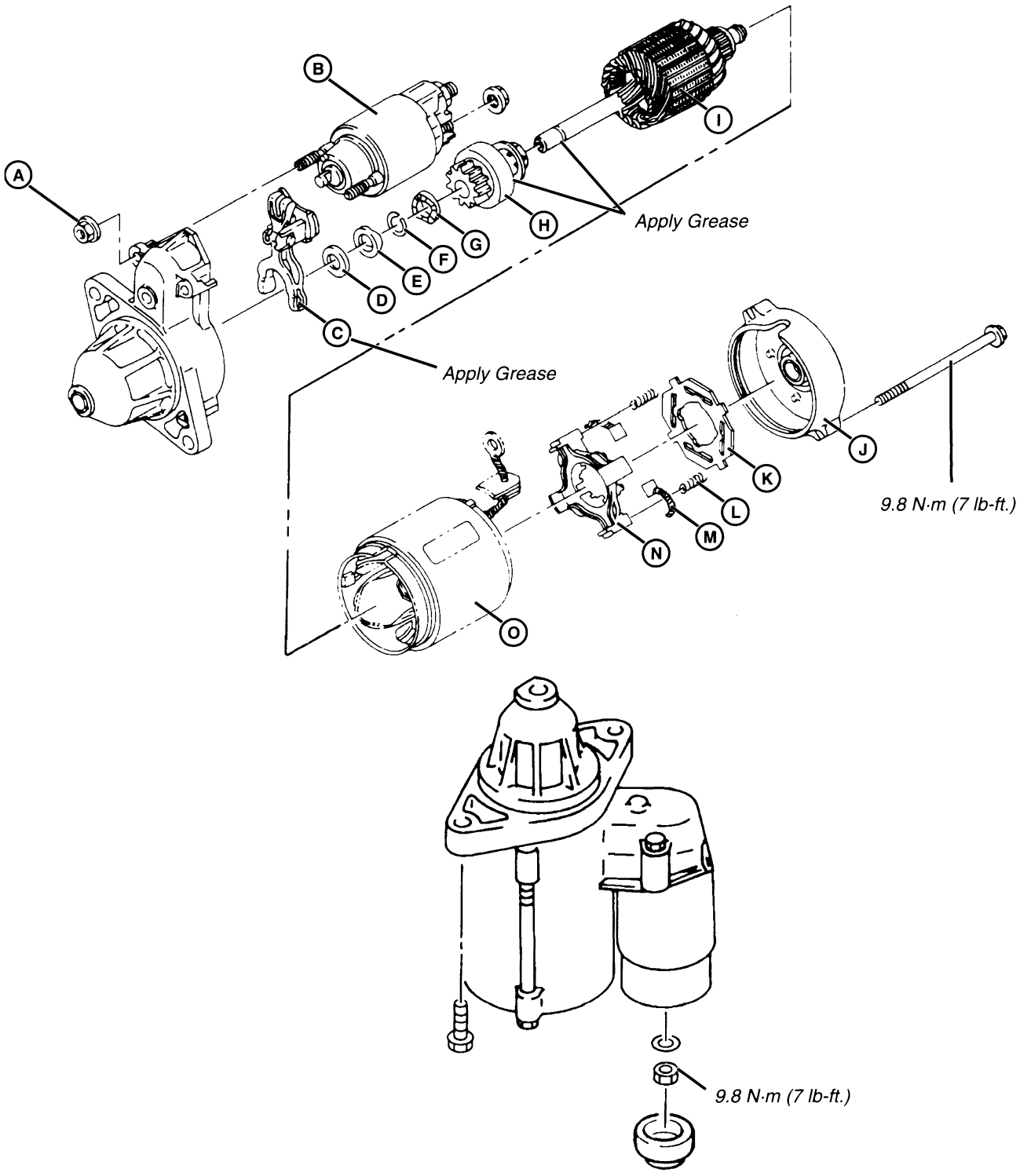
- **JTO5712 Current Gun**

1. Install current gun on battery positive (+) lead.



2. Use battery jumper cables to apply current to the starter terminal lead from the battery cable lead of the starter solenoid.
3. Record amperage reading. Amperage should be **50 Amps or less** and the starter armature should rotate freely, if not replace the starter.
4. Disconnect and ground spark plug leads.
5. Turn the ignition switch to the START position and record the amperage.
6. Amperage should be **72 Amps or less**, if not, check internal engine components, hydraulic pumps or mow drive for binding or damage.

STARTER COMPONENT LOCATION



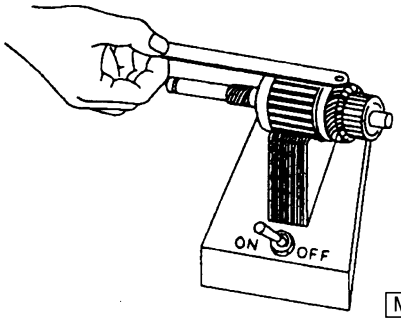
STARTER DISASSEMBLY AND INSPECTION

1. Mark body and covers for correct alignment during reassembly.
2. Separate pinion stopper halves (E, G) to remove retaining clip (F).
3. Inspect starter parts for wear or damage.
4. Measure brushes. Replace as a set if length of any one is less than **6 mm (0.240 in.).**

⚠ CAUTION

Most solvents can damage the insulation on the armature windings. Use an electrical contact cleaner.

5. Place the armature on a growler.



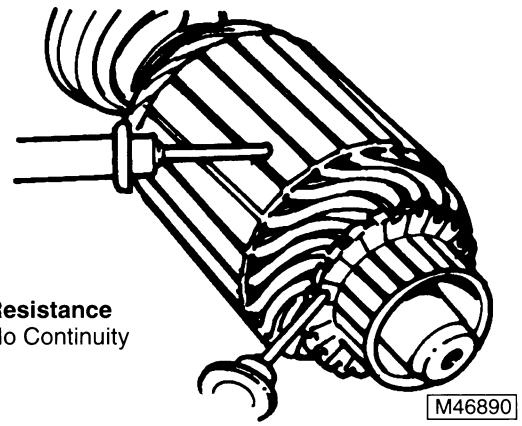
M46892

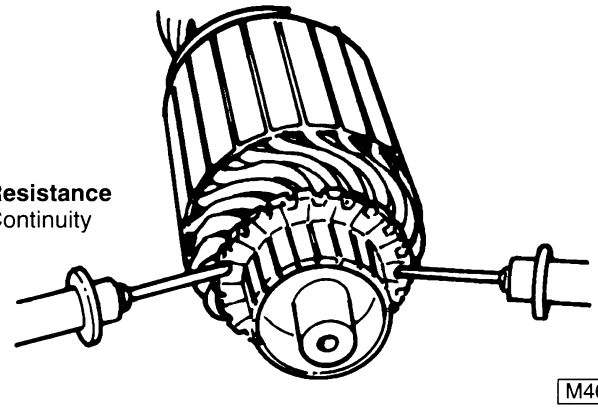
6. Locate shorts by rotating the armature on the growler while holding a thin metal strip (e.g., hacksaw blade) on top of the armature. If there is a short in the windings, the metal strip will vibrate at the point where the short exists.

NOTE: If the test indicates a short circuit, clean the armature carefully and retest before condemning the armature.

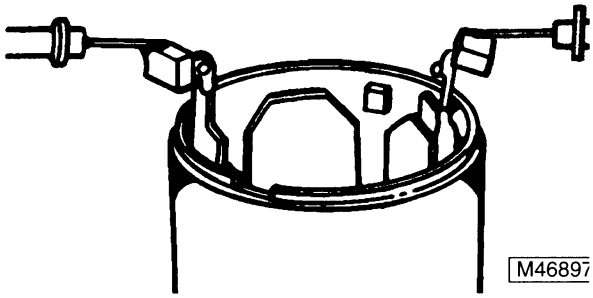
7. Test for grounded windings using an ohmmeter or test light.
8. Armature windings are connected in parallel, so each commutator bar must be checked.
9. If the test shows continuity, a winding is grounded and the armature must be replaced.
10. Test for open circuits in the windings. If the test shows no continuity, the armature has an open circuit and must be replaced.

IMPORTANT: The coil frame is a tie point for 12 separate field coils. It may be difficult to detect one bad coil. If rpm was slow and armature tests are normal, replace the field coil assembly.


Resistance
No Continuity
M46890


Resistance
Continuity
M4689

11. Perform continuity tests on field coil. Replace the coil if not within specifications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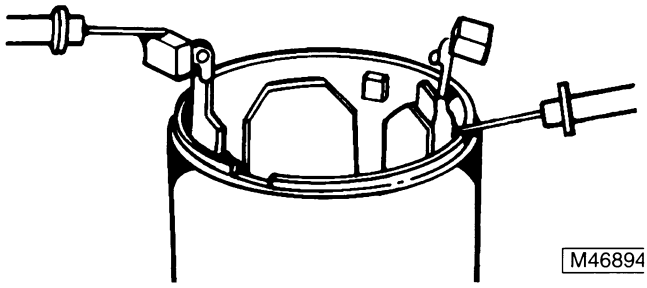
M46894

Continuity Test

Brush to Brush..... Continuity
Brush to Housing.....Continuity

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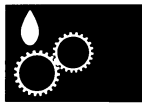
HYDROSTATIC POWER TRAIN



Page

SPECIFICATIONS

Hydrostatic Transmission

Make	Eaton
Type	Ball/Variable Displacement
Operating Pressure	1500 - 1800 psi
Flow	16 GPM
Acceleration Valves	Yes

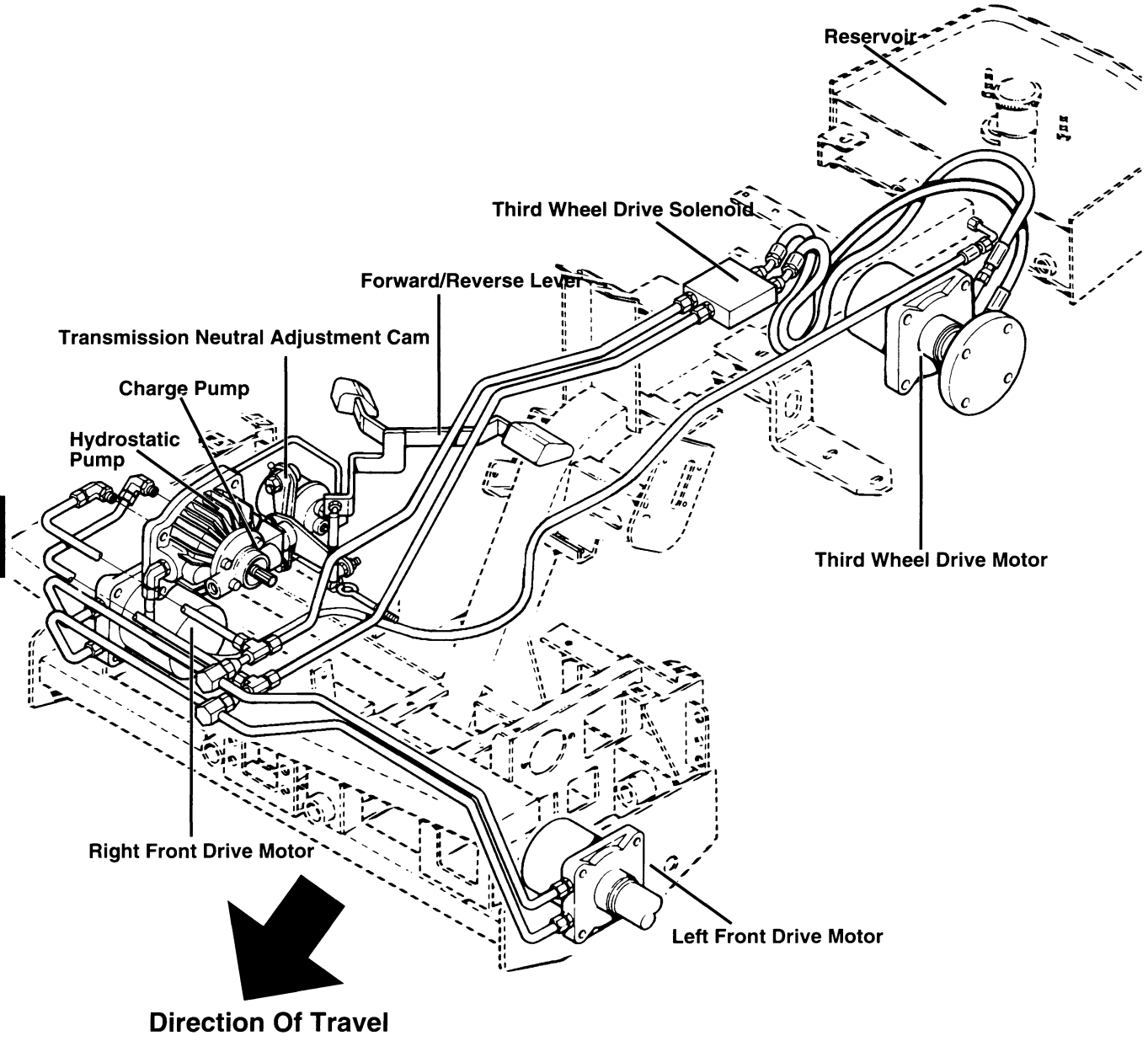
Torqmotors

Make	TRW
Series	MB
Type	Geroler/Positive Displacement

Travel Speeds

Mowing (3WD)	0 - 5 mph (0 - 8 km/h)
Mowing (2WD)	Adjustable
Transport	0 - 8.5 mph (0 - 13.7 km/h)
Reverse	0 - 3 mph (0 - 4.8 km/h)

COMPONENT LOCATION



M72874

TROUBLESHOOTING

Problem or Symptom / Check or Solution	System jerky/noisy when starting	Vehicle operates in one direction only	Loss of power or vehicle will not operate in either direction	System operating hot	Vehicle creeps in neutral	Vehicle does not operate in reverse	Mowing speed exceeds 8km/h (5 mph) (three wheel drive only)	Engine rpm low or engine stalls
Internal/external control linkage	●	●	●		●			
Air In system	●		●					
Check valves defective	●	●						
Acceleration valves defective	●	●	●	●				
Pump defective	●	●	●	●				
Reservoir oil level low			●	●				
System operating hot			●					
Low charge pressure			●	●				
Cooling fan				●				
Cooling fins clogged or dirty/ missing or broken				●				
Oil cooler clogged or not installed (optional)				●				
Third wheel valve malfunctioning						●	●	
Tow valve engaged			●					
Wheel motor defective			●					
Hydro not neutralizing								●
Hydraulic load on engine								●
Reel-to-Bed Knife clearance not adjusted properly, blades are dull, high grass density				●				

TROUBLESHOOTING HINTS

Almost all hydrostatic drive system failures will result in a *marked loss of vehicle speed*. Each individual component will have to be tested to determine if it has failed. This vehicle will not track, pull to one side or another, if a Torqmotor is weak. Fluid bypassing internally in a Torqmotor will reduce the pressure to the other Torqmotors resulting in a slower ground speed. A weak hydrostatic pump will result in a slower ground speed also, making it very difficult to determine what component has failed from observation alone.

Testing the Hydrostatic pump with a flow tester can confirm or eliminate it as the source of the problem. This however takes time and maybe some other components should be looked at first.

LOOK: Visually inspect hydraulic components for signs of overheating such as burnt/pealing paint and bluing. Check fittings and components for leaks. Check the fluid level in the hydraulic reservoir. Check the hydraulic fluid for contaminants such as metal particles. Look at the hydraulic hoses for signs of deterioration.

LISTEN: Listen to the sound of the Torqmotors, usually a defective component sounds different or makes no noise at all. Listen for metallic sounds resulting from metal to metal contact.

FEEL: Use a surface temperature gauge to determine if one component is hotter than another component, as faulty or weak components will operate at higher temperatures. .

THEORY OF OPERATION

Theory of Operation:

The Power Train consists of two major assemblies, the engine driven Hydrostatic pump and each individual Torqmotor.

The Hydrostatic pump is an engine driven, variable displacement pump. Fluid flow, and direction of fluid travel, are controlled by the operator with a foot pedal. Hydraulic fluid in the power train circulates in a closed loop, so fluid that leaves the pump and flows through the Torqmotors, is returned to the pump and not to the reservoir. Fluid that leaves this closed loop, such as case drain, is replenished by fluid from the charge pump. In addition to resupplying fluid, the charge pump supercharges the hydrostatic pump with a head pressure of 90 - 130 psi. To achieve smooth acceleration from neutral, acceleration valves are used in the circuit that allow pressure in the system to increase gradually. These acceleration valves prevent jerky stops and starts that can ruin turfgrass.

For optimum control and power, the transmission should be operated at constant input speeds. When operating the unit under varying load conditions, a noticeable change in the output speed can be expected. In these cases, the shift lever should be directed toward neutral to increase output torque. This produces the same result as shifting down to a lower gear with a typical manual transmission.

The wheel motors (Torqmotors), are positive displacement geroler motors, that are connected to the hydrostatic transmission through hydraulic lines and fittings.

The wheels are mounted to hubs that are keyed to the output shaft of the wheel motors.

Three Wheel Drive Speed Control

Speed for transport and mowing operations is controlled when the mode of operation (transport or mowing) is selected with the Mow switch. When the Mow switch is engaged for mowing, the third wheel drive motor is also engaged. Now pressure and flow from the hydrostatic transmission is divided among three motors instead of two. The result is lower groundspeed. Transport speed (13.7 km/h, 8.5 mph) is now lowered to Mow speed (8 km/h, 5 mph).

Two Wheel Drive Speed Control

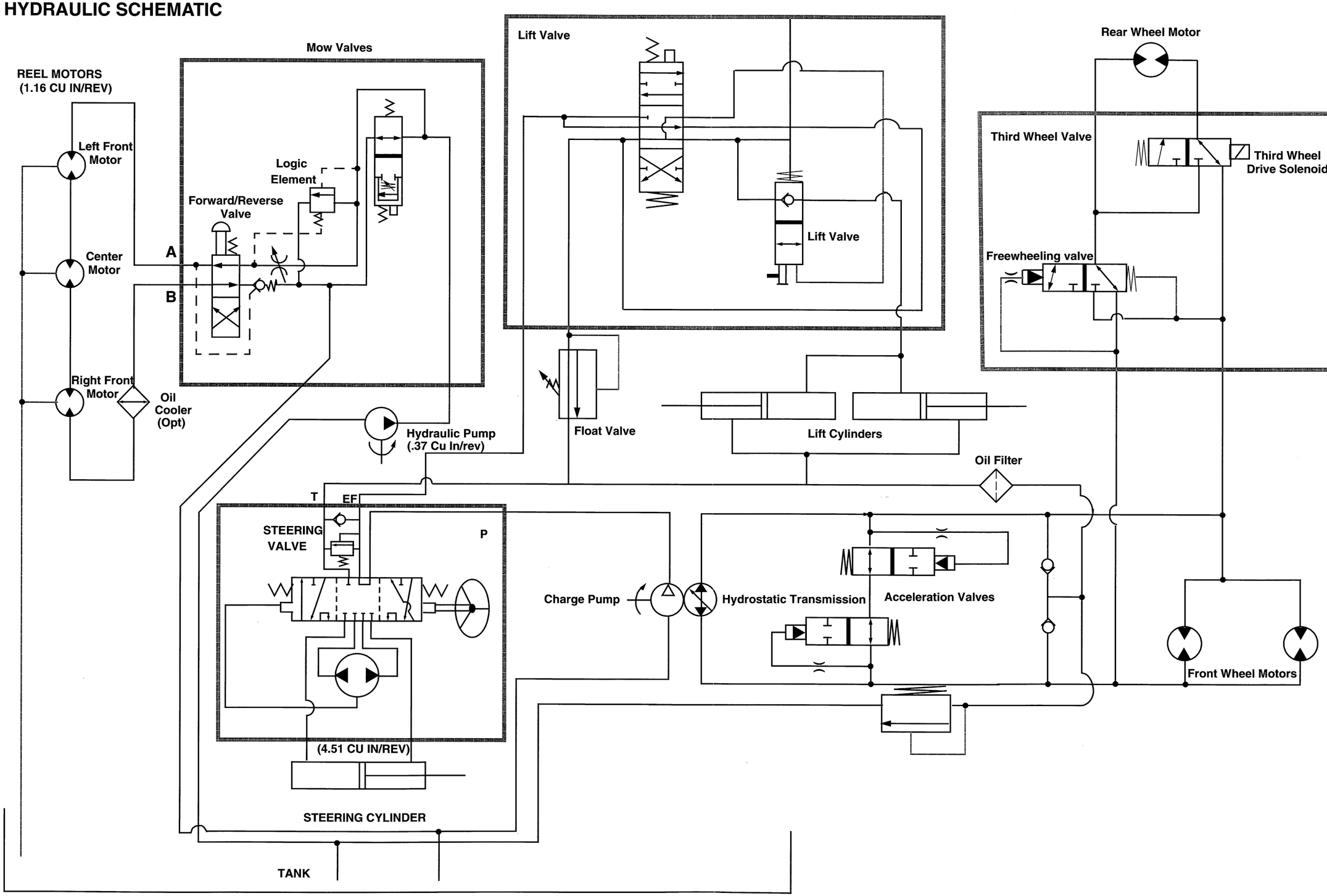
Speed for mowing operations is controlled by sliding the speed limiter bracket into position under the foot pedal.

For transport, the speed limiter bracket slides out of the way and allows the foot pedal to be moved to its full travel limits.

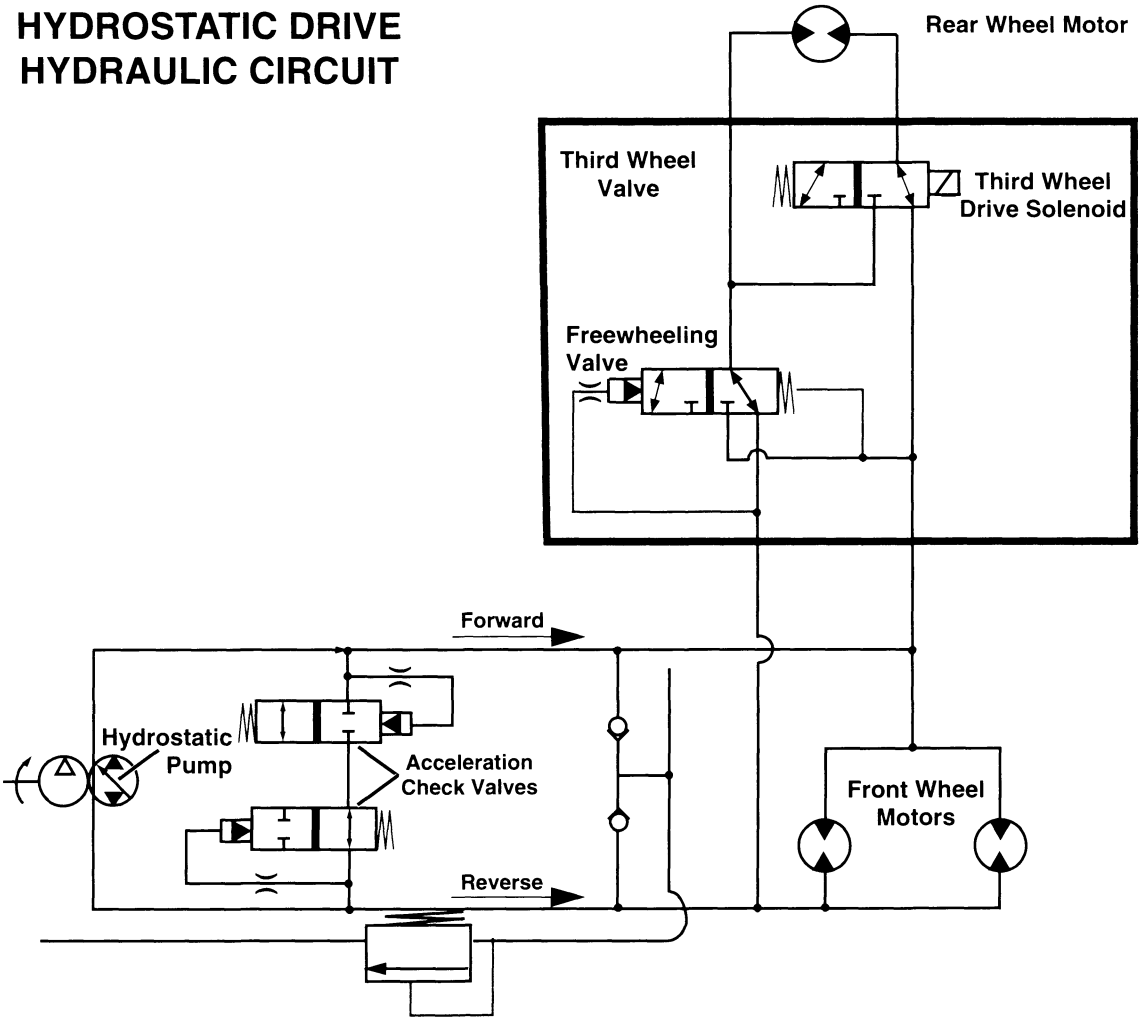
Runaway Operation (Three wheel drive only)

To prevent loss of steering control when operating on steep inclines, the third wheel valve incorporates a pressure sensing release valve in the return line of the third wheel hydraulic circuit. This valve senses when pressure in the return line exceeds the pressure in the supply or pressure line of the third wheel circuit (high pressure in the return line is a result of the vehicles momentum working against or trying to drive the hydrostatic pump). If the pressure where allowed to build without being relieved, the third wheel would lock-up and steering control would be lost.

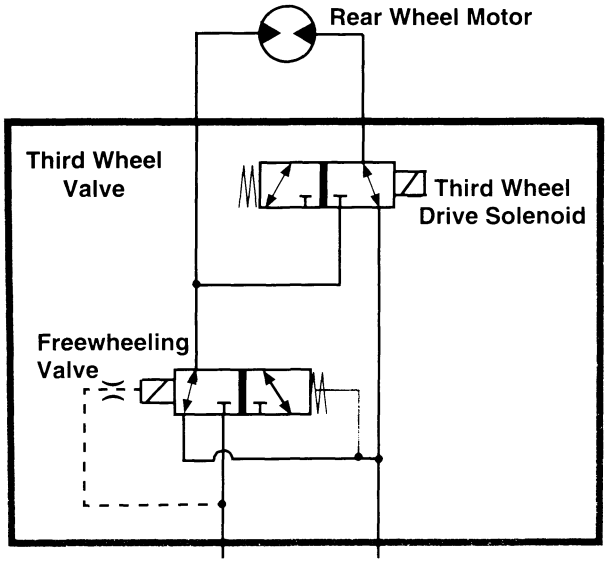
HYDRAULIC SCHEMATIC



HYDROSTATIC DRIVE HYDRAULIC CIRCUIT



Conditions:
Park Brake "OFF"
Transmission/Neutral Switch "Trans"
Operator On Seat
PTO Switch "ON" (Mowing Operation Only)
Raise/Lowered Switch "Lowered" (Mowing Operation Only)
Third Wheel Drive Solenoid "Energized" (Mowing Operation Only)
Mow Valve Solenoid "Energized" (Mowing Operation Only)
Third Wheel Shutoff Shuttle Valve "Energized" (Runaway Operation)



HTESTS AND ADJUSTMENTS

TORQMOTOR TEST

Reason:

To determine if the Torqmotor is operating at peak efficiency.

