2653A Diesel Professional Utility Mower

TECHNICAL MANUAL

John Deere
Worldwide Commercial and
Consumer Equipment Division
TM1554 (AUG 97)
Replaces TM1554 (JUL 95)

Litho in U.S.A

2653A Diesel
Professional Utility Mower

This technical manual is written for an experienced 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
- General Diagnostic Information
- Specifications
- Electrical Wiring Harness Legend
- Component Location
- System Schematic
- Wiring Harness
- Troubleshooting Chart
- Theory of Operation
- Diagnostics
- Tests & Adjustments
- 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.

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.

Safety

Specifications and Information

Diesel Engine

Electrical (S.N. —060554)

Electrical (S.N. 060555—)

Hydrostatic Power Train

Steering

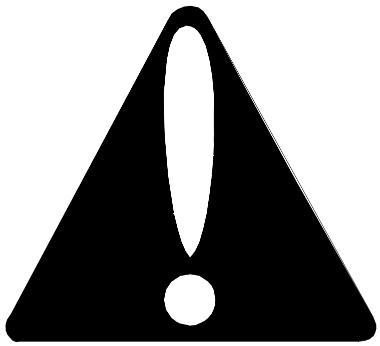
Brakes

Hydraulics

Attachments

Miscellaneous

RECOGNIZE SAFETY INFORMATION



This is the safety-alert symbol. When you see this symbol on your machine or in this manual, be alert to the potential for personal injury.

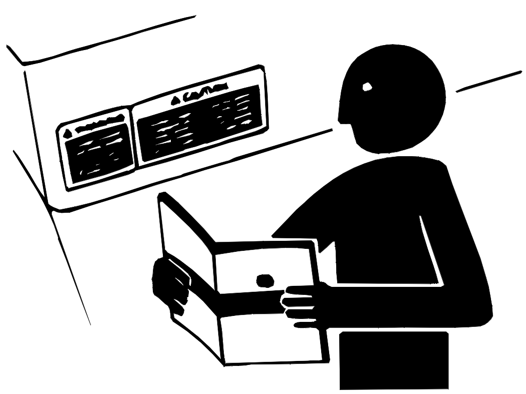
Follow recommended precautions and safe servicing practices.

Understand Signal Words

A signal word—DANGER, WARNING, or CAUTION—is used with the safety-alert symbol. DANGER identifies the most serious hazards.

DANGER or WARNING safety signs are located near specific hazards. General precautions are listed on CAUTION safety signs. CAUTION also calls attention to safety messages in this manual.

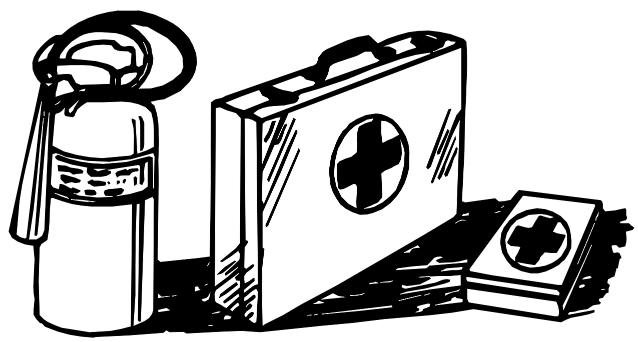
REPLACE SAFETY SIGNS



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

HANDLE FLUIDS SAFELY-AVOID FIRES

Be Prepared For Emergencies



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.

USE CARE IN HANDLING AND SERVICING BATTERIES

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:**

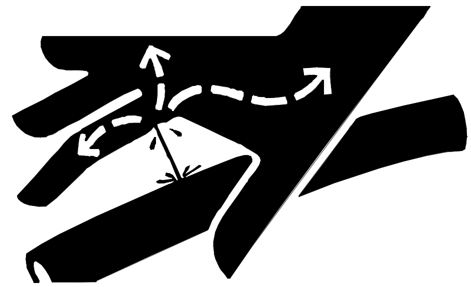
1. Flush your skin with water.
2. Apply baking soda or lime to help neutralize the acid.
3. Flush your eyes with water for 10_15 minutes.
4. Get medical attention immediately.

- **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 CARE AROUND HIGH-PRESSURE FLUID LINES

Avoid High-pressure Fluids



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

Avoid injury from escaping fluid under pressure by stopping the engine and relieving pressure in the system before disconnecting or connecting 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.

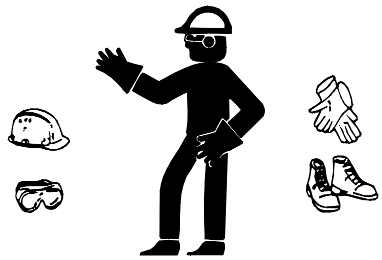
If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical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

Avoid Heating Near Pressurized Fluid Lines

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.

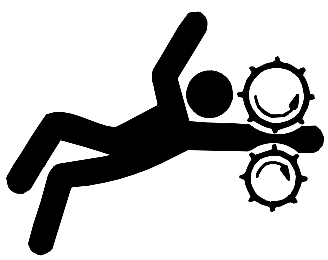
USE SAFE SERVICE PROCEDURES

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.

Service Machines Safely

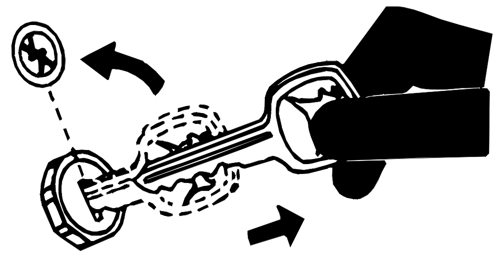


Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.
Remove rings and other jewelry to prevent electrical shorts and entanglement in moving parts.

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 tools on metric fasteners. Avoid bodily injury caused by slipping wrenches. Use only service parts meeting John Deere specifications.

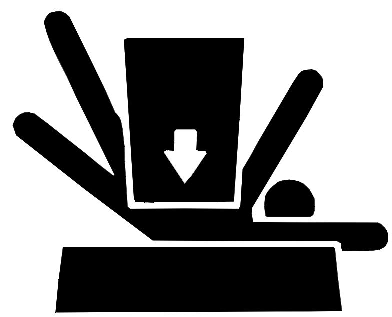
Park Machine Safely



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



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.

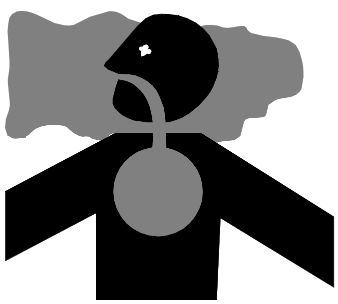
Using High Pressure Washers

Directing pressurized water at electronic/electrical components or connectors, bearings, hydraulic seals, fuel injection pumps or other sensitive parts and components may cause product malfunctions. Reduce pressure and spray at a 45 to 90 degree angle.

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



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.

WARNING: California Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

Gasoline engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

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

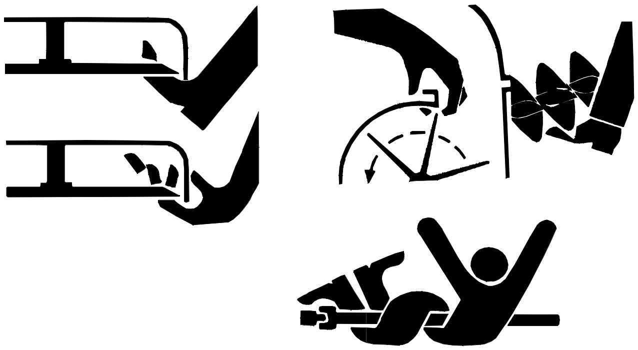
Explosive separation of a tire and rim parts can cause serious injury or death.

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.

AVOID INJURY FROM ROTATING BLADES, AUGERS AND PTO SHAFTS



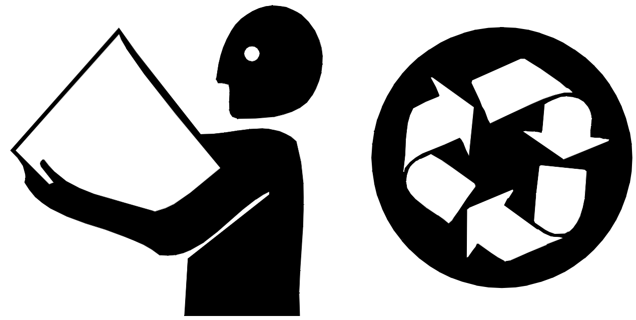
Keep hands and feet away while machine is running. Shut off power to service, lubricate or remove mower blades, augers or PTO shafts.

SERVICE COOLING SYSTEM SAFELY

Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off machine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

HANDLE CHEMICAL PRODUCTS SAFELY



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.

LIVE WITH SAFETY

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

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VEHICLE SPECIFICATIONS

ENGINE

Item	SPECIFICATION
Make	Yanmar, 3 Cylinder Diesel
Model	3008D002
Horsepower	13.4 kW (18HP)

(For detailed engine specifications, see Engine Section)

MACHINE

Battery

Voltage	12 VDC
Reserve Capacity @ 25 Amps	80 min.
Cold Cranking Amps @ -18°C (0°F)	480 CCA

Capacities

Crankcase	
W/Filter	2.4 L (2.5 U.S. qts.)
Coolant	
Engine & Radiator	4.0 L (4.2 U.S. qts.)
Overflow Bottle	0.53 L (1.25 U.S. pts.)
Fuel Tank	28 L (7.4 U.S. gal.)
Hydraulic Fluid	
Reservoir	20.8 L (U.S. 5.5 U.S. gal.)
System (Excluding Reservoir)	7.6 L (2 U.S. gal.) Approx.

Brakes

Type	Dual Disc (mechanical) 20.3 cm (8 in.)

Wheels/Tires

Front	20 x 10-10
Steer	20 x 10-8
Mowing Speed	0-8.0 km (0-5 m.p.h.)
Transport Speed	0-12.8 km (0-8 m.p.h.)
Reverse Speed	0-8 km (0-5 m.p.h.)

INSTRUMENTATION

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

FUEL SYSTEM

Fuel	Diesel
Fuel Filter	Replaceable in-line filter
Fuel Pump	Mechanical

WEIGHT AND DIMENSIONS

Wheel Base	140 cm (55 in.)
Tread Width	136 cm (53.5 in.)
Mowing Position Width	183 cm (72 in.)
Turning Radius uncut circle	50.8 cm (20 in.)
Vehicle Weight	703 kg (1550 lbs.)
Full Fluids, no operator	789 kg (1740 lbs.)
Ground Clearance	7.6 cm (3 in.)

HYDRAULIC SYSTEM

Reservoir

Capacity	20.8 L (5.5 U.S. gal.)
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

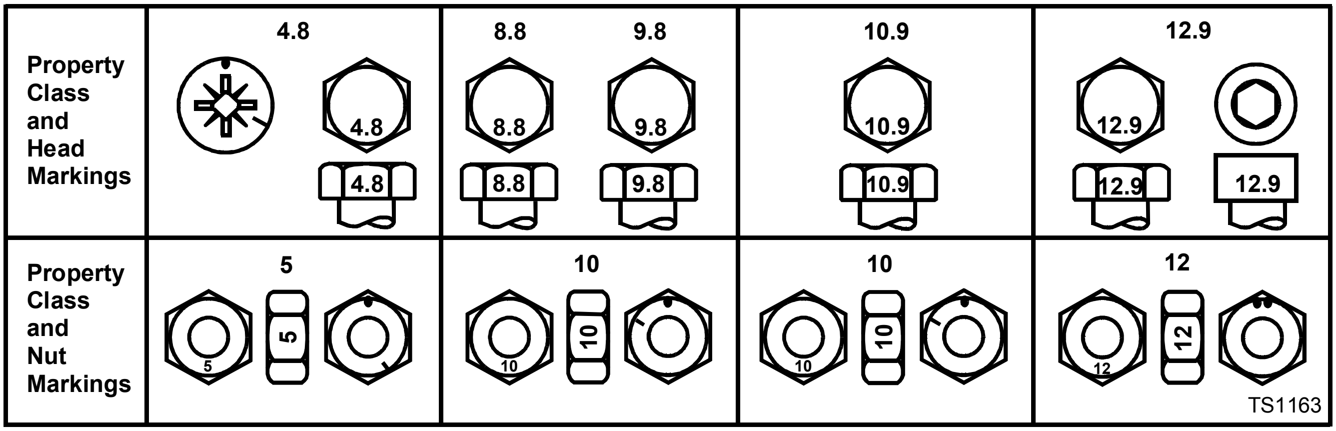
Wheel Drive System

Drive Wheels	Front, with optional third (rear) wheel drive
Traction Drive	Hydrostatic, 2 pedal
Pump	Variable Displacement Piston Pump

MOWER

Number	3
Size	66 or 79.2 cm (26 or 30 in.) Floating Standard
Backlapping	(Standard) On Machine, Variable adjustment
Clip frequency	
5 blade cutting units	0.201/MPH
8 blade cutting units	0.126/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

METRIC FASTENER 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	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft
M6	4.8	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 hand torque values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only and include a ±10% variance factor. Check tightness of fasteners periodically. DO NOT use air powered wrenches.

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

Fasteners should be replaced with the same class. Make sure fastener threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

When bolt and nut combination fasteners are used, torque values should be applied to the **NUT** instead of the bolt head.

Tighten toothed or serrated-type lock nuts to the full torque value.

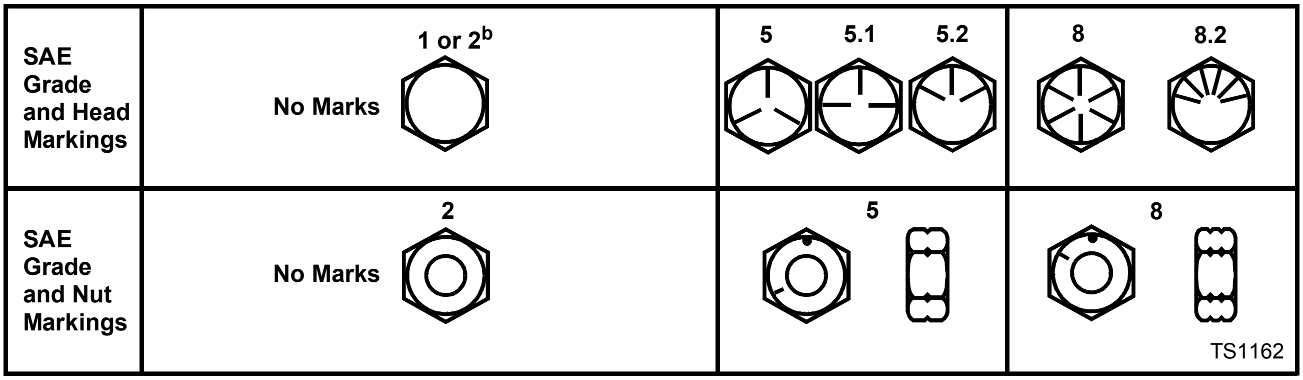
[a] *"Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated (yellow dichromate - Specification JDS117) without any lubrication.*

Reference: JDS—G200.

METRIC FASTENER TORQUE VALUE – GRADE 7

Size	Steel or Gray Iron Torque		Aluminum Torque	
	N•m	lb-ft	N•m	lb-ft
M6	11	8	8	6
M8	24	18	19	14
M10	52	38	41	30
M12	88	65	70	52
M14	138	102	111	82
M16	224	165	179	132

INCH FASTENER TORQUE VALUES



	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	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	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 hand torque values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only and include a ±10% variance factor. Check tightness of fasteners periodically. DO NOT use air powered wrenches.

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

Fasteners should be replaced with the same grade. Make sure fastener threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

When bolt and nut combination fasteners are used, torque values should be applied to the **NUT** instead of the bolt head.

Tighten toothed or serrated-type lock nuts to the full torque value.

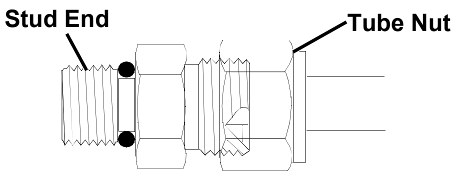
[a] *"Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated (yellow dichromate - Specification JDS117) without any lubrication.*

[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.*

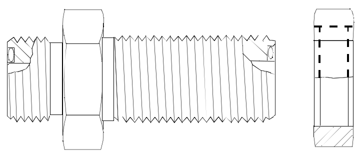
Reference: JDS—G200.

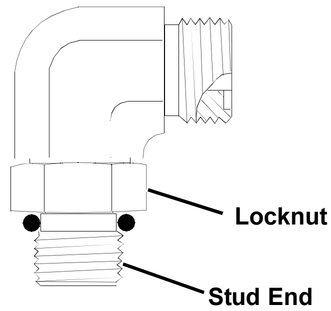
O-RING SEAL SERVICE RECOMMENDATIONS

FACE SEAL FITTINGS WITH INCH STUD ENDS TORQUE

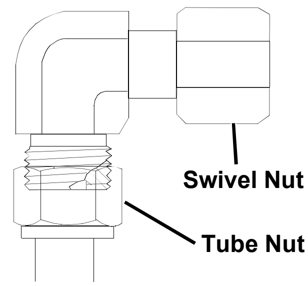


Stud Straight and Tube Nut


Bulkhead Union and Bulkhead Lucknut



90 Adjustable Stud Elbow

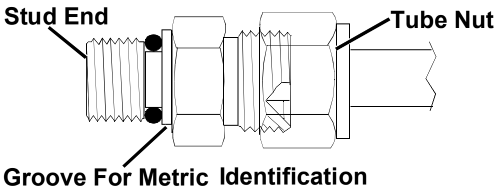


90 Swivel Elbow and Tube Nut

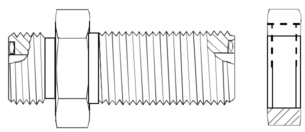
Nominal Tube O.D./Hose I.D.				Face Seal Tube/Hose End					O-ring Stud Ends		
Metric Tube O.D.	Inch Tube O.D.			Thread Size	Tube Nut/ Swivel Nut Torque		Bulkhead Locknut Torque		Thread Size	Straight Fitting or Locknut Torque	
mm	Dash Size	in.	mm	in.	N•m	lb-ft	N•m	lb-ft	in.	N•m	lb-ft
	-3	0.188	4.76						3/8-24	8	6
6	-4	0.250	6.35	9/16-18	16	12	12	9	7/16-20	12	9
8	-5	0.312	7.94						1/2-20	16	12
10	-6	0.375	9.52	11/16-16	24	18	24	18	9/16-18	24	18
12	-8	0.500	12.70	13/16-16	50	37	46	34	3/4-16	46	34
16	-10	0.625	15.88	1-14	69	51	62	46	7/8-14	62	46
	-12	0.750	19.05	1-3/16-12	102	75	102	75	1-1/16-12	102	75
22	-14	0.875	22.22	1-3/16-12	102	75	102	75	1-3/16-12	122	90
25	-16	1.000	25.40	1-7/16-12	142	105	142	105	1-5/16-12	142	105
32	-20	1.25	31.75	1-11/16-12	190	140	190	140	1-5/8-12	190	140
38	-24	1.50	38.10	2-12	217	160	217	160	1-7/8-12	217	160

NOTE: Torque tolerance is + 15 minus 20%.

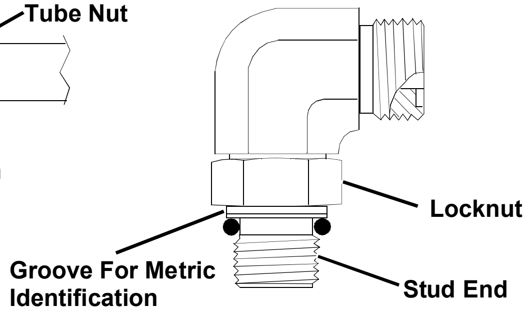
FACE SEAL FITTINGS WITH METRIC STUD ENDS TORQUE



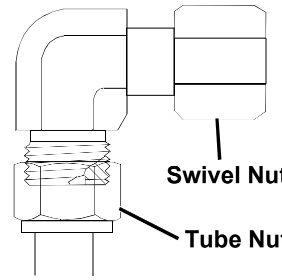
Stud Straight and Tube Nut



Bulkhead Union and Bulkhead Lucknut



90 Adjustable Stud Elbow

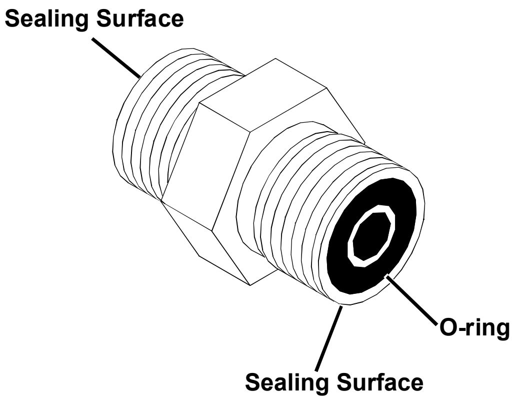


90 Swivel Elbow and Tube Nut

Nominal Tube O.D./Hose I.D.				Face Seal Tube/Hose End						O-ring Stud Ends, Straight Fitting or Locknut					
Metric Tube O.D.	Inch Tube O.D.			Thread Size	Hex Size	Tube Nut/ Swivel Nut Torque		Bulkhead Locknut Torque		Thread Size	Hex Size	Steel or Gray Iron Torque		Aluminum Torque	
mm	Dash Size	in.	mm	in.	mm	N•m	lb-ft	N•m	lb-ft	mm	mm	N•m	lb-ft	N•m	lb-ft
6	-4	0.250	6.35	9/16-18	17	16	12	12	9	M12X1.5	17	21	15.5	9	6.6
8	-5	0.312	7.94												
										M14X1.5	19	33	24	15	11
10	-6	0.375	9.52	11/16-16	22	24	18	24	18	M16X1.5	22	41	30	18	13
12	-8	0.500	12.70	13/16-16	24	50	37	46	34	M18X1.5	24	50	37	21	15
16	-10	0.625	15.88	1-14	30	69	51	62	46	M22X1.5	27	69	51	28	21
	-12	0.750	19.05	1-3/16-12	36	102	75	102	75	M27X2	32	102	75	46	34
22	-14	0.875	22.22	1-3/16-12	36	102	75	102	75	M30X2	36				
25	-16	1.000	25.40	1-7/16-12	41	142	105	142	105	M33X2	41	158	116	71	52
28										M38X2	46	176	130	79	58
32	-20	1.25	31.75	1-11/16-12	50	190	140	190	140	M42X2	50	190	140	85	63
38	-24	1.50	38.10	2-12	60	217	160	217	160	M48X2	55	217	160	98	72

NOTE: Torque tolerance is + 15 minus 20%.

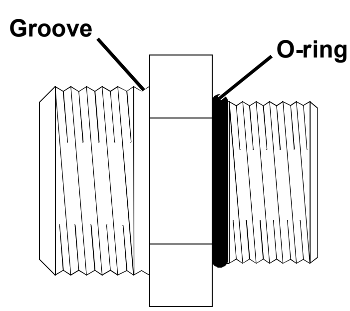
O-RING FACE SEAL FITTINGS



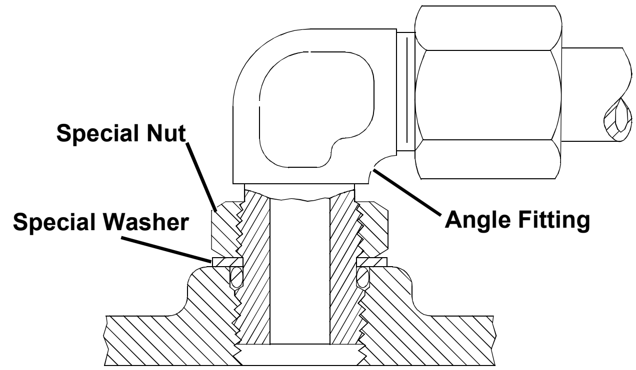
1. Inspect the fitting sealing surfaces. They must be free of dirt or defects.
2. Inspect the O-ring. It must be free of damage or defects.
3. Lubricate O-rings and install into groove using petroleum jelly to hold in place.
4. Push O-ring into the groove with plenty of petroleum jelly so O-ring is not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

O-RING BOSS FITTINGS

1. Inspect boss O-ring boss seat. It must be free of dirt and defects. If repeated leaks occur, inspect for defects with a magnifying glass. Some raised defects can be removed with a slip stone.



2. Put hydraulic oil or petroleum jelly on the O-ring. Place electrical tape over the threads to protect O-ring from nicks. Slide O-ring over the tape and into the groove of fitting. Remove tape.



3. For angle fittings, loosen special nut and push special washer against threads so O-ring can be installed into the groove of fitting.
4. Turn fitting into the boss by hand until special washer or washer face (straight fitting) contacts boss face and O-ring is squeezed into its seat.
5. To position angle fittings, turn the fitting counter-clockwise a maximum of one turn.
6. Tighten straight fittings to torque value shown on chart. For angle fittings, tighten the special nut to value shown in the chart while holding body of fitting with a wrench.

STRAIGHT FITTING OR SPECIAL NUT TORQUE

Thread Size	Torque[a] N•m	Torque[a] lb-ft	Number of Flats[b]
3/8-24 UNF	8	(6)	2
7/16-20 UNF	12	(9)	2
1/2-20 UNF	16	(12)	2
9/16-18 UNF	24	(18)	2
3/4-16 UNF	46	(34)	2
7/8-14 UNF	62	(46)	1-1/2
1-1/16-12 UN	102	(75)	1
1-3/16-12 UN	122	(90)	1
1-5/16-12 UN	142	(105)	3/4
1-5/8-12 UN	190	(140)	3/4
1-7/8-12 UN	217	(160)	1/2

a. Torque tolerance is ± 10 percent.
b. To be used if a torque wrench cannot be used. After tightening fitting by hand, put a mark on nut or boss; then tighten special nut or straight fitting the number of flats shown.

DIESEL FUEL SPECIFICATIONS

In general, diesel fuels are blended to satisfy the low air temperature requirements of the geographical area in which they are sold.

In **North America**, diesel fuel is usually specified to **ASTM D975** and sold as either **Grade 1** for cold air temperatures or **Grade 2** for warm air temperatures.

In **Europe**, diesel fuel is usually specified to **EN590** and sold in 5 different classes or 6 different grades.

If diesel fuels being supplied in your area **DO NOT** meet any of the above specifications, use diesel fuels with the following equivalent properties:

- **Cetane Number 40 (minimum)**

  A cetane number **greater than 50 is preferred**, especially for air temperatures below –20°C (–4°F) or elevations above 1500 m (5000 ft).

- **Cold Filter Plugging Point (CFPP)**

  The temperature at which diesel fuel **begins to cloud or jell.** Use diesel fuels with a CFPP which is at least 5°C (9°F) below the expected low air temperature.

- **Sulfur Content of 0.05% (maximum)**

  Diesel fuels for highway use in the United States now require sulfur content to be **less than 0.05%**.

  If diesel fuel being used has a sulfur content **greater than 0.5%, reduce the service interval for engine oil and filter by 50%**.

Bio-Diesel Fuels with bio-degradable properties that meet specification DIN 51606 or equivalent may be used.

Consult your local diesel fuel distributor for properties of the diesel fuel available in your area.

⚠ WARNING

California Proposition 65 Warning: Diesel engine exhaust and some of its elements from this product are known to the State of California to cause cancer, birth defects, or other reproductive harm.

LUBRICITY

Diesel fuel must have adequate lubricity to ensure proper operation and durability of fuel injection system components. Fuel lubricity should pass a **minimum of 3300 gram load level** as measured by the **BOCLE** scuffing test.

STORAGE

IMPORTANT: DO NOT USE GALVANIZED CONTAINERS—diesel fuel stored in galvanized containers reacts with zinc coating in the container to form zinc flakes. If fuel contains water, a zinc gel will also form. The gel and flakes will quickly plug fuel filters and damage fuel injectors and fuel pumps.

It is recommended that diesel fuel be stored **ONLY** in a clean, approved **POLYETHYLENE PLASTIC** container **WITHOUT** any metal screen or filter. This will help prevent any accidental sparks from occurring. Store fuel in an area that is well ventilated to prevent possible igniting of fumes by an open flame or spark, this includes any appliance with a pilot light.

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

Keep fuel in a safe, protected area and in a clean, properly marked **("DIESEL FUEL")** container. **DO NOT** use deicers to attempt to remove water from fuel. **DO NOT** depend on fuel filters to remove water from fuel. It is recommended that a water separator be installed in the storage tank outlet. **BE SURE** to properly discard unstable or contaminated diesel fuel and/or their containers when necessary.

ENGINE OIL SPECIFICATIONS

4–CYCLE DIESEL ENGINE OIL – NORTH AMERICA

Use the appropriate oil viscosity based on the expected air temperature range during the period between recommended oil changes. Operating outside of these recommended oil air temperature ranges may cause premature engine failure.

The following John Deere oils are **PREFERRED:**

- **PLUS–50®—SAE 15W-40;**
- **TORQ–GARD SUPREME®—SAE 5W-30**.

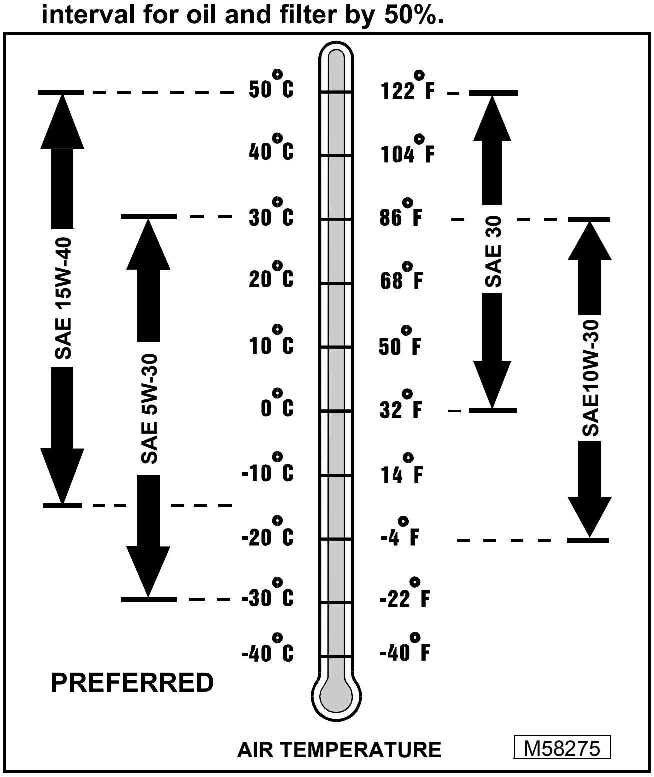
The following John Deere oils are **also recommended**, based on their specified temperature range:

- **TURF–GARD®—SAE 10W-30;**
- **PLUS–4®—SAE 10W-30;**
- **TORQ–GARD SUPREME®—SAE 30.**

Other oils may be used if above John Deere oils are not available, provided they meet one of the following specifications:

- SAE 15W-40—API Service Classification CF–4 or higher;
- SAE 5W-30—API Service Classification CC or higher;
- SAE 10W-30—API Service Classification CF or higher;
- SAE 30—API Service Classification CF or higher.

IMPORTANT: If diesel fuel with sulfur content greater than 0.5% is used, reduce the service interval for oil and filter by 50%.



4–CYCLE DIESEL ENGINE OIL – EUROPE

Use the appropriate oil viscosity based on the expected air temperature range during the period between recommended oil changes. Operating outside of these recommended oil air temperature ranges may cause premature engine failure.

The following John Deere oils are **PREFERRED**:

- **TORQ–GARD SUPREME®—SAE 15W-40;**
- **UNI–GARD™—SAE 15W-40;**
- **TORQ–GARD SUPREME®—SAE 5W-30;**
- **UNI–GARD™—SAE 5W-30.**

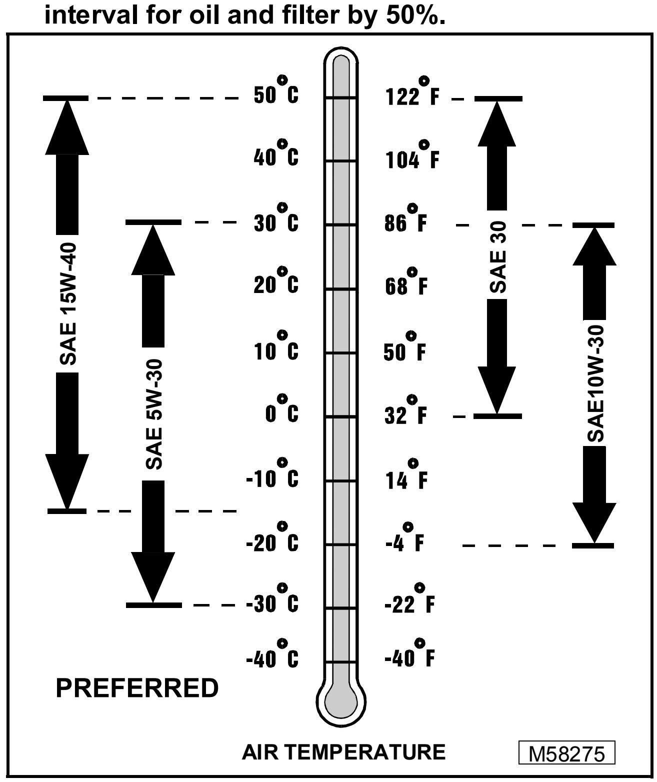
The following John Deere oils are **also recommended**, based on their specified temperature range:

- **TORQ–GARD SUPREME®—SAE 10W-30;**
- **UNI–GARD™—SAE 10W-30;**
- **TORQ–GARD SUPREME®—SAE 30;**
- **UNI–GARD™—SAE 30.**

Other oils may be used if above John Deere oils are not available, provided they meet one of the following specifications:

- CCMC Specification D4 or Mercedes Benz MB228.1 or higher.

IMPORTANT: If diesel fuel with sulfur content greater than 0.5% is used, reduce the service interval for oil and filter by 50%.



BREAK–IN DIESEL ENGINE OIL – NORTH AMERICA

IMPORTANT: ONLY use this specified break-in oil in rebuilt or remanufactured engines for the <u>first 100 hours (maximum) of operation</u>. DO NOT use PLUS–50®, SAE 15W40 oil or oils meeting specifications API CG–4 or API CF–4, these oils will not allow rebuilt or remanufactured engines to break-in properly.

The following John Deere oil is **PREFERRED**:

- **BREAK–IN ENGINE OIL**.

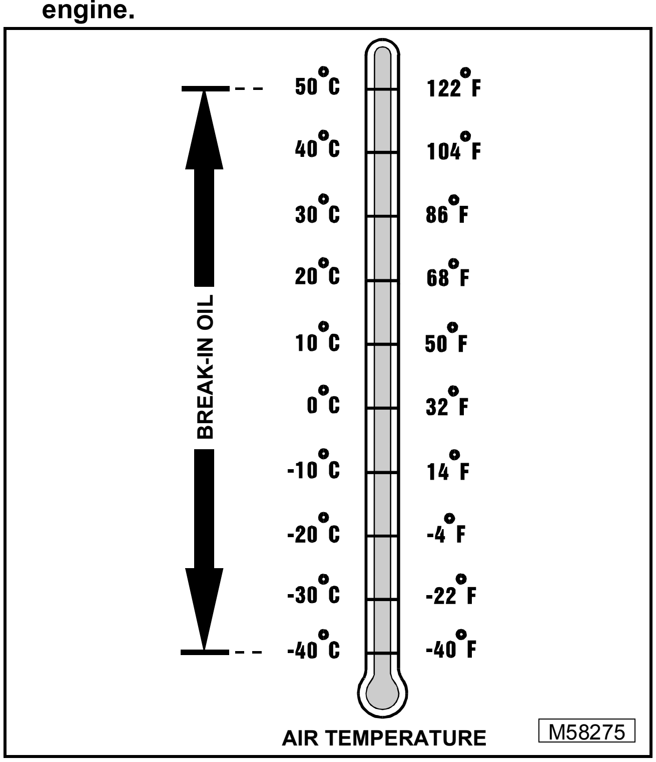
John Deere BREAK–IN ENGINE OIL is formulated with special additives for aluminum and cast iron type engines to allow the power cylinder components (pistons, rings, and liners as well) to “wear-in” while protecting other engine components, valve train and gears, from abnormal wear. Engine rebuild instructions should be followed closely to determine if special requirements are necessary.

John Deere BREAK–IN ENGINE OIL is also recommended for non-John Deere engines, both aluminum and cast iron types.

If this preferred John Deere oil is not available, use a break-in engine oil meeting the following specification during the first 100 hours of operation:

- API Service Classification CE or higher.

IMPORTANT: After the break-in period, use the John Deere oil that is recommended for this engine.



BREAK–IN DIESEL ENGINE OIL – EUROPE

IMPORTANT: ONLY use this specified break-in oil in rebuilt or remanufactured engines for the <u>first 100 hours (maximum) of operation</u>. DO NOT use SAE 15W-40 oil or oils meeting CCMC Specification D5—these oils will not allow rebuilt or remanufactured engines to break-in properly.

The following John Deere oil is **PREFERRED**:

- **BREAK–IN ENGINE OIL**.

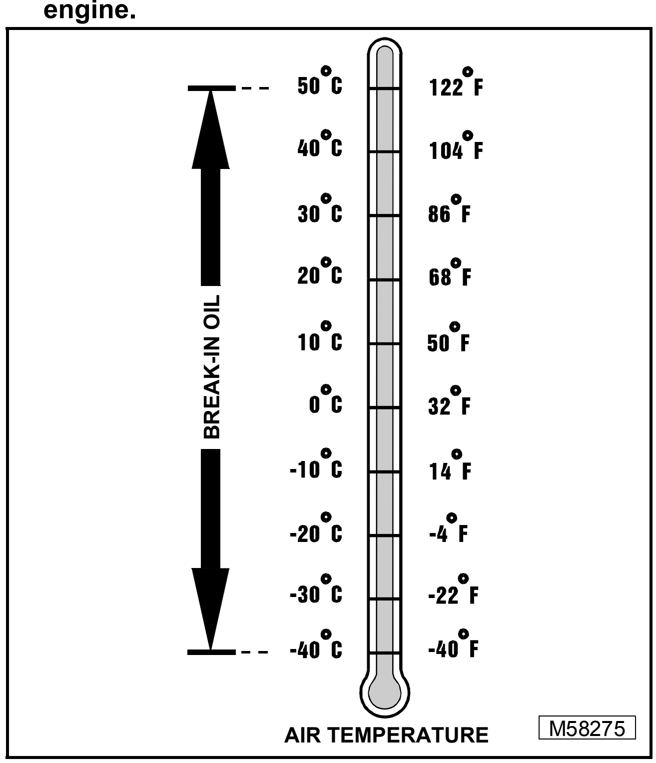
John Deere BREAK–IN ENGINE OIL is formulated with special additives for aluminum and cast iron type engines to allow the power cylinder components (pistons, rings, and liners as well) to “wear-in” while protecting other engine components, valve train and gears, from abnormal wear. Engine rebuild instructions should be followed closely to determine if special requirements are necessary.

John Deere BREAK–IN ENGINE OIL is also recommended for non-John Deere engines, both aluminum and cast iron types.

If above preferred John Deere oil is not available, use a break-in engine oil meeting the following specification during the first 100 hours of operation:

- CCMC Specification D4 or higher.

IMPORTANT: After the break-in period, use the John Deere oil that is recommended for this engine.



HYDROSTATIC TRANSMISSION AND HYDRAULIC OIL – NORTH AMERICA AND EUROPE

Use the following oil viscosity based on the air temperature range. Operating outside of the recommended oil air temperature range may cause premature hydrostatic transmission or hydraulic system failures.

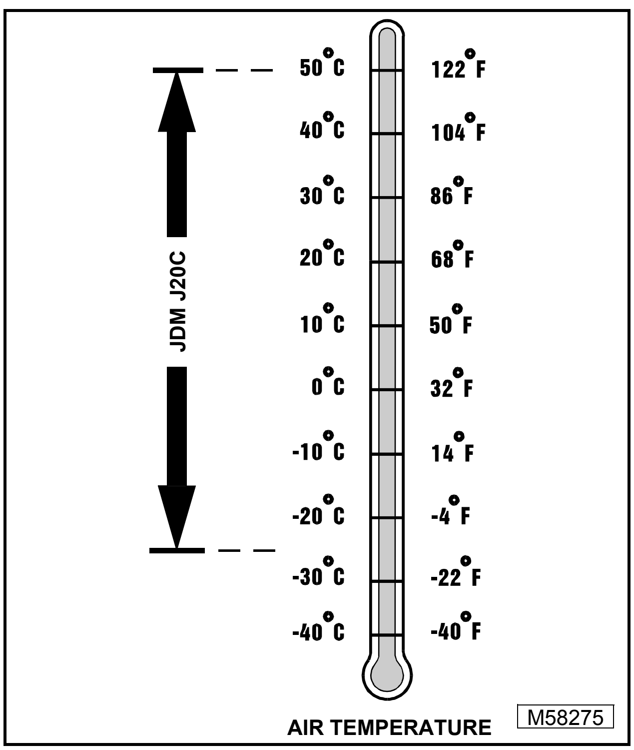
IMPORTANT: DO NOT use engine oil or "Type F" (Red) Automatic Transmission Fluid in this transmission. DO NOT mix any other oils in this transmission. DO NOT use BIO–HY–GARD® in this transmission.

The following John Deere transmission and hydraulic oil is **PREFERRED**:

- **HY–GARD®—JDM J20C**.

Other oils may be used if above recommended John Deere oil is not available, provided they meet the following specification:

- John Deere Standard JDM J20C.



REEL SUPPORT BEARING GREASE – NORTH AMERICA

Use the following reel support bearing greases based on the air temperature range. Operating outside of the recommended grease air temperature range may cause premature reel support failure.

The following John Deere grease is **PREFERRED**:

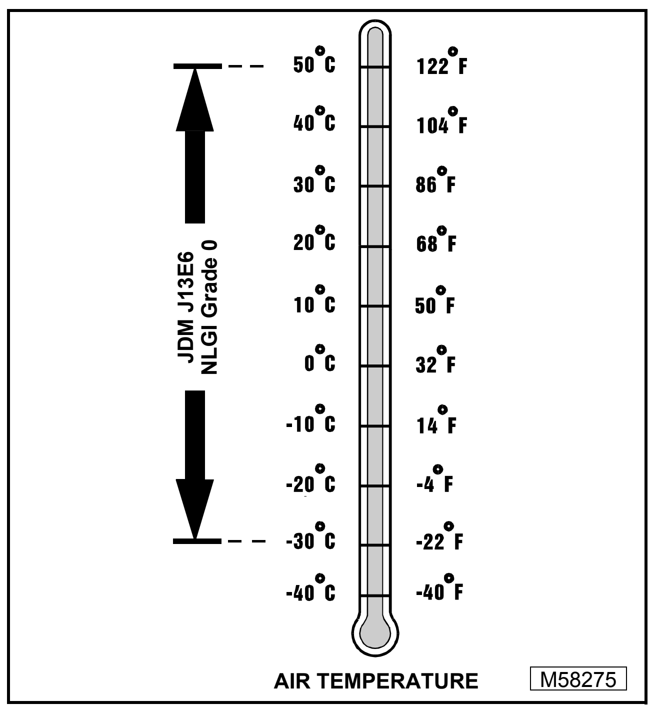
- **CORN HEAD GREASE—AH80490/AN102562**

NOTE: John Deere Track Idler and Roller Grease (PT512) may also be used.

Other greases may be used if above John Deere greases are not available, provided they **meet the following compatibility specifications only**:

- Polyurea Grease—NLGI Grade 0;
- Calcium Complex Grease—NLGI Grade 0.

IMPORTANT: DO NOT mix any other greases (including calcium, lithium, lithium complex, and lithium 12-hydroxy based greases) with above recommended greases, they are NOT COMPATIBLE. For best results, completely remove all non-compatible grease from housing and fill with above preferred grease or one of the other greases, which are compatible with each other. DO NOT use any BIO–GREASE.



REEL SUPPORT BEARING GREASE – EUROPE

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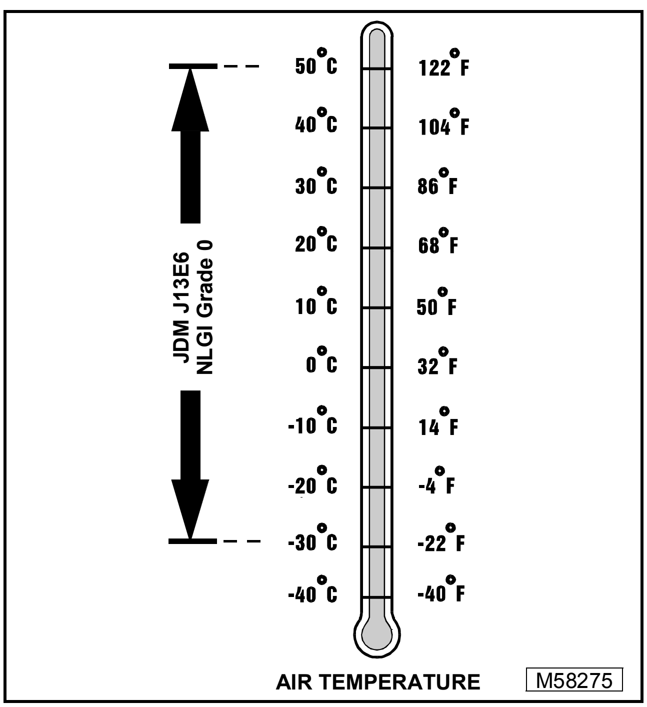


ANTI-CORROSION GREASE SPECIFICATIONS

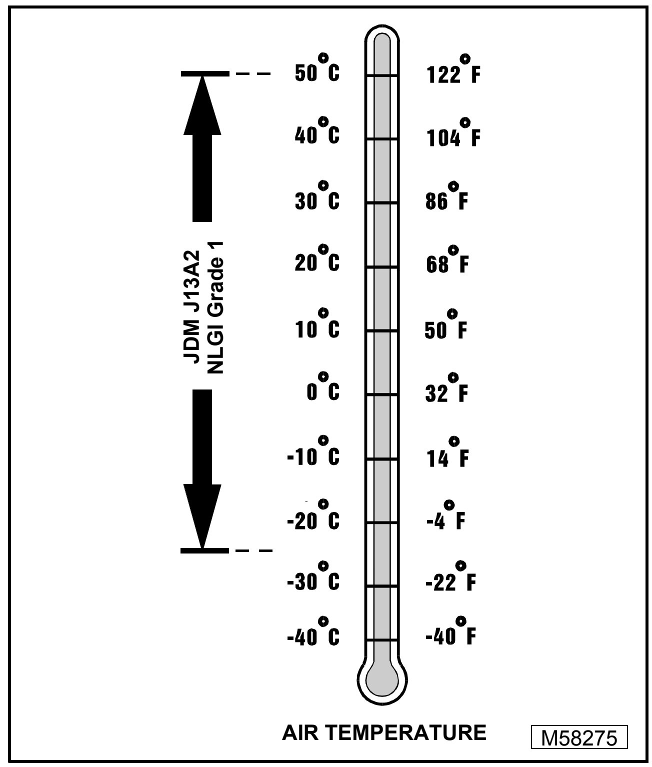
This anti-corrosion grease is formulated to provide the best protection against absorbing moisture, which is one of the major causes of corrosion. This grease is also superior in its resistance to separation and migration.

The following anti-corrosion grease is **PREFERRED**:

- **DuBois MPG-2® Multi-Purpose Polymer Grease—M79292.**

Other greases may be used if they meet or exceed the following specifications:

- John Deere Standard JDM J13A2, NLGI Grade 1.



GENERAL APPLICATION GREASE SPECIFICATIONS

GREASE – NORTH AMERICA

Use the following grease based on the air temperature range. Operating outside of the recommended grease air temperature range may cause premature failures.

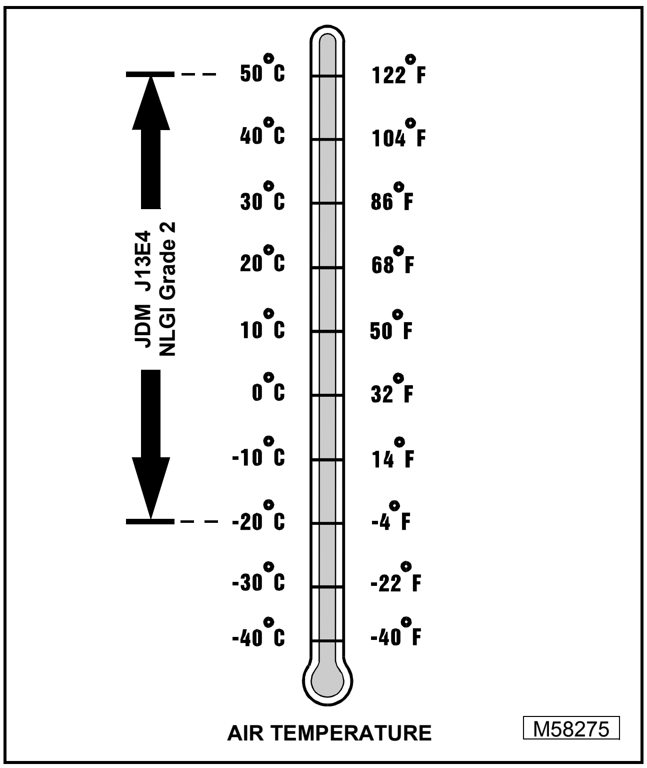
IMPORTANT: ONLY use a quality grease in this application. DO NOT mix any other greases in this application. DO NOT use any BIO–GREASE in this application.

The following John Deere grease is **PREFERRED**:

- **NON-CLAY HIGH-TEMPERATURE EP GREASE®—JDM J13E4, NLGI Grade 2.**

Other greases may be used if above preferred John Deere grease is not available, provided they meet the following specification:

- John Deere Standard JDM J13E4, NLGI Grade 2.



GREASE – EUROPE

Use the following grease based on the air temperature range. Operating outside of the recommended grease air temperature range may cause premature failures.

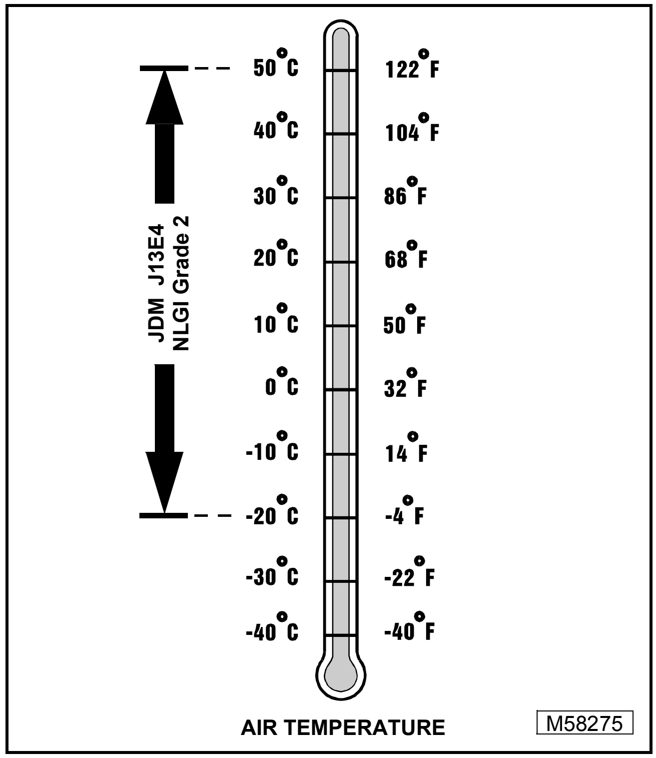
IMPORTANT: ONLY use a quality grease in this application. DO NOT mix any other greases in this application. DO NOT use any BIO–GREASE in this application.

The following John Deere grease is **PREFERRED**:

- **GREASE–GARD™—JDM J13E4, NLGI Grade 2.**

Other greases may be used if above preferred John Deere grease is not available, provided they meet the following specification:

- John Deere Standard JDM J13E4, NLGI Grade 2.



ALTERNATIVE LUBRICANTS

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

IMPORTANT: Use of alternative lubricants could cause reduced life of the component.

If alternative lubricants are to be used, it is recommended that the factory fill be thoroughly removed before switching to any alternative lubricant.

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 in this manual.

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

Avoid mixing different brands, grades, or types of oil. Oil manufacturers blend additives 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.

LUBRICANT STORAGE

All machines operate at top efficiency only when clean lubricants are used. Use clean storage containers to handle all lubricants. Store them in an area protected from dust, moisture, and other contamination. Store drums on their sides. Make sure all containers are properly marked as to their contents. Dispose of all old, used containers and their contents properly.

MIXING OF LUBRICANTS

In general, avoid mixing different brands or types of lubricants. Manufacturers blend additives in their lubricants to meet certain specifications and performance requirements. Mixing different lubricants can interfere with the proper functioning of these additives and lubricant properties which will downgrade their intended specified performance.

OIL FILTERS

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

The following John Deere oil filters are PREFERRED:

- AUTOMOTIVE AND LIGHT TRUCK ENGINE OIL FILTERS.

Most John Deere filters contain pressure relief and anti-drainback valves for better engine protection.

Other oil filters may be used if above recommended John Deere oil filters are not available, provided they meet the following specification:

- ASTB Tested In Accordance With SAE J806.

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SPECIFICATIONS

3TNE68 & 3TNE68C

Make . . . Yanmar
Number Of Cylinders . . . 3
Bore . . . 68 mm (2.68 in.)
Stroke . . . 72 mm (2.83 in.)
Displacement . . . 784 cm3 (47.8 cu in.)
Compression Ratio . . . 23:1
Slow Idle . . . 1450 ± 25 rpm
Fast Idle . . . 3425 ± 25 rpm
Firing Order . . . 1-3-2-1
Timing . . . 14× BTDC

Bearings:

Number Of Mains . . . 4
Main Diameter . . . 79.2 mm (3.12 in.)
Main Width . . . 28.4 mm (1.12 in.)
Rod Journal Diameter . . . 69.8 mm (2.75 in.)
Rod Journal Width . . . 30.0 mm (1.18 in.)

Lubrication System:

Pump Capacity . . . 11.9 L/min (3.14 gpm)
Normal Oil Pressure At Rated Speed, 30 W Oil At 105° C (220° F) . . . 290 kPa (46 psi)
Minimum Oil Pressure At Idle Speed . . . 50 kPa (7.25 psi)
Bypass Pressure Relief In Oil Filter . . . 98 kPa (14.2 psi)

REPAIR SPECIFICATIONS

Valve Clearance . . . 0.20 mm (0.008 in.)
Connecting Rod Side Play
  Standard Clearance . . . 0.20—0.40 mm (0.008—0.016 in.)
Connecting Rod Bearing Clearance
  Standard Clearance . . . 0.03—0.06 mm (0.001—0.002 in.)
Crankshaft End Play
  Standard Clearance . . . 0.09—0.27 mm (0.004—0.011 in.)
Crankshaft Main Bearing Clearance
    Main Bearing Cap Capscrew Torque . . . 54 N•m (40 lb-ft.)
    Standard Clearance . . . 0.03—0.06 mm (0.001—0.002 in.)
Valve Lift (Intake and Exhaust) . . . 7.5 mm (0.295 in.)
  Camshaft End Play
    Standard Clearance . . . 0.05—0.25 mm (0.002—0.010 in.)
    Wear Limit . . . 0.40 mm (0.016 in.)
Timing Gear Backlash—Standard Backlash
    All . . . 0.04—0.12 mm (0.002—0.005 in.)
Fuel Injection Nozzle
    Opening Pressure . . . 11722 ± 480 kPa (1700 ± 70 psi)
    Leakage at 11032 kPa (1600 psi) . . . Minimum of 10 Seconds
  Chatter and Spray Pattern at
    11722 ± 480 kPa (1700 ± 70 psi)
      Slow Hand Lever Movement . . . Chatter Sound
      Slow Hand Lever Movement . . . Fine Stream Spray Pattern
      Fast Hand Lever Movement . . . Fine Atomized Spray Pattern

Thermostat
- Begin Opening . . . 71° C (160°F)
- Fully Open . . . 85° C (184° F)
- Minimum Lift Height . . . 8 mm (0.310 in.)

Coolant Temperature Switch Continuity . . . 107—113° C (225—235° F)

Starter No-Load Amp Draw/RPM
- Maximum Starter Amperage—Hitachi 0.8 kW . . . 60 Amps at 7000 rpm
- Minimum Starter RPM—Hitachi 0.8 kW . . . 7000 rpm

Fuel Injection Pump Static Timing
- Injection Pump Timing . . . 14° BTDC (Before Top Dead Center)

Distance on Outer Surface of Crankshaft Pulley for Every 0.1 mm (0.004 in.) Of Shim Thickness . . . 1° or 1 mm (3/64 in.)

Engine Crankshaft Position . . . No. 1 Cylinder on TDC Compression Stroke

Total Shim Pack Thickness (New Shims) . . . 0.5 mm (0.020 in.)

Delivery Valve Fitting Torque . . . 51 N•m (38 lb-ft.)

Fan/Alternator Drive Belt Tension
- Applied Force . . . 98 N (22 lb-force)
- Deflection . . . 10—15 mm (0.400—0.600 in.)

Operational Tests

Radiator, Bubble Test
- Maximum Air Pressure Into Cylinder . . . 2448 kPa (355 psi)

Cooling System
- Maximum Pressure . . . 117 kPa (17 psi)
- Minimum Pressure after 15 Seconds . . . 90 kPa (13 psi)

Radiator Cap
- Valve Opening Pressure . . . 90 kPa (13 psi)

Cylinder, Compression Pressure
- Compression Pressure . . . 3233 kPa (469 psi)
- Maximum Difference Between Cylinders . . . 241 kPa (35 psi)

Idle Speed (3TNE68)
- Fast . . . 3400 + 25 - 150 rpm
- Slow . . . 1400 +150 - 50 rpm

Idle Speed (3TNE68C)
- Fast . . . 3425 ± 25 rpm
- Slow . . . 1450 ± 25 rpm

Engine Oil Pressure . . . 294—392 kPa (43—57 psi)

Air Intake System Holding Pressure . . . 34—69 kPa (5—10 psi)

Minimum Fuel Supply Pump Pressure . . . 29 kPa (4.3 psi)

Fuel System Holding Pressure (Maximum) . . . 103 kPa (15 psi)

Rocker Arm Cover
- Special Nut Torque . . . 18 N•m (160 lb-in.)

Rocker Arm Assembly
- Mounting Capscrew and Nut Torque . . . 26 N•m (226 lb-in.)

Rocker Arm Shaft O.D.
- Standard . . . 9.97—9.99 mm (0.392—0.393 in.)
- Wear Limit . . . 9.95 mm (0.391 in.)

Rocker Arm and Shaft Support I.D.'s
- Clearance . . . 0.14 mm (0.005 in.)
- Standard . . . 10.00—10.02 mm (0.393—0.394 in.)
- Wear Limit . . . 10.09 mm (0.397 in.)

Push Rod Length
- Standard . . . 110—111 mm (4.346—4.380 in.)

Push Rod Bend
- Wear Limit . . . 0.03 mm (0.001 in.)

- Cylinder Head and Valves
  - Mounting Capscrew Torque
    - First . . . 13 N•m (10 lb-in.)
    - Second . . . 26 N•m (20 lb-in.)
    - Final . . . 39 N•m (28 lb-ft.)
  - Cylinder Head Distortion
    - Standard . . . 0.05 mm (0.002 in.) Or less
    - Wear Limit . . . 0.15 mm (0.006 in.)
    - Maximum Amount of Metal to be Removed . . . 0.20 mm (0.008 in.)
  - Valve Seat Width
    - Intake Valve
      - Standard . . . 1.15 mm (0.045 in.)
      - Wear Limit . . . 1.65 mm (0.065 in.)
    - Exhaust Valve
      - Standard . . . 1.41 mm (0.056 in.)
      - Wear Limit . . . 1.91 mm (0.075 in.)
- Intake and Exhaust Valves
  - Valve Faces
    - Minimum Margin . . . 0.51 mm (0.020 in.)
    - Exhaust Angle . . . 45°
    - Intake Angle . . . 30°
  - Valve Stem O.D.
    - Distance A . . . 20 mm (0.787 in.)
    - Distance B . . . 40 mm (1.575 in.)
  - Intake Valve
    - Standard . . . 5.46—5.48 mm (0.215—0.216 in.)
    - Wear Limit . . . 5.40 mm (0.212 in.)
  - Exhaust Valve
    - Standard . . . 5.44—5.46 mm (0.214—0.215 in.)
    - Wear Limit . . . 5.40 mm (0.213 in.)
  - Valve Recession
    - Intake Valve . . . 0.40 mm (0.016 in.)
    - Exhaust Valve . . . 0.85 mm (0.033 in.)
- Valve Guides
  - Valve Guide I.D.
    - Maximum Clearance . . . 0.20 mm (0.008 in.)
    - Standard . . . 5.50—5.52 mm (0.216—0.217 in.)
    - Wear Limit . . . 5.58 mm (0.220 in.)
  - Valve Guide Height . . . 7 mm (0.276 in.)
- Valve Springs
  - Spring Free Length
    - Wear Limit . . . 28 mm (1.102 in.)
  - Maximum Spring Inclination . . . 0.81 mm (0.032 in.)
- Exhaust Manifold
  - Mounting Capscrew and Nut Torque . . . 11 N•m (97 lb-in.)
- Intake Manifold
  - Mounting Capscrew Torque . . . 11 N•m (97 lb-in.)
- Valve Seat Angles
  - Valve Seat Surface
    - Exhaust Valve . . . 45°
    - Intake Valve . . . 30°
  - Lower Seat Surface . . . 70°
  - Upper Seat Surface . . . 15°
- Piston-to-Cylinder Head Clearance . . . 0.61—0.73 mm (0.024—0.028 in.)
- Piston and Connecting Rod Capscrew Torque . . . 23 N•m (203 lb-in.)
- Connecting Rod Bearing I.D.
  - Clearance . . . 0.03—0.06 mm (0.001—0.002 in.)
  - Standard . . . 39.00—39.02 mm (1.535—1.536 in.)

- Piston Ring Groove Clearance
  - First Compression Ring—Standard . . . 0.06—0.10 mm (0.002—0.004 in.)
  - Second Compression Ring—Standard . . . 0.09—0.12 mm (0.003—0.005 in.)
  - Oil Ring—Standard . . . 0.02—0.05 mm (0.001—0.002 in.)
- Piston Ring End Gap
  - Standard
    - First Compression Ring . . . 0.10—0.25 mm (0.003—0.009 in.)
    - Second Compression Ring and Oil Ring . . . 0.15—0.35 mm (0.006—0.013 in.)
  - Wear Limit . . . 1.50 mm (0.059 in.)
- Piston Pins
  - Pin O.D.
    - Standard . . . 19.99—20.00 mm (0.787—0.788 in.)
    - Wear Limit . . . 19.90 mm (0.783 in.)
  - Bore I.D.
    - Clearance . . . 0.02 mm (0.001 in.)
    - Standard . . . 20.00—20.01 mm (0.788—0.789 in.)
    - Wear Limit . . . 20.02 mm (0.789 in.)
  - Bushing I.D.
    - Clearance . . . 0.17 mm (0.006 in.)
    - Standard . . . 20.00—20.04 mm (0.788—0.789 in.)
- Piston O.D.
  - Distance A . . . 5 mm (0.197 in.)
  - Standard Size Piston
    - Standard . . . 67.940—67.970 mm (2.6748—2.6760 in.)
    - Wear Limit . . . 67.90 mm (2.673 in.)
  - 0.25 mm (0.010 in.) Oversize Piston
    - Standard . . . 68.190—68.220 mm (2.685—2.686 in.)
- Cylinder Bore I.D.
  - Standard Size Bore
    - Clearance . . . 0.060 mm (0.0024 in.)
    - Standard . . . 68.00—68.03 mm (2.677—2.678 in.)
    - Wear Limit . . . 68.20 mm (2.685 in.)
  - 0.25 mm (0.010 in.) Oversize Bore
    - Standard . . . 68.25—68.28 mm (2.688—2.689 in.)
    - Wear Limit . . . 68.45 mm (2.695 in.)
  - Deglazing . . . 30—40° crosshatch pattern
  - Reboring . . . 30—40° crosshatch pattern
- Crankshaft Rear Oil Seal
  - Seal Case-to-Block Capscrew Torque . . . 11 N•m (96 lb-in.)
  - Oil Pan-to-Seal Case Capscrew Torque . . . 9 N•m (78 lb-in.)
- Crankshaft and Main Bearings
  - Main Bearing Capscrew Torque . . . 54 N•m (40 lb-ft.)
  - Crankshaft Maximum Bend . . . 0.02 mm (0.0007 in.)
  - Connecting Rod Journal O.D.
    - Standard . . . 35.97—35.98 mm (1.4161—1.417 in.)
    - Wear Limit . . . 35.91 mm (1.414 in.)
  - Main Bearing Journal O.D.
    - Standard . . . 39.97—39.98 mm (1.573—1.574 in.)
    - Wear Limit . . . 39.90 mm (1.571 in.)
  - Main Bearing I.D.
    - Clearance . . . 0.033—0.059 mm (0.0013—0.0023 in.)
    - Standard . . . 40.00—40.04 mm (1.575—1.577 in.)
- Flex Drive Coupler-to-Flywheel Capscrew Torque . . . 28 N•m (20 lb-ft.)
- Flywheel
  - Maximum Distortion . . . 0.02 mm (0.001 in.)
  - Mounting Capscrew Torque . . . 83 N•m (61 lb-ft.)
  - Flywheel Housing Mounting Capscrew Torque . . . 49 N•m (36 lb-ft.)
- Camshaft
  - Mounting Capscrew Torque . . . 11 N•m (96 lb-in.)
  - Camshaft Side Gap—Standard . . . 0.05—0.25 mm (0.002—0.010 in.)
  - Maximum Camshaft Bend . . . 0.02 mm (0.001 in.)

- Lobe Height
  - Standard . . . 29.97—30.03 mm (1.180—1.185 in.)
  - Wear Limit . . . 29.75 mm (1.171 in.)
- Journal O.D.
  - Gear Housing and Flywheel Ends
    - Standard . . . 35.94—35.96 mm (1.410—1.416 in.)
    - Wear Limit . . . 35.85 mm (1.411 in.)
  - Intermediate
    - Standard . . . 35.91—35.94 mm (1.414—1.415 in.)
    - Wear Limit . . . 35.85 mm (1.411 in.)
- Bushing I.D.
  - Clearance . . . 0.09 mm (0.004 in.)
  - Standard . . . 36.00—36.065 mm (1.417—1.420 in.)
  - Wear Limit . . . 36.10 mm (1.421 in.)
- Bore I.D.
  - Clearance . . . 0.18 mm (0.007 in.)
  - Standard . . . 36.00—36.025 mm (1.417—1.418 in.)
  - Wear Limit . . . 36.10 mm (1.421 in.)

Cam Followers

- O.D.
  - Standard . . . 17.95—17.97 mm (0.707—0.708 in.)
  - Wear Limit . . . 17.93 mm (0.706 in.)
- Bore I.D.
  - Clearance . . . 0.032—0.068 mm (0.001—0.003 in.)
  - Standard . . . 18.00—18.02 mm (0.708—0.709 in.)
  - Wear Limit . . . 18.05 mm (0.711 in.)

Timing Gear Cover

- Fan Mounting Capscrew Torque . . . 11 N•m (96 lb-in.)
- Cover Mounting Capscrew Torque . . . 9 N•m (78 lb-in.)
- Crankshaft Pulley Capscrew Torque . . . 115 N•m (85 lb-ft.)

Idler Gear

- Shaft O.D
  - Standard . . . 19.96—19.98 mm (0.786—0.787 in.)
  - Wear Limit . . . 19.93 mm (0.785 in.)
- Bushing I.D.
  - Clearance . . . 0.02—0.12 mm (0.001—0.005 in.)
  - Standard . . . 20.00—20.12 mm (0.787—0.792 in.)

Timing Gear Housing Capscrew Torque

- Aluminum Housing-to-Block . . . 9 N•m (78 lb-in.)
- Cast Iron Housing-to-Block . . . 11 N•m (96 lb-in.)

Oil Pan and Strainer Mounting Capscrew Torque

- Oil Pan-to-Block . . . 11 N•m (96 lb-in.)
- Oil Pan-to-Seal Case . . . 9 N•m (78 lb-in.)
- Oil Pan-to-Timing Gear Housing . . . 9 N•m (78 lb-in.)
- Oil Strainer-to-Block . . . 11 N•m (96 lb-in.)

Oil Pump

- Mounting Capscrew Torque . . . 9 N•m (78 lb-in.)
- Rotor Shaft O.D.-to-Backing Plate I.D. Clearance
  - Standard . . . 0.013—0.043 mm (0.001—0.002 in.)
  - Wear Limit . . . 0.20 mm (0.008 in.)
- Rotor Recess
  - Standard . . . 0.03—0.09 mm (0.001—0.003 in.)
  - Wear Limit . . . 0.13 mm (0.0051 in.)
- Outer Rotor-to-Pump Body Clearance
  - Standard . . . 0.10—0.16 mm (0.0039—0.0063 in.)
  - Wear Limit . . . 0.25 mm (0.0010 in.)
- Inner-to-Outer Rotor Clearance
  - Wear Limit . . . 0.15 mm (0.0059 in.)

- Oil Pressure Regulating Valve
  - Spring
    - Compressed Length . . . . 14.70 mm (0.580 in.) @12 N (2.7 lb-force)
    - Free Length . . . . 21.90—24.50 mm (0.860—0.960 in.)
  - Housing-to-Valve Body Retaining Nut Torque . . . . 30 N•m (22 lb-ft.)
- Thermostat
  - Thermostat Cover Capscrew Torque . . . . 9 N•m (78 lb-in.)
- Water Pump
  - Mounting Capscrew Torque . . . . 26 N•m (226 lb-in.)
  - Fan Mounting Capscrew Torque . . . . 11 N•m (96 lb-in.)
  - Plate-to-Housing Screw Torque . . . . 9 N•m (78 lb-in.)
- Fuel Injection Pump
  - Mounting Nut Torque . . . . 20 N•m (180 lb-in.)
- Fuel Injection Pump Camshaft
  - Bearing Retaining Screw Torque . . . . 20 N•m (180 lb-in.)
  - Minimum Lobe Height . . . . 30.90 mm (1.217 in.)
- Fuel Control and Governor Linkage
  - Governor Shaft O.D. (Minimum) . . . . 8.01 mm (0.315 in.)
  - Governor Shaft Bore I.D.
    - Wear Limit . . . . 8.50 mm (0.299 in.)
    - Clearance . . . . 0.09 mm (0.003 in.)
  - Sleeve I.D. (Maximum) . . . . 9.00 mm (0.354 in.)
  - Injection Pump Camshaft O.D.
    - Clearance . . . . 0.15 mm (0.006 in.)
    - Wear Limit . . . . 7.90 mm (0.311 in.)
- Fuel Injection Nozzles
  - Mounting Nut Torque . . . . 40 N•m (30 lb-ft.)
  - Nozzle Fitting Torque . . . . 51 N•m (38 lb-ft.)
  - Nozzle Torque . . . . 50 N•m (37 lb-ft.)
  - Separator Plate Nozzle Contact Surface Maximum Wear . . . . 0.10 mm (0.004 in.)
- Starter—Hitachi 0.8 kW
  - Cover Bushing (Reamed Out) . . . . 12.50—12.53 mm (0.492—0.493 in.)
  - Minimum Brush Length . . . . 7.70 mm (0.303 in.)
- Alternator—Kokosan 20A
  - Flywheel Assembly-to-Coil Plate Assembly Nut Torque . . . . 27 N•m (20 lb-ft.)

SPECIAL OR ESSENTIAL TOOLS

NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

JDG529 or JDST28 Belt Tension Gauge
Use to check fan/alternator drive belt tension.

JDG472 Adaptor
Use to apply air pressure to cylinder when performing Radiator Bubble Test.

D05104ST Cooling System Pressure Pump
Used to pressurize cooling system when performing Cooling System Pressure Test. Also used when performing Radiator Cap Pressure Test.

JDG692 Radiator Pressure Test Kit (Adaptors)
Used to adapt D05104ST Cooling System Pressure Pump to cooling system when performing Cooling System Pressure Test. Also used when performing Radiator Cap Pressure Test.

JT01682 Compression Gauge Assembly
Used to read cylinder compression pressure when performing Cylinder Compression Pressure Test.

JDG472 Adaptor
Adapts JT692 Compression Gauge Assembly to cylinder injector port.

JT03017 Hose Assembly
Adapts JT05577 Pressure Gauge to JT03349 Connector.

JT05577 Pressure Gauge (100 psi)
Used to read engine oil pressure when performing Engine Oil Pressure Test.

JT03349 Connector
Allows connection of the JT05577 Pressure Gauge and JT3017 Hose assembly to the engine oil pressure sender port when performing Engine Oil Pressure Test.

JT05719 Hand Held Digital Tachometer
Used to set engine idle speed.

JDF13 Nozzle Cleaning Kit
Used to clean fuel injection nozzles.

JDG504 Valve Guide Driver
Used to remove and install valve guides in cylinder head.

D15001NU Magnetic Follower Holder Kit
Hold cam followers when removing and installing camshaft.

D01109AA Diesel Fuel Injection Nozzle Tester
Used to test fuel injection nozzle performance.

D01110AA Adaptor Set
Used to connect fuel injector to D011109AA Diesel Fuel Injection Nozzle Tester.

23622 Straight Adaptor
Used to connect fuel injector to D011109AA Diesel Fuel Injection Nozzle Tester.

JDG991 Fast Idle Adjustment Tool **CARB/EPA**

JDG1060 Fuel Control Screw Adjustment Tool & M71632 Spring **CARB/EPA**

DEALER FABRICATED TOOLS

DFMX1A Fuel Injector Timing Tool

No. 1 fuel injection line cut off at first bend.

OTHER MATERIALS

Number Name Use

LOCTITE®
PRODUCTS
U.S.
Canadian
LOCTITE No.

TY9369 . . . . .Thread Lock and Sealer Apply to threads of studs in timing
N A. . . . . (Low Strength) gear housing.
#222

TY9370 . . . . .Thread Lock and Sealer Apply to threads of crankshaft pulley
TY9477 . . . .(Medium Strength) Capscrew.
#242

TY15130 . . . . .John Deere Form-In-Place Gasket Seals rear oil seal case, camshaft
N A. . . . . plug, timing gear cover and housing,
#395. . . . . .and oil pan to engine block.