Equipment:

JTO5984 Flo Tester

Fabricated wheel stop

Photo Tachometer

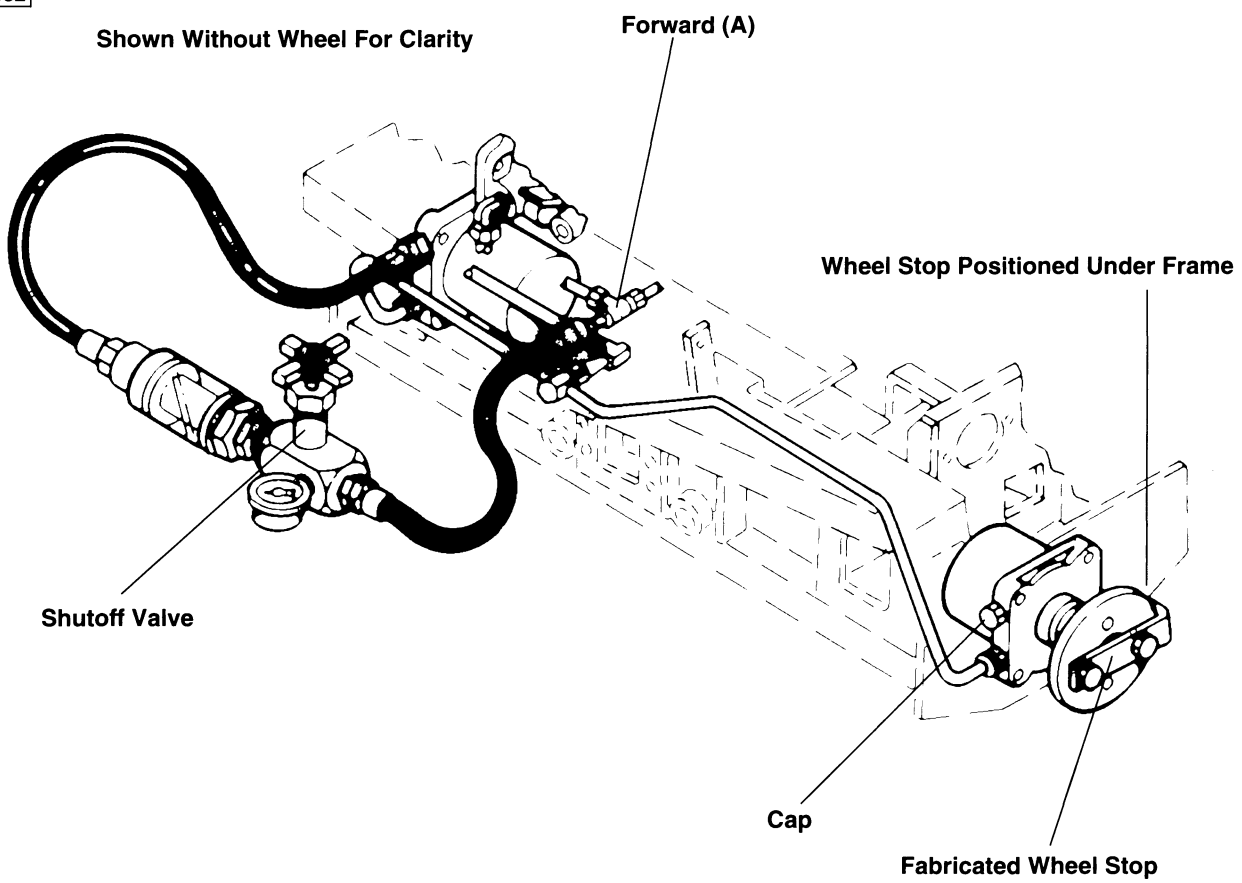
Connections:

- Remove the Upper hydraulic line (Forward operation) and install a flow tester capable of handling 30 GPM at 3000 psi on the wheel being tested.
- Install a cap on the wheel not being tested.
- Ensure the Mow switch is OFF when testing a front wheel motor.
- Install the wheel stop on the front wheel not being tested as shown.

Procedure:

1. Start engine and allow it to reach normal operating temperature.
2. Depress foot pedal to full Forward position.
3. Slowly buildup pressure with the shutoff valve until **1500 psi** is indicated on the pressure gauge.
4. Using a photo tachometer, measure the rpm of the wheel being tested.
5. Indicated rpm should be at least **300 rpm**, if not, disassemble and repair the torqmotor.
6. Remove test equipment and reconnect hydraulic lines. Replenish Hydraulic reservoir.

M56532



HYDROSTATIC PUMP OUTPUT TEST

Reason:

To determine if the pump flow falls below **16 GPM at 1500 psi.**

Equipment:

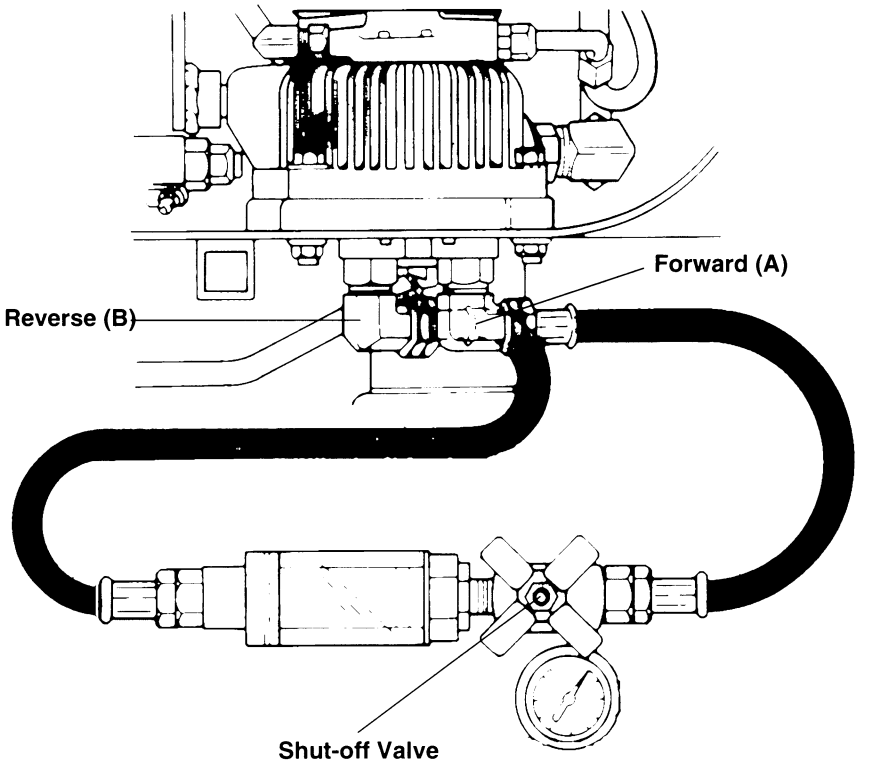
JTO5984 Flo Tester

Connections:

- Disconnect the output lines (A) and install a flow tester capable of handling 30 GPM at 3000 psi.

Procedure:

1. Start engine and allow it to reach normal operating temperature.
2. Depress foot pedal to full Forward position.
3. Slowly buildup pressure with the shutoff valve while observing fluid flow until **1500 psi** is indicated on the pressure gauge. Fluid flow should not fall below **16 GPM.**
4. If fluid flow falls below **16 GPM or at least 1500 psi (1800 psi maximum)** cannot be obtained, repair or replace the hydrostatic pump.
5. Remove test equipment and reconnect lines. Replenish hydraulic fluid.

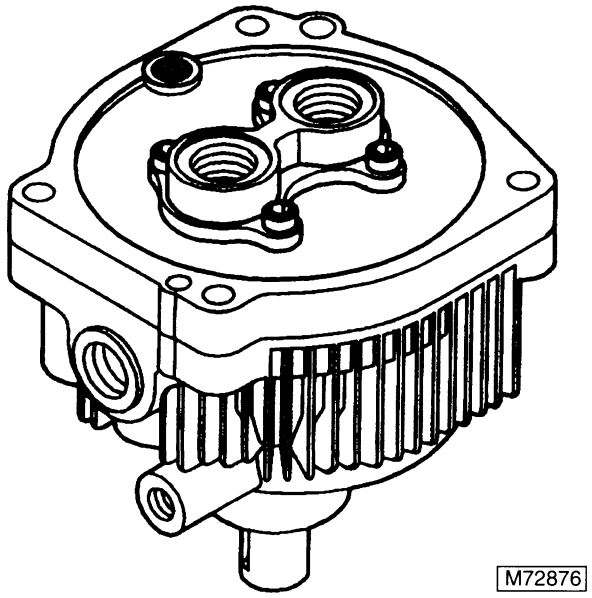


HYDROSTATIC PUMP SERVICE

DISASSEMBLY/ASSEMBLY

Tools Required

- 2" x 6" x 10" Wooden Block with a 3/4" dia. hole in the center
- 2 Large, Wide Rubber Bands
- Two Jaw Bearing Puller, modified slightly to fit notches in charge pump
- Light Petroleum Jelly
- Steel Bar Stock or Wood, 2" dia. x 2 1/2" long

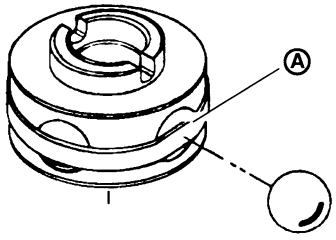


M72876

IMPORTANT: Clean the pump exterior thoroughly before disassembly to prevent foreign material from entering the inner passages while repairing the pump.
Use a cleaning solution that will not affect paint, gaskets, rubber seals and plastic.
When compressed air is used, Do Not expose lip seals or bearing surfaces to high pressure. Drain fluid from pump.

NOTE: A 2" x 6" x 10" wooden block with a 3/4" hole in the center is recommended for a suitable bench fixture

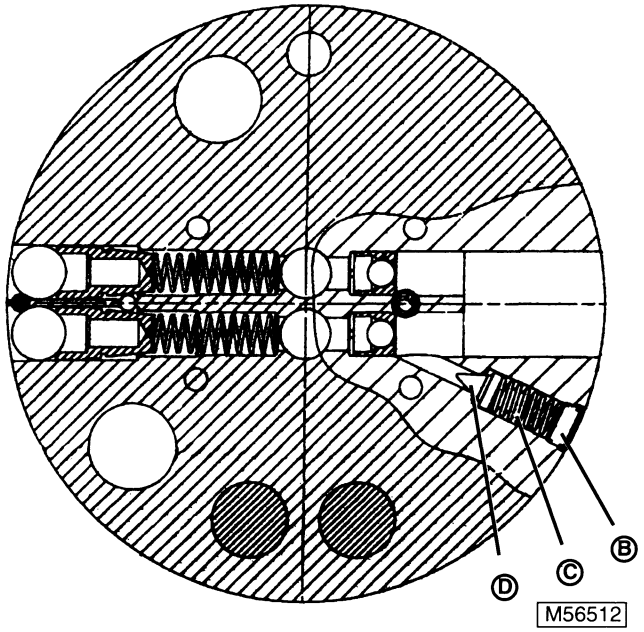
1. Remove six socket head cap screws securing the pintle cover to the pump housing and pintle.To ease disassembly, rotate the cover 1/4 turn and then remove.
2. Hold the pump assembly at the bottom and tap lightly on the cover with a wood or plastic hammer to prevent damage to the aluminum cover. Lift the pintle assembly out.



M72877

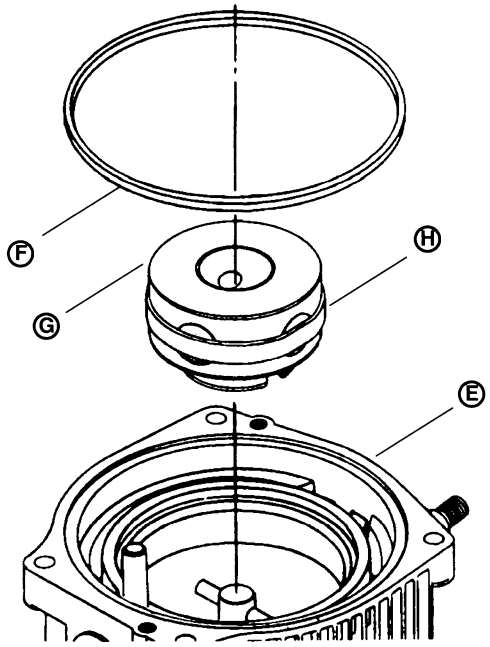
3. The pump ball piston assembly must remain intact as the ball pistons are matched to the pump rotor. Use a wide rubber band (A) to retain the ball pistons in place during handling.

NOTE: Normal flushing should be adequate to clean the pintle assembly. If the pintle assembly cannot be cleaned with flushing, replace it.



M56512

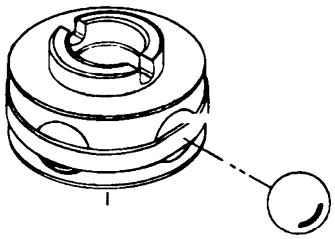
4. Use a 1/4" allen wrench to remove the relief valve plug (B). Then remove spring (C) and needle valve (D).
5. Inspect all parts for irregularities. Replace any defective part(s).
6. Install needle valve, spring and plug in pintle.
7. Screw plug (B) in to just below surface of pintle. **Do Not tighten.**



M72878

8. Remove seal (F) from cover (E), lift pump rotor assembly (G) intact from the cover assembly.

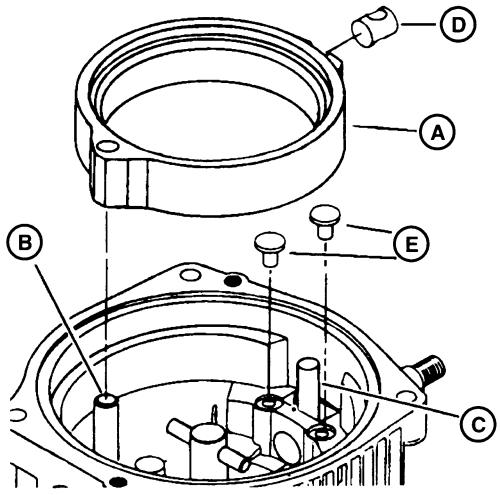
IMPORTANT: Use a wide rubber band (H) to retain the ball pistons in place during handling. The pump ball piston assembly must remain intact as the ball pistons are matched to the pump rotor.



M72877

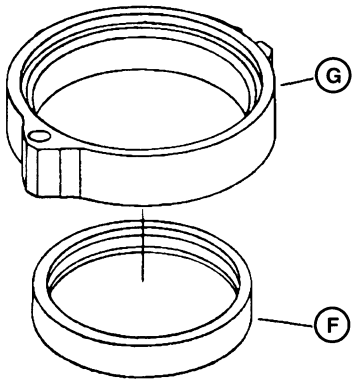
NOTE: Each ball must be replaced in the same bore from which it was removed. Use a suitable container for piston ball storage such as an egg carton or ice cube tray.

9. Inspect the rotor assembly. Remove the piston balls from the rotor, one at a time, by working clockwise from the letter stamped in the face of the rotor and placing in a prepared container.
10. Inspect the piston balls. They must be smooth and completely free of any irregularities.
11. Inspect rotor bores, rotor bushing and pintle journals for irregularities or excessive clearance. The ball piston to rotor bore clearance is select fit electronically to .0002 - .0006 of an inch. When irregularities or excessive clearance are noted, replace the complete rotor assembly.
12. Install pump ball pistons in their matching bores. Hold them in place with a rubber band.



M72879

13. Slide the cam ring (A) from the pivot pin (B) and control shaft (C) in the cover. Then lift ring from the cover.
14. Remove the control shaft insert (D).
15. Inspect the area where the ball pistons contact the race. This area must be smooth and completely free of irregularities. If it is not, replace the pump race.



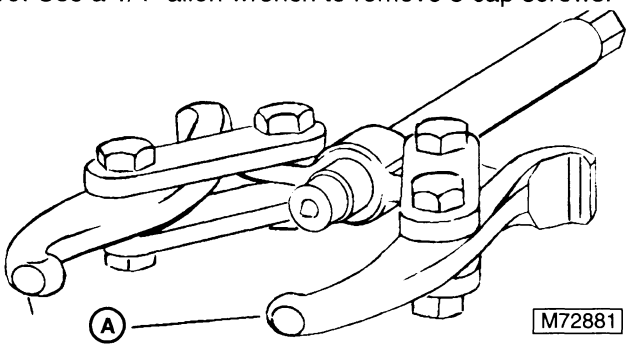
M72880

NOTE: The pump race (F) is press fit in the cam ring (G) and will require a press to remove it. The cam ring and pump race are available as an assembly.

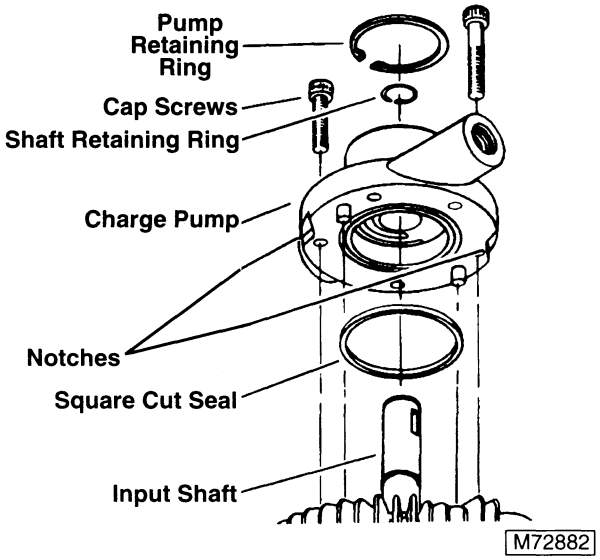
16. Remove the two buttons (E) from the cover.

IMPORTANT: Do Not pound on the bearing puller while removing the charge pump body. Apply force with a steady pull only.
Do Not damage the bore of the input shaft during removal of charge pump.

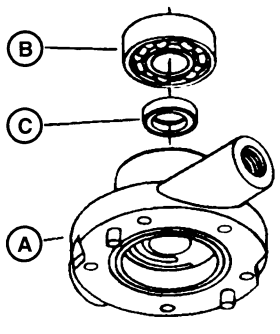
17. Remove pump retaining ring.
18. Remove shaft retaining ring.
19. Use a 1/4" allen wrench to remove 5 cap screws.



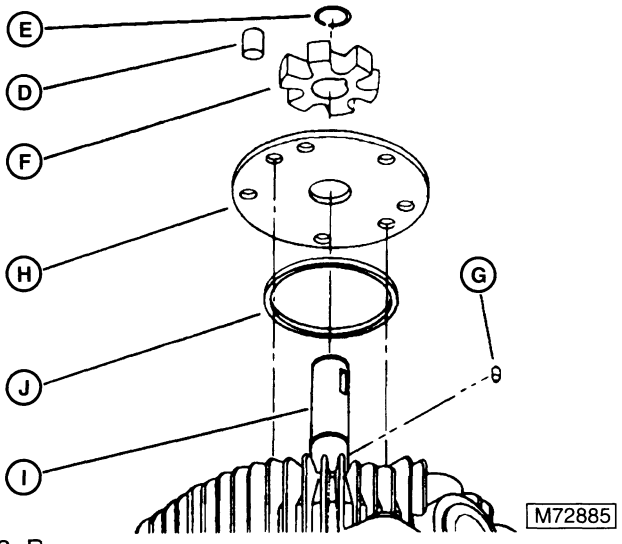
20. Use a modified two-jaw bearing puller, pulling against the two notches machined in the housing to remove the charge pump assembly.



21. Remove the square cut seal from the pump assembly.



22. Remove the bearing (B) and oil seal (C) from the charge pump (A). Discard the oil seal.

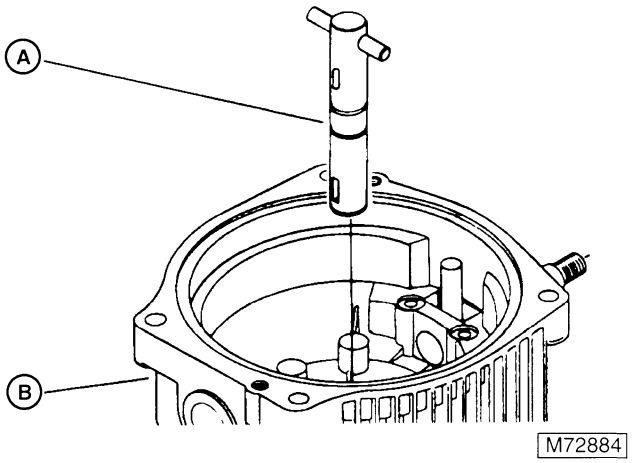


23. Remove 6 carrier rolls (D).
24. Remove snap-ring (E).

IMPORTANT: Do Not mark the carrier roll in such a way that would damage the carrier surface.

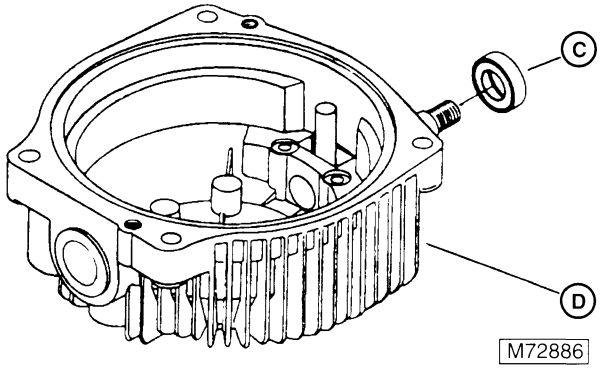
25. Mark top of carrier (F) indicating which side is up.
26. Remove carrier and carrier drive pin (G) from input shaft (I).
27. Remove pump plate (H). Remove square cut seal (J) from cover and discard.
28. Inspect the ball bearing. If any irregularities are present, replace the bearing.
29. Inspect the carrier, rolls, and inner race contact areas in the charge pump housing and pump plate. if any irregularities are found, replace the complete charge pump assembly.

IMPORTANT: Be careful not to damage the input shaft bushing in the cover when removing the input shaft.



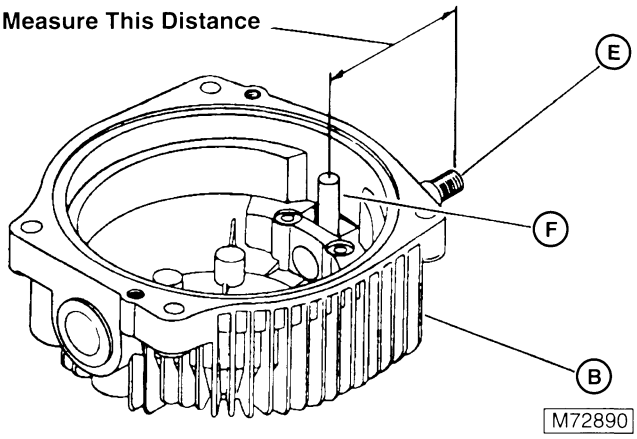
30. Reposition cover assembly (B) as shown, then remove input shaft.
31. Inspect input (A) shaft for stripped keyways or other irregularities. If found, replace the input shaft.
32. Inspect bushing located in face of cover. If broken or damaged, replace cover.

IMPORTANT: Do Not scratch the control shaft or distort the seal counter bore when removing seal.

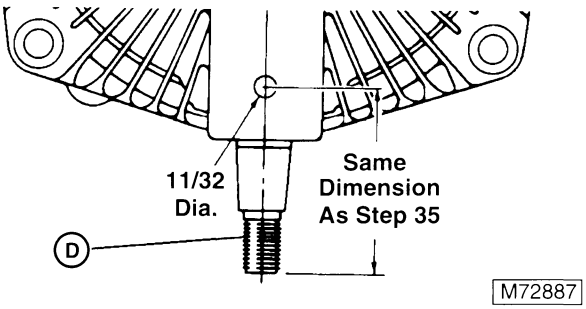


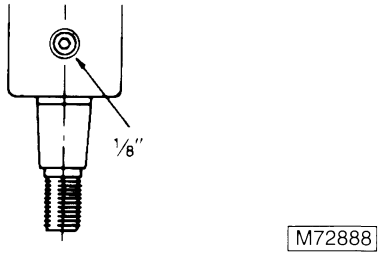
33. Use a sharp, narrow edged tool to pierce the top metal part of the oil seal (C) and remove seal from the cover (D)

NOTE: In most cases, it will not be necessary to remove the control shaft from the cover. if the dowel is loose or broken in the control shaft, remove the shaft using the following procedures.

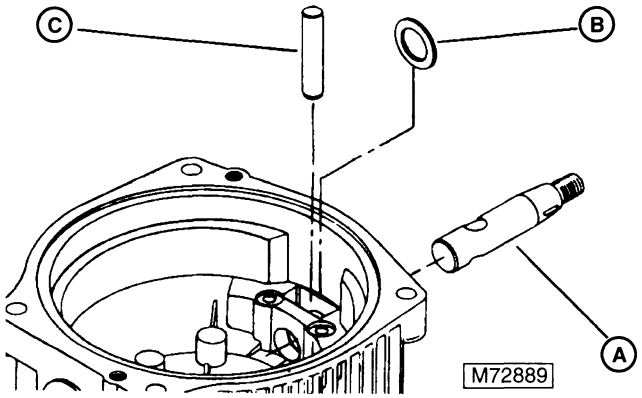


34. Inspect cover assembly, especially around the control shaft area. Replace the cover assembly if it is broken, cracked or if side clearance between control shaft (E) and cover exceeds .006".
35. Measure the distance between the center of the dowel pin (F) and the end of the shaft (E) as shown..

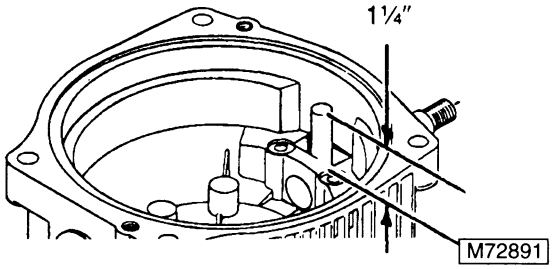


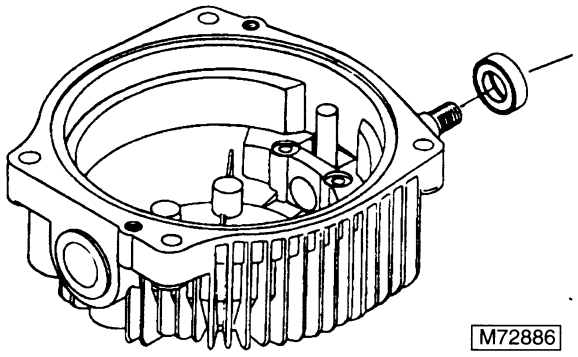


36. Turn cover over. use dimension obtained in step 35 to locate dowel pin in cover face. Drill 11/32' diameter hole at the center point of dowel pin. Drill hole exactly in line with center of shaft
37. Press damaged pin from control shaft.
38. Remove control shaft and washer.Tap hole drilled in step 66 with a 1/8" pipe tap. Install 1/8" diameter flush type pipe plug.



39. Install new control shaft (A) and washer (B) in cover.
40. Press new dowel pin (C) through the shaft. Leave 1 1/4" of dowel extending from the shaft.

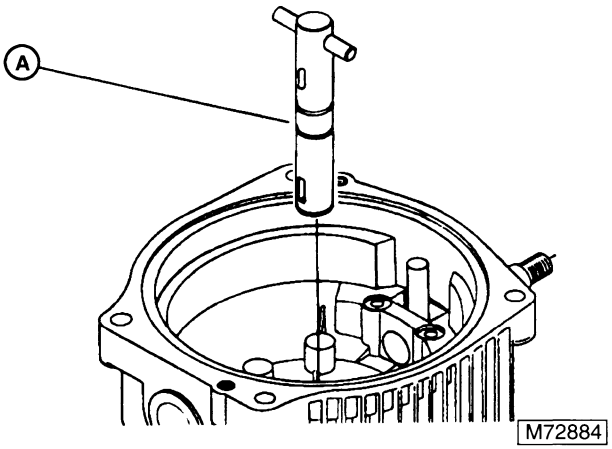




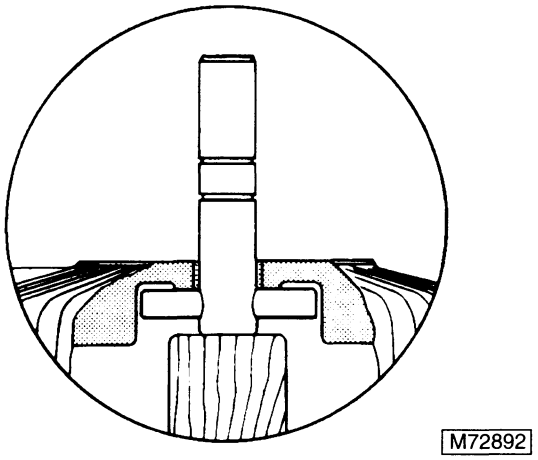
IMPORTANT: Be careful not to damage the inner portion of the oil seal. Excessive pressing or driving of the oil seal will damage the rubber portion of the oil seal.

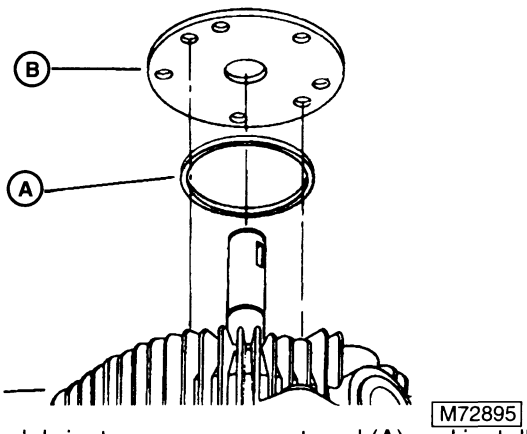
41. Lubricate I.D. of new oil seal with clean lubricant. Then press or tap seal (D) in bore until completely seated.

42. Install input shaft (E) in cover.



43. Turn cover over. Support input shaft from underneath. Use a piece of steel bar stock or hard wood 2" in diameter by at least 2 1/2" long to keep the shaft cross pin against the cover.



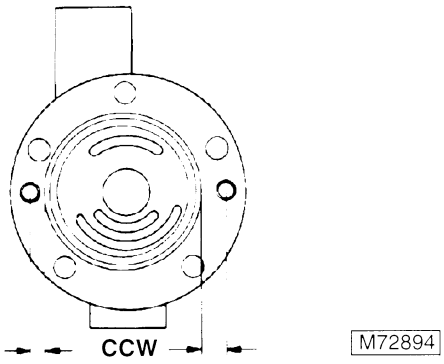


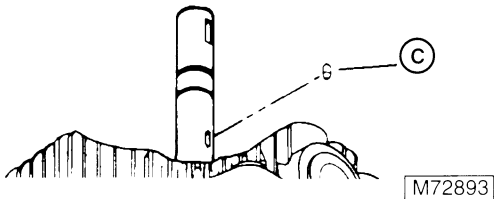
44. Lightly lubricate new square cut seal (A) and install in seal groove in cover

IMPORTANT: Stamping on cover indicates if charge pump rotation is clockwise or counterclockwise.

45. Install pump plate (B) on cover. Either side of the pump plate may face the cover regardless of input rotation.

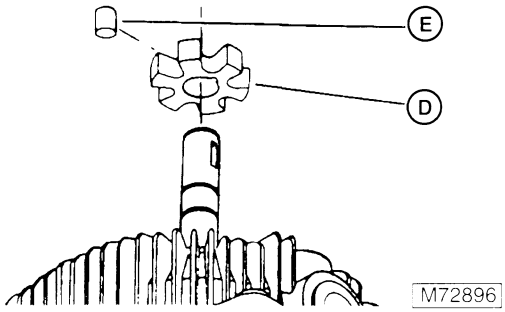
NOTE: If the charge pump body is replaced, it may be necessary to check the input rotation before assembly.





46. Lubricate carrier drive pin (C) and install in keyway of input shaft

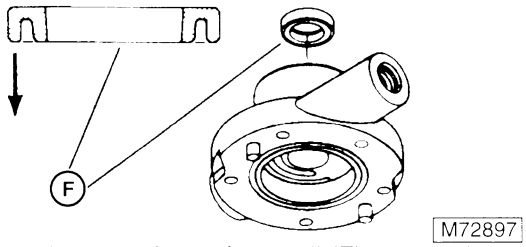
IMPORTANT: For correct carrier rotation, the leading edge of the carrier must rotate in the same direction as the input shaft.



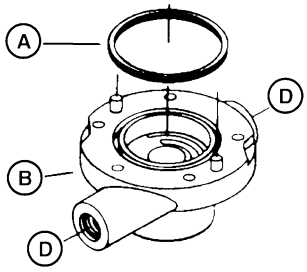
47. Install carrier (D) over input shaft with side marked "UP". Ensure keyway in carrier fits over carrier drive pin in input shaft.

48. Lightly lubricate and install the six carrier rolls (E) in the carrier. Use a small amount of petroleum jelly or equivalent to hold the rolls in place.

IMPORTANT: Excessive pressing or force on oil seal may cause damage to rubber sealing portion or may distort counterbore of housing.

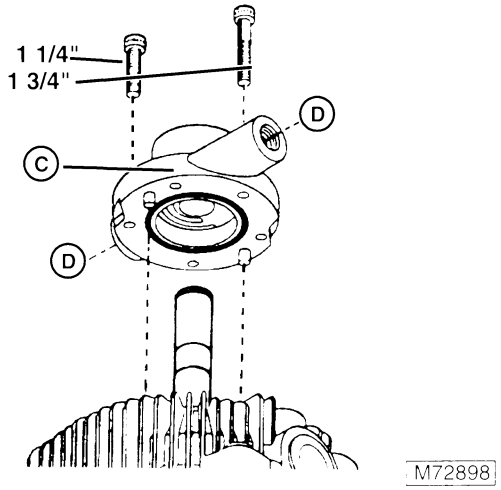


49. Lubricate inner surface of new oil (F) seal and install in charge pump housing as shown with the rubber lip toward the bore. Ensure seal is completely seated.

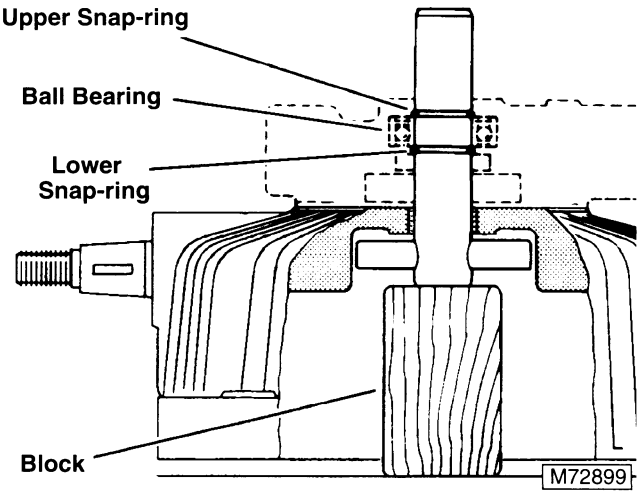


50. Lightly lubricate new square cut seal (A) and install in seal groove of pump housing (B).

IMPORTANT: Elbow fitting (s) (D) must be installed before mounting charge pump (C)

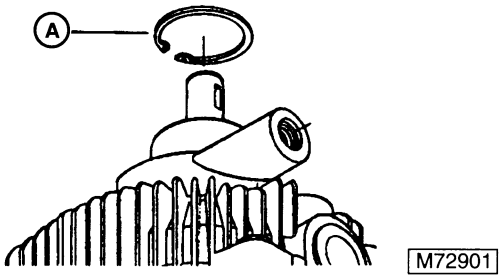


51. Align charge pump dowel pins with holes in cover. Protect oil seal lip from keyways, snap-ring grooves and shaft splines. Then guide pump over shaft, carrier and rolls until pins engage holes.



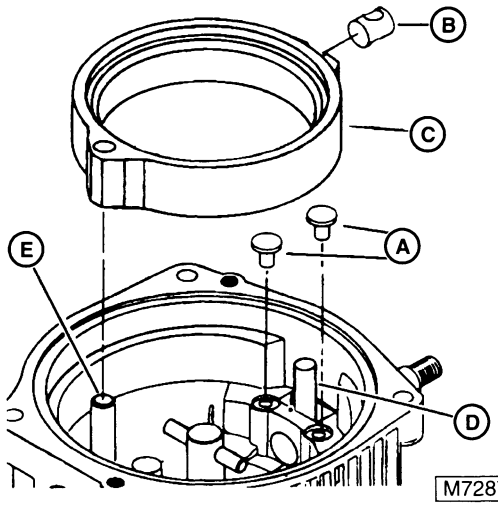
IMPORTANT: Install 1 3/4" screw in thicker section of charge pump body. If installed and tightened in any of the other four holes, internal damage could occur.

52. Install 4 screws (5/16 x 1 1/4") and one screw (5/16 x 1 3/4") in pump housing. **Torque to 20 N•m (15 lb-ft.).**
53. Install snap-ring in lower groove of input shaft.
54. With cover assembly separated from the body and the input shaft properly supported, the input shaft bearing may be pressed into position. (Press to the bottom position in the charge pump housing against the retaining ring).
55. Install snap-ring (A) in upper groove of input shaft against inner bearing race.



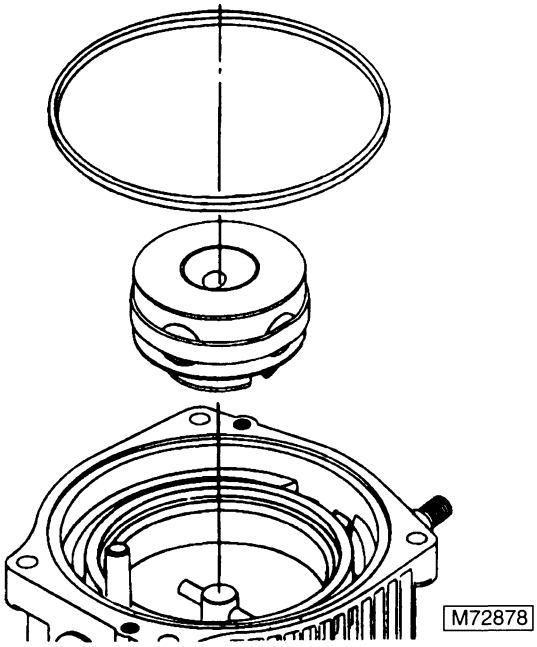
56. Install large snap-ring used to retain bearing in housing.

IMPORTANT: Input shaft must rotate freely by hand. If it does not, recheck installation.



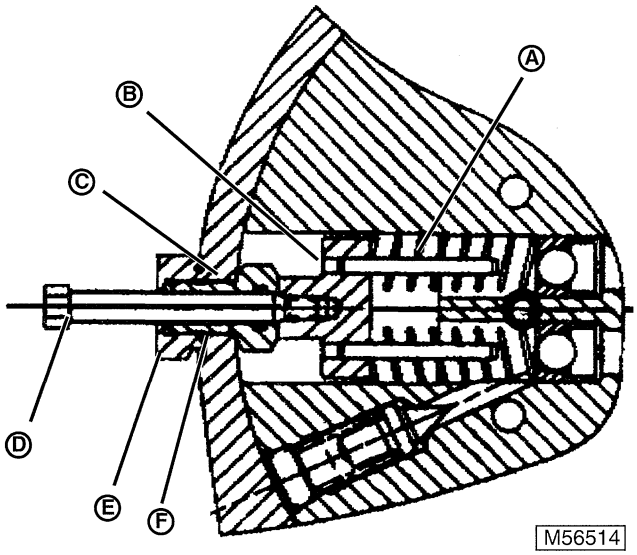
57. Install two buttons (A) in the cover as shownInstall the cam ring insert (B) with the hole away from the cam ring.
58. Align the cam ring (C) with the control shaft pin (D) and the cam ring pivot pin (E).
    Install the cam ring with the flush side of the bearing race facing the cover. Press in firmly until the cam ring has bottomed in the cover assembly.

IMPORTANT: Cam ring must move freely from stop to stop. If binding occurs at either stop, rotate the cam ring insert 180°. Check the cam ring movement again.



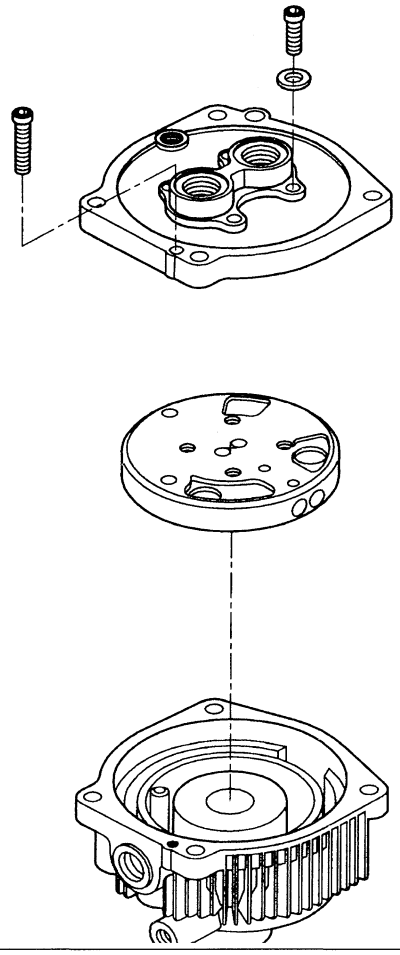
59. Align the slot in the pump rotor with input shaft cross pin. Install rotor assembly on shaft

NOTE: Do Not force pintle into pump rotor assembly. It is a slip fit.



M56514

60. Position the springs (A) onto the plunger (B) and insert this assembly into the check valve bodies.
61. Fit the O-ring onto the sleeve (C) and install the sleeve on the plunger.
62. Align dowel pin hole in pintle assembly with cam ring pivot pin. install the pintle, (while holding the sleeve and plunger assembly [B, C] depressed), into the pump rotor assembly and pump housing.
63. Lightly grease a new square cut seal and install it around the pintle assembly.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64. Install the pintle cover by aligning the cap screw holes. Install six socket head cap screws. Torque to 20 N•m (15 lb-ft.).
65. Lubricate and install O-ring (F) over threaded portion of sleeve (C). Install shoulder nut (E) and tow valve (D).

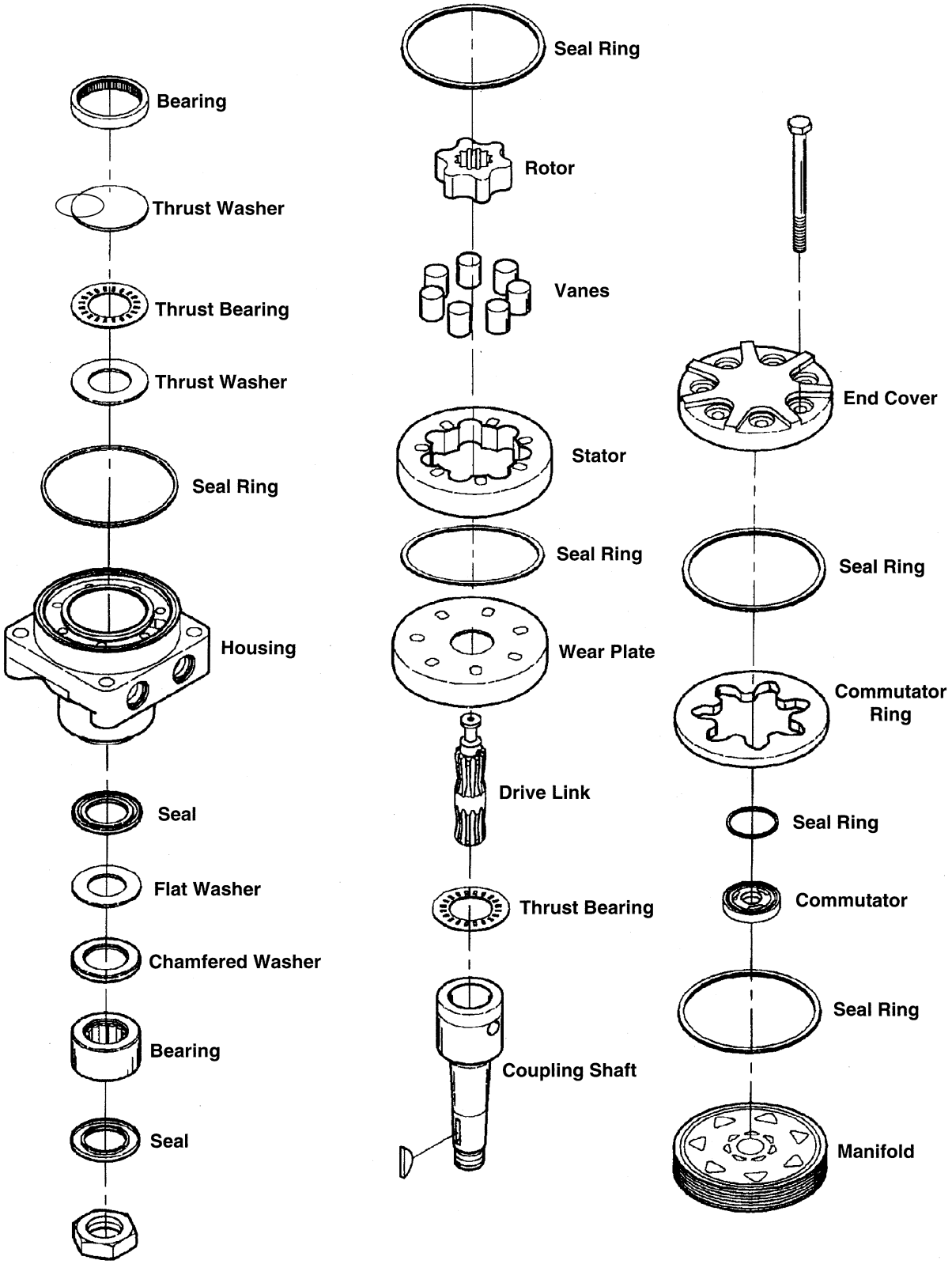
START-UP PROCEDURE

CAUTION

If the pump is installed on machine when accomplishing this procedure, ensure the drive wheels are off the ground and personal are kept clear of machine to prevent personal injury caused by tire rotation.

1. Fill pump with fluid through the case drain port.
2. Cycle pump slowly by hand or reconnect the control linkage. When the control linkage is reconnected, it is recommended to stop the prime while adjusting the linkage to the control handle.
3. Restart the prime mover and stroke the pump two or three times each direction to further purge any trapped air from the system

TORQMOTOR™ COMPONENTS



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TORQMOTOR™ SERVICE

TORQMOTOR™ DISASSEMBLY

Required Tools:

- Feeler gauge
- Torque Wrench
- Etching Ink
- Clean Hydraulic Fluid

⚠ CAUTION

If the torqmotor™ is not held firmly in a vise, it could be easily dislodged during the service procedure, fall, and cause severe personal injury.
• Do not weld, braze, solder or otherwise alter any torqmotor™ component.
replace any component that is damaged or questionable
• Do not force any coupling onto the torqmotor™ coupling shaft as this could damage the motor internally.
• Do not cold straighten, hot straighten or bend any torqmotor™ component.

IMPORTANT: Marking all rotor components and mating spline components for exact repositioning at assembly will ensure maximum wear life and performance of rotor set and Torqmotor™.

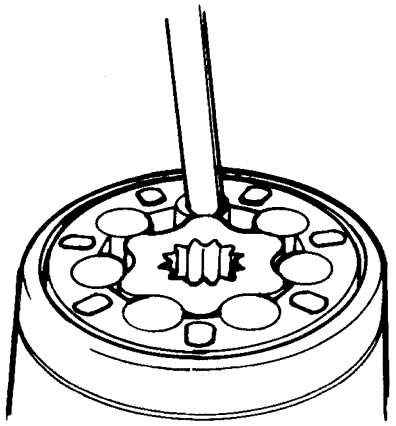
1. Place the Torqmotor™ in a soft jawed vice, with the coupling shaft pointed down and the vise jaws clamping firmly on the sides of the housing, mounting flange or port bosses.
2. Scribe an alignment mark down and across the Torqmotor™ components from end cover to housing to facilitate reassembly orientation where required.
3. Remove the seven end cover bolts and remove the components one by one; make notes of each piece's orientation as they are removed.

FOLLOW THESE NOTES;

- The manifold is constructed of plates bonded together to form an integral component not subject to further disassembly for service. Compare configuration of both sides of the manifold to ensure that the same surface is reassembled against the rotor set.
- The rotor set components may become disassembled during service procedures. Marking the surface of the rotor and stator that is facing "UP", with etching ink or grease pencil before removal from Torqmotor™ will ensure correct reassembly of rotor into stator and rotor set into Torqmotor™.
- Remove seal and backup washers from housing by working them around unseated thrust washers and thrust bearing.
- Do Not remove the main shaft bearings. Removing these bearings will destroy them and replacement bearings are not available.

TORQMOTOR™ COMPONENT INSPECTION

1. A polished pattern (not scratches) on the cover from rotation of the commutator is normal. Discoloration would indicate excess fluid temperature, thermal shock, or excess speed and require system investigation for cause and close inspection of end cover, commutator, manifold and rotor set.
2. Inspect commutator for cracks or burrs, wear, scoring, spalling or brinelling. If any of these conditions exist, replace Torqmotor™.
3. Inspect manifold for cracks, surface scoring, brinelling or spalling. Replace Torqmotor™.
4. Inspect the rotor set in its assembled form for nicks, scoring, or spalling on any surface and for broken or worn splines. if the rotor set component requires replacement, the complete Torqmotor™ must be replaced.
5. Place rotor set and wear plate on a flat surface and center rotor in stator to position the two rotor lobes 180° apart and the roller vane centerline is on the same stator centerline. Check the rotor lobe to rotor vane clearance with a feeler gage at this common centerline. If there is more than 0.13 mm (.005 in.) of clearance, replace Torqmotor™.


M72903

6. Inspect the wearplate for cracks, brinelling, or scoring.
7. Inspect drive link for cracks and worn or damaged splines. No perceptible lash (play) should be noted between mating spline parts.
8. Inspect thrust bearing for wear, brinelling, corrosion and a full compliment of retained rollers.

9. Inspect coupling shaft, seal surfaces and bearing for spalling, nicks, grooves, severe wear or corrosion and discoloration. Inspect for damaged or worn internal and external splines or keyway. Minor shaft wear in seal area is permissible. If wear exceeds 0.51 mm (.020 in.) diametrically, replace Torqmotor™.
   A slight "polish" is permissible in the shaft bearing areas. Anything more would require Torqmotor™ replacement.
10. Inspect housing for cracks, the machined surfaces for nicks, burrs, brinelling or corrosion. Remove burrs that can be removed without changing the dimensional characteristics. Inspect tapped holes for thread damage. If the housing is defective in these areas, replace Torqmotor™.

TORQMOTOR™ ASSEMBLY

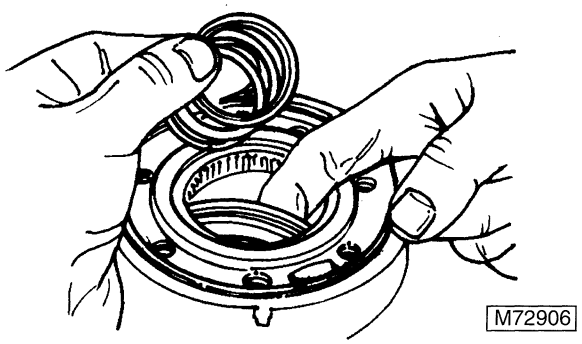
IMPORTANT:

- **Always use new seals and seal rings when reassembling the Torqmotor™.**
- **Unless otherwise indicated, do not oil or grease parts before assembly.**
- **Wash all components in clean petroleum-based solvents before assembly. Blow them dry with compressed air.**
- **Remove any paint chips from mating surfaces of the end cover, commutator set, manifold rotor set, wear plate and housing and from port and sealing surfaces.**

⚠ CAUTION

Always wear safety glasses when using a press or compressed air to prevent serious personal injury.

1. Thoroughly coat the outer bearings with clean corrosion resistant grease.
2. Install chamfered washer, flat washer and lip seal (lip facing out) past the unseated washers and thrust bearing.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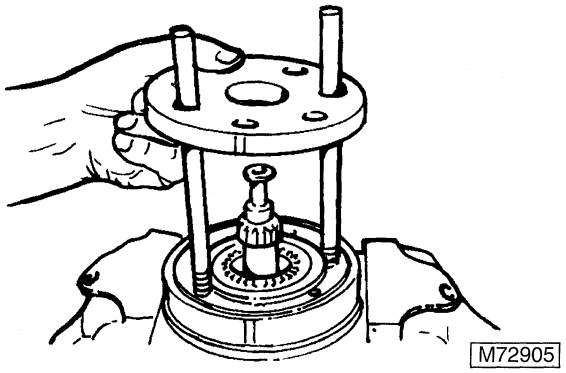
3. Apply masking tape to the threaded portion of the shaft to prevent damage to seal.Install the coupling shaft into the housing, seating it against the thrust bearing. The coupling shaft must rotate freely against the thrust bearing when installed.
4. Install thrust bearing onto the end of coupling shaft.
5. Apply a small amount of clean grease to a new seal ring and insert it into the housing seal ring groove.