SERVICE PARTS KITS

The following kits are available through your parts catalog:

- Cylinder Head Gasket Kit
- Cylinder Block Gasket Kit
- Oversized Pistons and Rings
- Undersized Connecting Rod Bearing Inserts
- Undersized Main Bearing Inserts
- Fuel Injector Nozzle Shim Pack

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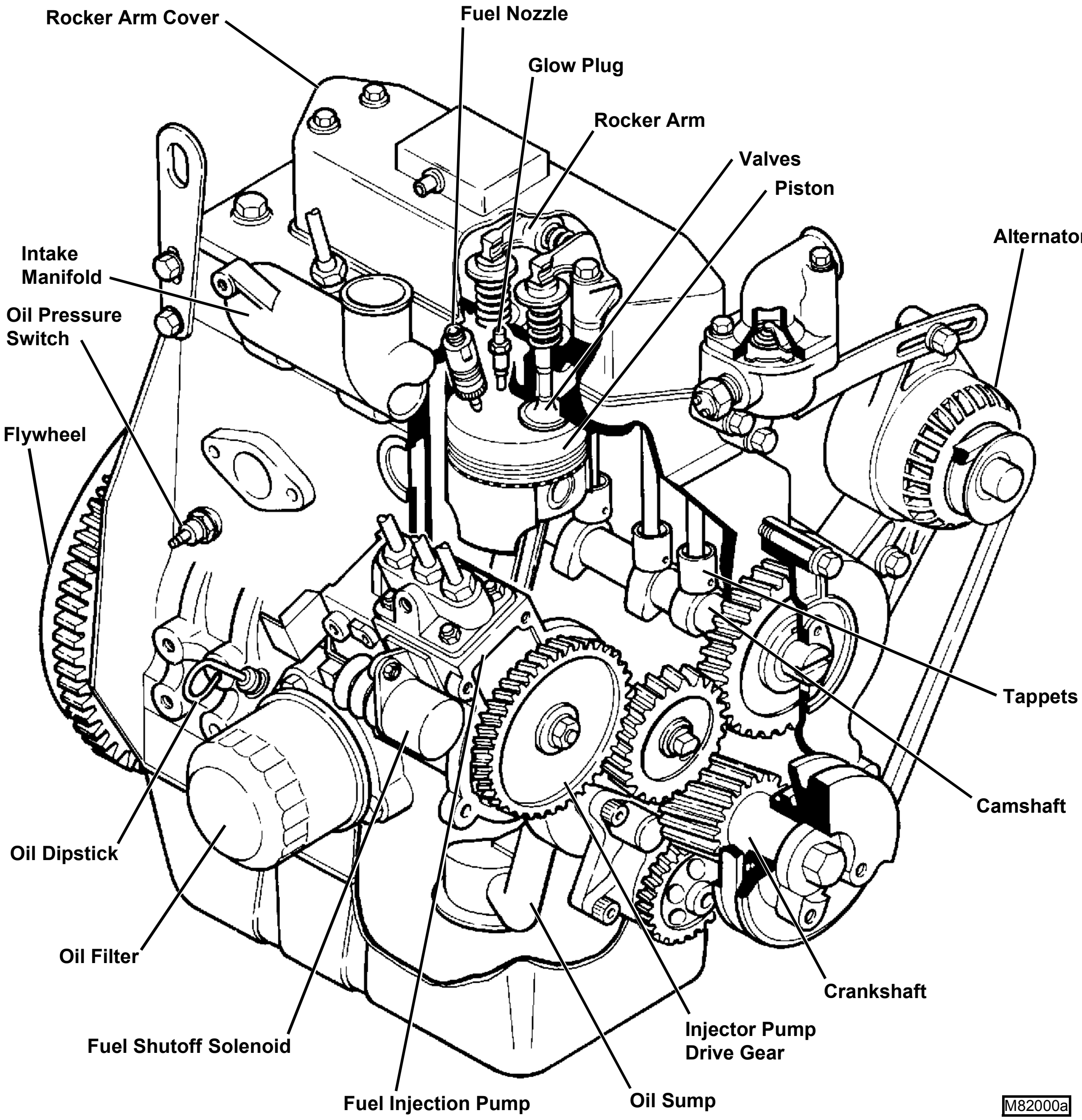
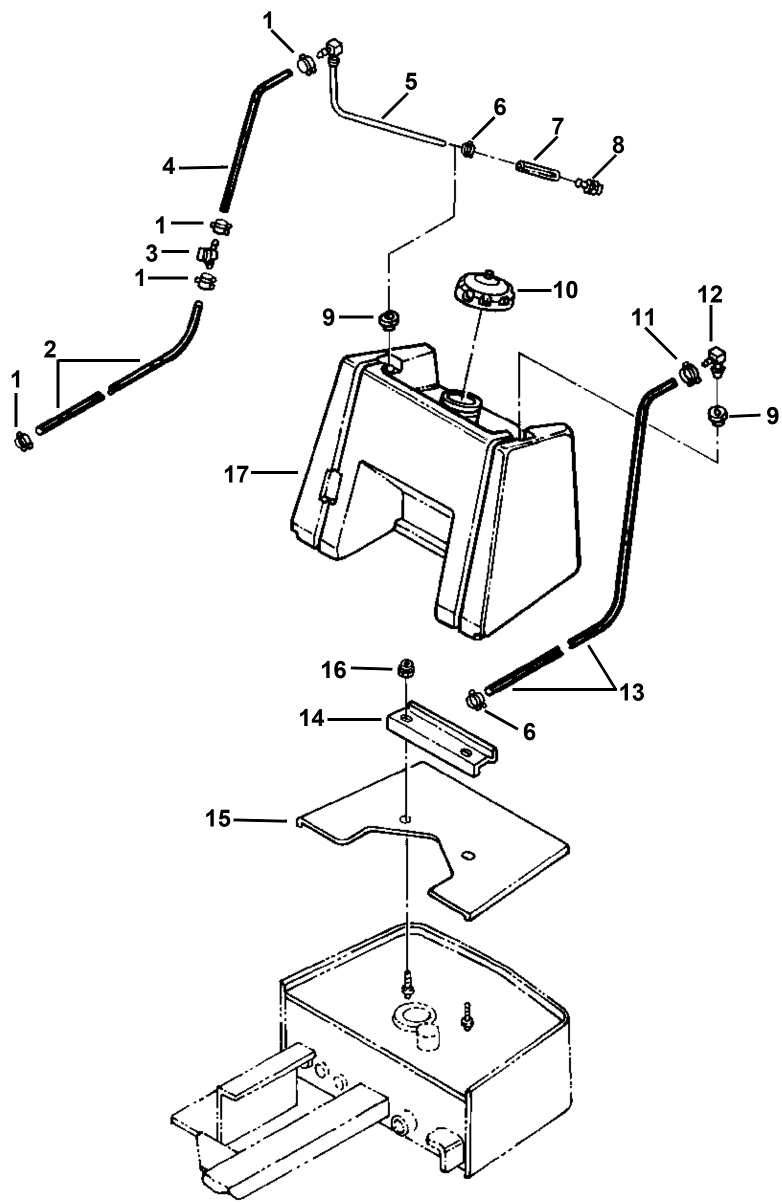
CUTAWAY VIEW - ENGINE



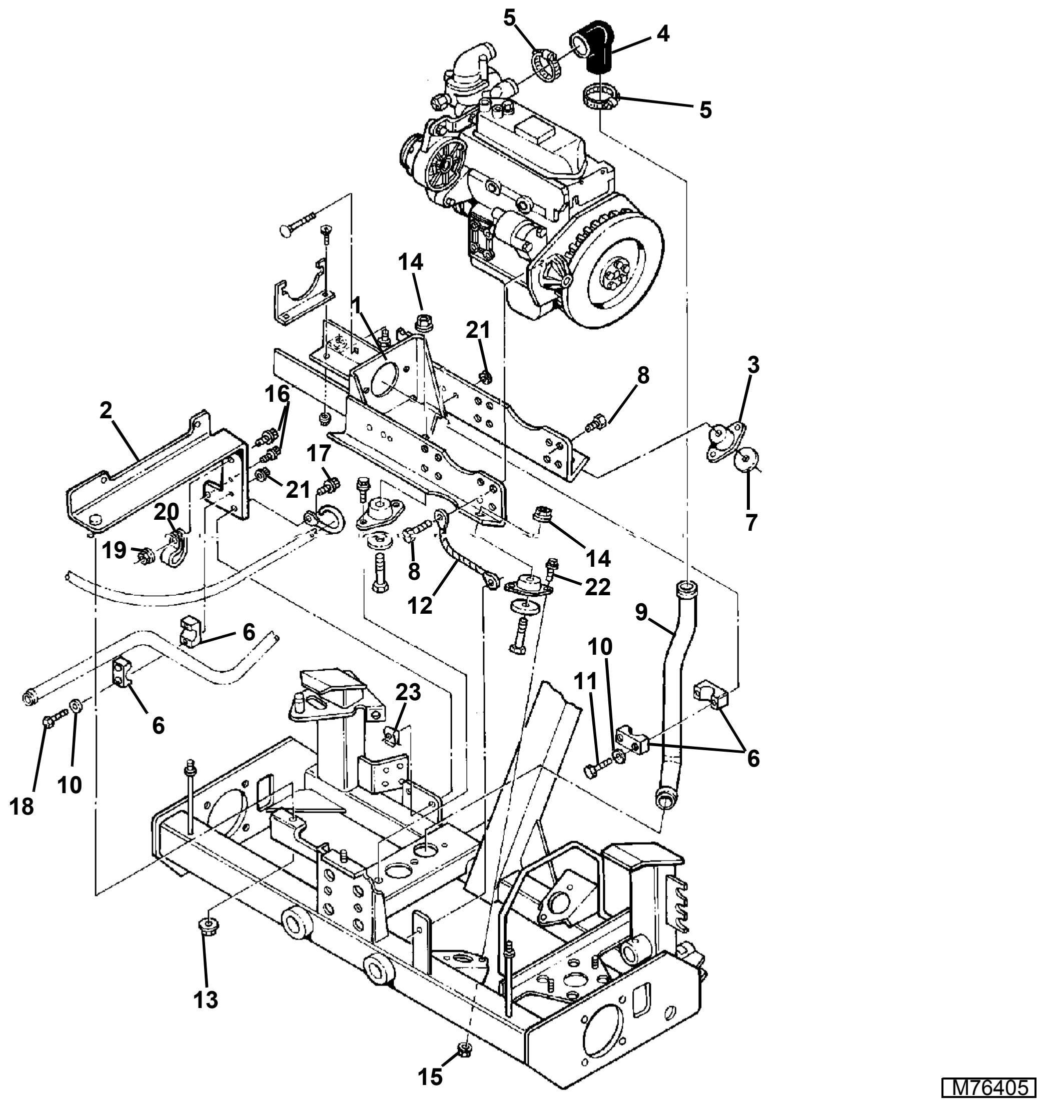
COMPONENT LOCATION

FUEL SYSTEM



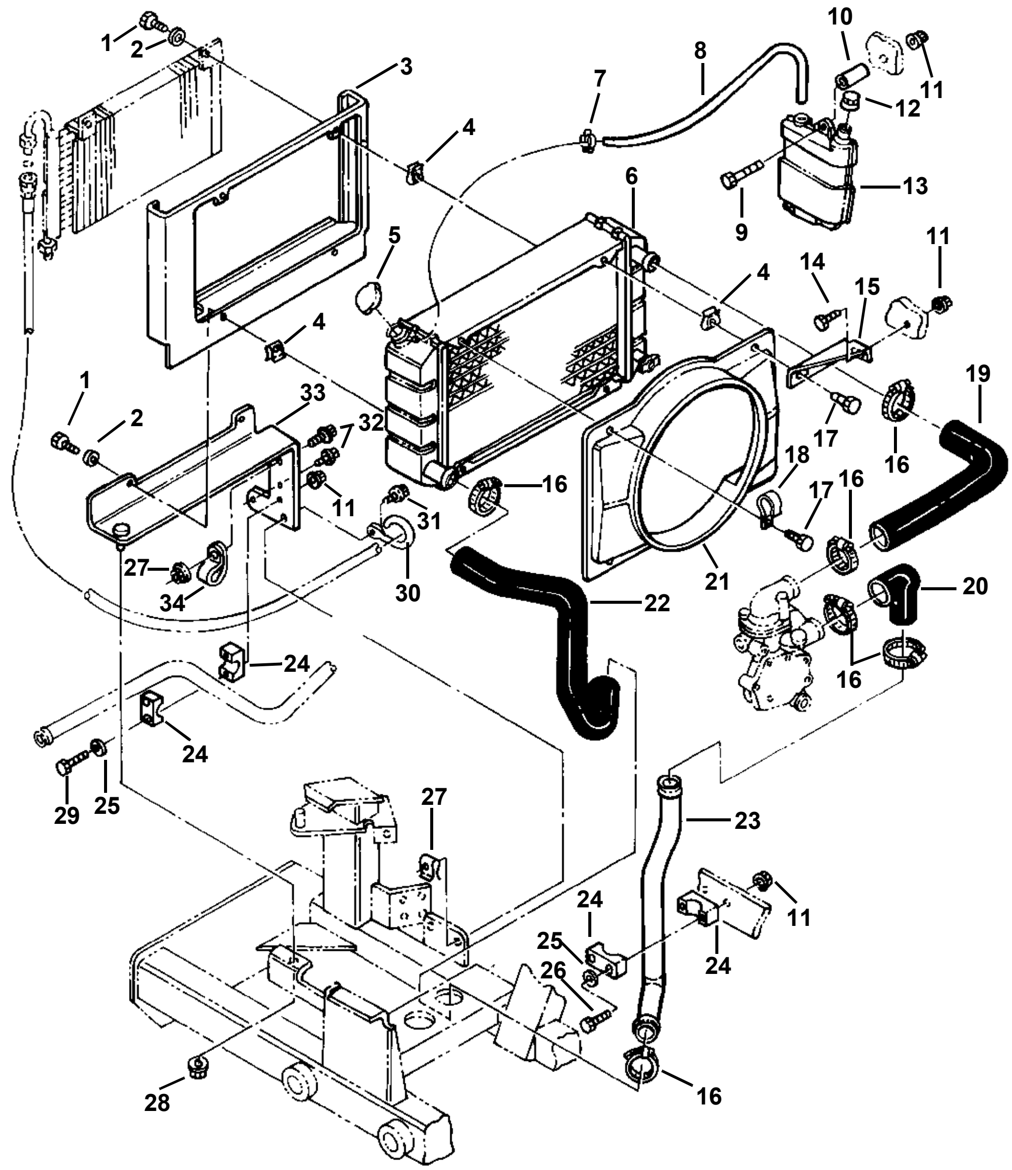
1. Clip
2. Hose
3. Shutoff Valve
4. Hose
5. Fuel Pickup
6. Clamp
7. Hose
8. Fuel Pickup
9. Bushing
10. Filler Cap
11. Clamp
12. Elbow Fitting
13. Hose
14. Clamp
15. Support MT530
16. Lock Nut
17. Fuel Tank

ENGINE MOUNT



1. Engine Subframe	9. Coolant Tube	17. Flange Bolt
2. Radiator Support	10. Washer	18. Capscrew
3. Vibration Isolator	11. Capscrew	19. Flange Nut
4. 90° Hose	12. Engine Ground Strap	20. Harness Retainer
5. Hose Clamp	13. Flange Nut	21. Flange Nut
6. Tube Clamp	14. Flange Nut	22. Capscrew
7. Support Washer	15. Flange Nut	23. Wire Nut
8. Capscrew	16. Flange Bolt	

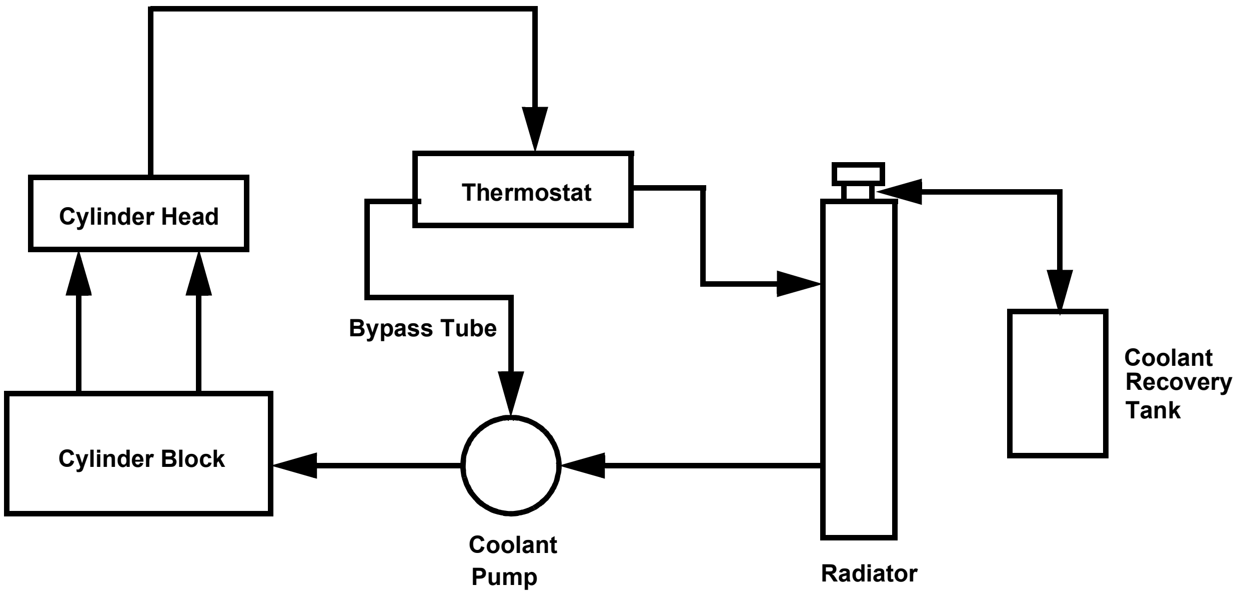
COOLING



1. Capscrew
2. Washer
3. Radiator Frame
4. Spring Nut
5. Filler Cap
6. Radiator
7. Spring Clip
8. Overflow Hose
9. Capscrew
10. Bushing
11. Nut
12. Cap
13. Overflow Tank
14. Screw
15. Upper Radiator Support
16. Hose Clamp
17. Capscrew
18. Hose Clip
19. Upper Radiator Hose
20. 90° Hose
21. Shroud
22. Lower Radiator Hose
23. Coolant Tube
24. Tube Clamp
25. Washer
26. Capscrew
27. Spring Nut
28. Flange Nut
29. Capscrew
30. Hydraulic Hose Retainer
31. Flange Bolt
32. Flange Bolt
33. Radiator Support
34. Harness Retainer

THEORY OF OPERATION

COOLING SYSTEM OPERATION



Function:

The coolant pump circulates coolant through the cooling system, drawing hot coolant from the engine block, circulating it through the radiator for cooling.

Theory of Operation:

The pressurized cooling system includes the radiator, water pump, fan and thermostat.

During the warm-up period, the thermostat remains closed and the impeller type coolant pump draws coolant from the bypass tube. Coolant from the pump flows to the cylinder block water jacket and up through the cylinder head providing a fast warm-up period.

Once the engine has reached operating temperature, the thermostat opens and coolant is pumped from the bottom of the radiator via the lower radiator hose into the cylinder block. Here it circulates through the block and around the cylinders.

From the block, coolant is then directed through the cylinder head, and into thermostat housing. With the thermostat open, **82° C (180° F)**, warm engine coolant passes through the housing into the top of the radiator where it is circulated to dissipate heat.

When coolant system pressure exceeds **48 kPa (7 psi)**, a valve in the radiator cap opens to allow coolant to discharge into the coolant recovery tank.

When temperature is reduced, a vacuum is produced in the radiator and coolant is drawn back out of the coolant recovery tank through a valve in the radiator cap.

A coolant temperature sensor informs the operator of the engine coolant temperature and warns of a high temperature condition by lighting a lamp.

LUBRICATION SYSTEM OPERATION

Function:

A full pressure system lubricates engine parts with clean oil.

Theory of Operation:

The pressure lubrication system consists of a positive displacement gear-driven pump, oil strainer, full flow oil filter, oil pressure regulating valve and an electrical pressure warning switch.

The pump draws lubrication oil from the oil pan through a strainer and a suction tube. The oil is then pumped through an oil passage to the oil filter and through the engine block main oil galley.

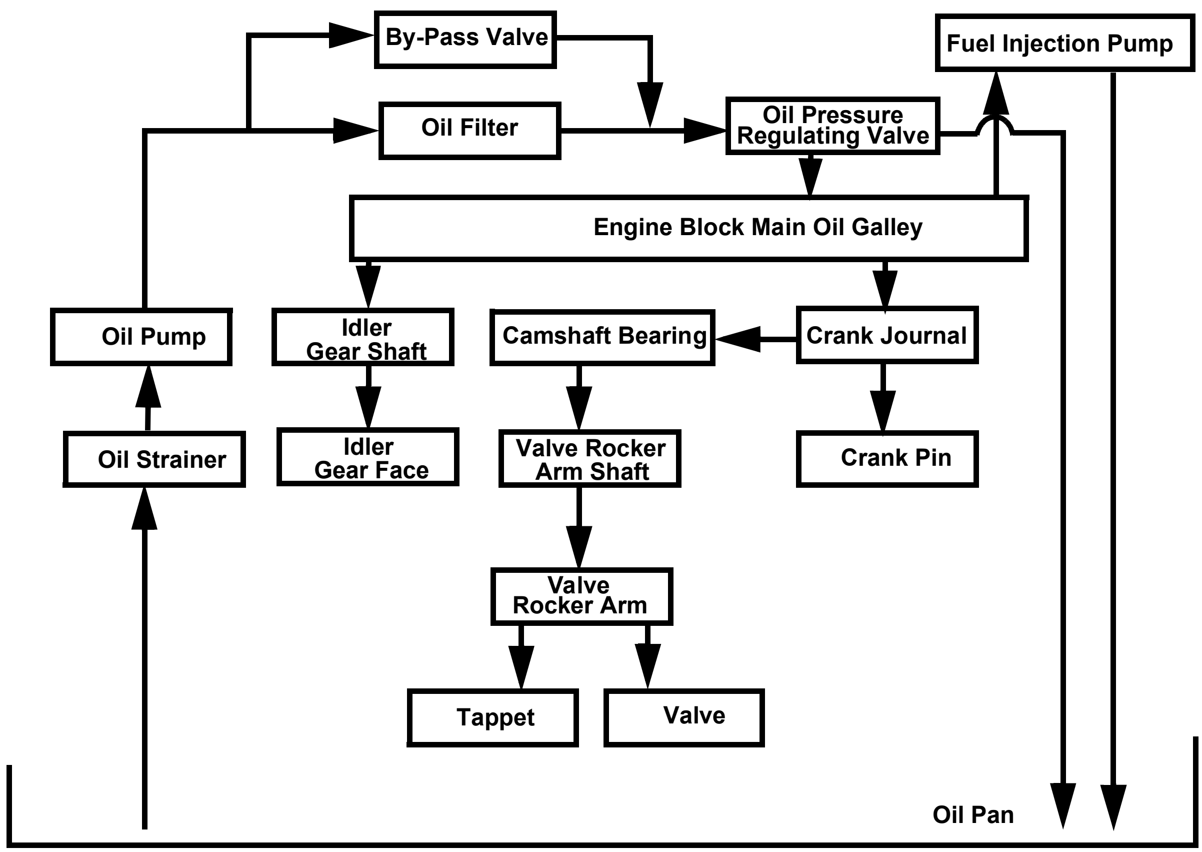
From the main oil galley, oil is forwarded under pressure to the crankshaft main bearing journals and idler gear shaft. Drilled cross-passages in the crankshaft distribute the oil from the main bearings to connecting rod bearings.

Lube oil holes in main bearing oil grooves are provided to direct oil to the camshaft bearings.

A drilled passage from the rear camshaft bearing through the cylinder block and cylinder head supplies lubricating oil to the rocker arm shaft. The hollow shaft distributes oil to the rocker arms, tappets and valves.

Oil passages direct from the main oil galley, through external oil lines, route lubricating oil to the fuel injection pump.

An oil pressure switch activates an indicator light to alert the operator to shut down the engine if oil pressure drops below a specification.



FUEL AND AIR SYSTEM OPERATION

Function:

Fuel system supplies fuel to injection nozzles.

The air intake system filters air needed for combustion.

Theory of Operation:

Fuel System:

An electric fuel transfer pump provides pressurized fuel to the injection pump. The fuel pump draws fuel from a vented fuel tank through an in-line filter. Low pressure fuel from the fuel pump flows through the fuel filter to the fuel gallery of an injection pump. After the injection pump galley is full, excess fuel is returned, along with fuel from the nozzles, through the return line to the fuel tank.

If the unit ever runs out of fuel, there are two air bleed lines that allow air to escape from the top of the filter and the injection pump. These two lines allow the system to be self bleeding.

The engine speed is controlled by the throttle lever and cable. The cable is connected to the injection pump governor control lever. The fuel shutoff solenoid controls the injection pump shutoff shaft. When the solenoid is retracted (Ignition ON), the engine can be started. When the Ignition is turned off, return springs on the shutoff shaft, extend the solenoid, moving the shutoff linkage to the shutoff position.

The injection pump meters fuel as determined by the governor and delivers it at high pressure to the injection nozzles.

The injection nozzle prevents flow until high pressure is reached, opening the valve and spraying atomized fuel into the combustion chamber. Injection lines have trapped fuel whenever injection is not taking place.

A small amount of fuel leaks past the nozzle valve to lubricate the fuel injection nozzle. This leakage combines with excess fuel from the injection pump and is returned to tank. Any air in the fuel system is bled out with return fuel to the fuel tank.

Air System:

Air enters the air filter through the perforated side holes. The primary and secondary elements filter the air before entering the intake manifold.

An air filter restriction indicator has a button that exposes a red indicator when the air filter needs servicing. The air filter restriction indicator is exposed when the vacuum reaches a specified level. A small amount of vacuum is always present due to some restriction of air movement through the filter elements. The unloading valve is like a one way valve. It ejects heavy dirt particles from the air stream during engine operation, but does not let air into the air filter housing. The operator can squeeze the valve to let the large particles out.

TROUBLESHOOTING

Problem or Symptom / Check or Solution	Engine will not crank.	Engine cranks but will not start or starts hard.	Engine will not stay running, or stalls frequently.	Engine runs rough, misses, noisy, vibrates or low on power. Fuel in oil. Oil level high.	Engine surges, or has uneven or uncontrolled rpm.	Oil in the coolant or coolant in the oil.	Engine has low oil pressure.	Engine operating temperature is incorrect.	Lack of fuel at injection pump.	Exhaust smoke blue or uses too much oil.	Exhaust smoke white.	Exhaust smoke black or grey or uses too much fuel.
Fuel pump screen, fuel filter, or fuel line restricted. Fuel dirty, contains water or wrong grade.		●	●	●	●				●		●	●
Air filter elements dirty or plugged. Replace.		●	●	●	●			●		●		●
Fuel shutoff valve turned off, or restricted.		●	●	●	●			●	●			
Muffler or exhaust manifold leak.			●	●								
Defective glow plugs.		●										
Injection pump or governor malfunctioning. Injection pump timing incorrect.		●		●	●						●	●
Defective cranking components or connectors.	●			●								
Low compression from worn rings, cylinder bore, piston, valves or warped head.		●	●	●		●				●		●
Valve clearance incorrect.	●	●	●	●				●				●
Burned or warped valves and valve seats. Defective valve spring.		●	●	●	●					●		●
Starter cranking rpm too slow. Damaged starter. Excessive engine load.	●	●							●			
Fuel pump leaking or not operating. See Fuel Supply Pump Pressure Test.		●	●	●	●				●		●	
Engine oil viscosity or level incorrect.	●	●					●	●		●		
Injector pressure incorrect or leaking.		●	●	●	●			●			●	●
Cylinder head gaskets leaking or damaged.	●	●	●		●	●	●	●		●		●
Radiator.				●		●		●				

DIAGNOSTICS

Conditions:

- Engine mounted on level surface.
- Ignition switch off unless indicated otherwise.

Test/Check Point	Normal	If Not Normal
1. Engine dipstick and exterior engine surface- engine oil check.	Oil level between “ADD” and “FULL” marks. Oil not burnt, or contaminated with metal particles, fuel, or coolant. No external leakage, filter clean.	Change oil and inspect for source of contamination. Check gaskets, seals, plugs, cylinder head, block, and intake manifold and breather. Change oil filter.
2. Recovery tank and radiator. 3. Cooling System Check.	Coolant level between marks on tank when engine is warm. Coolant in radiator full to top. Coolant not contaminated with oil, fuel or discolored brown.	Add proper coolant mix. Drain and flush system. Check for source of contamination.
	Radiator screen free of debris.	Clean or replace.
	Hoses not cracked or leaking, clamps and radiator cap tight.	Pressure test radiator and cap.
	Fan belt tight, not glazed or cracked.	Replace and adjust belt tension.
	Fan blades not damaged or warped.	Replace fan.
4. Fuel tanks, pump, pump screen, lines, filter, filter shutoff valves. 5. Fuel System Check	Fuel level correct, not contaminated, correct grade of fuel, no water. Fuel pump screen and in-line filter free of debris. Fuel shutoff valves in “ON” position.	Drain and clean fuel tanks. Add fresh fuel. Replace filters. Move to “ON” position.
	Fuel hoses not cracked or leaking.	Replace.
	Fuel hose clamps tight.	Replace or tighten.
	Fuel tanks do not have vacuum.	Replace fuel tank check valves.
6. Air filters and air intake. 7. Air Intake System Check	Air filter hose not cracked, clamps tight. Elements not plugged. Air filter housing sealed, no dirt tracking inside filter elements.	Replace and tighten clamps. Replace elements or housing.
8. Fuel shutoff solenoid. (Key in RUN position.)	Fuel shutoff solenoid must engage.	If solenoid will not pull in and hold in, see Fuel Shutoff Circuit Test Points in ELECTRICAL section.

ENGINE SYSTEM DIAGNOSIS - Continued

Test Location	Normal	If Not Normal
9. Fuel filter, fuel pump. (Engine cranking.)	Fuel level increases in filter. Fuel pump operating. Fuel present in return hose at fuel pump.	Test fuel pump pressure. (See procedure in this section.) Replace fuel filter.
10. Throttle lever and cable.	Linkage not binding and adjusted correctly.	Repair, replace or adjust cable.
11. Intake and exhaust valves.	Cold engine. Valve clearance within specification. Valves not sticking.	Check and adjust. (See procedure in this section.) Check valve guides and stems.
12. Fuel at nozzles. (Key in START position - engine cranking.)	Crack fuel injection lines at nozzles. Fuel shutoff solenoid pulled in. Engine must crank.	Check spray pattern and cracking pressure. (See procedure in this section.) Replace nozzles. See Cranking Circuit Test Points in ELECTRICAL section.
13. Injector ports. (Key in START position.)	Cylinder compression within specification. Pressure difference between cylinders within specification.	Perform cylinder compression test. (See procedure in this section.)
14. Flywheel and starter.	Minimum cranking rpm within specification.	See Starter Amp Draw Test in ELECTRICAL section.
15. Injection pump timing inspection. (Ignition OFF.)	Timing should be correct. Remove pump as the LAST possible solution.	Perform injection pump static timing adjustment. (See procedure in this section.) Have pump tested by a qualified Service Repair Shop.
16. Injection pump idle settings. (Engine running).	Engine runs smooth under load. Engine rpm to specification.	Adjust idle speeds. (See procedures in this section.)
17. Oil pressure sender port.	Oil pressure in specification.	Test engine oil pressure. (See procedure in this section.)
18. Thermostat. (Engine at operating temperature.)	Clean from corrosion, rust, or debris. Opening temperature within specification.	Replace thermostat. Perform thermostat opening test. (See procedure in this section.)
19. Muffler.	Not restricted.	Replace muffler.

TESTS AND ADJUSTMENTS

VALVE CLEARANCE CHECK AND ADJUSTMENT

Equipment:

• Feeler Gauge

Procedure:

1. Remove rocker arm cover.

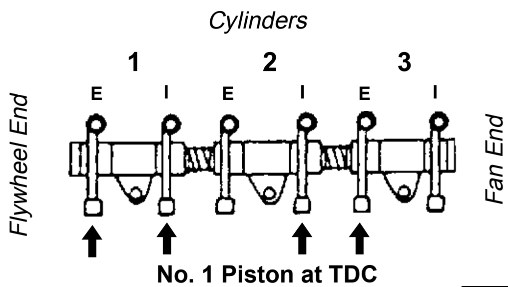
NOTE: "Top Dead Center (TDC)" is the piston at its highest point.

2. Turn crankshaft pulley clockwise until No.3 cylinder valves are both rocking. This will put No. 1 cylinder at TDC.

NOTE: No. 1 cylinder is the closest to the flywheel.

3. Try to move both No. 1 cylinder rocker arms or push rods.

NOTE: If rocker arm push rods are not loose, rotate flywheel one revolution (360°). If both rocker arm push rods are loose, the piston is at TDC on compression stroke.



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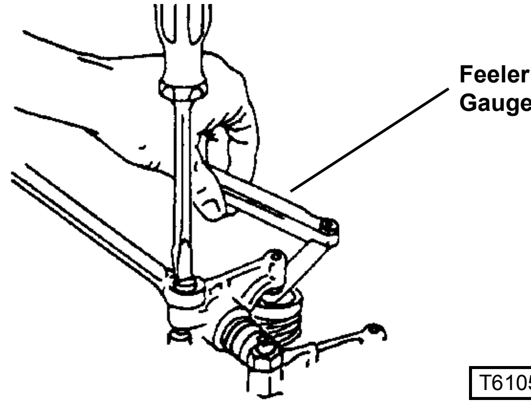
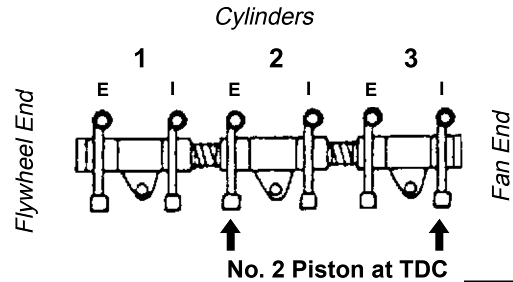
4. Measure and adjust valve clearance on the valves (arrows) with No. 1 piston at TDC.



T6105BF

5. To adjust valves, loosen nut and turn adjusting screw until clearance is **0.20 mm (0.008 in.)**. Hold screw while tightening nut.
6. Turn crankshaft pulley one revolution (360°). This puts the piston in No. 2 cylinder at TDC compression stroke.



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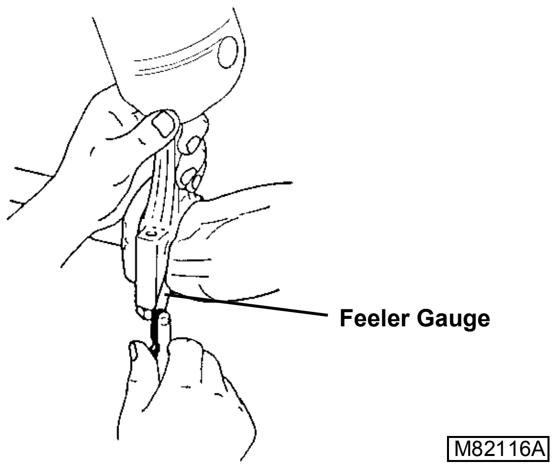
7. Measure and adjust valve clearance on the valves (arrows) with No. 2 piston at TDC.

CONNECTING ROD SIDE PLAY CHECK

Equipment:

• Feeler Gauge

Procedure:



1. Insert a feeler gauge, according to specifications, between connecting rod cap and crankshaft.

Specifications:

Standard Clearance . . . . 0.20—0.40 mm (0.008—0.016 in.)

Results:

• If side play exceeds specification, replace connecting rod and connecting rod cap.

CONNECTING ROD BEARING CLEARANCE CHECK

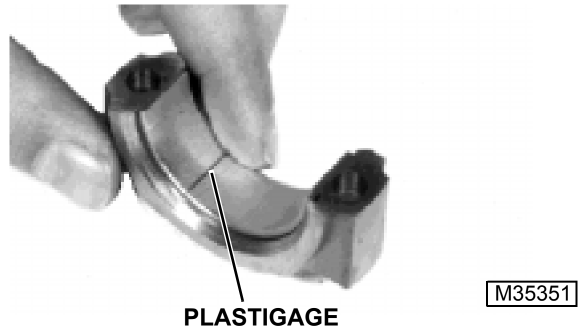
Equipment:

• PLASTIGAGE®

Procedure:

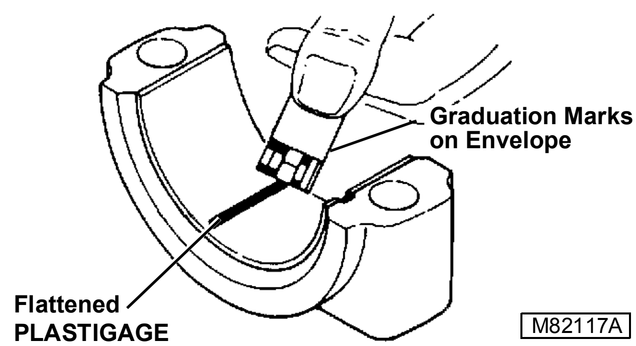
IMPORTANT: Connecting rod caps must be installed on the same connecting rod and in the same direction to prevent crankshaft and connecting rod damage.

1. Remove connecting rod cap.
2. Wipe oil from bearing insert and crankshaft journal.



3. Put a piece of PLASTIGAGE, or an equivalent, along the full length of the bearing insert approximately 6 mm (0.250 in.) off center.
4. Turn crankshaft approximately 30° from bottom dead center.
5. Install connecting rod end cap and original capscrews. Tighten capscrews to **23 N•m (203 lb-in.)**.
6. Remove capscrews and connecting rod cap.

NOTE: The flattened PLASTIGAGE will be found on either the bearing insert or crankshaft journal.



7. Use the graduation marks on the envelope to compare the width of the flattened PLASTIGAGE at its widest point.
8. Determine bearing clearance. The number within the graduation marks indicates the bearing clearance in inches or millimeters depending on which side of the envelope is used.
9. Remove PLASTIGAGE.

Specifications:

Standard Clearance . . . . 0.03—0.06 mm (0.001—0.002 in.)

Results:

• If clearance exceeds specification, replace bearing inserts.

®PLASTIGAGE is a registered trademark of the DANA Corporation.

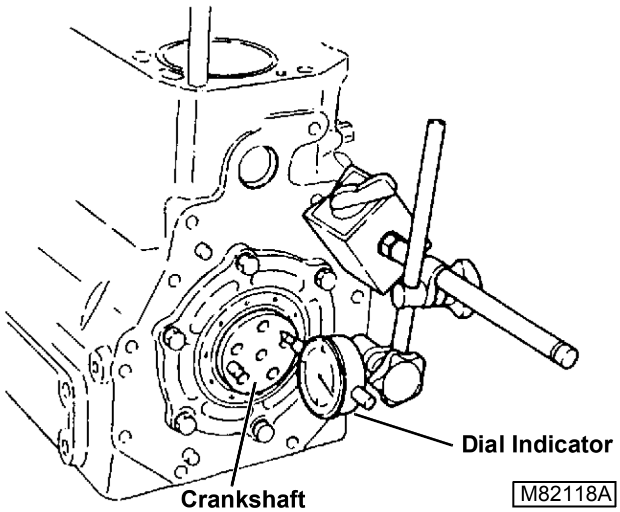
CRANKSHAFT END PLAY CHECK

Equipment:

- Dial Indicator

Procedure:

NOTE: Crankshaft end play can be measured at front end or rear end of crankshaft. Procedure is performed from the rear end. The flywheel is removed to show detail.



1. Fasten dial indicator to engine and position indicator tip on end of crankshaft.

IMPORTANT: Do not use excessive force when moving crankshaft to avoid damaging bearings.

2. Push crankshaft toward rear as far as possible.
3. Zero the dial indicator.
4. Using a bar, gently pry the crankshaft as far forward as possible.

Specifications:

Standard Clearance . . . . 0.09—0.27 mm (0.004—0.011 in.)

Results:

- If end play exceeds specification, replace thrust bearings.

CRANKSHAFT MAIN BEARING CLEARANCE CHECK

Reason:

To measure oil clearance between main bearing and crankshaft journal.

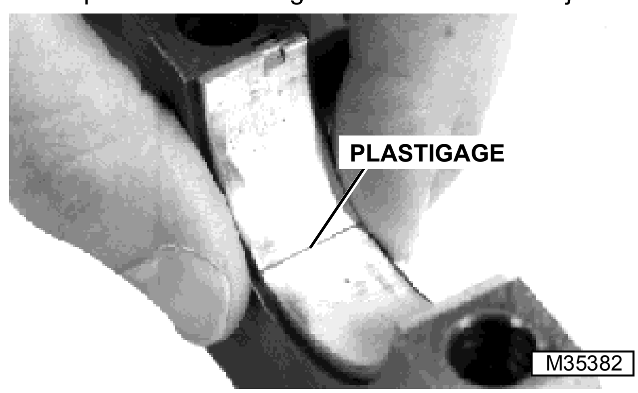
Equipment:

- PLASTIGAGE®

Procedure:

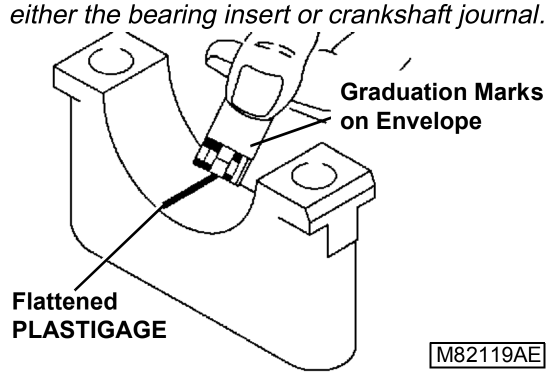
IMPORTANT: Main bearing caps must be installed on the same main bearing and in the same direction to prevent crankshaft and main bearing damage.

1. Remove main bearing cap.
2. Wipe oil from bearing insert and crankshaft journal.



3. Put a piece of PLASTIGAGE, or an equivalent, along the full length of the bearing insert approximately 6 mm (0.250 in.) off center.
4. Install main bearing cap and capscrews. Tighten capscrews to **54 N•m (40 lb-ft.)**.
5. Remove capscrews and main bearing cap.

NOTE: The flattened PLASTIGAGE will be found on either the bearing insert or crankshaft journal.



6. Use the graduation marks on the envelope to compare the width of the flattened PLASTIGAGE at its widest point.
7. Determine main bearing clearance. The number within the graduation marks indicates the bearing clearance in inches or millimeters depending on which side of the envelope is used.
8. Remove PLASTIGAGE.

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Specifications:

Standard Clearance . . . . 0.03—0.06 mm (0.001—0.002 in.)

Results:

- If clearance exceeds specification, replace bearing inserts.

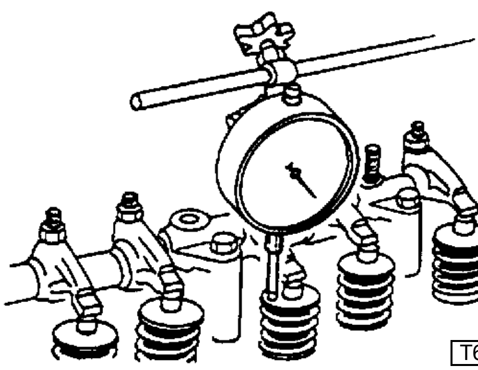
VALVE LIFT CHECK

Equipment:

- Dial Indicator

Procedure:

1. Adjust valve clearance. (See procedure in this section.)



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2. Fasten dial indicator to engine and position indicator tip on valve retainer. Valve must be fully closed and rocker arm must move freely.
3. Zero the dial indicator.
4. Manually turn crankshaft pulley clockwise (from fan end).
5. Observe dial indicator as valve is moved to the full open position. Valve lift is the same for intake and exhaust valves.

Valve Lift . . . . 7.5 mm (0.295 in.)

6. Repeat for each valve.

Results:

- If valve lift is less than specification, remove and inspect camshaft, followers and push rods.

CAMSHAFT END PLAY CHECK

Equipment:

- Dial Indicator

Procedure:

1. Remove timing gear cover. (See procedure in this section.)

M37512

2. Fasten dial indicator to engine and position indicator tip on end of camshaft.
3. Push camshaft toward the rear as far as possible.
4. Zero the dial indicator.
5. Pull camshaft forward as far as possible.

Specifications:

Standard Clearance . . . . 0.05—0.25 mm (0.002—0.010 in.)

Wear Limit. . . . . 0.40 mm (0.016 in.)

Results:

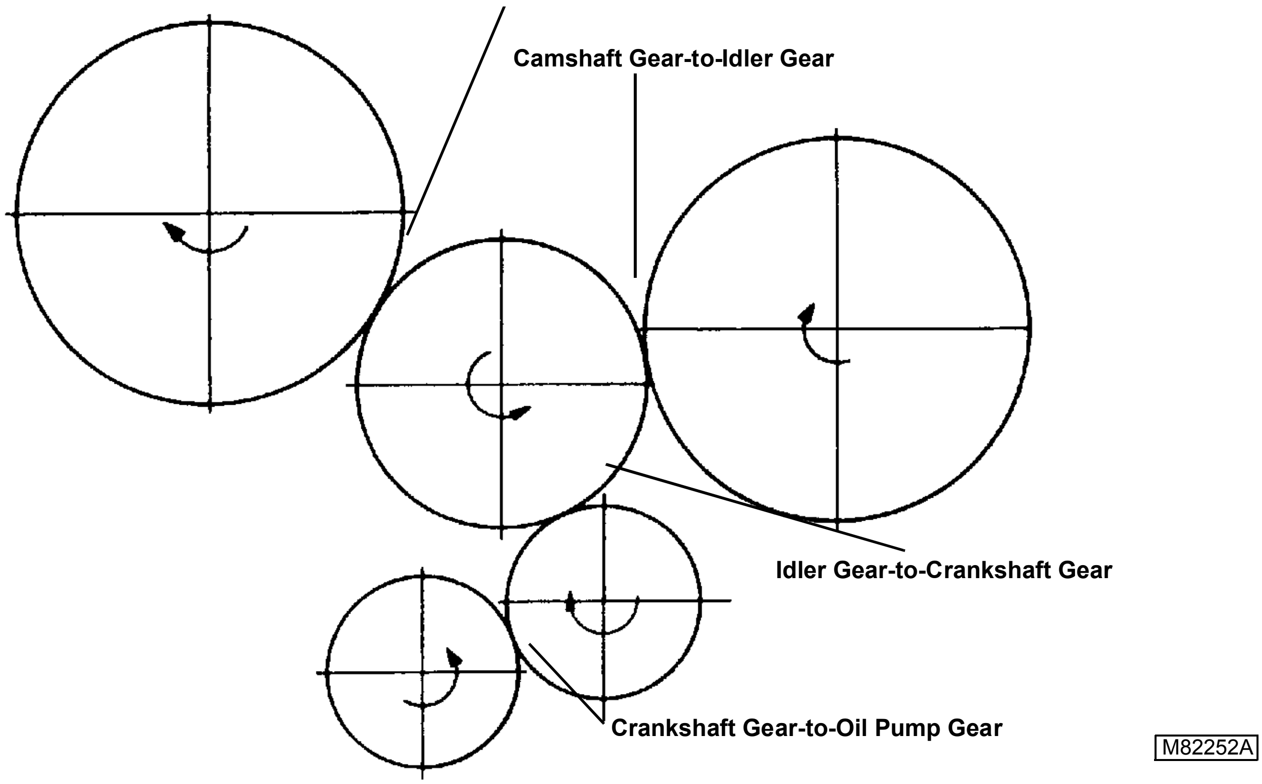
If end play exceeds wear limit, remove camshaft and replace thrust plate. (See procedure in this section.)

TIMING GEAR BACKLASH CHECK

Equipment:

• Dial Indicator

Procedure:



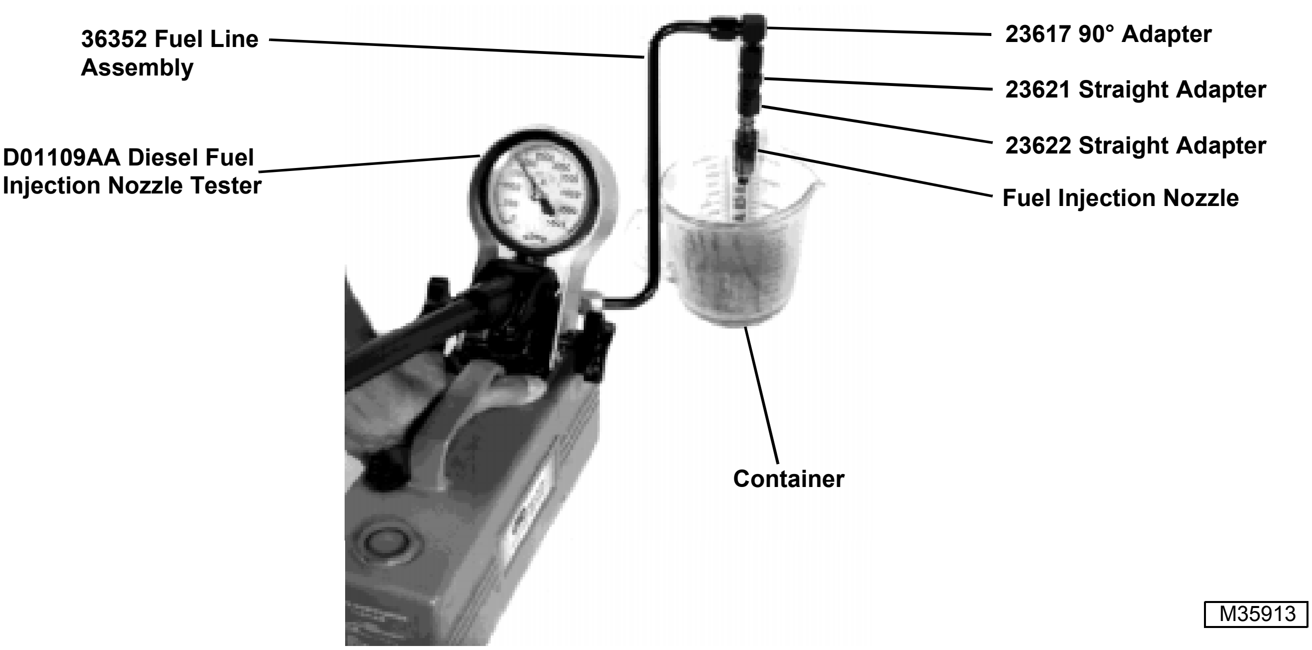
1. Measure backlash between meshing gears.

Specifications:

Standard Backlash . . . . 0.04—0.12 mm (0.002—0.005 in.)

Results:

• If backlash exceeds specification, replace meshing gears as a set.



FUEL INJECTION NOZZLE TEST (PINTLE-TYPE)

CAUTION

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 knowledgable source. Such information is available from the Deere & Company Medical Department in Moline, Illinois, U.S.A.

Equipment:

- D01109AA Diesel Fuel Injection Nozzle Tester
- D01110AA Adapter Set
- 23622 Straight Adapter
- Container

Connections:

1. Connect fuel injection nozzle to D01109AA Diesel Fuel Injection Nozzle Tester using parts from D01110AA Adapter Set and 23622 Straight Adapter.

IMPORTANT: Use clean filtered diesel fuel when testing injection nozzles to get best test results.

Procedure 1:

Test fuel injection nozzle **opening pressure** following the Nozzle Tester manufacturer's instructions.

Specifications:

Opening Pressure . . . . 11722 ± 480 kPa (1700 ± 70 psi)

Results:

- If pressure reading does not meet specification, disassemble injection nozzle and inspect nozzle assembly for contamination or stuck valve. If necessary, add or remove shims to change opening pressure.

Procedure 2:

Test fuel injection nozzle **leakage** following the Nozzle Tester manufacturer's instructions.

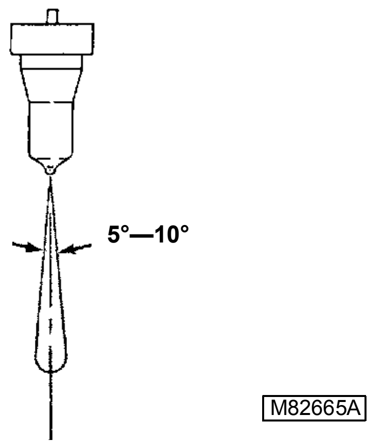
1. Dry nozzle completely using a lint-free cloth.
2. Pressurize nozzle to **11032 kPa (1600 psi)**.
3. Watch for leakage from nozzle spray orifice. There should be no leakage for a **minimum of 10 seconds**.

Results:

- If leakage time does not meet specification, disassemble injection nozzle and inspect nozzle assembly for contamination. Inspect valve seating surface. Replace nozzle assembly if necessary.

Procedure 3:

Test fuel injection nozzle **chatter and spray pattern** following the Nozzle Tester manufacturer's instructions.



1. Pressurize nozzle to **1722 ± 480 kPa (1700 ± 70 psi)**.
2. Listen for “chatter” sound and watch spray pattern.

Specifications:

Slow Hand
Lever Movement. . . . . Chatter Sound

Slow Hand
Lever Movement. . . . . Fine Stream Spray Pattern

Fast Hand
Lever Movement. . . . . Fine Atomized Spray Pattern

Results:

- If nozzle chatter or spray pattern does not meet specifications, disassemble injection nozzle and inspect nozzle assembly for contamination. Inspect valve seating surface. Replace nozzle assembly if necessary.
- If there is excessive difference in spray angle or injection angle, incomplete atomization or sluggish starting/stopping of injection, disassemble injection nozzle and inspect nozzle assembly for contamination. Replace nozzle assembly if necessary.

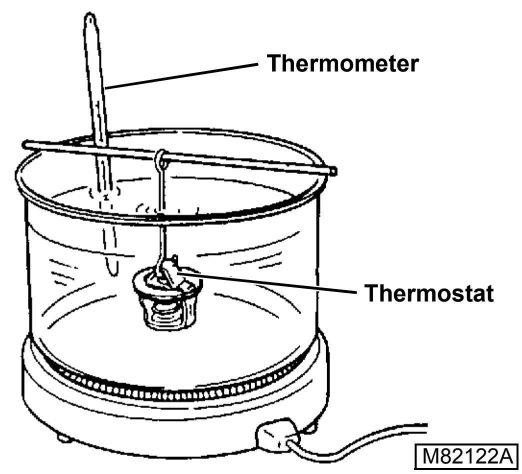
THERMOSTAT OPENING TEST

Equipment:

- Thermometer
- Glass Container
- Heating Unit

Procedure:

> **⚠ CAUTION**
>
> **DO NOT allow thermostat or thermometer to rest against the side or bottom of glass container when heating water. Either may rupture if overheated.**



1. Suspend thermostat and a thermometer in a container of water.
2. Heat and stir the water. Observe opening action of thermometer and compare temperatures with specifications.
3. Remove thermostat and observe its closing action as it cools.

Specifications:

Begin Opening . . . . 71° C (160° F)
Fully Open. . . . . 85° C (184° F)
Minimum Lift Height. . . . . 8 mm (0.310 in.)

Results:

- If thermostat does not open according to specifications, replace.
- If closing action is not smooth and slow, replace thermostat.

COOLANT TEMPERATURE SWITCH TEST

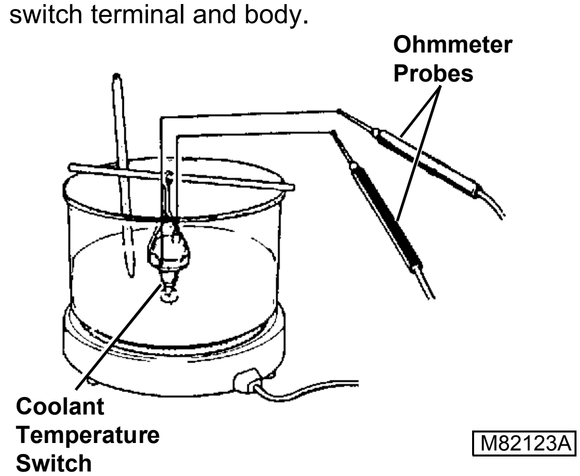
Equipment:

- Thermometer
- Glass Container
- Heating Unit
- Ohmmeter

Procedure:

> **⚠ CAUTION**
>
> **DO NOT allow switch or thermometer to rest against the side or bottom of glass container when heating water. Either may rupture if overheated.**

1. Connect lead wires from ohmmeter probes, to switch terminal and body.

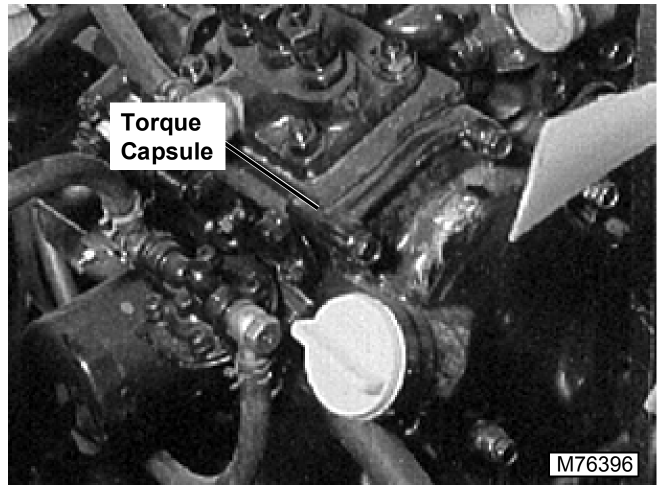


2. Suspend switch and a thermometer in a container of water.
3. Heat and stir the water. Observe water temperature when continuity occurs. Water temperature should be **107—113° C (225—235°F)**.

Results:

- If continuity does not occur within temperature listed, replace switch.

INJECTION PUMP TIMING ADJUSTMENT



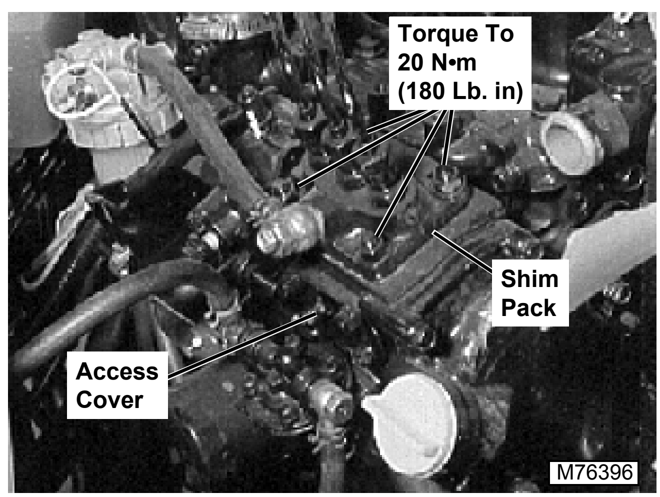
IMPORTANT: DO NOT attempt to adjust torque capsule. This is a factory set adjustment and can not be reset accurately.

Procedure:

IMPORTANT: Injection pump timing should be correct. Once timing is set, it will not normally change during the life of the engine, unless it was altered.

Check and adjust timing only as the last option. Check fuel, fuel supply system, nozzles, air intake system and cylinder compression before continuing.

1. Clean around injection pump area.



NOTE: Injection pump timing is set by a shim pack between pump body and housing.

2. Remove access cover and disconnect linkage from pump body.
3. Remove and measure shim pack. Shim pack should be close to the manufacturers specifications. It should only be adjusted if performance is still a problem after everything else has been eliminated as a possible cause.
4. Tighten injection pump nuts to **20 N•m (180 lb.-in.)**.
5. Tighten access cover nuts to **11 N•m (102 lb.-in.)**.

Specification:

Shim Pack Thickness . . . . 0.5 mm (0.020 in.)

Results:

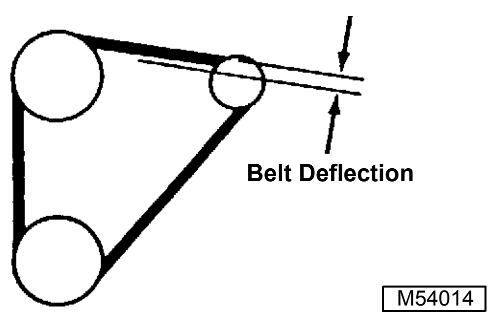
- If engine performance is poor, check air cleaners, fuel filter, fuel supply, nozzles and cylinder compression before removing pump for service. Check all timing gears for wear. Retest performance.
- If performance did not change, have pump tested by a diesel injection service. When reinstalling injection pump, use same thickness of shim pack removed. If shim pack thickness is unknown or new pump is installed, replace with specified shim pack thickness.

FAN/ALTERNATOR DRIVE BELT ADJUSTMENT

Equipment:

- JDG529 or JDST28 Belt Tension Gauge
- Straight Edge

Procedure:



1. Check belt tension between fan and alternator using Belt Tension Gauge and a straight edge.

Specifications:

Applied Force . . . . 98 N (22 lb-force)
Deflection . . . . 10—15 mm (0.400—0.600 in.)

Results:

If deflection is not within specifications:

1. Loosen both alternator mounting capscrews/nuts.
2. Apply force to FRONT alternator housing only (near the belt) until tension is correct.
3. Tighten capscrews/nuts.

RADIATOR BUBBLE TEST

Equipment:

- JDG472 Adapter

Procedure:

1. With coolant at proper level and radiator cap tight, run engine for 5 minutes to bring to operating temperature.
2. Remove cap from recovery tank.
3. Check for bubbles coming from overflow hose at bottom of tank.

If bubbles are present, isolate source of compression leak:

Remove injection nozzles.

Install JDG472 Adapter in injection port of cylinder to be tested.

Move piston to bottom of stroke with intake and exhaust valves closed.

Connect hose from compressed air source to adapter.

Apply **2448 kPa (355 psi)** maximum air pressure into cylinder.

Check for bubbles in recovery tank or air escaping from muffler, air cleaner or oil fill opening.

Repeat for each cylinder.

Results:

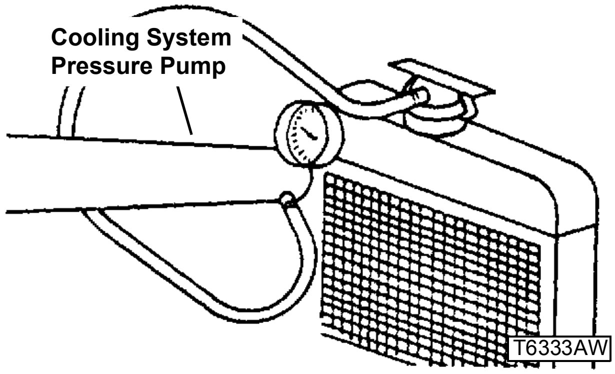
- If bubbles are present, check for cracks in cylinder head and block. Check for damaged head gasket.
- If air escapes from muffler, check for worn exhaust valve.
- If air escapes from air cleaner, check for worn intake valve.
- If air escapes from engine oil fill, check for worn piston rings.

COOLING SYSTEM PRESSURE TEST

Equipment:

- D05104ST Cooling System Pressure Pump
- JDG692 Radiator Pressure Test Kit (Adapters)

Procedure:



1. Remove cap and attach pressure pump to radiator.
2. Apply **117 kPa (17 psi) maximum pressure** to cooling system.
3. Check for leaks throughout cooling system.

Results:

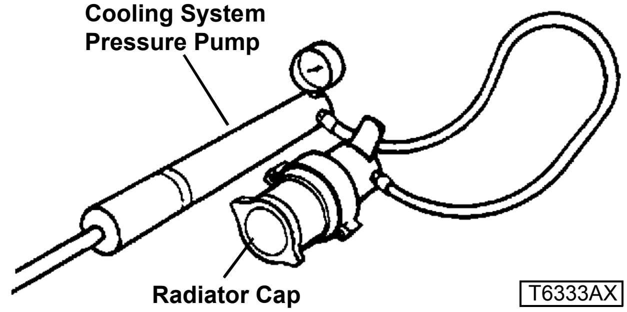
- Pressure should hold to specifications. If pressure decreases, check for leaks. Repair leaks or replace parts as necessary.
- If pressure test still indicates leakage after all external leaks have been stopped, a defective head gasket, cracked block, or cylinder head may be the cause. Perform *RADIATOR BUBBLE TEST*.

RADIATOR CAP PRESSURE TEST

Equipment:

- D05104ST Cooling System Pressure Pump
- JDG692 Radiator Pressure Test Kit (Adapters)

Procedure:



1. Install radiator cap on pressure pump.
2. Apply pressure. Pressure valve in cap should open at **90 kPa (13 psi)**.

Results:

- If cap leaks, retighten and test again. Replace cap if pressure is not within specification.

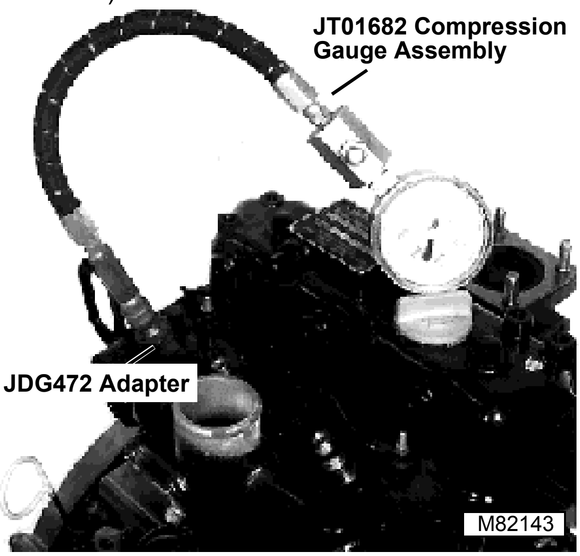
CYLINDER COMPRESSION PRESSURE TEST

Equipment:

- JT01682 Compression Gauge Assembly
- JDG472 Adapter

Procedure:

1. Run engine for 5 minutes to bring to operating temperature. Shut off engine.
2. Remove injection nozzles. (See procedure in this section.)



3. Install Adapter and Compression Gauge Assembly in injector port.
4. Disconnect fuel shutoff solenoid connector.
5. Crank engine for three seconds with starter.
6. Record pressure reading for each cylinder.

Specifications:

Compression Pressure . . . . 3233 kPa (469 psi)

Maximum Difference
Between Cylinders . . . . 241 kPa (35 psi)

NOTE: Pressure listed is for 300 m (1000 ft.) above sea level. For naturally aspirated engines, reduce specification an additional 4% for each 300 m (1000 ft.) of altitude.

Results:

- If pressure reading is below specification, squirt approximately two teaspoons of clean engine oil into cylinders through injector ports and repeat test.
- If pressure increases significantly, check piston, rings and cylinder walls for wear or damage.
- If pressure does not increase significantly after retest, check for leaking valves, valve seats or cylinder head gasket.

ENGINE OIL PRESSURE TEST

Equipment:

- JT03017 Hose Assembly
- JT05577 Pressure Gauge (100 psi)
- JT03349 Connector

Procedure:

1. Remove oil pressure sender.
2. Install Connector.
3. Connect Hose Assembly and Pressure Gauge.

IMPORTANT: Do not run if no pressure present.

4. Start engine. If pressure reading is below 69 kPa (10 psi), STOP ENGINE.
5. Run engine approximately five minutes to heat oil, then check oil pressure at fast and/or slow idle.

Specifications

Idle Speed

Fast . . . . .3400 +25 (-150) rpm

Slow . . . . 1400 +150 (-50)rpm

Engine Oil Pressure . . . . 294—392 kPa (43—57 psi)

Results:

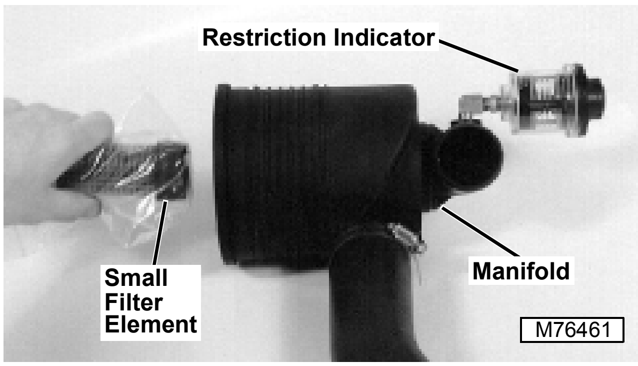
- If oil pressure is not within specifications, inspect oil pressure regulating valve parts for wear or damage. Add or remove shims as necessary. (See procedure in this section.)
- If oil pressure does not increase, see “Engine Has Low Oil Pressure” in TROUBLESHOOTING.

AIR INTAKE SYSTEM LEAKAGE TEST

Equipment:

• Air Pressure Regulator

Procedure:



1. Remove air cleaner restriction indicator and install test fitting to pressurize air intake system.
2. Connect air pressure regulator to manifold using hose and fitting from air cleaner.
3. Remove air cleaner cover and both filter elements.
4. Put small plastic bag over end of small filter element. Install small filter element into air cleaner housing.
5. Pressurize air intake system between **34—69 kPa (5 - 10 psi)**. If air intake system cannot be pressurized, turn engine slightly to close valves.
6. Spray soap solution over all connections from air cleaner to intake manifold and check for leaks.

Results:

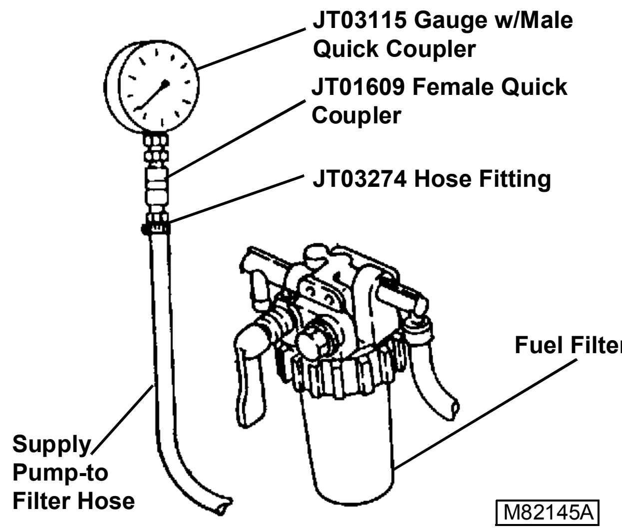
• Find leaks and repair or replace parts as necessary.

FUEL PUMP PRESSURE TEST

Equipment:

• JT03274 Hose Fitting
• JT01609 Female Quick Coupler
• JT03115 Gauge w/Male Quick Coupler (0—150 psi)

Procedure:



1. Disconnect supply pump-to-filter hose.
2. Install Hose Fitting, Coupler and Gauge.
3. Disconnect wire connector to fuel shutoff solenoid.
4. Crank engine using the starter. Do not run starter for more than 10 seconds at a time. Gauge should read more than **29 kPa (4.3 psi)**.

Results:

• If pressure is below specification, replace fuel supply pump.

FUEL SYSTEM LEAKAGE TEST

Procedure:

1. Disconnect fuel supply line and return line at fuel tank.
2. Place fuel return line into a suitable container to catch drained fuel.

> **⚠ CAUTION**
>
> **DO NOT apply more than 15 psi air pressure to the fuel system. Damage to the injection pump or personal injury may result.**

3. Apply **34 - 69 kPa (5 - 10 psi)** air pressure to fuel supply hose until all fuel is drained from the system.
4. Plug end of fuel return hose.
5. Apply **34 - 69 kPa (5 - 10 psi)** air pressure to fuel system at fuel supply line. ***DO NOT*** exceed maximum pressure of **103 kPa (15 psi)**.
6. Apply liquid soap and water solution to all joints and connections in the fuel system and inspect for leaks.

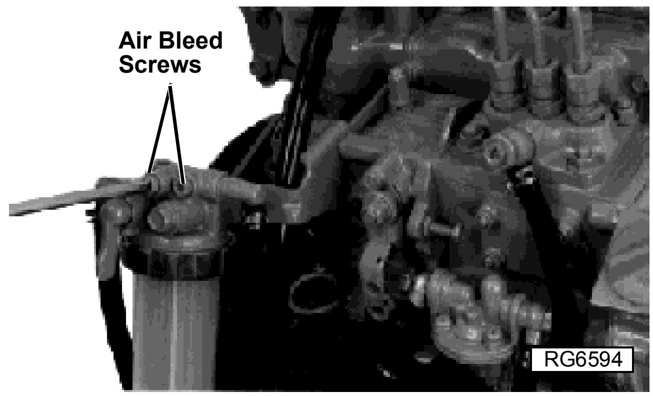
Results:

- Find leaks and repair or replace parts as necessary.

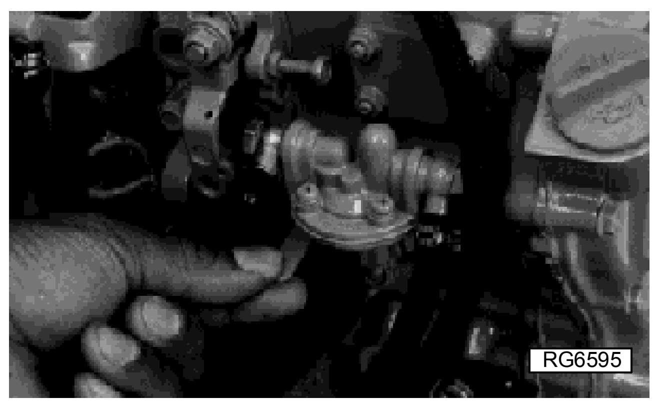
BLEED FUEL SYSTEM

Procedure:

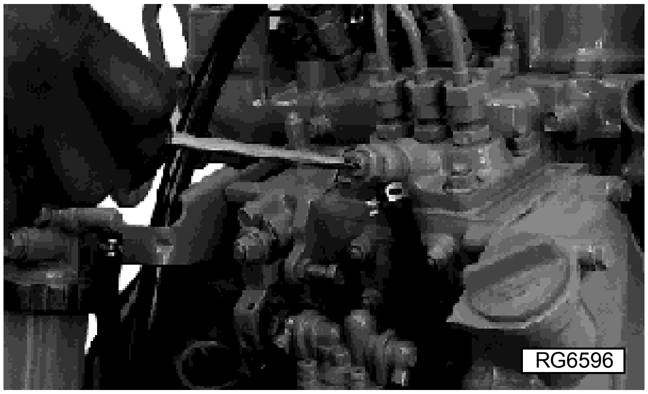
IMPORTANT: Modification or alteration of the injection pump, pump timing, or the injection nozzles in any way not approved by the manufacturer will terminate the warranty obligation.



1. Loosen both air bleed screws on fuel filter base.
2. Turn ignition switch to “ON” position.



3. Operate hand primer lever of fuel supply pump until fuel flows free of air bubbles. Tighten bleed screws.



4. Loosen bleed screw on injection pump. Operate hand primer and tighten bleed screw when fuel flows free of air bubbles.
5. Start engine. If engine does not start after several attempts, proceed with steps 6 through 9.

6. Loosen all three injector line nuts using a 17 mm wrench. Be sure not to loosen bottom nut of injector.
7. Crank engine over with starter.
8. When fuel appears at nozzles, tighten line nuts.
9. Start engine. If engine does not start, repeat entire bleed procedure.

SLOW IDLE ADJUSTMENT

Reason:

To achieve proper slow idle rpm setting. Provides adequate rpm to keep engine running smoothly without stalling.

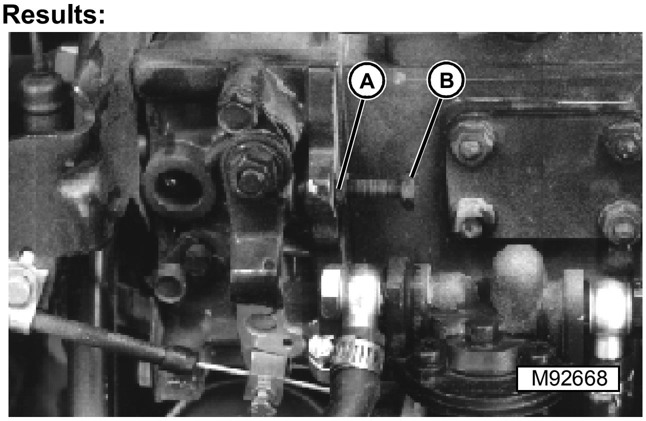
Equipment:

- JT05719 Hand Held Digital Tachometer

Procedure:

1. Park machine on level surface.
2. Move Mow/Transport lever to TRANSPORT position.
3. Lower cutting units to the ground.
4. Place travel pedals in NEUTRAL.
5. Engage parking brake.
6. Start engine and run for five minutes.
7. Raise hood.
8. Remove plenum air duct.
9. Place throttle control lever in slow idle position.
10. Use JT05719 Hand Held Tachometer to check engine speed at crankshaft pulley.
11. Visually check that the injection pump throttle lever is against the slow idle stop screw. Check slow idle speed, slow idle speed should be **1450 ± 25 rpm**.
12. After slow idle speed adjustment, adjust throttle cable.