NOTE: One or two alignment studs screwed finger tight into the housing bolt holes 180° apart, will facilitate the assembly and alignment of components as required in the following procedures. The studs can be made by cutting off the heads of 3/8-24 UNF 2A bolts that are at least .5 in. longer than the bolts used on the Torqmotor™.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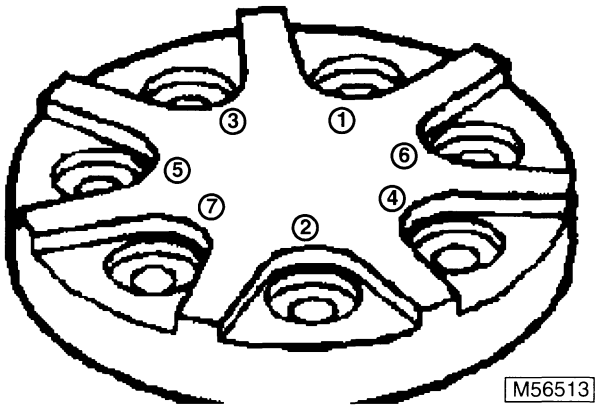
6. Install drive link (long splined end down and previously marked when disassembled) to engage the coupling shaft splines.
7. Install wear plate.
8. Apply a small amount of clean grease to the seal ring and install seal ring.
9. Install the assembled rotor set onto wear plate with rotor counterbore and seal ring down.

NOTE: The manifold surface that must contact the rotor set has a set of irregular shaped cavities on the largest circumference or circle around the inside diameter. This surface may appear polished from contact with the rotor set.

10. Apply clean grease to a new seal and install it into the manifold, place the manifold onto the assembly rotor set contact side down.
11. Install a new seal and the commutator ring.
12. Install a new seal ring (flat side up) on the commutator and install on the assembly (seal side up).



13. Install a new seal ring onto the end cover and install end cover. Torque bolts in sequence shown in two steps to a final torque of **61-75 N•m (45-55 lb-ft.).**

FINAL CHECKS

1. Pressurize the Torqmotor™ with 100 PSI dry air or nitrogen and submerge in solvent to check for external leaks.
2. Check Torqmotor™ for rotation. Torque required to rotate the coupling shaft should not be more than 68 N•m (50 lb-ft.).

NOTE: Pressure port with "B" cast under it on housing is for clockwise rotation and port "A" is for counterclockwise rotation.

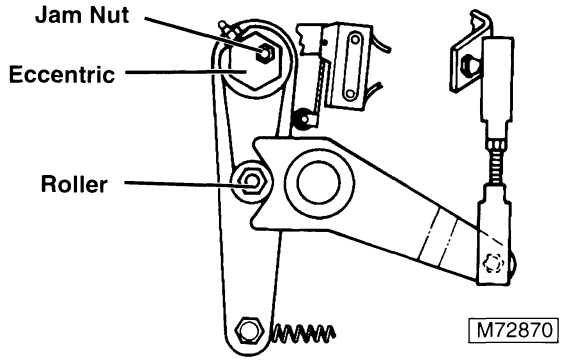
3. Use test stand if available, to check for proper operation of the Torqmotor™.

TRANSMISSION NEUTRAL ADJUSTMENT

1. Raise and support vehicle with suitable support stands. Ensure vehicle is raised high enough that all three wheels can rotate freely without contacting the ground.
2. Inspect drive linkage for wear, excessive play, corrosion or any damage that could cause binding or restrict full travel of the pedal assembly. Repair or replace if necessary. Lubricate cam roller and eccentric adjustment mechanism.
3. Disconnect seat switch and install a jumper wire across the open contacts of the seat switch connector.

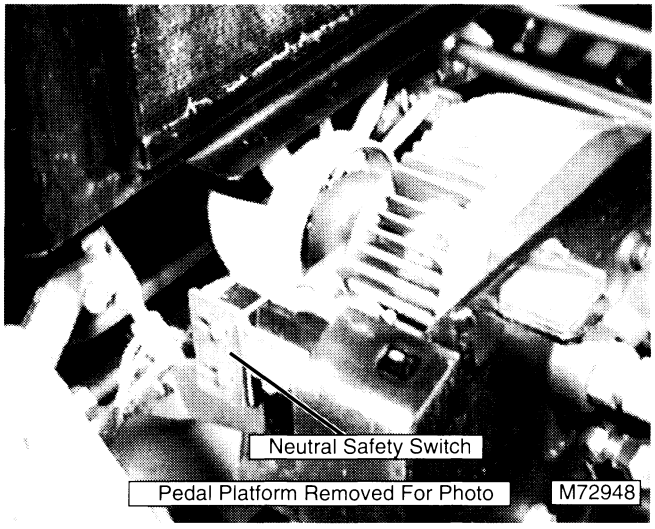
⚠ CAUTION

Rope off the perimeter of the machine to prevent personnel from approaching or standing near the rotating wheels of the machine during operation.



4. Release the parking brake and start the engine. Advance the throttle to the wide open position.
5. Loosen the jam nut on the eccentric adjustment nut. Rotate the adjustment cam with a wrench until the drive wheels stop turning. Tighten the jam nut.
6. Depress the Forward/ Reverse pedal in both directions several times while hesitating in the Neutral position to ensure the drive wheels stop in Neutral. Readjust as necessary and repeat this step after each adjustment.
7. If the wheels do not stop after the pedals are operated, reinspect the pedal linkage for binding and the pedal platform for loose attachments or flexing before readjusting the eccentric mechanism.

NEUTRAL SAFETY SWITCH ADJUSTMENT



1. Loosen two nuts and slide switch towards the lever arm.
2. When adjusted properly, the forward/reverse pedal should move only 1 inch before the engine kills. (If the engine is running, the park brake is engaged and the operator is off the seat).

NOTES:

CONTENTS

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STEERING

SPECIFICATIONS

Steering Control Unit

Make	Eaton
Type	Char-Lynn® 2 Series
Maximum Operating Pressure	70 bar (1000 psi)
Maximum Back Pressure	10 bar (150 psi)
Maximum Operating Temperature	93° C (200° F)
Maximum Flow	15 LPM (4 GPM)
Maximum Differential Temperature (Between Steering Unit and System Temperature)	28° C (50° F)
Input Torque (Powered)	15 - 25 lb-in. @ 100 psi tank pressure
Non-Powered)	81 N•m (60 lb-ft.)
Check Valve For Limited Manual Steering	Yes

TROUBLESHOOTING

Problem or Symptom / Check or Solution	Steering Wanders	Steering Shimmy	Sluggish Steering Response	Excessive Steering Wheel Free Play	High Steering Effort In One	High Steering Effort In Both Directions	Steering Cylinder will Not Fully Extend Or Retract	Wheel Continues To Turn After Steering Wheel Is Stopped
Incorrect Tire Size or Inflation Pressure	●					●		
Steering Cylinder Ball Joints Worn	●	●			●	●		
Internal/External Steering Cylinder Leakage	●		●		●	●	●	
Internal/External Steering Valve Leakage	●		●		●	●	●	
Hydraulic Fluid Contamination		●	●					
Air In System	●	●	●	●				
Hydraulic Fitting(s) Loose	●	●	●					
Hydraulic Line(s)/Oil Cooler Restricted			●				●	
Hydraulic line(s)/Fluid Filter Clogged/Restricted			●		●	●		
Defective Charge pump						●	●	
Engine rpm Too Low			●				●	
Steering Valve Not Mounted Securely				●				
Defective Steering Valve				●	●	●	●	●
Steering Cylinder Rod Bent							●	
Third Wheel Pivot Seized/Bent		●	●				●	

STEERING VALVE OPERATION

Function:

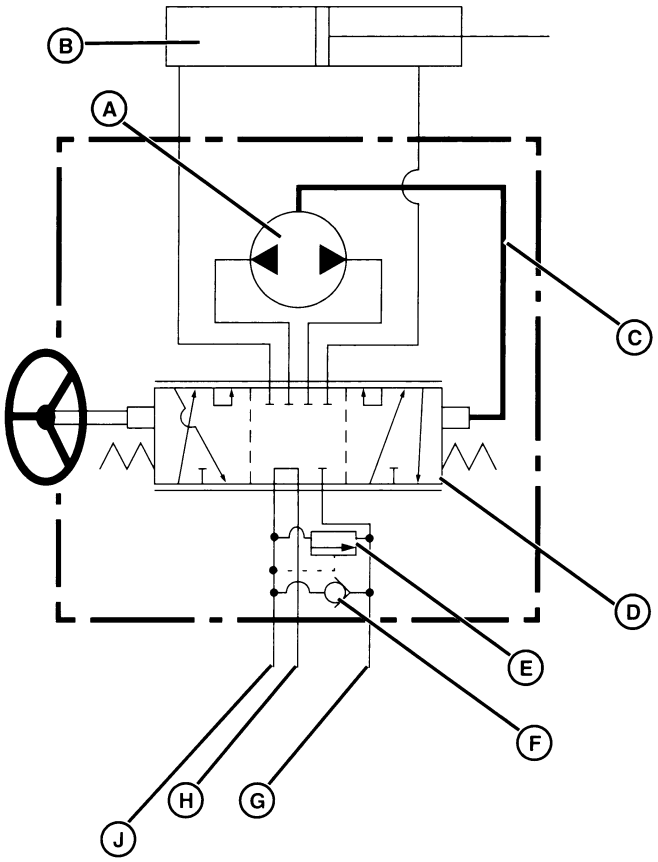
Controls oil flow to and from the steering cylinder for hydraulic or manual steering.

Theory Of Operation:

Hydraulic pressure to operate the steering system is provided by the charge pump. The charge pump, has two functions;

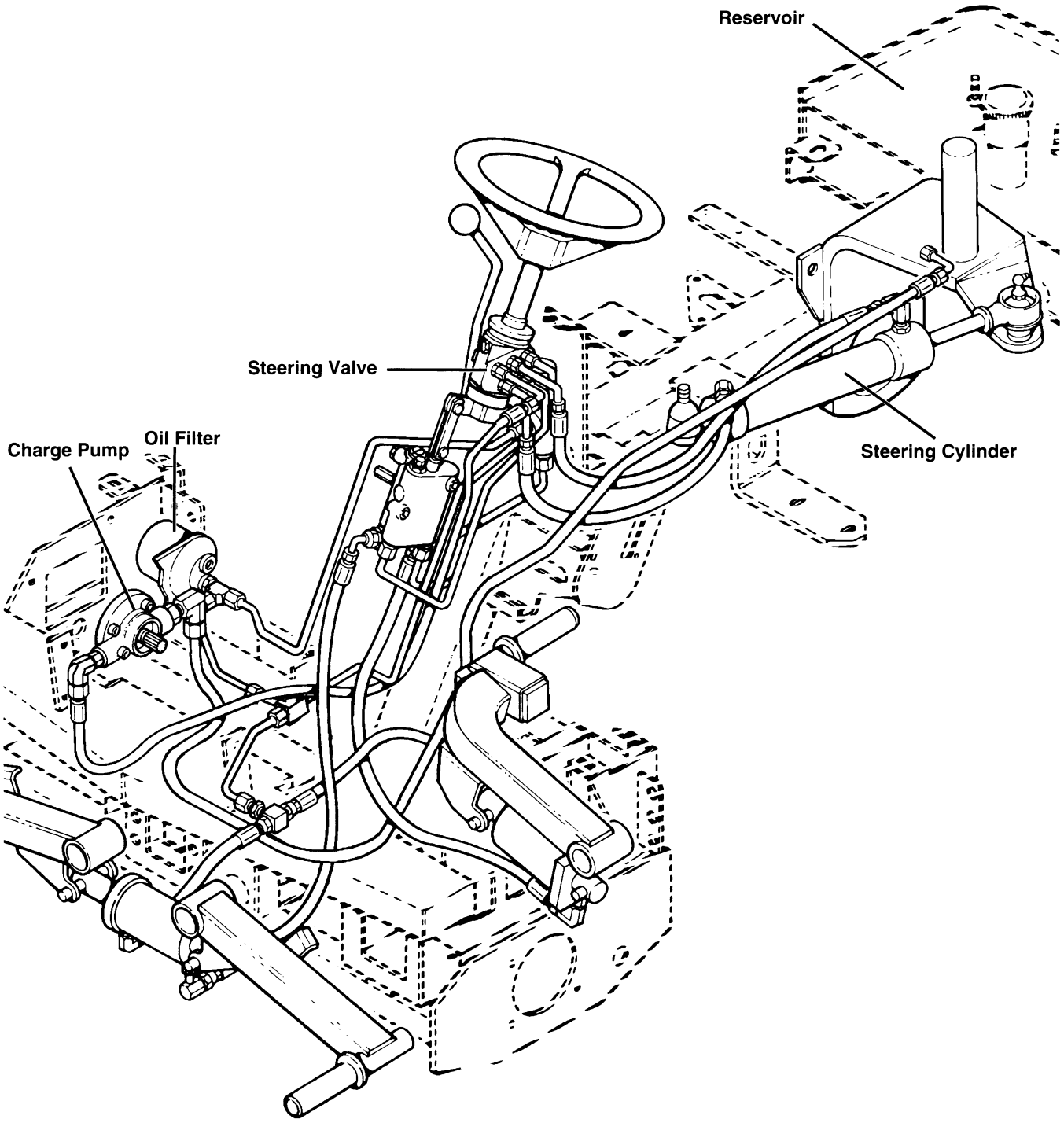
- Maintains a pressure of 2 - 3 Bar (30 - 50 psi) on the low pressure side of the circuit to supercharge the variable displacement pump (Hydrostatic pump).
- Maintains a pressure of 3 - 55 Bar (50 - 800 psi) at 1.7 - 5.7 LPM (.4 - 1.5 GPM) on the auxiliary side of the circuit for steering and lift system operation.

Pressure from the charge pump is routed to the Steering Control Unit (SCU). The SCU utilizes an open center control valve that gives priority to the steering of the machine when turns are initiated and routes pressure to the lift system when the steering wheel is not being turned. In the event that the charge pump should fail or the engine stops running, a gerotor motor, located inside the SCU and mechanically linked to the steering wheel, will act as a pump and supply fluid to the steering cylinder to steer the machine. Fluid supply to the gerotor motor enters the motor through an inlet check valve in the SCU.



A - Gerotor
B - Steering Cylinder
C - Mechanical Link
D - Spool Valve
E - Relief Valve
F - Inlet Check Valve
G - Return Line
H - Lift Valve Pressure Line
J - Charge Pressure

COMPONENT LOCATION



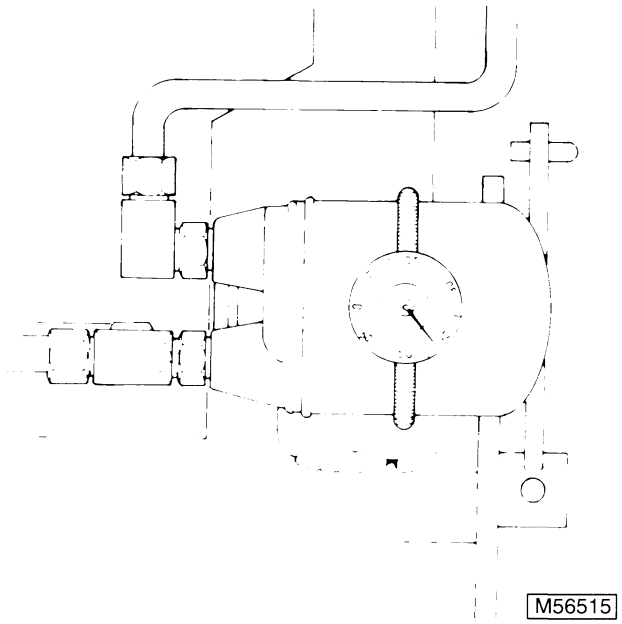
M72933

STEERING CONTROL UNIT (SCU) SERVICE

STEERING SYSTEM LEAKAGE TEST

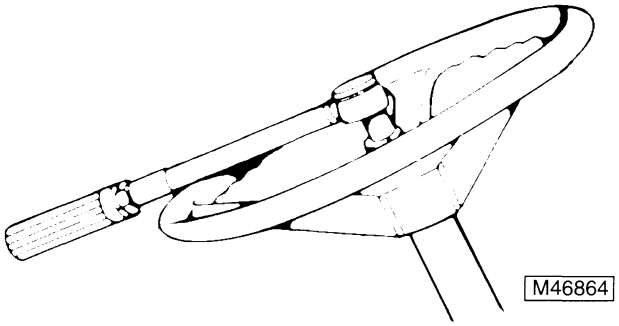
Tools Needed

- Torque Wrench



NOTE: Ensure Hydraulic fluid temperature is 43° C (110° F) or above.

1. Start engine and set throttle to slow idle.



2. With steering wheel at a maximum right turn position, apply a constant torque of 6.8 N•m (72 lb-in.) and count the number of rotations occurring in one minute.
3. Repeat step 2 with the steering wheel at a maximum left turn position.
4. If rpm/min exceeds 6, perform the steering valve leakage test.

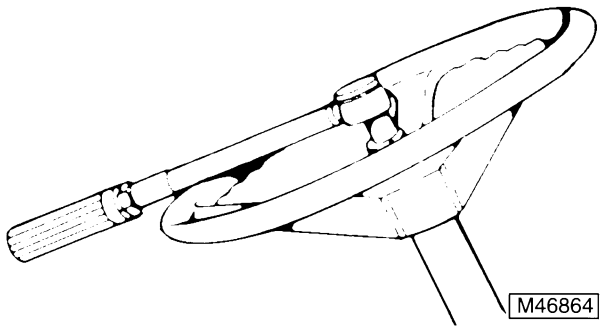
STEERING VALVE LEAKAGE TEST

Tools Needed

- Torque Wrench
- Plugs to cap the lines at the steering cylinder

NOTE: Ensure hydraulic fluid temperature is 43° C (110° F) or above.

1. Disconnect and cap the lines at the steering cylinder.
2. Start engine and set throttle to slow idle.



3. With steering wheel at a maximum right turn position, apply a constant torque of 6.8 N•m (72 lb-in.) and count the number of rotations occurring in one minute.
4. Repeat step 2 with the steering wheel at a maximum left turn position.
5. If rpm/min exceeds 6, repair the steering valve.
6. If rpm/min is less than 6, replace the steering cylinder.

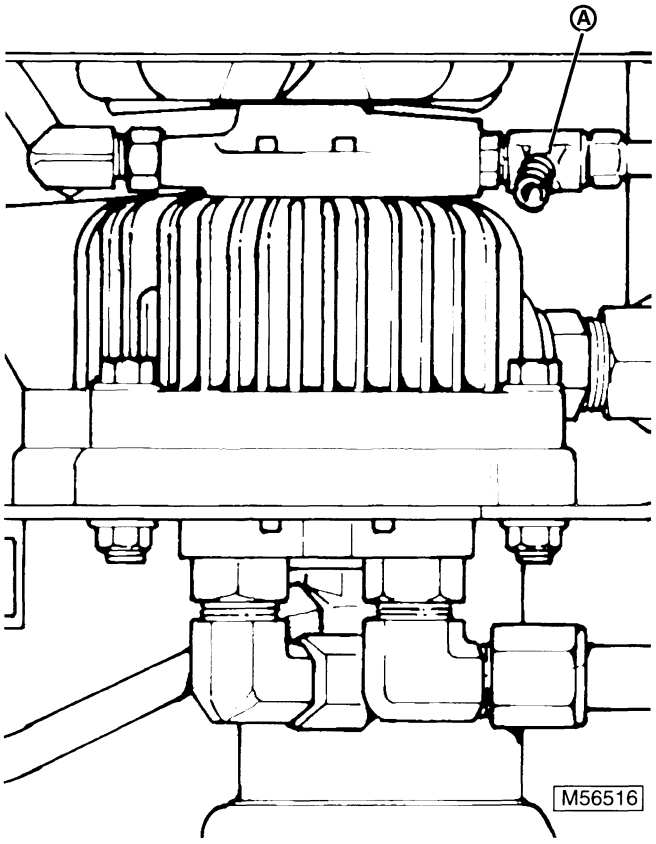
STEERING SYSTEM RELIEF VALVE PRESSURE TEST

NOTE: Ensure Hydraulic fluid temperature is at least 43° C (110° F).

⚠ CAUTION

Ensure system pressure is depleted prior to loosening or removing hydraulic lines to avoid serious personal injury.

1. Deplete system pressure by operating the lift system (if the lift cylinders will not raise the cutting units, the pressure is depleted).



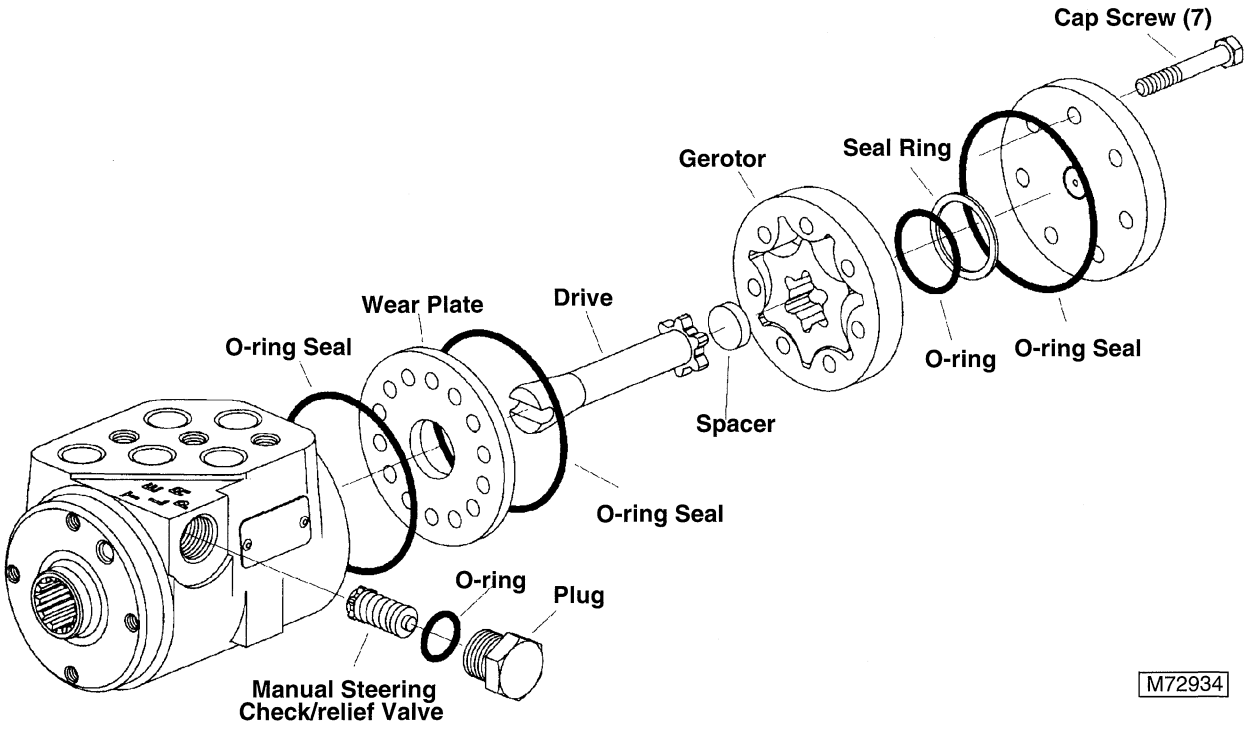
2. Disconnect the charge pump pressure hose and install a "T" fitting (A) and a direct reading pressure gauge.

NOTE: The pressure gauge should be capable of indicating in excess of 70 Bar (1015 PSI).

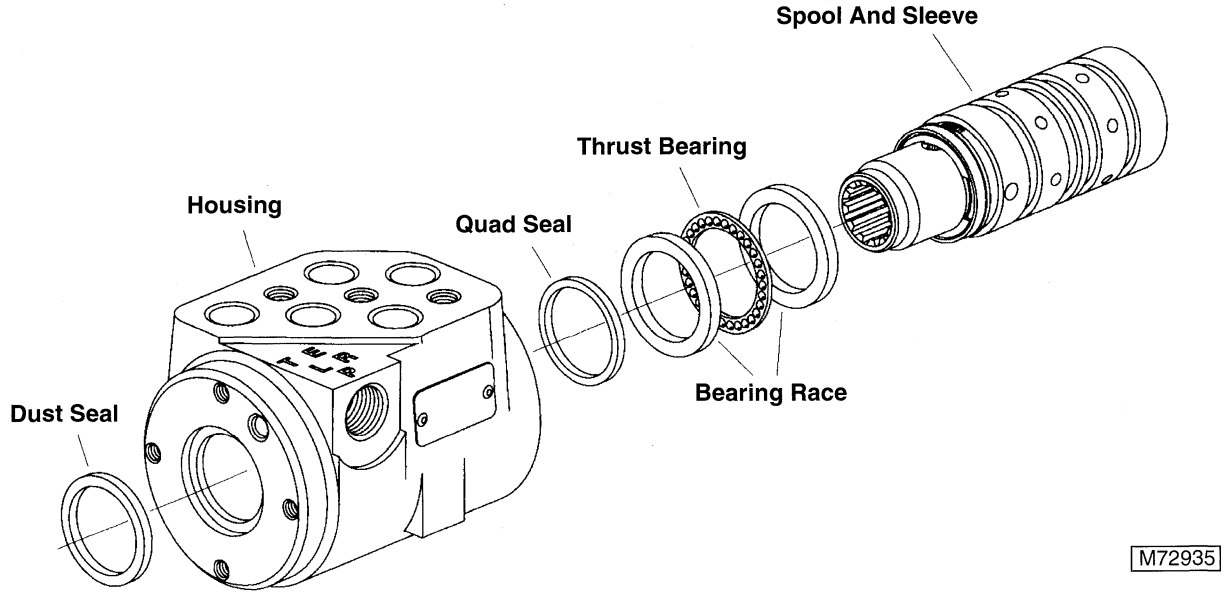
3. Start the engine and set the throttle to Fast Idle.
4. Raise the lift arms and hold the lift lever in the full raise position and record the pressure reading.
5. Indicated pressure should cycle at approximately 900 psi.

STEERING CONTROL UNIT DISASSEMBLY

IMPORTANT: Cleanliness is extremely important when repairing the hydraulic Steering Control Unit (SCU). Before disconnecting the hydraulic lines, clean the port area of the SCU, then drain the fluid and plug all ports. Clean the exterior of the SCU thoroughly and protect the machined surfaces during the repair procedure.

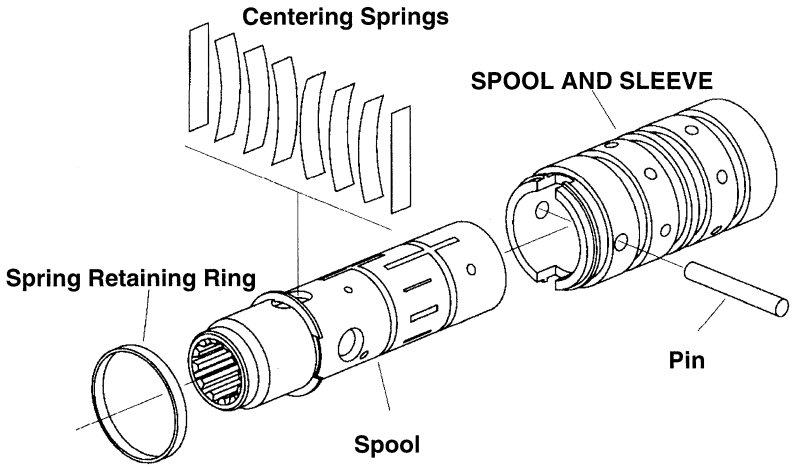


1. Remove the 7 cap screws and disassemble the SCU as shown.
2. Slide the spool and sleeve from the housing.Remove the thrust bearing and bearing races.
3. Remove the quad seal.



IMPORTANT: Do Not damage the dust seal seat.

4. Remove the pin that holds the spool and sleeve together.



5. Carefully slide the spool out of the sleeve. The springs and retaining ring will stay with the spool when it is removed.
6. Remove the retaining ring and springs.

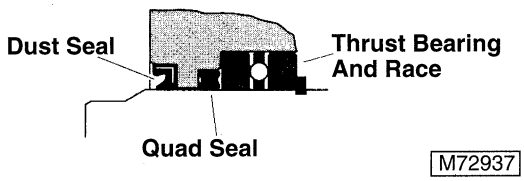
⚠ CAUTION

The centering springs are under tension; Remove the retaining ring carefully.

STEERING CONTROL UNIT ASSEMBLY

IMPORTANT: 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 compressed air. Do Not dry with paper towels or cloth. Lint in a hydraulic system will cause damage.

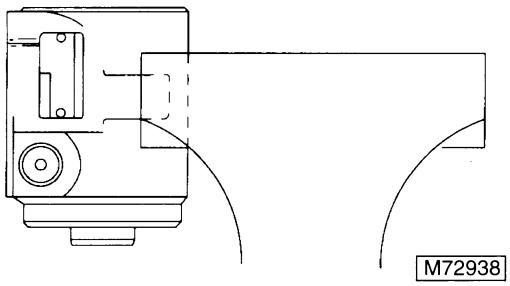
NOTE: Always use new seals when reassembling the hydraulic steering control unit. During reassembly, lubricate the new seals with a petroleum jelly. Also lubricate the machined surfaces and bearings with clean hydraulic fluid.



1. Install the quad seal:
   - Put one of the bearing races and sleeve into the housing.
   - Together, the housing and bearing race create a groove into which the quad seal will be installed.
   - Hold the bearing race tightly against the input end of the housing by pushing on the gerotor end of the sleeve.
   - Fit the quad seal into its seat through the input end of the housing. Ensure the seal is not twisted.
2. Remove the sleeve and bearing race.
3. Lubricate and install the dust seal for correct seal orientation.
4. Install the centering springs in the spool. It is best to install the two flat pieces first. Next install the curved pieces, three at a time.
5. Fit the retaining ring over the centering springs.
6. Apply a light coat of clean hydraulic fluid to the spool and slide it into the sleeve. Ensure the centering springs fit into the notches in the sleeve.
7. Install the pin.
8. Apply a light coat of petroleum jelly to the inner edge of the dust and quad seals.
9. Put the thrust bearing and races into the housing. The thrust bearing goes between the two races.
10. Apply a light coat 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.

11. Clamp the housing in a vise, use just enough clamping force to hold the housing secure.



12. Lubricate and install a new O-ring seal in the groove in the housing.
13. Install the wear plate and align the holes in the wear plate with the threaded holes in the housing.

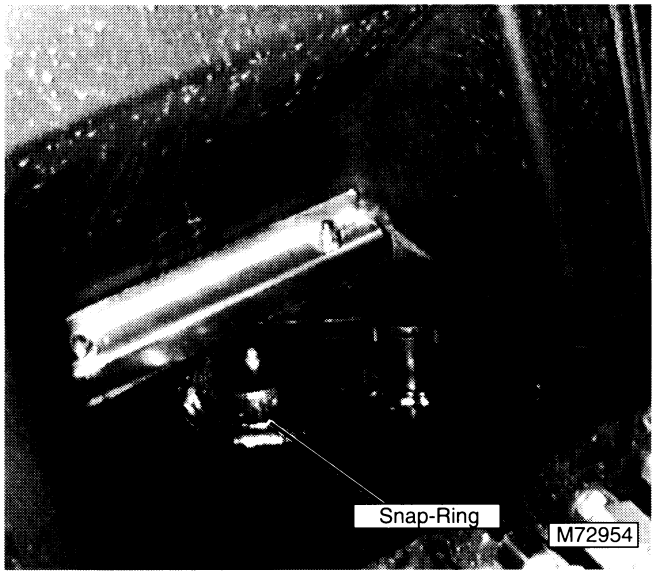
NOTE: The holes in the wear plate are symmetrical.

14. Install the drive, ensure the slot in the drive engages the pin.
15. Lubricate and install a new O-ring seal in the groove of the wear plate.
16. Install the gerotor and align the screw holes.
17. Lubricate and install a new O-ring and seal ring in the groove of the gerotor star.
18. Install the spacer.
19. Install the end cap and 7 cap screws. Tighten the cap screws, in a criss-cross pattern, to 16-18 N•m (140-160 lb-in.).

REAR WHEEL SERVICE

REMOVAL

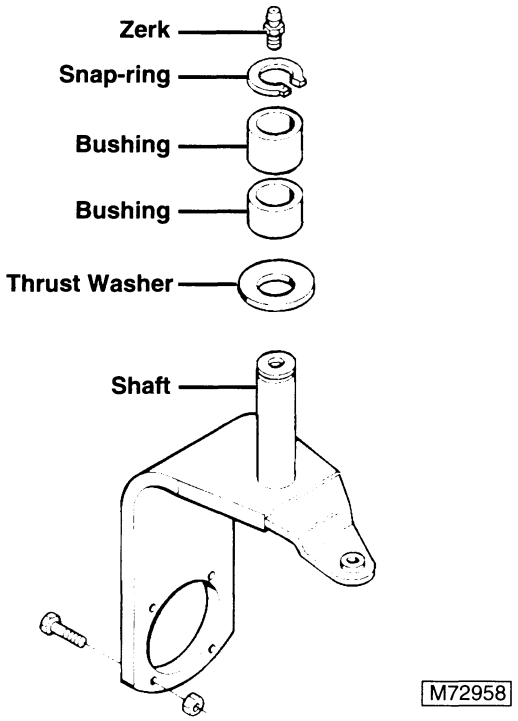
1. Disconnect seat switch and fuel line.
2. Remove the four nuts that secure the seat platform to the vehicle frame and remove the platform.
3. Block the front wheels and support the rear of the vehicle with stands.
4. Remove the third wheel and wheel motor.



5. Place support stands under the third wheel support.
6. Remove snap-ring and lower the third wheel support to the ground.
7. Inspect third wheel support shaft and bushings, replace parts as necessary.

IMPORTANT: If the upper bushing is found near the bottom of the shaft housing, it may be necessary to purchase a third bushing (identical to those found in the housing) to install in the housing as a spacer between the other two bushings.

INSTALLATION



IMPORTANT: If the upper bushing is found near the bottom of the shaft housing, it may be necessary to purchase a third bushing (identical to those found in the housing) to install in the housing as a spacer between the other two bushings.

1. Apply a light film of grease to the third wheel support shaft and bushings.
2. Carefully guide the third wheel support into the shaft housing being careful not to damage the bushings.
3. Install the snap-ring with the sharp edge of the snap-ring up. Be sure it is locked in the groove.
4. Reinstall the wheel motor and wheel.
5. Reinstall the seat platform and connect the fuel line and seat switch.
6. Grease the third wheel support shaft at the zerk fitting.

CONTENTS

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HYDRAULICS

Page

SPECIFICATIONS

Reel Pump

Make	Danfoss
Model, Series	37B
Type	Gear, Positive Displacement
Displacement	0.37 cu-in./rev (6.06 ml/rev)
Operating Pressure	3000 psi max.

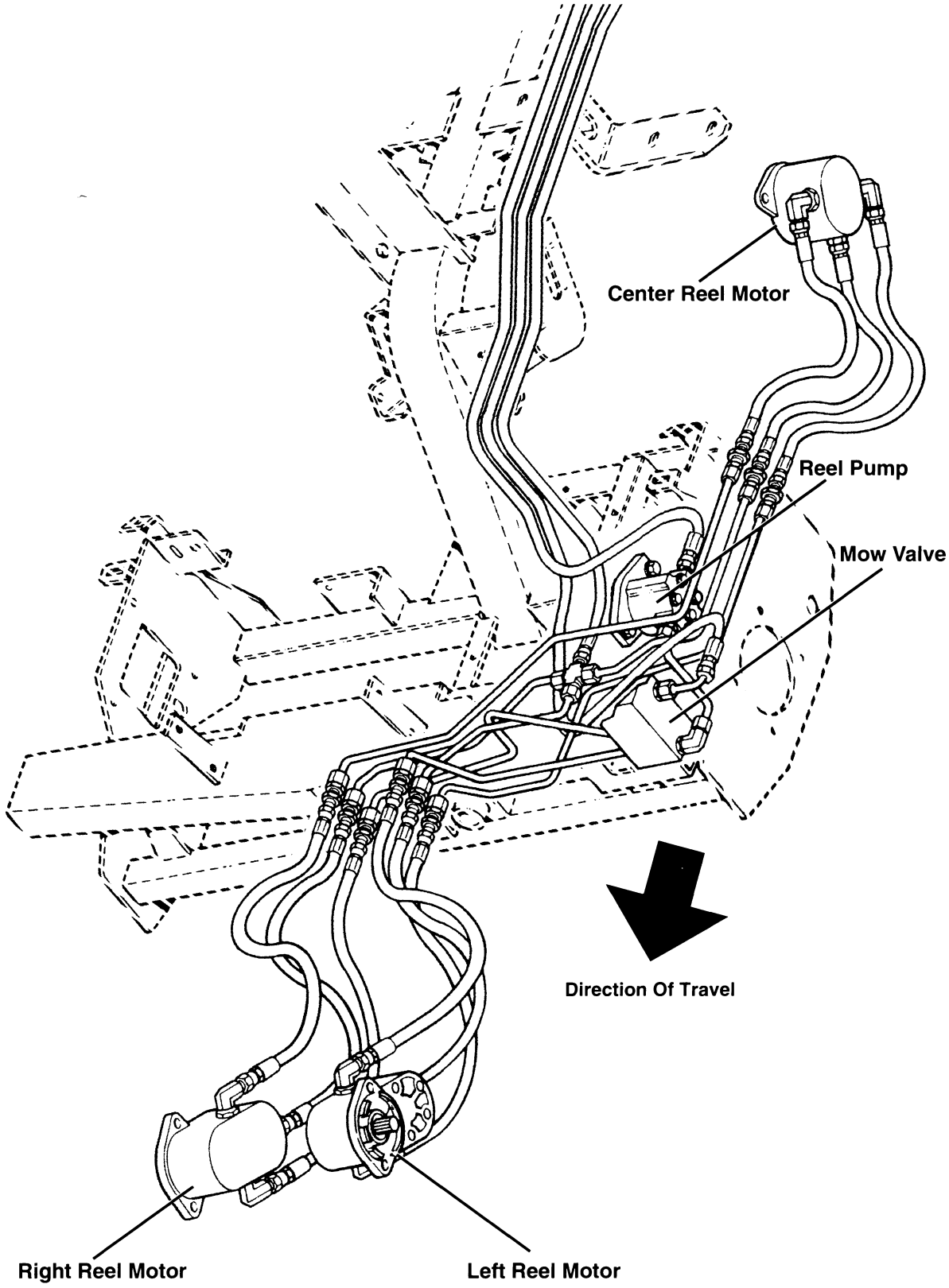
Reel Motors

Make	Danfoss
Type	Gear, with case drain flow
Case Drain Flow	should not exceed 1 GPM
Operating Pressure	3000 psi max.

Lift Valve

Type	Spool/ Manually Operated

COMPONENT LOCATION



REEL DRIVE TROUBLESHOOTING

Problem or Symptom / Check or Solution	One reel turning slow	All reels turning slow	Right and center reels turning slow	One cutting unit not turning	No reel speed	System will not backlap	Reel decel excessive	Pump noisy	Pump cavitation	Oil foaming
Adjust reel-to-bed knife clearance	●			●						
Cutting unit bearings worn or seized	●			●						
Reel drive motor worn	●			●	●					
First motor in series worn		●								
First cutting unit in series binding		●								
Reel drive pump worn		●								
Adjust reel-to-bed knife clearance of middle cutting unit			●							
Middle cutting unit bearings worn or seized			●							
Flow control valve not fully open		●								
Coupler between motor and cutting unit missing, broken or worn				●						
Mow solenoid not energized or stuck open		●			●	●	●			
Flow control not set properly		●			●	●				
Backlapping valve must be in down position		●								
Backlapping valve must be in detent position						●				
Inlet to pump blocked								●	●	●
Oil returning above oil level, check oil level										●
See Electrical Troubleshooting					●	●				

LIFT SYSTEM TROUBLESHOOTING

Problem or Symptom / Check or Solution	Lift system will not operate	Cutting units will not lower	Cutting units will not raise	Cutting units will not float	Cuttings units will not stay in raised position
Internal/External steering valve leakage	●		●		
Air in system	●		●		●
Hydraulic fitting(s) loose	●		●		●
Hydraulic lines/fluid filter restricted	●	●	●	●	
Defective charge pump	●		●		
Engine rpm too low	●	●			
Defective steering valve	●		●		
Defective lift cylinder			●		
Float valve not adjusted properly or defective				●	
Defective lift valve	●	●	●	●	●

TROUBLESHOOTING HINTS

It is best to use another person to observe the reels while you are cutting dense turf. A weak motor will be obvious with slow speed, less clippings, and marcelling. Listen for unusual noises. If the pump or backlapping valve assembly is defective, it will usually result in poor cutting from all cutting units. If the pump tests good, measure the motor case drain. Excessive case drain will not only slow one motor but also the next motor(s) in series. Before taking a motor apart, do a thorough visual inspection of the cutting units. A cutting unit that is not adjusted properly or has mechanical problems will run slowly. Resistance is a combination of internal friction (bearings and reel-to-bed knife contact) and cutting action of the reels (density of the turf). If the cutting unit with high resistance is the first unit in series in the system, it will affect the speed of the cutting unit(s) next in series. To determine if there is a problem with a cutting unit, remove the reel motor, and turn the reel by hand (*use gloves*). Check for contact between the reel blades and the bed knife and adjust it if necessary. Check for vertical/horizontal play and rolling resistance of the blade. Test the reel motors with the reels under load. Standing in front of the reels when they are turning under no-load conditions may not give any clues as to which motor is defective.

NOTE: Load testing the motor must be done with the motor turning. The pump must be at normal operating pressure for the test to be accurate

A test fixture will allow pressure, flow and rpm readings to be taken to determine motor efficiency. If a test fixture is not available, observe the machine cutting in dense turf.

REEL DRIVE SYSTEM THEORY OF OPERATION

System Function:

Rotates the cutting units for forward mowing and reverses for backlapping operations.

Reel Motors:

The reel motors are 1.16 cu-in/reversible, positive displacement gear motors.

Mow Valve:

The mow valve is a solenoid actuated, pressure limiting shuttle valve. It is used to control the flow hydraulic fluid flow the reel motors. The mow valve is energized through the mow switch during mowing operations. It limits pressure in the reel drive circuit to 3000 psi. The mow valve is incorporated into the backlapping valve when the optional backlapping valve is installed.

Backlapping Valve Assembly:

The backlapping valve assembly houses the mow valve, forward/reverse valve, flow control valve and logic element.

Forward/Reverse Valve:

Before Serial No. MO2653A/B030001

The forward/reverse valve, located in the backlapping valve assembly, is a manually operated, two position valve that sets into a detent when pulled up and rotated 90 °. The up position (detent) reverses fluid flow to the reel motors for backlapping and the down position routes fluid to the reel motors for normal mowing operations.

Forward/Reverse Valve:

Serial No. MO2653A/B030001 —)

The forward/reverse valve, located in the backlapping valve assembly, is a manually operated, two position, push-pull valve. The up position reverses fluid flow to the reel motors for backlapping and the down position routes fluid to the reel motors for normal mowing operations.

Flow Control Valve:

The flow control valve, also located in the backlapping valve assembly, is a manually operated flow regulator used to control the reel rpm. It is adjusted by rotating the knob clockwise to restrict the flow and counterclockwise to increase the flow.

Theory: (Units W/O Optional Backlapping Valve Assembly)

With the cutting units lowered and the mow switch on, the mow valve is energized to limit hydraulic pressure in the mow circuit to 3000 psi and the flow rate to 6 GPM.

Hydraulic fluid is then routed in series to the reel motors starting at the left front cutting unit and ending at the right front cutting unit.

Theory:
(Units With Optional Backlapping Valve Assembly)

With the cutting units lowered and the mow switch on, the mow valve is energized to limit hydraulic pressure in the mow circuit to 3000 psi and the flow rate to 6 GPM.

Pressure and flow are now routed to the flow control valve and logic element. Once the flow rate is adjusted at the flow control valve, pressure in the reel drive circuit will vary to maintain the flow rate.

The logic element is a pilot operated dump valve. It maintains pressure at the inlet and outlet ports of the flow control valve. It opens to dump excess pressure to return when pressure on the input side of the flow control valve exceeds pressure on the output side. This maintains a constant reel rpm under varying load conditions.

The hydraulic fluid now enters the backlapping valve and is directed to either the forward or reverse side of the reel motors.

A soft start feature is incorporated into the backlapping assembly to prevent damage to the cutting units from full pressure start-ups.

Hydraulic fluid is then routed in series to the reel motors starting at the left front cutting unit and ending at the right front cutting unit.

Lift Valve:

Charge pump pressure, when not being used by the Steering Control Unit (SCU), is routed to the Lift valve. The Lift valve is a manually positioned (raise or lower) spool valve that is spring loaded to the center position (float).

Positioning the lift valve to raise the cutting units, directs pressure to a float valve inside the lift valve. This valve allows pressure to the raise side of the lift cylinders through a one-way check valve that is held in position by a spring. This one-way check valve prevents fluid from leaving the lift cylinders, forming a liquid-lock that keeps the cutting units raised when the manual lift lever is released.

Positioning the Lift valve to lower the cutting units, directs pressure to the float valve, positioning it to the float side of the valve. This float side of the valve is held in position by a detent ball and spring and allows fluid flow in or out of the lift cylinders when the manual lift lever is released.

TESTS & ADJUSTMENTS

REEL MOTORS PRESSURE RELIEF TEST

Reason:

To ensure that the reel pressure relief valve is operating properly

Tools:

- MT1531 Adaptor
- AMT846 Hose
- RE48122 Adaptor
- JTO3362 Gauge 70,000 kPa (10,000 psi).

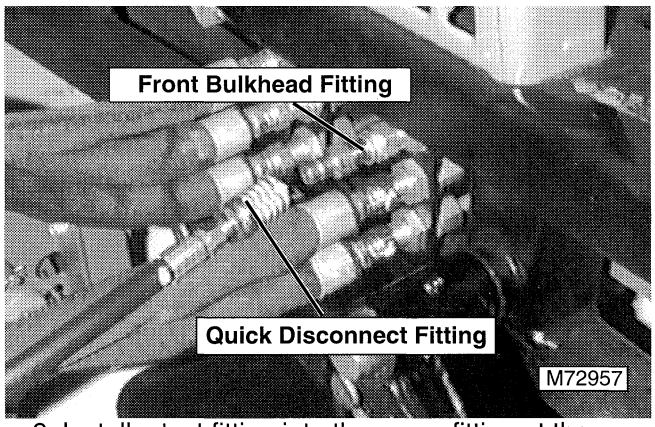
Procedure:

⚠ CAUTION

Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

IMPORTANT: Check and adjust service brake, if necessary, prior to performing this test.

1. Test is performed by reading system pressure at the inlet hose to the first reel motor (left front).



2. Install a test fitting into the upper fitting at the bulkhead as shown.
3. Install JTO3362 test pressure gauge to the test fitting.
4. Apply and lock parking brake.
5. Start engine and set throttle to 2000 rpm (min).

NOTE: If the engine stalls while performing this test, set the throttle to full speed and repeat test.

6. Set mow switch to mow.
7. Note reading on gauge.

Specifications:

- Observe pressure gauge. Pressure should indicate 20,684 ± 1,380 kPa (3000 ± 150 psi).

Corrections:

- If relief valve does not meet specifications replace relief valve.

IMPORTANT: Relief valves are not adjustable. If unit is defective replace entire unit.

REEL MOTORS CASE DRAIN TEST

⚠ CAUTION

Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

Reason:

To test the reel motor bypass to case drain. As the motor gears wear, more fluid is by-passed to the hydraulic reservoir

Tools:

- D01074AA In-Line Hydraulic Tester
- JTO3377 (2) 120" Hydraulic Test Hoses

Procedure:

Left Reel Motor Test

1. Park machine on level surface, reels lowered, park brake on, engine off.
2. Place drain pan under left reel motor. Clean hydraulic hose fittings and remove top hose from elbow on motor.
3. Install hose removed in step two into outlet port of DO1074AA hydraulic tester.
4. Install JTO3377 test hose between elbow on top of motor and inlet port of hydraulic tester
5. Remove center hose from motor.
6. Connect a second test hose to elbow on top of reel motor and place other end into a clean five gallon container.
7. Turn tester control knob out (counter-clockwise) completely
8. Set backlapping valve to forward (mow) position
9. Start machine and run at full throttle. Start reels
10. Turn tester control knob in (clockwise) until pressure reaches 3000 PSI. Hold for one minute
11. Turn out control knob and stop engine
12. Measure amount of oil in five gallon container

Results:

The reel motor case drain should not exceed one gallon per minute. Rebuild or replace motors.

Right Reel Motor Test

(Continued From Left Reel Test Above)

13. Remove test hose from center port of right motor leading to bucket
14. Reinstall hose to center port of left motor
15. Place drain pan under right reel motor. Clean hydraulic hose fittings and remove hose from center port of right reel motor.
16. Connect second test hose to center port of right reel motor and place other end into empty five gallon container.
17. Start machine and run at full throttle. Start reels
18. Turn tester control knob in (clockwise) until pressure reaches 3000 PSI. Hold for one minute
19. Turn out control knob and stop engine
20. Measure amount of oil in five gallon container

Results:

The reel motor case drain should not exceed one gallon per minute. Rebuild or replace motors.

Center Reel Motor Test

(Continued From Right Reel Test Above)

21. Remove test hose from center port of right reel motor leading to bucket
22. Reinstall hose to center port of center motor
23. Place drain pan under center reel motor. Clean hydraulic hose fittings and remove hose from center port of center reel motor.
24. Connect second test hose to center port of center reel motor and place other end into empty five gallon container.
25. Start machine and run at full throttle. Start reels
26. Turn tester control knob in (clockwise) until pressure reaches 3000 PSI. Hold for one minute
27. Turn out control knob and stop engine
28. Measure amount of oil in five gallon container

Results:

The reel motor case drain should not exceed one gallon per minute. Rebuild or replace motors.

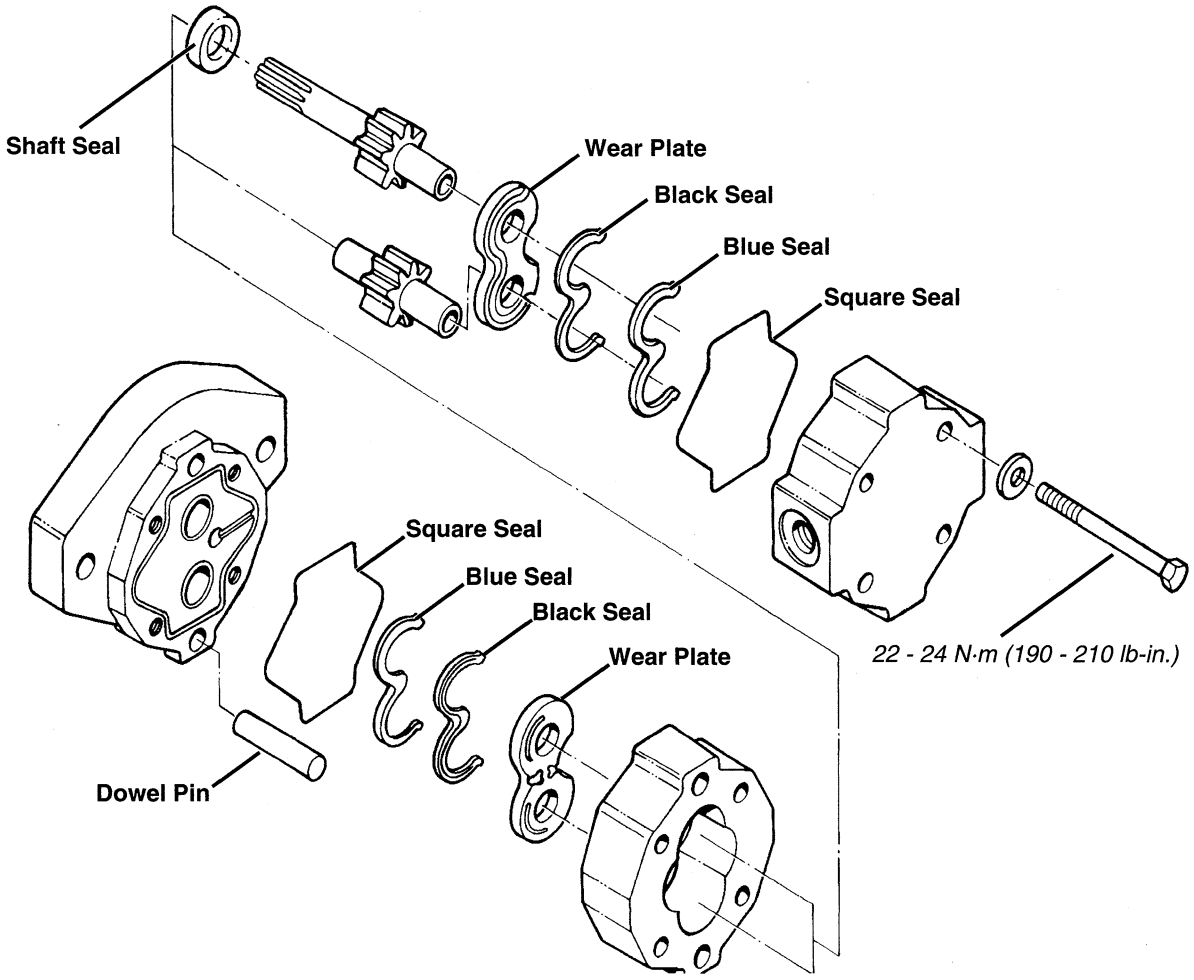
REEL DRIVE PUMP REPAIR

1. Remove pump, plug ports and wash pump with mineral spirits or solvent.

⚠ CAUTION

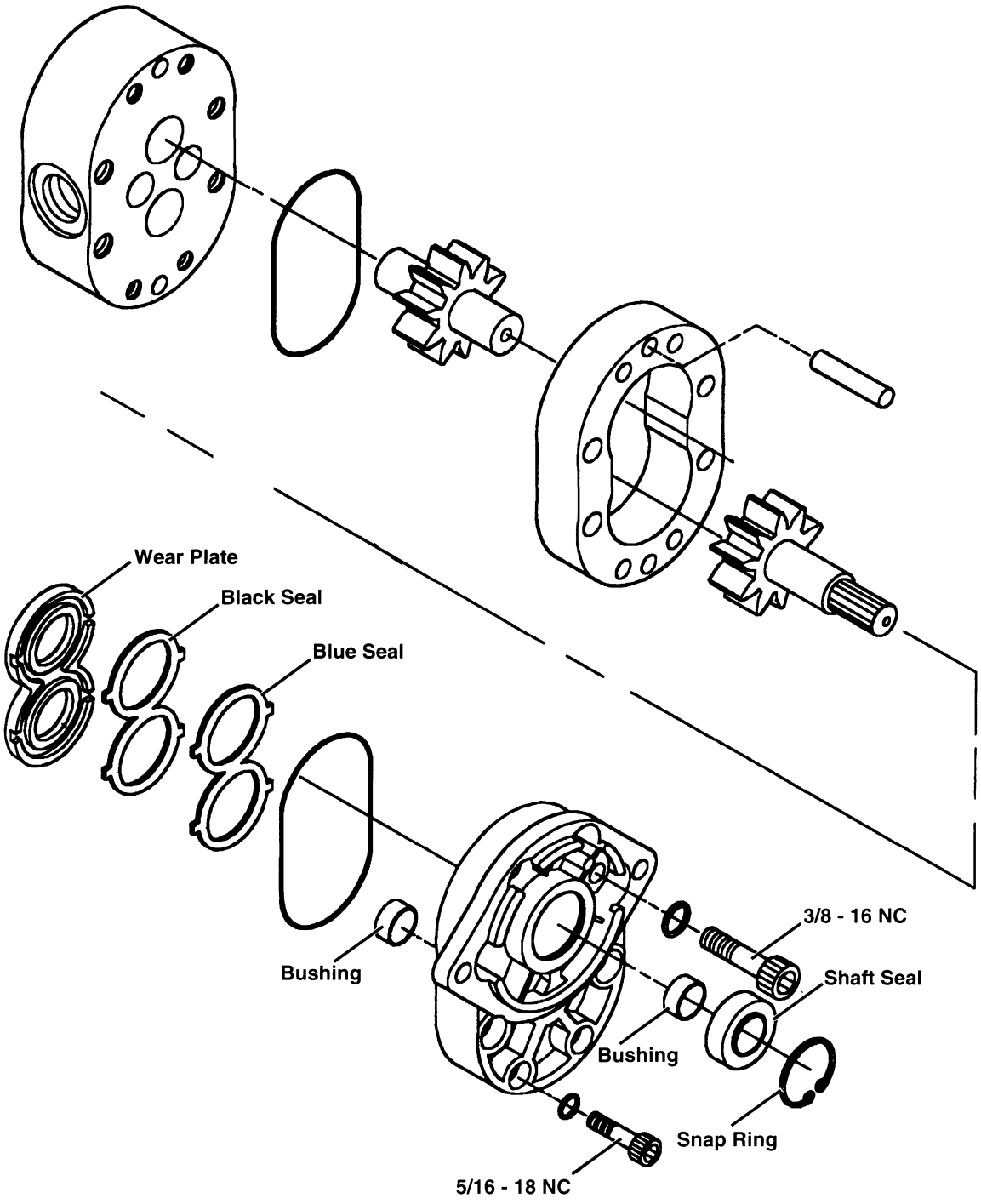
Extreme caution must be used when using a vise to avoid distorting parts. Never pry components apart. light tapping with a plastic or brass hammer on mounting ears will separate body from cover without burring.