Results:



- If slow idle rpm is not according to specifications, loosen nut (A) and turn screw (B). After adjustment, tighten nut.

FAST IDLE ADJUSTMENT—CARB/EPA ENGINES

*NOTE: For engines **WITH** California Air Resources Board/Environmental Protection Agency (CARB/EPA) Emissions Controls.*

IMPORTANT: DO NOT attempt to adjust fuel control assembly unless you are a factory trained technician with authorization to service CARB/EPA Certified Engines.

Equipment:

- Digital Tachometer
- JDG991 Fast Idle Adjustment Tool

Procedure:

1. Place a small piece of reflective tape on crankshaft pulley.

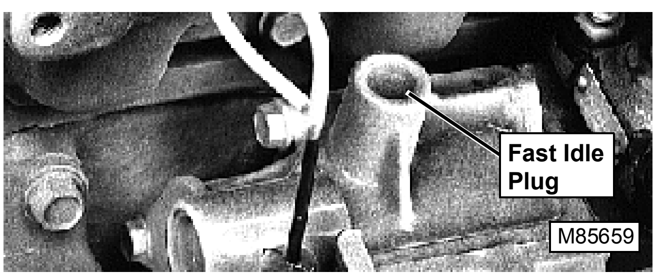
NOTE: Make sure air cleaner is clean and not restricted. Replace air cleaner element as necessary.

2. Start engine and run for 5 minutes to obtain normal operating temperature.
3. Move throttle lever to fast idle position.
4. Use a digital tachometer to check engine speed at crankshaft pulley.

Specification:

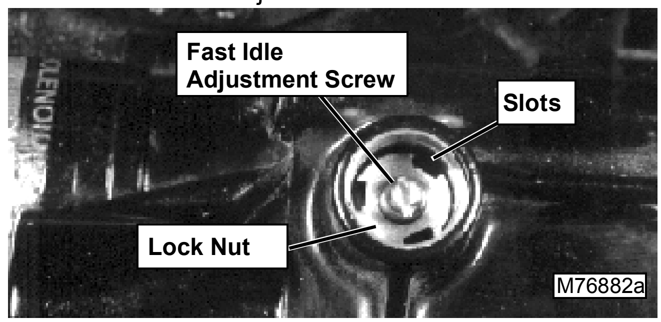
Fast Idle Speed. . . . . 3425 ± 25 rpm

5. Turn engine OFF.

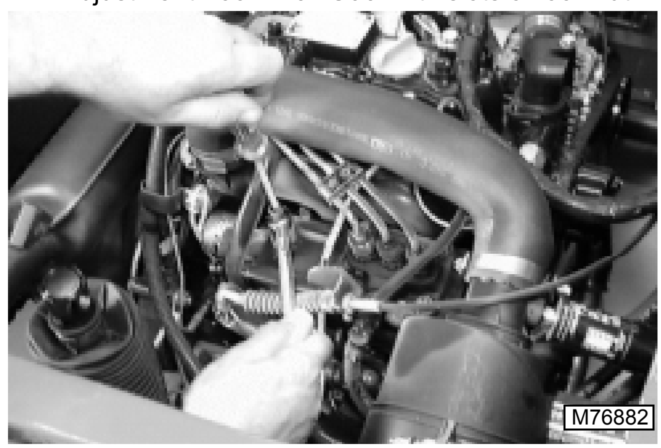


6. If fast idle speed DOES NOT meet specification, remove plug from fast idle adjustment screw hole.

Fast Idle Adjustment Tool—JDG991.



7. Loosen lock nut by aligning tabs of Fast Idle Adjustment Tool — JDG99l with slots of lock nut.



8. Start engine and move throttle lever to fast idle position.
9. Use a flat blade screwdriver to turn fast idle adjustment screw until fast idle speed is set at **3425 ± 25** rpm. Adjust throttle cable, if necessary.
10. While holding fast idle adjustment screw stationary, tighten lock nut with essential adjustment tool to 4 N•m (35 lb-in.).
11. Check fast idle speed again (steps 2—5).
12. Install a new plug into the fast idle adjustment screw hole.

Results:

- If engine DOES NOT adjust to meet fast idle speed specification, have injection pump inspected by an Authorized Diesel Service (ADS) center. After injection pump has been serviced by an ADS center, the fuel control screw MUST BE adjusted. (See FUEL CONTROL SCREW ADJUSTMENT on next page.)

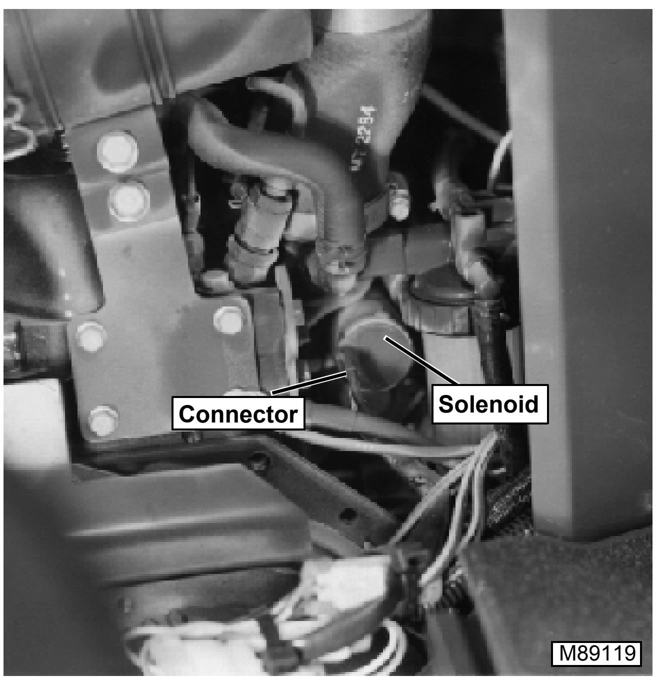
FUEL CONTROL SCREW ADJUSTMENT— CARB/EPA ENGINES

*NOTE: For engines **WITH** California Air Resources Board/Environmental Protection Agency (CARB/EPA) Emissions Controls.*

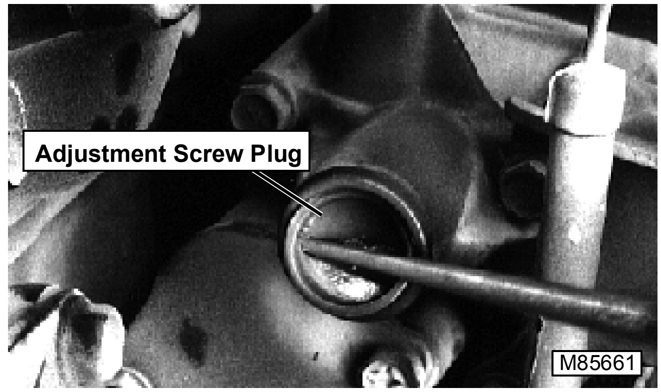
IMPORTANT: DO NOT attempt to adjust fuel control assembly unless you are a factory trained technician with authorization to service CARB/EPA Certified Engines.
Adjust fuel control screw ONLY when governor assembly or any of it's individual components are replaced and/or fuel injection pump is serviced by an Authorized Diesel Service (ADS) center or it's control rack alignment mark has been recalibrated.

Equipment:
Fuel Control Screw Adjustment Tool. JDG1060
Spring M72632

Procedure:



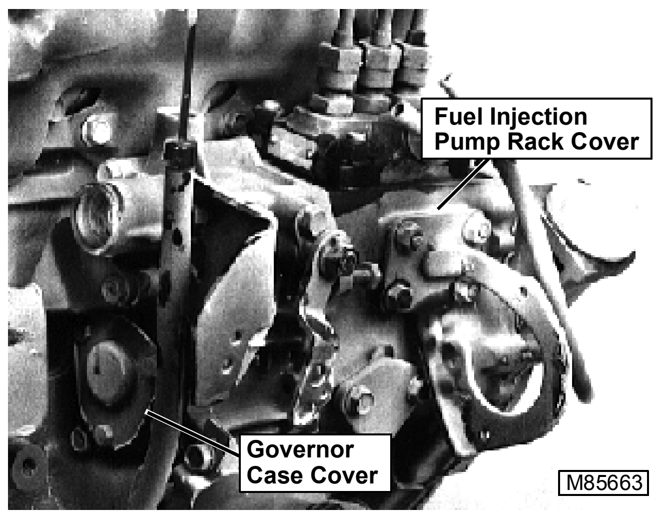
1. Disconnect and remove solenoid from bracket.
2. Disconnect throttle cable from throttle lever.
3. Remove fuel filter from bracket WITHOUT disconnecting fuel lines.
4. Remove air cleaner assembly and intake hose.
5. Remove any additional components to allow easy access to the governor assembly.



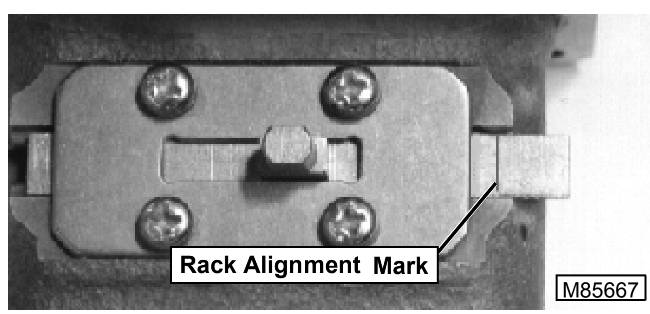
6. CARB/EPA engines use a plug to cover the fuel control screw instead of an acorn nut.

IMPORTANT: Make sure punch is used at inside edge of plug or damage to the internal components may occur.

7. Use a sharp pointed punch and hammer to drive punch through the inside edge of plug. Pry plug out, being careful not to damage the case or internal components. Check that internal E-shaped snap ring and washer(s) have not become dislodged, re-install if necessary.



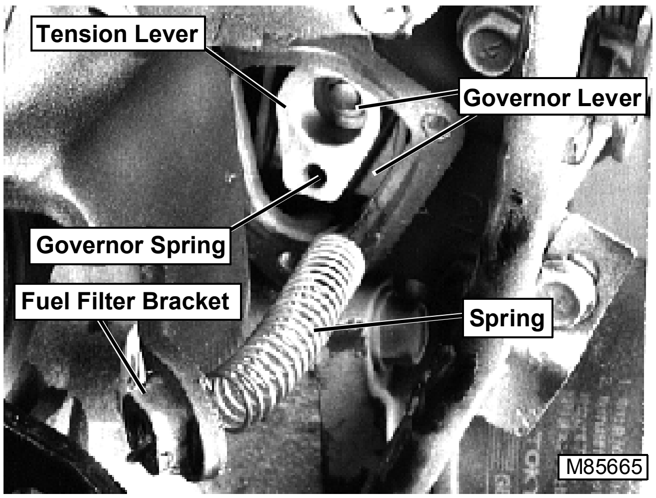
8. Remove governor case cover and fuel injection pump rack cover.

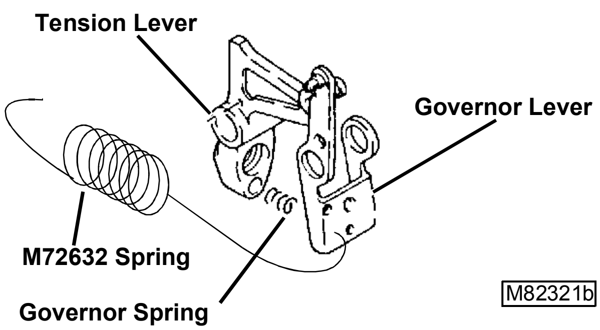


IMPORTANT: Fuel injection rack should have an alignment mark on it. If rack is NOT MARKED, fuel injection pump MUST BE sent to an Authorized Diesel Service (ADS) center to be calibrated and re-marked. Instruct ADS technician that there must be only one distinguishable alignment mark on rack.

Always replace shims between fuel injection pump and injection pump housing whenever pump has been removed.

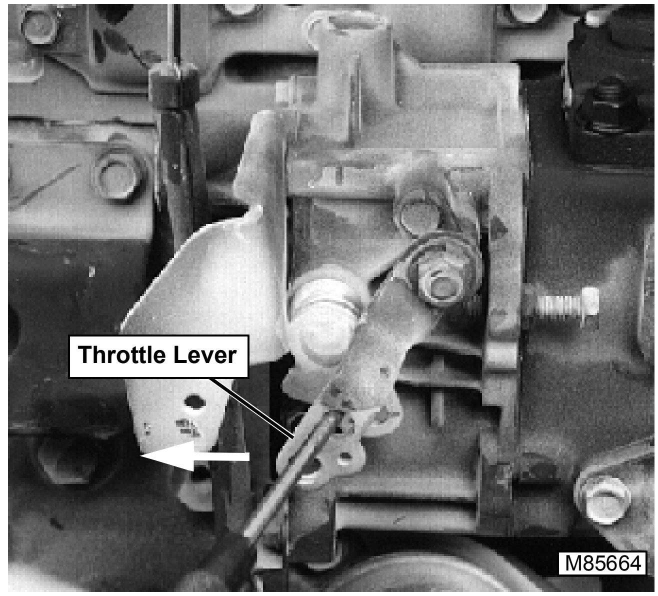
9. Find rack alignment mark before adjusting fuel control screw. Correct mark is approximately 9 mm (11/32-in.) from right edge of rack.



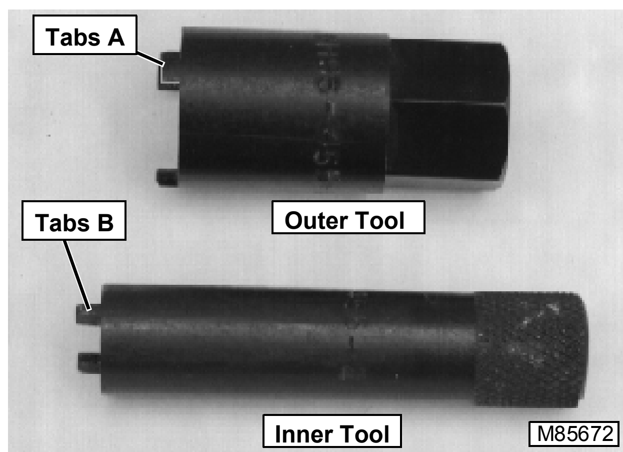


10. Install M72632 spring to compress governor spring between tension lever and governor lever.

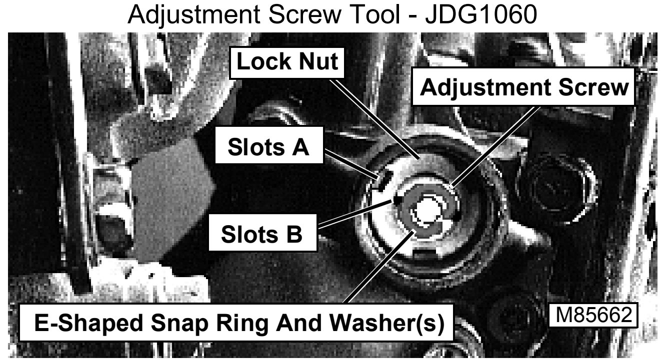
NOTE: Ends of spring may have to be bent to fit behind governor lever and attach to fuel filter bracket.



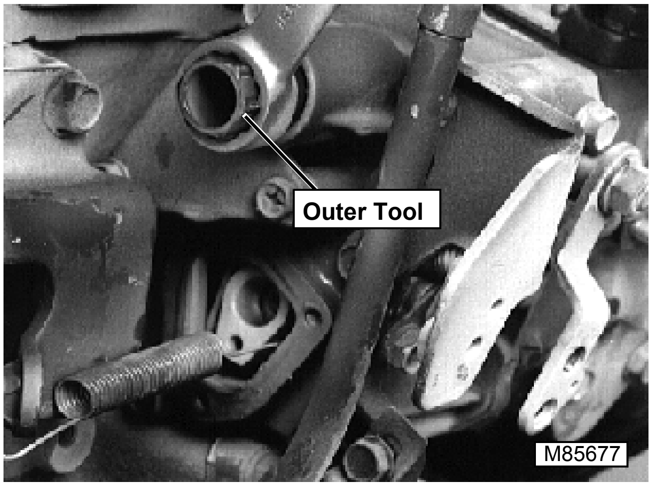
11. Energize the fuel shutoff solenoid by removing the white wire from the starter and touching it to the battery tie point at the starter while turning the ignition switch to the RUN position, then remove the white wire from the battery tie point.



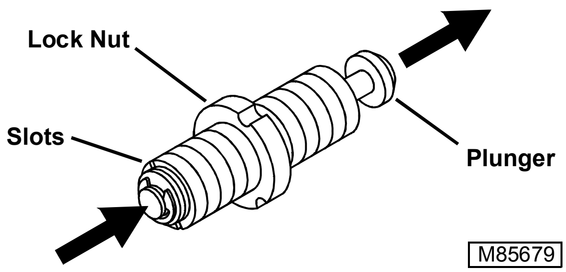
Adjustment Screw Tool - JDG1060



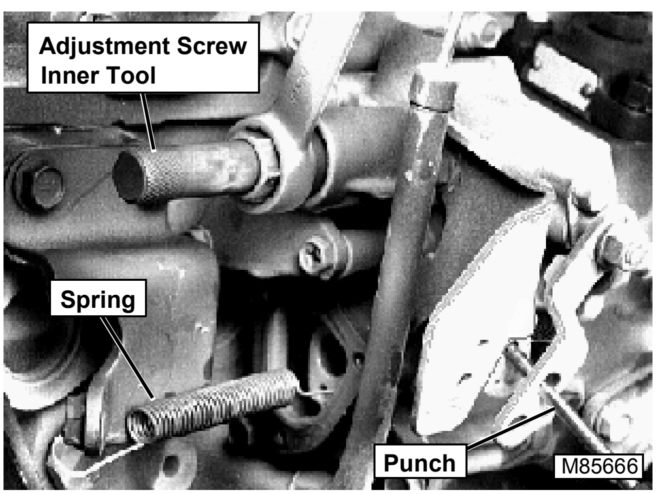
12. Use tabs (A) on outer tool in slots (A) of lock nut and tabs (B) on inner tool in slots (B) of adjustment screw. Check that E-shaped snap ring and washer(s) are not damaged and installed properly.



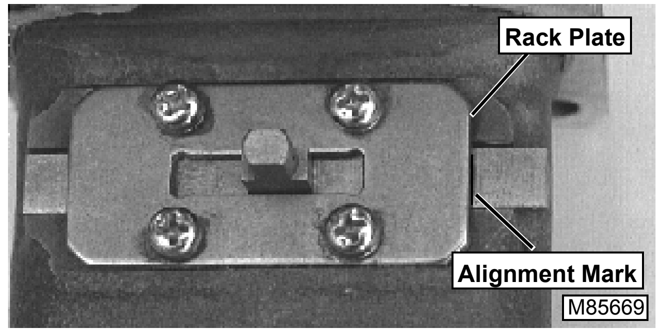
13. Insert outer tool in lock nut chamber and rotate slowly until tabs seat into slots on lock nut. Loosen lock nut which then allows adjustment of fuel control screw.



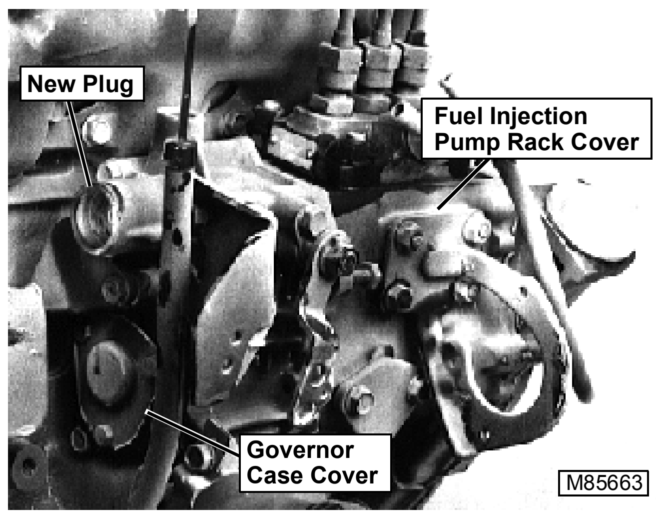
IMPORTANT: Fuel control screw plunger MUST BE fully forward any time adjustment is made. Inner tool has been design to accomplish this when properly installed in slots of adjustment screw.



14. Properly install adjustment screw inner tool and rotate slowly until tabs seat into slots of adjustment screw.
15. Have helper hold outer tool and lock nut stationary and maintain tension on fuel shut-off lever and throttle lever with punch.



16. While turning inner tool and adjustment screw, watch for alignment of mark on fuel injection pump rack with right edge of rack plate.
17. Have helper tighten lock nut with outer tool while you keep inner tool and adjustment screw from moving.
18. Check that tightening lock nut DID NOT change adjustment.
19. Remove inner and outer tools, spring, and punch (or wire retainers).



20. Install new fuel control screw plug.
21. Assemble parts in reverse order of removal.

IMPORTANT: BE SURE to install new gaskets on governor case cover and fuel injection pump rack cover (part of solenoid mounting bracket).

FAST IDLE ADJUSTMENT—NON CARB/EPA ENGINES

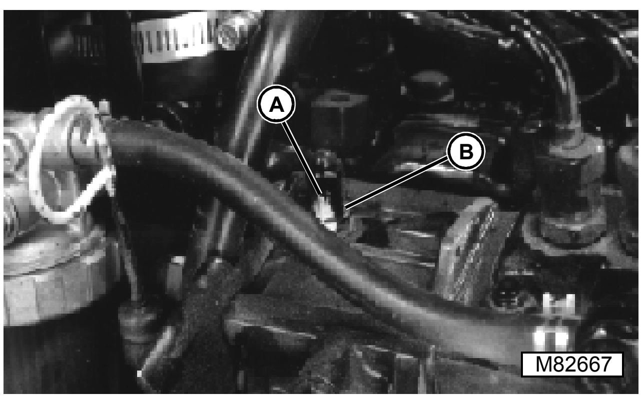
Equipment:

• JT05719 Hand Held Digital Tachometer

Procedure:

1. Park machine on level surface.
2. Move Mow/Transport lever to TRANSPORT position.
3. Lower cutting units to the ground.
4. Place travel pedals in NEUTRAL.
5. Engage parking brake.
6. Start engine and run for five minutes.
7. Raise hood.
8. Remove plenum air duct.
9. Place throttle control lever in fast idle position.
10. Use JT05719 Hand Held Tachometer to check engine speed at crankshaft pulley.
11. Push against injection pump throttle lever to insure it is against the fast idle stop screw. Check fast idle speed, fast idle speed should be **3425 ± 25 rpm**.
12. After fast idle speed adjustment, adjust throttle cable.

Results:



• If fast idle rpm is not according to specifications, remove cap nut (A), loosen nut (B) and turn screw. After adjustment, tighten nut and install cap nut.

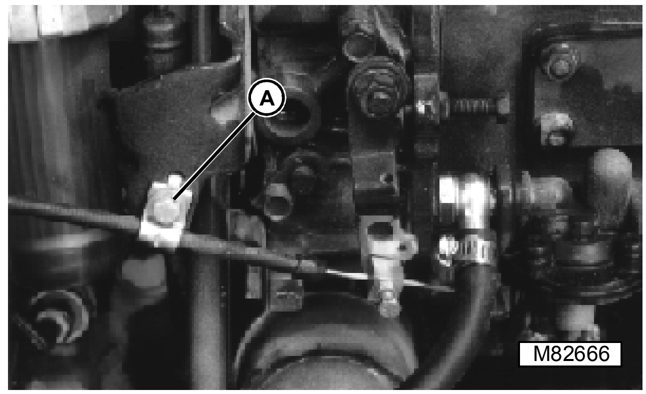
NOTE: Make sure air cleaner is clean and not restricted. Replace air cleaner element as necessary.

• If engine still does not meet fast idle speed specifications after adjustment, have injection pump inspected by a diesel injection service.

THROTTLE CABLE ADJUSTMENT

Procedure:

1. Park machine on level surface.
2. Move Mow/Transport lever to TRANSPORT position.
3. Lower cutting units to the ground.
4. Turn Ignition switch OFF.
5. Engage parking brake.
6. Raise hood.
7. Remove plenum air duct.

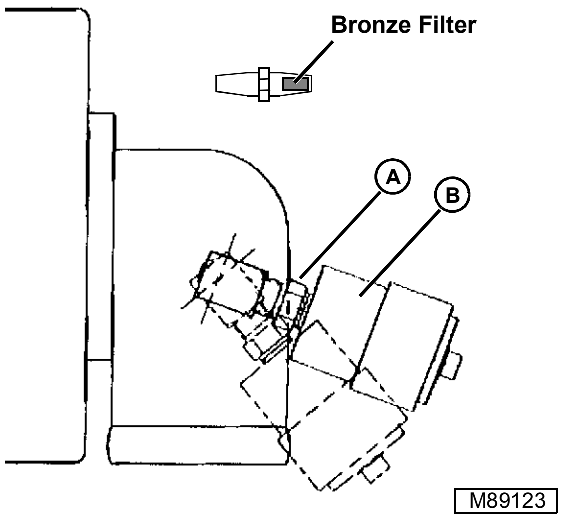


8. Loosen throttle cable clamp (A).
9. Move throttle lever toward fast idle position until throttle lever is **2—3 mm (0.080—0.120 in.)** away from frame slot.
10. Hold throttle control lever against fast idle stop. Pull throttle cable tight. Tighten cable clamp.
11. Move throttle lever through full range. Check to be sure governor control lever moves through complete range and linkage is not binding.

ENGINE REPAIR

AIR FILTER RESTRICTION INDICATOR REPLACEMENT

NOTE: Replace the bronze filter whenever the indicator is replaced.



IMPORTANT: The porous bronze filter end of fitting (A) must be threaded into the indicator (B).

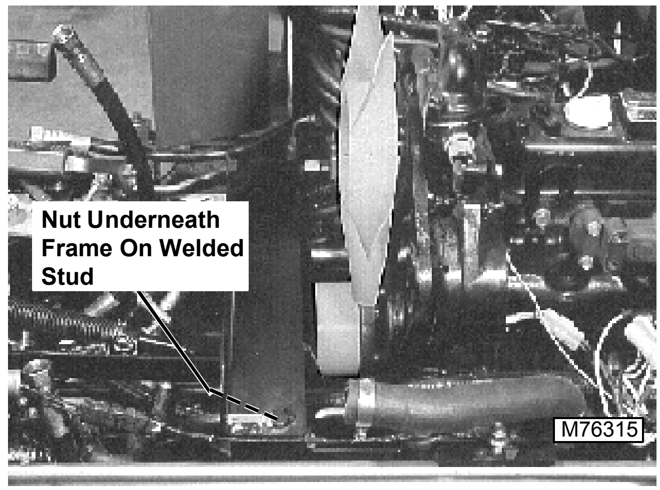
1. The air filter restriction indicator (B) is threaded onto the bronze filter until snug.
2. Position the indicator (as viewed from the side of the machine) at a 20—50° angle.

ENGINE REMOVAL

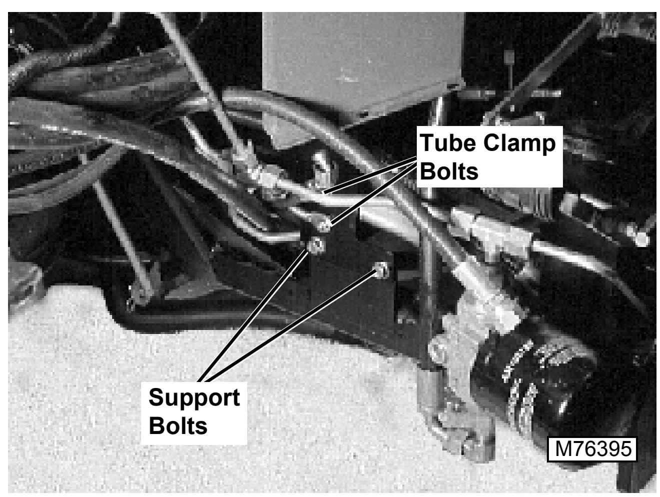
1. Park vehicle on a level surface.

> **CAUTION**
>
> **Raise the machine safely and support it with suitable jack stands.**
>
> **Never work on machine while supported only on mechanical or hydraulic jack**

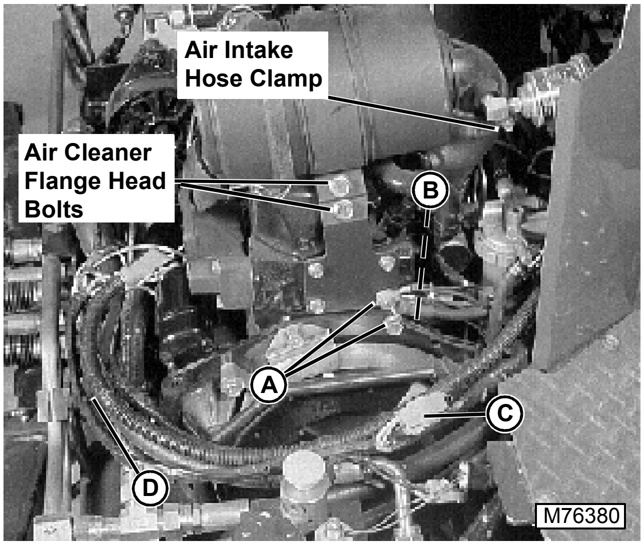
2. Jack and block machine to provide a minimum of 18" of clearance between the floor and the bottom of the frame of the machine at the engine.
3. Move Mow/Transport lever to TRANSPORT position.
4. Lower cutting units to the ground.
5. Turn Ignition switch OFF.
6. Engage park brake.
7. Disconnect battery negative (-) cable.
8. Close fuel shutoff valves located on right side of fuel tank.
9. Place 5 gal. container under sump and drain hydraulic fluid.
10. Remove hood.
11. Remove plenum air duct.
12. Remove front bumper assembly.
13. Remove Radiator.



14. Remove nut from welded stud on underside of radiator support crossmember.



15. Remove two flange head bolts securing tube clamp to frame.
16. Remove two flange head bolts retaining lower end of radiator support to frame.
17. Swing radiator support bracket out of the way of the front of the engine subframe.
18. Remove hydraulic pumps.



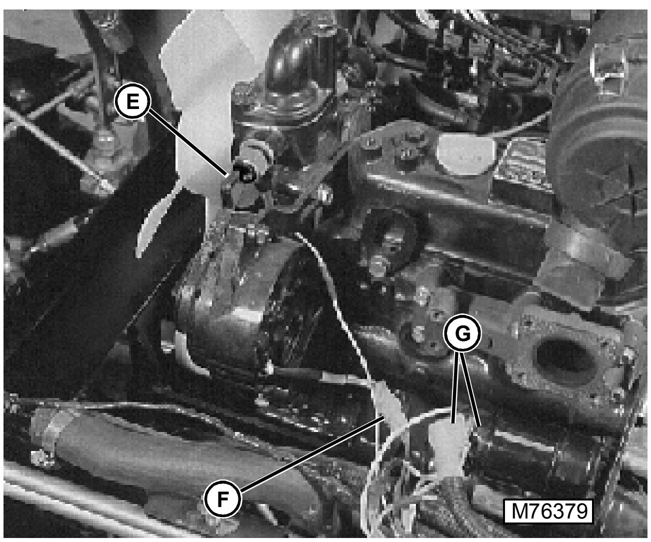
19. Remove air cleaner bracket bolts and intake hose and remove air cleaner
20. On left-hand side of engine, label and disconnect the following:

A—Wire leads from engine ground connection

B—Oil pressure sending unit wire lead

C—Fuel shutoff solenoid wire connector

D—Engine to Frame Ground Strap

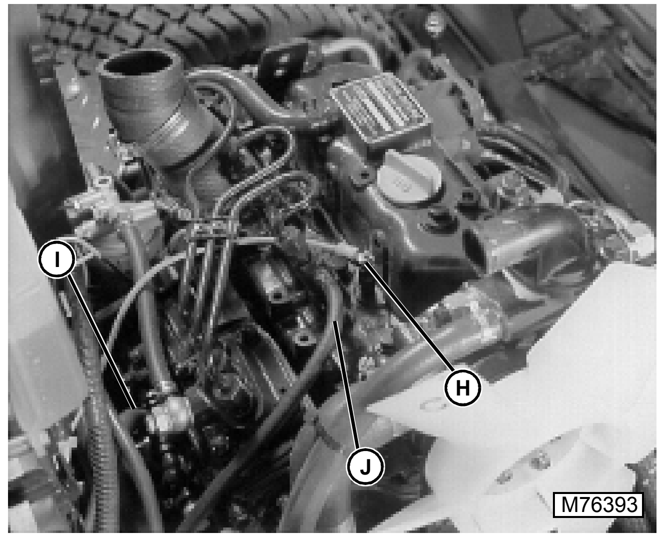


5. On front side of engine, label and disconnect the following:

E—Coolant temperature sensor lead

F—Alternator wire harness

G—Starter Connections

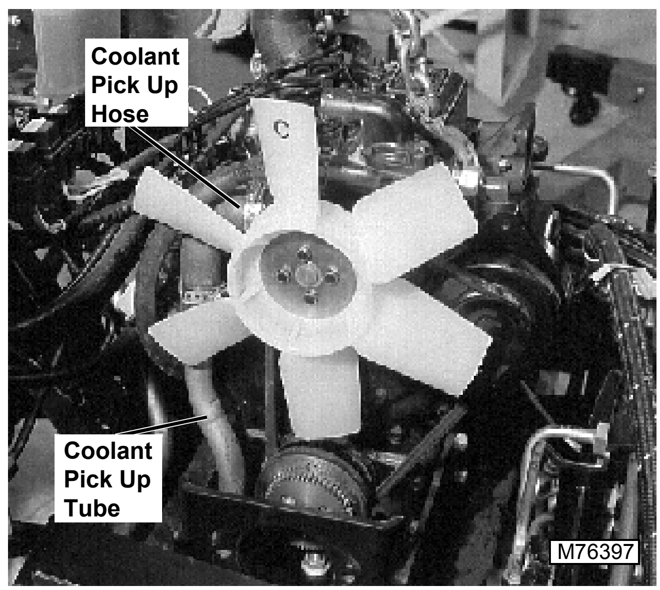


6. On firewall side of engine, label and disconnect the following:

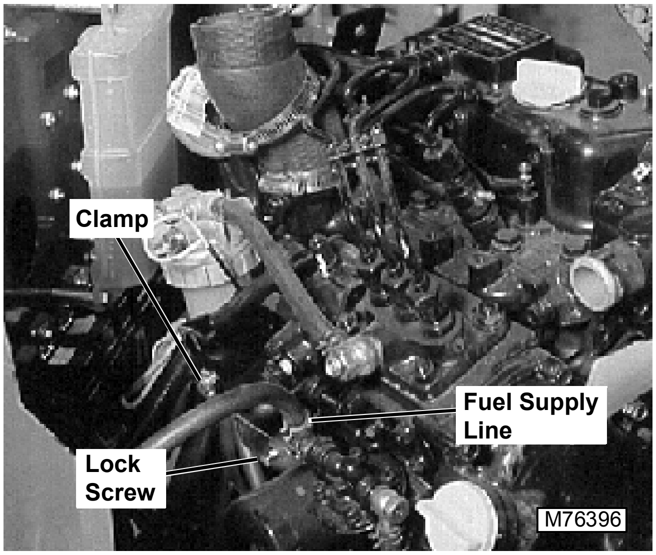
H—Glow plug lead

I— Fuel supply line

J— Fuel return line



11. Remove short hose connecting coolant pick up tube and water pump housing.
12. Remove coolant pick up tube through the bottom of the vehicle frame.
13. Remove engine mount capscrews and flat washers.
14. Connect a hoist to lifting eyes on engine.
15. Lift engine until clear of frame and can be rotated slightly.



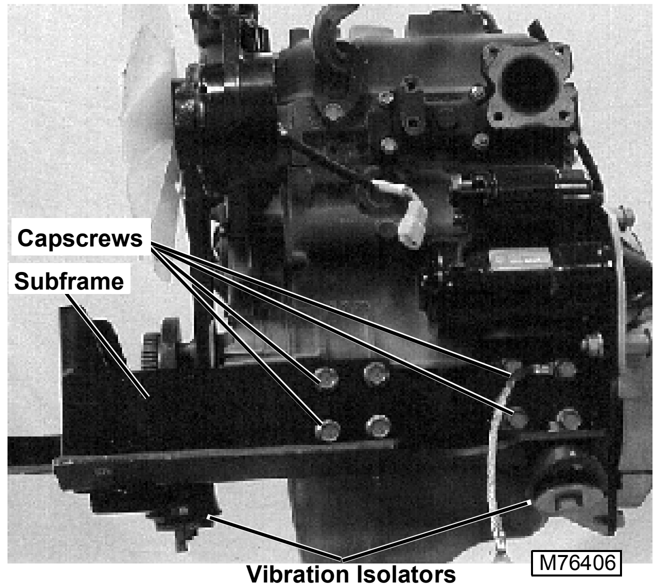
16. Loosen throttle cable lock screw and clamp. Move throttle cable away from engine.
17. If fuel supply line has not been previously disconnected, disconnect now.
18. Raise engine the rest of the way and remove from vehicle.

ENGINE SUBFRAME

REMOVAL

1. Remove Engine. “ENGINE REMOVAL” on page 42.

> ⚠ **CAUTION**
>
> **Engine Subframe is heavy. Support Subframe and engine properly before removing capscrews securing Subframe to engine.**

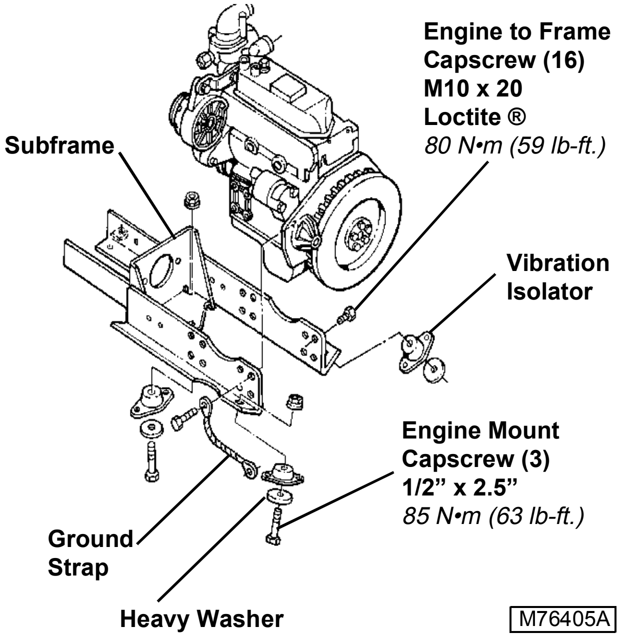


2. Remove engine to frame capscrews.
3. Inspect three (3) rubber vibration isolators on Subframe for wear or damage. Replace as necessary.

NOTE: Location of braided ground strap on upper bolt on left hand side of Subframe only.

INSTALLATION

IMPORTANT: Thread locking agent such as Loctite® #242 MUST be used on the sixteen (16) M10 x 20 capscrews securing Subframe to engine block. Capscrews must be torqued to 89 N•m (59 lb-ft.).



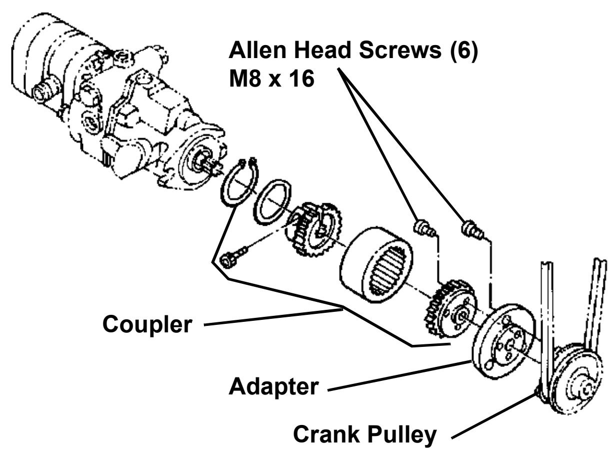
1. Install new vibration isolators, if required, and torque 1/2” x 2-1/2” capscrew to **85 N•m (63 lb-ft.)**.

NOTE: Install ground strap as shown in illustration. AN alignment tool is required to properly install subframe to engine

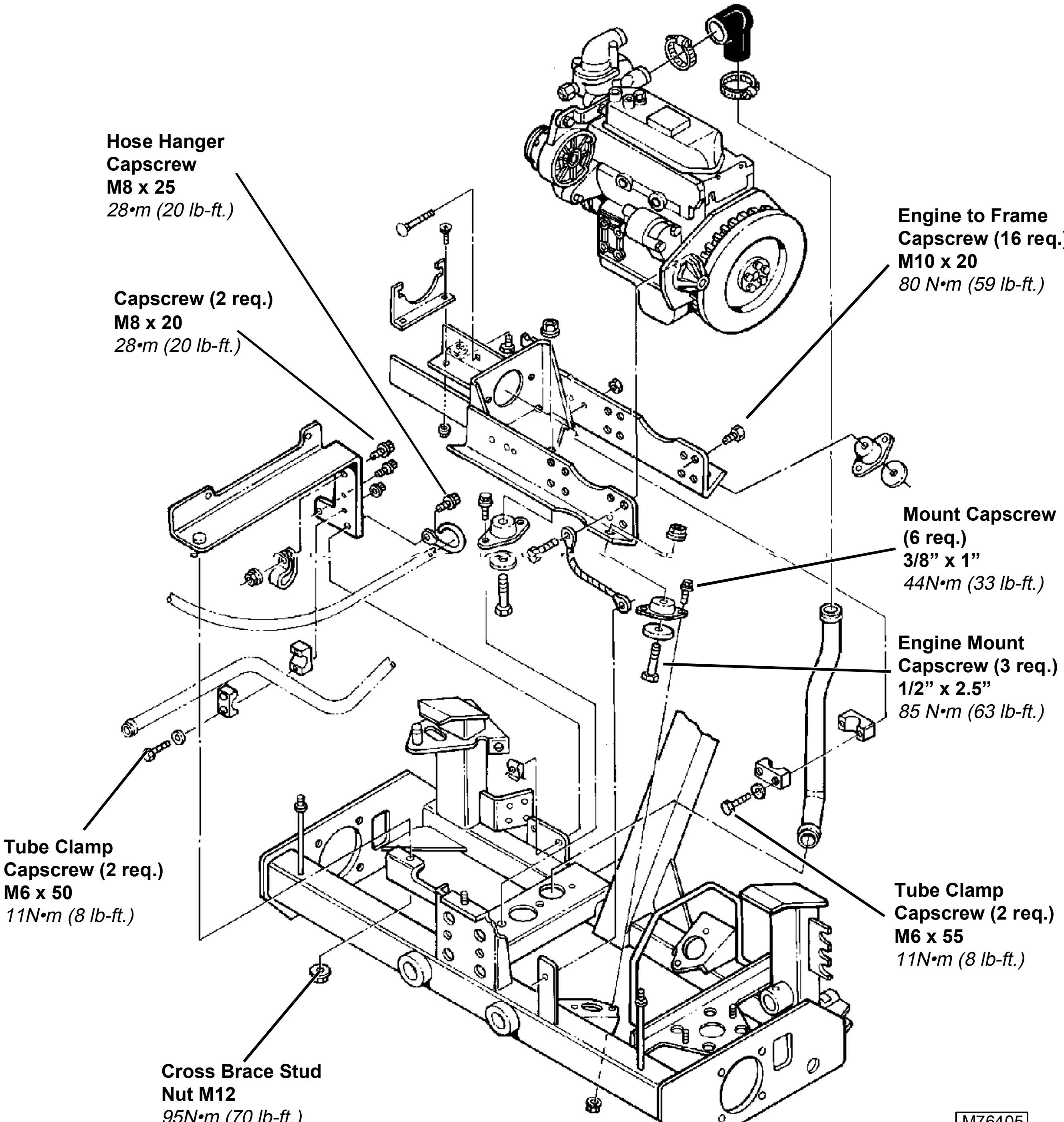
2. Secure Subframe to engine block with sixteen (16) M10 x 20 capscrews and torque to **80 N•m (59 lb-ft.)**.

HYDRAULIC COUPLER

The hydraulic coupler transfers power from the engine to the Hydrostatic pump assembly. Installation and adjustment procedures can be found in Hydraulic Power Train Section.



ENGINE INSTALLATION



1. Install Subframe.
2. Install engine in reverse order from removal.
3. Install Hydraulic Pumps.

⚠ CAUTION

When filling engine with oil use care not to fill to fast. Excess oil will flow out crankcase breather and run into intake manifold and into engine cylinder. Attempting to start engine with oil in cylinder will severely damage engine!

4. Replace fluids, Hydraulic, Coolant, and Engine oil.
5. Connect Battery.
6. Perform Throttle adjustment. (See THROTTLE CABLE ADJUSTMENT on page 41.)
7. Bleed fuel system.

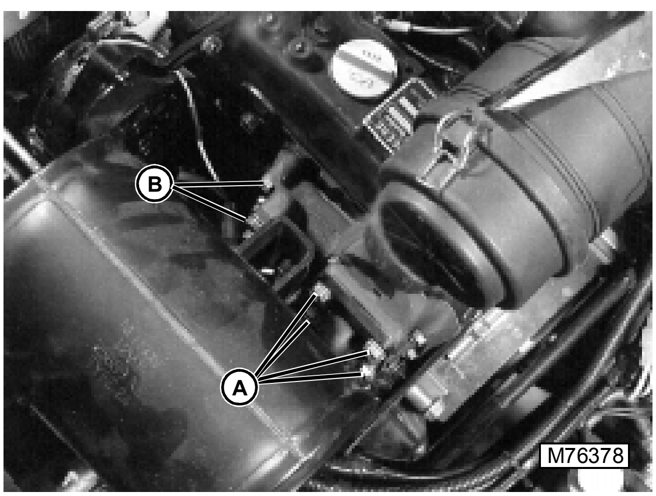
> **⚠ CAUTION**
>
> **Because Transmission mechanism has been disturbed vehicle may move when engine is started if wheels are on ground. Neutral adjustment must be performed before unit is lowered to ground.**

8. Adjust Transmission neutral.
9. Replace front bumper, hood and plenum.
10. Remove vehicle from jack stands.

MUFFLER REMOVAL/ INSTALLATION

> **⚠ CAUTION**
>
> **To prevent possible burns, allow engine to cool before removing muffler.**

1. Remove four flange head bolts (A) securing muffler flange to manifold flange.
2. Remove two flange head bolts (B) securing muffler support to manifold.
3. Remove muffler and gasket.



Installation is done in the reverse order of removal.

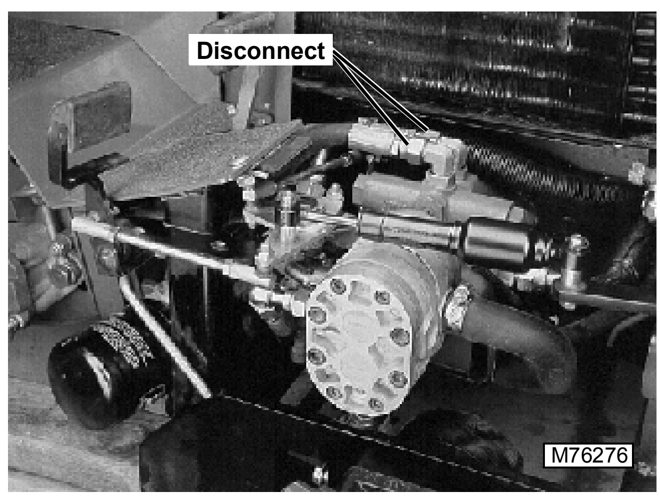
- Install new gasket on exhaust manifold with metal side of gasket facing out.

RADIATOR REMOVAL/ INSTALLATION

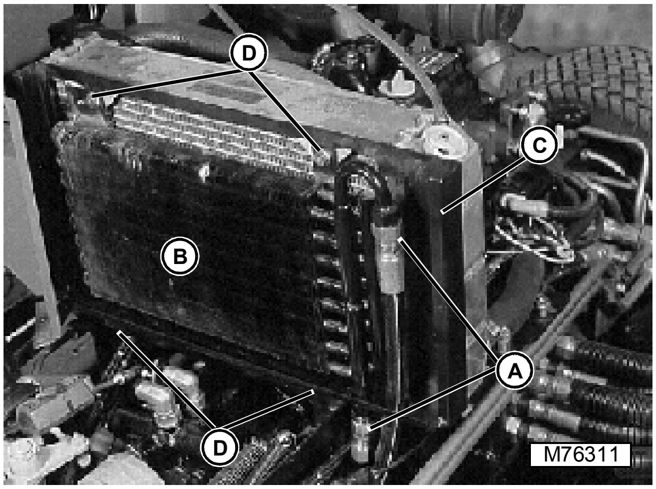
1. Park machine on level surface.
2. Move Mow/Transport lever to TRANSPORT position.
3. Lower cutting units to the ground.
4. Turn Ignition switch OFF.
5. Engage park brake.

> **⚠ CAUTION**
>
> **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 may call Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.**

6. Tilt and secure hood in the up position.
7. Remove plenum/air duct.
8. Disconnect battery negative (-) cable.
9. Remove hood if required for further servicing.
10. Place a 10 gallon container below the Hydraulic sump and drain oil.



11. Disconnect two hydraulic lines to top of hydrostatic pump.

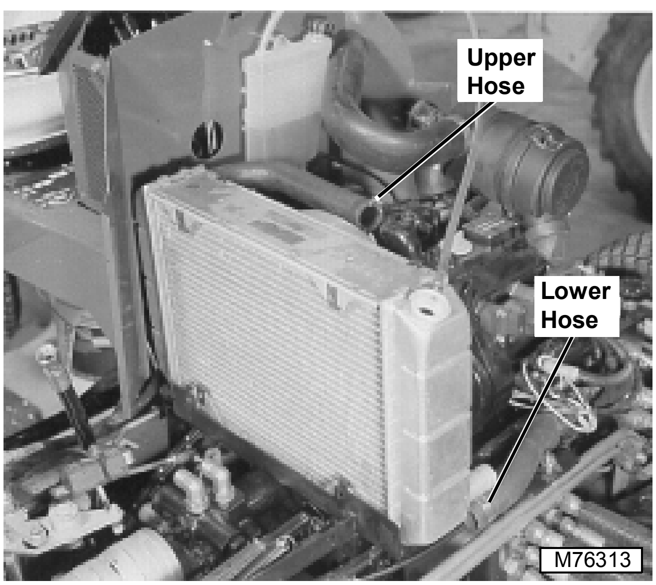


12. Disconnect Oil cooler lines (A). Remove Oil cooler (B) and frame (C) by detaching four capscrews (D).

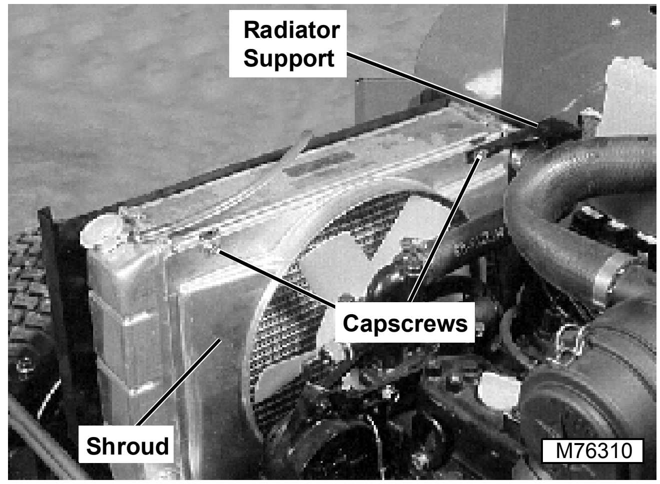
> **⚠ CAUTION**
>
> **Explosive release of fluids from pressurized cooling system can cause serious burns. Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap.**

13. Drain coolant from Radiator/Engine. Drain cock is located under frame on lower left side of radiator. Capacity is approximately 4 L (4.2 U.S. qt).

.



14. Disconnect radiator hoses.



15. Pull hose from recovery tank.
16. Remove Capscrew securing radiator support to firewall.
17. Remove radiator and fan shroud.

Installation is done in the reverse order of removal.

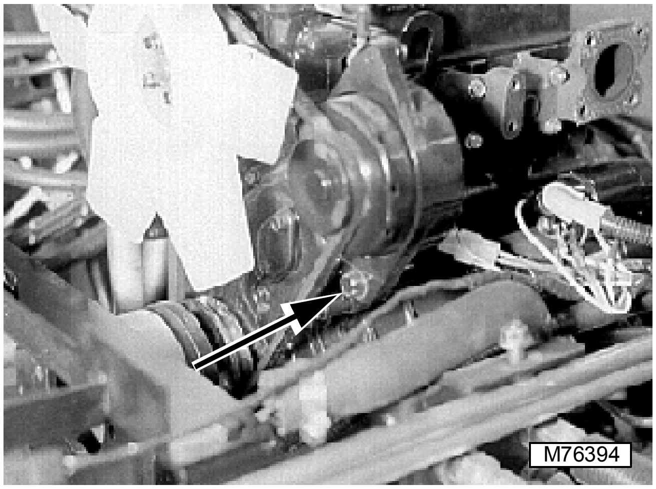
- Make sure radiator flange fits inside mounting bracket.
- Close drain cock on bottom of radiator and fill radiator with proper mix of coolant.
- Run engine and check for leaks at coolant and hydraulic hoses. Add coolant to recovery tank and hydraulic oil to reservoir as necessary.

FAN BELT REPLACEMENT

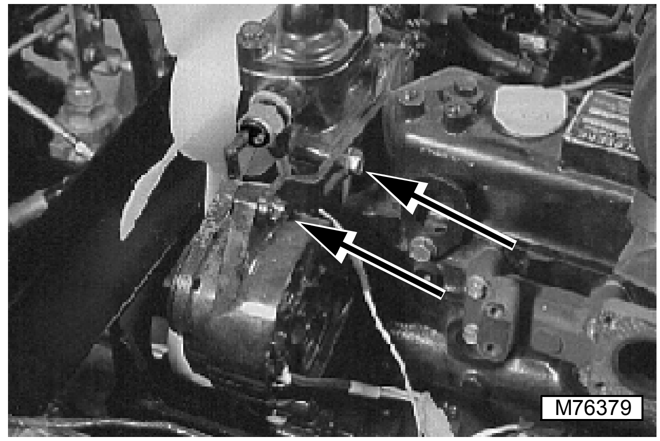
1. Park machine on level surface.
2. Move Mow/Transport lever to TRANSPORT position.
3. Lower cutting units to the ground.
4. Turn Ignition switch OFF.
5. Engage park brake.
6. Disconnect battery negative (-) cable.

> **⚠ CAUTION**
>
> **Explosive release of fluids from pressurized cooling system can cause serious burns. Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap.**

7. Remove radiator.
8. Remove Hydraulic Pumps.

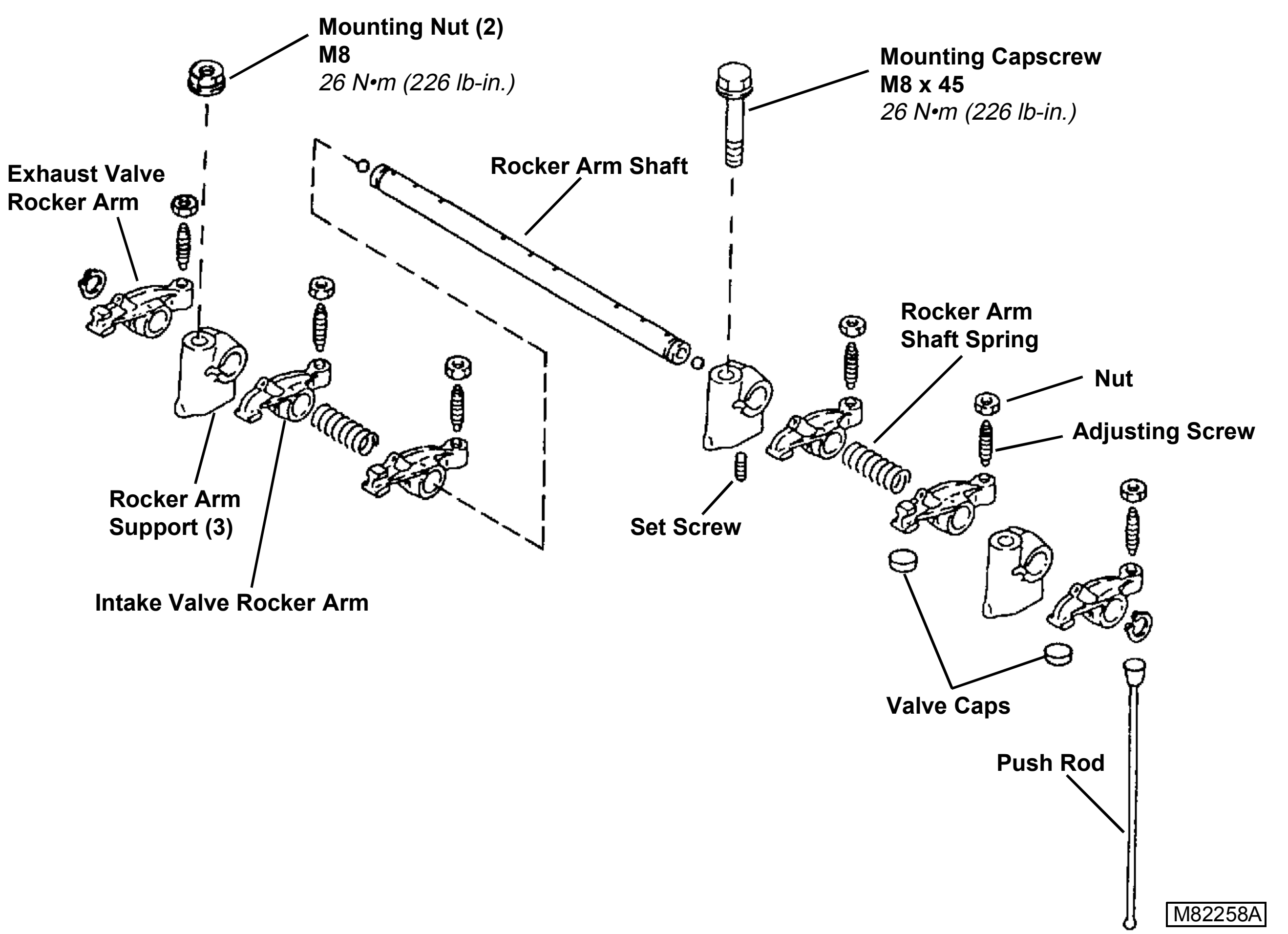


9. Loosen capscrew on bottom mounting bracket of alternator.



10. Loosen capscrews on top mounting bracket of alternator.
11. Swing alternator towards engine.
12. Remove belt.
13. Install new belt and adjust tension.
14. Replace Hydraulic Pumps.
15. Replace radiator.

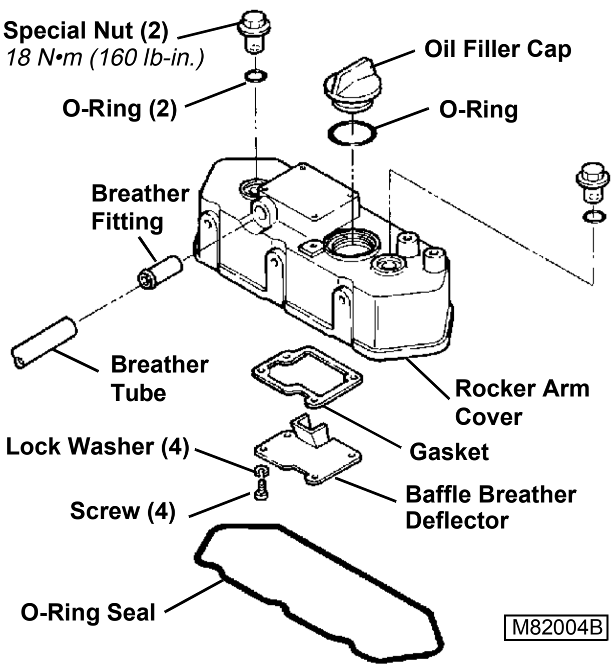
ROCKER ARM ASSEMBLY



ROCKER ARM COVER

IMPORTANT: DO NOT over torque special nuts securing rocker arm cover to engine.

1. Remove two special nuts.
2. Pull crankcase breather tube up from side of engine and lay aside.
3. Remove rocker arm cover from cylinder head.
4. Inspect O-ring seal before reinstalling rocker arm cover. Replace if damaged.
5. Clean cylinder head surface and install rocker arm cover on cylinder head. Replace special nuts and torque to **18 N•m (160 lb-in.)**.



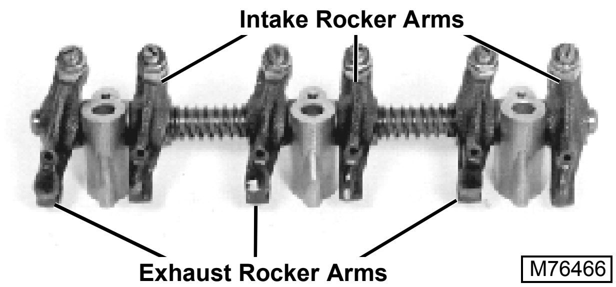
ROCKER ARM REMOVAL/ INSTALLATION

1. Remove rocker arm cover. (See ROCKER ARM COVER on page 50.)
2. Remove rocker arm support mounting cap screws.
3. Lift rocker arm assembly from cylinder head and set on bench.

NOTE: If rocker arm assembly is to be disassembled, replace components in same location on rocker arm shaft they were removed from.

4. Slide rocker arm assembly components off rocker arm shaft while noting positions for reassembly.
5. Lift push rods from cylinder head and note order of removal for reassembly in same positions in head.
6. Inspect rocker arm components and push rods. (See below)
7. Reinstall push rods in cylinder head with ball shaped end down in head. Push rods should be installed in same locations they were remove from.

NOTE: Lubricate all parts with clean oil during assembly.



8. Assemble rocker arm assembly components on rocker arm shaft in the reverse order of removal.
9. Check to be sure valve caps are installed on end of all valves.
10. Place rocker arm assembly on cylinder head. Align rocker arms with valves and push rods. Align rocker arm end supports and center supports with corresponding holes in head. *Maintain proper alignment during tightening of mounting cap screws.*
11. Install rocker arm support mounting cap screws and torque to **26 N•m (226 lb-in.)**.
12. Adjust valve clearance. (See VALVE CLEARANCE CHECK AND ADJUSTMENT on page 23.)

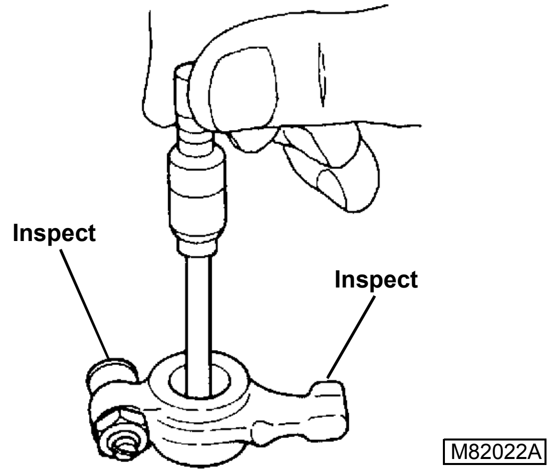
INSPECTION

1. Measure outer diameter of rocker arm shaft at each rocker arm location.

Rocker Arm Shaft O.D.

Standard . . . . 9.97—9.99 mm (0.392—0.393 in.)
Wear Limit. . . . . 9.95 mm (0.391 in.)

2. Replace rocker arm shaft if less than wear limit.



3. Measure inner diameters of rocker arms and supports.

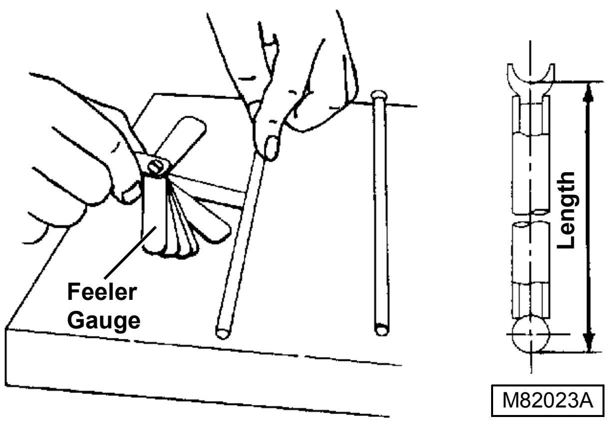
Rocker Arm and Shaft Support I.D.'s

Standard . . . . 10.00—10.02 mm (0.393—0.394 in.)

Wear Limit. . . . . 10.09 mm (0.397 in.)

Clearance . . . . 0.14 mm (0.005 in.)

4. Replace rocker arms and/or supports if I.D. is more than wear limit.
5. If shaft and support/arm clearance (support/arm I.D. minus shaft O.D.) exceed wear limit, replace all parts.



6. Measure length and bending of push rod.
7. Use the corner of a known true surface to check bending of the push rod since both ends of the push rods have raised edges.

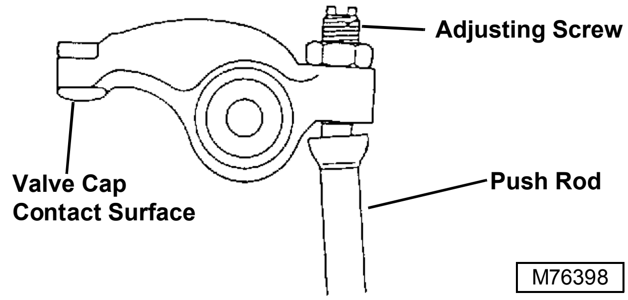
Push Rod Length:

Standard . . . . 110 - 111 mm 4.346 - 4.380 in.)

Push Rod Bend:

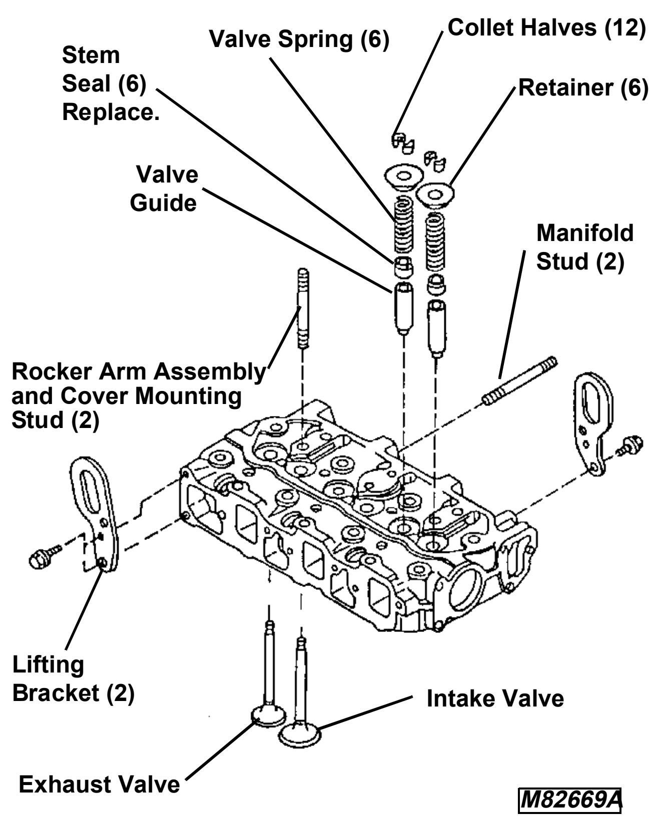
Standard . . . . 0.03 mm (0.001 in.) or less

8. Replace push rod if not within specifications.



9. Inspect Rocker Arm Contact Surfaces
10. Check the surface of the adjusting screw that contacts the push rod for wear, replace push rod or adjusting screw if worn.
11. Check the contact surface that comes in contact with the valve stem cap for wear, replace rocker arm if necessary.

CYLINDER HEAD REMOVAL/INSTALLATION

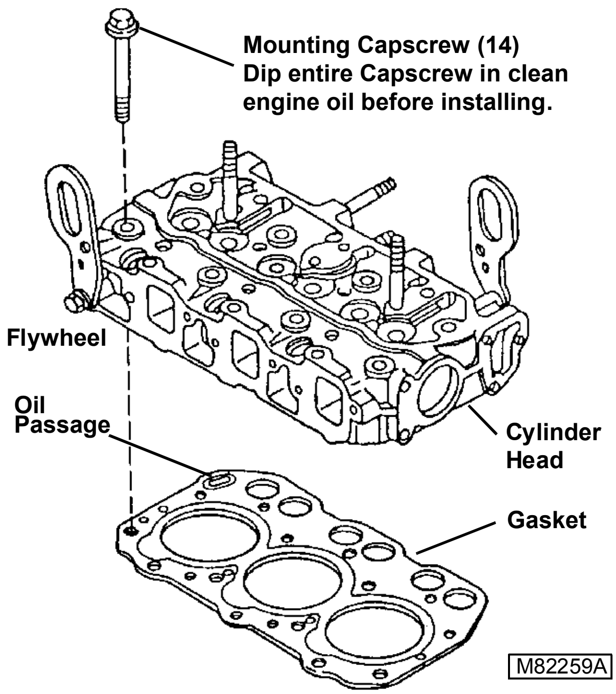


REMOVAL

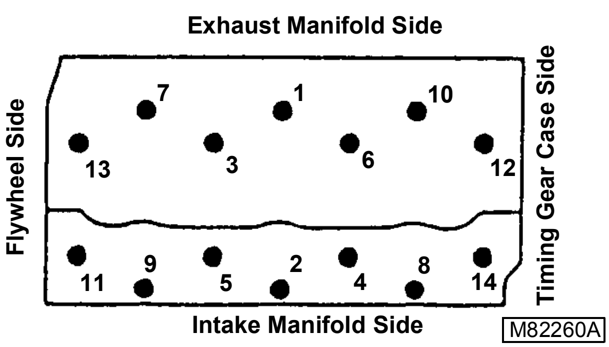
1. Remove rocker arm assembly, push rods and valve caps. (See ROCKER ARM ASSEMBLY on page 49.)
2. Remove exhaust manifold. (See EXHAUST MANIFOLD REMOVAL/INSTALLATION on page 55.)

3. Remove Intake manifold. (See INTAKE MANIFOLD on page 56.)
4. Remove water pump. (See WATER PUMP REMOVAL/INSTALLATION on page 80.)
5. Remove fuel injection nozzles. (See FUEL INJECTION NOZZLES (PINTLE-TYPE) on page 90.)
6. Remove glow plugs.
7. Disassemble and inspect cylinder head and valves.
8. Clean all Mating surfaces of old gasket and sealant material.

INSTALLATION



IMPORTANT: Oil passage in gasket must be located over oil passage in cylinder block. Install gasket as shown.



1. Using new gaskets install head and torque as shown.

IMPORTANT: Tighten mounting capscrews, in the sequence shown, in three stages of gradually-increasing torque.

Torque Specifications:

First	**13 N•m (10 lb-ft.)**
Second	**26 N•m (20 lb-ft.)**
Final	**39 N•m (28 lb-ft.)**

IMPORTANT: Cylinder head mounting capscrews must be checked for proper torque after 50 hours of engine operation.

DISASSEMBLY/ASSEMBLY

1. Remove valve caps from valves. Valve caps should be installed on valves they were removed from.
2. Compress valve spring using a valve spring compressor and remove the collet halves, retainer, valve spring and valve stem seal for each valve.
3. Intake and exhaust valve guides are press fit. Replace guides only if replacement is necessary. (See Valve Guide Inspection on page 54.)
4. Intake and exhaust valve seat inserts are not serviceable. If inspection of cylinder head reveals worn or damaged valve seats, cylinder head must be replaced. (See Cylinder Head Inspection on page 52.)
5. Inspect all remaining parts for wear or damage. (See Cylinder Head Inspection on page 52.)

IMPORTANT: Do not reuse stem seals if removed. Used seals will leak.

6. Install new valve stem seals over valve guides.
7. Apply clean engine oil on intake and exhaust valve stems during assembly.
8. Install springs with smaller pitch end or paint mark toward cylinder head.
9. Compress valve springs and retainer until collet halves are able to be installed in grooves of valve stem.
10. Carefully release tension on spring compressor.
11. Tap on end of valve with a plastic hammer to ensure collet halves have seated properly on valve stem.
12. Repeat for remaining valves.
13. Measure valve recession if new valves were installed. (See Valve Recession on page 54.)

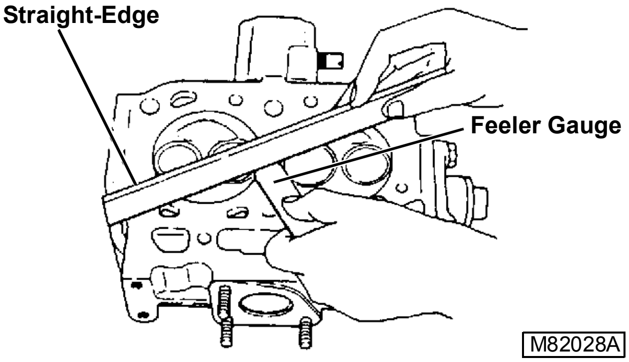
INSPECTION

Before inspection, thoroughly clean all components of carbon, dirt and old gasket material.

Cylinder Head Inspection

- **Measure cylinder head flatness.**

1. Place a straightedge along each of the four sides and each diagonal.



2. Measure clearance between straight edge and combustion surface with a feeler gauge.

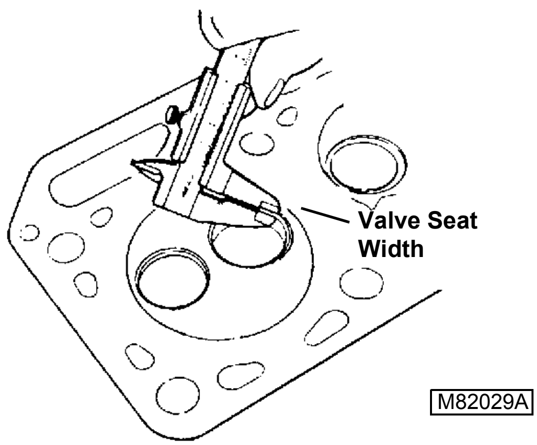
Cylinder Head Distortion:

Standard . . . . 0.05 mm (0.002 in.) or less
Wear Limit. . . . . 0.15 mm (0.006 in.)

3. If distortion exceeds the wear limit, resurface or replace cylinder head.

IMPORTANT: Remove only enough metal to make cylinder head flat; but DO NOT remove more than 0.20 mm (0.008 in.).

4. If cylinder head was resurfaced:
   - Measure piston-to-cylinder head clearance.
   - Measure valve recession.
   - Measure valve seat width.



5. Measure valve seat width.

Intake Valve

Standard . . . . 1.15 mm (0.045 in.)
Wear Limit. . . . . 1.65 mm (0.065 in.)

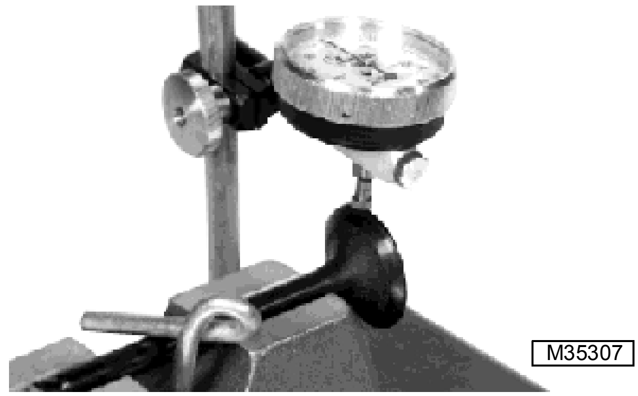
Exhaust Valve

Standard . . . . 1.41 mm (0.056 in.)
Wear Limit. . . . . 1.91 mm (0.075 in.)

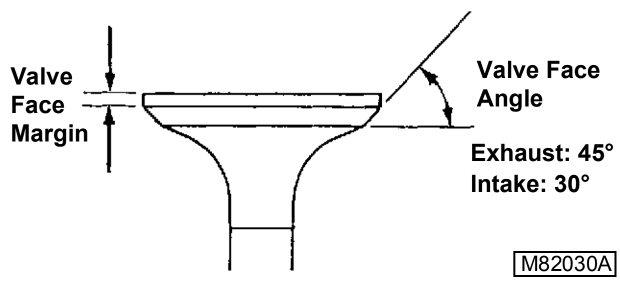
If necessary, grind valve seats to meet specifications. (See *GRIND VALVE SEATS* procedure.)

Intake and Exhaust Valve Inspection

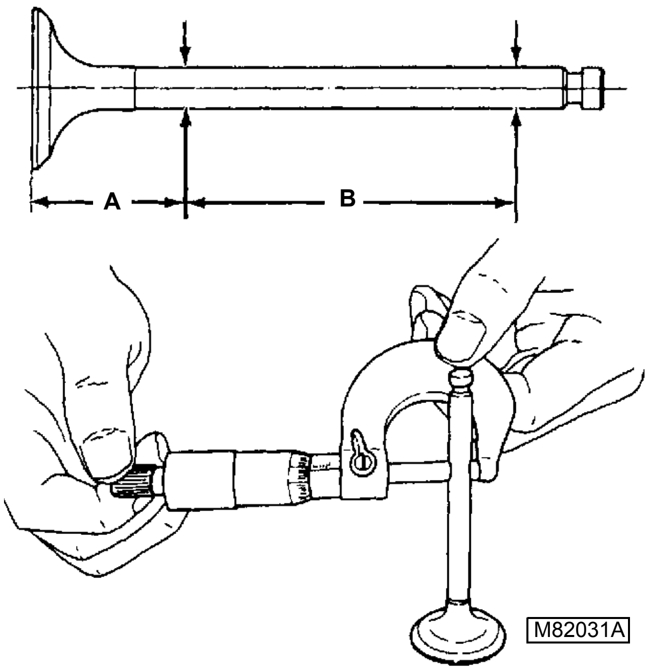
- **Intake and Exhaust Valves**



6. Check valves for out-of-round, bent or warped condition using a valve inspection center. Replace valve if necessary.



7. If valve faces are worn, burned or pitted, grind valves to proper face angle. If valve face margin is less than **0.51 mm (0.020 in.)** after grinding, replace valve.



8. Measure valve stem diameter at two locations shown. Replace valve if measurement exceeds wear limit.

Valve Stem O.D.:

Distance A . . . . 20 mm (0.787 in.)
Distance B . . . . 40 mm (1.575 in.)

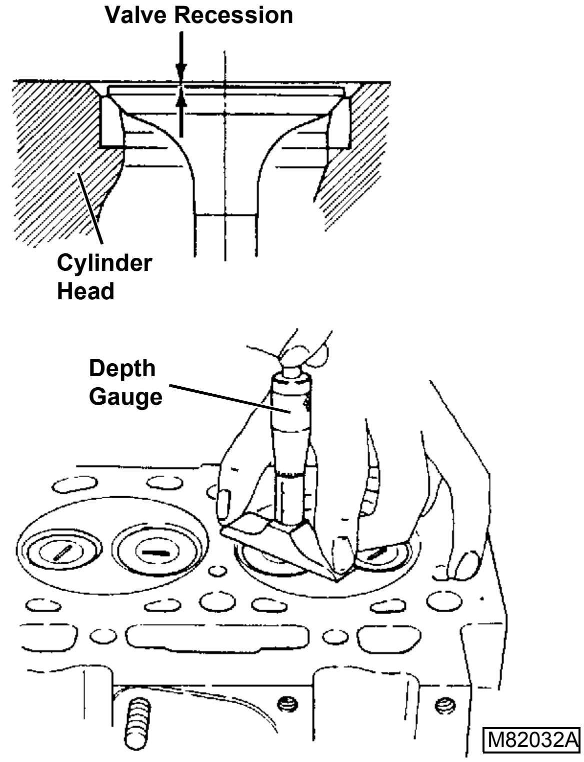
Intake Valve

Standard . . . . 5.46—5.48 mm (0.215—0.216 in.)
Wear Limit. . . . . 5.40 mm (0.212 in.)

Exhaust Valve

Standard . . . . 5.44—5.46 mm (0.214—0.215 in.)
Wear Limit. . . . . 5.40 mm (0.213 in.)

Valve Recession



9. Measure valve recession using a depth gauge. Replace valve or cylinder head if measurement exceeds specification.

Valve Recession:

Intake Valve . . . . 0.40 mm (0.016 in.)
Exhaust Valve. . . . . 0.85 mm (0.033 in.)

Valve Guide Inspection

- **Measure valve guide inside diameter.**

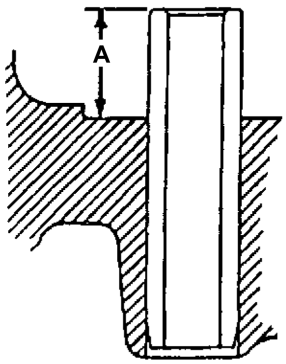
NOTE: Clean valve guides using a valve guide brush before measuring.

Valve Guide I.D.:

Standard . . . . 5.50—5.52 mm (0.216—0.217 in.)
Wear Limit. . . . . 5.58 mm (0.220 in.)

10. If diameter exceeds wear limit, knurl or replace guide.
11. If diameter is less than wear limit, determine guide-to-stem clearance (guide diameter minus stem diameter).
12. If clearance between valve stem and valve guide exceeds **0.15 mm (0.006 in.)** but is less than **0.20 mm (0.008 in.)**, knurl valve guides.
    - Knurl valve guides using a 5.50 mm Valve Guide Knurler

13. If clearance exceeds **0.20 mm (0.008 in.)**, replace valve guides.
   • Replace valve guides using a JDG504 Valve Guide Driver



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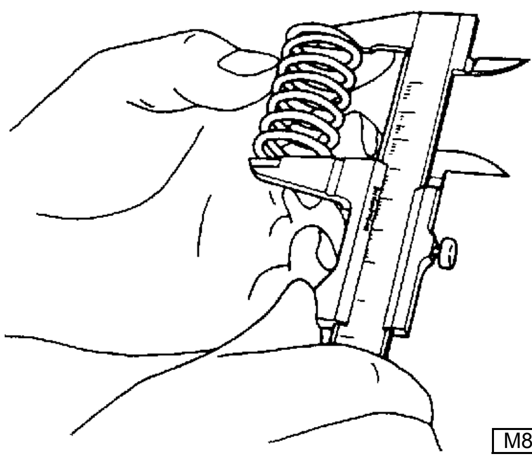
14. **Install valve guides with tapered ends down.** Push valve guides down until top of valve guides are **7 mm (0.276 in.)** (A) from top of cylinder head.
15. Ream inside diameter of valve guides using a 5.50 mm Valve Guide Reamer

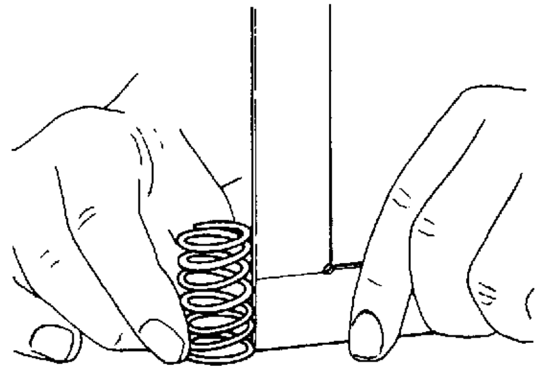
Valve Spring Inspection

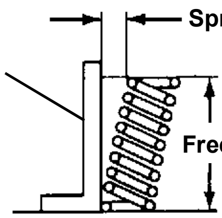


M82034A

16. Measure valve spring free length.
17. Replace spring if measurement is off specification.

Free Length . . . . 28 mm (1.102 in)
Minimum Length . . . . 26.2 mm (1.032 in)





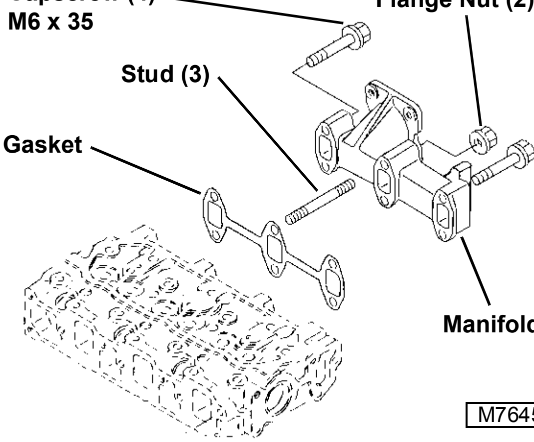
M82035A

18. Measure spring inclination.
19. Replace spring if measurement is off specification.

Inclination . . . . 0.81 mm (0.032 in)

EXHAUST MANIFOLD REMOVAL/INSTALLATION

1. Remove muffler and gasket. (See MUFFLER REMOVAL/INSTALLATION on page 47.)

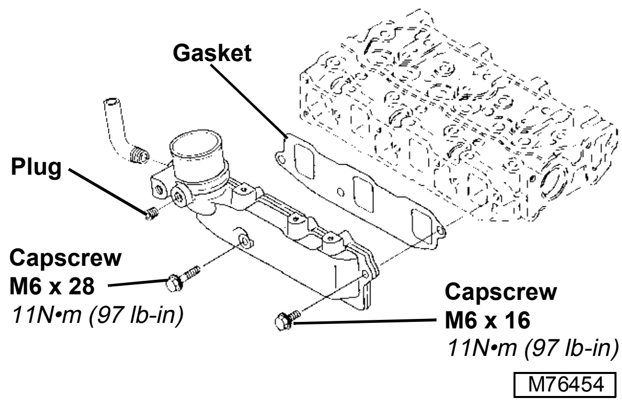


M76454A

2. Remove four capscrews and two flange nuts that attach exhaust manifold to cylinder head.
3. Remove manifold.
4. Clean all mating surfaces thoroughly.
5. Install new gasket between exhaust manifold and cylinder head.
6. Tighten all mounting hardware to **11 N•m (97 lb-in)**.
7. Install muffler and gasket. (See MUFFLER REMOVAL/INSTALLATION on page 47.)

INTAKE MANIFOLD

1. Remove fuel filter assembly mounting capscrews.
2. Remove fuel injection lines.
3. Remove manifold mounting capscrews and manifold.



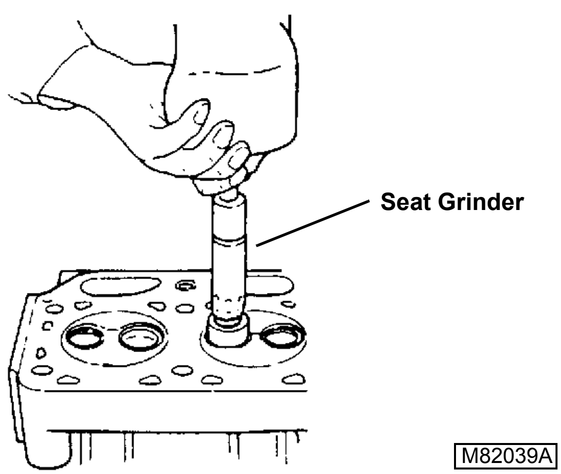
4. Clean all mating surfaces thoroughly.
5. Install new gasket.
6. Tighten all mounting hardware to **11 N•m (97 lb-in.).**

GRIND VALVE SEATS

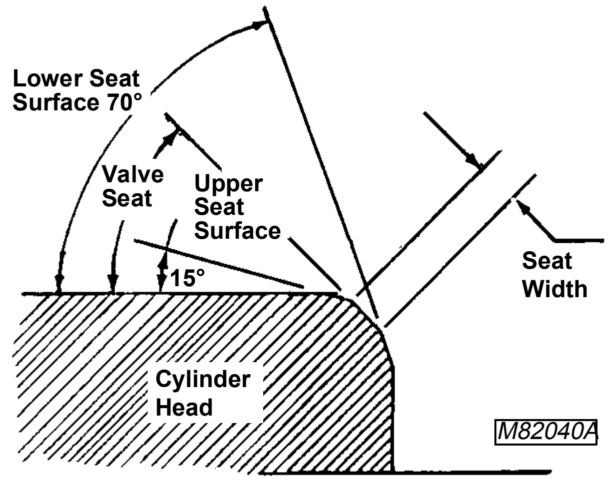
IMPORTANT: Valve seats should never be cut. Cutting a valve seat can damage its sealing surface, which may result in leaks or valve/seat failure. Valve seats should be ground and lapped.

NOTE: LIGHTLY grind valve seats for a few seconds only to avoid excessive valve seat width.

1. Grind intake valve seat using a 30° seat grinder and exhaust valve seat using a 45° seat grinder. Follow tool manufacturers instructions.



2. Measure valve seat width after grinding.
3. If seat is too wide after grinding, grind lower seat surface using a 70° seat grinder until seat width is close to specifications.
4. Grind upper seat surface using a 15° seat grinder until seat width is narrowed to specifications.
5. If valve seats are ground, measure valve recession and check contact pattern between the seat and valve with bluing dye.
6. Lap valves.

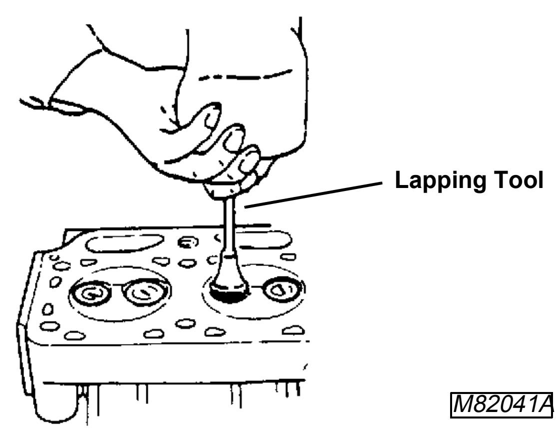


If valve recession exceeds maximum specifications or seats cannot be reconditioned, replace valves, and/or cylinder head.

LAP VALVES

NOTE: Use a rubber type lapping tool.

If seat does not make proper contact, lap the valve into the seat:



1. Apply small amount of fine lapping compound to face of valve.
2. Turn valve to lap valve to seat.

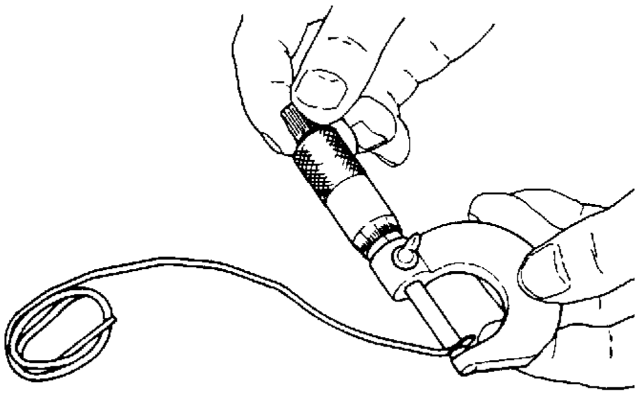
3. Lift valve from seat every 8 to 10 strokes. Lap until a uniform ring appears around the surface of the valve face.
4. Wash all parts in solvent to remove lapping compound. Dry parts.
5. Check position of lap mark on valve face. Lap mark must be on or near center of valve face.

MEASURE PISTON-TO-CYLINDER HEAD CLEARANCE

IMPORTANT: Use ONLY soft lead, solder or tin wire to perform this procedure. Use of Steel, Aluminum, Copper, or other hard wires could result in inaccurate reading and damage to pistons and/or head.

1. Place three 10 mm (0.400 in.) long pieces of 1.50 mm (0.060 in.) diameter soft wire in three positions on the flat part of the piston head.
2. Install cylinder head and old gasket. Install cylinder head capscrews and tighten in proper sequence to specified torque. (See *CYLINDER HEAD AND VALVES—Removal/Installation* in this group.)
3. Slowly turn crankshaft one complete revolution.
4. Remove cylinder head and gasket.
5. Measure thickness of flattened section of each piece of wire. Calculate average thickness of wires to obtain piston-to-cylinder head clearance of **0.61—0.73 mm (0.024—0.028 in.)**.

If clearance is less than specifications, replace cylinder head.

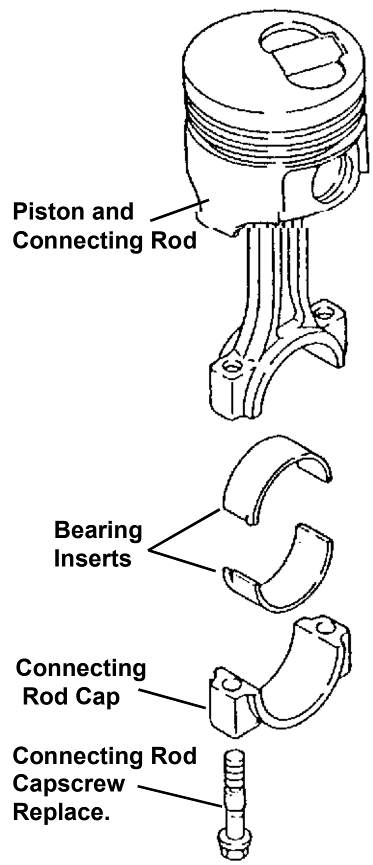


M82042A

PISTON AND CONNECTING ROD REMOVAL

1. Remove oil pan and strainer tube. (See OIL PAN AND STRAINER REMOVAL/INSTALLATION on page 77.)
2. Remove cylinder head. (See REMOVAL on page 51.)
3. Check top of cylinder bore for ridges. These ridges can cause damage to piston if not removed.
4. If necessary, remove ridge from top of cylinder bore using a ridge reamer.
5. Measure connecting rod side play.
6. Measure connecting rod bearing clearance.

IMPORTANT: Keep connecting rods and caps together. Rods and caps are a matched set. Note alignment marks on each part.



M82273A

7. Remove two capscrews, connecting rod cap and bearing inserts.

IMPORTANT: Pistons and cylinders are matched. Pistons must be installed in the cylinders from which they are removed.

8. Note connecting rod alignment mark in relation to the cylinders. Starting at flywheel end with cylinder number one, then two, etc.
9. Push piston and connecting rod out of cylinder bore using a wooden dowel.

10. Disassemble and inspect all parts for wear or damage. (See PISTON AND CONNECTING ROD INSPECTION/REPLACEMENT on page 61.)

PISTON AND CONNECTING ROD INSTALLATION

- Apply clean engine oil on all parts during installation.
- Never reuse connecting rod capscrews, replace with new.

IMPORTANT: Pistons must be installed in cylinders from which they were removed and in the same direction. Be careful not to damage crankshaft rod journal while installing piston.

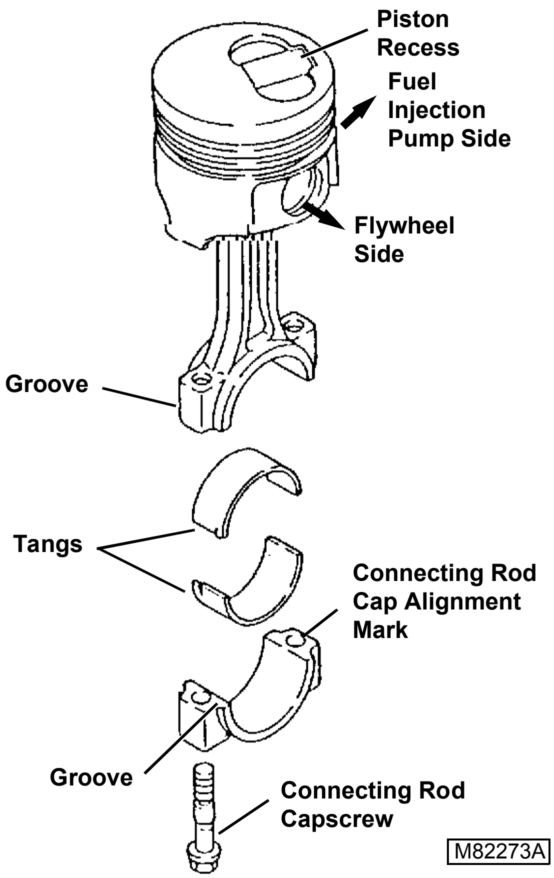
1. Assemble piston and connecting rod.
2. Install piston and connecting rod into the cylinder from which it was removed, with piston recess on top of piston toward fuel injection pump.

IMPORTANT: Do not touch bearing insert surfaces. Oil and acid from your finger will corrode the bearing surface.

3. Install bearing inserts on connecting rod and rod cap, aligning tangs with grooves.

IMPORTANT: Connecting rod caps must be installed on the same connecting rods they were removed from.

4. Match the connecting rods to caps using alignment marks.
5. ***If new bearing inserts are being installed*** perform rod bearing oil clearance check.
6. Install caps on matching connecting rods.
7. Dip entire connecting rod capscrews in clean engine oil. Install new capscrews and tighten to **23 N•m (203 lb-in.)**.
8. If a new piston and connecting rod were installed, carefully stamp a number corresponding to the cylinder number on the connecting rod cap and connecting rod.

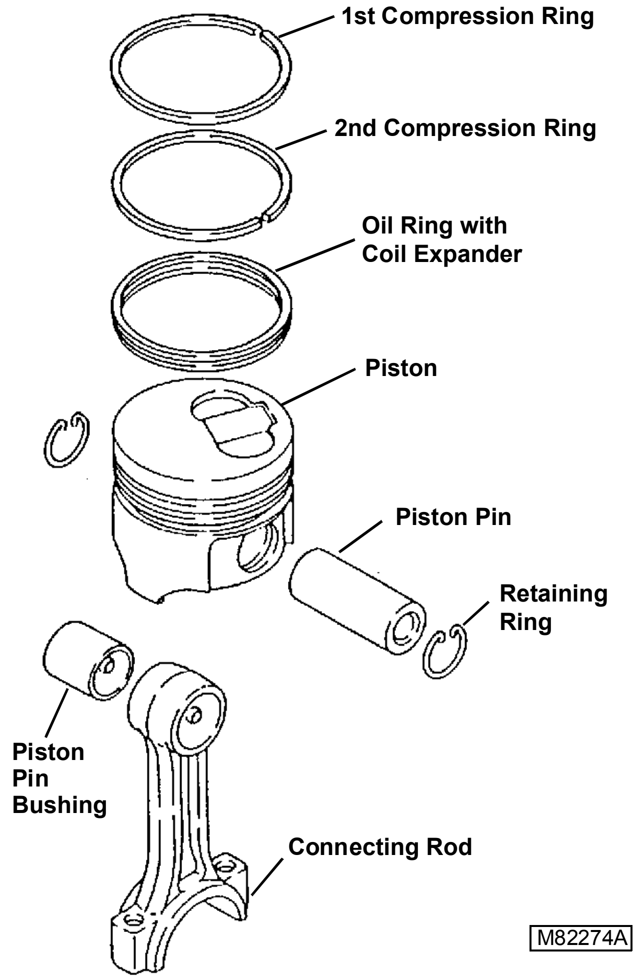


9. Install cylinder head. (See INSTALLATION on page 52.)
10. Install oil pan and strainer tube. (See OIL PAN AND STRAINER REMOVAL/INSTALLATION on page 77.)

PISTON AND CONNECTING ROD DISASSEMBLY

IMPORTANT: Pistons must be installed on the same connecting rod they were removed from.

1. Put a mark on each piston and connecting rod to aid in assembly.



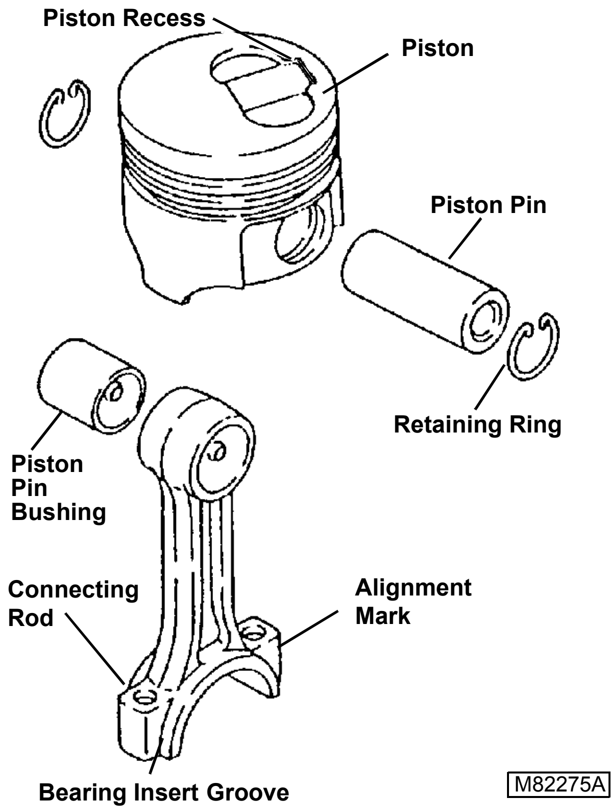
2. Remove piston rings, starting with the first compression ring, by gently spreading them open just enough to clear the outside diameter of the piston. This can be done by hand or with a ring expander.
3. Remove piston pin retaining rings.
4. Remove piston pin. Excessive pressure should not be necessary to remove piston pin.
5. Inspect all parts for wear or damage. Replace as necessary. (See PISTON AND CONNECTING ROD INSPECTION/REPLACEMENT on page 61.)

- Piston pin bushing is press fit in connecting rod. Remove bushing only if replacement is necessary.

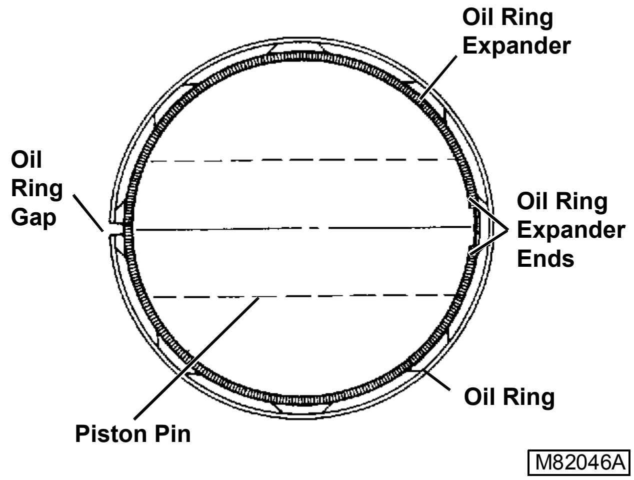
PISTON AND CONNECTING ROD ASSEMBLY

• Apply clean engine oil to all parts during assembly.

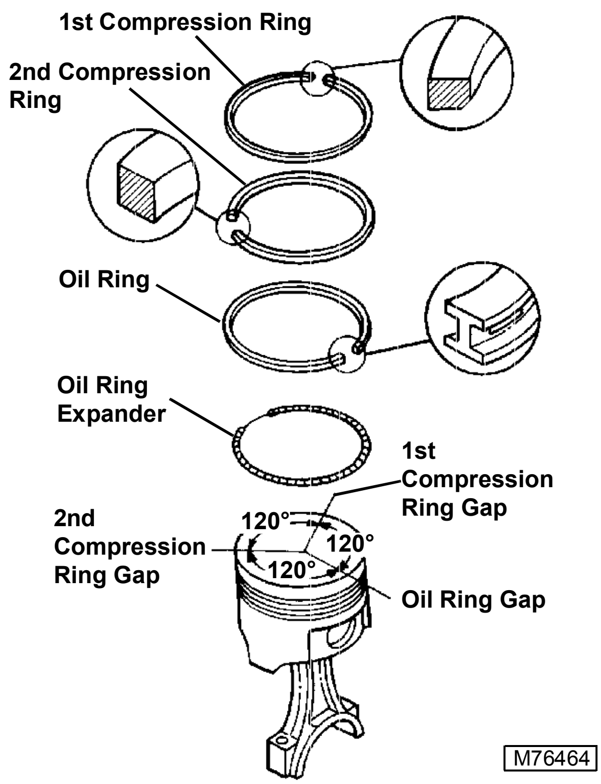
IMPORTANT: Pistons must be installed on the same connecting rod they were removed from.



1. Assemble piston to connecting rod with piston recess on same side as connecting rod "punched" alignment marks. If a new connecting rod is used, assemble piston to connecting rod with piston recess opposite connecting rod bearing insert groove.
2. Install piston pin and retaining rings.



3. Install oil ring expander in bottom ring groove of piston with expander ends above either end of piston pin.
4. Install oil ring over expander with ring gap opposite (180°) of expander ends.



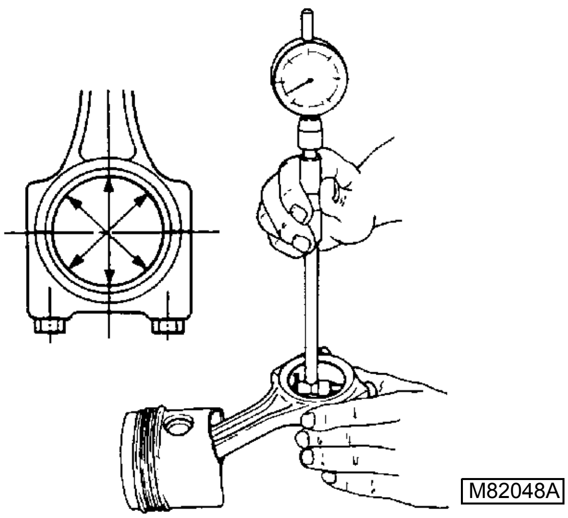
5. Install second compression ring in middle groove. Turn ring until gap is 120° away from oil ring gap.
6. Install first compression ring in top groove, with beveled corner toward the bottom of the piston. Turn ring until gap is 120° away from second ring gap.

PISTON AND CONNECTING ROD INSPECTION/REPLACEMENT

1. Inspect all parts for wear or damage. Replace as necessary.

Connecting Rod Bearing

2. Measure crankshaft connecting rod journal diameter.
3. Note the measurement for calculation of bearing clearance.



4. Install connecting rod cap and bearing inserts on connecting rod. Install old connecting rod capscrews and tighten to **23 N•m (203 lb-in.)**.
5. Measure connecting rod bearing diameter.
6. Subtract rod journal diameter from rod bearing diameter to get clearance.

Connecting Rod Bearing I.D.:

Standard . . . . 39.00—39.02 mm (1.535—1.536 in.)
Clearance . . . . 0.03—0.06 mm (0.001—0.002 in.)

If bearing diameter exceeds wear limit, replace bearing inserts.

If bearing clearance (bearing I.D. minus crankshaft journal O.D.) exceeds specification, grind crankshaft connecting rod journals and install undersized bearing inserts, or replace bearing inserts and crankshaft.

Piston Ring Groove

7. With rings installed on piston, measure piston ring groove clearance. Measure several places around each piston.

Piston Ring Groove Clearance:

First Compression Ring

Standard . . . . 0.06—0.10 mm (0.002—0.004 in.)
Wear Limit. . . . . 0.20 mm (0.008 in.)

Second Compression Ring

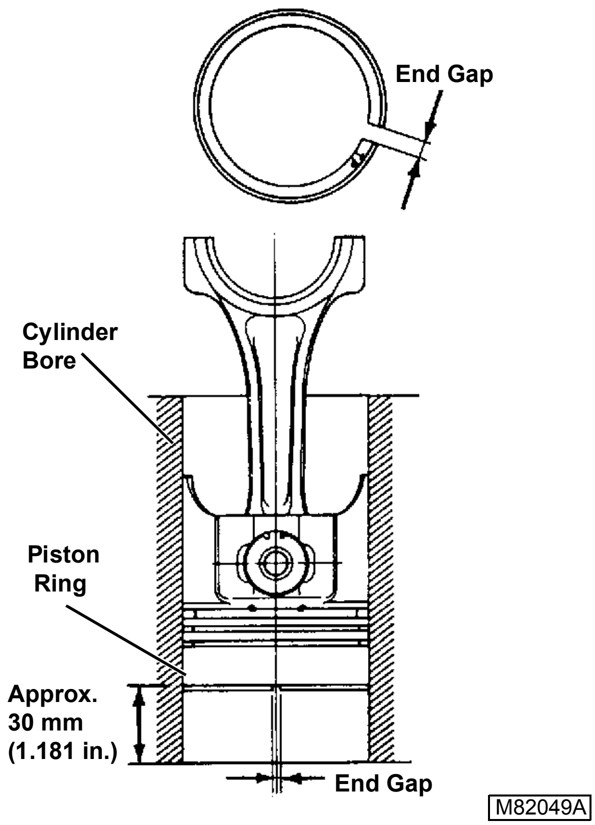
Standard . . . . 0.09—0.12 mm (0.003—0.005 in.)
Wear Limit. . . . . 0.20 mm (0.008 in.)

Oil Ring

Standard . . . . 0.02—0.05 mm (0.001—0.002 in.)
Wear Limit. . . . . 0.20 mm (0.008 in.)

If clearance exceeds wear limit, replace rings or piston.

Piston Ring End Gap



8. Measure piston ring end gap. Push ring into cylinder bore, using a piston, until ring is approximately **30 mm (1.181 in.)** from bottom of cylinder bore.

Piston Ring End Gap:

Standard

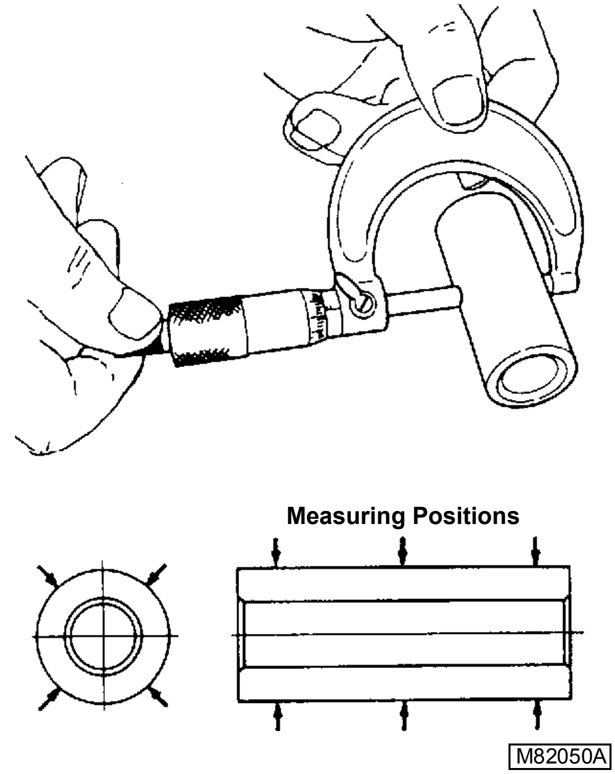
First Compression Ring . . . . 0.100—0.250 mm (0.003—0.009 in.)

Second Compression Ring and Oil Ring . . . . 0.15—0.35 mm (0.006—0.013 in.)

Wear Limit. . . . . 1.50 mm (0.059 in.)

If end gap exceeds wear limit, replace rings.

Piston Pin Diameter



9. Measure piston pin diameter. Measure diameter at six places.

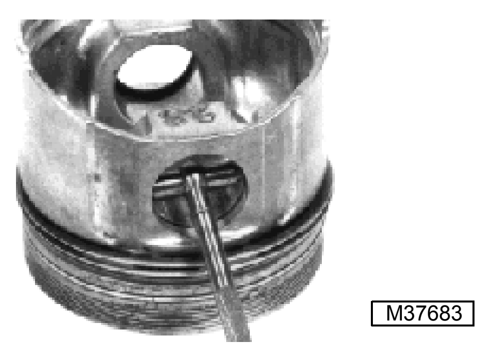
Piston Pin O.D.:

Standard . . . . 19.99—20.00 mm (0.787—0.788 in.)

Wear Limit. . . . . 19.90 mm (0.783 in.)

If pin diameter is less than wear limit, replace pin.

Piston Pin Bore Diameter



10. Measure piston pin bore diameter in piston.

Piston Pin Bore I.D.:

Standard . . . . 20.00—20.01 mm

(0.788—0.789 in.)

Wear Limit. . . . . 20.02 mm (0.789 in.)

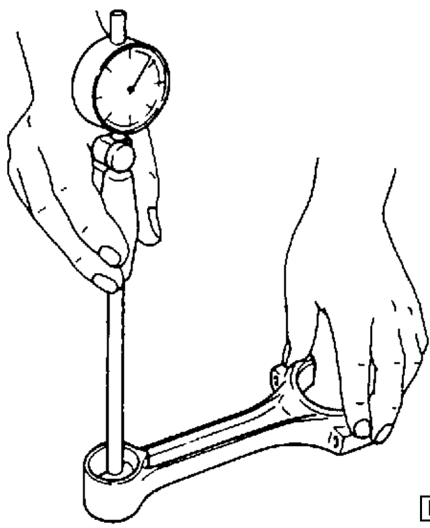
Clearance . . . . 0.02 mm (0.001 in.)

If piston pin bore exceeds wear limit, replace piston.

If bore clearance (bore I.D. minus pin O.D.) exceeds specification, replace piston, piston pin or both.

Piston Pin Bushing Diameter

11. Measure piston pin bushing diameter in connecting rod.



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Piston Pin Bushing I.D.:

Standard . . . . 20.00—20.04 mm (0.788—0.789 in.)

Clearance . . . . 0.17 mm (0.006 in.)

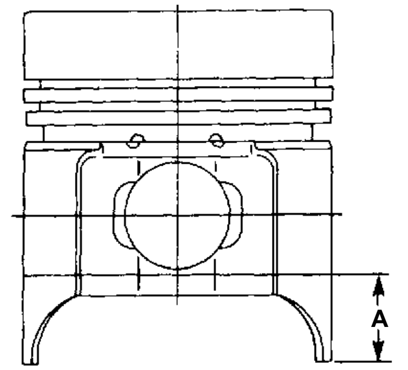
If bushing diameter exceeds specification, replace bushing.

If bushing clearance (bushing I.D. minus pin O.D.) exceeds specification, replace bushing, piston pin or both.

Piston pin bushing is press fit. Replace bushing using a driver set. **When installing bushing, make sure to align oil hole in bushing with hole in connecting rod.**

Piston Diameter

NOTE: If engine has had a previous major overhaul, oversize pistons and rings may have been installed. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.



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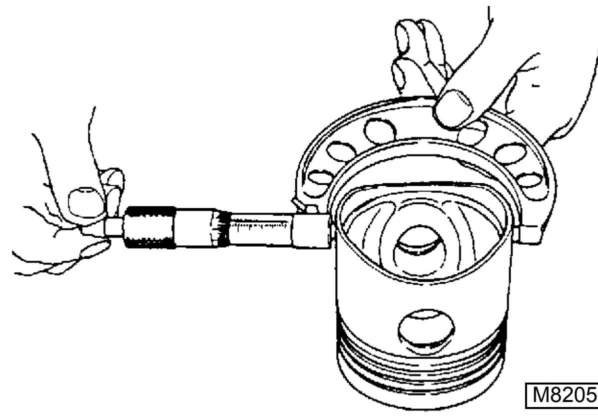


M82052A

12. Measure piston diameter perpendicular to piston pin bore at distance A.

Piston O.D.:

Distance A. 24 mm (0.945 in.)

Standard Size Piston

Standard . . . . 67.940—67.970 mm (2.6748—2.6760 in.)

Wear Limit. . . . . 67.90 mm (2.673 in.)

0.25 mm (0.010 in.) Oversize Piston

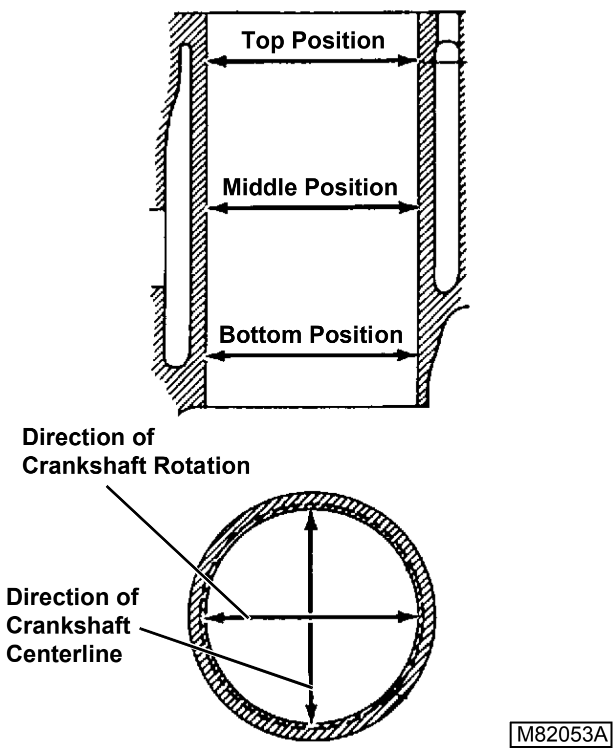
Standard . . . . 68.190—68.220 mm (2.685—2.686 in.)

If piston diameter is less than wear limit, install a new piston.

CYLINDER BORE INSPECTION

Measure cylinder bore diameter at three positions; top, middle and bottom. At these three positions, measure in both directions; along crankshaft center line and direction of crankshaft rotation.

NOTE: If engine has had a previous major overhaul, oversize pistons and rings may have been installed. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.



Cylinder Bore I.D.:

Standard Size Bore

Standard . . . . 68.00—68.03 mm (2.677—2.678 in.)
Wear Limit . . . . 68.20 mm (2.685 in.)
Clearance (min.) . . . . 0.060 mm (0.0024 in.)

0.25 mm (0.010 in.) Oversize Bore

Standard . . . . 68.25—68.28 mm (2.688—2.688 in.)
Wear Limit. . . . . 68.45 mm (2.695 in.)
Clearance (min.) . . . . 0.060 mm (0.0024 in.)

If cylinder bore exceeds wear limit, replace cylinder block or have cylinder rebored. (See CYLINDER REBORING on page 65.)

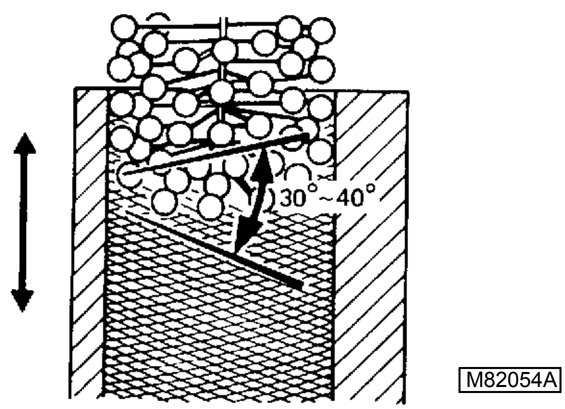
If cylinder is rebored, oversize pistons and rings must be installed. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.

If clearance (cylinder bore I.D. minus piston O.D.) is less than specification, replace cylinder block, piston or both; or rebore cylinder and install oversize piston and rings.

CYLINDER BORE DEGLAZING

IMPORTANT: If cylinder bores are to be deglazed with crankshaft installed in engine, put clean shop towels over crankshaft to protect journal and bearing surfaces from any abrasives.

1. Deglaze cylinder bores using a flex-hone with 180 grit stones.



2. Use flex-hone as instructed by manufacturer to obtain a **30—40°cross-hatch pattern** as shown.

IMPORTANT: Do not use gasoline, kerosene or commercial solvents to clean cylinder bores. Solvents will not remove all abrasives from cylinder walls.

3. Remove excess abrasive residue from cylinder walls using a clean dry rag. Clean cylinder walls using clean white rags and warm soapy water. Continue to clean cylinder until white rags show no discoloration.

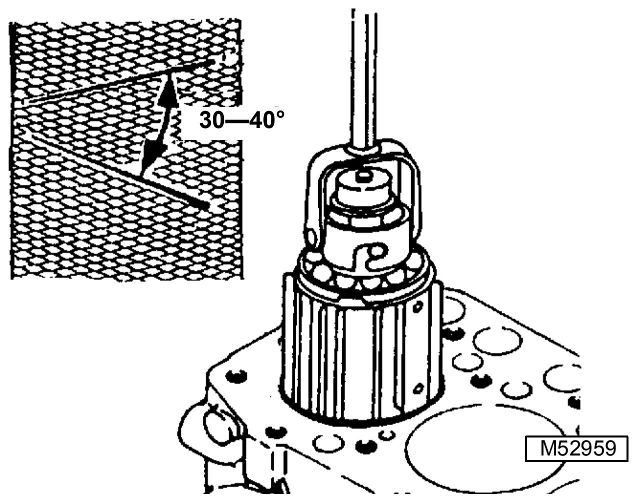
CYLINDER REBORING

NOTE: The cylinder block can be rebored to use oversize pistons and rings. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.

1. Align center of bore to drill press center.

IMPORTANT: Check stone for wear or damage. Use a rigid hone with 300 grit stones.

2. Adjust hone so lower end is even with lower end of cylinder bore.
3. Adjust rigid hone stones until they contact narrowest point of cylinder.
4. Coat cylinder with honing oil. Hone should turn by hand. Adjust if too tight.



5. Run drill press at about 250 RPM. Move hone up and down in order to obtain a **30—40°crosshatch pattern.**

NOTE: Measure bore when cylinder is cool.

6. Stop press and check cylinder diameter.

NOTE: Finish should not be smooth. It should have a 30—40^{o} crosshatch pattern.

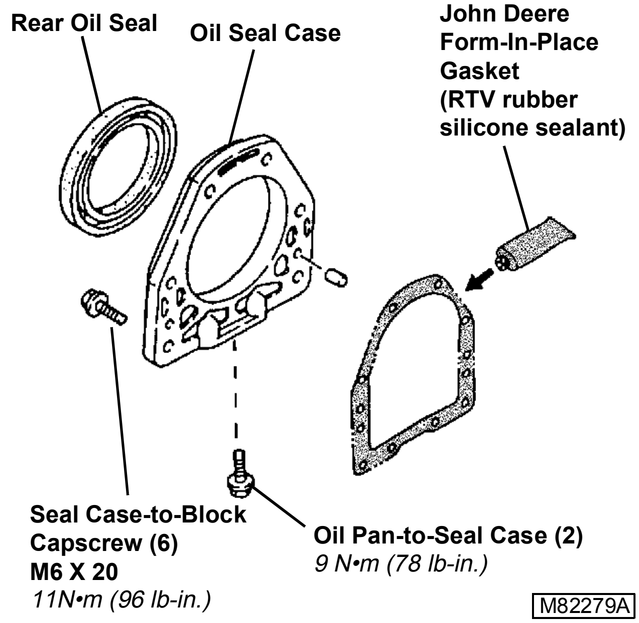
7. Remove rigid hone when cylinder is within 0.03 mm (0.001 in.) of desired size.
8. Use a flex hone with 180 grit stones for honing to final size.
9. Check bore for size, taper and out-of-round.

IMPORTANT: Do not use solvents to clean cylinder bore. Solvents will not remove all metal particles and abrasives produced during honing.

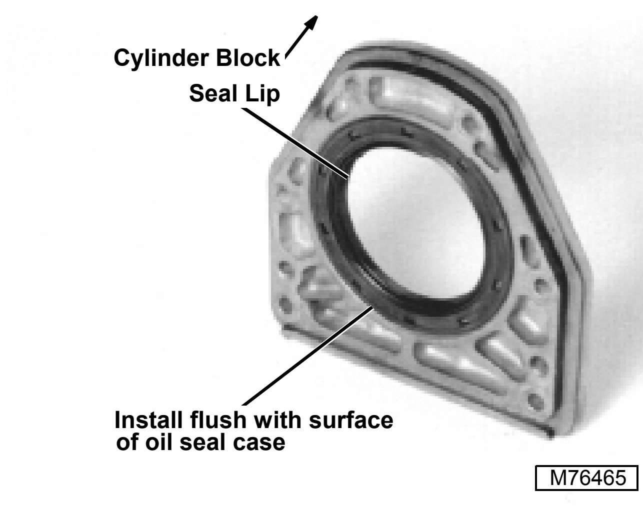
10. Clean cylinder thoroughly using warm soapy water until clean white rags show no discoloration.
11. Dry cylinder and apply engine oil.

CRANKSHAFT REAR OIL SEAL REPLACEMENT

1. Remove flywheel. (See FLYWHEEL REMOVAL & INSPECTION on page 69.)



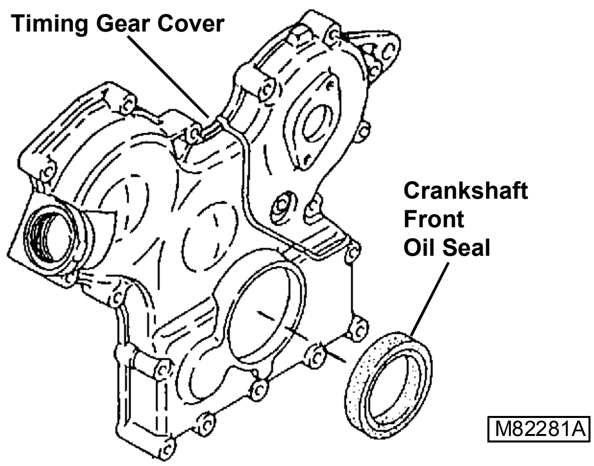
2. Remove oil seal case from engine block.
3. Remove oil seal using a driver set.



4. Install seal, with lip toward cylinder block. Install seal flush with surface of oil seal case.
5. Apply RTV Silicone Sealant to the seal case and install on cylinder block. Be sure not to damage seal when installing over crankshaft seal surface. Torque case-to-block capscrews to **11 N•m (96 lb-in.).** Torque oil pan-to-case capscrews to **9 N•m (78 lb-in.).**
6. Install flywheel.

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

1. Remove timing gear cover. (See TIMING GEAR COVER REMOVAL/INSTALLATION on page 74.)



2. Replace oil seal using a driver set.
3. Install seal with lip toward inside of gear housing cover. Install seal flush with outside surface of cover.
4. Install timing gear cover.

CRANKSHAFT REMOVAL

1. Check crankshaft end play. (See CRANKSHAFT END PLAY CHECK on page 25.)
2. Remove oil pan and strainer. (See OIL PAN AND STRAINER REMOVAL/INSTALLATION on page 77.)
3. Remove rear oil seal. (See CRANKSHAFT REAR OIL SEAL REPLACEMENT on page 65.)
4. Remove timing gear housing. (See TIMING GEAR COVER REMOVAL/INSTALLATION on page 74.)
5. Check crankshaft bearing clearance. (See CRANKSHAFT MAIN BEARING CLEARANCE CHECK on page 25.)

IMPORTANT: Connecting rod end caps must be installed on the same connecting rods from which they were removed. Note alignment marks on caps and rods.

6. Remove connecting rod capscrews and end caps.
7. Push pistons and connecting rods away from crankshaft.

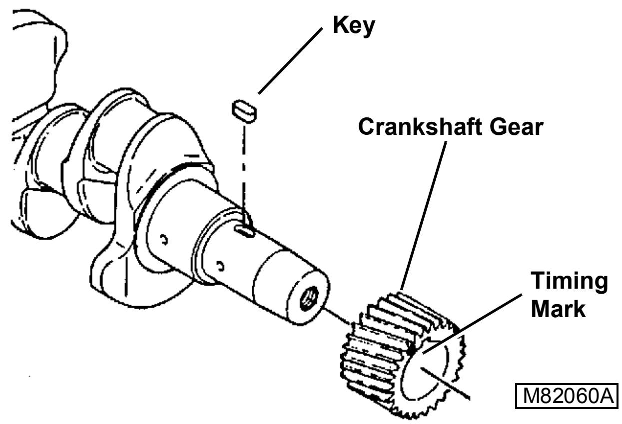
IMPORTANT: Main bearing caps must be installed on the same main bearings from which they were removed.

8. Remove main bearing capscrews, caps and cap thrust bearings.
9. Remove crankshaft.
10. Remove block thrust bearings and main bearing inserts.
11. Inspect all parts for wear or damage. (See CRANKSHAFT AND MAIN BEARINGS INSPECTION/REPLACEMENT on page 68.)

CRANKSHAFT GEAR REPLACEMENT

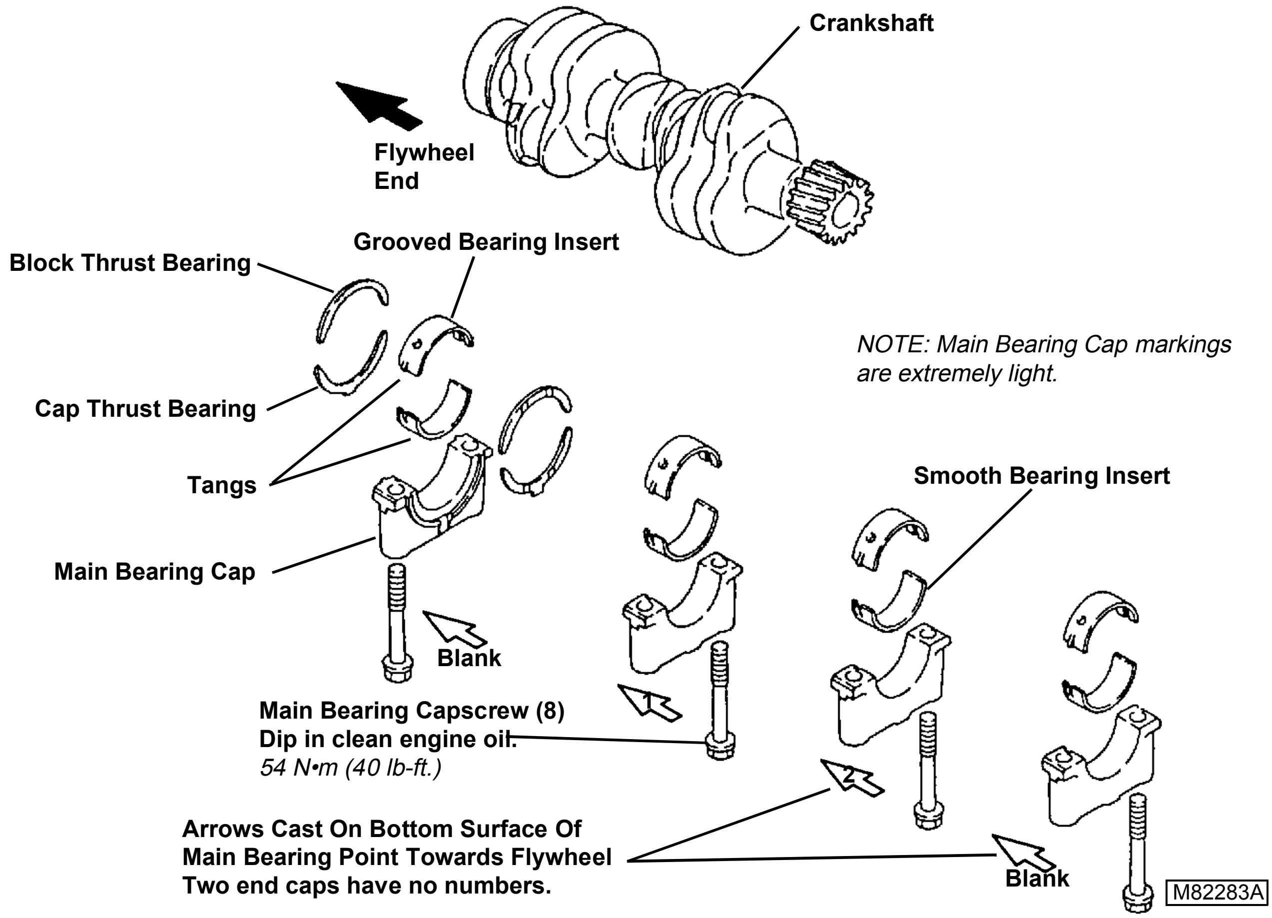
NOTE: Inspect crankshaft gear for chipped or broken teeth. Replace if necessary.

1. Remove gear from crankshaft using a knife-edge puller and a press.



2. Heat gear to approximately 150°C (300°F). Install gear with timing mark “A” facing away from crank. Align slot in gear with key in shaft. Press crankshaft into gear until gear is tight against crankshaft shoulder.
3. Inspect crankshaft for bend using V-blocks and a dial indicator. Turn crankshaft slowly and read variation on indicator. If variation is greater than **0.02 mm (0.001 in.)**, replace crankshaft.

CRANKSHAFT AND MAIN BEARINGS INSTALLATION



NOTE: Liberally apply clean engine oil on all parts during installation.

IMPORTANT: Do not touch bearing insert surfaces. Oil and acid from your finger will corrode the bearing surface.

1. Install grooved bearing inserts in crankshaft bearing bores, aligning tangs with slots in bores.
2. Install block thrust bearings with oil grooves facing away from engine block.

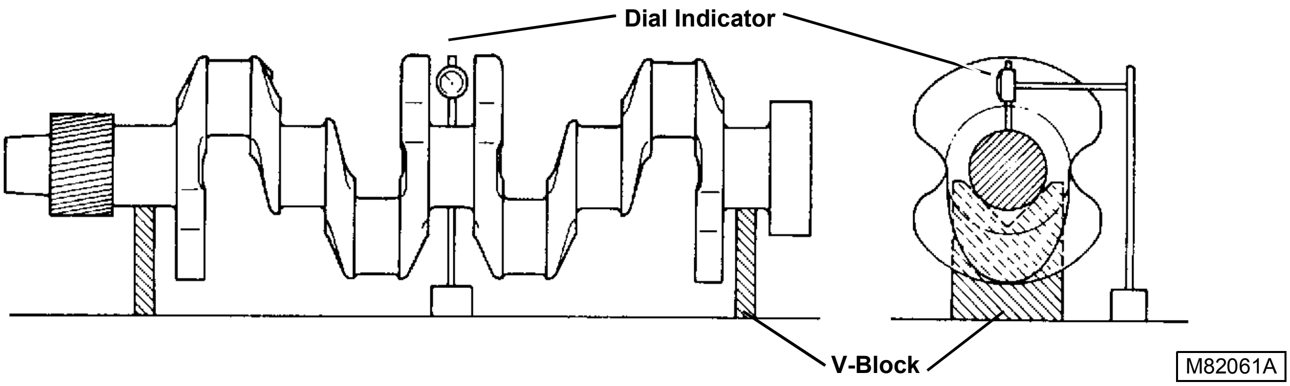
NOTE: Main bearing caps have “raised arrows” that indicate direction of installation. Arrows should point towards flywheel. Thrust bearing cap is at flywheel end and holds thrust bearings. The two end main bearing caps have no marks on the arrows.

3. Install smooth bearing inserts in main bearing caps, aligning tangs with slots in caps.
4. Install cap thrust bearings, with oil grooves facing away from cap, in the number thrust bearing cap.
5. Install main bearing caps in their original locations with arrows pointing toward flywheel side of engine.

IMPORTANT: DO NOT use high speed power tools or air wrenches to tighten main bearing capscrews.

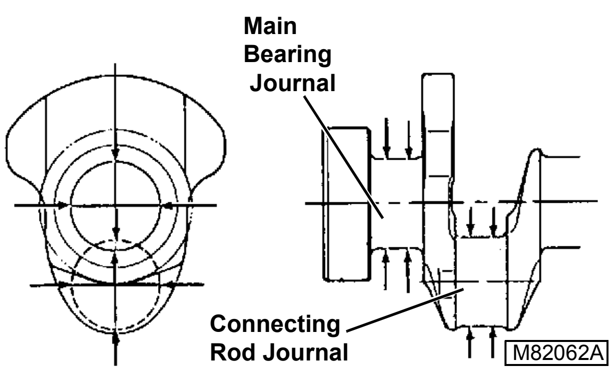
6. Dip entire main bearing capscrews in clean engine oil. Install capscrews and tighten. DO NOT tighten to specifications at this time.
7. Using a **soft-faced** hammer, tap the front end of the crankshaft then the rear end of the crankshaft to align the thrust bearings.
8. Tighten main bearing capscrews to specifications. When tightening, start at center main bearing cap and work your way out, alternating to the ends. Turn crankshaft by hand. If it does not turn easily, disassemble the parts and find the cause.
9. Install timing gear housing. (See TIMING GEAR HOUSING REMOVAL/INSTALLATION on page 76.)
10. Install rear oil seal. (See CRANKSHAFT REAR OIL SEAL REPLACEMENT on page 65.)
11. Install oil pan and strainer. (See OIL PAN AND STRAINER REMOVAL/INSTALLATION on page 77.)

CRANKSHAFT AND MAIN BEARINGS INSPECTION/REPLACEMENT



1. Inspect crankshaft gear for chipped or broken teeth. Replace if necessary. (See CRANKSHAFT GEAR REPLACEMENT on page 66.)
2. Measure crankshaft connecting rod journal and main bearing journal diameters. Measure several places around each journal.

NOTE: If engine has had a previous major overhaul, journals may have been ground and undersized bearing inserts installed.



Connecting Rod Journal O.D.:

Standard . . . . 35.97—35.98 mm (1.416—1.417 in.)

Wear Limit. . . . . 35.91 mm (1.414 in.)

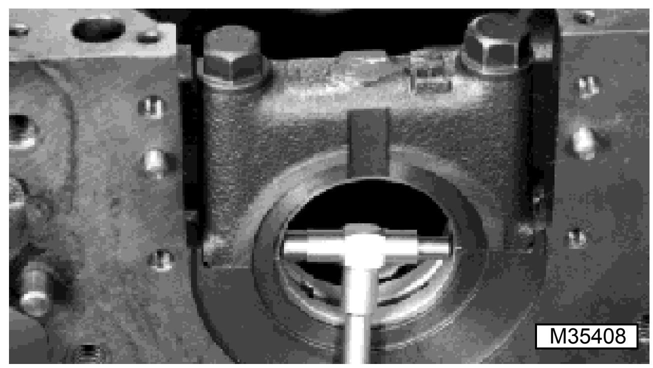
Main Bearing Journal O.D.:

Standard . . . . 39.97—39.98 mm (1.573—1.574 in.)

Wear Limit. . . . . 39.90 mm (1.571 in.)

If journal diameter is less than wear limit, replace crankshaft or have journals ground undersize by a qualified machine shop.

If journals are ground, undersize bearing inserts must be installed. Bearing inserts are available in 0.25 mm (0.010 in.) undersize.



3. Install bearing inserts and main bearing cap on main bearing. Tighten main bearing capscrews to **54 N•m (40 lb-ft.)**.
4. Measure main bearing inner diameter.

Main Bearing I.D.:

Standard . . . . 40.00—40.04 mm (1.575—1.577 in.)

Wear Limit. . . . . 40.07 mm (1.578 in.)

Clearance . . . . 0.15 mm (0.006 in.)

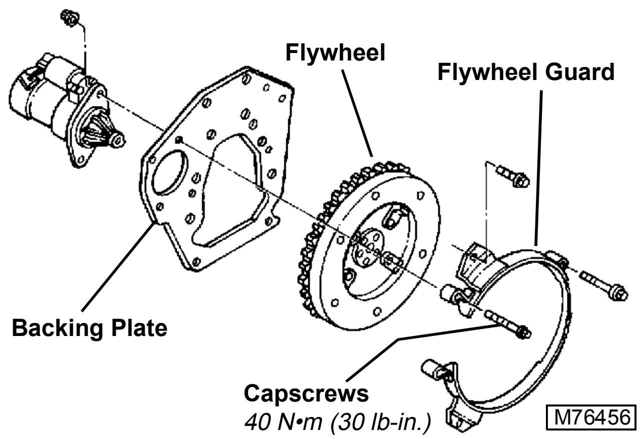
If bearing diameter exceeds wear limit, replace bearing inserts.

If bearing clearance (bearing I.D. minus crankshaft main bearing journal O.D.) exceeds specification, replace bearing inserts and crankshaft or have crankshaft journals ground undersize by a qualified machine shop and install undersized bearing inserts.

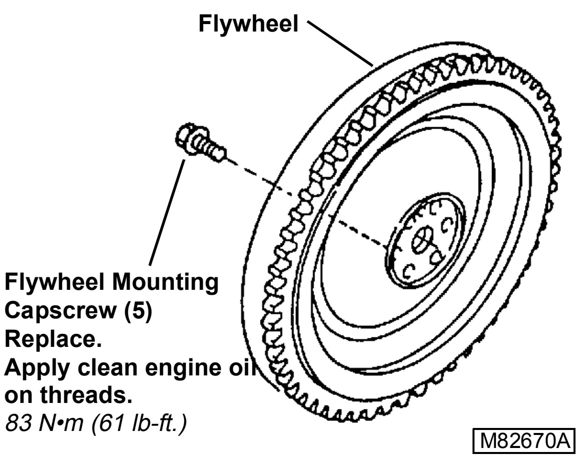
5. Clean and inspect oil passages in main bearing journals, connecting rod journals and main bearing bores in cylinder block.
6. Inspect crankshaft for cracks or damage. Replace if necessary. (See CRANKSHAFT REMOVAL on page 66.)

FLYWHEEL REMOVAL & INSPECTION

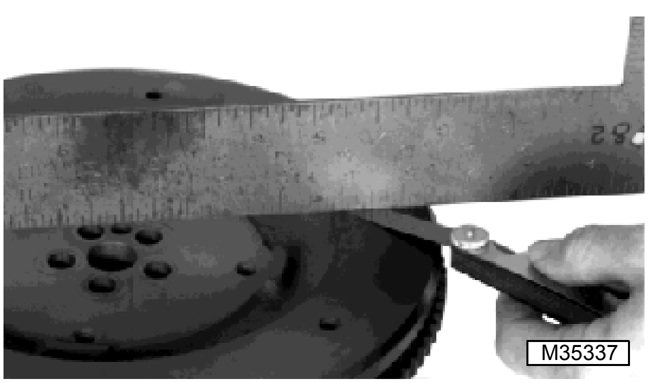
1. Remove starter. (See Starter Removal in Electrical Section.)



2. Remove flywheel guard mounting capscrews.



3. Remove five mounting capscrews and flywheel.



IMPORTANT: Flywheel surface must be absolutely clean and free off all paint, corrosion or dirt before measuring.

4. Measure flywheel flatness. Place a straight edge across flywheel surface opposite of ring gear. Measure clearance between straight edge and flywheel surface with a feeler gauge. If clearance exceeds **0.12 mm (0.005 in.)**, replace flywheel.

IMPORTANT: Never reuse flywheel mounting capscrews. Always install new.

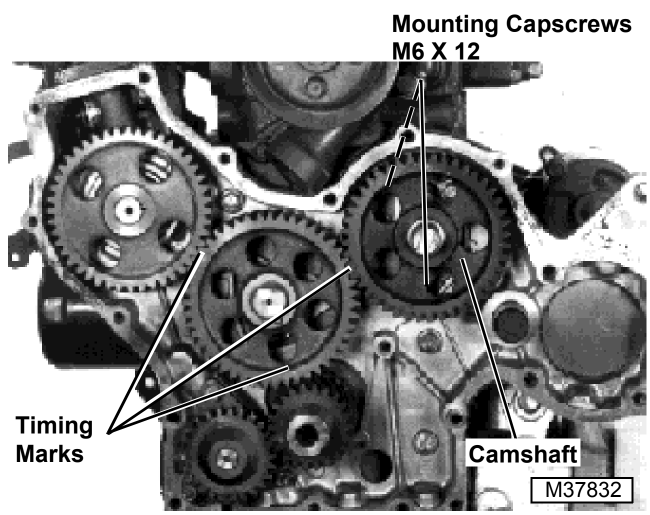
5. Flywheel is installed in reverse of removal.

CAMSHAFT REMOVAL

1. Remove rocker arm assembly and push rods. (See ROCKER ARM ASSEMBLY on page 49.)
2. Remove timing gear cover. (See TIMING GEAR COVER REMOVAL/INSTALLATION on page 74.)
3. Check camshaft end play.(See CAMSHAFT END PLAY CHECK on page 26.)
4. Check backlash of timing gears.(See TIMING GEAR BACKLASH CHECK on page 27.)

NOTE: If a magnetic follower holder kit is not available, turn engine until oil pan is upward, to hold cam followers away from camshaft.

5. Hold cam followers away from camshaft using a magnetic follower holder kit such as D15001NU.



NOTE: Due to the odd number of teeth on the idler gear, timing marks will only align periodically.

6. Rotate crankshaft and align timing marks.

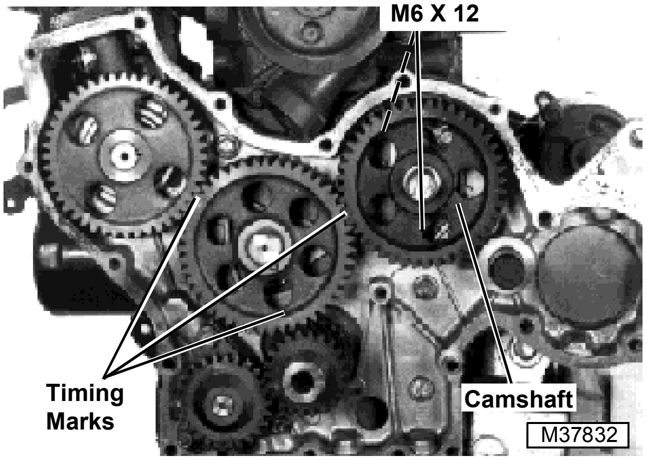
IMPORTANT: DO NOT allow camshaft lobes to hit bearing surfaces while removing camshaft. Machined surfaces can be damaged.

7. Remove two capscrews and camshaft.
8. Inspect all parts for wear or damage. (See CAMSHAFT INSPECTION/REPLACEMENT on page 70.)

CAMSHAFT INSTALLATION

1. Apply clean engine oil on all parts during installation.

IMPORTANT: DO NOT allow camshaft lobes to hit bearing surfaces while installing camshaft. Machined surfaces can be damaged.



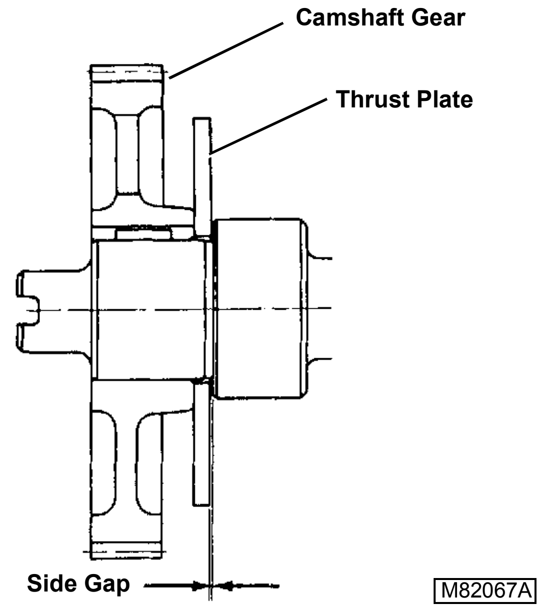
2. Rotate crankshaft to align timing marks.

NOTE: If a magnetic follower holder kit is not available, turn engine until oil pan is upward, to hold cam followers away from camshaft.

3. Install cam followers and hold away from camshaft using a magnetic follower holder kit such as D15001NU.
4. Install camshaft.
5. Install and tighten mounting capscrews to **11 N•m (96 lb-in.).**
6. Install timing gear cover. (See TIMING GEAR HOUSING REMOVAL/INSTALLATION on page 76.)
7. Install push rods and rocker arm assembly. (See ROCKER ARM ASSEMBLY on page 49.)

CAMSHAFT INSPECTION/ REPLACEMENT

1. Check camshaft side gap using a feeler gauge.



If side gap is not within **0.05—0.25 mm (0.002—0.010 in.)**, remove gear and replace thrust plate.

2. Inspect gear for chipped or broken teeth. Replace if necessary.

To remove/replace gear:

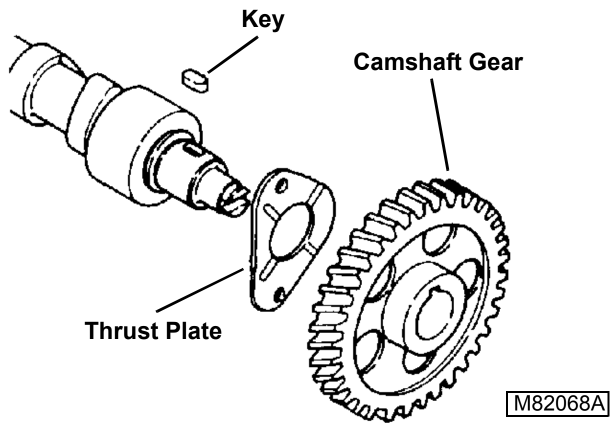
3. Remove gear from camshaft using a knife-edge puller and a press.

⚠ CAUTION

DO NOT heat oil over 182° C (360° F). Oil fumes or oil can ignite above 193° C (380° F). Use a thermometer. 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

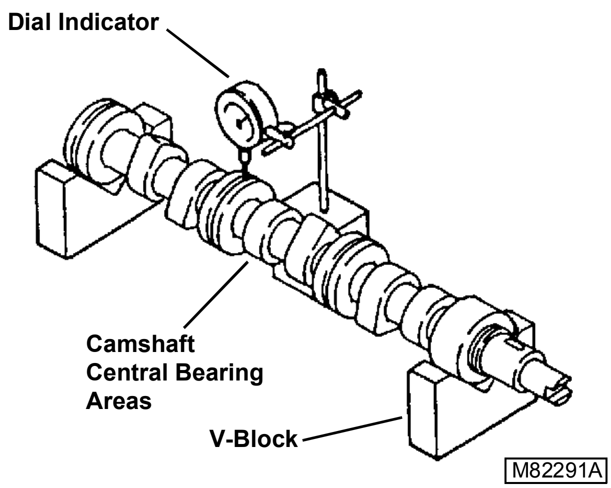
4. Heat gear to approximately 150°C (300°F).

IMPORTANT: Be sure thrust plate is not between camshaft gear and camshaft shoulder while installing gear.

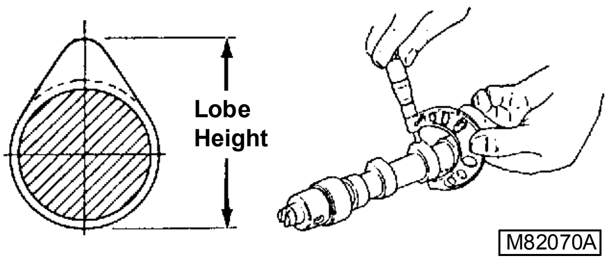


5. Install thrust plate if removed.
6. Install gear with timing mark “C” side toward press table.
7. Align slot in gear with key in shaft.
8. Press camshaft into gear until gear is tight against camshaft shoulder.