NOTE: Pump gear mating teeth must be marked for relative position for reassembly.



2. Remove four cap screws and disassemble pump as shown above.
3. Remove and discard seals,
4. Inspect parts for nicks, scoring or burrs. If parts cannot be restored to a like new condition, the pump must be replaced.
5. Extreme care must be used when replacing the shaft seal. It must be installed square with seal bore and with metal case to the outside of the pump. Great care must be taken to prevent the drive shaft keyway or spline from cutting the new seal. Use a "bullet" type seal sleeve or tape over the keyway and generously grease the lips of the seal before installing over the shaft.
6. Grease O-rings to retain them in the gear plate groove during assembly.
7. Rotate drive shaft before and after tightening bolts. Torque all bolts and cap screws evenly to avoid distortion. Use the following specifications for dry unlubricated threads.
   5/16-18 NC, Torque 22-24 N•m, 190-210 lb-in. (15.8-17.5 lb-ft.)

REEL MOTOR DISASSEMBLY AND REPAIR



1. Plug all ports and wash motor with mineral spirits or solvent.

> **⚠ CAUTION**
>
> **Extreme caution must be used when clamping the motor body in a vise to avoid distorting the housing.**
> **Never pry components apart. Light tapping with a plastic hammer on the drive shaft will separate the body from the cover without burring.**

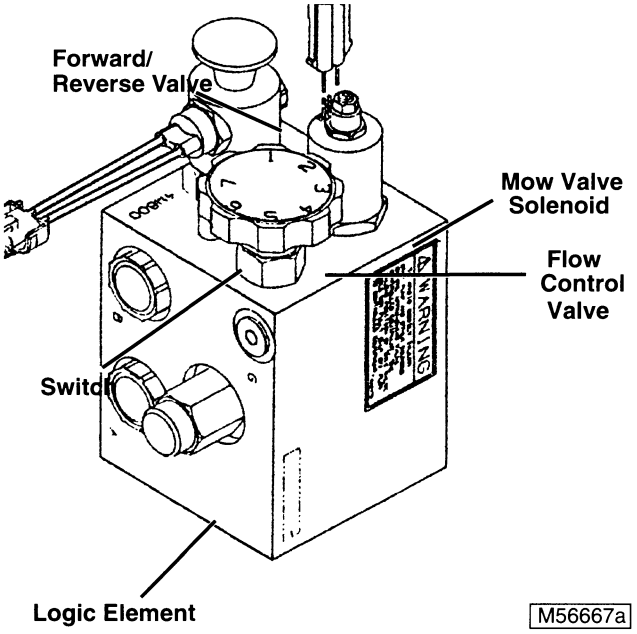
2. All parts must be free of all burrs, scores, nicks, etc.
3. Use marking dye to mark the outside of the gear case for reassembly.
4. Before removing gear set, apply a marking dye to the gear mating teeth to retain the "timing" when reassembling.
5. Extreme care must be used when replacing the shaft seal. It must be installed square with seal bore and with the metal case to the outside of the motor. Use a "tapered" sleeve or apply tape over the splines of the gear shaft to avoid cutting the seal when installing the shaft.
6. If it is necessary to replace a gear, replace them as a set. Oil the gears before installing them and maintain the original location and timing.
7. Install the black seal with the cup of the seal towards the wear plate.
8. Install the blue seal over the black seal and install the wear plate with the blue seal away from the gear set.
9. Ensure mating surfaces are free of dirt and oil when assembling the motor body and hand tighten the bolts before torquing them. Rotate the drive shaft to ensure freedom of movement and torque the bolts evenly to avoid distorting the motor body.

Capscrew Torque (Dry Threads)

3/8 - 16 NC. . . . . 41-44 N•m (30-32 lb-ft.)
5/16 - 18 NC. . . . . 22-24 N•m (15.8-17.5 lb-ft.)

BACKLAPPING VALVE

COMPONENT LOCATION



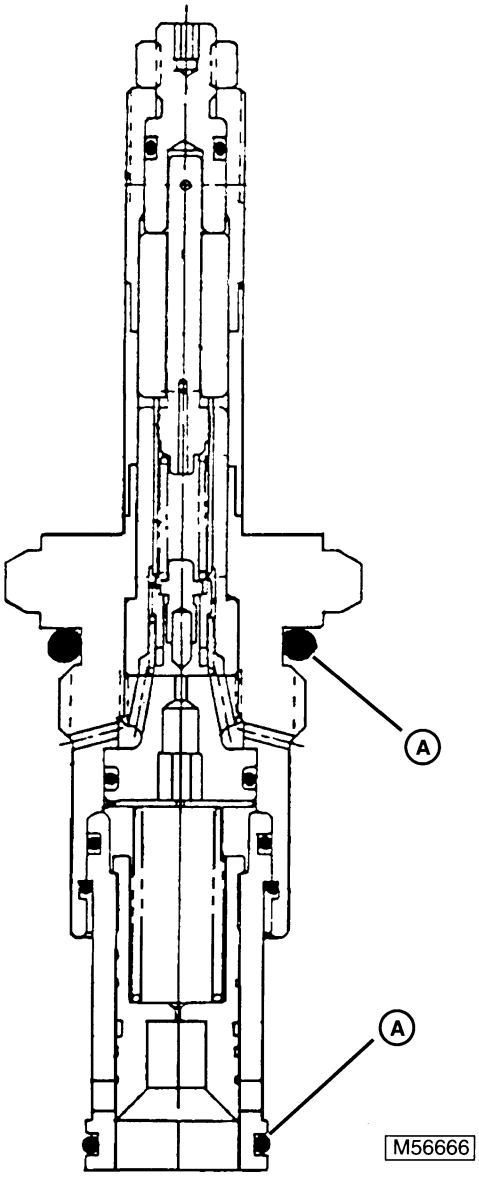
REMOVAL

1. Place drain pan under backlapping valve
2. Label and remove four hydraulic hoses to valve body.
3. Remove two electrical connectors to harness
4. Remove two mounting bolts holding valve body to frame

DISASSEMBLY & REASSEMBLY

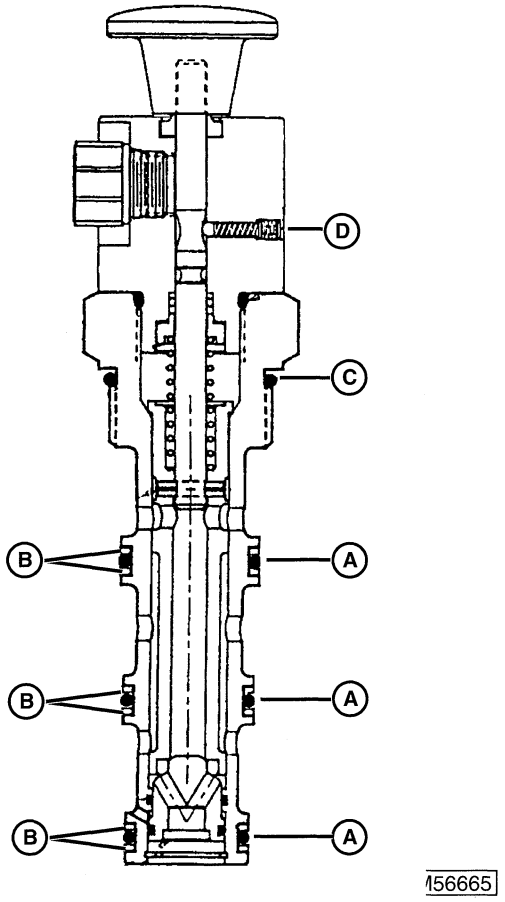
1. The valve body is a single machined block. The valves may be removed and inspected for wear, and seals replaced. The following diagrams show seal placement:

MOW VALVE SOLENOID PLUNGER



2. Ensure O-rings (A) are installed and lubricated before installing plunger.

FORWARD/REVERSE VALVE

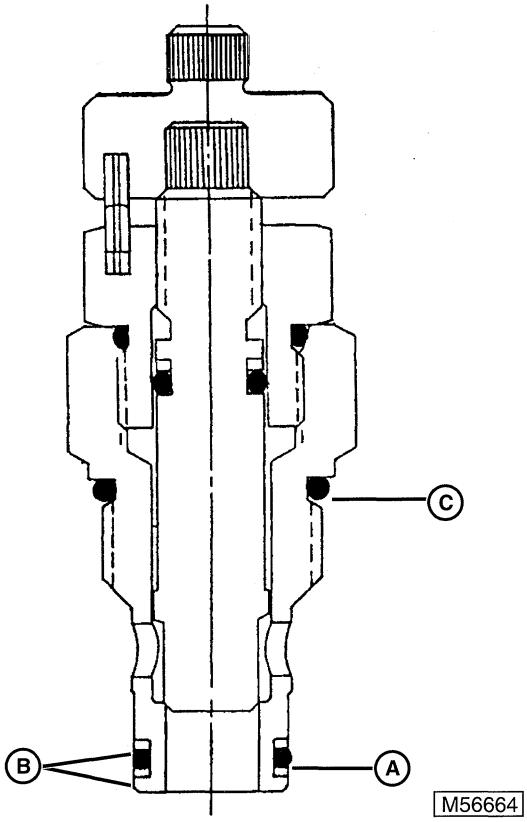


3. Ensure O-ring (A) is installed between back-up washers (B). Install O-ring (C). Lubricate O-rings and back-up washers before installing valve.
4. Install detent ball and spring (D), secure with allen head retainer.

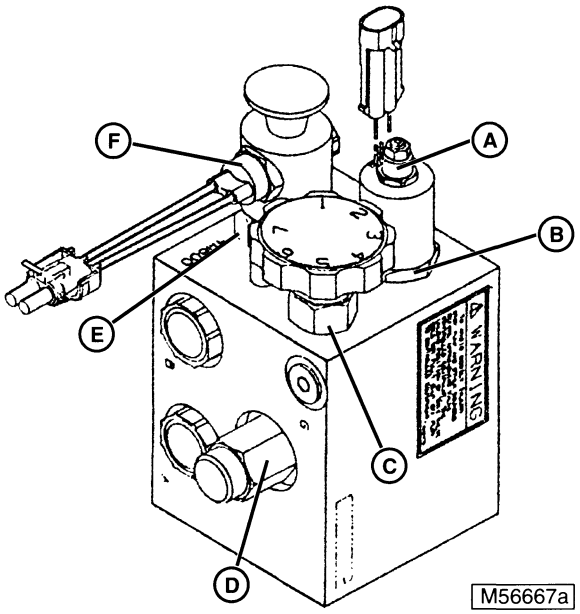
NOTE: Detent ball and spring must be adjusted with machine running and system under pressure.

5. Adjust detent tension with system under pressure. Proper tension is achieved when the forward/ reverse knob stays IN with the system pressurized.

FLOW CONTROL VALVE



6. Ensure o-ring (A) is installed between back-up washers (B). Install o-ring (C). Lubricate o-rings and back-up washers before installing flow control valve.

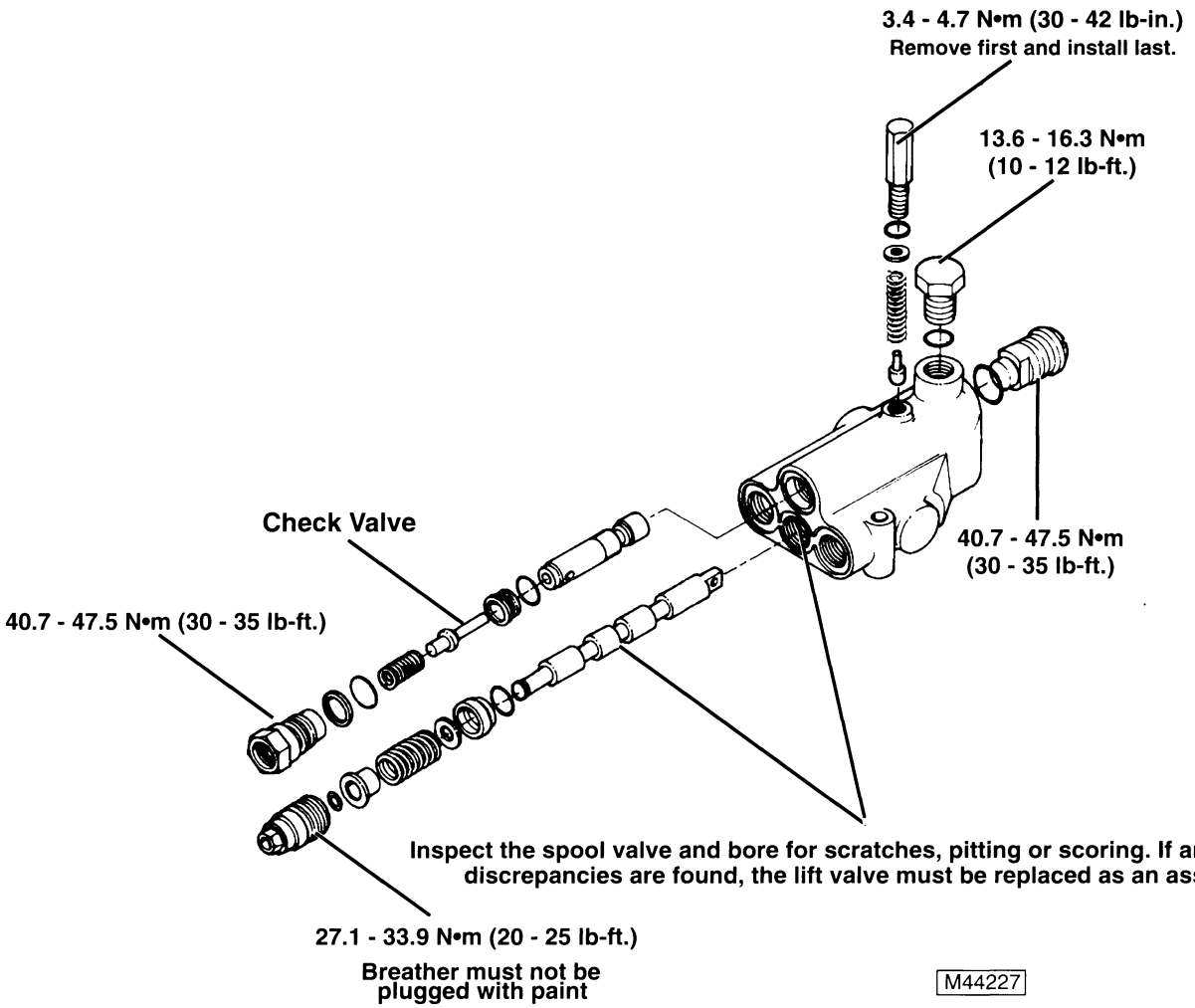


7. Use the table below for installation torques when assembling components into the backlapping valve.

Item	Description	Torque N•m (ft-lbs)
A	Solenoid Coil	94.9 (70)
B	Solenoid Plunger	27.1-33.9 (20-25)
C	Flow Control Valve	61-67.8 (45-50)
D	Pressure Relief Valve	61-67.8 (45-50)
E	Forward/Reverse Valve	237.3 (175)
F	Switch	13.6-20.3 (10-15)
	SAE Plugs	
	#2	54.2-61 (40-45)
	#4	10.9-13.6 (8-10)
	#6	30.3-24.4 (15-18)

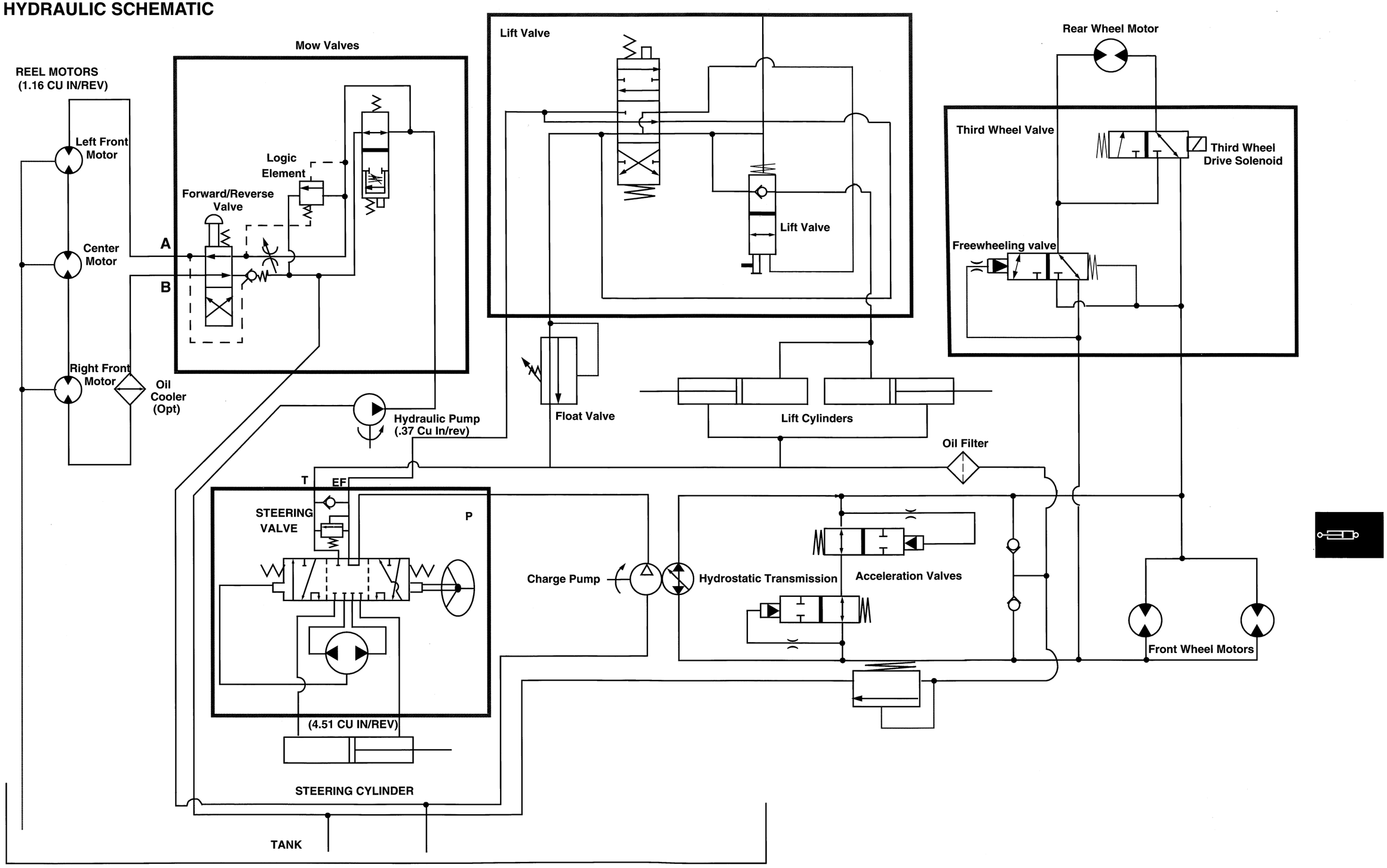
LIFT VALVE REPAIR

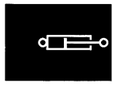
NOTE: Use the following Exploded View to disassemble and repair the lift valve.



IMPORTANT: Clean the outside of the valve body with solvent prior to disassembly. Unless disassembling the whole valve is necessary, remove one component at a time, clean the parts and bore, and assemble the component with new seals and parts as necessary before removing another component. If it is necessary to use rags or brushes for cleaning, use "lint free" rags and ensure the bristles from the brush are not left inside the bores after cleaning. Apply fresh hydraulic fluid to seals and parts when assembling the components.

HYDRAULIC SCHEMATIC





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ATTACHMENTS

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SPECIFICATIONS

Make	John Deere
Size	66 cm (26 in)
Backlapping	On machine variable speed (Optional)
Clip Ratio	
5 Blade	0.211/mph
8 Blade	0.132/mph
Front Rollers	Optional (smooth or grooved)
Reel Diameter	17.8 cm (7 in.)
Bed Knife Adjustment	Reel to Bed Knife
Height-of-Cut	(3/8 - 15/8 in.) (11/2 - 31/2 in.)
Number of Blades	(5 or 8)
Cutting Unit Drive	Hydraulic

Options:

Rear Solid Roller Scraper	Optional

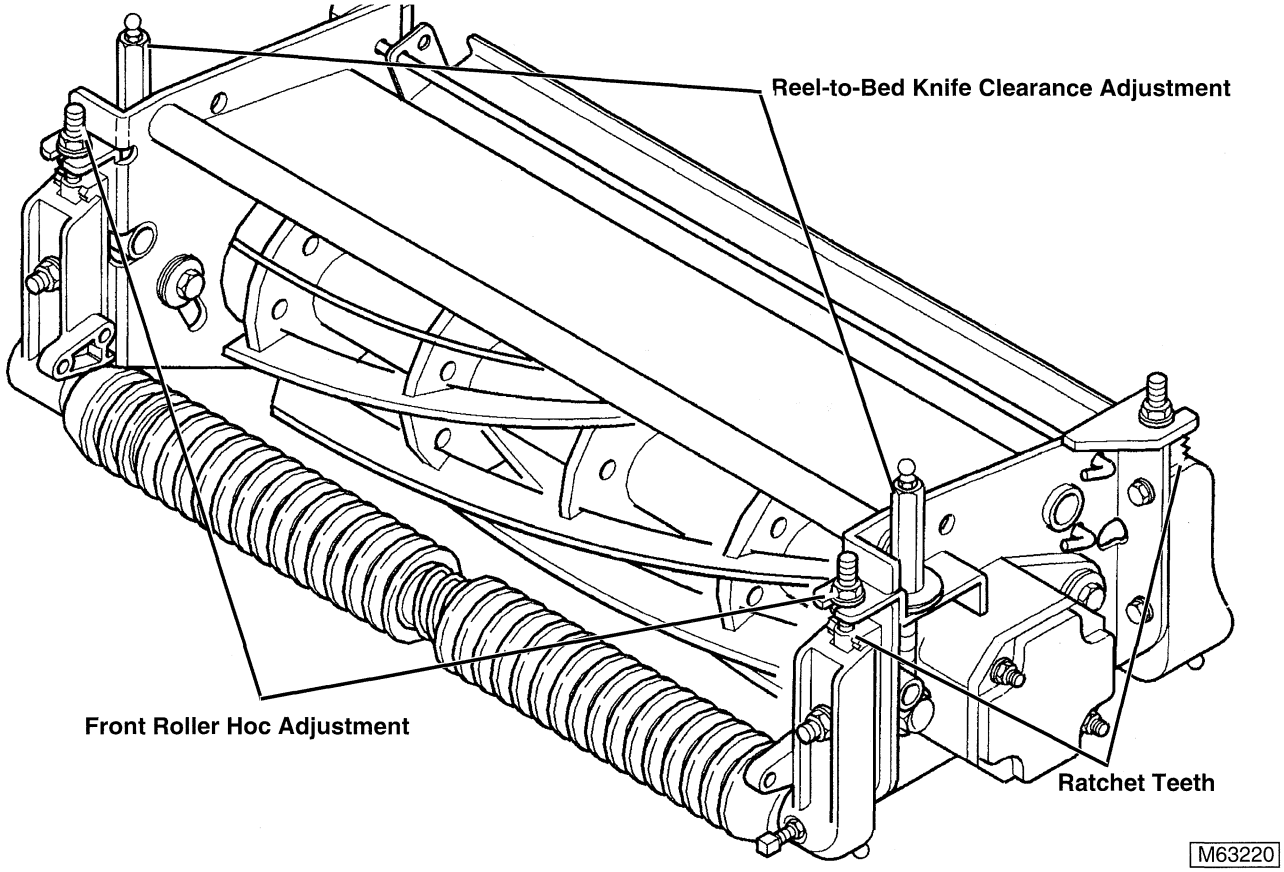
REPAIR SPECIFICATIONS

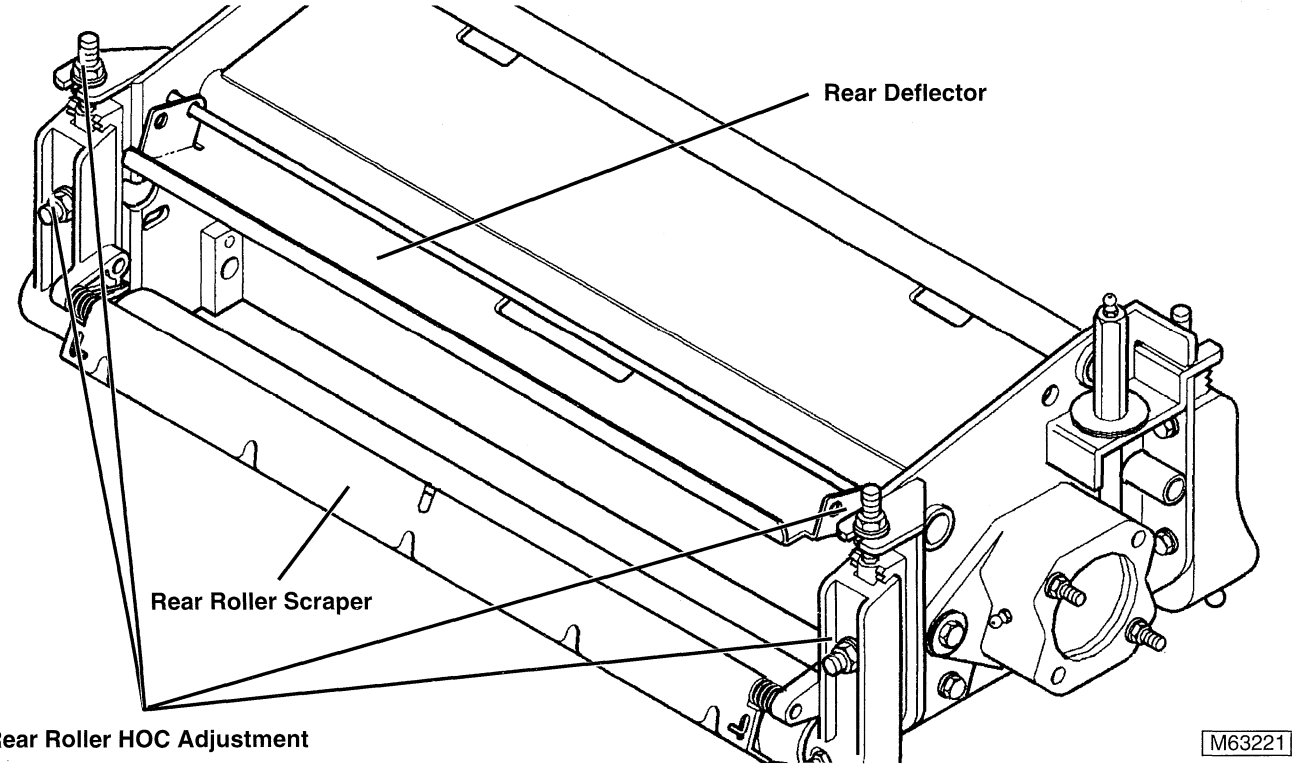
Item	Specification
Bed Knife Top surface,	5° Relief Angle
Front Surface,	5° Relief Angle
Reel	Spin Grind 20° Relief Grind
Roller	Smooth, Grooved
Bed Knife Support	
Mounting Bolts	63 N•m (46 lb-ft.)
Mounting Screws	45 - 51 N•m (33 - 38 lb-ft.)
Reel Mounting	
Pivot Arm	
(Forward)	47 N•m (35 lb-ft.)
(Rear)	81 N•m (60 lb-ft.)
Shaft Rotation Torque	0.80 N•m (7 lb-in.) W/ET15755 Grease
Roller Mounting	
Bolts	47 N•m (35 lb-ft.)
Shaft end-play	0.152 mm (0.006 in.)
Reel/Bed Knife	
Clearance	0-0.003 in.