IMPORTANT: Thrust plate must spin freely on camshaft.



9. Inspect camshaft for bend using Vblocks and a dial indicator.
10. Turn camshaft slowly and read variation on indicator. If variation is greater than **0.02 mm (0.001 in.)**, replace camshaft.



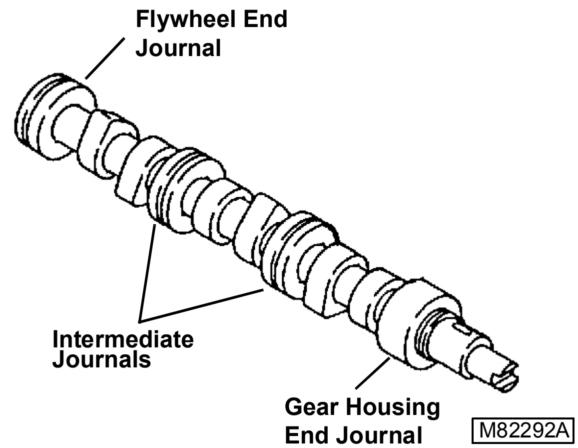
11. Measure camshaft lobe height.

Lobe Height:

Standard . . . . 29.97—30.03 mm (1.180—1.185 in.)

Wear Limit. . . . . 29.75 mm (1.171 in.)

If lobe height is less than wear limit, replace camshaft.



12. Measure camshaft end and intermediate journal diameters.

Camshaft Journal O.D.:

Gear Housing and Flywheel Ends

Standard . . . . 35.94—35.96 mm (1.415—1.416 in.)

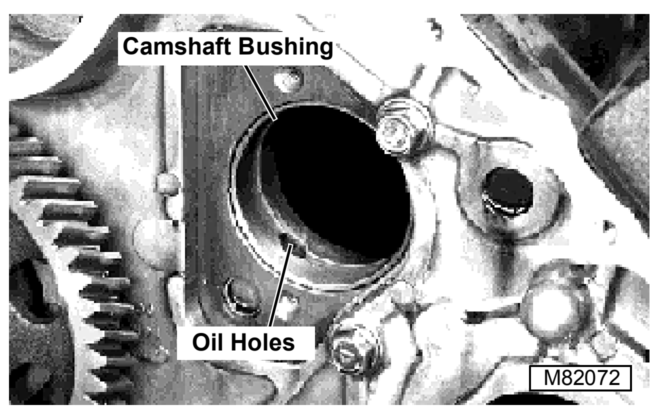
Wear Limit. . . . . 35.85 mm (1.411 in.)

Intermediate Journals

Standard . . . . 35.91—35.94 mm (1.414—1.415 in.)

Wear Limit. . . . . 35.85 mm (1.411 in.)

13. If journal diameters are less than wear limit, replace camshaft.



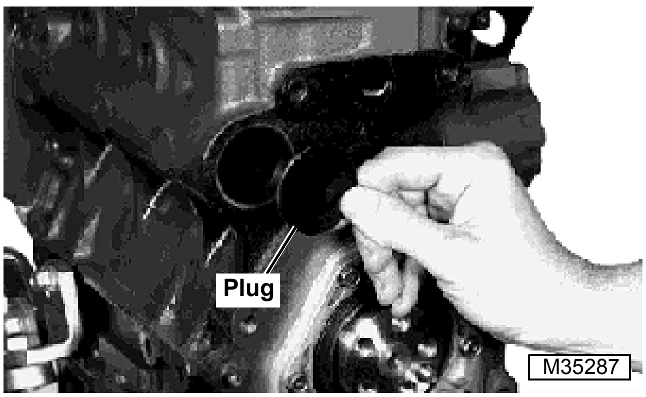
14. Measure camshaft bushing diameter at gear housing end.

IMPORTANT: Camshaft bearing journals must be measured and found to be within specifications before camshaft bushings can be determined serviceable or unserviceable.

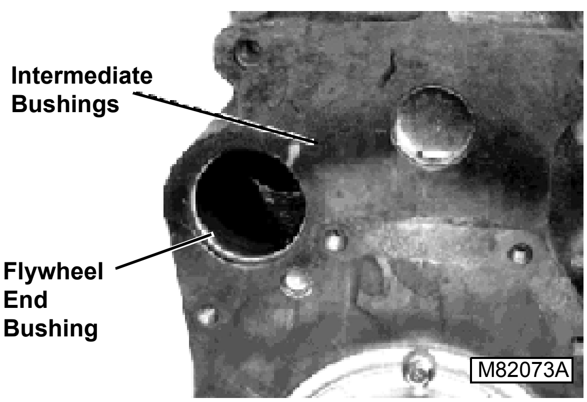
Camshaft Bushing I.D.:

Clearance . . . . 0.09 mm (0.004 in.)

15. If bushing clearance (bushing I.D. minus camshaft journal O.D.) exceeds clearance specification, replace bushings.
16. Measure intermediate and flywheel end camshaft bushing diameters using the following procedures:
17. Remove flywheel. (See FLYWHEEL REMOVAL & INSPECTION on page 69.)



18. Remove plug using a long wooden dowel. Insert wooden dowel through gear housing side.



19. Measure bushing I.D. with telescoping gauge and micrometer.

Camshaft Bushing I.D.:

Intermediate Bushings

Clearance . . . . 0.12 mm (0.005 in.)

Flywheel End Bushing

Clearance . . . . 0.09 mm (0.004 in.)

20. If bushing clearance (bushing I.D. minus camshaft journal O.D.) exceeds specification, replace bushings.
21. Apply John Deere Form-In Place Gasket, or an equivalent, on outer edge of plug. Install plug until it bottoms in bore.
22. Install flywheel. (See FLYWHEEL REMOVAL & INSPECTION on page 69.)

To replace bushings:

NOTE: Be careful not to push bushing inside of engine or damage cylinder block.

1. Remove bushing using a chisel.
2. Align oil holes in new bushing and cylinder block.
3. Install bushing using a driver set.

CAM FOLLOWERS REMOVAL/ INSTALLATION

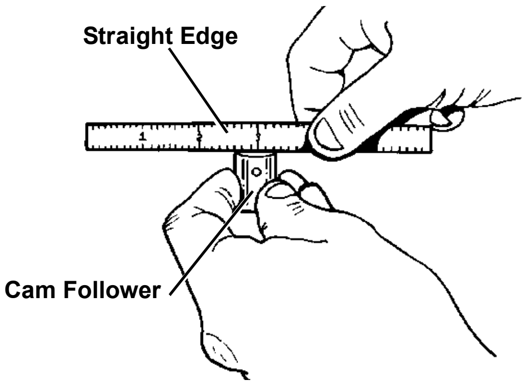
1. Remove cylinder head. (See CYLINDER HEAD REMOVAL/INSTALLATION on page 51.)

IMPORTANT: Cam followers must be installed in the same bores from which they were removed.

2. Put a mark on each cam follower and cylinder block bore to aid in installation.
3. Remove cam followers.
4. Inspect all parts for wear or damage. (See CAM FOLLOWERS INSPECTION on page 73.)
5. Apply clean engine oil on all parts during installation.
6. Install cam followers in cylinder head in the same bore they were removed from with the flat contact surface toward the camshaft.
7. Install cylinder head. (See CYLINDER HEAD REMOVAL/INSTALLATION on page 51.)
8. Install rocker arm assembly. (See ROCKER ARM ASSEMBLY on page 49.)

CAM FOLLOWERS INSPECTION

1. Inspect cam follower contact surface for abnormal wear. Replace if necessary.



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2. Use a straight edge and place it on the contact surface perpendicular to the wear mark across cam follower. Replace if surface appears to “valley” on wear mark.

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3. Measure cam follower diameter.

Cam Follower O.D.:

Standard . . . . . . 17.95—17.97 mm (0.707—0.708 in.)
Wear Limit. . . . . 17.93 mm (0.706 in.)
If diameter is less than wear limit, replace cam follower.

- Measure cam follower bore diameter in cylinder block.

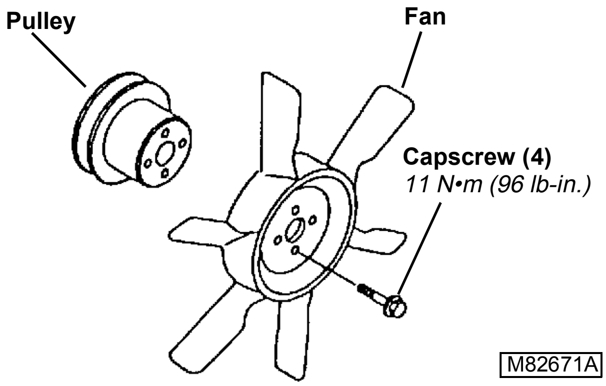
Cam Follower Bore I.D.:

Standard . . . . . . 18.00—18.02 mm (0.708—0.709 in.)
Wear Limit. . . . . 18.05 mm (0.711 in.)
Clearance . . . . . 0.032—0.068 mm (0.001—0.003 in.)
If cam follower bore diameter exceeds wear limit, replace cylinder block.

If bore clearance (bore I.D. minus follower stem O.D.) exceeds specification, replace cam follower, cylinder block or both.

TIMING GEAR COVER REMOVAL/ INSTALLATION

1. Remove alternator and fan belt.



2. Remove fan and pulley.
3. Remove crankshaft pulley capscrew and washer.
4. Remove crankshaft pulley using a two-jaw puller kit.

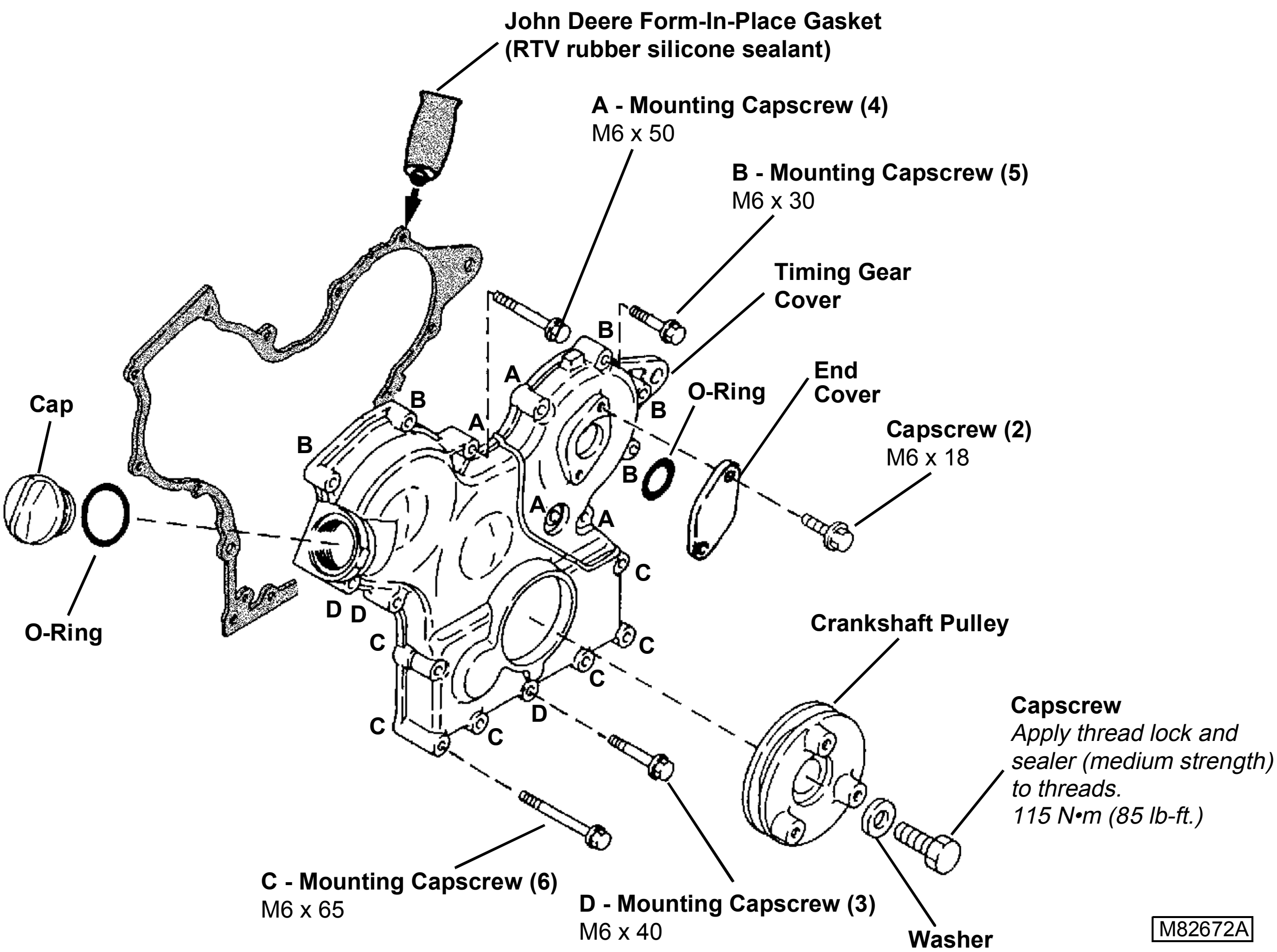
NOTE: *It is not necessary to remove end cover and o-ring to remove timing gear cover.*

5. Remove 18 mounting capscrews and timing gear cover.

IMPORTANT: Use extreme care in removal of cover. Cover is aluminum and easily damaged, broken or bent by prying. DO NOT hammer on cover at any time.

Installation is done in the reverse order of removal.

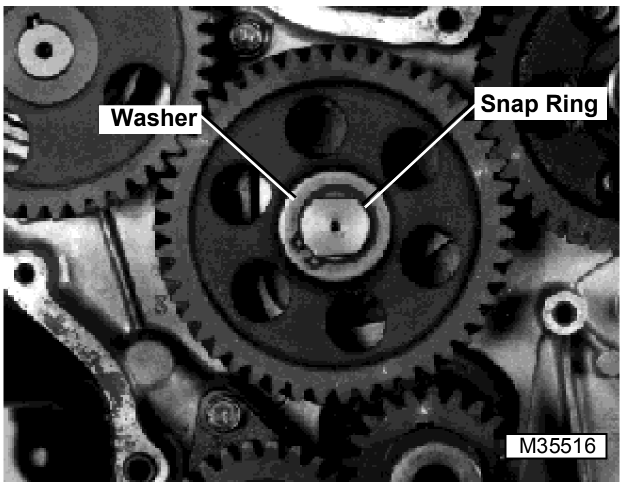
6. Tighten all mounting capscrews to **9 N•m (78 lb-in.)**
7. Adjust fan/alternator drive belt tension. (See FAN/ ALTERNATOR DRIVE BELT ADJUSTMENT on page 31.)



IDLER GEAR REMOVAL/ INSTALLATION

1. Remove timing gear cover. (See TIMING GEAR COVER REMOVAL/INSTALLATION on page 74.)
2. Check backlash of timing gears. (See TIMING GEAR BACKLASH CHECK on page 27.)

NOTE: Due to the odd number of teeth on the idler gear, timing marks will only align periodically. When all timing marks on gears are aligned, the piston closest to the water pump is at TDC on compression stroke. Number one cylinder is closest to the flywheel.

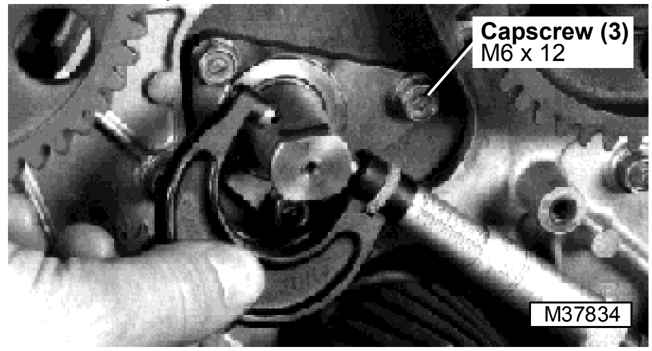


3. Rotate crankshaft and align timing marks.
4. Remove snap ring, washer and gear.
5. Inspect all parts for wear or damage. (See IDLER GEAR INSPECTION/REPLACEMENT on page 75.)

Installation is the reverse order of removal.

IDLER GEAR INSPECTION/ REPLACEMENT

1. Inspect gear for chipped or broken teeth. Replace if necessary.



2. Measure idler gear shaft diameter.

Idler Gear Shaft O.D.:

Standard . . . . 19.96—19.98 mm (0.786—0.787 in.)
Wear Limit. . . . . 19.93 mm (0.785 in.)

3. If shaft diameter is less than wear limit, remove three capscrews and replace idler gear shaft.

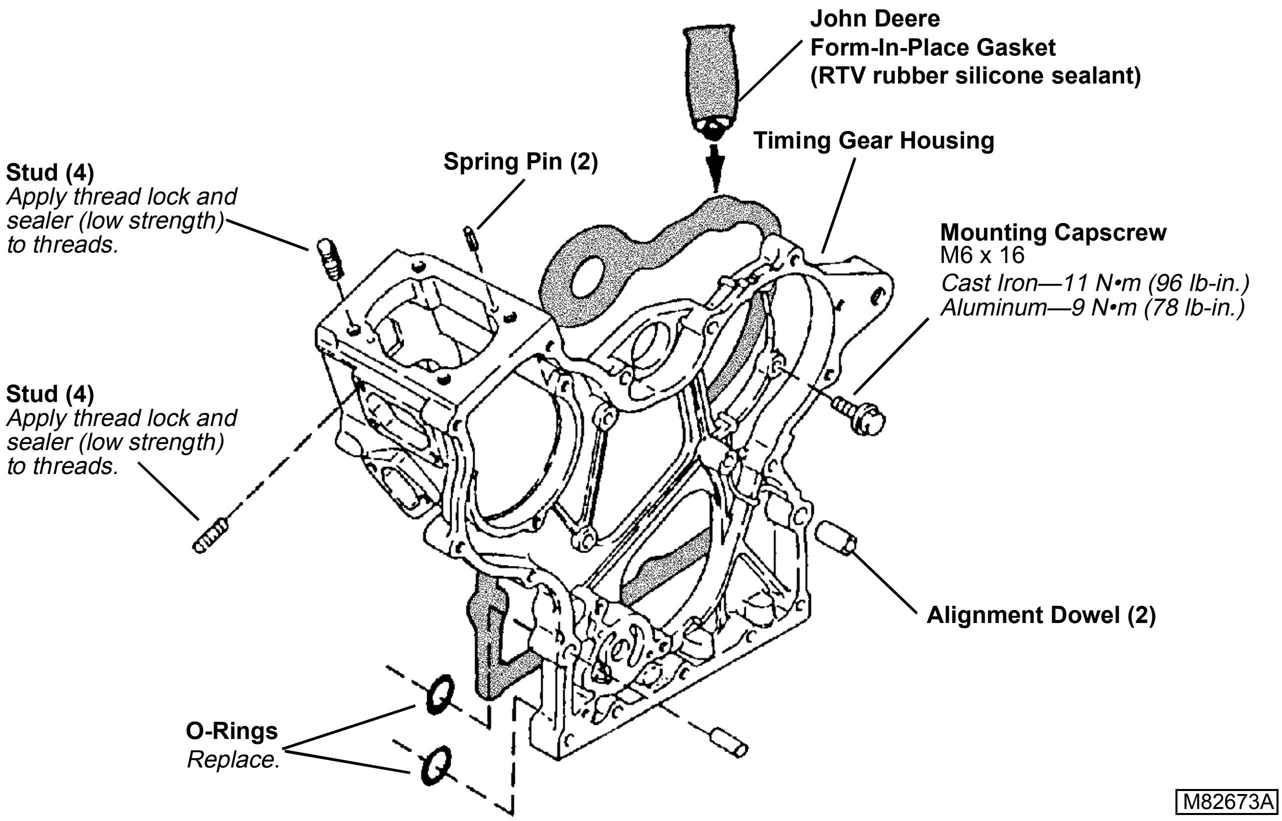
4. Measure idler gear bushing diameter.

Idler Gear Bushing I.D.:

Standard . . . . 20.00—20.12 mm (0.787—0.792 in.)
Clearance . . . . .0.02—0.12 (0.001—0.005 in.)

5. If bushing diameter is not within specifications, replace bushing.
6. Replace bushing if needed using a driver set. Align oil holes in bushing and idler gear. Install bushing flush with surface of idler gear.
7. If bushing clearance (bushing I.D. minus shaft O.D.) exceeds specification, replace bushing, shaft or both.

TIMING GEAR HOUSING REMOVAL/ INSTALLATION



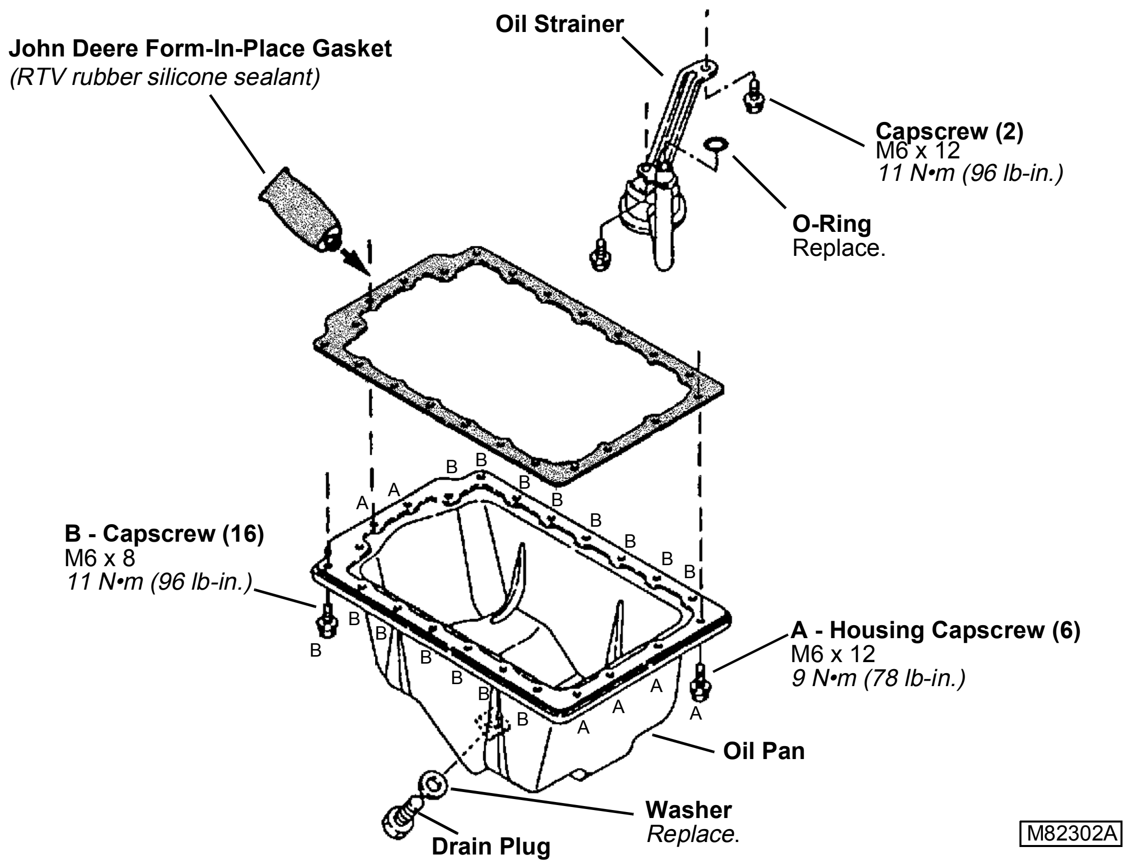
1. Remove the following:

- Water pump. (See WATER PUMP REMOVAL/ INSTALLATION on page 80.)
- Timing gear cover. (See TIMING GEAR COVER REMOVAL/INSTALLATION on page 74.)
- Idler gear. (See IDLER GEAR REMOVAL/ INSTALLATION on page 75.)
- Injection pump camshaft. (See FUEL INJECTION PUMP CAMSHAFT REMOVAL on page 84.)
- Engine camshaft. (See CAMSHAFT REMOVAL on page 69.)
- Oil pump. (See OIL PUMP REMOVAL/ INSTALLATION on page 78.)
- Timing gear housing mounting capscrews and housing.

Installation is done in the reverse order of removal.

- Replace all O-rings.

OIL PAN AND STRAINER REMOVAL/INSTALLATION



NOTE: Approximate crankcase oil capacity is 2.4 L (2.5 qt).

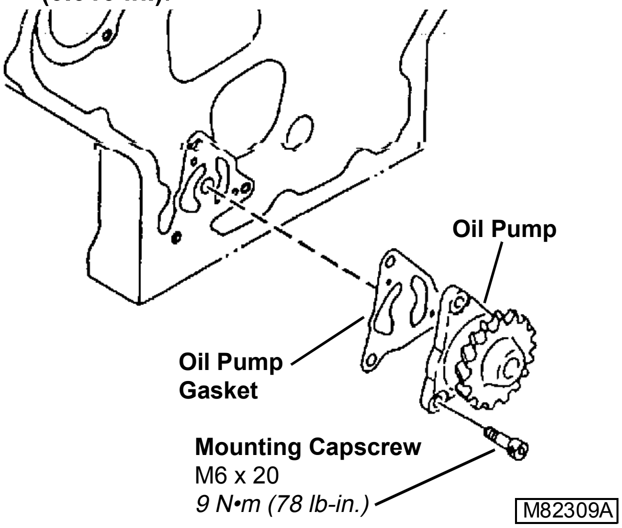
1. Drain engine oil in suitable container.
2. Remove all oil pan mounting capscrews.

IMPORTANT: DO NOT use a screwdriver to pry oil pan from engine block. Oil pan or engine block may be damaged.

3. Carefully tap on oil pan with a soft-faced mallet to loosen oil pan from engine block.
4. Remove oil strainer mounting bolts.
5. Remove oil strainer and discard O-ring. Replace O-ring before installation.
6. Install oil strainer to engine block. Torque capscrews to **11 N•m (96 lb-in.).**
7. Apply RTV silicone sealant to oil pan sealing surface.
8. Place oil pan on engine block and install mounting capscrews in the proper locations. Capscrews are not all same length (refer to illustration). Torque capscrews to specifications shown in illustration.
9. Fill engine with proper engine oil.

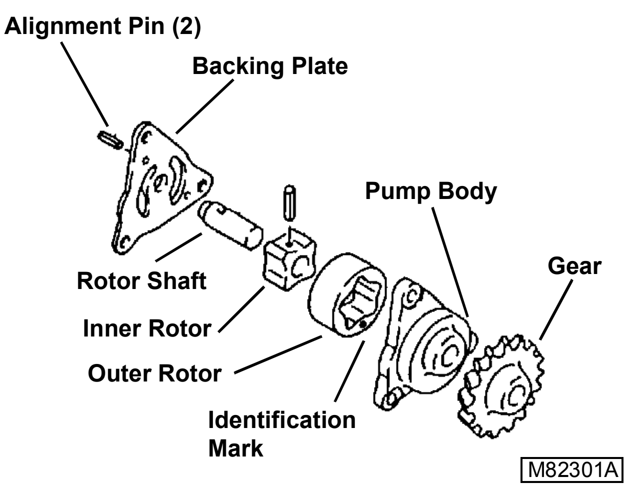
OIL PUMP REMOVAL/ INSTALLATION

1. Remove timing gear cover. (See TIMING GEAR COVER REMOVAL/INSTALLATION on page 74.)
2. Check oil pump gear backlash. Replace entire oil pump assembly if backlash is more than **0.25 mm (0.010 in.)**.



3. Remove four mounting capscrews, oil pump and gasket.
4. If oil pump is to be reused, disassemble and inspect all parts for wear or damage. (See OIL PUMP DISASSEMBLY/ASSEMBLY on page 78.)

OIL PUMP DISASSEMBLY/ ASSEMBLY



- Gear is press fit on rotor shaft. Remove gear using a knife edge puller and a press.
- Inspect parts for wear or damage. (See OIL PUMP INSPECTION on page 78.)
- Coat all parts with clean engine oil.
- Install outer rotor with identification mark facing toward rotor shaft assembly.

OIL PUMP INSPECTION

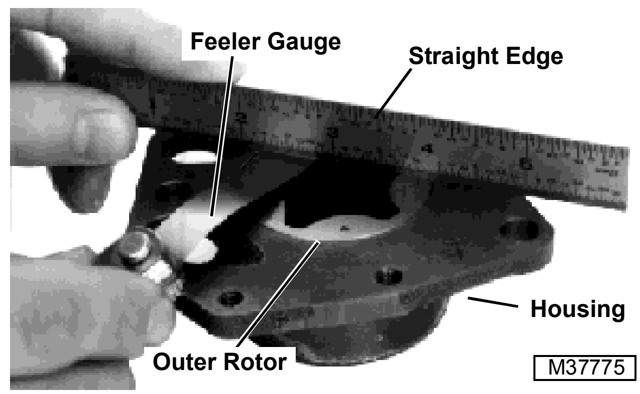
5. Check rotor shaft outer diameter and the shaft hole diameter in backing plate.
6. If clearance is more than wear limit, replace entire assembly.

Rotor Shaft and Plate Clearance:

Standard . . . . 0.013—0.043 mm (0.001—0.002 in.)

Wear Limit. . . . . 0.20 mm (0.008 in.)

- **Check rotor recess.**



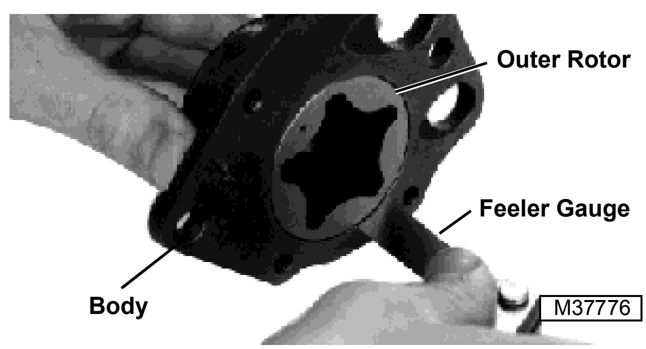
7. If rotors are below face of pump housing more than specifications, replace rotor assembly.

Rotor Recess Clearance:

Standard . . . . 0.03—0.09 mm (0.001—0.003 in.)

Wear Limit. . . . . 0.13 mm (0.0051 in.)

8. Check outer rotor-to-pump body clearance.

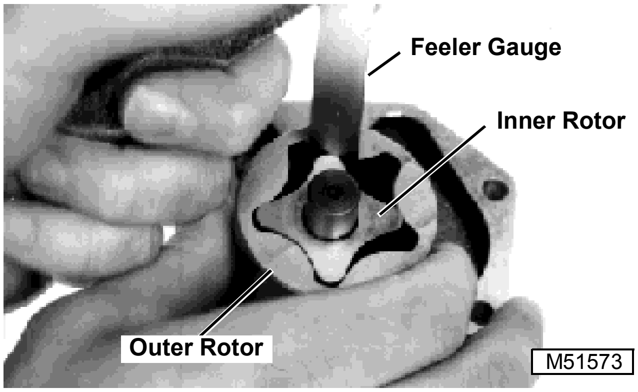


9. If clearance is more than wear limit, replace entire assembly.

Outer Rotor-to-Pump Body Clearance:

Standard . . . . 0.10—0.16 mm (0.0039—0.0063 in.)

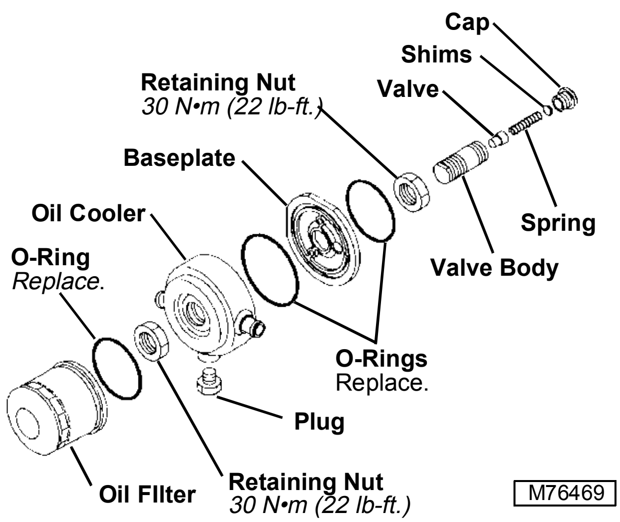
Wear Limit. . . . . 0.25 mm (0.0010 in.)



10. Check inner-to-outer rotor clearance.
11. If clearance is more than **0.15 mm (0.0059 in.)**, replace rotor assembly.

OIL PRESSURE REGULATING VALVE

Removal/Installation



1. Remove oil filter and o-ring.
2. Remove retaining nut, oil cooler and baseplate.
3. Remove retaining nut and valve assembly.
4. If adjusting pressure only, remove cap and add shims. Each 1 mm (0.039 in.) of shim thickness increases oil pressure 13.8 kPa (2 psi).

NOTE: Valve components are not serviced individually. Replace complete regulating valve if any components are defective.

5. Inspect all parts for wear or damage. Replace complete valve if necessary.
6. Check spring free and compressed lengths.

Spring Specifications:

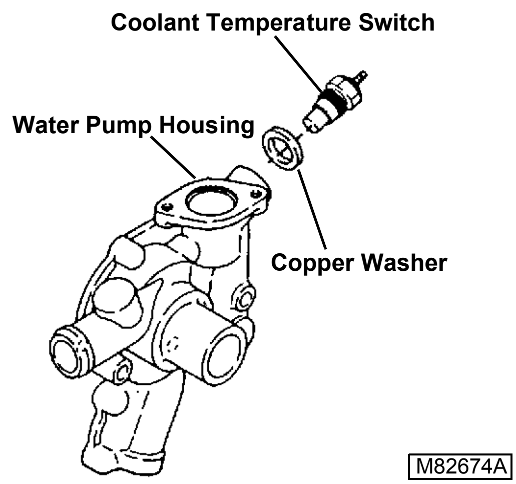
Free Length. . . . . 21.90—24.50 mm (0.860—0.960 in.)
Compressed Length . . . . 14.70 mm (0.580 in.) @12 N (2.7 lb-force)

Installation is done in the reverse order of removal.

COOLANT TEMPERATURE SWITCH

Replacement

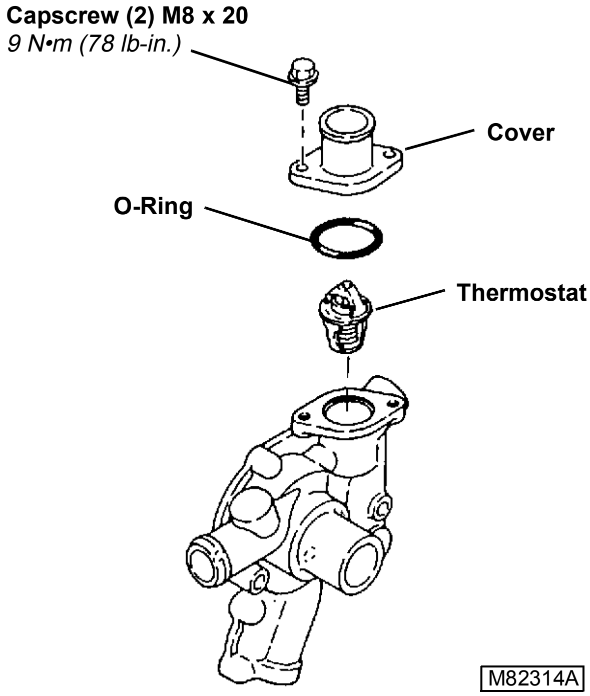
1. Open drain valve on radiator to drain coolant.



2. Remove switch and copper washer.
3. Test switch. (See COOLANT TEMPERATURE SWITCH TEST on page 30.)

Installation is done in reverse order of removal.

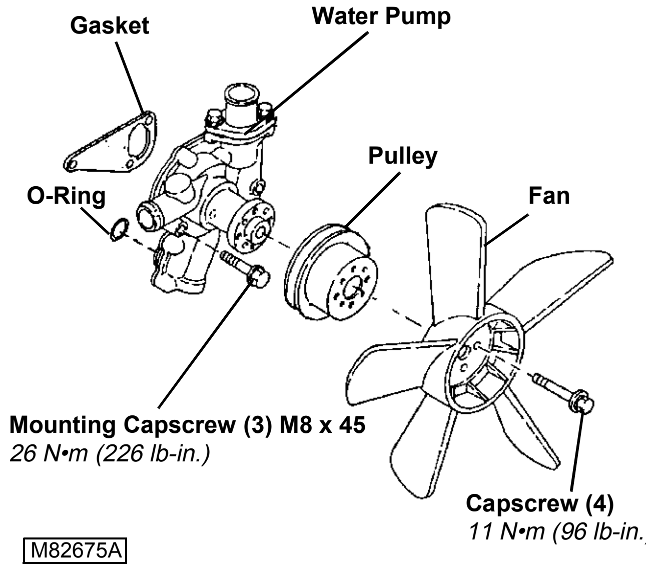
THERMOSTAT REMOVAL



1. Open drain valve on radiator to drain coolant.
2. Remove radiator hose from thermostat cover.
3. Remove capscrews from cover and remove cover and O-ring.
4. Remove thermostat from water pump.
5. If thermostat is to be reinstalled, test thermostat. (See THERMOSTAT OPENING TEST on page 29.)
6. Install thermostat in water pump with spring end inside water pump.
7. Place O-ring over thermostat and place cover over thermostat on water pump.
8. Install capscrews and torque to **9 N•m (78 lb-in.)**
9. Install radiator hose on thermostat cover and refill coolant system.

WATER PUMP REMOVAL/ INSTALLATION

1. Remove Radiator. (See RADIATOR REMOVAL/ INSTALLATION on page 47.)
2. Remove Hydraulic pump assembly.
3. Remove fan/alternator drive belt.
4. Remove fan and pulley.



5. Remove three mounting capscrews, pump and gasket.

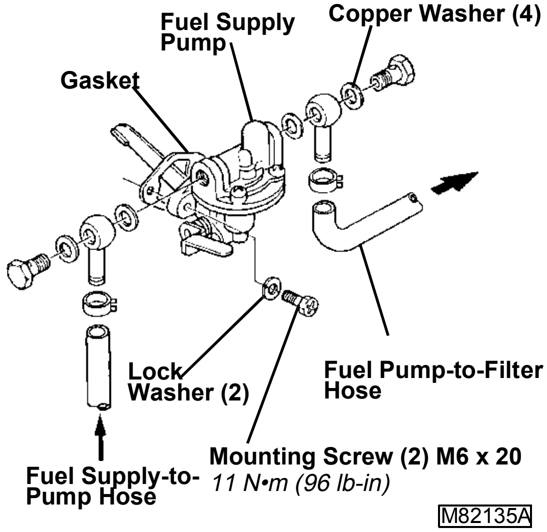
Installation is done in the reverse order of removal.

6. Adjust fan/alternator drive belt tension. (See FAN/ ALTERNATOR DRIVE BELT ADJUSTMENT on page 31.)

REPAIR - FUEL DELIVERY SYSTEMS

FUEL PUMP REPLACEMENT

IMPORTANT: Replace all copper washers. Damaged or used washers may leak.

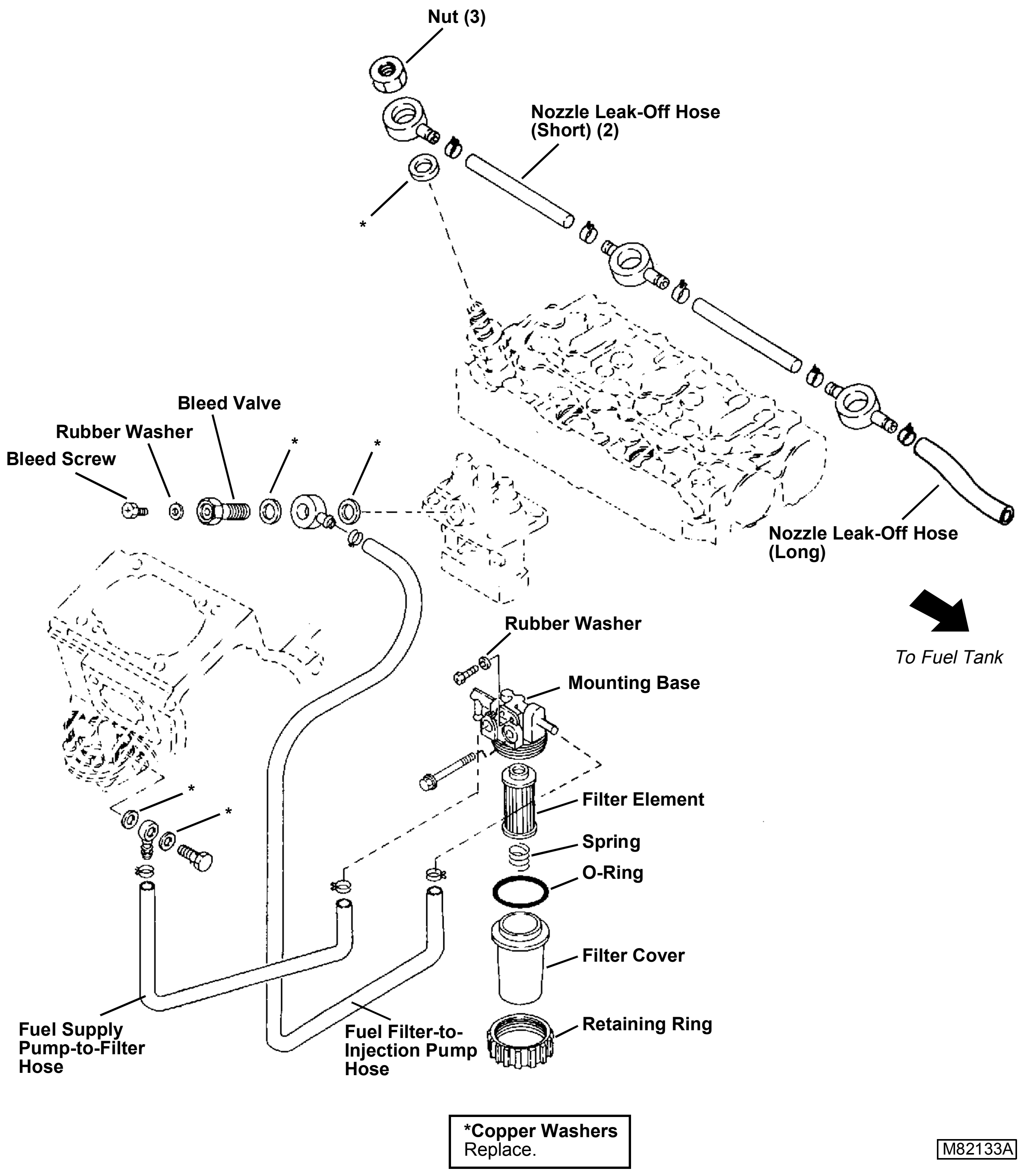


1. Disconnect fuel hoses from fuel pump. Raise hose from fuel tank above the level of fuel in the tank to prevent fuel tank from draining.
2. Remove two mounting screws.
3. Remove fuel pump from engine block.
4. Clean mating surfaces before installation of pump.
5. Install pump with new gasket and torque mounting screws to **11 N•m (96 lb-in).**
6. Install fuel hoses to fuel pump.
7. Start engine check for leaks. If engine does not start, bleed fuel system. (See BLEED FUEL SYSTEM on page 35.)

FUEL FILTER ASSEMBLY

All parts are serviceable. Inspect and replace as necessary.

IMPORTANT: Replace all copper washers. Damaged or used washers may leak.



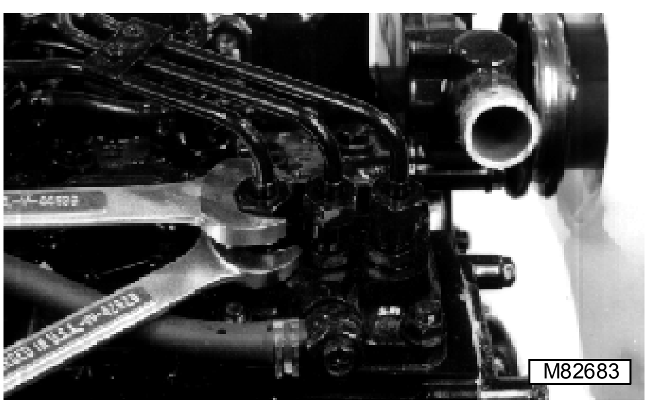
FUEL INJECTION PUMP REMOVAL

> **⚠ CAUTION**
>
> **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 knowledgable source. Such information is available from the Deere & Company Medical Department in Moline, Illinois, U.S.A.**

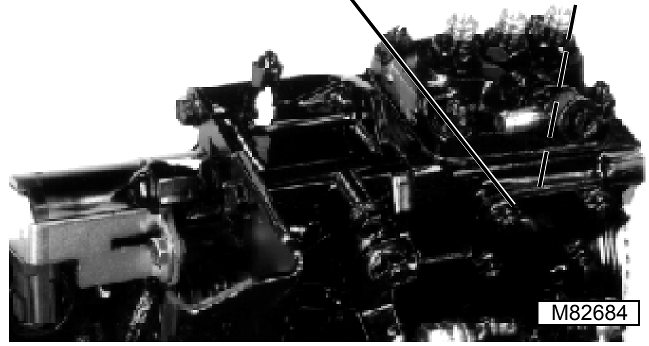
IMPORTANT: Never steam clean or pour cold water on injection pump while the pump is running or warm. Doing so can damage the pump.

1. Clean the injection pump lines and area around the pump using a parts cleaning solvent or steam cleaner.

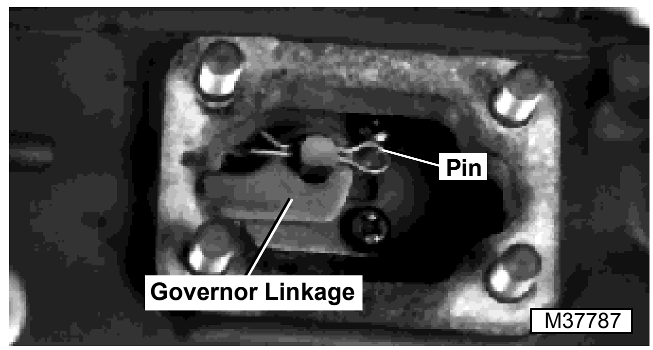
IMPORTANT: When removing injection lines, DO NOT turn pump delivery valve fittings. Turning fittings may damage pump internally.



2. Loosen fuel injection line connectors slightly to release pressure in the fuel system. When loosening connectors, use another wrench to keep delivery valves from loosening.
3. Loosen line clamp and remove fuel injection lines.
4. Disconnect hose from supply pump.
5. Disconnect leak-off hoses to/from injection pump.

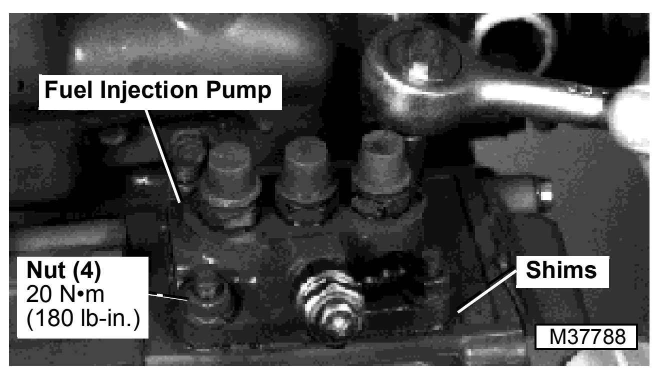


6. Remove four nuts, governor linkage cover and gasket.



7. Remove pin and washer, if equipped. Disconnect governor linkage.

IMPORTANT: If injection pump is being removed to be serviced or replaced, the same number and thickness of new shims must be installed when pump is assembled.



8. Remove four nuts to remove fuel injection pump and shims.

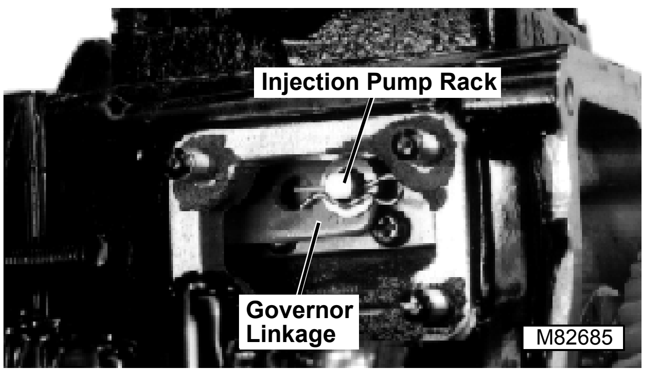
DO NOT attempt to service the injection pump except for fuel delivery valves. If unit is in need of repair, it must be serviced by a qualified fuel injection repair shop. If replacement is necessary, replace entire unit.

FUEL INJECTION PUMP INSTALLATION

Installation is done in the reverse order of removal.

NOTE: Governor linkage has two holes. Connect governor linkage to injection pump rack using hole closest to injection pump gear.

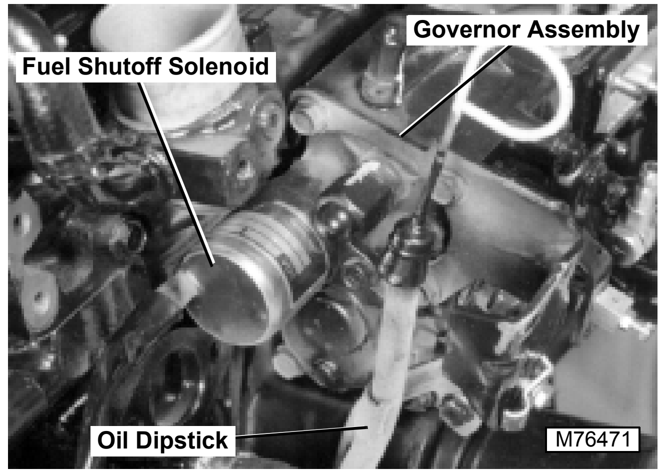
IMPORTANT: If a serviced or replacement fuel injection pump is installed, measure old shim thickness and install new shims of the same thickness.



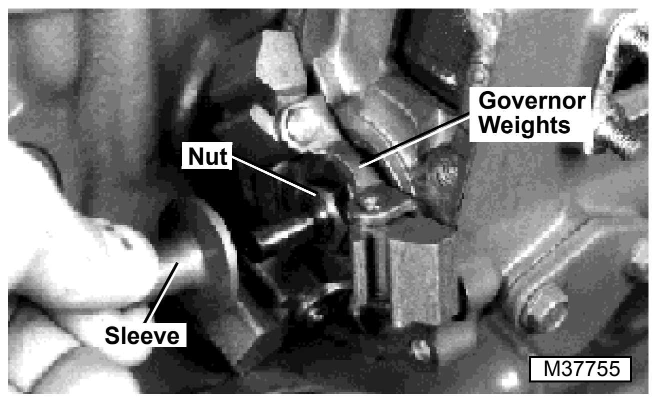
- When connecting governor linkage to injection pump rack, attach link to rack at hole closest to injection pump gear.
- Bleed the fuel system. (See BLEED FUEL SYSTEM on page 35.)
- If new injection pump is being installed, check and adjust injection pump timing. (See INJECTION PUMP TIMING ADJUSTMENT on page 30.)

FUEL INJECTION PUMP CAMSHAFT REMOVAL

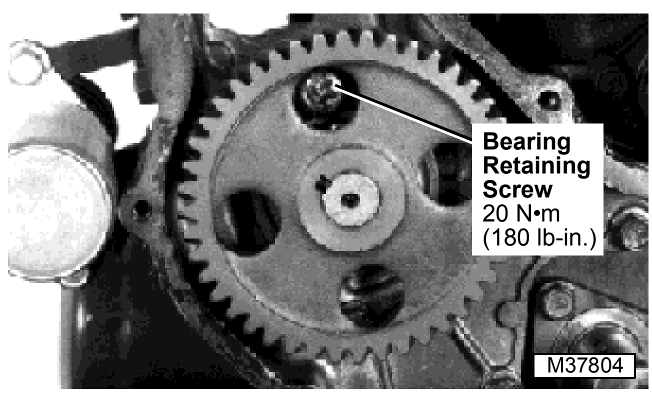
1. Remove timing gear cover. (See TIMING GEAR COVER REMOVAL/INSTALLATION on page 74.)
2. Remove fuel injection pump. (See FUEL INJECTION PUMP REMOVAL on page 83.)
3. Remove fuel pump. (See FUEL PUMP REPLACEMENT on page 81.)



4. Remove oil dipstick.
5. Disconnect fuel shutoff solenoid.
6. Remove capscrews attaching governor assembly to timing gear housing.
7. Remove governor assembly.



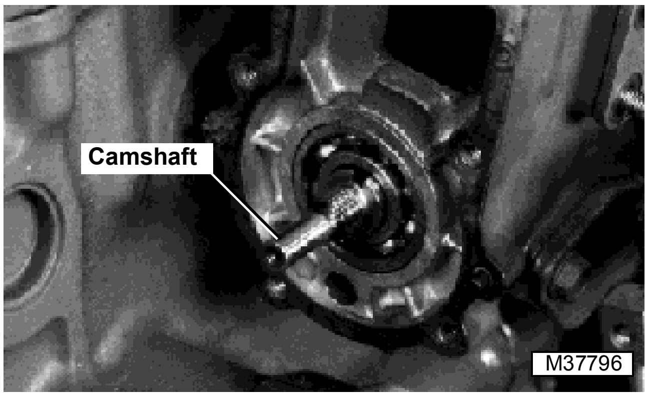
8. Remove sleeve, nut and governor weights from end of injection pump camshaft.



9. Remove bearing retaining screw.

IMPORTANT: DO NOT allow fuel injection pump camshaft lobes to hit bearing surfaces while removing camshaft. Machined surfaces may be damaged.

10. Carefully tap the rear of camshaft with plastic hammer to remove from housing.

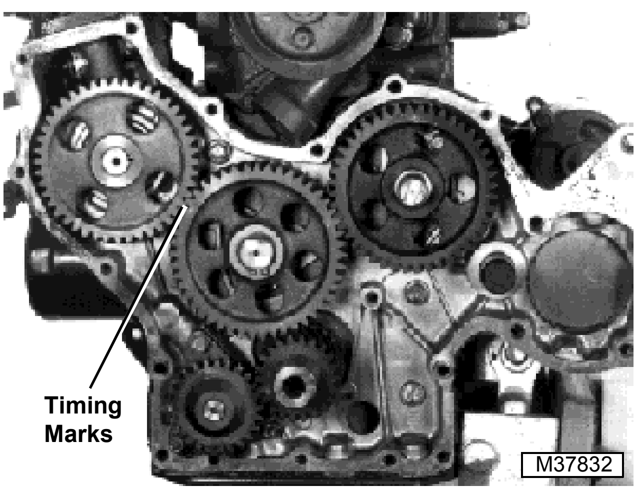


11. Disassemble and inspect all parts for wear or damage.

FUEL INJECTION PUMP CAMSHAFT INSTALLATION

Installation is done in reverse order of removal.

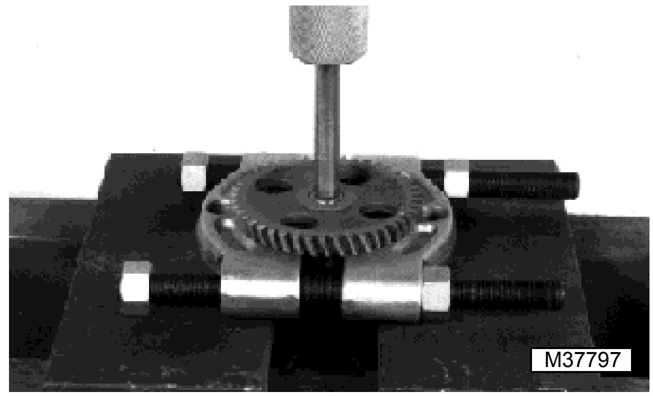
- After installing camshaft assembly into housing, tap on end of camshaft gear with a plastic hammer to seat bearings in bores.
- Align timing marks on injection pump gear and idler gear when installing camshaft.



FUEL INJECTION PUMP CAMSHAFT DISASSEMBLY

NOTE: Gear and bearings are press fit on shaft.

IMPORTANT: Hold camshaft while removing gear and bearings. Shaft can be damaged if dropped.



1. Remove gear using knife edge puller and a press.
2. Remove key.
3. Remove bearings using a knife edge puller and a press.
4. Inspect all parts for wear or damage. (See FUEL INJECTION PUMP CAMSHAFT INSPECTION on page 86.)

FUEL INJECTION PUMP CAMSHAFT ASSEMBLY

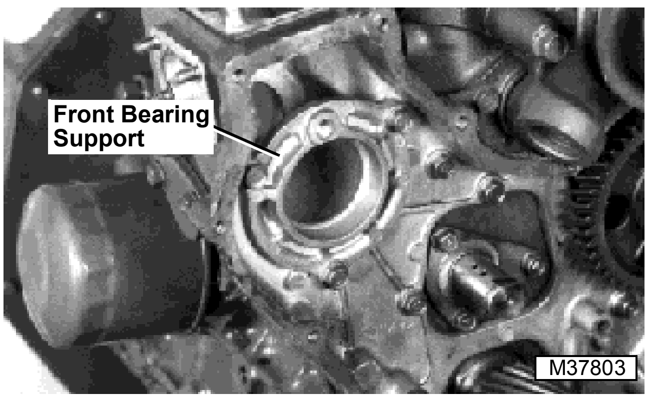
NOTE: Install large bearing on gear end.

IMPORTANT: When pressing bearings apply pressure on the inner bearing race only.

1. Install bearings on ends of camshaft using a 3/4 in. deep well socket and a press. Press until bearing races bottom on camshaft shoulders.
2. Install key.
3. Put camshaft gear on a flat surface and press camshaft assembly into gear. Press until gear shoulder butts up against inner bearing race.

FUEL INJECTION PUMP CAMSHAFT INSPECTION

- Measure height of each camshaft lobe. Replace camshaft if lobe height is less than **30.90 mm (1.217 in.)**.



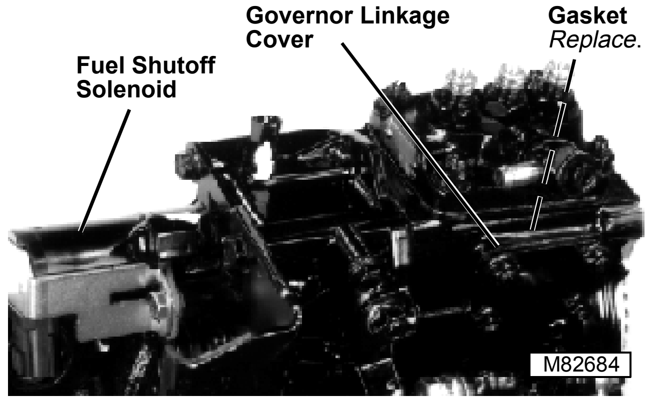
- Inspect camshaft bearing supports in timing gear housing. Check for cracks, damage or indications that bearings have spun in support.

If rear bearing bore is damaged, replace timing gear housing.

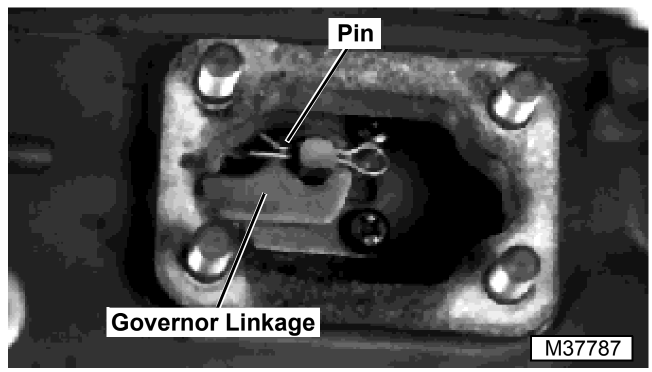
If front bearing bore is damaged, remove three capscrews and replace support.

- Inspect all parts for wear or damage. Replace as necessary.

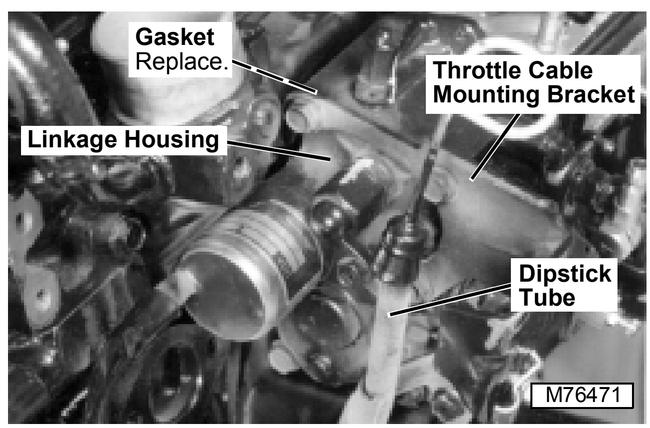
FUEL CONTROL AND GOVERNOR LINKAGE REMOVAL



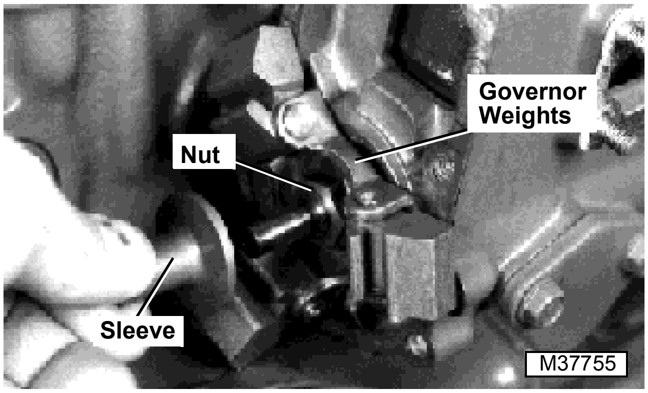
1. Disconnect fuel shutoff solenoid.
2. Remove four nuts, governor linkage cover and gasket.



3. Remove pin and washer to disconnect governor linkage.



4. Remove dipstick tube.
5. Remove three capscrews and throttle cable mounting bracket.
6. Remove three capscrews, linkage housing and gasket.



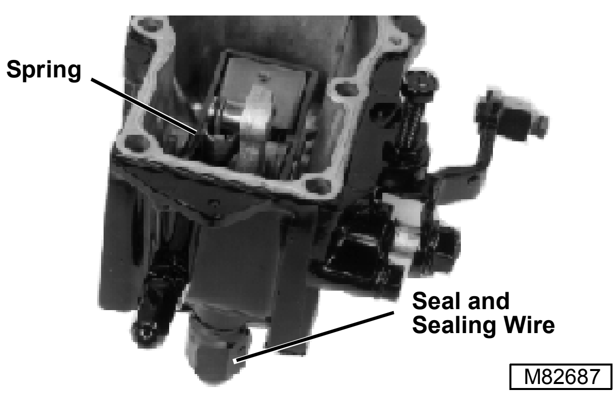
7. Remove sleeve.
8. Remove nut and governor weights.
9. Disassemble and inspect all parts for wear or damage. (See FUEL CONTROL AND GOVERNOR LINKAGE INSPECTION on page 89.)

FUEL CONTROL AND GOVERNOR LINKAGE INSTALLATION

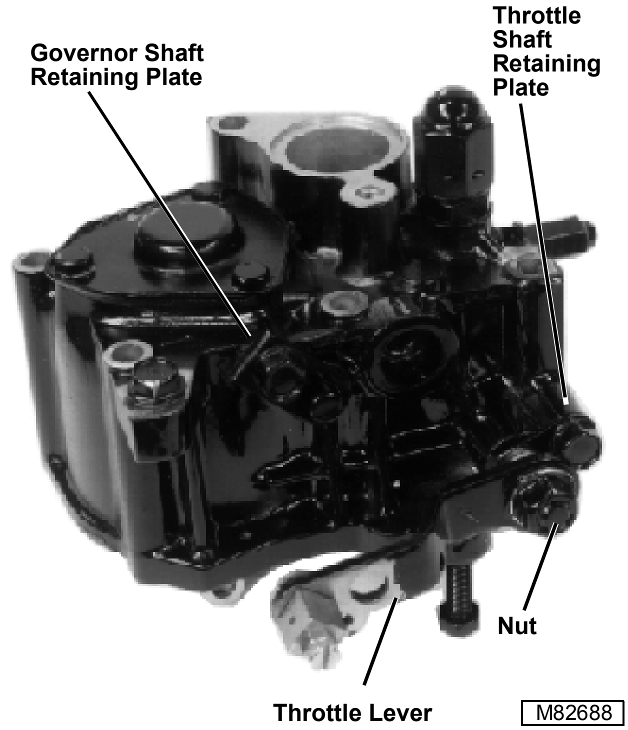
Installation is done in the reverse order of removal.

- Governor linkage has two holes. Connect governor linkage to injection pump rack using hole closest to injection pump gear.
- Check and adjust slow and fast idle settings. (See SLOW IDLE ADJUSTMENT on page 36.)

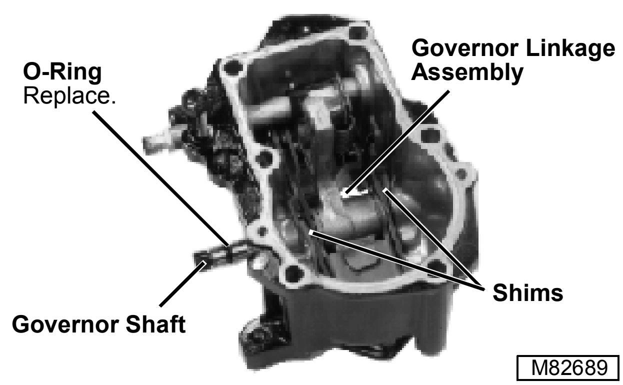
FUEL CONTROL AND GOVERNOR LINKAGE DISASSEMBLY



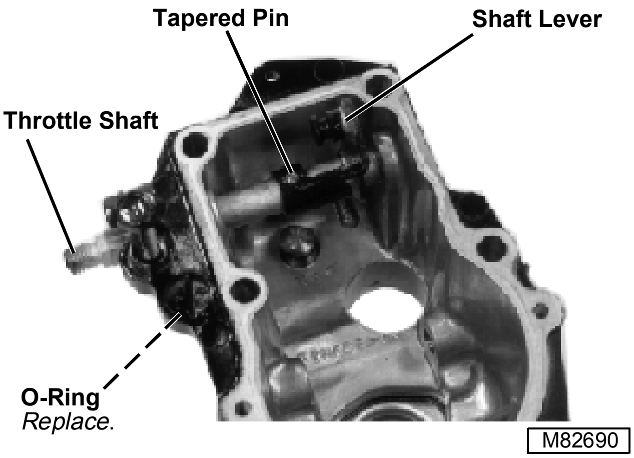
1. Remove spring.
2. Remove seal and sealing wire.



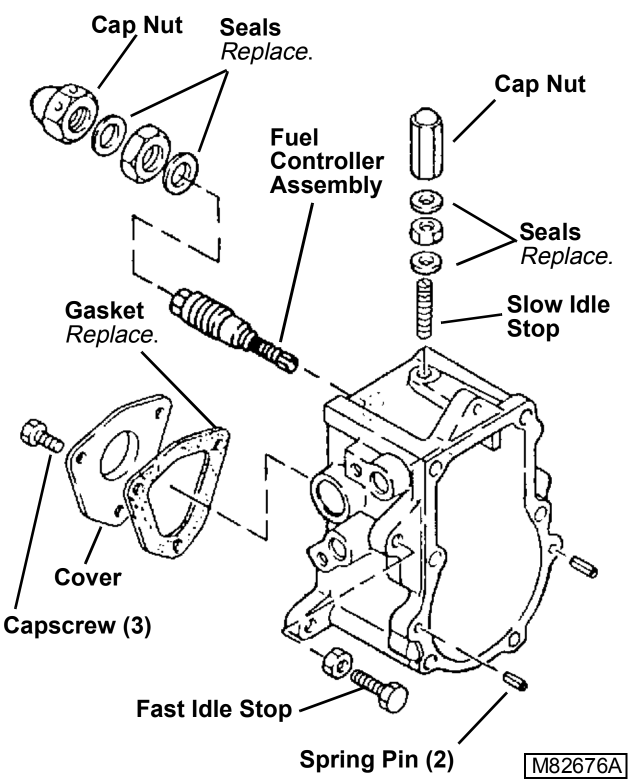
3. Remove nut and throttle lever.
4. Remove capscrew and throttle shaft retaining plate.
5. Remove capscrew and governor shaft retaining plate.



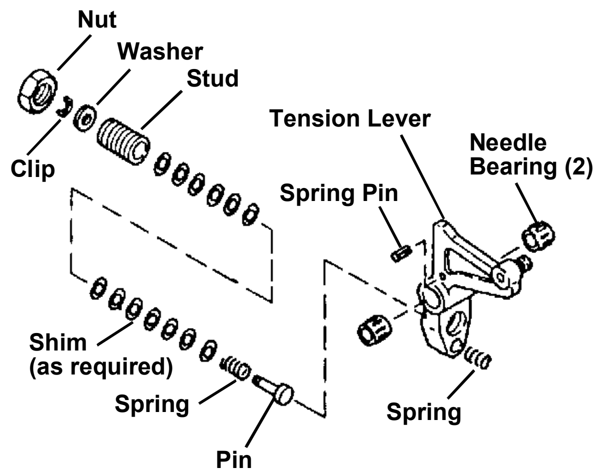
6. Remove governor shaft, governor linkage assembly, shims and O-ring.

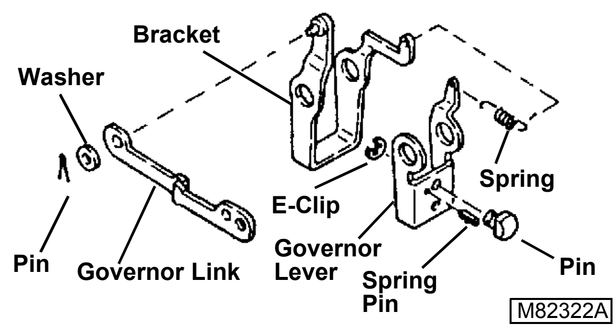


7. Rotate throttle shaft assembly as shown.
8. Remove tapered pin from tapered hole using a punch.
9. Remove throttle shaft, shaft lever and O-ring.

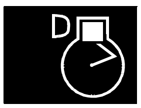


10. Remove cover, gasket, fuel controller assembly, fast idle stop and slow idle stop.





11. Disassemble governor linkage assembly.
12. Inspect all parts for wear or damage. Replace as necessary. (See FUEL CONTROL AND GOVERNOR LINKAGE INSPECTION on page 89.)



FUEL CONTROL AND GOVERNOR LINKAGE ASSEMBLY

Assembly is done in the reverse order of disassembly.

- Apply clean engine oil on all internal parts.
- When installing throttle shaft:

  Install new O-ring, throttle shaft and shaft lever.

  Install tapered pin in tapered hole.
- Seal and sealing wire are not installed until governor linkage housing installation procedures have been completed and fast and slow idle adjustments have been made.
- Idle adjustments are made after engine has been installed in the machine.

FUEL CONTROL AND GOVERNOR LINKAGE INSPECTION

M37763

1. Measure governor shaft diameter. If O.D. is less than **8.01 mm (0.315 in.)**, replace governor shaft.
2. Measure governor shaft bore diameter in governor linkage.

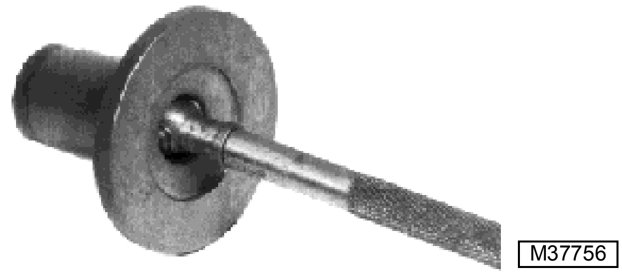
Governor Shaft Bore I.D.:

Wear Limit. . . . . 8.50 mm (0.299 in.)

Clearance . . . . 0.09 mm (0.003 in.)

If shaft bore exceeds wear limit, replace governor linkage.

If bore clearance (bore I.D. minus shaft O.D.) exceeds specification, replace governor shaft, governor linkage or both.



M37756

3. Measure inside diameter of sleeve. If I.D. is **more than 9.00 mm (0.354 in.)**, replace sleeve.

M37757

4. Measure injection pump camshaft diameter.

Injection Pump Camshaft O.D.:

Wear Limit. . . . . 7.90 mm (0.311 in.)

Clearance . . . . 0.15 mm (0.006 in.)

If camshaft diameter is less than wear limit, replace injection pump camshaft.

If clearance (sleeve I.D. minus camshaft O.D.) exceeds specification, replace sleeve, injection pump camshaft or both.

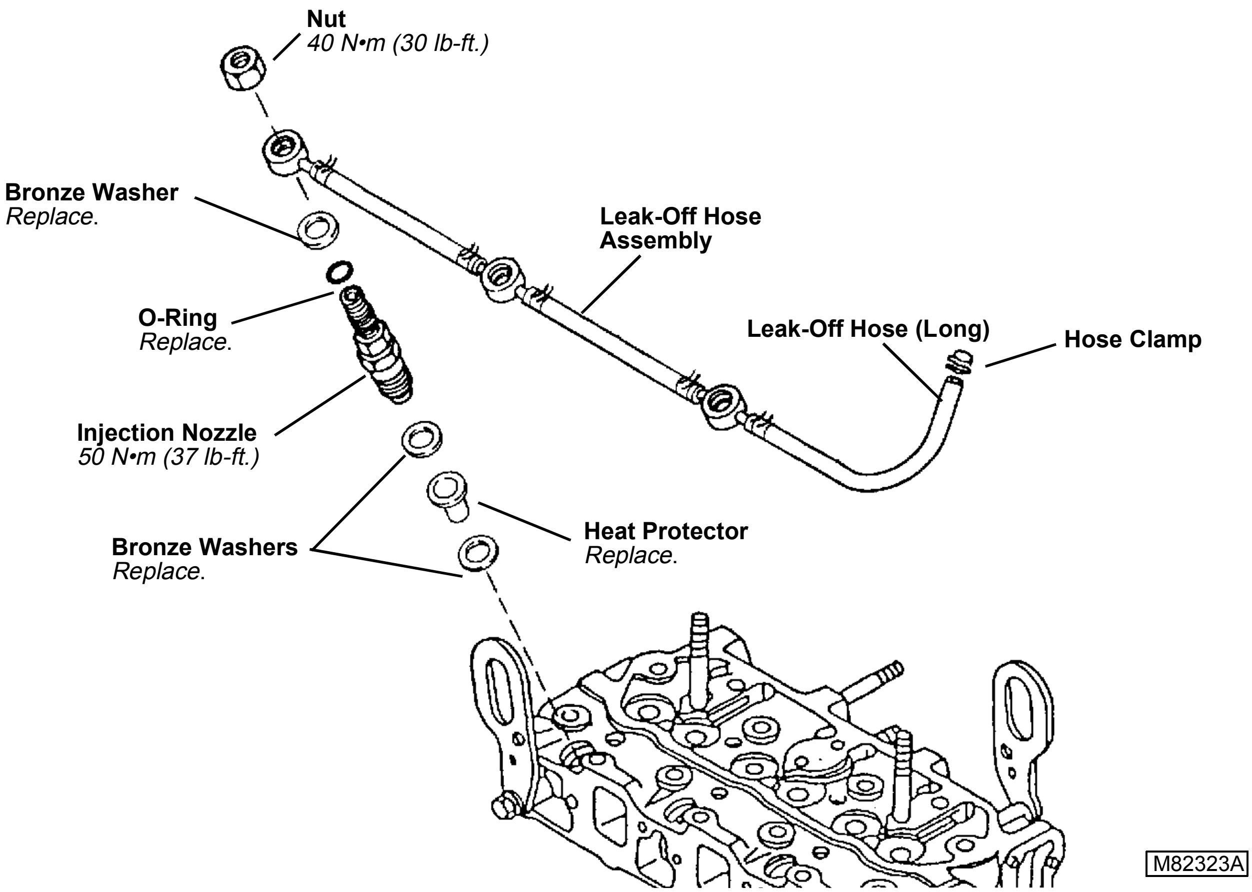
FUEL INJECTION NOZZLES (PINTLE-TYPE)

Removal/Installation

IMPORTANT: Never steam clean or pour cold water on injection pump while the pump is running or warm. Doing so can damage the pump.

1. Clean the injection pump lines and area around the pump using a parts cleaning solvent or steam cleaner.

NOTE: Nozzles are matched to the cylinders. If removing more than one nozzle, tag nozzles, according to the cylinder from which it was removed.

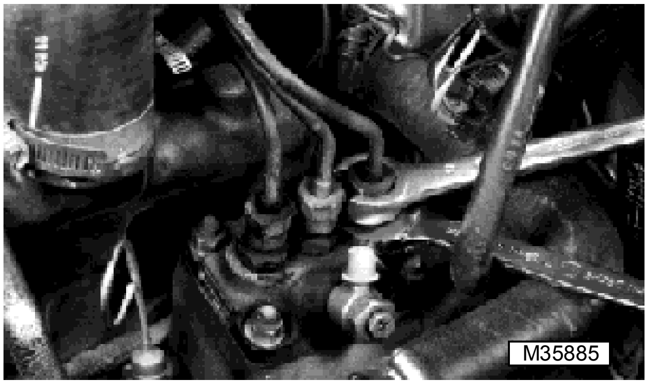


IMPORTANT: When removing injection lines, DO NOT turn pump delivery valve fittings. Turning fittings may damage pump internally.

⚠ CAUTION

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 knowledgable source. Such information is available from the Deere & Company Medical Department in Moline, Illinois, U.S.A.



2. Loosen fuel injection line connectors slightly to release pressure in the fuel system. When loosening connectors, use another wrench to keep delivery valves from loosening.
3. Loosen line clamp and remove fuel injection lines.
4. Disconnect long leak-off hose.
5. Remove nuts and leak-off hose assembly.
6. Remove bronze washers and O-rings.
7. Remove injection nozzle, washers and heat protector.
8. Test injection nozzles. (See FUEL INJECTION NOZZLE TEST (PINTLE-TYPE) on page 28.)

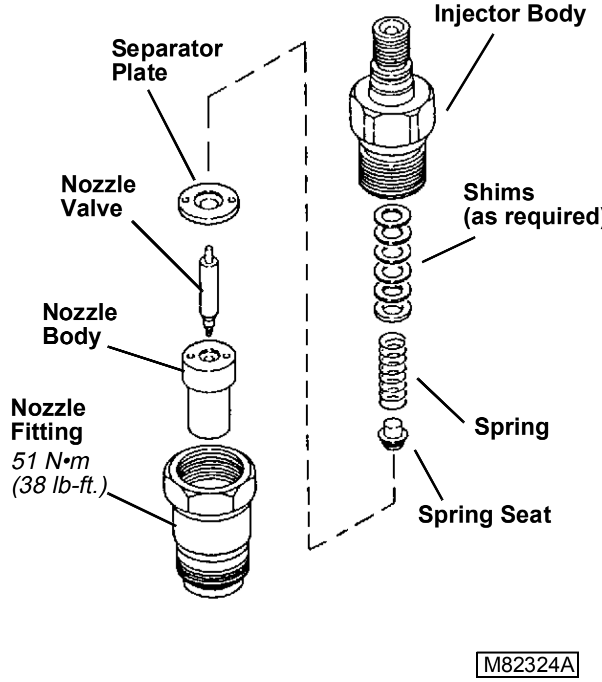
Installation is done in reverse order of removal.

FUEL INJECTION NOZZLES DISASSEMBLY/ASSEMBLY

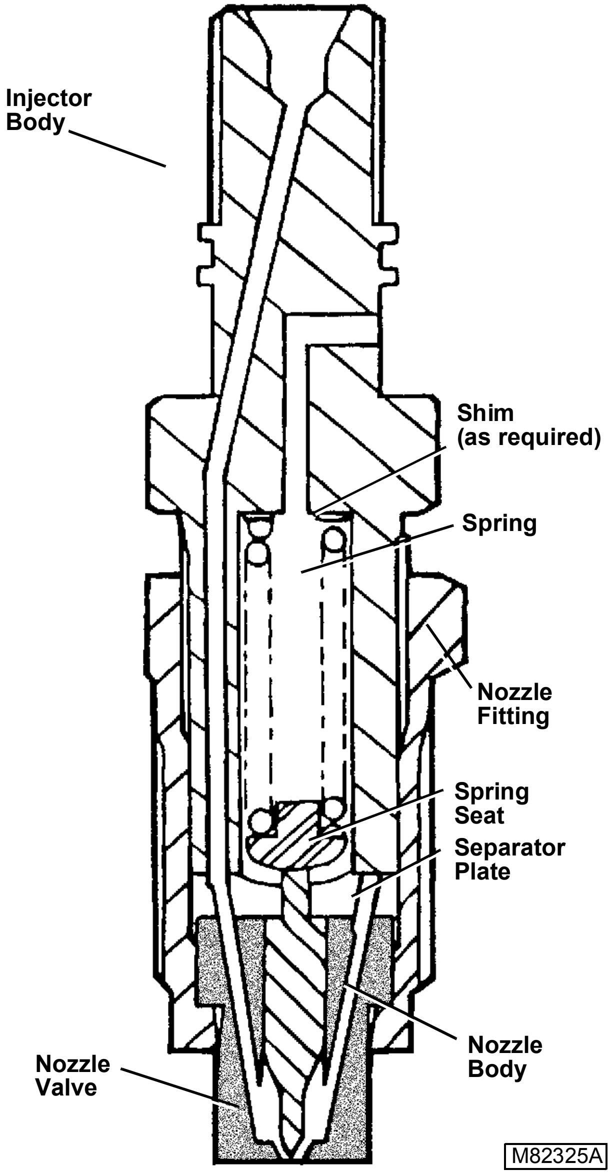
NOTE: If servicing more than one nozzle, keep parts for each nozzle separate from one another.

IMPORTANT: If injection nozzles are disassembled to be cleaned, the same number and thickness of shims must be installed.

- Clean and inspect nozzle assembly. (See FUEL INJECTION NOZZLES CLEANING/INSPECTION on page 92.)
- After assembly is complete, test injection nozzle. (See FUEL INJECTION NOZZLE TEST (PINTLE-TYPE) on page 28.)



FUEL INJECTION NOZZLES CROSS SECTION



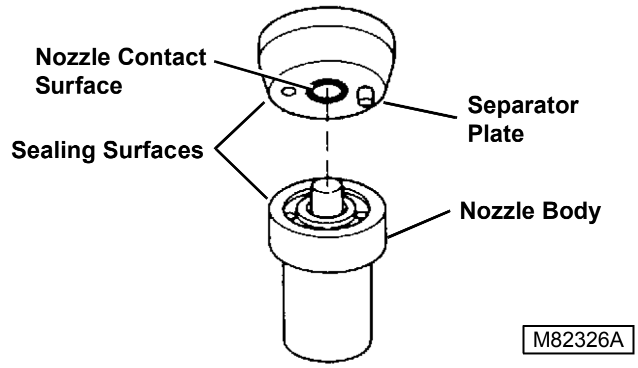
FUEL INJECTION NOZZLES CLEANING/INSPECTION

NOTE: To clean nozzles properly, JDF13 Nozzle Cleaning Kit is recommended. The Cleaning Kit is available through the John Deere SERVICE GARD™ Catalog.

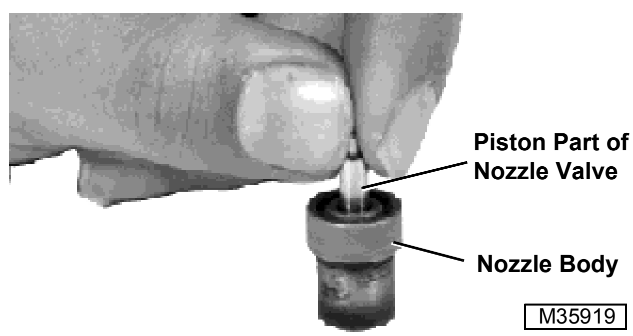
1. Remove anticorrosive grease from new or reconditioned nozzles by washing them thoroughly in diesel fuel.

IMPORTANT: Never use a steel brush to clean nozzles as this will distort the spray hole.

2. Remove carbon from used nozzles, and clean by washing in diesel fuel. If parts are coated with hardened carbon or lacquer, it may be necessary to use a brass wire brush (supplied in Nozzle Cleaning Kit).
3. After removing carbon or lacquer from the exterior of nozzle, inspect sealing surfaces between separator plate and nozzle body for nicks or scratches.
4. Inspect condition of separator plate and nozzle body. Contact area of separator plate (both parts) must not be scored or pitted. Use an inspection magnifier (No. 16487 or equivalent) to aid in making the inspection.
5. Check nozzle contact surface on separator plate for wear. If contact surface is more than **0.10 mm (0.004 in.)**, replace nozzle assembly.



Inspect the piston (large) part of nozzle valve to see that it is not scratched or scored and that lower (tip) end of valve is not broken. If any of these conditions are present, replace the nozzle assembly.



6. Further inspect the nozzle assembly by performing a slide test. Use the following procedure:
   - Dip the nozzle valve in clean diesel fuel. Insert valve in nozzle body.
   - Hold nozzle vertical, and pull valve out about 1/3 of its engaged length.
   - Release valve. Valve should slide down to its seat by its own weight.

Replace nozzle assembly if the valve does not slide freely to its seat.

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STARTER—HITACHI 0.8 kW. 42
ALTERNATOR—KOKOSAN 20A. 46
METRO-PACK™ CONNECTOR REMOVAL 48
METRO PACK™ CONNECTOR REPLACEMENT 49

SPECIFICATIONS

Voltage

Unregulated . . . . 26 VAC @ 3400 rpm
Regulated. . . . . 12.2—14.7 VDC @ 3400 rpm

Amperage

Regulated. . . . . 15 Amps @ 3400 rpm

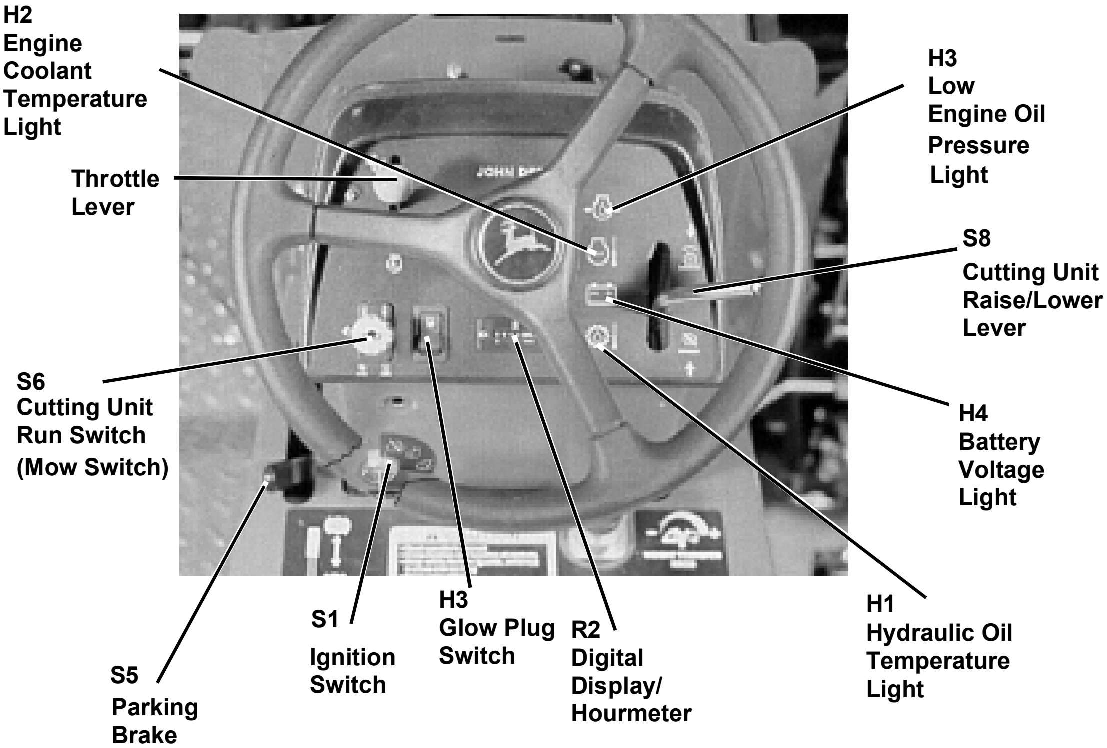
Battery

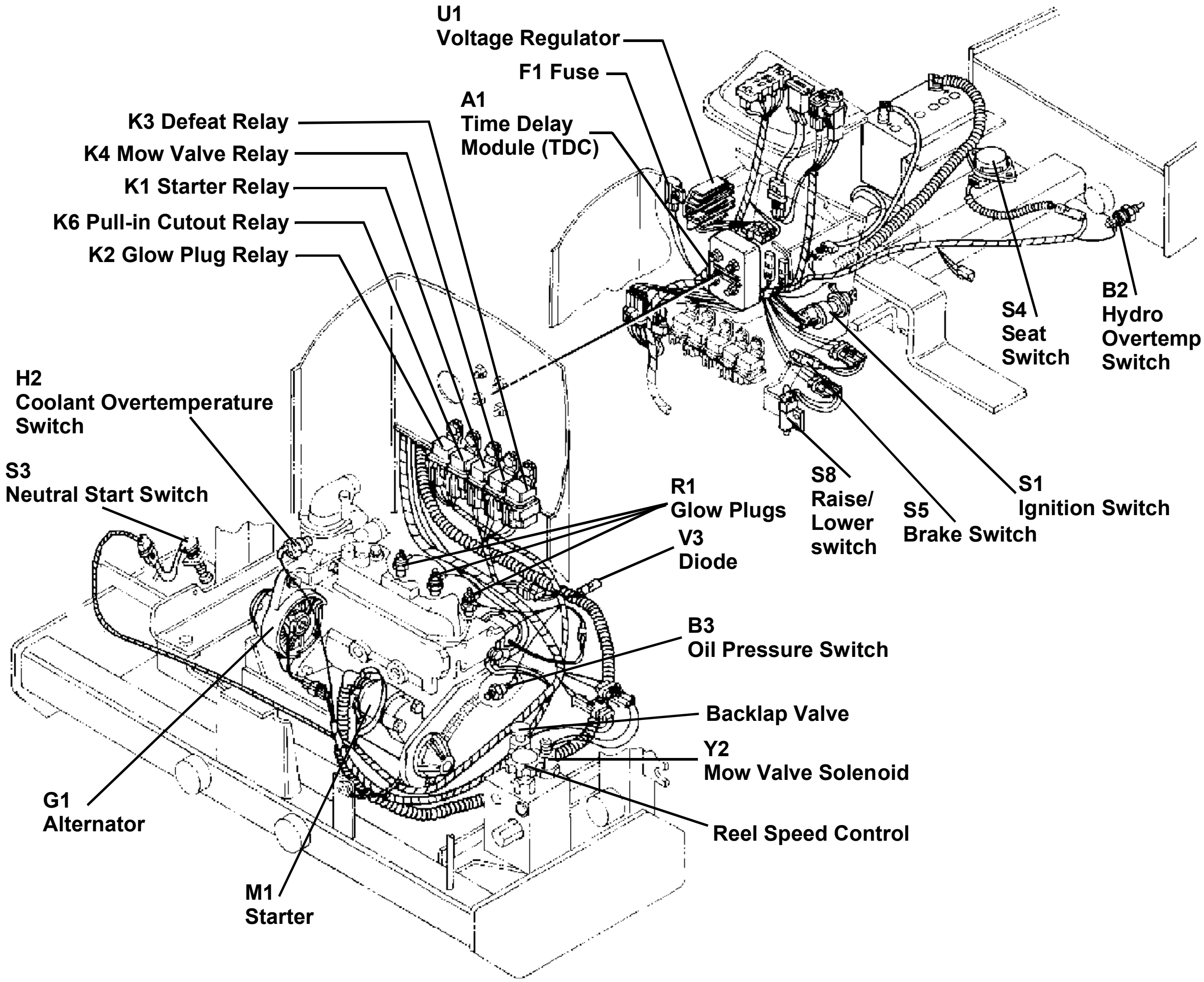
Voltage . . . . 11.8—13.2 VDC
Reserve Capacity @ 25 Amps. . . . . 80 min.
Cold Cranking Amps @ -18^{o} C (0^{o} F) . . . . 430 CCA

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

COMPONENT LOCATION





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.

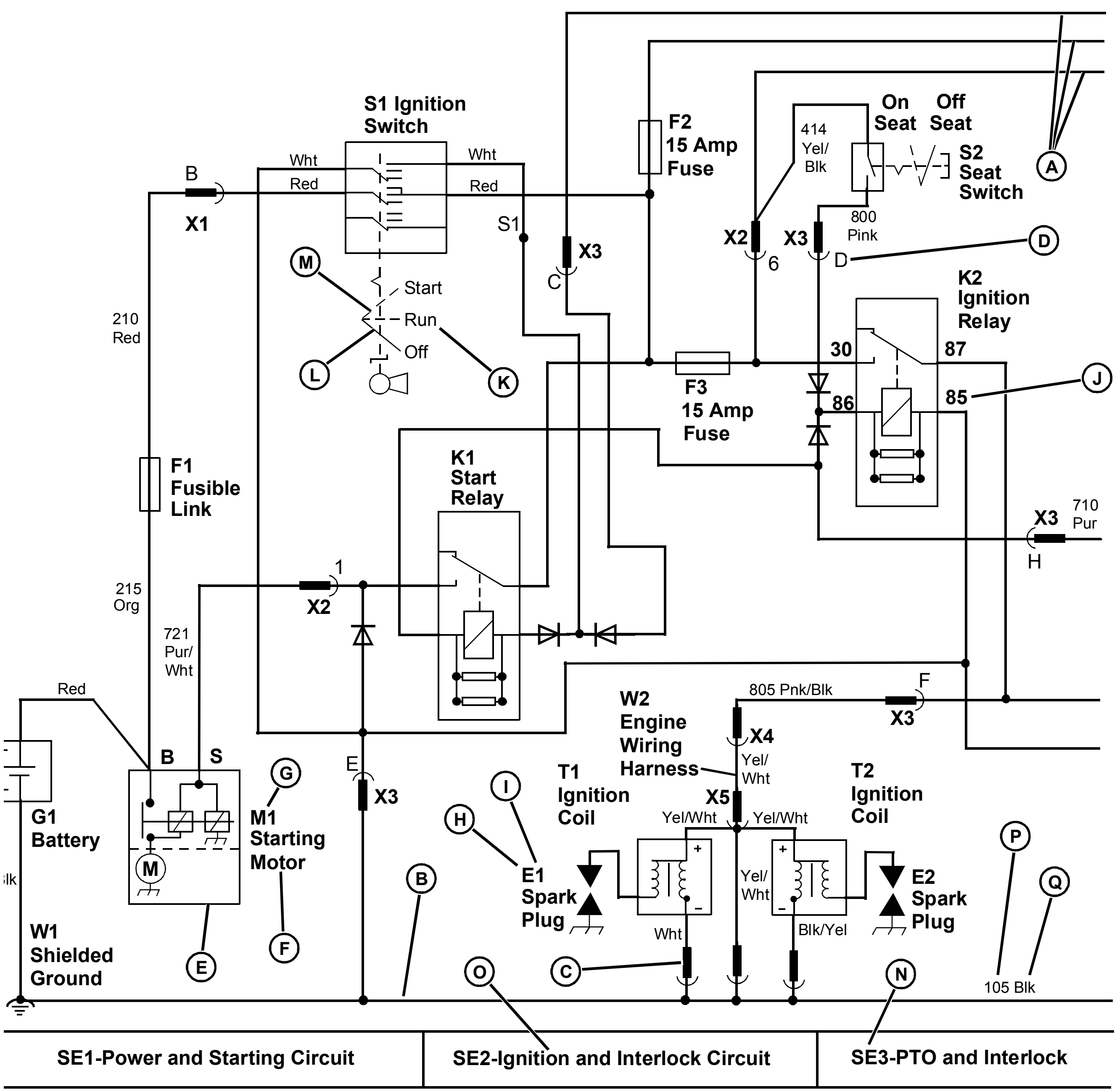
Each component is shown by a symbol (E), its name (F), and an identification code (G). The identification code contains a device identifying letter (H) and number (I).

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).

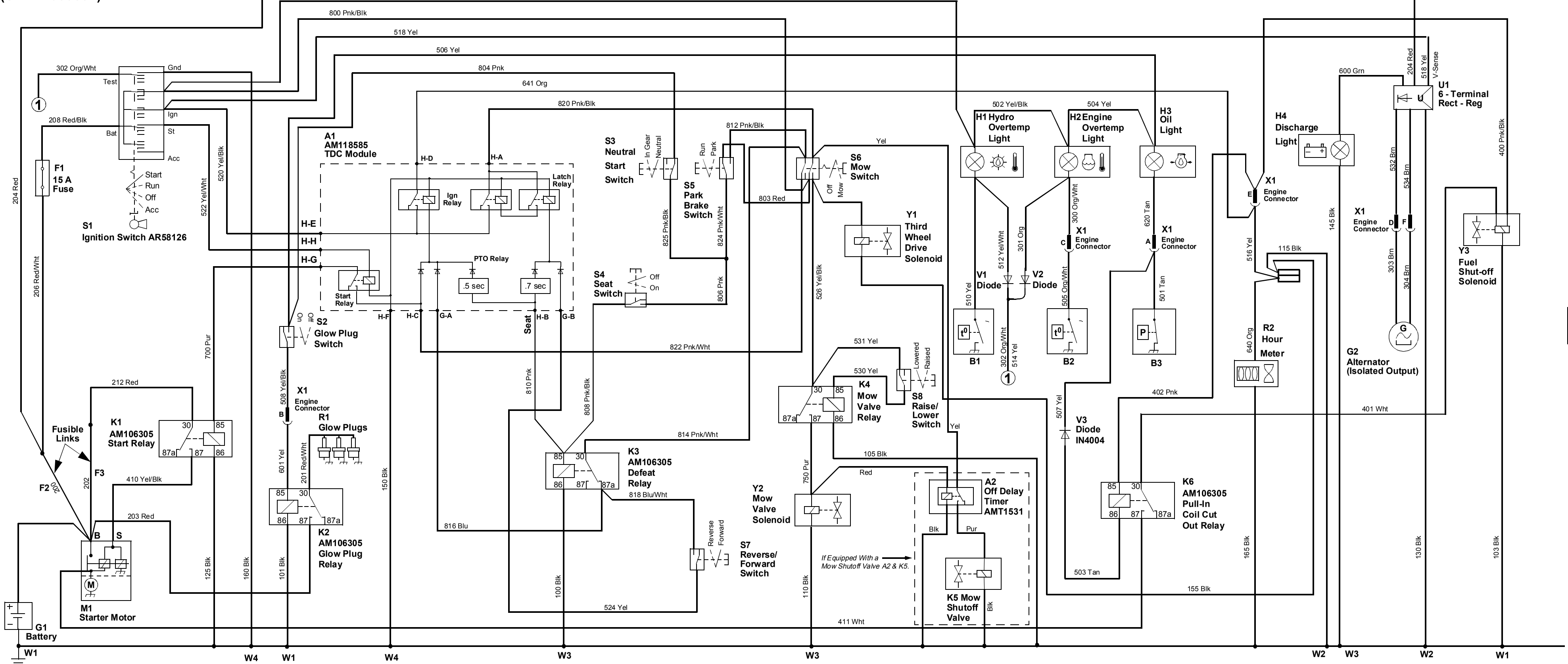
The circuit number (P) and wire color (Q) of the wires are shown directly next to the wire path.

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

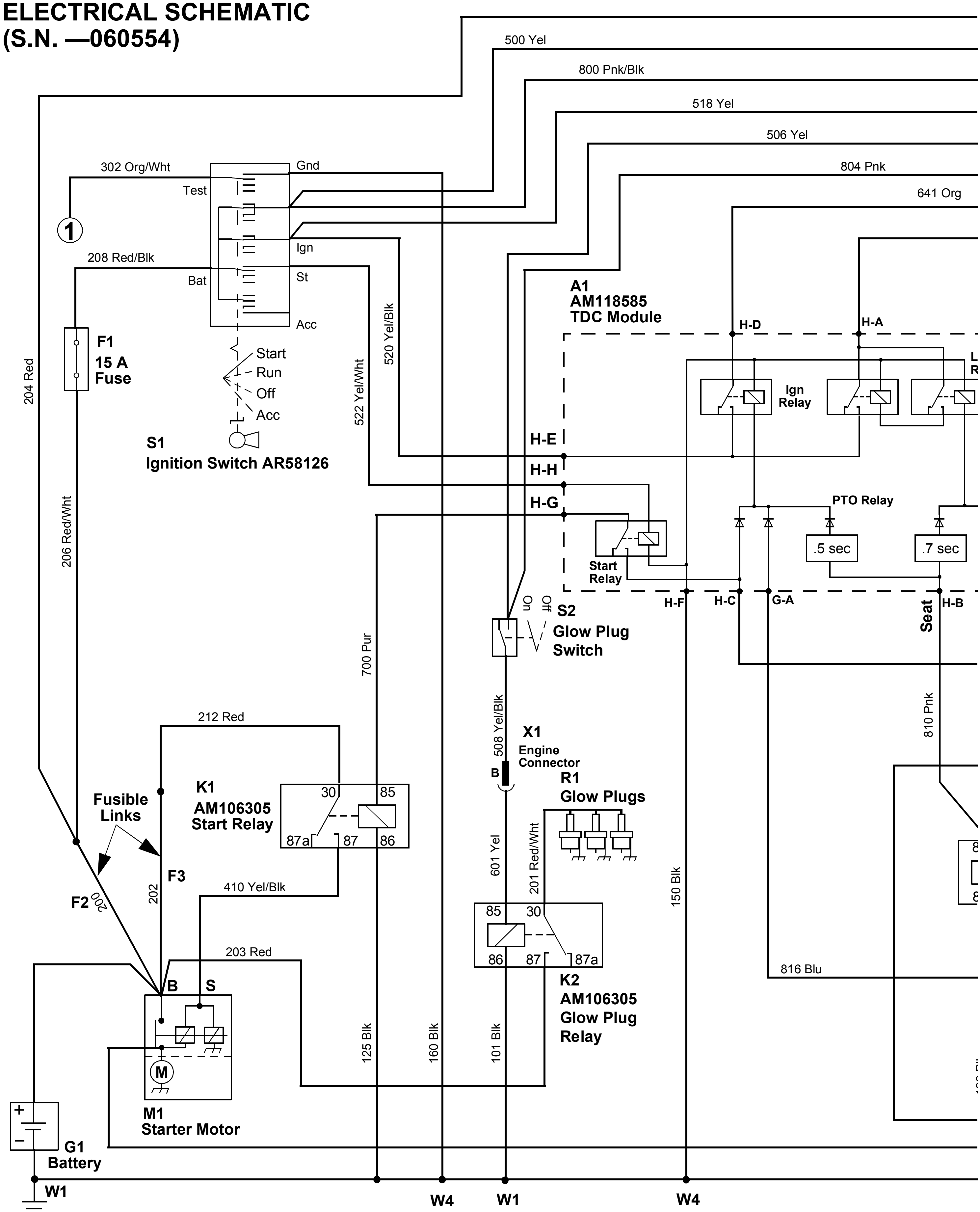


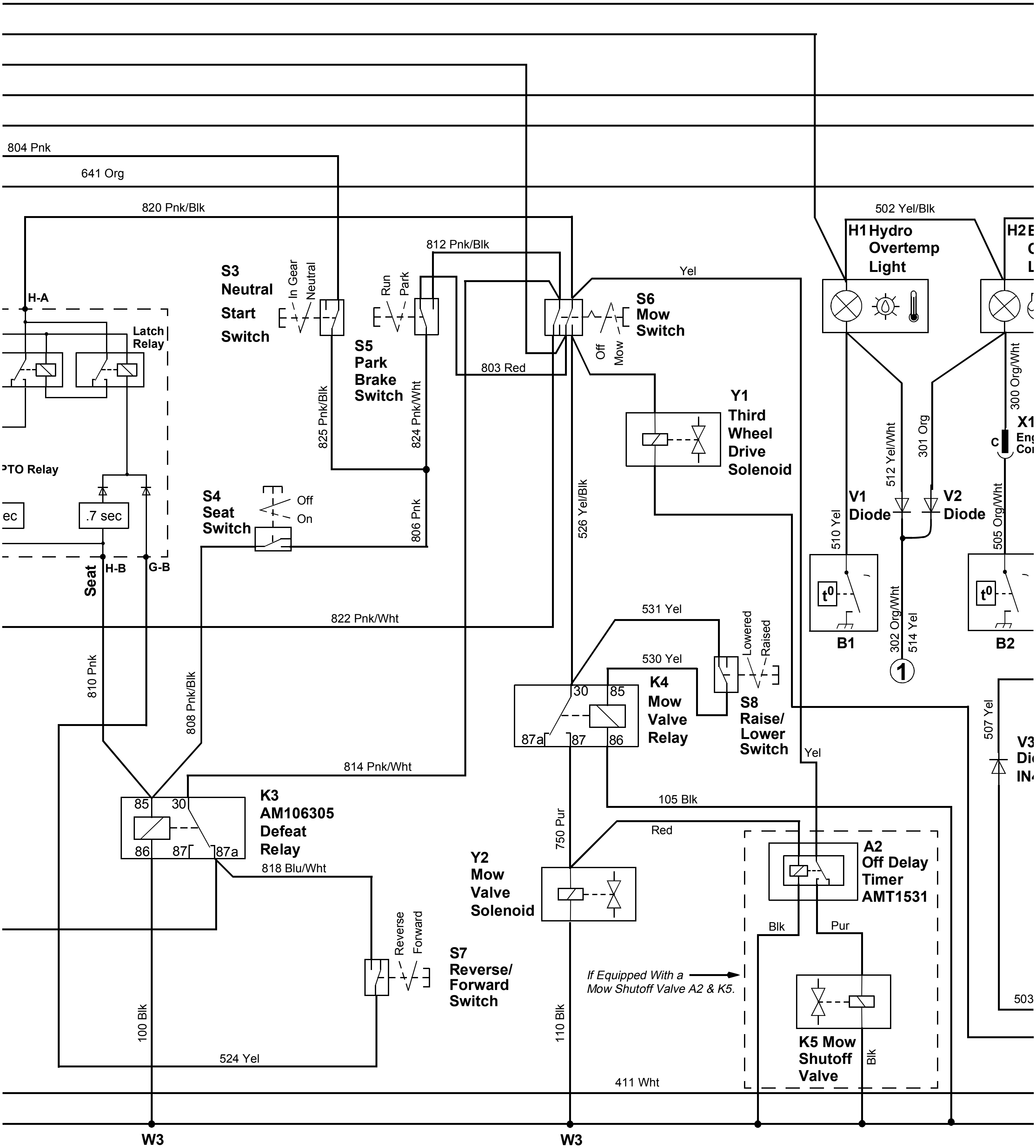
NOTES:

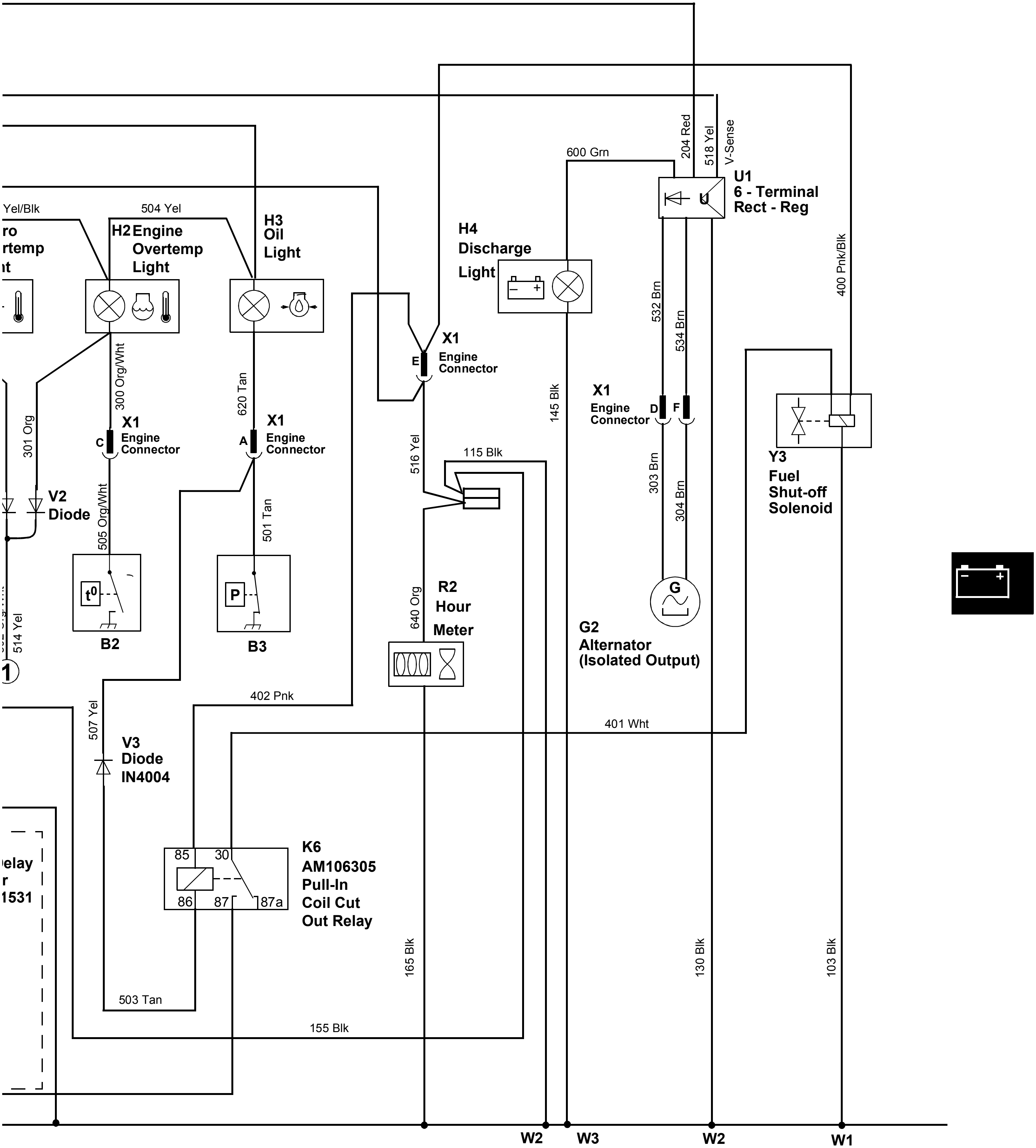
ELECTRICAL SCHEMATIC (S.N. —060554)



ELECTRICAL SCHEMATIC (S.N. —060554)




804 Pnk
641 Org
820 Pnk/Blk
812 Pnk/Blk
502 Yel/Blk
H1 Hydro Overtemp Light
S3 Neutral Start Switch
In Gear
Neutral
Run
Park
Yel
S6 Mow Switch
H-A
Latch Relay
S5 Park Brake Switch
803 Red
Off
Mow
Y1 Third Wheel Drive Solenoid
825 Pnk/Blk
824 Pnk/Wht
512 Yel/Wht
301 Org
300 Org/Wht
X1
PTO Relay
S4 Seat Switch
Off
On
806 Pnk
526 Yel/Blk
V1 Diode
V2 Diode
510 Yel
505 Org/Wht
.7 sec
Seat
H-B
G-B
B1
B2
822 Pnk/Wht
531 Yel
Lowered
Raised
302 Org/Wht
514 Yel
1
810 Pnk
808 Pnk/Blk
530 Yel
K4 Mow Valve Relay
30
85
87a
87
86
S8 Raise/ Lower Switch
Yel
507 Yel
814 Pnk/Wht
K3 AM106305 Defeat Relay
85
30
86
87
87a
105 Blk
750 Pur
Red
818 Blu/Wht
Y2 Mow Valve Solenoid
A2 Off Delay Timer AMT1531
Blk
Pur
Reverse
Forward
S7 Reverse/ Forward Switch
If Equipped With a Mow Shutoff Valve A2 & K5.
503
100 Blk
110 Blk
K5 Mow Shutoff Valve
Blk
524 Yel
411 Wht
W3
W3



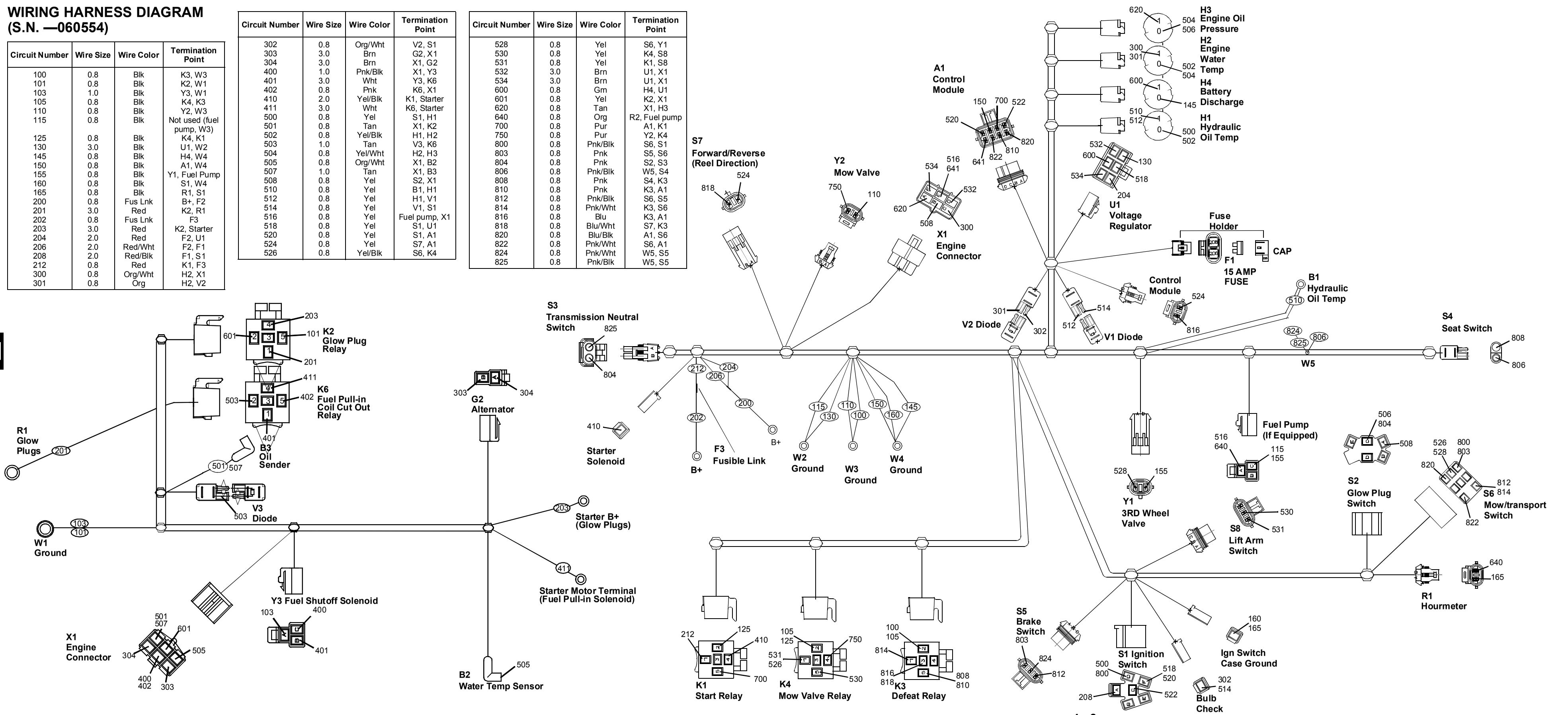
Yel/Blk
504 Yel
H2 Engine Overtemp Light
H3 Oil Light
H4 Discharge Light
600 Grn
204 Red
518 Yel
V-Sense
U1 6 - Terminal Rect - Reg
400 Pnk/Blk
X1 Engine Connector
E
300 Org/Wht
620 Tan
C
A
D
F
301 Org
V2 Diode
505 Org/Wht
501 Tan
516 Yel
145 Blk
532 Brn
534 Brn
303 Brn
304 Brn
115 Blk
Y3 Fuel Shut-off Solenoid
B2
B3
514 Yel
R2 Hour Meter
640 Org
G
G2 Alternator (Isolated Output)
402 Pnk
401 Wht
507 Yel
V3 Diode IN4004
K6 AM106305 Pull-In Coil Cut Out Relay
85
30
86
87
87a
165 Blk
130 Blk
103 Blk
503 Tan
155 Blk
W2
W3
W2
W1

WIRING HARNESS DIAGRAM (S.N. —060554)

Circuit Number	Wire Size	Wire Color	Termination Point
100	0.8	Blk	K3, W3
101	0.8	Blk	K2, W1
103	1.0	Blk	Y3, W1
105	0.8	Blk	K4, K3
110	0.8	Blk	Y2, W3
115	0.8	Blk	Not used (fuel pump, W3)
125	0.8	Blk	K4, K1
130	3.0	Blk	U1, W2
145	0.8	Blk	H4, W4
150	0.8	Blk	A1, W4
155	0.8	Blk	Y1, Fuel Pump
160	0.8	Blk	S1, W4
165	0.8	Blk	R1, S1
200	0.8	Fus Lnk	B+, F2
201	3.0	Red	K2, R1
202	0.8	Fus Lnk	F3
203	3.0	Red	K2, Starter
204	2.0	Red	F2, U1
206	2.0	Red/Wht	F2, F1
208	2.0	Red/Blk	F1, S1
212	0.8	Red	K1, F3
300	0.8	Org/Wht	H2, X1
301	0.8	Org	H2, V2

Circuit Number	Wire Size	Wire Color	Termination Point
302	0.8	Org/Wht	V2, S1
303	3.0	Brn	G2, X1
304	3.0	Brn	X1, G2
400	1.0	Pnk/Blk	X1, Y3
401	3.0	Wht	Y3, K6
402	0.8	Pnk	K6, X1
410	2.0	Yel/Blk	K1, Starter
411	3.0	Wht	K6, Starter
500	0.8	Yel	S1, H1
501	0.8	Tan	X1, K2
502	0.8	Yel/Blk	H1, H2
503	1.0	Tan	V3, K6
504	0.8	Yel/Wht	H2, H3
505	0.8	Org/Wht	X1, B2
507	1.0	Tan	X1, B3
508	0.8	Yel	S2, X1
510	0.8	Yel	B1, H1
512	0.8	Yel	H1, V1
514	0.8	Yel	V1, S1
516	0.8	Yel	Fuel pump, X1
518	0.8	Yel	S1, U1
520	0.8	Yel	S1, A1
524	0.8	Yel	S7, A1
526	0.8	Yel/Blk	S6, K4

Circuit Number	Wire Size	Wire Color	Termination Point
528	0.8	Yel	S6, Y1
530	0.8	Yel	K4, S8
531	0.8	Yel	K1, S8
532	3.0	Brn	U1, X1
534	3.0	Brn	U1, X1
600	0.8	Grn	H4, U1
601	0.8	Yel	K2, X1
620	0.8	Tan	X1, H3
640	0.8	Org	R2, Fuel pump
700	0.8	Pur	A1, K1
750	0.8	Pur	Y2, K4
800	0.8	Pnk/Blk	S6, S1
803	0.8	Pnk	S5, S6
804	0.8	Pnk	S2, S3
806	0.8	Pnk/Blk	W5, S4
808	0.8	Pnk	S4, K3
810	0.8	Pnk	K3, A1
812	0.8	Pnk/Blk	S6, S5
814	0.8	Pnk/Wht	K3, S6
816	0.8	Blu	K3, A1
818	0.8	Blu/Wht	S7, K3
820	0.8	Blu/Blk	A1, S6
822	0.8	Pnk/Wht	S6, A1
824	0.8	Pnk/Wht	W5, S5
825	0.8	Pnk/Blk	W5, S5



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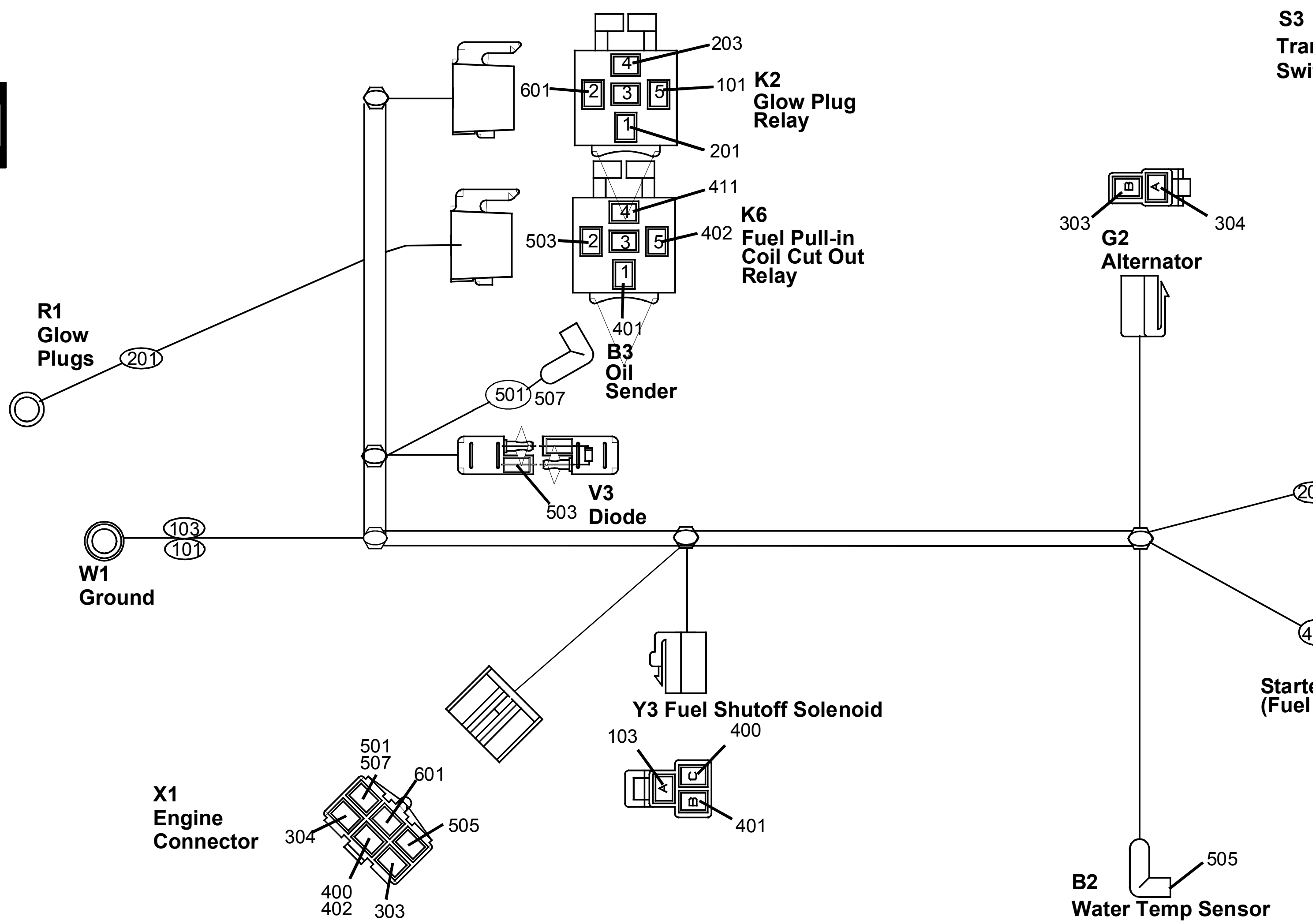
WIRING HARNESS DIAGRAM (S.N. —060554)

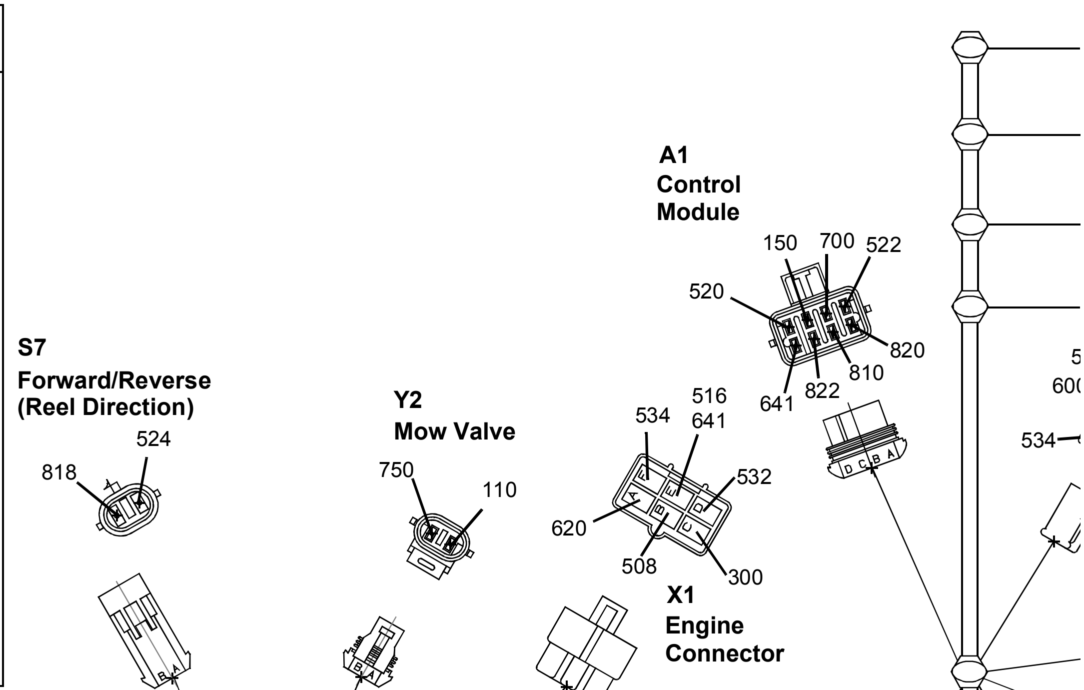
Circuit Number	Wire Size	Wire Color	Termination Point
100	0.8	Blk	K3, W3
101	0.8	Blk	K2, W1
103	1.0	Blk	Y3, W1
105	0.8	Blk	K4, K3
110	0.8	Blk	Y2, W3
115	0.8	Blk	Not used (fuel pump, W3)
125	0.8	Blk	K4, K1
130	3.0	Blk	U1, W2
145	0.8	Blk	H4, W4
150	0.8	Blk	A1, W4
155	0.8	Blk	Y1, Fuel Pump
160	0.8	Blk	S1, W4
165	0.8	Blk	R1, S1
200	0.8	Fus Lnk	B+, F2
201	3.0	Red	K2, R1
202	0.8	Fus Lnk	F3
203	3.0	Red	K2, Starter
204	2.0	Red	F2, U1
206	2.0	Red/Wht	F2, F1
208	2.0	Red/Blk	F1, S1
212	0.8	Red	K1, F3
300	0.8	Org/Wht	H2, X1
301	0.8	Org	H2, V2

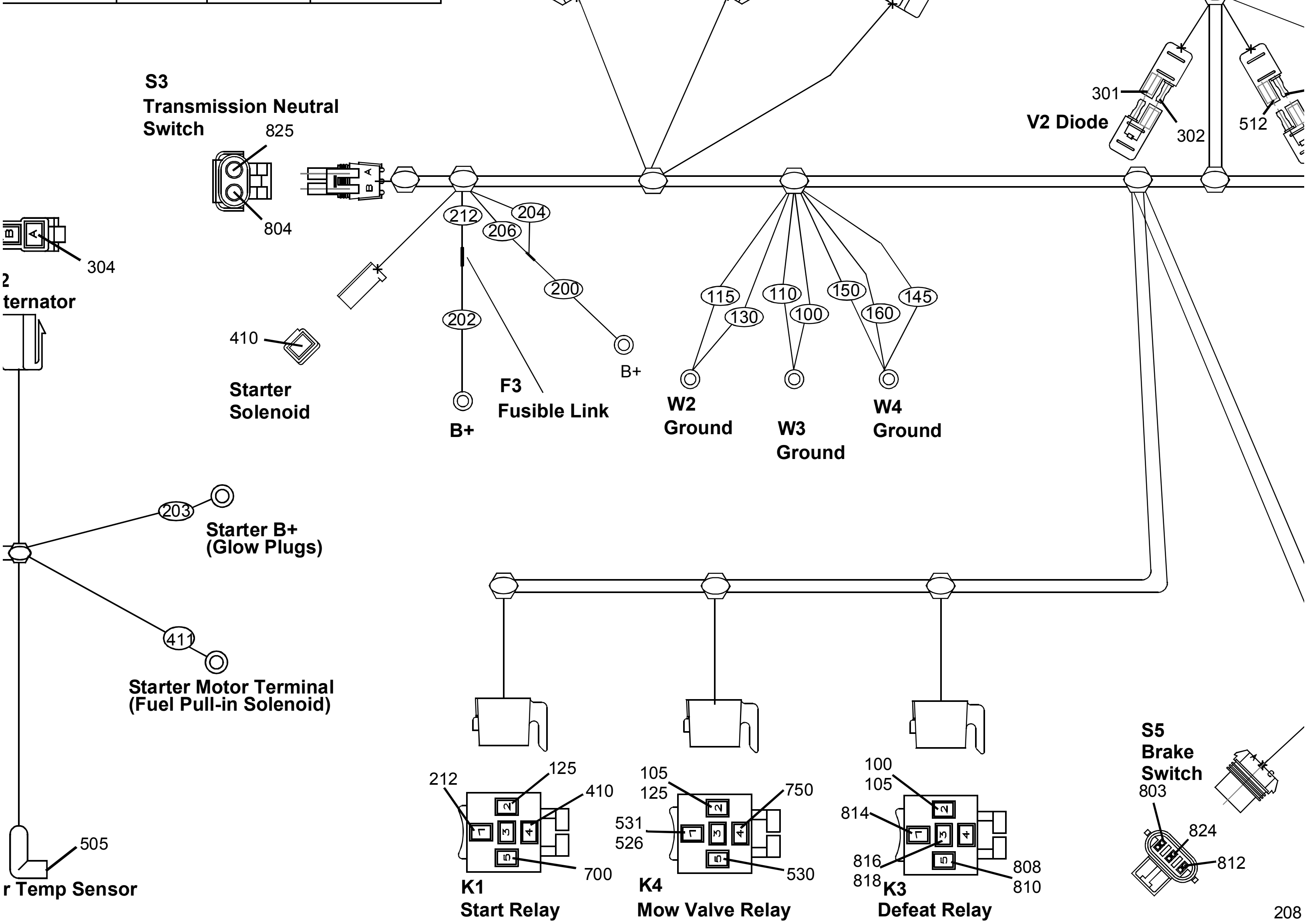
Circuit Number	Wire Size	Wire Color	Termination Point
302	0.8	Org/Wht	V2, S1
303	3.0	Brn	G2, X1
304	3.0	Brn	X1, G2
400	1.0	Pnk/Blk	X1, Y3
401	3.0	Wht	Y3, K6
402	0.8	Pnk	K6, X1
410	2.0	Yel/Blk	K1, Starter
411	3.0	Wht	K6, Starter
500	0.8	Yel	S1, H1
501	0.8	Tan	X1, K2
502	0.8	Yel/Blk	H1, H2
503	1.0	Tan	V3, K6
504	0.8	Yel/Wht	H2, H3
505	0.8	Org/Wht	X1, B2
507	1.0	Tan	X1, B3
508	0.8	Yel	S2, X1
510	0.8	Yel	B1, H1
512	0.8	Yel	H1, V1
514	0.8	Yel	V1, S1
516	0.8	Yel	Fuel pump, X1
518	0.8	Yel	S1, U1
520	0.8	Yel	S1, A1
524	0.8	Yel	S7, A1
526	0.8	Yel/Blk	S6, K4

Circuit Number	Wire S
528	0.8
530	0.8
531	0.8
532	3.0
534	3.0
600	0.8
601	0.8
620	0.8
640	0.8
700	0.8
750	0.8
800	0.8
803	0.8
804	0.8
806	0.8
808	0.8
810	0.8
812	0.8
814	0.8
816	0.8
818	0.8
820	0.8
822	0.8
824	0.8
825	0.8



rcuit Number	Wire Size	Wire Color	Termination Point
528	0.8	Yel	S6, Y1
530	0.8	Yel	K4, S8
531	0.8	Yel	K1, S8
532	3.0	Brn	U1, X1
534	3.0	Brn	U1, X1
600	0.8	Grn	H4, U1
601	0.8	Yel	K2, X1
620	0.8	Tan	X1, H3
640	0.8	Org	R2, Fuel pump
700	0.8	Pur	A1, K1
750	0.8	Pur	Y2, K4
800	0.8	Pnk/Blk	S6, S1
803	0.8	Pnk	S5, S6
804	0.8	Pnk	S2, S3
806	0.8	Pnk/Blk	W5, S4
808	0.8	Pnk	S4, K3
810	0.8	Pnk	K3, A1
812	0.8	Pnk/Blk	S6, S5
814	0.8	Pnk/Wht	K3, S6
816	0.8	Blu	K3, A1
818	0.8	Blu/Wht	S7, K3
820	0.8	Blu/Blk	A1, S6
822	0.8	Pnk/Wht	S6, A1
824	0.8	Pnk/Wht	W5, S5
825	0.8	Pnk/Blk	W5, S5





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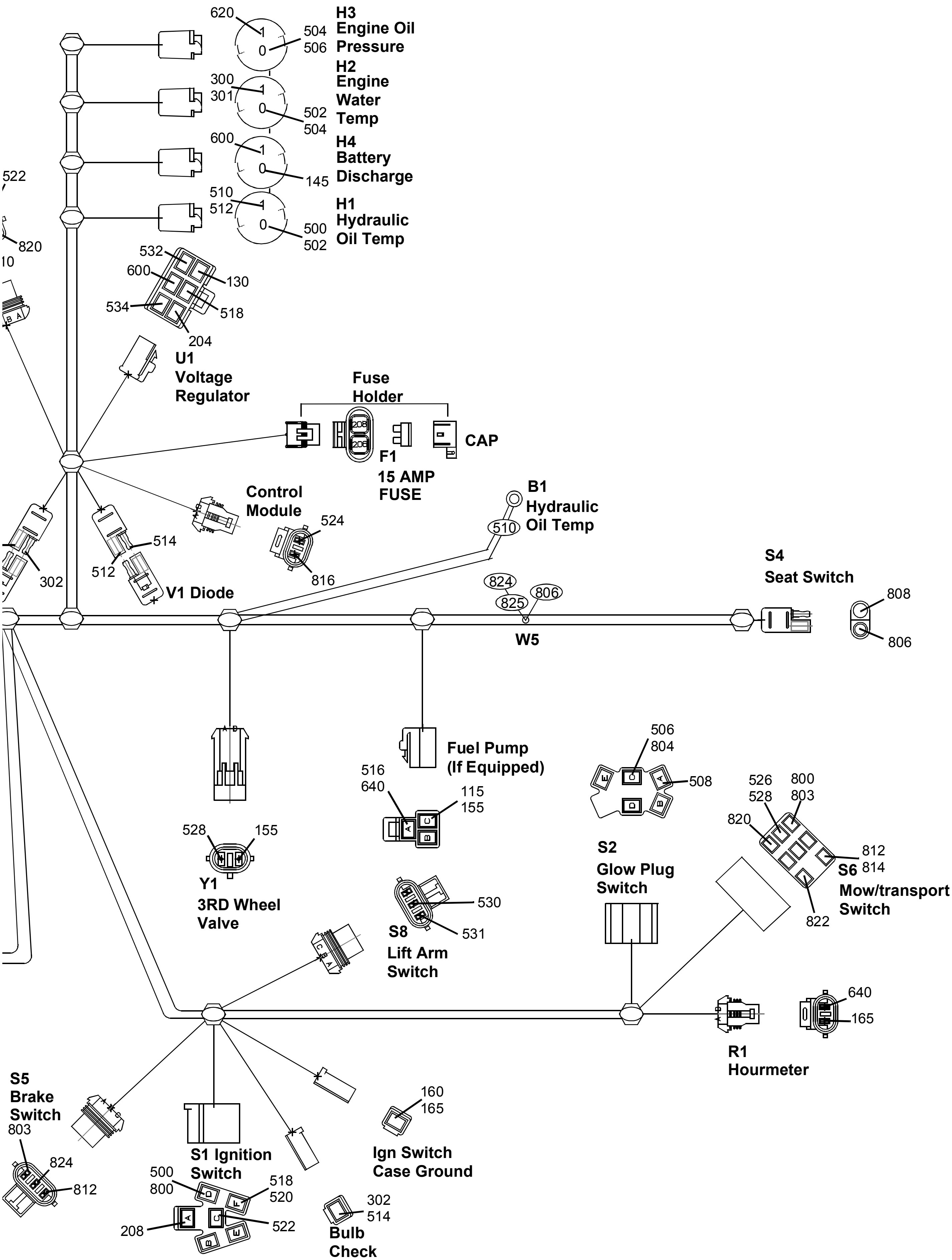


620
1
504
0
506
H3
Engine Oil
Pressure
300
301
502
504
H2
Engine
Water
Temp
600
145
H4
Battery
Discharge
510
512
500
502
H1
Hydraulic
Oil Temp
522
820
532
600
534
130
518
204
U1
Voltage
Regulator
Fuse
Holder
208
206
CAP
F1
15 AMP
FUSE
Control
Module
524
816
B1
Hydraulic
Oil Temp
510
514
512
302
V1 Diode
824
825
806
W5
S4
Seat Switch
808
806
Fuel Pump
(If Equipped)
516
640
115
155
528
155
Y1
3RD Wheel
Valve
530
531
S8
Lift Arm
Switch
506
804
508
S2
Glow Plug
Switch
526
528
800
803
820
812
814
S6
Mow/transport
Switch
822
640
165
R1
Hourmeter
S5
Brake
Switch
803
824
812
S1 Ignition
Switch
500
800
518
520
208
522
160
165
Ign Switch
Case Ground
302
514
Bulb
Check

THEORY AND DIAGNOSTIC INFORMATION

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 leader line points to the exact point the test is to be made.

WIRE COLOR ABBREVIATION CHART

Blk	Black
Blu	Blue
Brn	Brown
Grn	Green
Gry	Gray
Org	Orange
Pnk	Pink
Pur	Purple
Red	Red
Tan	Tan
Wht	White
Yel	Yellow
Blk/Wht	Black/White
Blu/Wht	Blue/White
Brn/Wht	Brown/White
Brn/Yel	Brown/Yellow
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
Lt Blue	Light Blue
Lt Grn	Light Green
Org/Wht	Orange/White
Pnk/Blk	Pink/Black
Pur/Wht	Purple/White
Red/Blk	Red/Black
Red/Wht	Red/White
Wht/Blk	White/Black
Wht/Red	White/Red
Yel/Blk	Yellow/Black
Yel/Red	Yellow/Red
Yel/Wht	Yellow/White

THEORY OF OPERATION

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:

- Ignition switch **S1** in the START position.
- Travel pedal **S3** must be in NEUTRAL position.
- Mow switch **S6** must be in the OFF position.
- Parking brake **S5** ON.

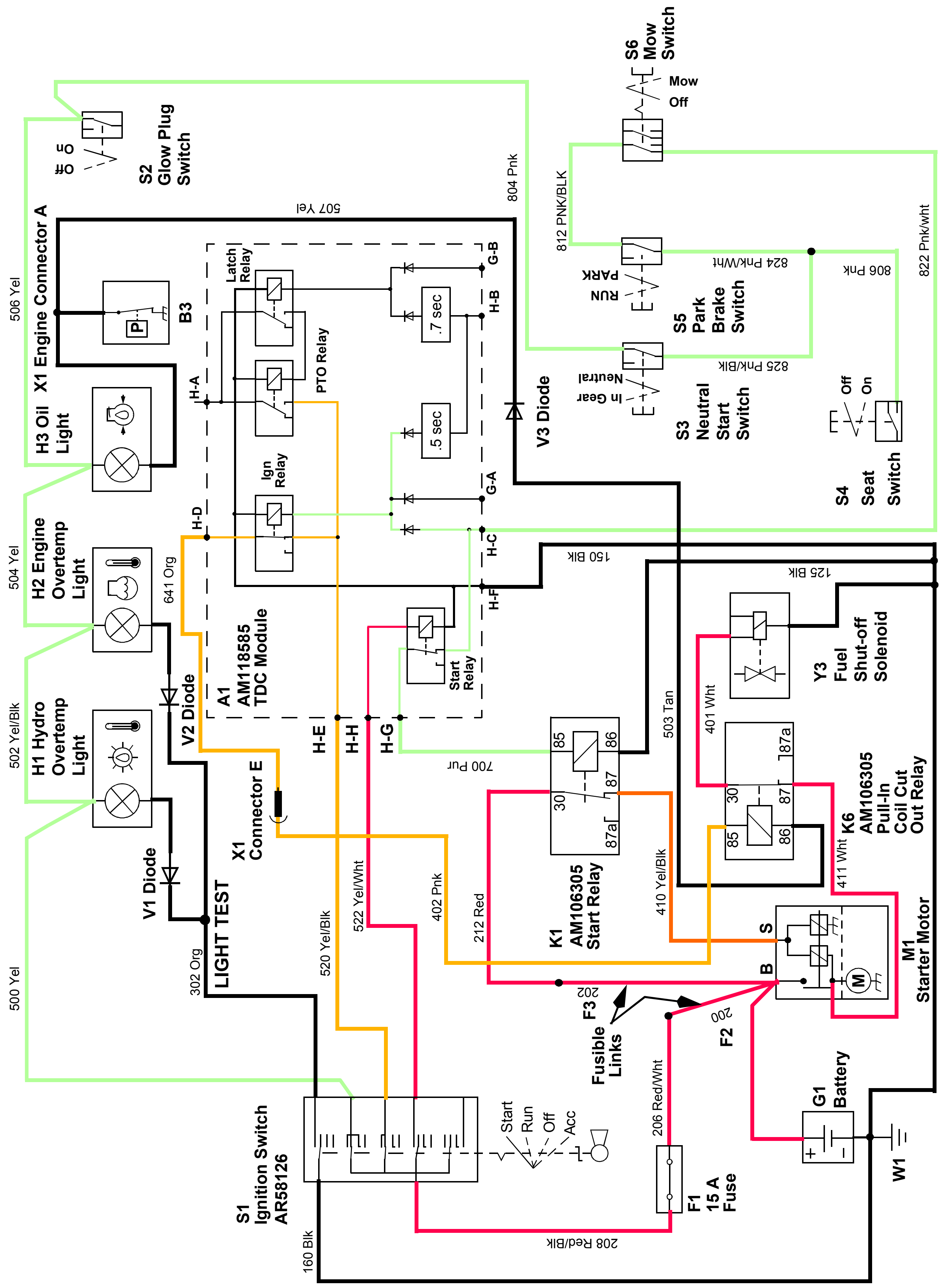
Theory of Operation:

The battery **G1** is connected to a tie point at the starter, the ignition switch **S1** is connected to the same tie point through a fusible link **F2** and a 15 amp fuse **F1**. When the ignition switch is turned to the START position, the starter relay, located inside the TDC module **A1** is energized. 12 V switched power is also available at the neutral start switch **S3** through the ignition switch in the START or RUN position. If the transmission is in NEUTRAL, voltage flows to the park brake switch **S5**. With the park brake engaged, voltage flows through the mow switch **S6** (OFF position) to the main contacts of the starter relay inside the TDC module.

The TDC module start relay energizes the main starter relay **K1** allowing current to flow from the battery tie point on the starter, through a fusible link **F3**, contacts of the main start relay and thus energizing the starter motor **M1** to crank the engine.

The fuel shutoff solenoid **Y3** pull-in circuit is energized through the main contacts of the pull-in coil cut out relay **K6**. The relay is energized when the starter solenoid receives power at the S terminal of the starter motor. A ground path for the relay is provided through the **V4** diode and the oil pressure switch **B3**.

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


S2 Glow Plug Switch
Off
On
X1 Engine Connector A
B3
H3 Oil Light
H2 Engine Overtemp Light
H1 Hydro Overtemp Light
V1 Diode
V2 Diode
V3 Diode
LIGHT TEST
506 Yel
504 Yel
502 Yel/Blk
500 Yel
507 Yel
641 Org
302 Org
804 Pnk
Latch Relay
PTO Relay
Ign Relay
Start Relay
.7 sec
.5 sec
H-A
H-B
H-C
H-D
H-E
H-F
H-G
H-H
G-A
G-B
A1 AM118585 TDC Module
X1 Connector E
520 Yel/Blk
522 Yel/Wht
402 Pnk
212 Red
700 Pur
S6 Mow Switch
Mow
Off
812 PNK/BLK
824 Pnk/Wht
806 Pnk
822 Pnk/wht
RUN
PARK
S5 Park Brake Switch
825 Pnk/Blk
Neutral
In Gear
S3 Neutral Start Switch
Off
On
S4 Seat Switch
150 Blk
125 Blk
Y3 Fuel Shut-off Solenoid
503 Tan
401 Wht
K1 AM106305 Start Relay
K6 AM106305 Pull-In Coil Cut Out Relay
410 Yel/Blk
411 Wht
S
B
M1 Starter Motor
202
F3
Fusible Links
200
F2
G1 Battery
W1
206 Red/Wht
F1 15 A Fuse
208 Red/Blk
160 Blk
S1 Ignition Switch AR58126
Start
Run
Off
Acc

IGNITION 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:

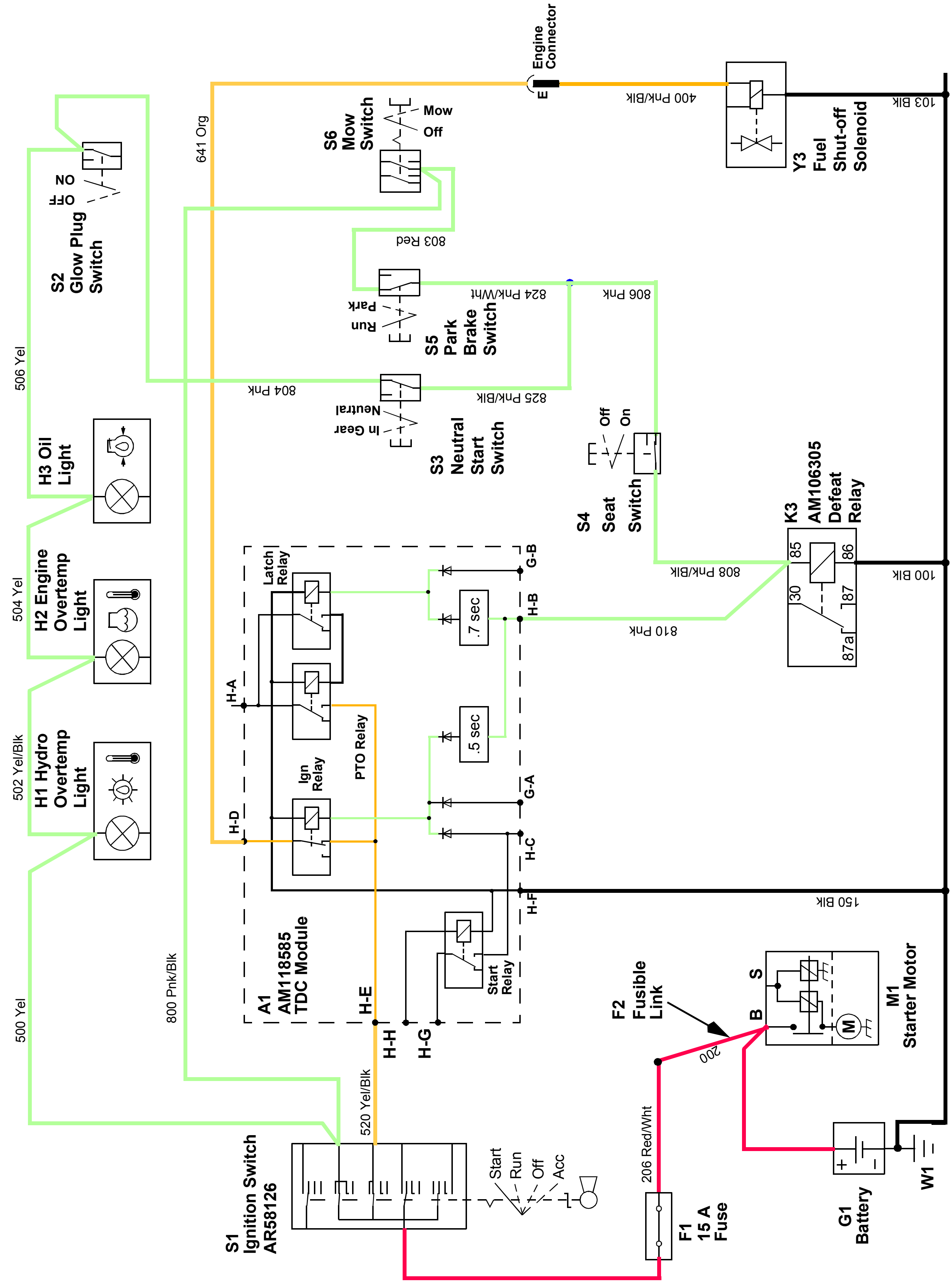
- Ignition switch **S1** in the RUN position.
- Operator on seat **S4** and parking brake OFF **S5** or operator on seat and travel pedal **S3** in NEUTRAL.

Theory of Operation:

With the ignition switch **S1** in the RUN position and operator on the seat **S4**, voltage flows from the ignition switch through the neutral start switch **S3** (NEUTRAL), the seat switch (operator on seat) and into the TDC Module **A1**. Voltage then flows through a 0.5 sec. delay timer and energizes the Ignition Relay.

If the transmission is in gear, voltage flows from the ignition Switch through the park brake switch **S5** (OFF), the seat switch (operator on seat) and into the TDC Module. Voltage then flows through a 0.5 sec. delay timer and energizes the Ignition Relay.

Either situation allows voltage coming from the ignition switch to flow through the main contacts of the ignition relay and to the fuel shutoff solenoid **Y3**, providing fuel flow and allowing the engine to run.