26 IN. E.S.P. HEAVY DUTY IDENTIFICATION AND APPLICATION

The 26-Inch Cutting Units are manufactured by John Deere at the John Deere Horicon Works Factory. The 26-Inch cutting unit is used only on the 2653 Professional Utility Mower.

COMPONENT LOCATION





INFORMATION

REEL AND BED KNIFE RELATIONSHIP

Reel Mowers are precision machines requiring daily maintenance to maintain the well-groomed appearance of turfgrass. The scissor-like shearing action, that only a reel mower is capable of achieving, is only possible if the reel and bed knife are sharp and the reel-to-bed knife clearance is maintained.

Close examination of the reel-to-bed knife relationship reveals two square edges passing one another with approximately .002 of an inch clearance. There are several reasons why this clearance is necessary.

•When the reel is allowed to contact the bed knife, the square (sharp) edges of the reel and bed knife will roll-over, becoming dull.

•Contact between the reel and bed knife generates heat. Heat generated through this contact will distort the shape of the bed knife. Distortion causes the bed knife to draw closer to the reel, resulting in more rollover of the cutting surfaces and more heat generated in the bed knife.

•Drag produced by an improperly adjusted cutting unit may result in an unacceptable clip ratio, undue strain on drive mechanisms and premature wear of the cutting unit.

REEL/BED KNIFE GRINDING

Reasons for grinding:

•To restore the cylindrical shape of a reel that has become cone-shaped due to improper adjustment of the reel-to-bed knife clearance or worn reel bearings.

•To restore the edge when the grass is not being cut across the entire length of the bed knife, evidenced by streaks of grass left after the mower has passed. Usually the result of nicked blades caused by hitting foreign objects in the grass.

•To restore the edge when the lack of frequent backlapping allowed the edge to be rounded beyond the capability of the backlapping procedure to restore the edge.

•To restore the edge when the reel-to-bed knife clearance has been improperly adjusted (Reel contacting bed knife).

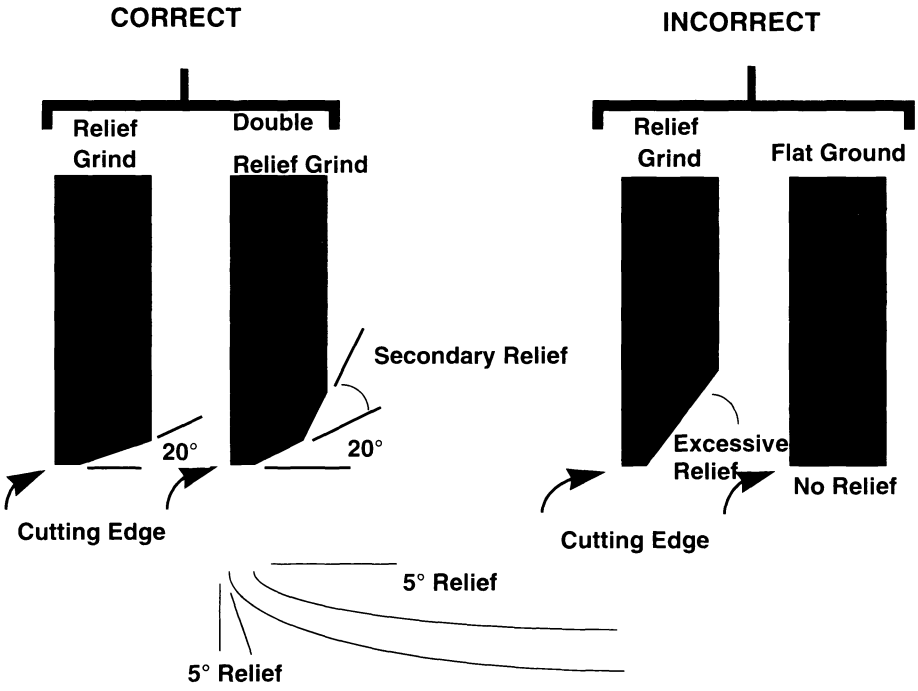
Cutting action begins as the bed knife positions the grass to be cut at the cutting edge. The reel then pulls the grass towards the bed knife where it is sheared by the cutting edges as they pass one another.

In order for the grass to be cut at the proper height, it must contact the bed knife at the cutting edge. This is accomplished by grinding a 5° relief angle on the front face of the bed knife. Without a relief angle, the blade of grass will contact the lower edge of the bed knife and be bent over at too much of an angle prior to being cut. In the case of mowing greens, where very small cuts are being taken, the reel may not capture the grass at all, and no grass will be cut.

Although some spingrinding machine manufacturers say backlapping is not necessary, John Deere recommends backlapping after spingrinding to remove burrs and rough edges left from the spingrinding procedure. Backlapping produces a honed edge that will cut the grass evenly and leave the tops of the grass with clean, straight edges.

It is important to note, dull cutting edges will tear rather than shear the grass drawn into the bed knife. This will shock the grass plant and retard its growth.

RELIEF GRINDING



John Deere recommends Relief Grinding the reels before spingrinding for these reasons:

- Reduced blade contact area, results in less friction, requiring less horsepower to drive the reel.
- Ensures longer wear life.
- Less time is required to backlap.
- Reduces pulling and tearing of the grass as the unit gets dull by use.
- Provides an area for backlapping compound to be trapped to more effectively backlap reels.
- Relief grinding removes metal from the trailing edge of the blade forming an angle (Relief Angle) to reduce the contact area of the cutting edges.
- Because of the relief grind it is possible, with backlapping, to true a reel (make it round) if a blade is .001" to .002" too high.

BACKLAPPING

This procedure is used to sharpen the cutting edges when grinding is not necessary. See Reel/Bed Knife Grinding, in this section, to determine if grinding is necessary.

Backlapping, when compared to grinding, removes a very small amount of metal, requires less time and will effect a smooth, clean cut.

The backlapping procedure is accomplished by spinning the reel backwards while applying special abrasive compounds to the reel. Usually course compounds are used initially followed by a finer abrasive for final honing. Recommended grits for fairways and roughs are 60, 80 and 120. Reel sharpening compounds should not be toxic, oily or greasy.

The cutting unit should be inspected, backlapped, adjusted and checked daily for a uniform cut along the complete length of the bed knife. It is important that the adjustment allows the reel to turn freely without dragging against the bed knife. Metal-to-metal contact will generate heat, causing the reel to expand and intensifying the dragging that produces more heat. This viscous cycle will quickly "shut-down" the mower.

SMOOTH ROLLER

The roller is used as a ground sensing device to detect changes in the contour of the turf as the mower moves forward.

A smooth roller is generally used on the rear of a cutting unit to establish the cutting height range. (under certain circumstances, grooved rollers are used on the rear)

A front roller used in conjunction with a rear roller is needed to achieve more exact cutting heights under 1 inch.

GROOVED ROLLER

The grooved roller is used as a ground sensing device to detect changes in the contour of the turf as the mower moves forward. The main advantage in using a grooved roller rather than a smooth one comes when cutting long grass that is very wet. Grass that is wet will tend to stay down rather than spring up after the roller passes. Grooved rollers will not bend the grass over, allowing it to be cut rather than passed over.
Along with advantages come disadvantages. Because of the reduced contact area, inherent with a grooved roller, the roller may penetrate deeper into the soil, lowering the effective cutting height and possibly scalping the turf.

PERFORMANCE VARIABLES

Three performance variables that affect the quality of cut are.

- Number of reel blades
- Reel rpm
- Ground speed of machine

NOTE: When discussing performance variables, we must assume that other factors such as rate of growth, mowing frequency, mowing patterns, soil fertility and equipment condition have been considered and are not affecting the quality of cut.

To apply Performance Variables to a formula we need to understand three terms:

- Shear point - A single point of cutting contact between the cutting unit and the turf. Due to the Reel mower design, there are an infinite number of shear points across the bed knife.
- Clip Ratio (CR) - The forward distance traveled between successive cutting contacts at any one shear point.
- Cutting Height (CH) - The distance above the soil line that grasses are clipped.

The most uniform cut occurs when the Clip Ratio (CR) equals the Cutting height (CH). If CR is greater than CH, Marcelling (a wavy, rib-like appearance) occurs. If CH is greater than CR, the rotating blades create a fanning affect that blows the grass down without cutting it. CR is controlled by the Performance Variables, (the number of blades selected, ground speed and reel speed).
Of these Performance Variables, only two, in most cases, are we able to change. We can use a reel with a different number of blades, and/or we can change the vehicle ground speed.
Since we know the number of blades the reel has, what the reel speed is, the cutting height and the clip ratio (since CR must equal CH), let's find the vehicle ground speed.
Here's the formula:
MPH = (Reel rpm) x (CR or CH) x (Number of Reel Blades) ÷ 1056
Example
Using:
•2653 Professional Utility Mower at a tested reel speed of 1000 - 1050 RPM
•8 blade reel on a E.S.P. cutting unit
•CH = CR (0.58)
Find: MPH (Vehicle Speed)

NOTE: To calculate MPH, multiply .68148 x ft. traveled/sec. Another way to calculate speed is to measure off an 88 ft. distance, record the length of time, in seconds, it takes to travel that distance and divide 60 by that time.

DIAGNOSTICS

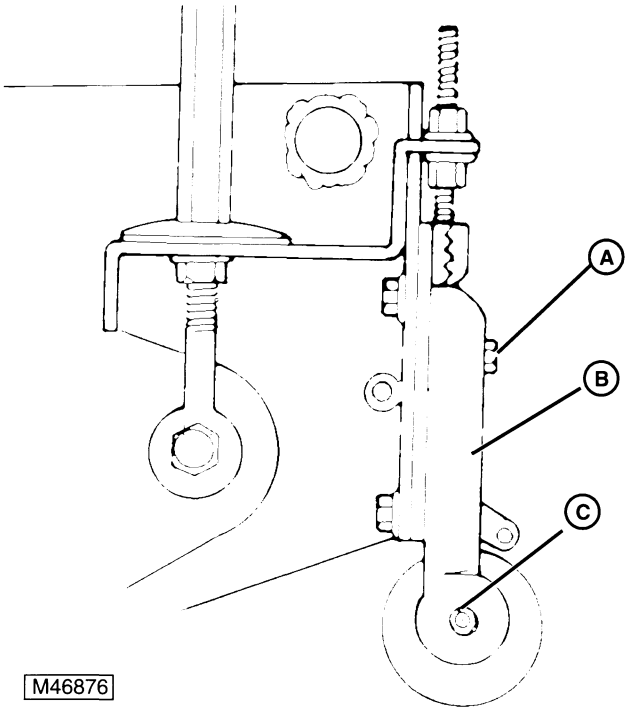
Test Conditions:

- Lift arms lowered
- Normal forward mowing operation

Symptom	Problem	Solution
Marcelling	Ground speed too High/Low	See Performance Variables,
	Machine rpm too High/Low	See Machine Operator's Manual
	Wrong Number of Reel Blades For Desired Clip Ratio	See Performance Variables,
Streaking	Reel/Bed Knife Clearance Inconsistent Along Bed Knife	See Backlapping and Reel-to-Bed Knife Adjustment
	Damaged Section of Reel or Bed Knife	Grind or replace as Needed
HOC Changes	Roller Clamp Bolts Loose	See HOC Adjustment
	Roller Bearings Worn	See Roller Removal
	Roller Bent	See Roller Removal
	Cutting Unit Not Floating Properly	See Machine Operator's Manual
	Changing Soil Conditions	Use a Smooth Roller
	Grass Too Wet	Allow Sufficient Time To Dry
	Cut Grass Collecting on Roller	Install Scraper
	Traction Unit Pivot Arms Worn	Repair Or Replace
Poor Quality of Cut	Improper Reel-to-Bed Knife Clearance	See Reel-to-Bed Knife Adjustment
	Reel/Bed Knife Dull	See Backlapping and Reel-to-Bed Knife Adjustment
	No Relief Grind	See Reel/Bed Knife Grinding
	Weight Transfer System Needs Adjustment or Malfunctioning	See Machine Operator' Manual
Reel Does Not Rotate	Improper Reel-to-Bed Knife Clearance	See Reel-to-Bed Knife Adjustment
	Reel Bearings Worn Or Seized	See Reel Removal
	Machine Not Operating Properly	See Machine Operator's Manual

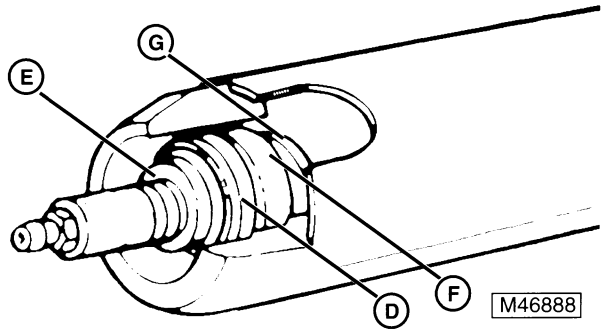
26 IN. E.S.P. CUTTING UNIT REPAIR

ROLLER REMOVAL



1. Remove the two cap screws (A) securing the roller adjustment brackets to the cutter frame. Remove roller with brackets from cutting unit.
2. Loosen lock nut and set screw (left side only). Slide the roller adjustment brackets (B) off the roller.
3. Remove grease fittings (C).

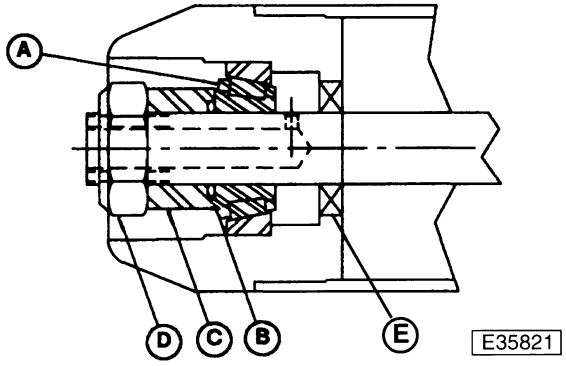
ROLLER DISASSEMBLY AND INSPECTION



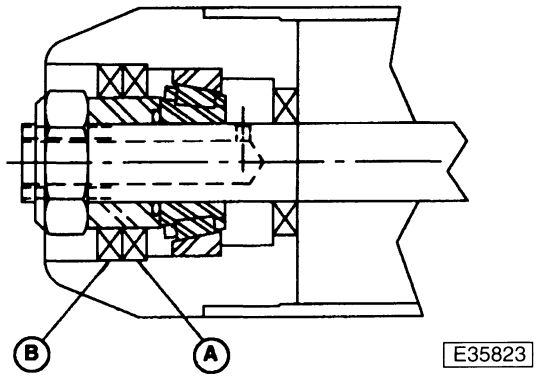
1. Remove lock nuts from each end of the roller.
2. Press roller shaft out of roller.
3. Remove seals (D) (G, smooth roller only) spacer (E) and bearings (F), clean bearings and end caps with a suitable solvent.
4. Inspect bearings and bearing cups for pitting, scoring and bluing from overheating. Replace bearings and bearing cups as necessary.

ROLLER ASSEMBLY

1. Install bearing cup. Install shaft into roller.



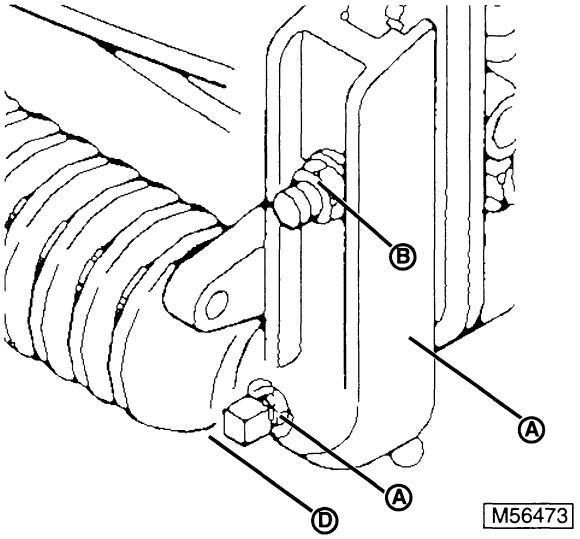
2. Apply grease to seal lip and install seal (E) over shaft with lip of seal facing out.
3. Pack bearing (A) with grease and slide over shaft into bearing cup.
4. Lubricate O-ring (B) and install next to bearing.
5. Slide spacer (C) over shaft with O-ring groove facing bearing.



6. Apply grease to lips of seals (A, B) and install (seal lip facing bearing). Repeat steps 2 through 6 on opposite end.
7. Install self-locking nuts (D) and tighten until snug, then back off slightly and retighten to a rolling torque of .35 N•m (3-7 lb-in.).
8. Install grease fittings and lubricate.

ROLLER INSTALLATION

1. Slide adjustment brackets (A) onto roller shaft (bracket with set screw on left side).
2. Secure brackets to frame with two cap screws (B)



3. Center the roller between the brackets and tighten set screw (D). Tighten jam nut (C).
4. Refer to Height-of-Cut Adjustment.

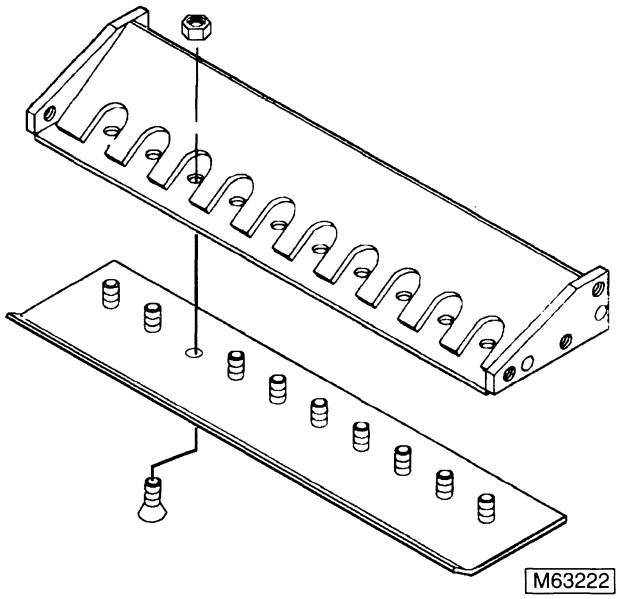
BED KNIFE/SUPPORT REMOVAL

⚠ CAUTION

Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

1. Raise reel away from bed knife approximately 10 mm (3/8 in.).
2. Remove six cap screws (3 each side) securing bed knife support to cutter frame.
3. Carefully remove bed knife support from cutter frame.
4. Remove and discard 10 hex head cap screws and nuts securing bed knife to support, discard bed knife.
5. Remove dirt and corrosion from bed knife mounting surface.
6. Inspect support for straightness, repair or replace if necessary.

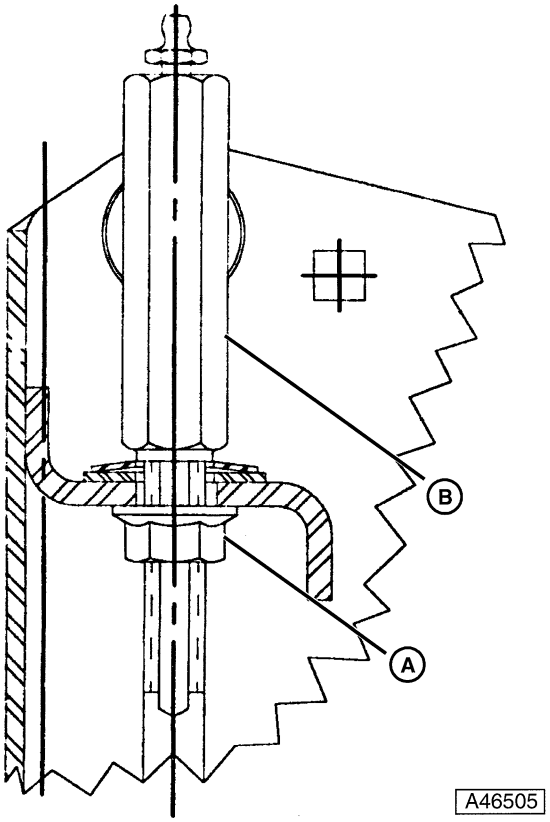
BED KNIFE/SUPPORT INSTALLATION



7. Position the bed knife on the support. Using new mounting hardware.
8. Install and tighten the 2 outer screws first to position the bed knife.
9. Install the rest of the screws.
10. Starting with the center hex screw and working your way toward the ends of the bed knife alternating from side to side, torque the bolts first to 26 N•m (19 lb-ft.) and then to a final torque of 51 N•m (38 lb-ft.).

NOTE: Minimum torque is 45 N•m (33 lb-ft.).

11. Grind bed knife, (until flat and uniformly ground across the top surface), after securing it to the support and before installing in cutter frame.



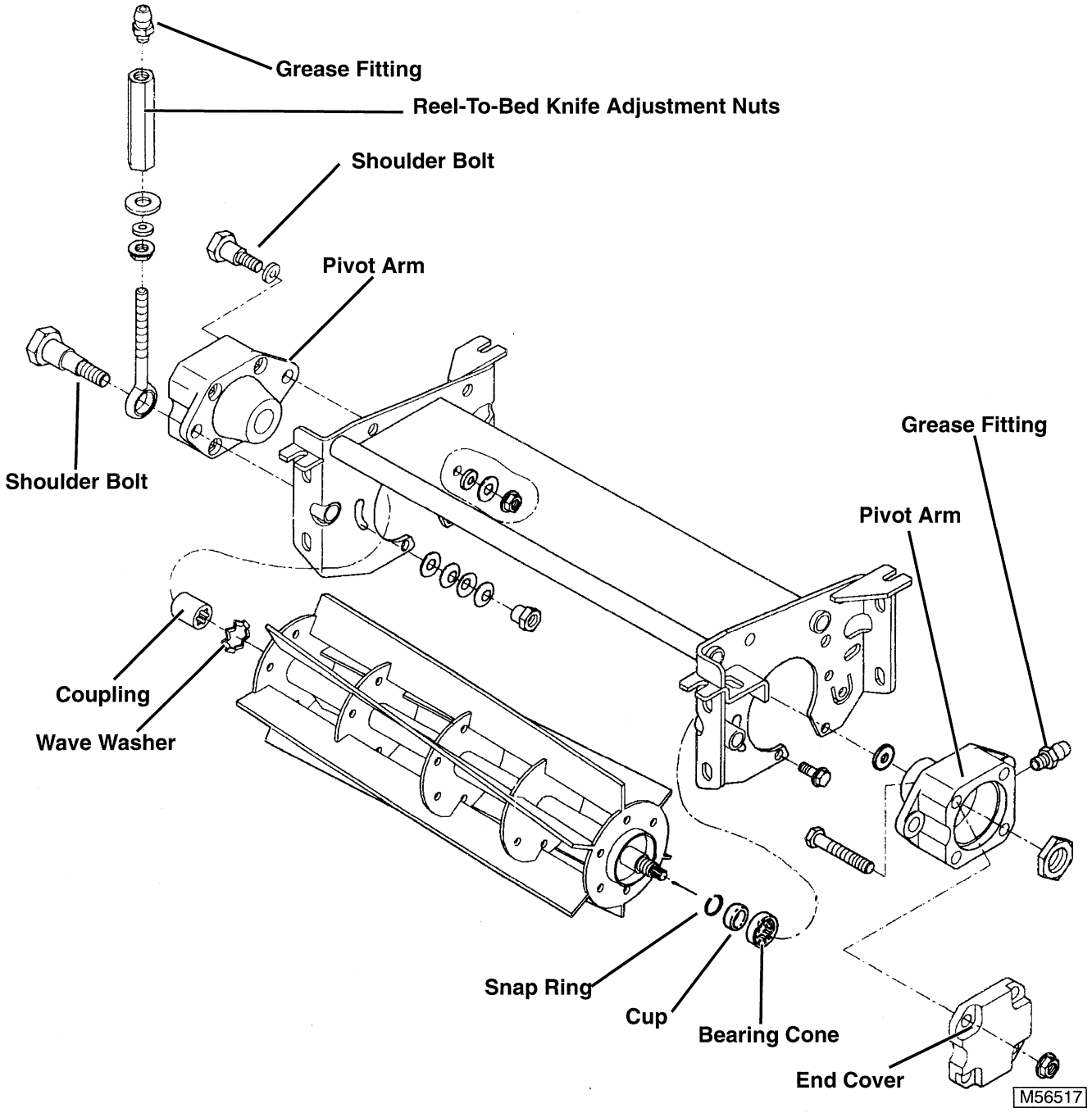
12. Raise reel, by turning the reel adjusting nut (B) clockwise and nut (A) counterclockwise, until the knife can be installed.
13. Position the bed knife support in the frame and snug the cap screws (6) on both ends of the support.
14. Tap both ends of the bed knife support with a brass hammer to remove any play.
15. Torque the bolts to 43 N•m (32 lb-ft.).
16. Refer to Reel-to-Bed Knife Adjustment, Backlapping and Height-of-Cut Adjustment.