Engine Connector
E
400 Pnk/Blk
103 Blk
Y3 Fuel Shut-off Solenoid
641 Org
S6 Mow Switch
Mow
Off
803 Red
S2 Glow Plug Switch
ON
OFF
506 Yel
S5 Park Brake Switch
Park
Run
824 Pnk/Wht
806 Pnk
804 Pnk
825 Pnk/Blk
Neutral
In Gear
S3 Neutral Start Switch
Off
On
S4 Seat Switch
H3 Oil Light
504 Yel
H2 Engine Overtemp Light
502 Yel/Blk
H1 Hydro Overtemp Light
K3 AM106305 Defeat Relay
85
86
30
87
87a
808 Pnk/Blk
100 Blk
810 Pnk
Latch Relay
G-B
H-B
.7 sec
H-A
.5 sec
Ign Relay
PTO Relay
G-A
H-D
H-C
H-F
150 Blk
Start Relay
A1 AM118585 TDC Module
H-E
H-H
H-G
800 Pnk/Blk
500 Yel
F2 Fusible Link
S
B
M1 Starter Motor
200
520 Yel/Blk
206 Red/Wht
S1 Ignition Switch AR58126
Start
Run
Off
Acc
F1 15 A Fuse
G1 Battery
W1

IGNITION (RUN) CIRCUIT OPERATION—OPERATOR OFF SEAT

Function:

With an operator off the seat, allows the engine to run after the ignition switch is released to the RUN position (starter disengaged).

Operating Conditions:

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

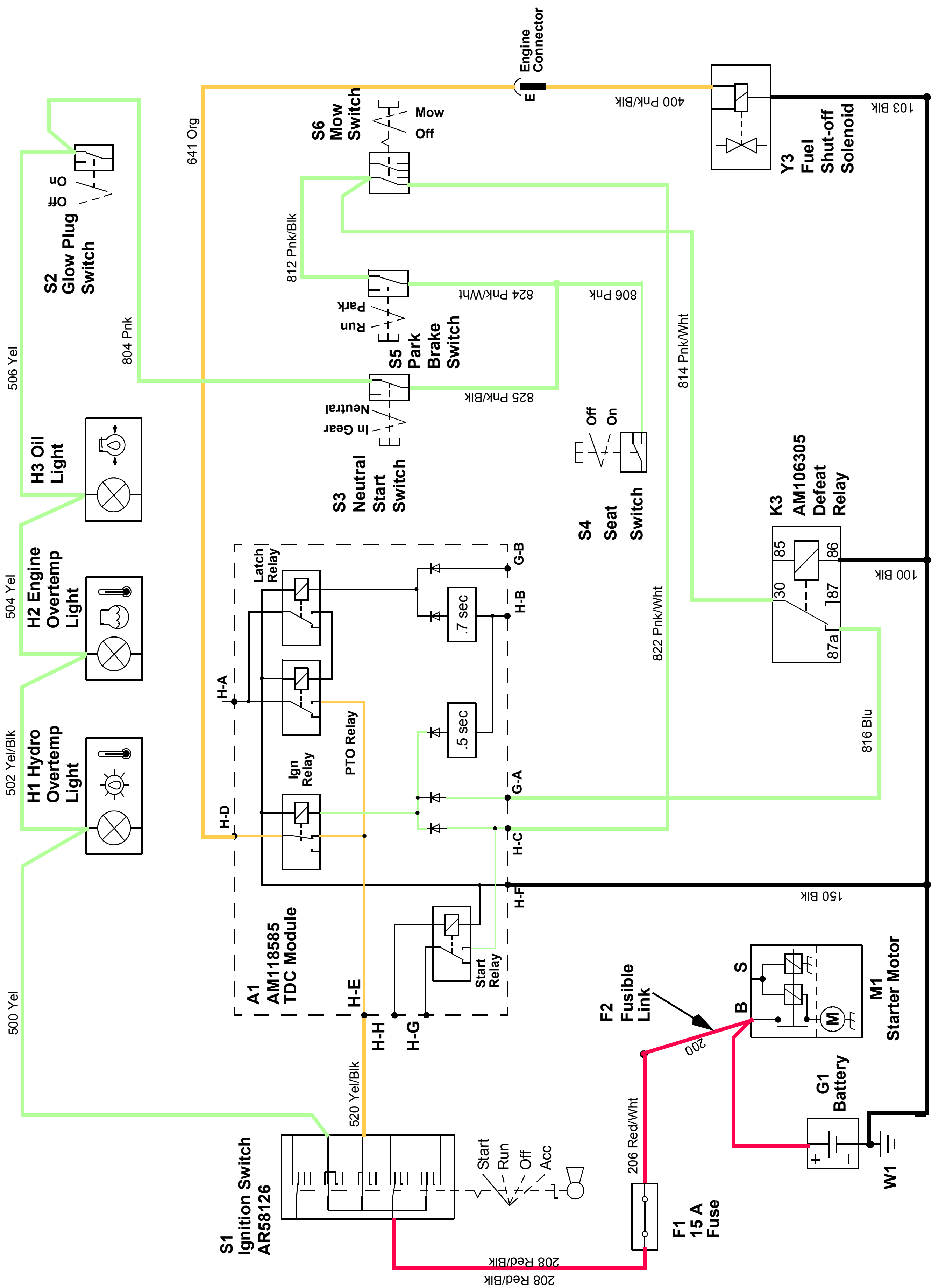
For the engine to continue to run, the following conditions must be met:

- Ignition switch **S1** in the RUN position.
- Travel pedal **S3** must be in NEUTRAL position.
- Mow switch **S6** must be in the OFF position.
- Operator OFF seat **S4**.
- Parking brake **S5** ON.

Theory of Operation:

With the Ignition switch **S1** in the RUN position and operator OFF the seat **S4**, voltage flows from the Ignition switch through the neutral start switch **S3**, the park brake switch **S5** (ON) and mow switch **S6** (OFF). Voltage then flows into the TDC module **A1**, by-passing the 0.5 second time delay and activating the ignition relay.

This creates a path for the voltage coming from the Ignition switch to pass through the main contacts of the ignition relay and on to the fuel shutoff solenoid **Y3** providing fuel flow and allowing the engine to run.



S1 Ignition Switch AR58126
Start
Run
Off
Acc
F1 15 A Fuse
F2 Fusible Link
G1 Battery
W1
M1 Starter Motor
B
S
A1 AM118585 TDC Module
Start Relay
Ign Relay
PTO Relay
Latch Relay
.5 sec
.7 sec
H-A
H-B
H-C
H-D
H-E
H-F
H-G
H-H
G-A
G-B
H1 Hydro Overtemp Light
H2 Engine Overtemp Light
H3 Oil Light
S2 Glow Plug Switch
Off
On
S3 Neutral Start Switch
In Gear
Neutral
S4 Seat Switch
S5 Park Brake Switch
Run
Park
S6 Mow Switch
Mow
K3 AM106305 Defeat Relay
85
86
30
87
87a
Y3 Fuel Shut-off Solenoid
Engine Connector
E
100 Blk
103 Blk
150 Blk
200
206 Red/Wht
208 Red/Blk
208 Red/Blk
400 Pnk/Blk
500 Yel
502 Yel/Blk
504 Yel
506 Yel
520 Yel/Blk
641 Org
804 Pnk
806 Pnk
812 Pnk/Blk
814 Pnk/Wht
816 Blu
822 Pnk/Wht
824 Pnk/Wht
825 Pnk/Blk

MOW CIRCUIT (3 WHEEL DRIVE)

Function:

To allow reels to turn and, at the same time, engage the Third Wheel Drive.

Operating Conditions:

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

- Ignition switch **S1** in the RUN position.
- Park brake **S5** disengaged (OFF).
- Mow switch **S6** (OFF) initially, then (ON).
- Operator ON seat **S4**.
- Reels in LOWERED position **S8**.

Theory of Operation:

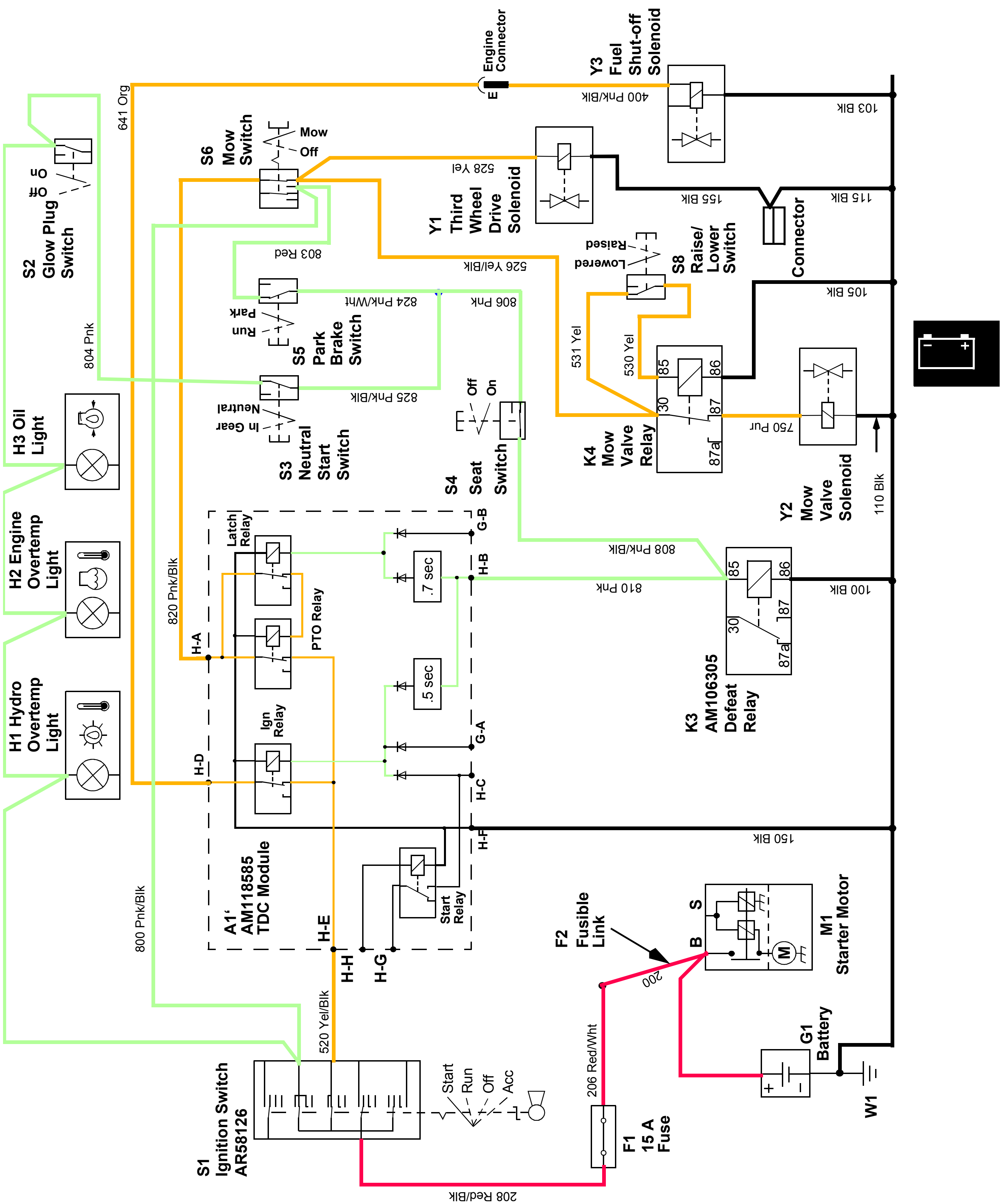
With the ignition switch **S1** in the RUN position, voltage flows from the ignition switch, through the park brake switch **S5** (OFF) and to the seat switch **S4**. With the operator ON the seat, voltage flows into the TDC Module **A1** and through the time delays to energize the latch relay and keep the ignition relay energized. At this time voltage from the mow switch **S6** (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 ignition 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 **S8** (LOWERED) and energizes the mow valve solenoid **Y2**. Voltage from the mow switch also energizes the third wheel drive solenoid **Y1**.

Mow Shutoff Valve (if equipped):

Voltage from the mow switch energizes the third wheel drive solenoid **Y1** and powers the relay inside the off delay timer **A2**. Voltage now passes through the main contacts of the relay inside the off delay timer and energizes the mow shutoff valve **K5** and the mow shutoff valve opens. When the mow switch is turned off a two second delay from the off delay timer prevents the mow shutoff valve from closing immediately allowing the reels to slow down before shutting off the flow of fluid to the reel motors. This prevents cavitation of the reel motors.


S1
Ignition Switch
AR58126
Start
Run
Off
Acc
F1
15 A
Fuse
208 Red/Blk
206 Red/Wht
200
F2
Fusible
Link
G1
Battery
W1
M1
Starter Motor
B
S
150 Blk
520 Yel/Blk
800 Pnk/Blk
H-H
H-G
H-E
A1'
AM118585
TDC Module
Start
Relay
H-F
H-C
H-D
Ign
Relay
G-A
.5 sec
H-A
PTO Relay
.7 sec
H-B
Latch
Relay
G-B
820 Pnk/Blk
H1 Hydro
Overtemp
Light
H2 Engine
Overtemp
Light
H3 Oil
Light
S2
Glow Plug
Switch
On
Off
804 Pnk
641 Org
S6
Mow
Switch
Mow
Off
803 Red
S5
Park
Brake
Switch
Run
Park
824 Pnk/Wht
S3
Neutral
Start
Switch
In Gear
Neutral
825 Pnk/Blk
S4
Seat
Switch
Off
On
808 Pnk
528 Yel
526 Yel/Blk
Y1
Third
Wheel
Drive
Solenoid
Engine
Connector
E
400 Pnk/Blk
Y3
Fuel
Shut-off
Solenoid
103 Blk
155 Blk
115 Blk
Connector
S8
Raise/
Lower
Switch
Raised
Lowered
531 Yel
530 Yel
K4
Mow
Valve
Relay
85
86
30
87
87a
105 Blk
750 Pur
Y2
Mow
Valve
Solenoid
110 Blk
808 Pnk/Blk
810 Pnk
100 Blk
K3
AM106305
Defeat
Relay

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:

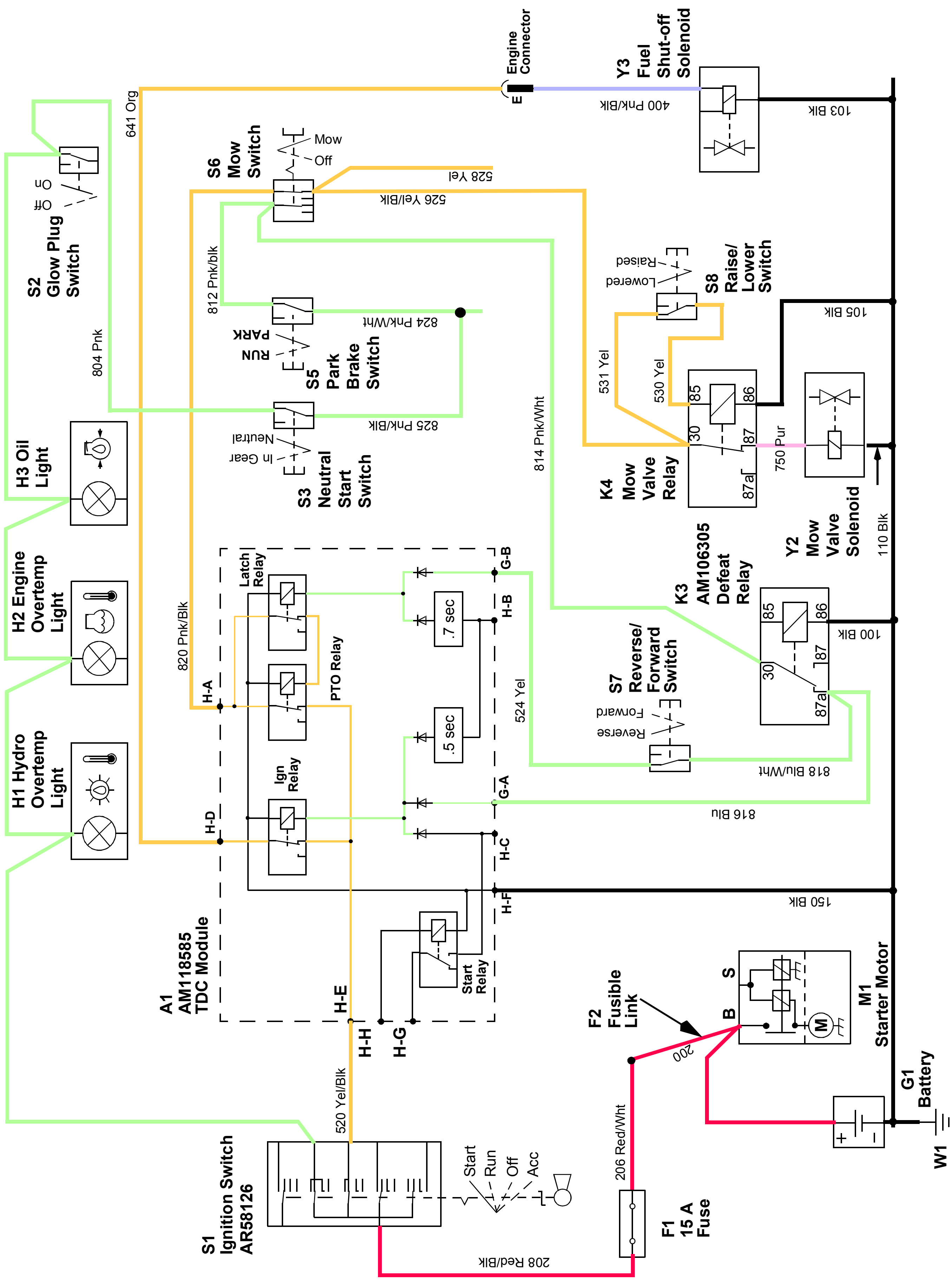
- Ignition switch **S1** in the RUN position.
- Travel pedal **S3** in NEUTRAL.
- Park brake **S5** engaged (ON).
- Mow switch **S6** (OFF) initially, then (ON).
- Operator OFF seat **S4**.
- Reels in LOWERED position **S8**.
- Forward/reverse switch **S7** in REVERSE position.

Theory Of Operation:

With the ignition switch **S1** in the RUN position, voltage travels through the neutral start switch **S3** (NEUTRAL), the park brake switch **S5** (BRAKE ON) to a tie point at the mow switch **S6** (NEUTRAL) and to the defeat relay **K3**. With the operator off the seat **S4**, the defeat relay is de-energized, allowing voltage from the brake switch to keep the ignition relay energized and provide voltage through the forward/reverse switch **S7** (REVERSE) to energize the latch relay. 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 ignition 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 **S8** (LOWERED) and energizes the mow valve solenoid **Y2**.


S2 Glow Plug Switch
Off
On
804 Pnk
641 Org
H3 Oil Light
H2 Engine Overtemp Light
H1 Hydro Overtemp Light
S6 Mow Switch
Mow
Off
528 Yel
526 Yel/Blk
812 Pnk/blk
S5 Park Brake Switch
RUN
PARK
824 Pnk/Wht
S3 Neutral Start Switch
In Gear
Neutral
825 Pnk/Blk
820 Pnk/Blk
814 Pnk/Wht
A1 AM118585 TDC Module
Latch Relay
PTO Relay
Ign Relay
Start Relay
.7 sec
.5 sec
H-A
H-B
H-C
H-D
H-E
H-F
H-G
H-H
G-A
G-B
524 Yel
520 Yel/Blk
S1 Ignition Switch AR58126
Start
Run
Off
Acc
208 Red/Blk
206 Red/Wht
F1 15 A Fuse
F2 Fusible Link
200
Engine Connector
E
400 Pnk/Blk
Y3 Fuel Shut-off Solenoid
103 Blk
S8 Raise/ Lower Switch
Raised
Lowered
531 Yel
530 Yel
105 Blk
K4 Mow Valve Relay
750 Pur
Y2 Mow Valve Solenoid
110 Blk
K3 AM106305 Defeat Relay
100 Blk
S7 Reverse/ Forward Switch
Reverse
Forward
818 Blu/Wht
816 Blu
150 Blk
M1 Starter Motor
S
B
M
G1 Battery
W1

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"
Transmission not in neutral or neutral start 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			●							●			
Defeat relay defective			●										

TROUBLESHOOTING

Check or Solution / Problem or Symptom	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”
Seat switch defective					●								
Park brake 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 pinion return mechanism													●
Worn pinion or ring gear												●	

DIAGNOSTICS

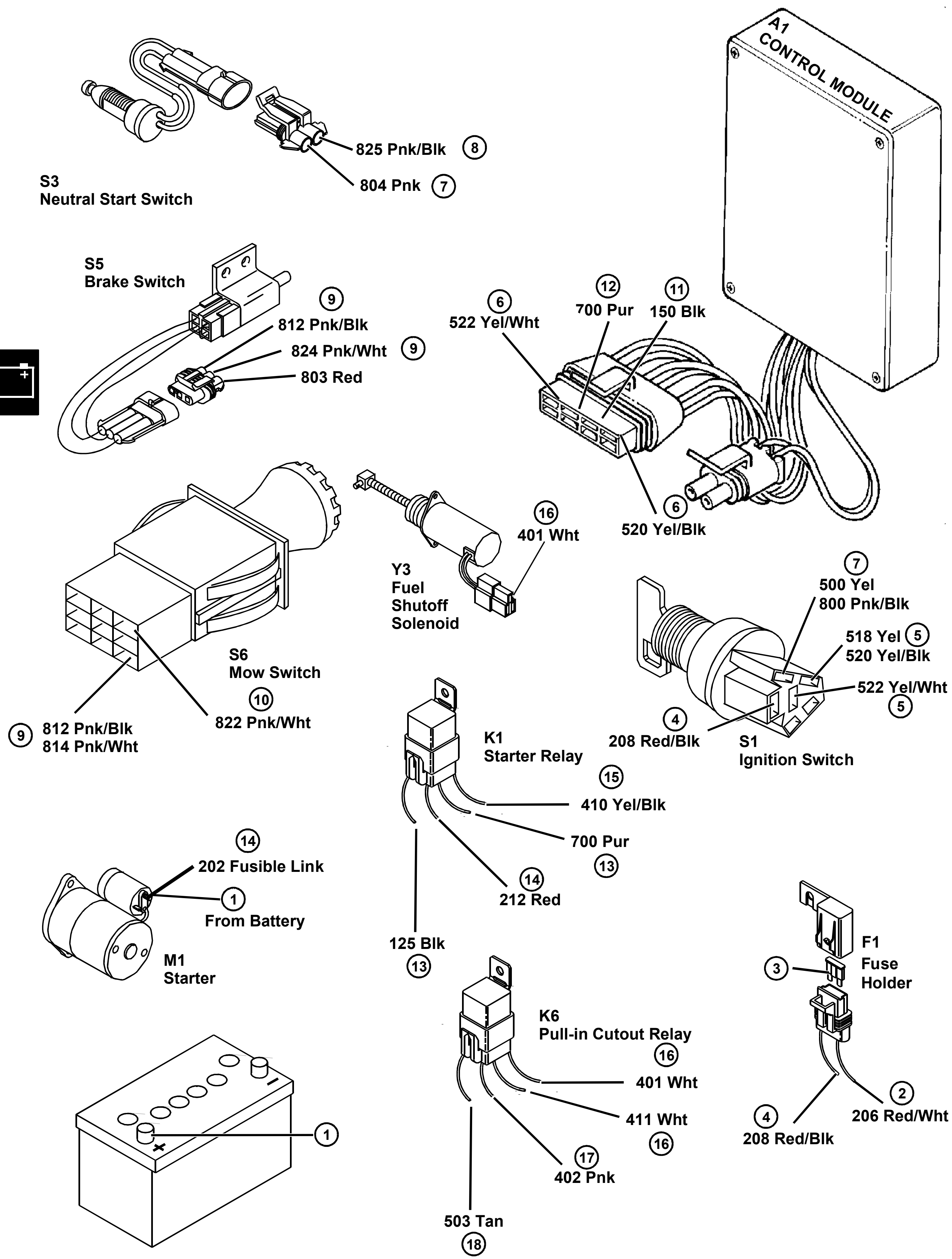
CRANKING CIRCUIT TEST POINTS

Test Conditions:

- Mow switch **S6** "OFF"
- Ignition switch **S1** "START"
- Park brake **S5** engaged
- Transmission **S3** in Neutral

Test/Check Point	Normal	If Not Normal
1. Starter **M1** positive terminal	11.8—13.2 volts	Check battery connections and test battery
2. Fuse **F1**	11.8—13.2 volts	Test 200 fusible link, 206 Red/Wht, and fuse connections
3. Fuse	Continuity	Replace fuse
4. Ignition switch **S1**	11.8—13.2 volts	Test 208 Red/Blk. If no voltage repair/replace wire harness.
5. Ignition switch	11.8—13.2 volts	Check ignition switch connections 522 Yel/Wht and 520 Yel/Blk. If no voltage replace switch.
6. Control module **A1**	11.8—13.2 volts	Test 522 Yel/Wht at module terminal H-H, and 520 Yel/Blk at module terminal H-E. If no voltage repair/ replace wire harness.
7. Neutral start switch **S3**	11.8—13.2 volts	Test 804 Pnk at neutral switch. If no voltage check 500 Yel at Ignition switch. Replace switch if bad. If voltage at ignition switch check 506 Yel at glow plug switch, and 504 Yel at oil light, and 502 Yel/Blk at engine overtemp light. If no voltage at any of these replace or repair wire harness.
8. Neutral start switch	11.8—13.2 volts	Insure that neutral switch is in neutral position and check voltage at 825 Pnk/Blk. If no voltage replace switch.
9. Park brake switch **S5**	11.8—13.2 volts	Insure that park brake switch is in park position. Test 812 Pnk/Blk between mow switch and park brake switch. Test 824 Pnk/Wht and 825 Pnk/Blk between the brake switch and the neutral start switch.
10. Mow switch **S6**	11.8—13.2 volts	Ensure mow switch is OFF. Test 822 Pnk/Wht to the control module. if no voltage replace mow switch.
11. Control module	Ground	Test 150 Blk connections, if no ground repair/replace wire harness. If ground is good replace module with a known good module and test for voltage on terminal H-G, 700 Pur again.
12. Control module	11.8—13.2 volts	Test 700 Pur to start relay. If no voltage replace module with a known good module and test again.

Test/Check Point	Normal	If Not Normal
13. Start relay **K1**	11.8—13.2 volts and a clicking sound when ignition switch is placed to “START”	If no voltage is present, test 700 Pur, if voltage is present and no clicking sound is heard, test 125 Blk and relay.
14. Start relay	11.8—13.2 volts	Test 202 fusible link, and 212 Red.
15. Starter solenoid	11.8—13.2 volts	Test 410 Yel/Blk If voltage present and starter does not work replace starter.
16. Fuel shutoff solenoid **Y3**	11.8—13.2 volts	Test 401 Wht, if voltage is present and solenoid does not click or open, replace fuel shutoff solenoid. If no voltage present test for voltage at pull-in cutout relay, 401 Wht.
17. Pull-in cutout relay **K6**	11.8—13.2 volts	Test 411 Wht, if voltage is present test 402 Pnk, if no voltage is present, repair wiring harness. *NOTE: If hourmeter is operational, the problem exists either at the* ***X1*** *engine connector or between the connector and the relay.*
18. Pull-in cutout relay	Ground	Test for ground at 503 Tan, if no continuity test the **V3** diode. *NOTE: If the V3 diode is good and the oil pressure light goes out when the engine is cranked, the problem exists between the X1 connector and the relay.*
NOTE: These tests do not always 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.		


A1
CONTROL MODULE
825 Pnk/Blk 8
804 Pnk 7
S3
Neutral Start Switch
S5
Brake Switch
9
812 Pnk/Blk
824 Pnk/Wht 9
803 Red
6
522 Yel/Wht
12
700 Pur
11
150 Blk
6
520 Yel/Blk
16
401 Wht
Y3
Fuel
Shutoff
Solenoid
7
500 Yel
800 Pnk/Blk
518 Yel 5
520 Yel/Blk
522 Yel/Wht
5
4
208 Red/Blk
S1
Ignition Switch
S6
Mow Switch
10
822 Pnk/Wht
9
812 Pnk/Blk
814 Pnk/Wht
K1
Starter Relay
15
410 Yel/Blk
700 Pur
13
14
212 Red
125 Blk
13
14
202 Fusible Link
1
From Battery
M1
Starter
F1
Fuse
Holder
3
2
206 Red/Wht
4
208 Red/Blk
K6
Pull-in Cutout Relay
16
401 Wht
411 Wht
16
17
402 Pnk
503 Tan
18
1

IGNITION TEST POINTS—OPERATOR ON SEAT

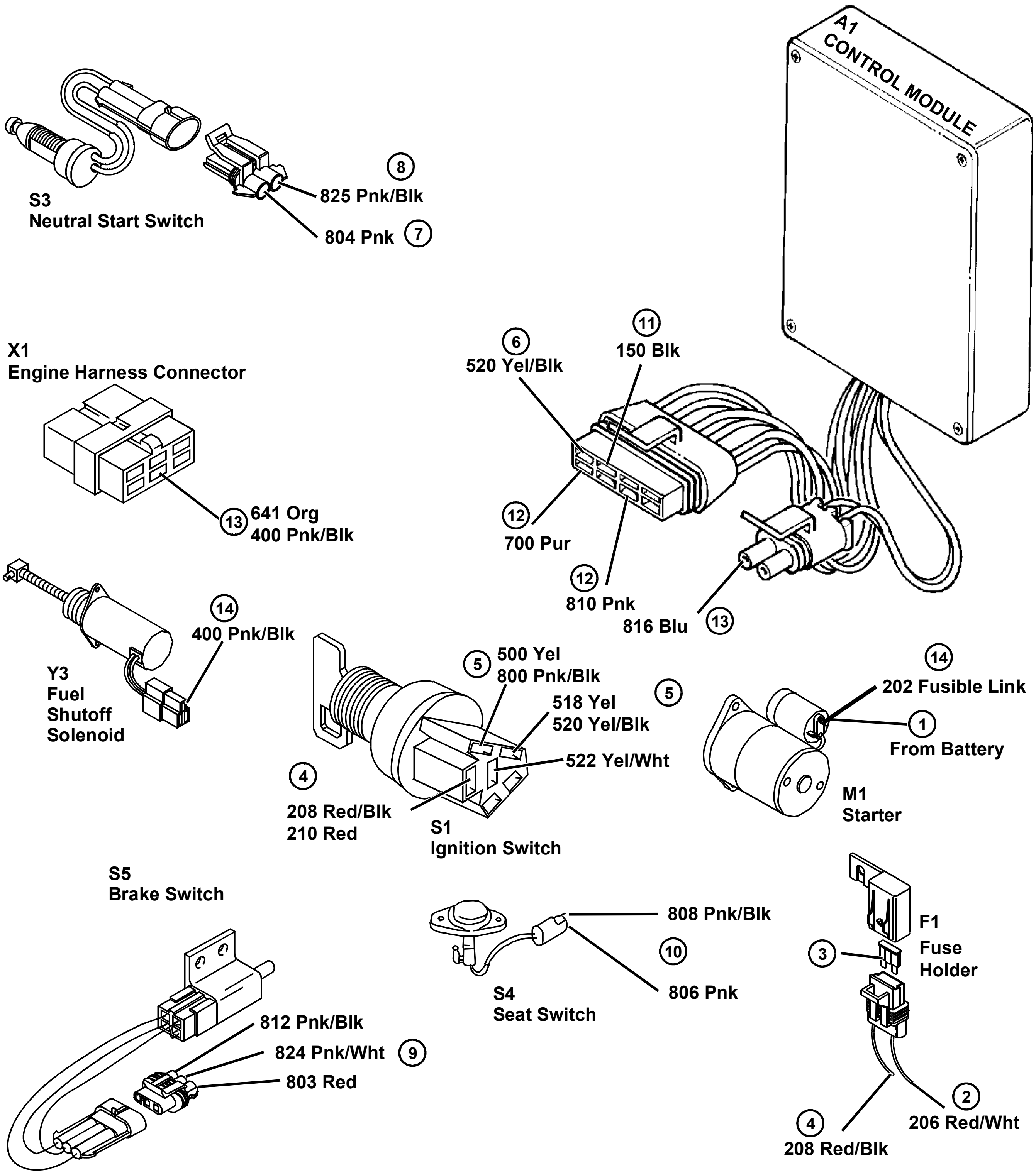
Test Conditions:

- Engine cranks
- Park brake **S5** disengaged
- Operator ON seat **S4**
- Battery fully charged
- Transmission **S3** in NEUTRAL
- Ignition switch **S1** in RUN position

Test/Check Point	Normal	If Not Normal
1. Starter **M1** positive terminal	11.8—13.2 volts	Check battery connections and test battery
2. Fuse **F1**	11.8—13.2 volts	Test 200 fusible link, 206 Red/Wht, and fuse connections
3. Fuse	Continuity	Replace fuse
4. Ignition switch **S1**	11.8—13.2 volts	Test 208 Red/Blk. If no voltage repair/replace wire harness.
5. Ignition switch	11.8—13.2 volts	Check ignition switch connections 520 Yel/Blk, 800 Pnk/Blk, 500 Yel. If no voltage replace switch.
6. Control module **A1**	11.8—13.2 volts	Test 520 Yel/Blk at module terminal H-E. If no voltage repair/replace wire harness.
7. Neutral start switch **S3**	11.8—13.2 volts	Test 804 Pnk at neutral switch. If no voltage check 506 Yel at glow plug switch, and 504 Yel at oil light, and 502 Yel/Blk at engine overtemp light. If no voltage at any of these replace/repair wire harness.
8. Neutral start switch	11.8—13.2 volts	Insure that neutral switch is in neutral position and check voltage at 825 Pnk/Blk. If no voltage replace switch.
9. Park brake switch **S5**	11.8—13.2 volts	Insure that park brake switch is in RUN. Test 803 Red between mow switch and park brake switch. If no voltage replace/repair wire harness. Test 824 Pnk/Wht and 825 Pnk/Blk between the brake switch and the neutral start switch. If no voltage at these replace or repair wire harness
10. Seat switch **S4**	11.8—13.2 volts	Test 806 Pnk. If no voltage repair/replace wire harness. Test 808 Pnk/Blk. If no voltage present with operator on seat replace switch.
11. Control module	Ground	Test 150 Blk connections, if no ground repair/replace wire harness. If ground is good replace module with a known good module and test for voltage on terminal H-D, 641 Org.
12. Control module	11.8—13.2 volts	Test 810 Pnk terminal H-B. If no voltage repair/replace wire harness. If voltage present test for voltage on terminal H-D, 641 Org. If no voltage replace module with a known good module.
13. Engine harness connector **X1**	11.8—13.2 volts	Test 641 Org. If no voltage repair/replace wire harness. Test 400 Pnk/Blk. If no voltage repair engine connector.

Test/Check Point	Normal	If Not Normal
14. Fuel shutoff solenoid **Y3**	11.8—13.2 volts	Test 400 Pnk/Blk. If no voltage repair/replace wire harness. If voltage present and fuel solenoid does not work check ground before replacing solenoid.

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.



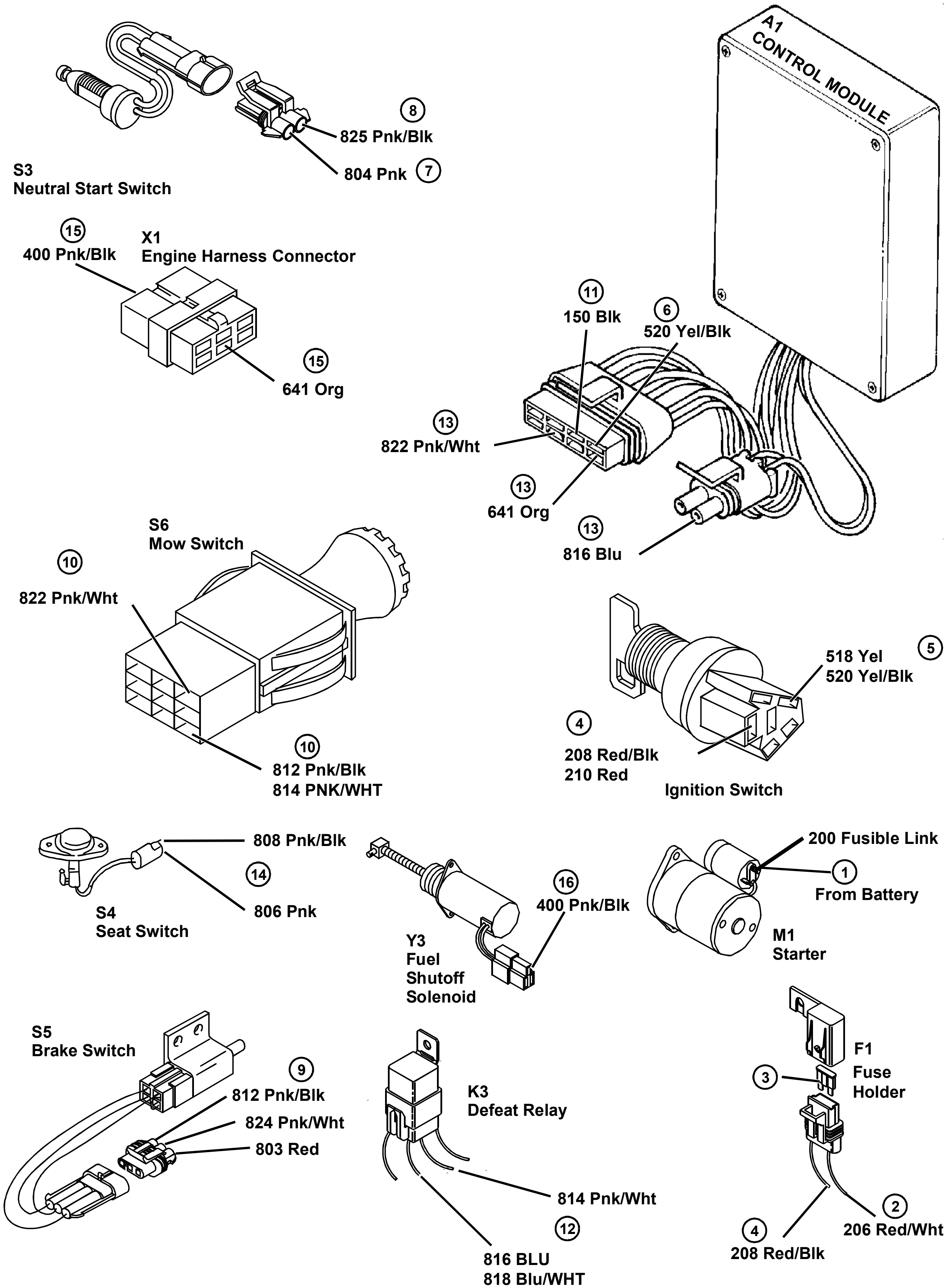
IGNITION TEST POINTS—OPERATOR OFF SEAT

Test Conditions:

- Engine cranks
- Park brake engaged **S5**
- Operator off seat **S4**
- Battery fully charged
- Transmission in NEUTRAL **S3**
- Ignition switch **S1** in RUN position

Test/Check Point	Normal	If Not Normal
1. Starter **M1** positive terminal	11.8—13.2 volts	Check battery connections and test battery
2. Fuse **F1**	11.8—13.2 volts	Test 200 fusible link, 206 Red/Wht, and fuse connections
3. Fuse	Continuity	Replace fuse
4. Ignition switch **S1**	11.8—13.2 volts	Test 208 Red/Blk. If no voltage repair/replace wire harness.
5. Ignition switch	11.8—13.2 volts	Check ignition switch connections 520 Yel/Blk. If no voltage replace switch.
6. Control module **A1**	11.8—13.2 volts	Test 520 Yel/Blk at module terminal H-E. If no voltage repair/replace wire harness.
7. Neutral start switch **S3**	11.8—13.2 volts	Test 804 Pnk at neutral start switch. If no voltage check 506 Yel at glow plug switch, and 504 Yel at Oil Light, and 502 Yel/Blk at engine overtemp Light. If no voltage at any of these check 500 Yel back to ignition switch replace or repair wire harness/ignition switch.
8. Neutral start switch	11.8—13.2 volts	Ensure that neutral start switch is in neutral position and check voltage at 825 Pnk/Blk. If no voltage replace switch.
9. Park brake switch **S5**	11.8—13.2 volts	Insure that park brake switch is in park position. Test 812 Pnk/Blk between mow switch and park brake switch. Test 824 Pnk/Wht and 825 Pnk/Blk between the brake switch and the neutral start switch.
10. Mow switch **S6**	11.8—13.2 volts	Ensure mow switch is OFF. Test 814 Pnk/Wht. If no voltage repair/replace wire harness. Test 822 Pnk/Wht. If no voltage replace mow switch
11. Control module	Ground	Test 150 Blk connections, if no ground repair/ replace wire harness. If ground is good replace module with a known good module and test for voltage on terminal H-D, 641 Org.
12. Defeat Relay **K3**	11.8—13.2 volts	Test 814 Pnk/Wht, if no voltage repair/replace wire harness. Test 816 Blu, If no voltage replace relay.

Test/Check Point	Normal	If Not Normal
13. Control module	11.8—13.2 volts	Test 816 Blu Terminal G-A and 822 Pnk/Wht. If no Voltage repair/replace wire harness. If voltage present test for voltage on terminal H-D, 641 Org. If no voltage replace module with a known good module.
14. Seat switch **S4**	11.8—13.2 volts No Voltage	Test 806 Pnk. If no voltage repair/replace wire harness. Test 808 Pnk/Blk. If Voltage present with operator off seat replace switch.
15. Engine harness connector **X1**	11.8—13.2 volts	Test 641 Org. If no voltage repair/replace wire harness. Test 400 Pnk/Blk. If no voltage repair engine connector.
16. Fuel shutoff solenoid **Y3**	11.8—13.2 volts	Test 400 Pnk/Blk. If no voltage repair/replace wire harness. If voltage present and fuel solenoid does not work check ground before replacing solenoid.
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.		


A1
CONTROL MODULE
8
825 Pnk/Blk
804 Pnk
7
S3
Neutral Start Switch
15
400 Pnk/Blk
X1
Engine Harness Connector
15
641 Org
11
150 Blk
6
520 Yel/Blk
13
822 Pnk/Wht
13
641 Org
13
816 Blu
S6
Mow Switch
10
822 Pnk/Wht
10
812 Pnk/Blk
814 PNK/WHT
518 Yel
5
520 Yel/Blk
4
208 Red/Blk
210 Red
Ignition Switch
808 Pnk/Blk
14
806 Pnk
S4
Seat Switch
16
400 Pnk/Blk
Y3
Fuel
Shutoff
Solenoid
200 Fusible Link
1
From Battery
M1
Starter
S5
Brake Switch
9
812 Pnk/Blk
824 Pnk/Wht
803 Red
K3
Defeat Relay
814 Pnk/Wht
12
816 BLU
818 Blu/WHT
F1
Fuse
Holder
3
2
206 Red/Wht
4
208 Red/Blk

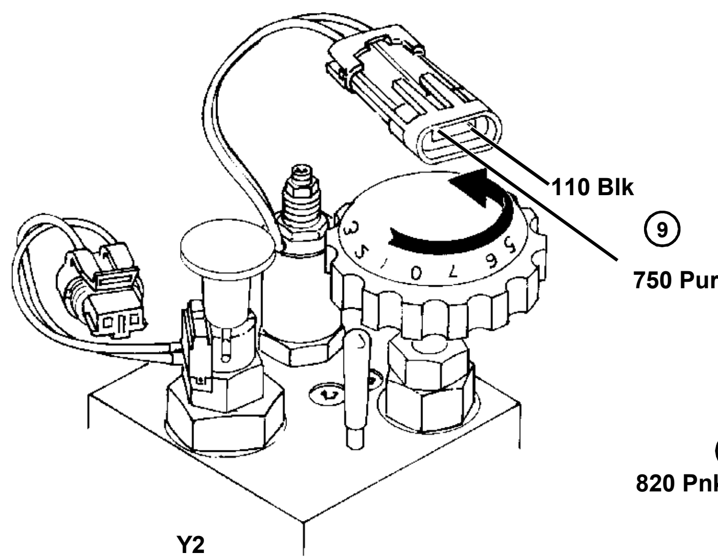
MOW CIRCUIT TEST POINTS

Test Conditions:

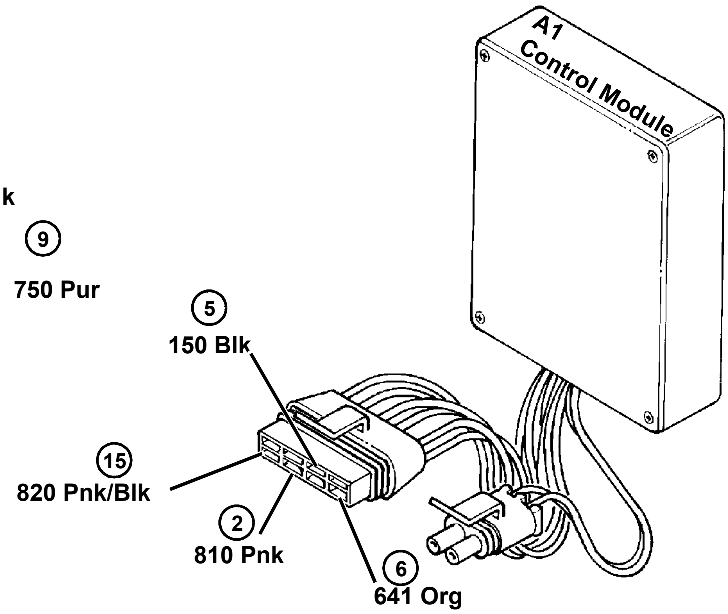
NOTE: To test the mow switch in the "OFF" position, refer to Cranking Circuit Test.

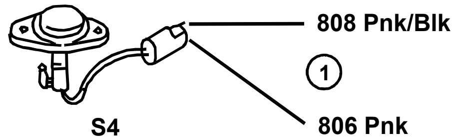
- Park brake **S5** ON
- Ignition switch **S1** "RUN"
- Operator on seat **S4**
- Transmission in NEUTRAL **S3**
- Mow switch **S6** OFF momentarily then "ON"
- Cutting units lowered **S8**

Test/Check Point	Normal	If Not Normal
1. Seat switch **S4**	11.8—13.2 volts	Test 806 Pnk. If no voltage replace/repair wire harness. Test 808 Pnk/Blk. If no voltage replace switch.
2. Control module	11.8—13.2 volts	Test 810 Pnk at connection H-B. If no voltage replace/repair wire harness.
3. Mow switch **S6**	11.8—13.2 volts	Ensure mow switch is in MOW position. Test 800 Pnk/Blk, 803 Red between Ignition switch and park brake switch. If no voltage replace/repair wire harness. Test 526 Yel/Blk and 528 Yel. If no voltage replace switch.
4. Third wheel drive solenoid **Y1**	11.8—13.2 volts	Test 528 Yel. If no voltage replace/repair wire harness. If voltage is present check ground before replacing solenoid.
5. Control module	Ground	Test 150 Blk connections, if no ground repair/replace wire harness. If ground is good replace module with a known good module.
6. Control module	11.8—13.2 volts	Test 641 Org and 820 Pnk/Blk. If no voltage replace module with a known good module.
7. Mow valve relay **K4**	11.8—13.2 volts	Test 526 Yel/Blk & 531 Yel. If no voltage replace/ repair wire harness.
8. Raise lower switch **S8**	11.8—13.2 volts	Make sure that switch is in the LOWERED position. Test 531 Yel. If no voltage replace/repair wire harness. Test 530 Yel. If no voltage replace switch.
9. Mow valve solenoid **Y2**	11.8—13.2 volts	Test 750 Pur. If no voltage replace/repair wire harness. If voltage present and solenoid does not work, click when energized, check ground before replacing solenoid

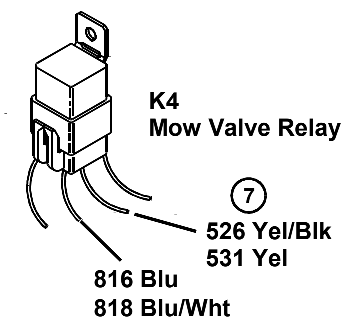


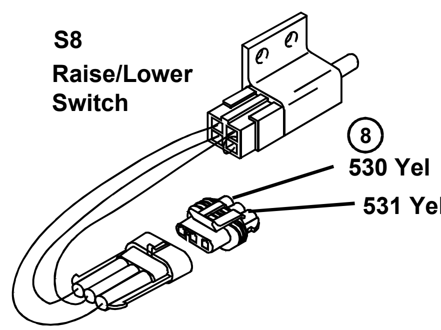
Y2
Mow Valve Solenoid

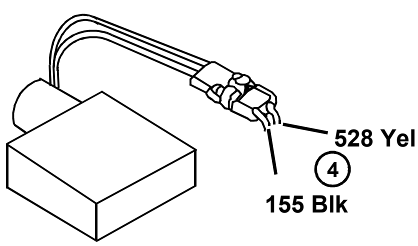




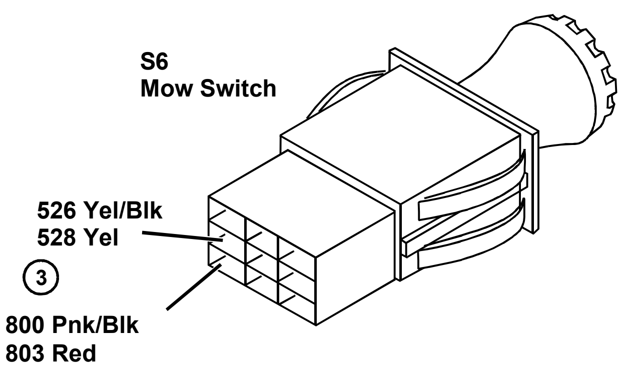
S4
Seat Switch

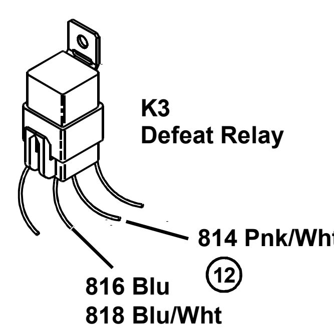






Y1
Third Wheel Drive Solenoid





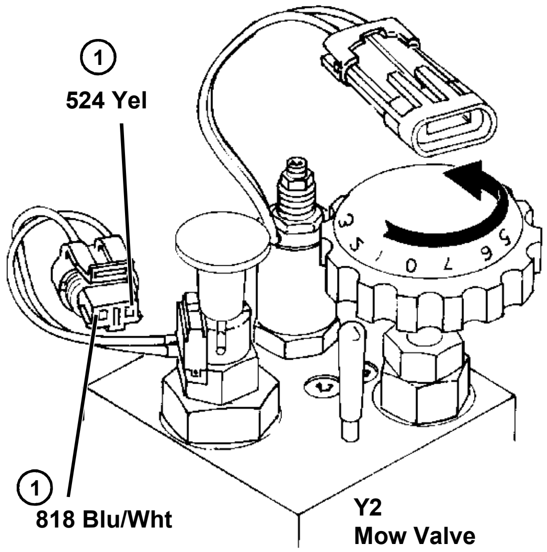
BACKLAPPING CIRCUIT TEST POINTS

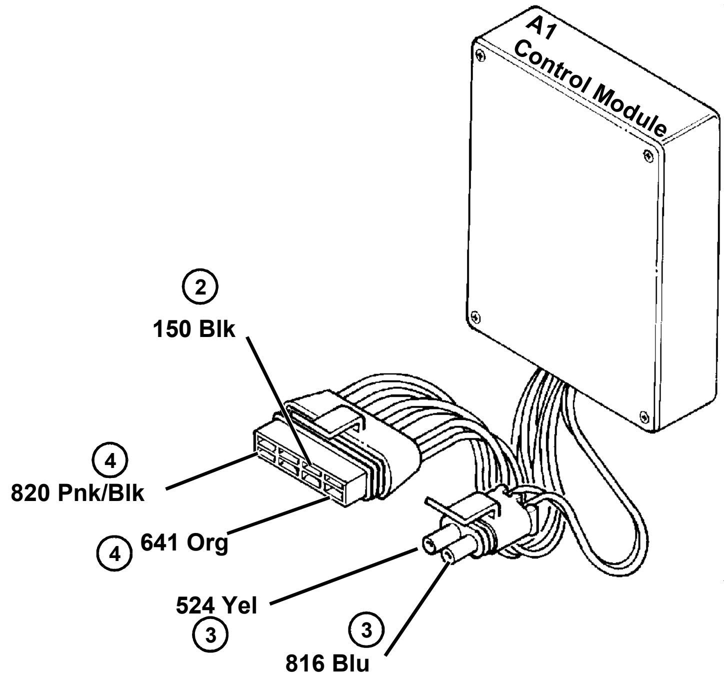
Test Conditions:

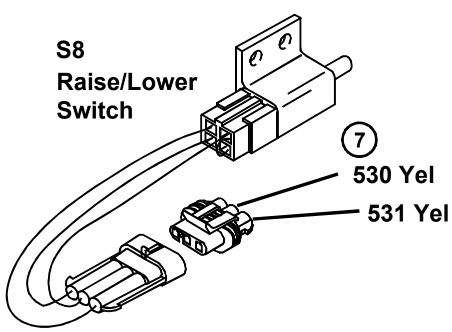
- Ignition switch **S1** “RUN”
- Transmission in NEUTRAL **S3**
- Mow switch **S6** “ON”
- Park brake **S5** “ON”
- Operator off seat **S4**
- Forward/Reverse switch **S7** “Pulled up for backlapping”

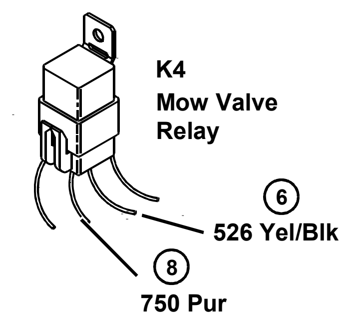
Test/Check Point	Normal	If Not Normal
1. Forward/Reverse Switch **S7**	11.8—13.2 volts	Insure switch in REVERSE position. Test 818 Blu/ Wht. If no voltage replace/repair wire harness. Test 524 Yel. If no voltage replace switch.
2. Control module **A1**	Ground	Test 150 Blk connections, if no ground repair/ replace wire harness. If ground is good replace module with a known good module and test for voltage on terminal H-D, 641 Org.
3. Control module	11.8—13.2 volts	Test 524 Yel at connection G-B and 816 Blu. If no voltage replace/repair wire harness.
4. Control module	11.8—13.2 volts	Test 641 Org and 820 Pnk/Blk. If no voltage replace module with a known good module.
5. Mow switch **S6**	11.8—13.2 volts	Ensure mow switch is in MOW position. Test 820 Pnk/Blk. If no voltage replace/repair wire harness. Test 526 YEL/BLK and 528YEL. If no voltage replace switch.
6. Mow valve relay **K4**	11.8—13.2 volts	Test 526 Yel/Blk & 531 Yel. If no voltage replace/ repair wire harness.
7. Raise lower switch **S8**	11.8—13.2 volts	Make sure that switch is in the LOWERED position. Test 531 Yel. If no voltage replace/repair wire harness. Test 530 Yel. If no voltage replace switch.
8. Mow valve relay	11.8—13.2 volts	Test 750 Pur. If no voltage replace relay.

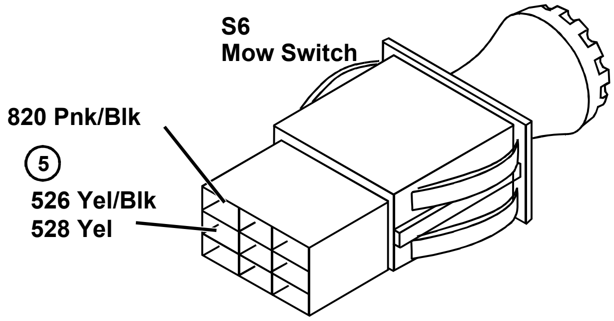
NOTE: These tests do not determine if ground connections are defective. To test the ground connections, connect the POS terminal of a voltmeter to the POS terminal of the battery and connect the NEG terminal of the voltmeter to the ground terminals. Battery voltage should be indicated, if not, test the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


1
524 Yel
1
818 Blu/Wht
Y2
Mow Valve


A1
Control Module
2
150 Blk
4
820 Pnk/Blk
4
641 Org
524 Yel
3
3
816 Blu


S8
Raise/Lower
Switch
7
530 Yel
531 Yel


K4
Mow Valve
Relay
6
526 Yel/Blk
8
750 Pur


S6
Mow Switch
820 Pnk/Blk
5
526 Yel/Blk
528 Yel

TESTS & ADJUSTMENTS

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

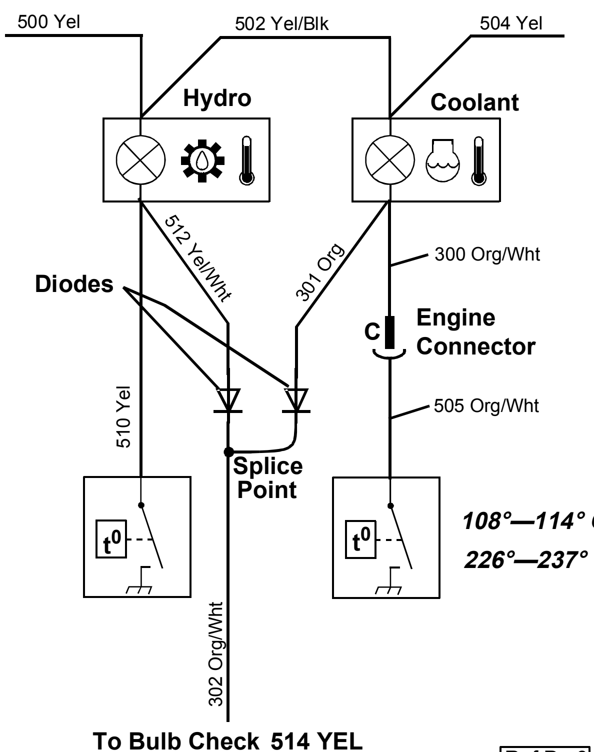
HYDRO/ENGINE OVERTEMP INDICATING LIGHTS

Tools Needed:

- JTO5791 Digital Multimeter

Procedure:

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 (500 Yel, 502 Yel/Blk, 504 Yel) 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 512 Yel/Wht wire (for the hydraulic temperature light) or 301 Org wire (for the coolant temperature light) to a splice point and look for a open in the wire before or at the splice point.
4. If neither indicator bulb illuminates, remove the diode, plugged into the wiring harness near the indicator bulb receptacle, and test. (See DIODE TEST on page 35.)
5. If diodes test good ground 512 Yel/Wht wire (for the hydraulic circuit) or 301 Org 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

Tools Needed:

- JTO5791 Digital Multimeter

Reason:

- 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.
- 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.

Procedure:

1. 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.
2. If the indicator light fails to illuminate, inspect the wiring and engine connector for an open circuit, repair or replace as necessary.
3. 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.

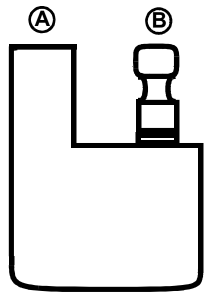
DIODE TEST

Tools Needed:

• JTO5791 Digital Multimeter

Procedure:

1. Remove the diode from the electrical harness.



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.

Results:

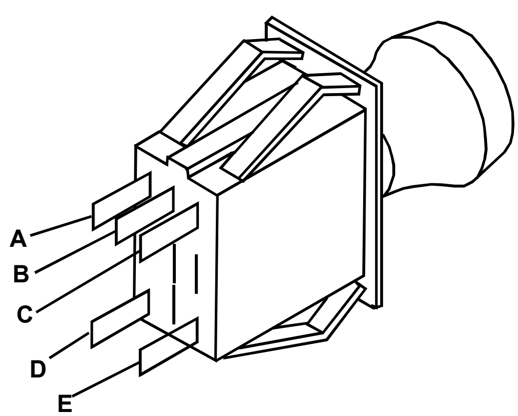
1. If continuity is noted in both steps, the diode is defective and must be replaced.
2. If continuity is noted in step 2 and not in step 3, the diode is good.

MOW SWITCH TEST

Tools Needed:

• JTO5791 Digital Multimeter

Procedure:



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.

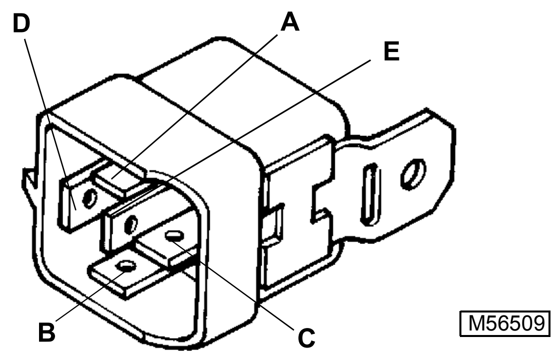
RELAY TESTS

NOTE: All five (5) relays are identical and are tested the same way.

Tools Needed:

• JTO5791 Digital Multimeter

Procedure:



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

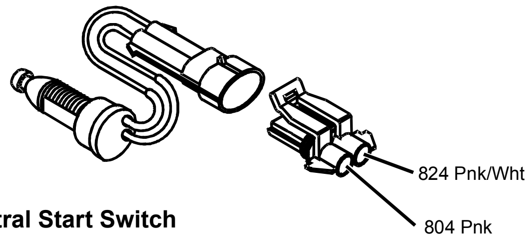
NEUTRAL START SWITCH TEST

Tools Needed:

• JTO5791 Digital Multimeter

Procedure:

1. Remove the switch and inspect the plunger for flat spots and freedom of movement. Replace the switch if plunger end is rough, worn or if plunger does not move smoothly.
2. Connect an ohmmeter to the contacts of the switch.
3. There should be **NO** continuity with the plunger extended.
4. Depress plunger. Continuity should be indicated when the plunger reaches the midway point of full travel and should indicate continuity through the



Neutral Start Switch

rest of the plunger travel. Replace the switch if it fails this test.

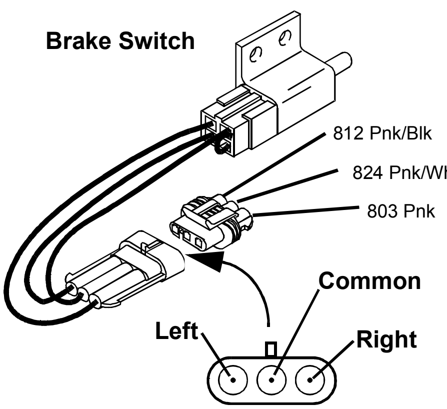
5. (See TRANSMISSION NEUTRAL ADJUSTMENT on page 19.)

PARK BRAKE SWITCH TEST

Tools Needed:

• JTO5791 Digital Multimeter

Procedure:



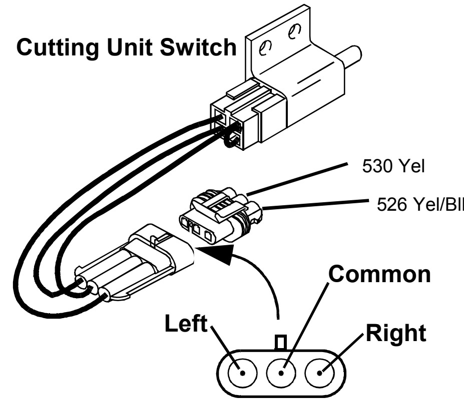
1. Remove the switch and inspect the plunger for flat spots and freedom of movement. Replace the switch if plunger end is rough, worn or if plunger does not move smoothly.
2. Using an ohmmeter, place one lead of the ohmmeter on the center terminal and touch the other lead to the **Right** outside terminal (looking at the end of the three terminal connector, see illustration). The ohmmeter **SHOULD NOT** have continuity until the switch is actuated. Continuity should be indicated until the lever is released. If not, replace switch.
3. Reverse the lead to the **Left** outside terminal (looking at the end of the three terminal connector, see illustration). The ohmmeter **SHOULD** have continuity with the switch in the extended position. Depress plunger, thus breaking the circuit. Continuity should not be indicated until the plunger is released. If it does, replace switch.

RAISE/LOWER SWITCH

Tools Needed:

• JTO5791 Digital Multimeter

Procedure:

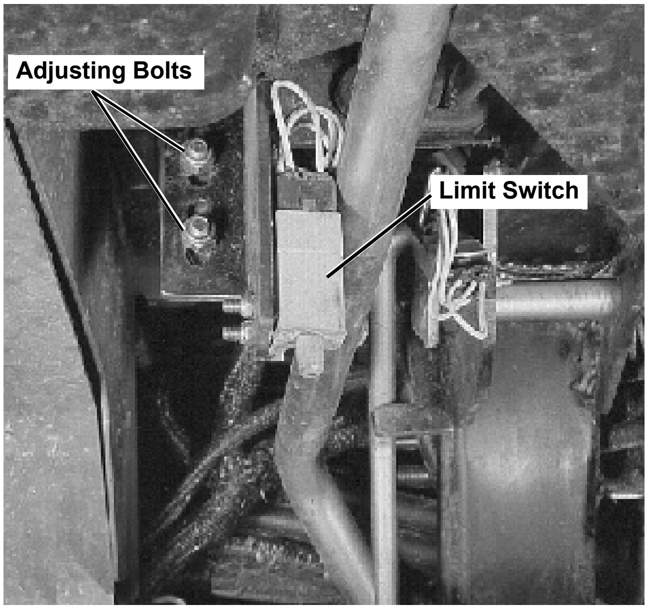


1. Remove the switch and inspect the plunger for flat spots and freedom of movement. Replace the switch if plunger end is rough, worn or if plunger does not move smoothly.
2. Using an ohmmeter, place one lead of the ohmmeter on the center terminal and touch the other lead to the **Right** outside terminal (looking at the end of the three terminal connector, see illustration). The ohmmeter **SHOULD NOT** have continuity until the switch is actuated. Continuity should be indicated until the lever is released. If not, replace switch.
3. Reverse the lead to the **Left** outside terminal (looking at the end of the three terminal connector, see illustration). The ohmmeter **SHOULD** have continuity with the switch in the extended position. Depress plunger, thus breaking the circuit. Continuity should not be indicated until the plunger is released. If it does, replace switch.

CUTTING UNIT RAISED SWITCH ADJUSTMENT

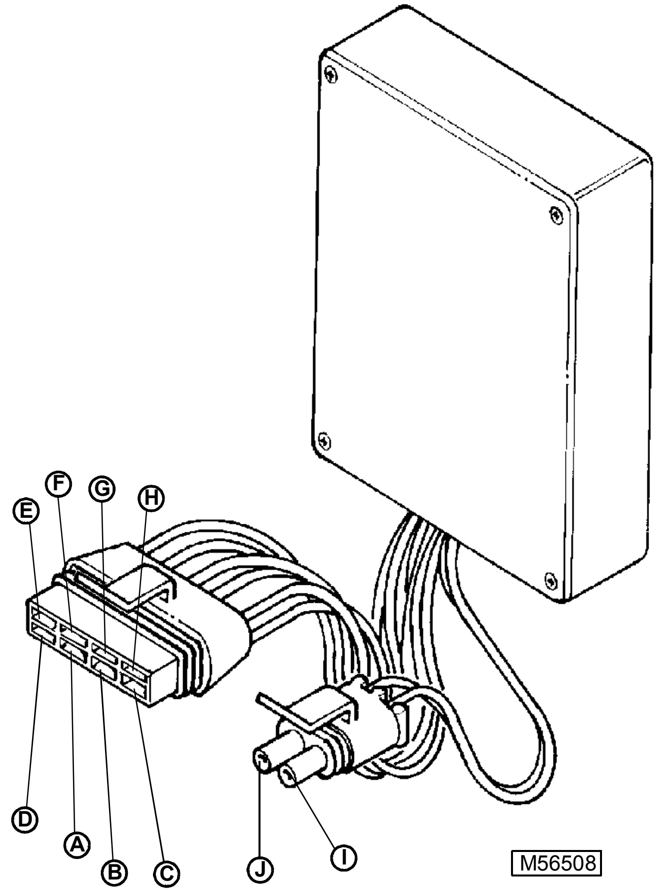
Procedure:

1. Park machine on level surface, reels raised, park brake on, engine off.
2. Block wheels to prevent inadvertent movement of the machine.
3. Loosen two bolts securing lift arm switch bracket to frame.



4. Slide lift arm switch bracket up or down as required to insure that switch is fully actuated when lift arm is in up position.

NOTE: There should be approximately 1/16" between lift arm switch bracket *lift arm when switch is properly adjusted.*

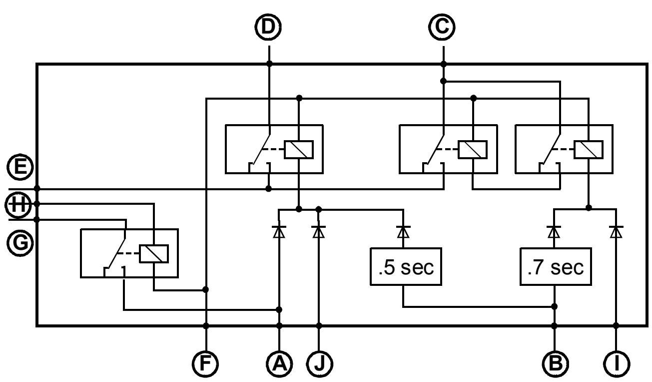


CONTROL MODULE TESTS

Tools Needed:

- Two, 12V Batteries
- JTO5791 Digital Multimeter
- 12V Test Light

Procedure:



Ref Pg 6

COLOR CODES:

A—822 Pnk/Wht	**F—150 Blk**
B—810 Pnk	**G—700 Pur**
C—820 Pnk/Blk	**H—522 Yel/Wht**
D—641 Org	**I—524 Yel**
E—520 Yel/Blk	**J—816 Blu**

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 0.5 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 0.7 second release delay when voltage is removed from terminal (B).
5. If the Control Module fails any of these tests, replace it.

ENGINE ELECTRICAL

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	
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 run out	~	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.

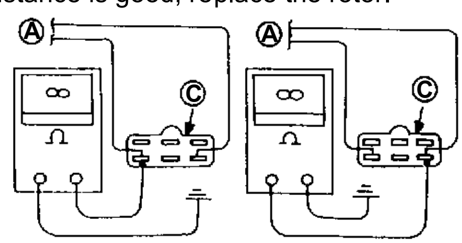
STATOR UNREGULATED OUTPUT TEST

Tools Needed:

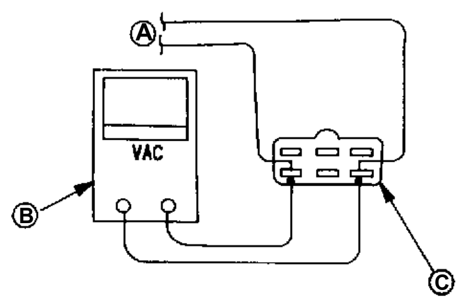
- JTO5791 Digital Multimeter

Procedure:

1. Disconnect the Engine wiring harness at the 6-point connector and connect an AC voltmeter to the stator pins.
2. Start and run engine at **fast idle (3400 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.



Stator Pin and Ground (Infinite Ohm)

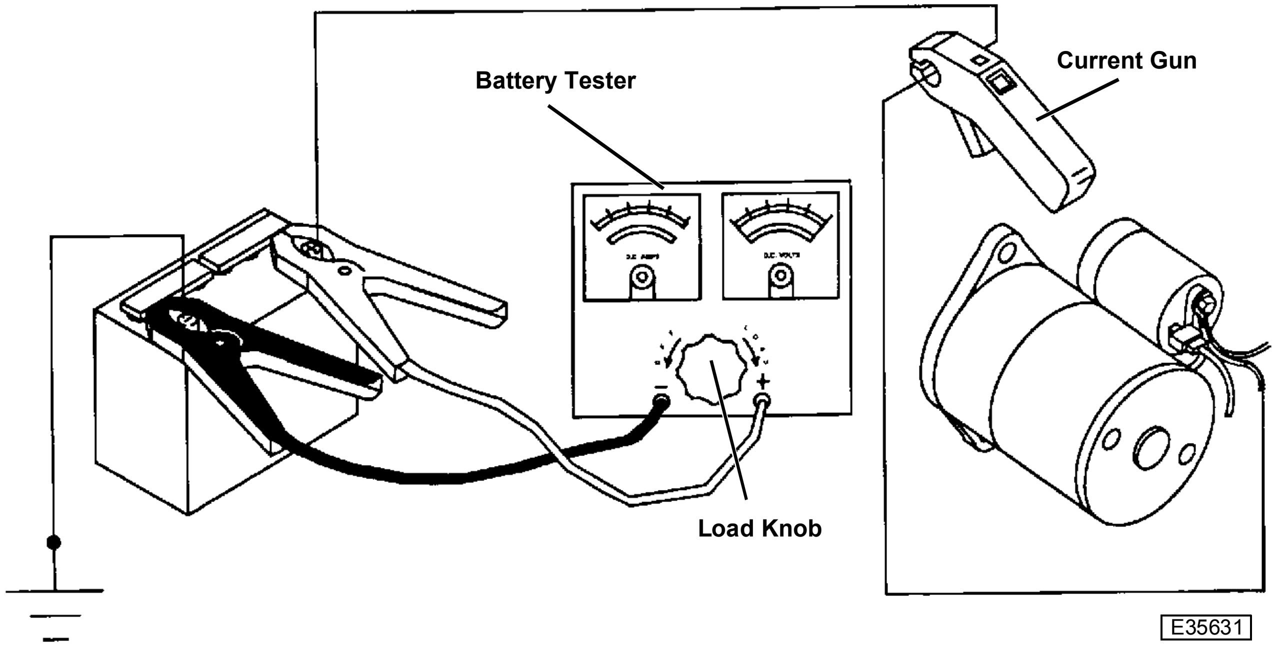


Unregulated Stator Output, 26 VAC/3000 RPM

M72871

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

REGULATED AMPERAGE AND VOLTAGE TESTS



Reason:

To determine the regulated voltage (charging) output of the regulator/rectifier.

Equipment:

- JTO5712 Current Gun
- JTO5685 Battery Tester

Procedure:

1. Park machine on level surface.
2. Move Mow/Transport lever to Transport position.
3. Lower cutting units to the ground.
4. Turn ignition switch OFF.
5. Engage parking brake.
6. Raise hood.
7. Disconnect pin connector from stator.

NOTE: Battery must be in a good state of charge.

8. Put JTO5712 Current Gun around positive (Red) battery cable going to starter so current-flow arrow cable points toward battery. Set current gun for DC current.

IMPORTANT: Turn load knob fully counterclockwise (out) into OFF position BEFORE making any test connections.

9. Connect battery tester to battery.

IMPORTANT: Perform this test quickly to prevent damage to battery tester. DO NOT apply full load to battery for more than 5—10 seconds.

10. Turn load knob clockwise (in) until voltage on voltage tester scale reads **11 volts for 5 seconds only** to partially drain battery.
11. Quickly turn load knob completely counterclockwise (out) to OFF position.
12. Start and run engine at **fast idle (3400 rpm).** Battery voltage should read **between 12.2—14.7 volts DC.**
13. Turn load knob clockwise (in) until voltage on voltage tester scale reads **11 volts** and look at current gun for a minimum reading of **13.5 amps.**
14. Quickly turn load knob completely counterclockwise (out) to OFF position.
15. After load test, voltmeter should return to a **maximum of 14.7 volts DC.**

Results:

- If current gun amp reading is BELOW specification, test for unregulated voltage output. If unregulated voltage output test meets specifications and you have verified voltage to ground to regulator/ rectifier, replace regulator/rectifier
- If at any time voltage increase exceeds 14.7 volts DC, replace regulator/rectifier

STARTER NO-LOAD AMPERAGE DRAW AND RPM TEST

Equipment:

- JT02153 Current Clamp
- JT05791 Multimeter
- JTO5719 Hand-Held Digital Tachometer
- Jumper Cables
- Jumper Wire

Procedure:

NOTE: Check that battery is fully charged and of proper size to ensure accuracy of test.