REEL REMOVAL

⚠ CAUTION

Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

1. See Bed Knife/Support Removal prior to performing this procedure.
2. Loosen reel-to-bed knife adjustment nuts.
3. Remove end cover.
4. Remove one retaining nut, washer, tapered roller bearing and one spring (right side only) from each end of the reel.
5. Remove nuts, washers and shoulder bolts securing the pivot arms to the cutter frame.
6. Remove the pivot arms. Remove reel



PIVOT ARM DISASSEMBLY AND INSPECTION

1. Remove bearing cup, wave spring and seal from the right side.

> **⚠ CAUTION**
>
> **Never spin bearings with compressed air. Bearings can separate from their cage at high velocity and cause injury.**

2. Clean parts with mineral spirits.

IMPORTANT: Always replace bearing and bearing cup as a set.

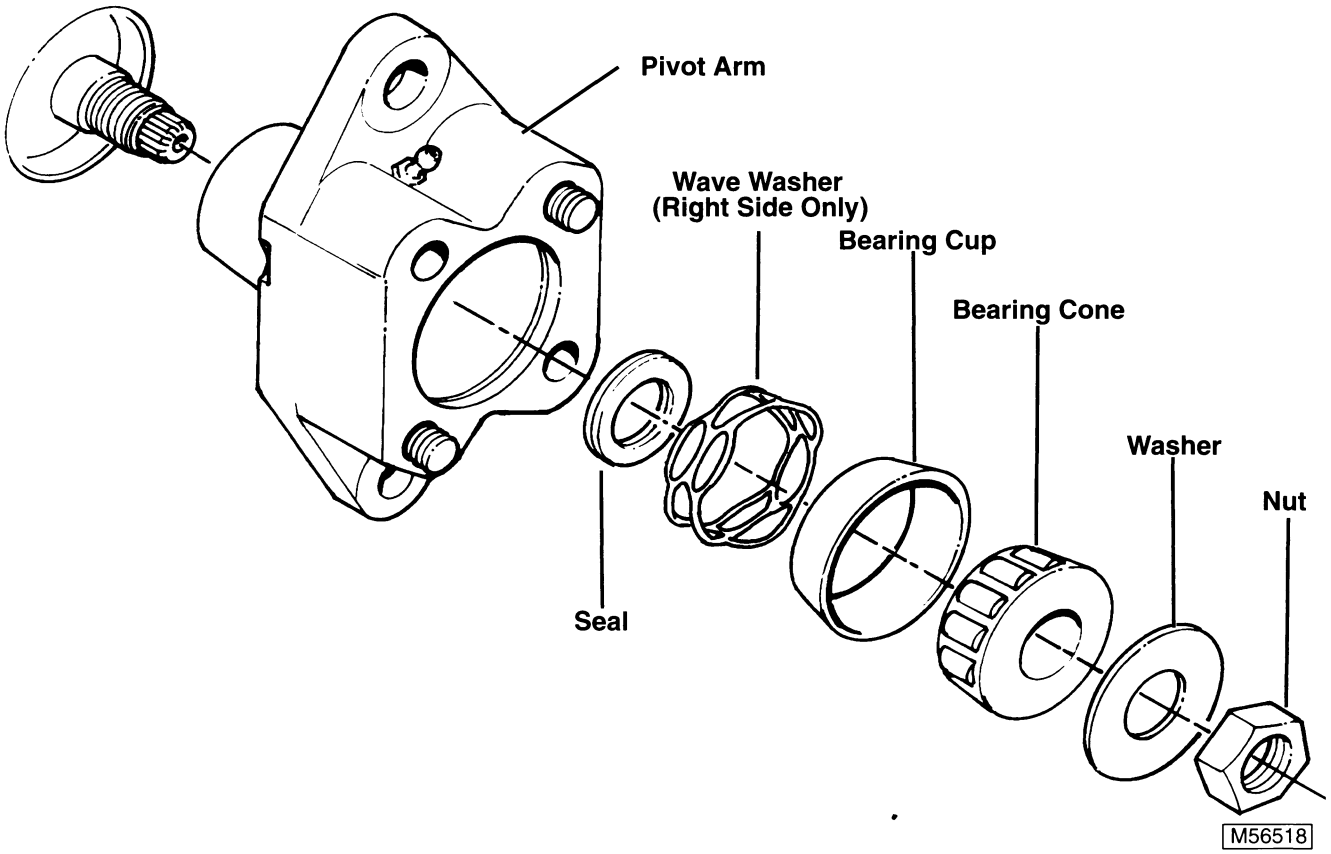
3. Inspect bearings and bearing cups for wear, scoring and bluing from overheating. Replace if necessary.
4. Inspect wave spring for distortion or wear, replace if worn.

PIVOT ARM ASSEMBLY

1. Install seals (flush with pivot arm housing).
2. Install wave spring (right side only).
3. Install bearing cup.

REEL INSTALLATION

1. Position reel in frame. Apply grease to lip of seal and slide pivot arm over reel shaft.
2. Install shoulder bolts through adjustment link, pivot arm and cutter frame. Install spring washers and shoulder nuts, Do Not tighten. Repeat on opposite side.
3. Position shoulder bolt through pivot arm and cutter frame, secure with washer and nut, Do Not tighten. Repeat on opposite side.
4. Pack bearings with grease and slide over shaft and into bearing cup (one each side). Install washers and nuts. Do Not tighten.
5. Torque reel attachment nuts to 50 lb-ft. (min.).
6. See Reel-To-Bed Knife Adjustment.

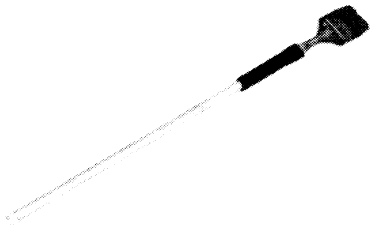


BACKLAPPING AND REEL-TO-BED KNIFE ADJUSTMENT

Essential Tools:

- .002 Feeler Gauge
- Lapping Compound
- Two Bolt Gauge Bar

Fabricated Tools:



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- 2" OR 4" Paint brush, attach a piece of rubber hose to the handle to extend its length. This is used to apply backlapping compound.

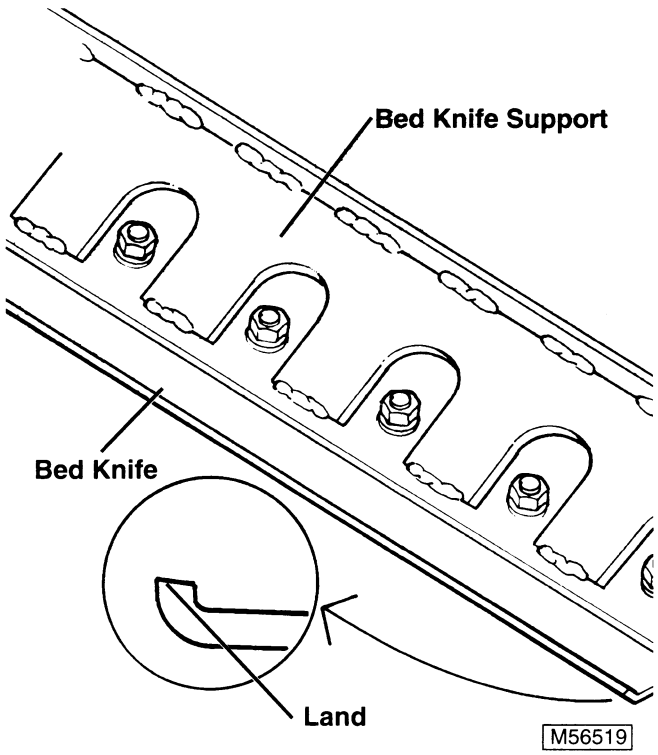
It is best to think of backlapping and reel-to-bed knife adjustments as one procedure. Although backlapping removes only a small amount of metal, the clearance between the reel and bed knife will be increased and must be readjusted.

Another very important point to remember is that adjustments can only be successful if the frame integrity (straightness and strength) is maintained. Attaching bolts must be secure and bearings must be well lubricated and not worn.

REEL AND BED KNIFE INSPECTION

⚠ CAUTION

Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.
Never allow more than one person at a time to work on any one cutting unit. Never allow work to be accomplished on more than one cutting unit at the same time. Serious personal injury could result.



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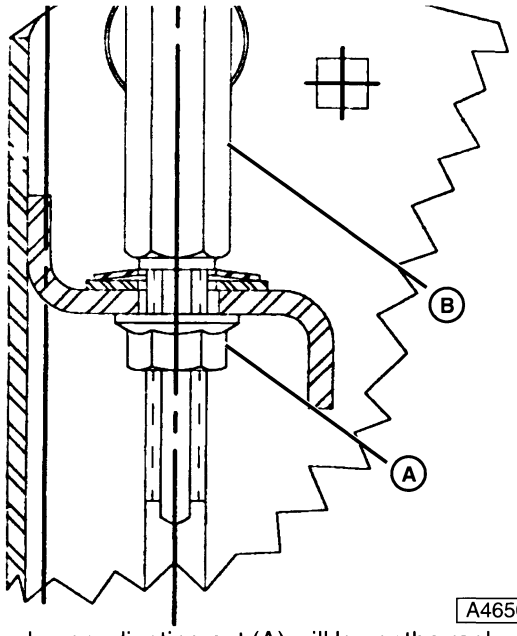
1. Visually inspect cutting unit for damage. Chipped paint, dents or gouges may indicate the need for a closer look at the frame for distortion, broken weldments or other damage that could prevent proper adjustment. Repair or replace parts as necessary.
2. Inspect for vertical or lateral movement in the reel or bearings supporting the reel, repair or replace as necessary.
3. While rotating the reel in the reverse direction by hand, inspect each blade cutting edge for nicks, gouges or distortion. Ensure the cutting edge land does not exceed more than 3/4 of the blade thickness. See Reel and Bed Knife grinding to restore the relief angle and cutting edge before continuing with this procedure.
4. Inspect the bed knife cutting edge for nicks, gouges or distortion.
5. Inspect the bed knife for uneven wear (indicated by uneven land width across the length of the bed knife). Ensure the cutting edge land does not exceed 3/4 of the cutting edge. Replace the bed knife if the cutting edge extends below 1.45 mm from the mounting surface.

REEL-TO-BED KNIFE ADJUSTMENT

⚠ CAUTION

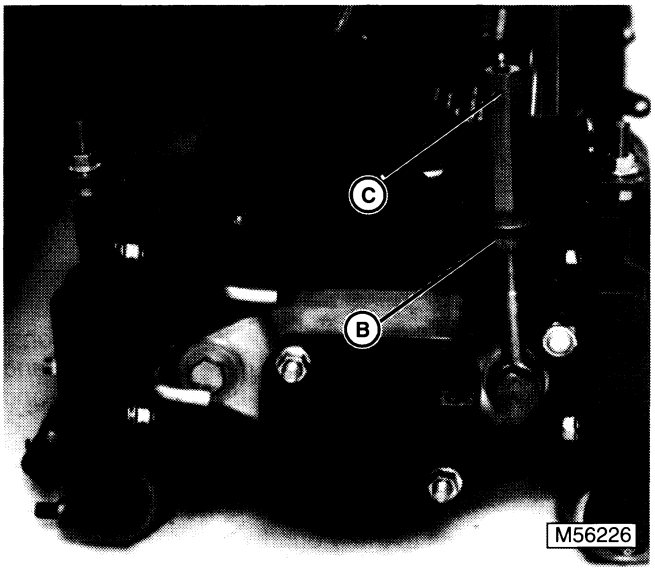
Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.



1. The lower adjusting nut (A) will lower the reel when turned counterclockwise and the upper adjusting nut (B) will raise the reel when turned clockwise. (as viewed from the top of the unit looking down).

IMPORTANT: Before adjusting the reel-to-bed knife clearance, bring the reel down to just contact the bed knife, then adjust the clearance as you bring the reel up. This will remove any play in the bearings.

2. Adjust ends of reel to set drag with a .002" feeler gauge (A), check at both ends of the reel and 2 areas near the center



3. If adjustment is necessary, loosen jam nut (B) and adjusting nut (C) at both ends of the reel, equal amounts, preferably one flat at a time. Turn adjusting nuts (C) clockwise to raise the reel. Turn jam nut (B) clockwise to lower the reel. Adjust reel until .5 mm (0.002 in.) is reached across the entire length of the bed knife.
4. Tighten adjusting nuts (C) and jam nuts (B). Recheck to insure reel has not moved. Readjust if necessary.

IMPORTANT: Always rotate the reel in the reverse direction to avoid damaging or dulling the cutting edges of the reel or bed knife.

5. Slowly rotate the reel backwards watching for contact between the reel and bed knife at the center of the bed knife. If contact is made, backlap the reel and bed knife to eliminate the "Frown" in the bed knife or the out-of-round condition of the reel.
6. Measure the clearance at the center of the bed knife. If the clearance exceeds .010 of an inch, grind the reel and bed knife to eliminate the "Smile" in the bed knife or the out-of-round condition of the reel.
7. When properly adjusted and sharpened, each reel blade should cut a piece of paper held at 90° to the top surface of the bed knife along the entire length of the bed knife with minimal contact to .002" clearance (max.).

BACKLAPPING

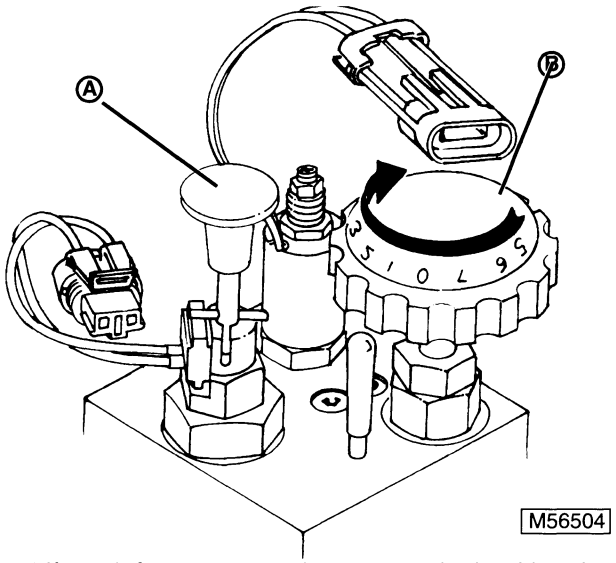
(WITH OPTIONAL BACKLAPPING VALVE)

⚠ CAUTION

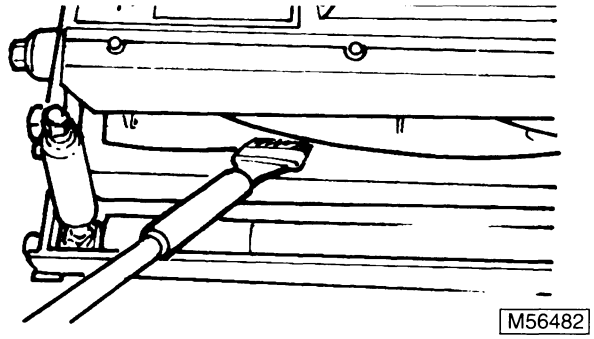
Avoid injury from rotating blades. keep hands and feet away from blades while machine is running.
Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.
Never allow more than one person at a time to work on any one cutting unit. Never allow work to be accomplished on more than one cutting unit at the same time. Serious personal injury could result.

NOTE: If the unit does not have the optional backlapping valve, reverse the upper and lower hydraulic lines on the reel motors and use the engine speed to vary the reel rpm.

1. Set the parking brake and start the engine. Lower the cutting units to the ground.



2. Lift the left access panel to expose the backlapping valve. Pull up and rotate the Forward/Reverse knob (A) to align it with the notch on the valve block.
3. Engage the PTO. (The reels should now be rotating in the reverse direction)
4. Using the flow control knob (B), adjust machine speed to rotate reels at 100-200 rpm, or slow enough to prevent the backlapping compound from being thrown from the reel blades.



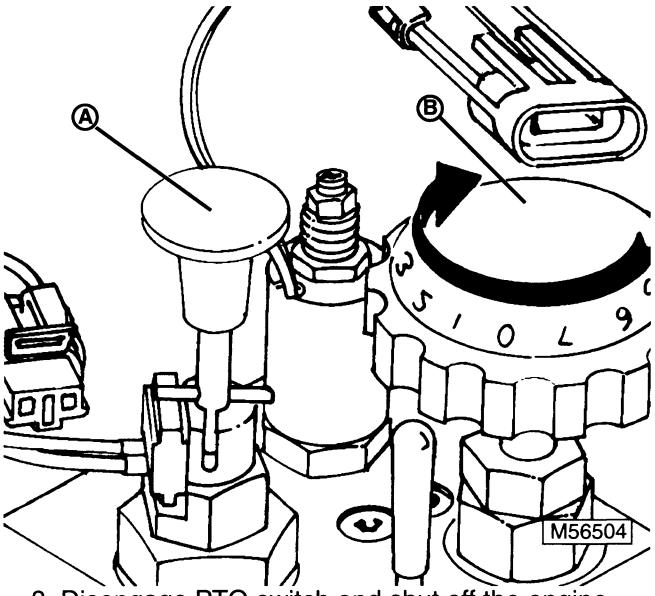
5. Apply 60-80 grit compound for units with extended service time and 120 grit compound for new, newly ground reels or when applied on a weekly basis to the rotating reel evenly from one side to the other and back again with a long handled brush (see Fabricated Tools).
6. Allow the reel to spin until quiet. If desired, follow with a 120 grit compound to achieve a smoother finish.

IMPORTANT: Never operate cutting unit in the Forward direction until abrasive compounds are removed from the cutting unit. The abrasive compound will dull the cutting edge.

⚠ CAUTION

Avoid injury from rotating blades. keep hands and feet away from blades while machine is running.
Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.
Never allow more than one person at a time to work on any one cutting unit. Never allow work to be accomplished on more than one cutting unit at the same time. Serious personal injury could result.

7. Rinse the lapping compound off the cutting unit with water and repeat the Reel-to-Bed knife Adjustment Procedure before returning the unit back to service.



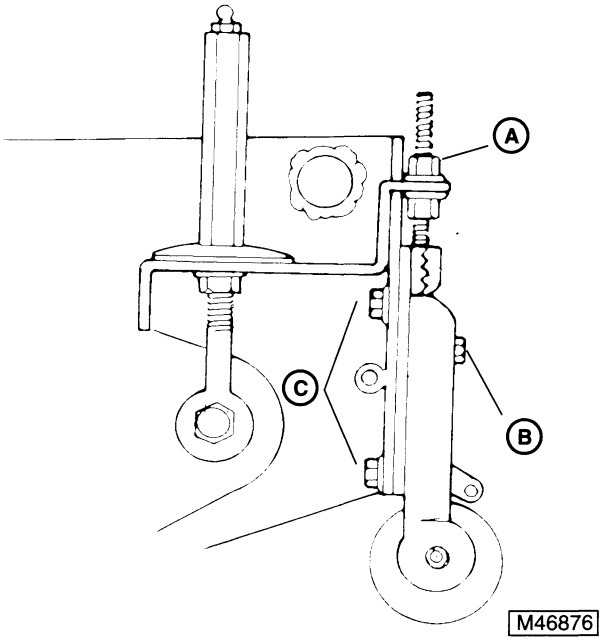
8. Disengage PTO switch and shut off the engine. Turn the flow control knob (B) fully counterclockwise.
9. Rotate Forward/Reverse knob (A) to allow the pin to engage the slot

HEIGHT-OF-CUT (HOC) ADJUSTMENT.

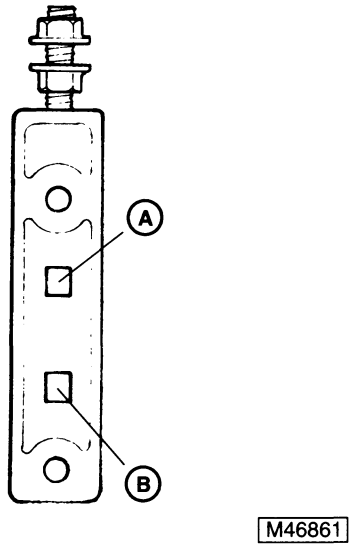
⚠ CAUTION

Do not service or adjust cutting units while the engine is running. Disengage pto and shutoff engine prior to making any adjustments.
Always wear protective gloves when working on or near the reel or bed knife.
Never allow more than one person at a time to work on any one cutting unit. Never allow adjustments to be accomplished on more than one cutting unit at the same time. Serious personal injury could result.

NOTE: The Effective Height-of-Cut may differ from the bench setting due to the weight of options used, type of roller (grooved or smooth), soil conditions, grass condition and the use of competitive machines in conjunction with one another. Floating units may not provide a quality cut when grass length exceeds 38 mm (1-1/2 in.), operate cutting units in fixed position only.

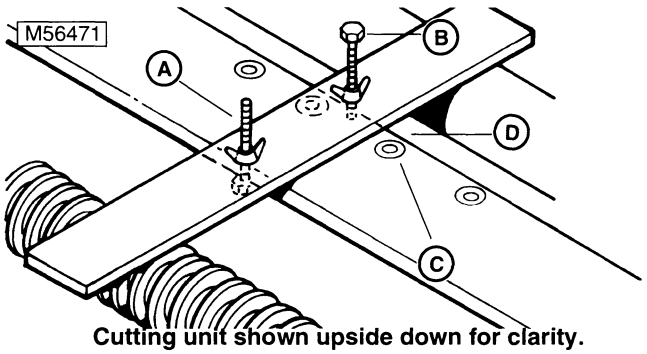


1. If HOC range needs to be changed, loosen nut (A). Remove nut and washer (B) and two bolts (C) (per side) and position the carriage bolt for the cutting height range.



NOTE: For cutting heights of 3/8 - 1 5/8 in., position carriage bolt into the upper square opening (A). For cutting heights of 1 1/2 - 3 1/2 in., position carriage bolt into the lower square opening (B).

NOTE: It may be necessary to raise the rollers, to allow for installation of the gauge bar. Forcing the gauge bar into position will bend it and result in an inaccurate height adjustment.



Cutting unit shown upside down for clarity.

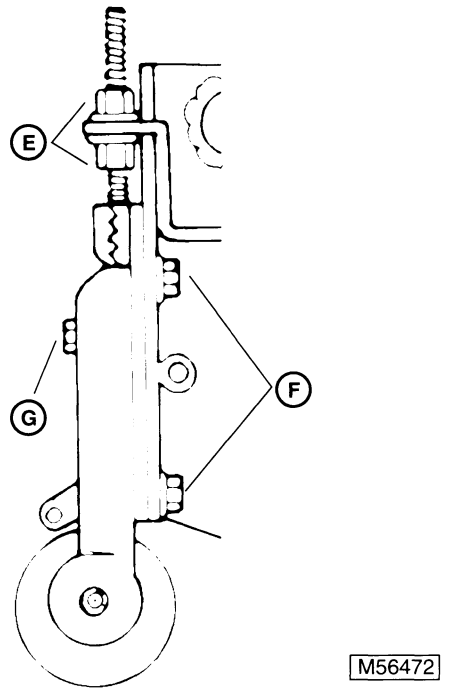
A-FORWARD BOLT	**C-BED KNIFE MOUNTING BOLT**
B-REAR BOLT	**D-BED KNIFE SUPPORT**

IMPORTANT: Ensure the rear bolt (B) on the gauge bar rests on the bed knife support, ensure it does not rest on a bed knife mounting bolt (C).

NOTE: Gauge bar should be positioned near the end of the solid roller but not on the end cap.

2. Adjust gauge bar for desired height-of-cut and install on cutting unit (see *Note* above), ensure the head of the bolt (A) rests on the lip of the bed knife.
3. Adjust rear bolt (B) until the gauge bar is parallel to the bed knife.

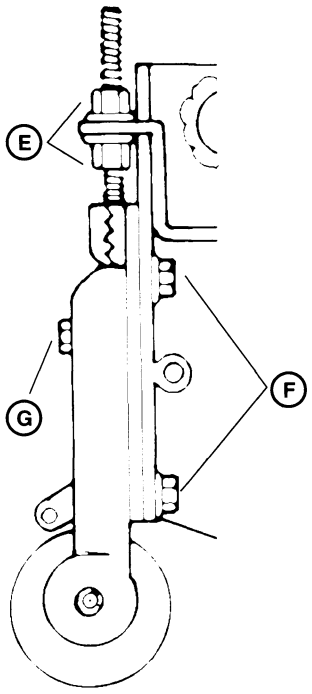
Rear Roller



NOTE: To avoid binding the adjustment mechanisms, make small adjustments on each end of the roller.
Each tooth on the adjustment mechanism equals 1/8 in

4. Loosen bolts (F) and adjustment nuts (E) (both sides) on the rear roller and slide the roller up or down to center the bolts (F) in the slot. Tighten bolts and adjustment nuts.
5. Loosen nut (G) (both sides) and position the roller as close to the gauge bar as possible without touching it. Tighten nuts (G). Ensure the same number of ratchet teeth are exposed at each end of the roller.
6. Loosen bolts (F) and adjustment nuts (E) and slide the roller down until it just touches the gauge bar. Repeat on opposite end. Recheck the adjustment for the opposite side and readjust if necessary.

Front Roller



NOTE: To avoid binding the adjustment mechanisms, make small adjustments on each end of the roller.
Each tooth on the adjustment mechanism equals 1/8 in.

7. Loosen bolts (F) and adjustment nuts (E) (both sides) on the front roller and slide the roller up or down to center the bolts (F) in the slot. Tighten bolts and adjustment nuts.
8. Tighten all hardware and recheck with a HOC gage to ensure setting did not change.
9. Loosen nut (G) (both sides) and position the roller as close to the gauge bar as possible without touching it. Tighten nuts (G). Ensure the same number of ratchet teeth are exposed at each end of the roller. (setting should agree with rear roller)
10. Loosen bolts (F) and adjustment nuts (E) and slide the roller down until it just touches the gauge bar. Repeat on opposite end. Recheck the adjustment for the opposite side and readjust if necessary.

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