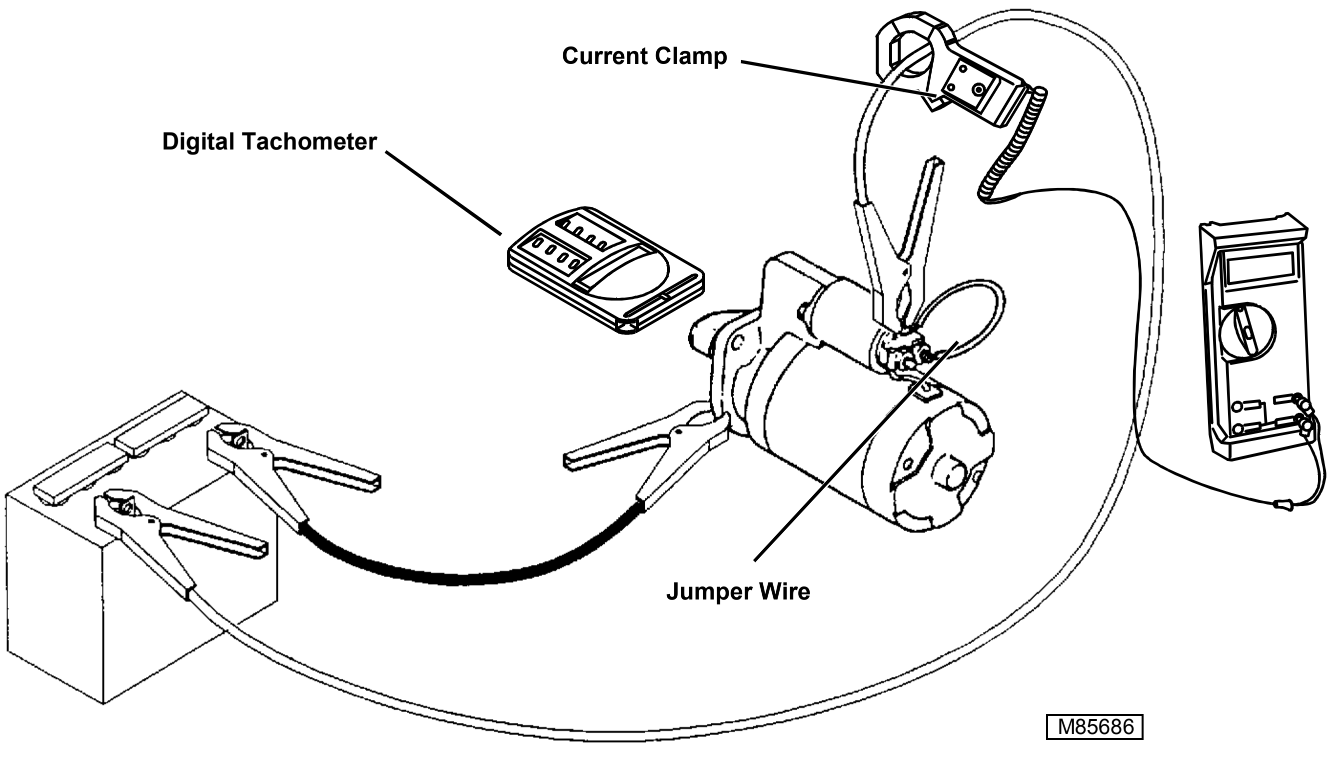
1. Remove starter assembly from mower and place starter in vice.
2. Connect jumper cables to a 12 volt battery.
3. Connect positive (+) cable to solenoid battery terminal on starter.
4. Connect negative (-) cable to starter body.
5. Attach current clamp around positive (+) cable.

IMPORTANT: Complete this test in 20 seconds or less to prevent starter damage.

6. Use jumper wire to briefly connect positive (+) starter terminal to solenoid battery terminal. Starter should engage and run.
7. Read and record amperage and rpm. 1mV = 1 amp

Results:

- If solenoid “clicks” or chatters and motor does not turn, replace solenoid
- If pinion gear engages and motor does not turn, repair or replace starter
- If starter engages and runs, but **amperage is more than 30 amps at 6000 rpm,** repair or replace starter
- If **free-running rpm is less than 6000 rpm,** repair or replace starter



STARTER LOADED AMPERAGE DRAW TEST

Reason:

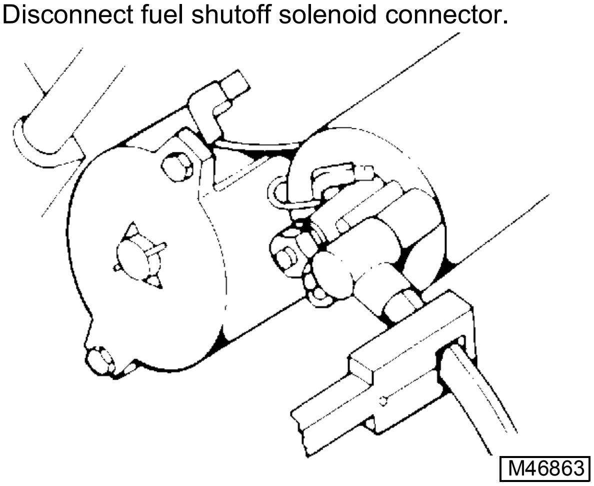
To determine the amperage required to crank the engine under load.

Equipment:

- JT02153 Current Clamp
- JT05791 Multimeter

Procedure:

1. Engage parking brake.
2. Test ground connections and battery.
3. Disconnect fuel shutoff solenoid connector.



4. Connect Red lead from current clamp to meter VW connection and Black lead to meter Common or ground connection.
5. Set current clamp slide switch to 200 Amp.
6. Set multimeter to 300mV range.
7. Crank engine and read voltage. 1mV = 1 amp

Results:

- If amperage is greater than 72 amps, test starter No-load rpm and amperage to determine if the starter is binding or damaged
- If the starter is good, check internal engine components for binding or damage

STARTER SOLENOID TEST

Reason:

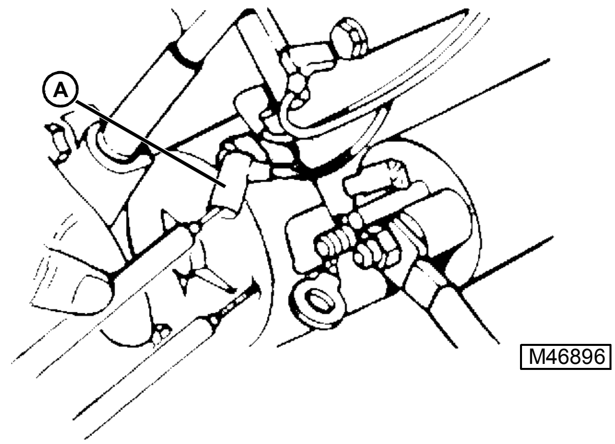
To determine if starter solenoid is defective.

Equipment:

- Voltmeter
- Ohmmeter

Procedure:

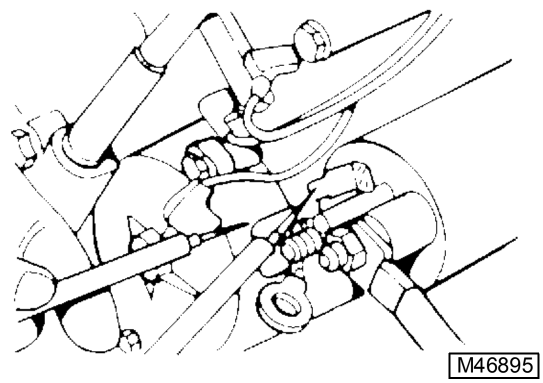
1. Engage parking brake.
2. Raise hood.
3. Disconnect fuel shutoff solenoid wire connector.



4. Disconnect 410 Yel/Blk wire from starter solenoid terminal (A).
5. With the ignition switch in the START position check for voltage at 410 Yel/Blk.

Results:

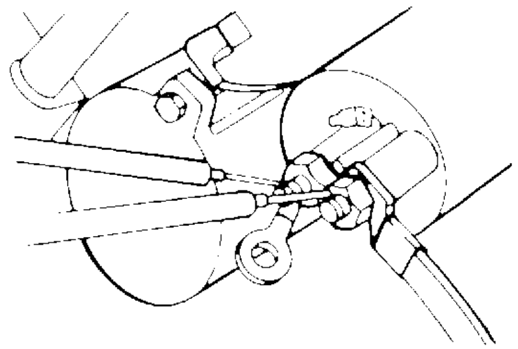
- If the meter reads battery voltage, the circuit is good.
- If not, inspect the wiring to and from the ignition switch for damage or breaks. Test ignition switch.



6. Measure the resistance between the solenoid starter terminal and ground with an ohmmeter. resistance should be zero or close to it.

Results:

- If circuit is open, replace solenoid.
- If resistance is zero or close to it, go to next step.


M46898

7. Disconnect the starter lead from the starter solenoid and keep it away from the solenoid.
8. Check resistance across the large terminals of the starter with the ignition switch in the START position. Resistance should be zero or close to it, a clicking sound should be heard and the pinion gear should engage the flywheel.

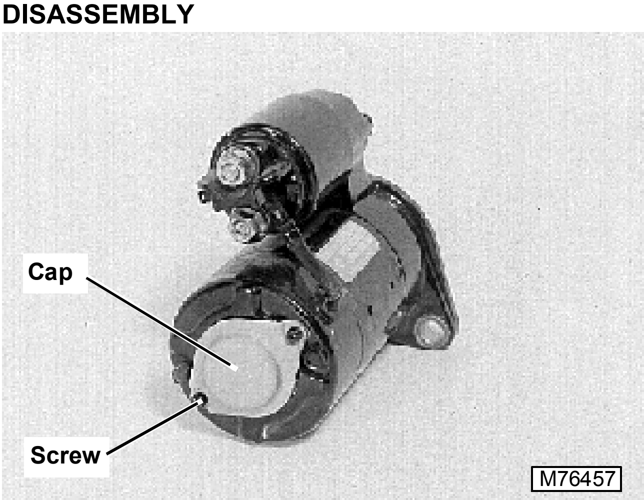
Results:

- If all tests are good, test the starter motor.
- If not, replace the solenoid.

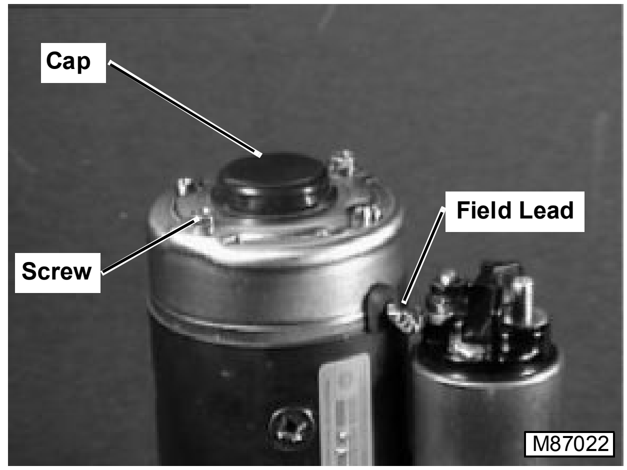
REPAIR

STARTER—HITACHI 0.8 kW

DISASSEMBLY

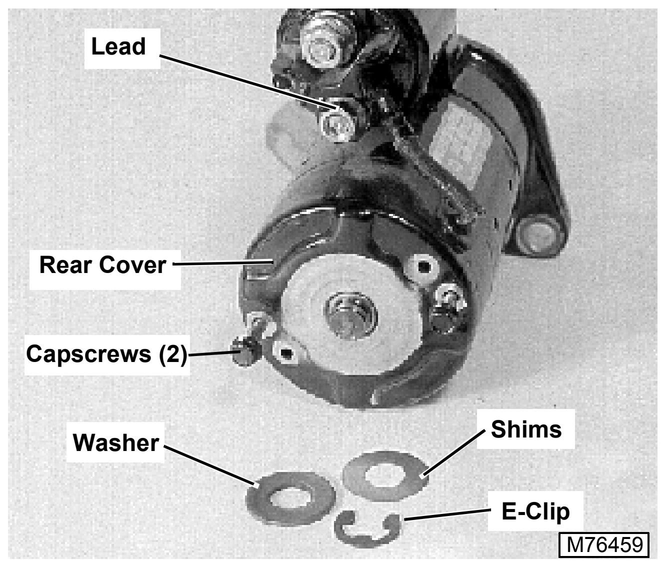


Older style starter

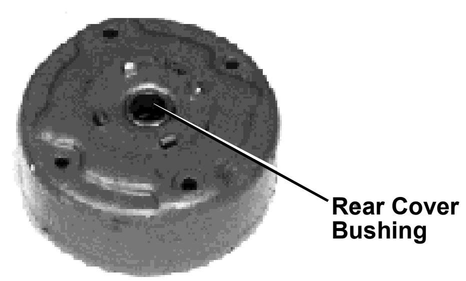


New style starter

1. Disconnect field lead.
2. Pry rubber end cap off using a screw driver and remove cap. (New style)
3. Remove two screws from end cap and remove cap.



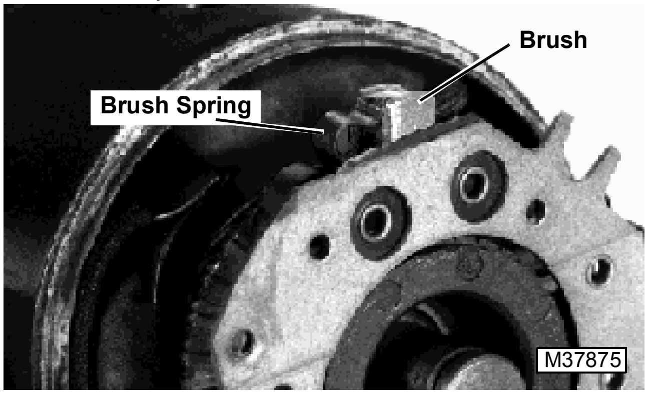
4. Remove E-clip, washer and shims. (If included)
5. Remove two capscrews holding rear cover on field housing.



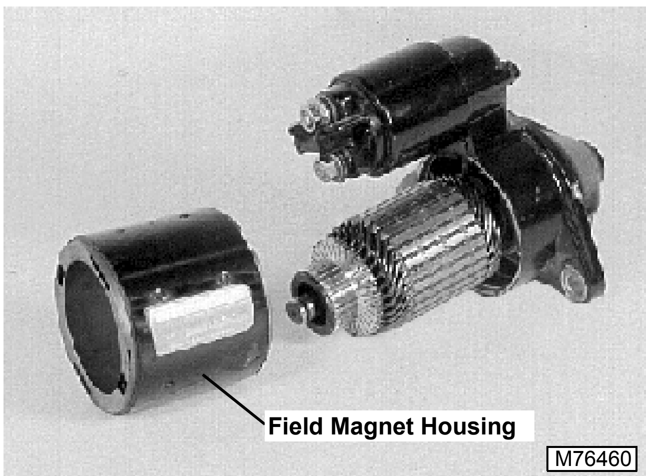
6. Inspect cover bushing for wear or damage. Measure inside diameter of bushing which should not exceed 12.53 mm (0.493 in.). Replace if necessary.

To replace bushing:

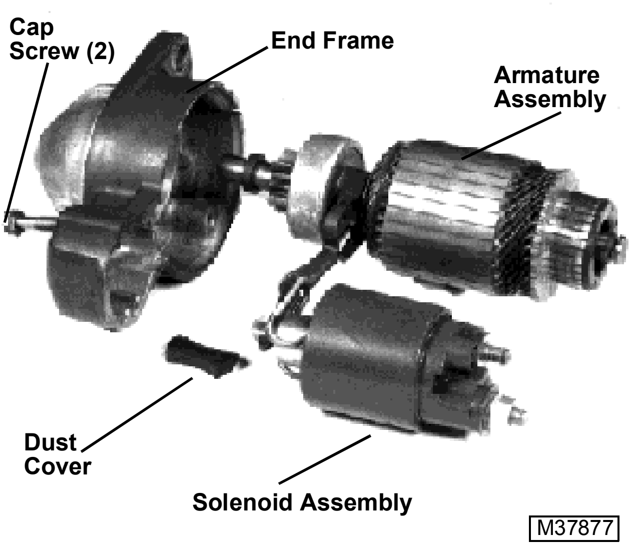
- Remove bushing using a blind-hole puller set. Install new bushing until it bottoms in cover bore using a driver set.
- Ream out bushing to **12.50—12.53 mm (0.492—0.493 in.)**.



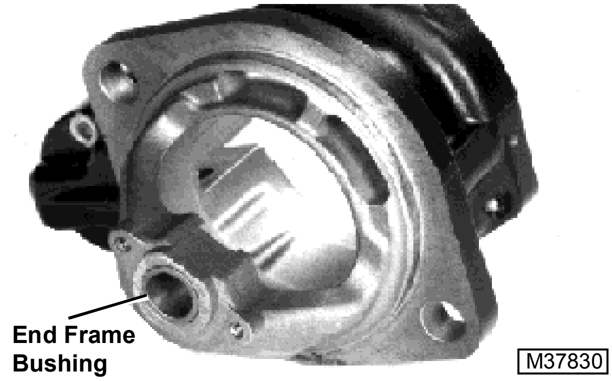
7. Pry brush springs away and pull brushes up enough to allow spring to hold brush in place.
8. Remove brush holder.



9. Remove field magnet housing from armature/ solenoid assembly.



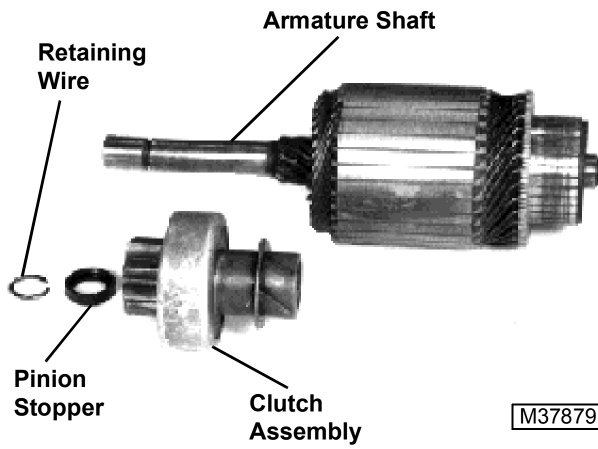
10. Remove two cap screws and pivot bolt, if equipped.
11. Remove dust cover.
12. Remove solenoid and armature assemblies from end frame.



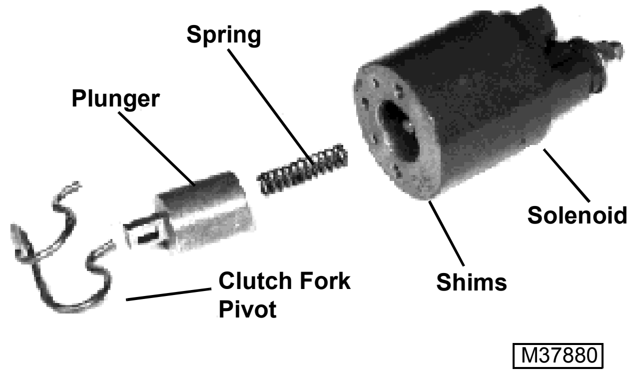
13. Inspect end frame bushing for wear or damage. Replace if necessary.

To replace bushing:

- Replace bushing using a driver set. Install bushing flush with face of housing.



14. Slide pinion stopper away from retaining wire using a piece of pipe or deep socket. Remove retaining wire, pinion stopper, and clutch assembly from armature shaft.
15. Inspect clutch assembly for wear or damage. Gear should rotate in one direction only. Replace if necessary.

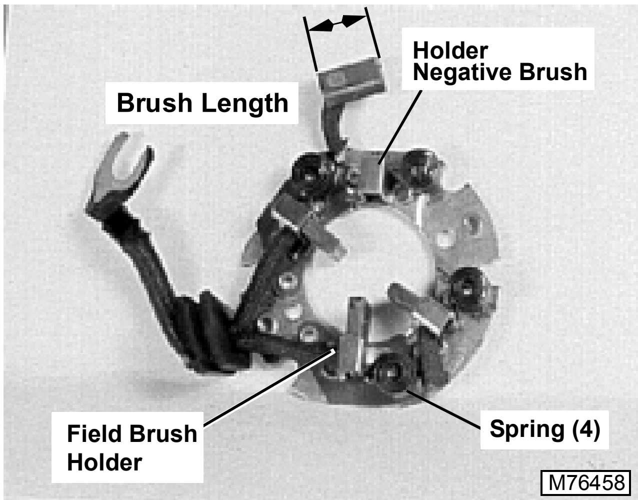


16. Remove clutch fork pivot, plunger, spring and shims from solenoid.
17. Inspect all parts for wear or damage. Replace as

necessary.

18. Inspect and test brushes, holder, field coil and armature. (See *Test* procedures.)

INSPECTION



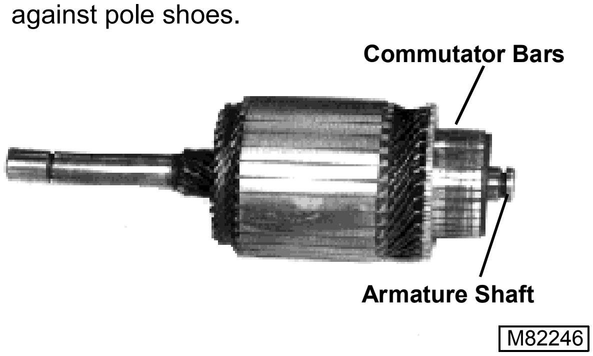
1. Measure brush lengths. Minimum brush length is **7.70 mm (0.303 in.)**. Replace brush if length is below minimum.

NOTE: Test brush holder using an ohmmeter or test light.

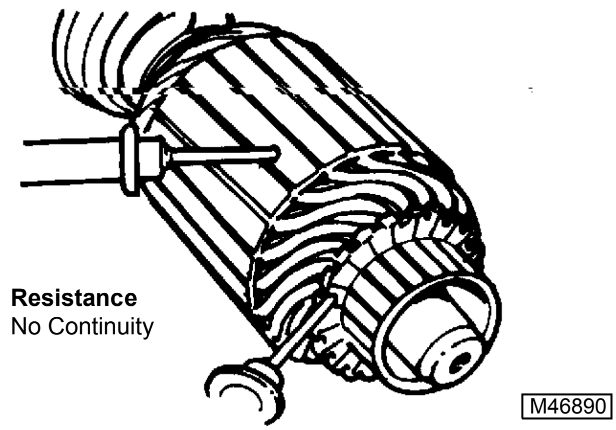
2. Test brush holder:
   Touch one probe of tester to negative brush holder and other probe to field brush holder. If there is continuity, replace the brush holder.
3. Inspect springs for wear or damage. Replace if necessary.

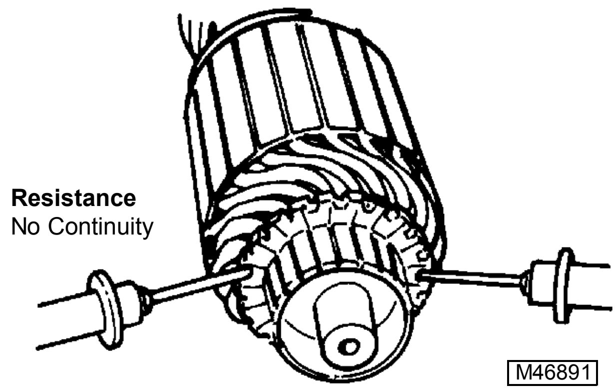
IMPORTANT: Do not clean armature with solvent. Solvent can damage insulation on windings. Use only mineral spirits and a brush.

4. Inspect armature. Look for signs of dragging against pole shoes.



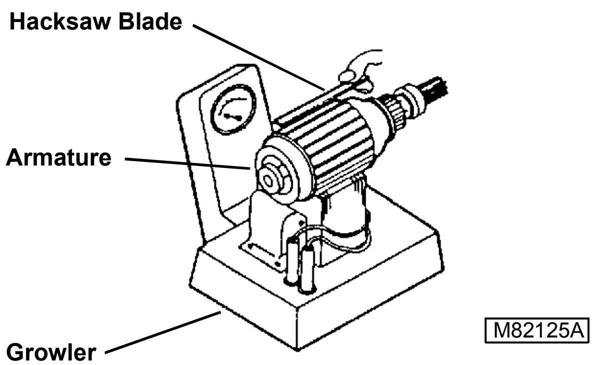
5. Inspect commutator. Look for roughness, burned bars, or any material which might cause short circuits between bars. If necessary, clean and touch up with 400 sandpaper. NEVER use emery cloth. Clean all dust from armature when finished. Test for grounded windings using an ohmmeter or test light.
6. Armature windings are connected in parallel, so each commutator bar must be checked.
7. If the test shows continuity, a winding is grounded and the armature must be replaced.
8. Test for open circuits in the windings. If the test shows no continuity, the armature has an open circuit and must be replaced





NOTE: Test armature windings using an ohmmeter or test light.

9. Test for grounded windings:
   Touch probes on one commutator bar and armature shaft. Armature windings are connected in series, so only one commutator bar needs to be checked.
   - If test shows continuity, a winding is grounded and the armature must be replaced.
10. Test for open circuited windings:
    Touch probes on two different commutator bars.
    - If test shows no continuity, there is an open circuit and the armature must be replaced.



11. Test for short circuited windings using a growler. Put armature in a growler and hold a hacksaw blade above each slot while slowly rotating armature.
   - If coil is shorted, the blade will vibrate on the slot.

NOTE: A short circuit most often occurs because of copper dust or filings between two commutator segments.

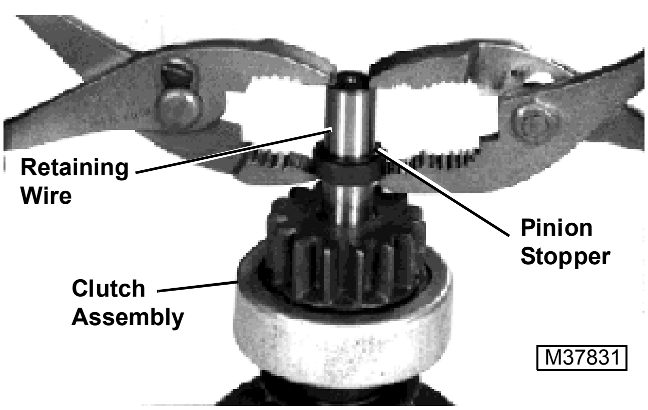
12. If test indicates short circuited windings, clean the commutator of dust and filings. Check the armature again. If the test still indicates a short circuit, replace the armature.

NOTE: Field uses permanent magnets which are not serviceable. Visually inspect for broken magnets or damage to housing.

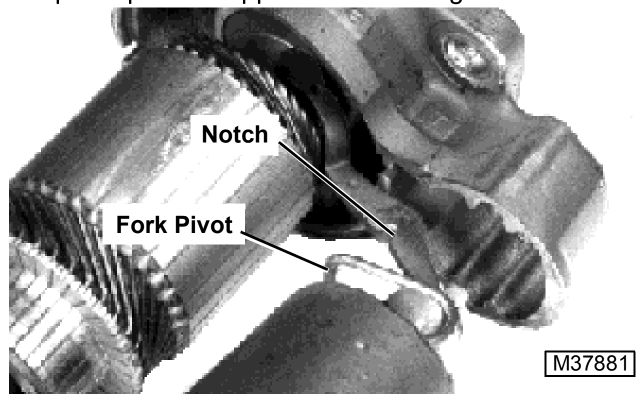
13. If rpm was slow and armature tests are normal, replace the field coil assembly.

ASSEMBLY

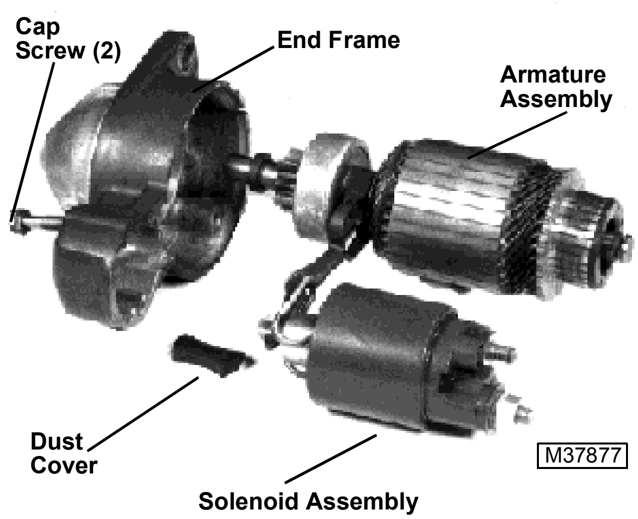
Assembly is done in the reverse order of disassembly.



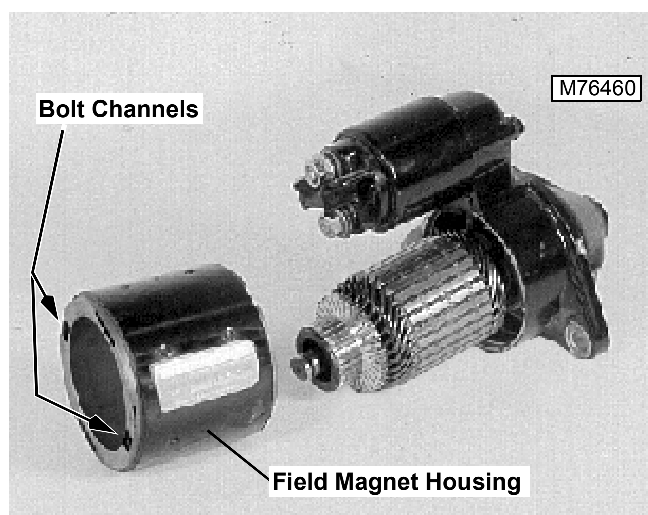
1. After installing clutch assembly, pinion stopper and retaining wire on armature shaft, use two pliers to press pinion stopper over retaining wire.



2. When installing solenoid and armature assemblies into end frame, make sure fork pivot seats in notch on clutch fork.

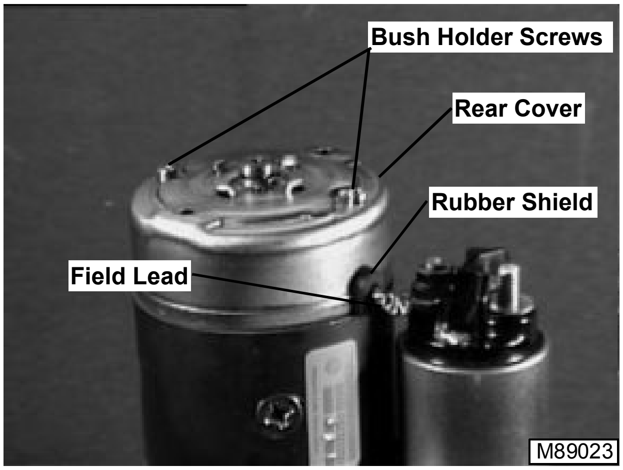


3. Be sure to install dust cover in recess between End Frame and solenoid assembly.

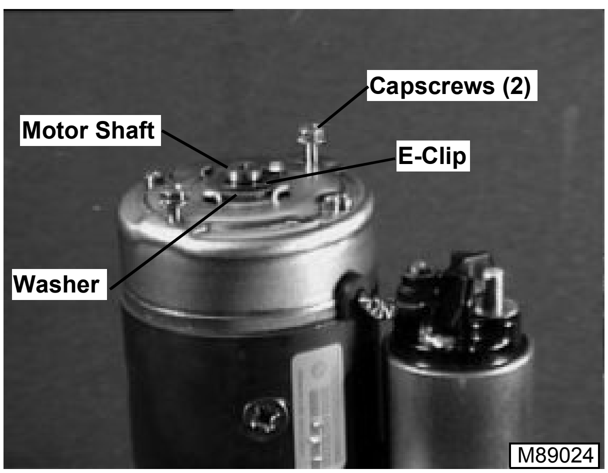


4. When installing field magnet housing be sure to align threaded bolt holes in end cap with channels in housing. (Older Style)

IMPORTANT: When installing rear cover, be sure wires do not touch cover. Press wires inward to clear rear cover.



1. Install field lead, washer and nut on solenoid.
2. Place rear cover over rubber shield and align cover with bush holder screw holes. Install screws in rear cover.(New style)

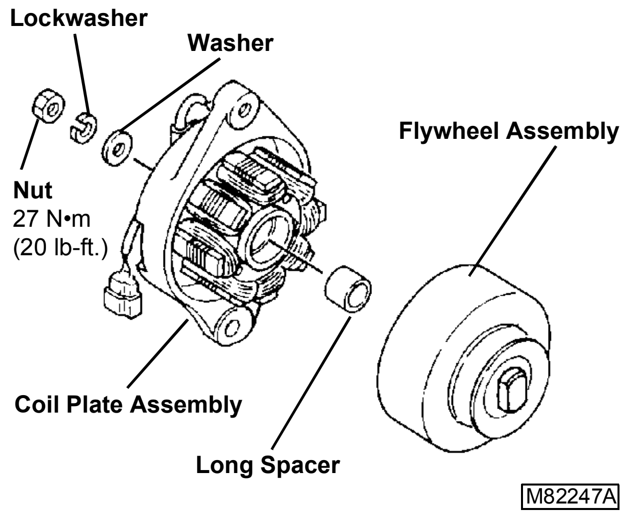


3. Install capscrews through end cap.
4. In order to install the washer and E-ring, it may be necessary to push up on the motor shaft to expose the E-ring groove. Install shims if included, washer and E-ring.
5. Install rubber end cap.

ALTERNATOR—KOKOSAN 20A

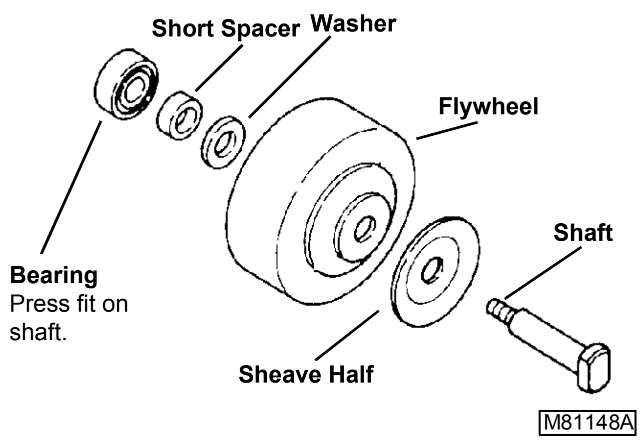
DISASSEMBLY/INSPECTION

1. Remove nut and washers.
2. Tap on end of shaft with a soft-faced hammer to separate flywheel assembly from coil plate assembly.
3. Remove long spacer.



NOTE: Bearing and flywheel are press fit on shaft.

4. Remove shaft from bearing, short spacer, washer, flywheel and sheave half, using a press.
5. Inspect all parts for wear or damage. Replace as necessary.

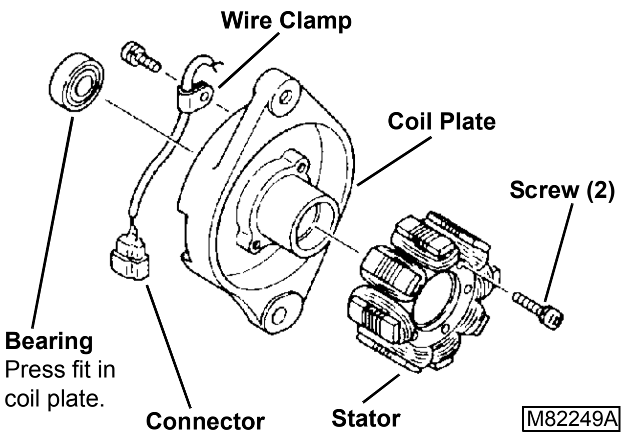


NOTE: Remove bearing only if replacement is necessary.

6. Inspect bearing in coil plate for wear or damage. Replace if necessary.

To replace bearing:
Remove bearing using a spark plug socket and a press. Install bearing into coil plate until it bottoms in bore using a 1 in. socket.

7. Remove wire clamp.
8. Remove connector from harness leads.
9. Remove two screws and stator.
10. Inspect all parts for wear or damage. Replace as necessary.

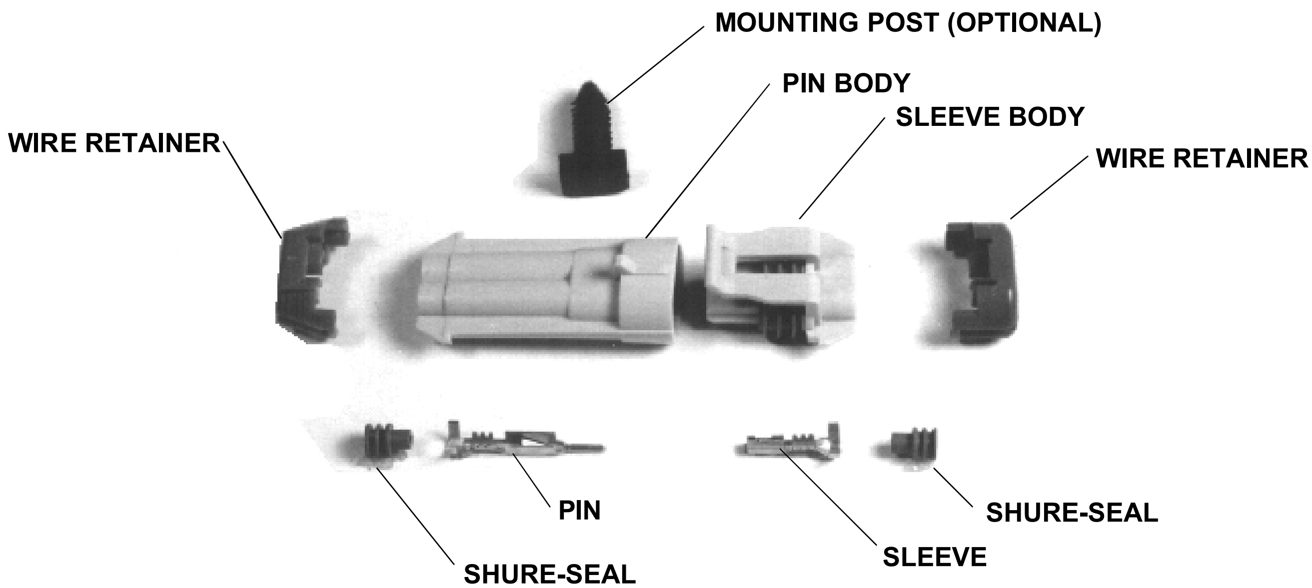


ALTERNATOR ASSEMBLY

Assembly is done in the reverse order of disassembly.

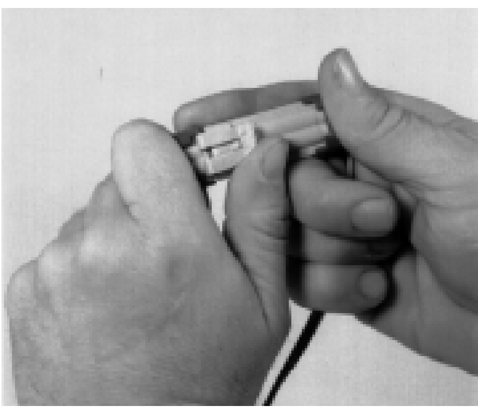
- With sheave half on shaft, press shaft into flywheel until sheave half bottoms on flywheel face.
- With washer and short spacer installed, press new bearing onto shaft until it bottoms on spacer.

METRO-PACK™ CONNECTOR REMOVAL



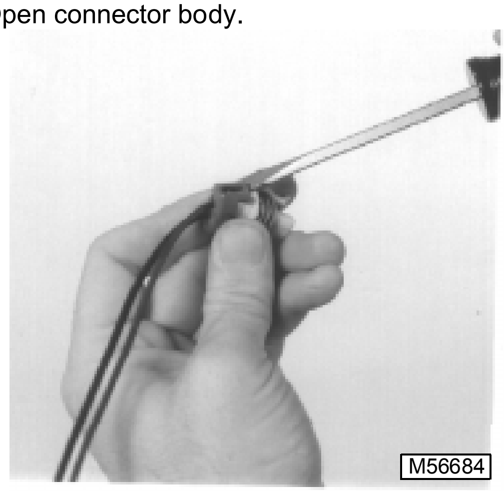
M56685

IMPORTANT: Identify wire number/color locations with connector terminal letters.



M56682

1. Open connector body.

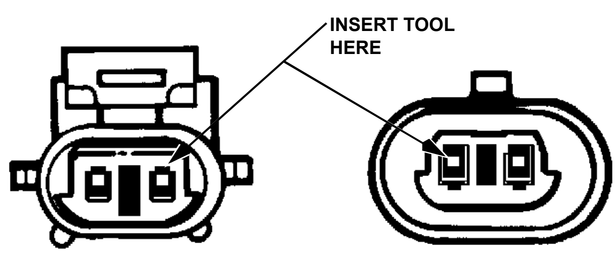


M56684

2. Remove retainer on wire end of connector with a screwdriver.

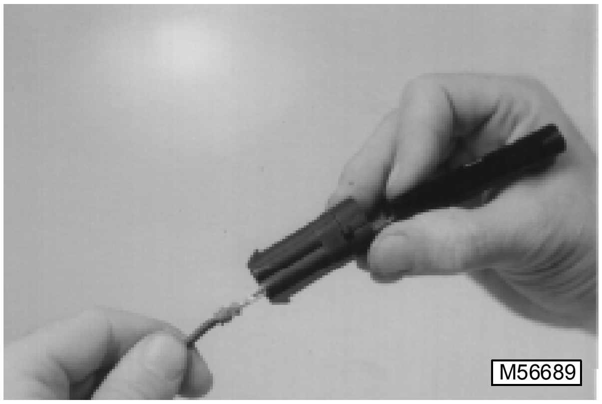
M56690

3. Use JDG777 Terminal Removal Tool to remove contact from connector body.



M56691

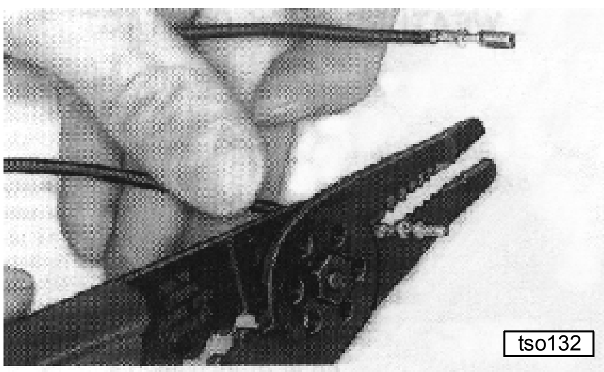
NOTE: To remove sleeve connector from sleeve body (short connector half) insert tool in slot between terminal contact and connector body. To remove pin connector from pin body (long connector half) insert tool in center of contact.



4. Hold the removal tool fully seated and pull wire from connector body

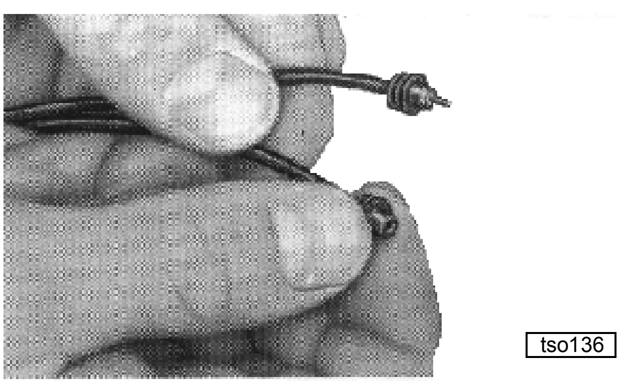
METRO PACK™ CONNECTOR REPLACEMENT

1. Remove wire from connector body as described above.



2. Use JDG145 Universal Electrical Pliers to remove wire as close as possible to old contact.

IMPORTANT: METRO PACK™ connectors are keyed A, B, C, etc. for proper contact mating. Be sure contacts and wire colors/numbers match and are in proper alignment.

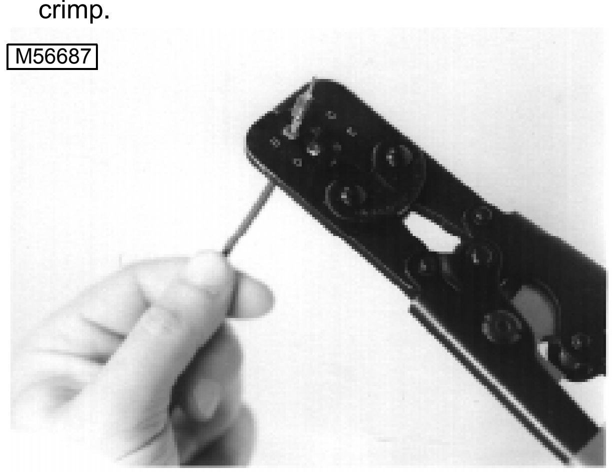


3. Install correct size cable seal on wire.

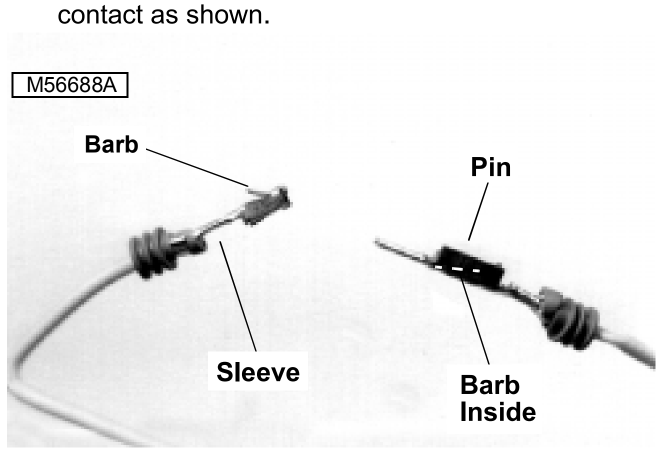
NOTE: Cable seals are available for three sizes of wire:
- *Large—1.0 mm (16 gauge) wire*
- *Medium—0.8 mm (18 gauge) wire*
- *Small—0.5 mm (20 gauge) wire*

4. Strip insulation from wire to expose 6mm (1/4 in) and align cable seal with edge of insulation

5. Place proper size contact on wire and use JDG776 CRIMPER to crimp contact in place with a “W” type crimp.



6. Use JDG776 CRIMPER to secure cable seal to contact as shown.

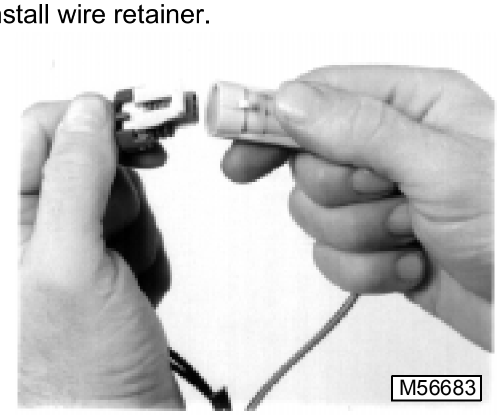


IMPORTANT: Proper barb location and orientation for installation of “sleeve and “pin is shown.

NOTE: Connector bodies are “keyed for proper contact mating. be sure contacts are in proper alignment.


M56689

7. Push contact into new connector body until fully seated.
8. Pull on wire slightly to be certain terminal is locked in place.
9. Install wire retainer.


M56683

10. Transfer remaining wires to correct terminal in new connector.
11. Place retainer on wire end of connector and snap in place.
12. Close connector body.

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METRO PACK™ CONNECTOR REPLACEMENT 50

SPECIFICATIONS

Voltage

Unregulated. . . . . 26 VAC @ 3400 rpm
Regulated . . . . 12.2—14.7 VDC @ 3400 rpm

Amperage

Regulated . . . . 15 Amps @ 3400 rpm

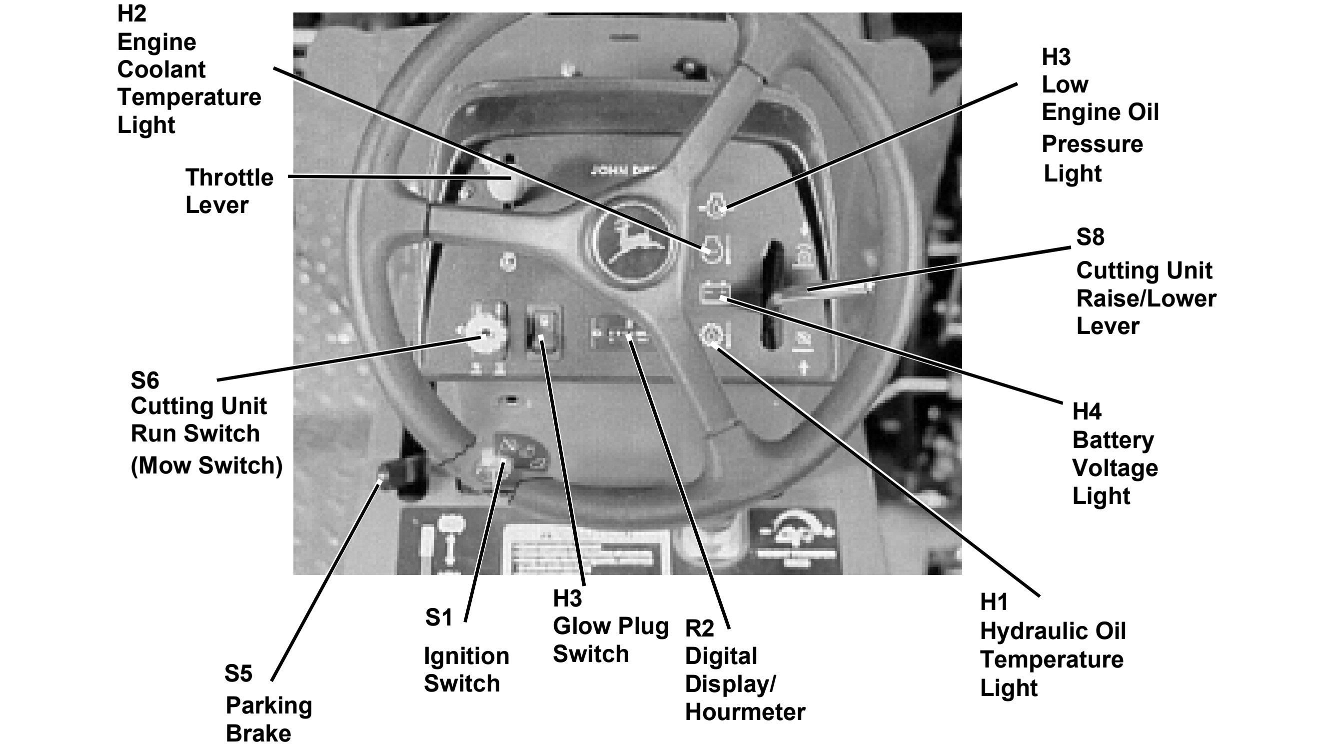
Battery

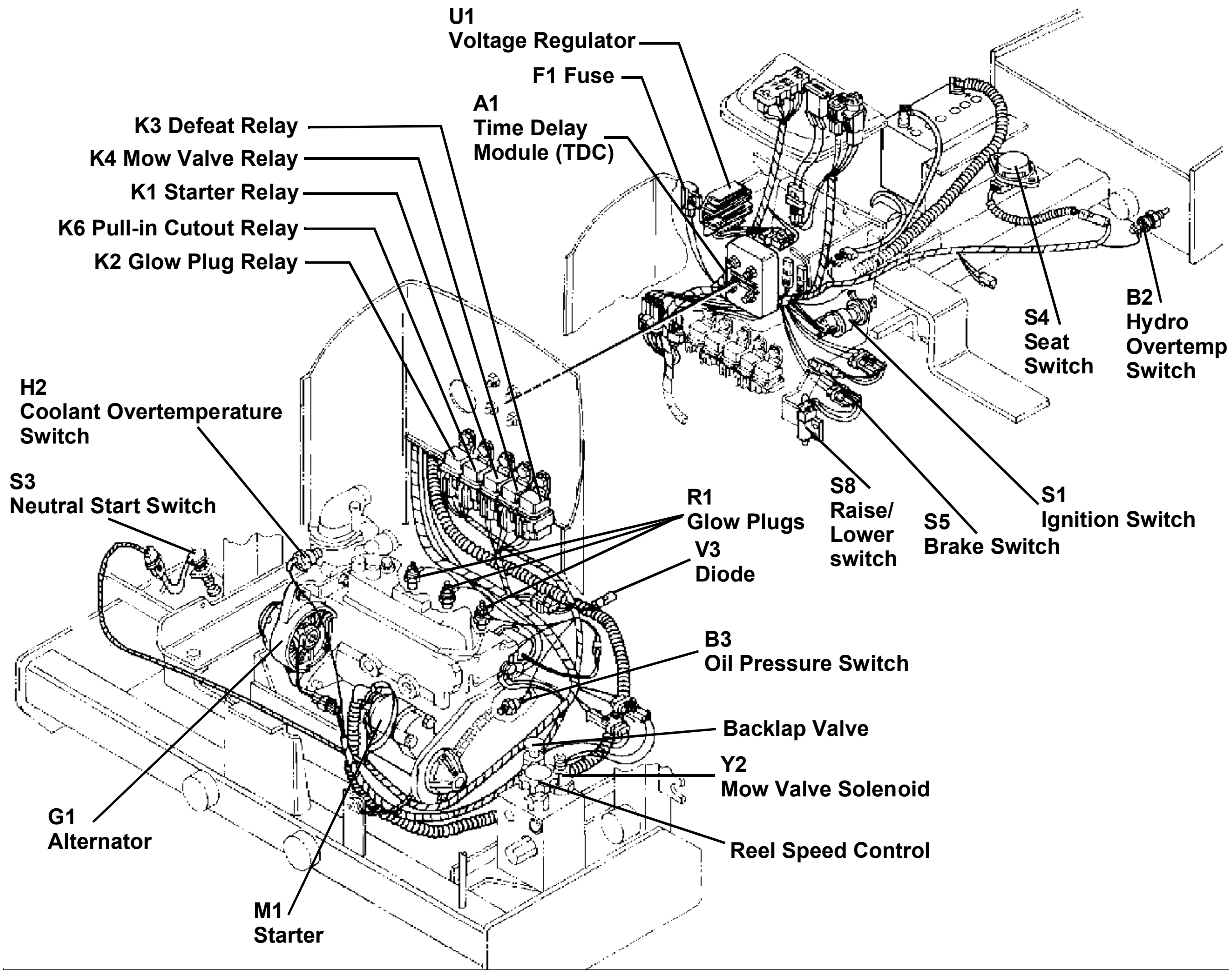
Voltage . . . . 11.8—13.2 VDC
Reserve Capacity @ 25 Amps . . . . .80 min.
Cold Cranking Amps @ -18^{o} C (0^{o} F) . . . . 430 CCA

Electric Starter

Minimum Brush Length . . . . 6 mm (.240 in.)
Maximum No-load Starter Draw . . . . 60 Amps
Starter Draw (Loaded). . . . . 200 Amps

COMPONENT LOCATION





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.

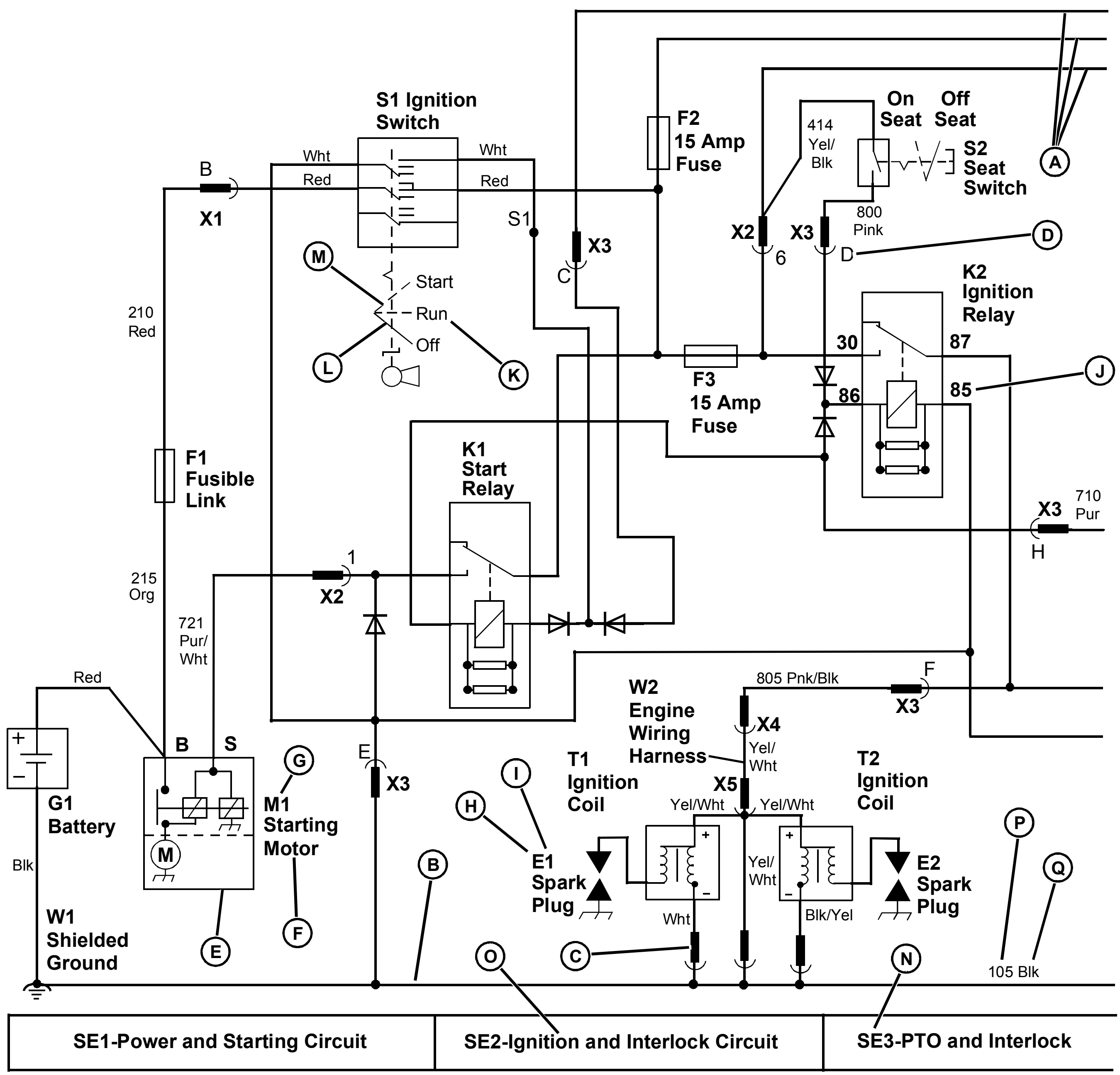
Each component is shown by a symbol (E), its name (F), and an identification code (G). The identification code contains a device identifying letter (H) and number (I).

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).

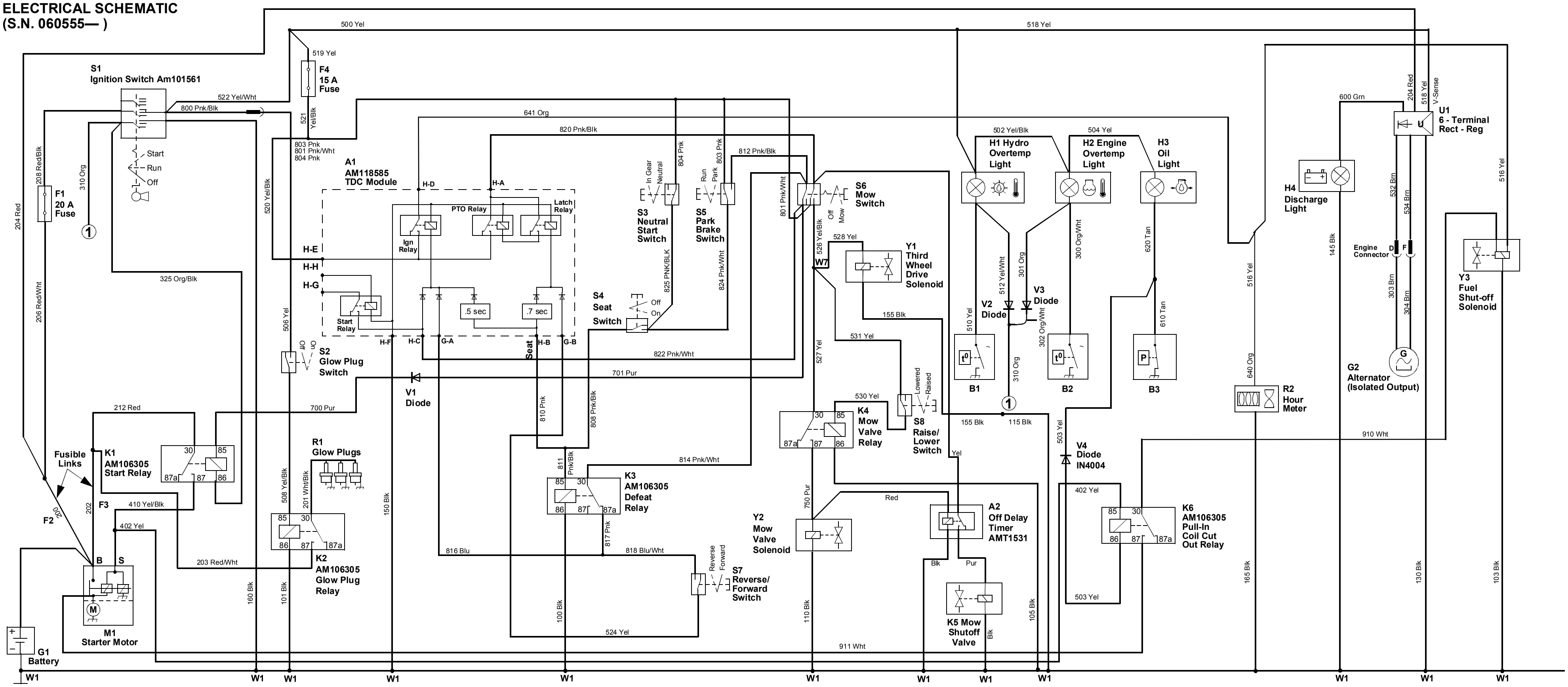
The circuit number (P) and wire color (Q) of the wires are shown directly next to the wire path.

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

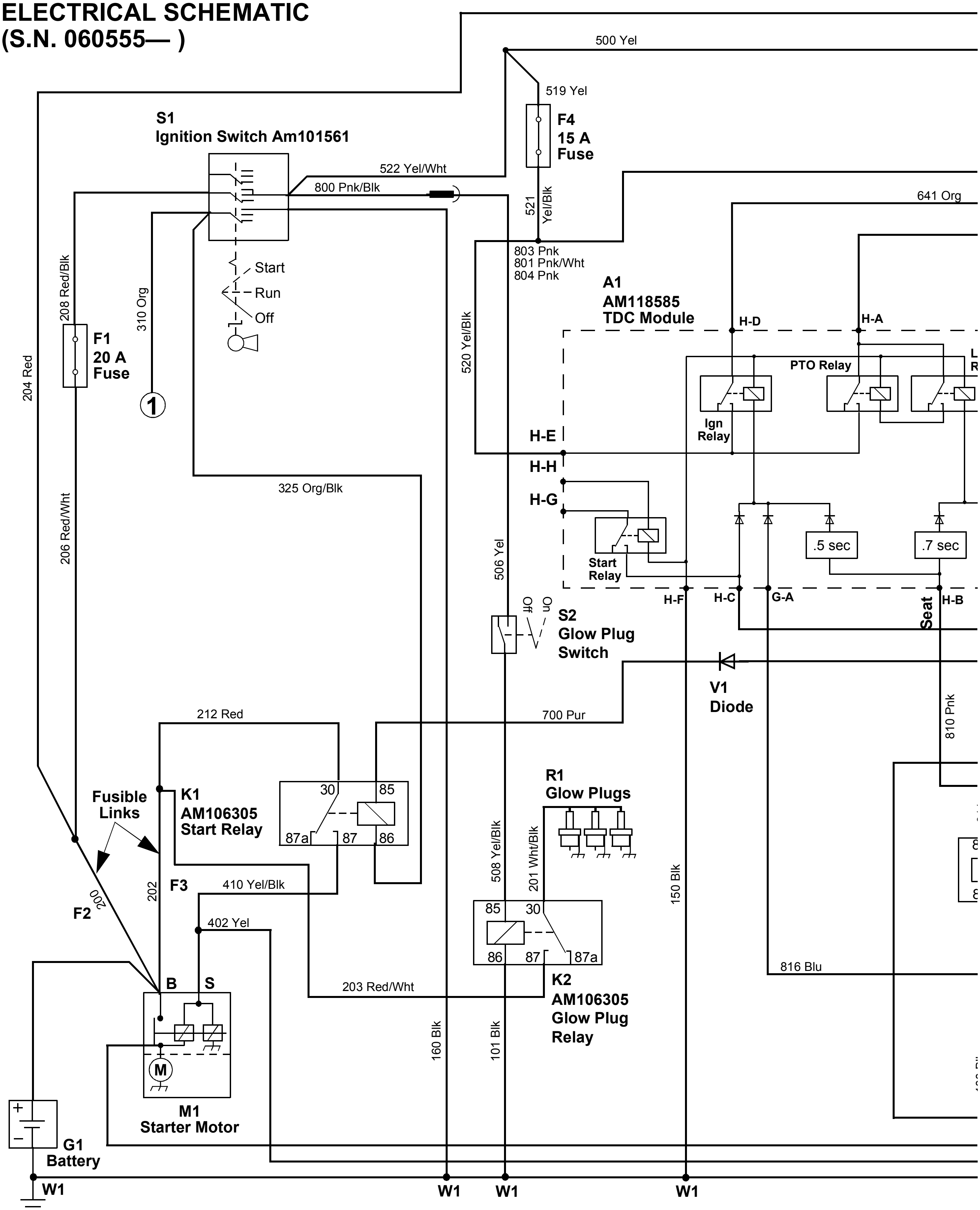


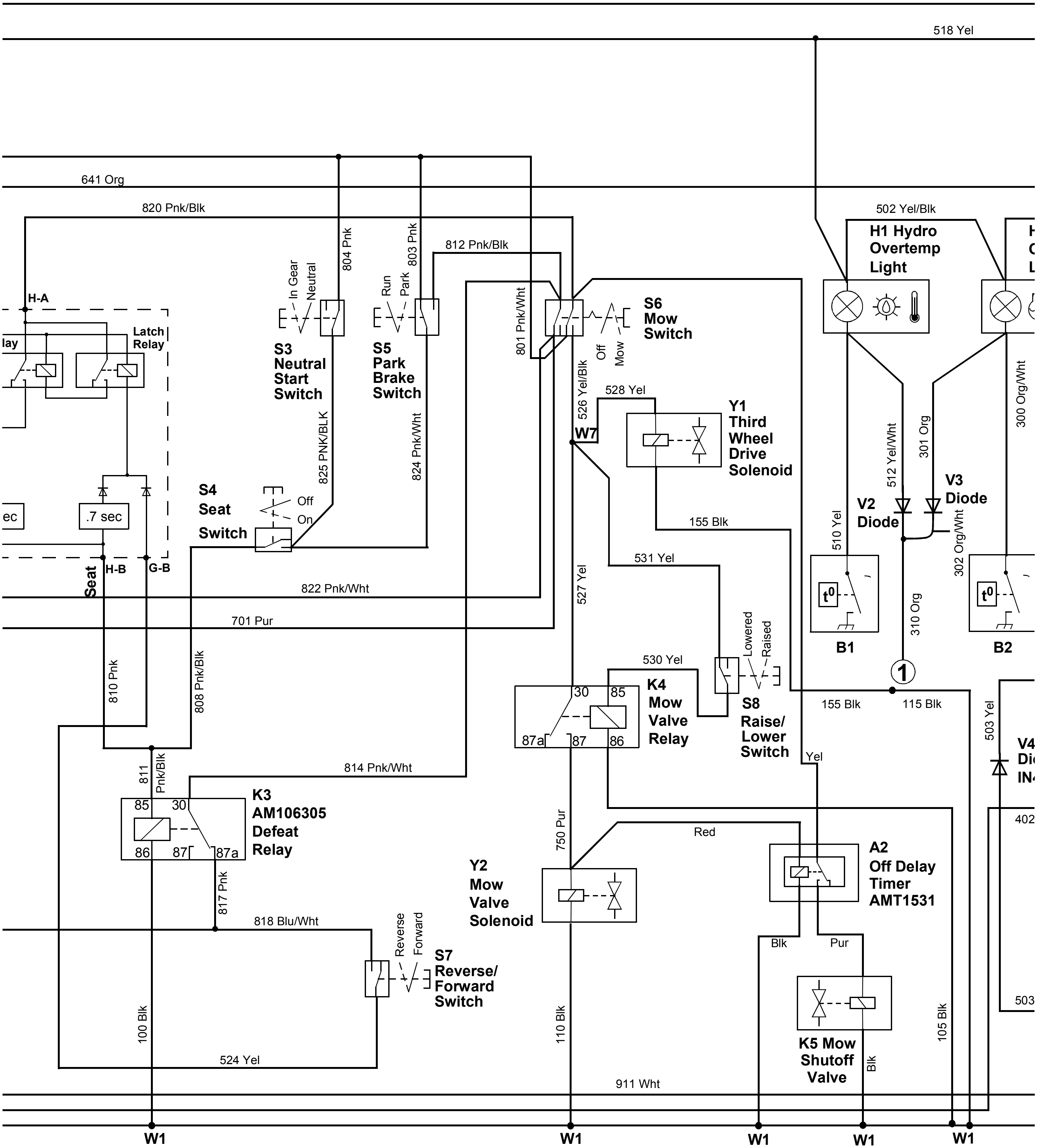
NOTES:

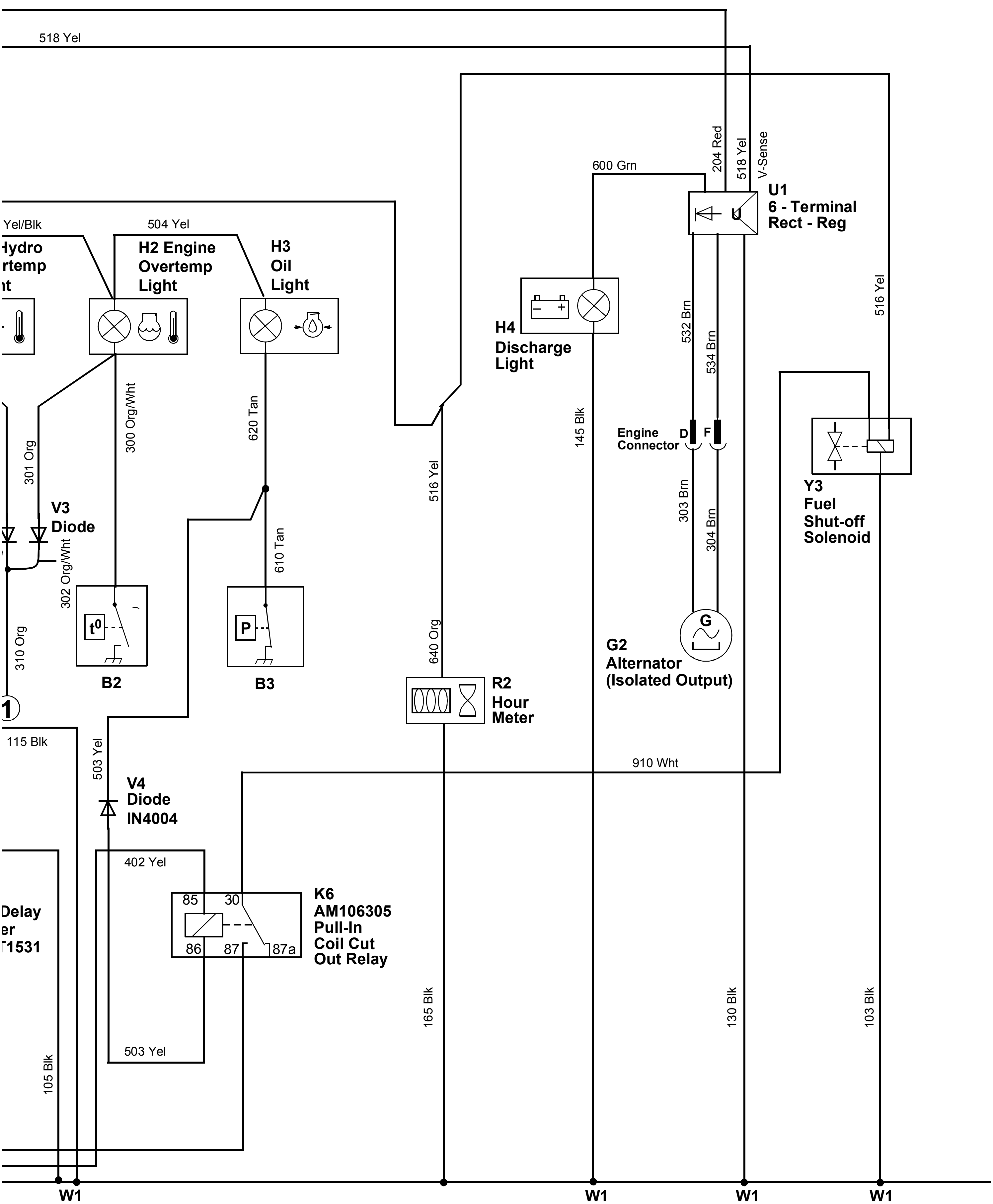
ELECTRICAL SCHEMATIC (S.N. 060555—)



ELECTRICAL SCHEMATIC (S.N. 060555—)




518 Yel
641 Org
820 Pnk/Blk
502 Yel/Blk
H1 Hydro Overtemp Light
812 Pnk/Blk
804 Pnk
803 Pnk
H-A
In Gear
Neutral
Run
Park
801 Pnk/Wht
S6 Mow Switch
Off
Mow
Latch Relay
lay
S3 Neutral Start Switch
S5 Park Brake Switch
526 Yel/Blk
528 Yel
Y1 Third Wheel Drive Solenoid
W7
825 PNK/BLK
824 Pnk/Wht
512 Yel/Wht
301 Org
300 Org/Wht
S4 Seat Switch
Off
On
.7 sec
ec
155 Blk
V2 Diode
V3 Diode
510 Yel
302 Org/Wht
531 Yel
Seat
H-B
G-B
822 Pnk/Wht
527 Yel
701 Pur
Lowered
Raised
B1
B2
810 Pnk
808 Pnk/Blk
530 Yel
K4 Mow Valve Relay
30
85
87a
87
86
S8 Raise/ Lower Switch
155 Blk
115 Blk
503 Yel
V4
Di
IN
Yel
811 Pnk/Blk
814 Pnk/Wht
K3 AM106305 Defeat Relay
85
30
86
87
87a
402
750 Pur
Red
A2 Off Delay Timer AMT1531
Y2 Mow Valve Solenoid
817 Pnk
818 Blu/Wht
Reverse
Forward
S7 Reverse/ Forward Switch
Blk
Pur
K5 Mow Shutoff Valve
503
100 Blk
110 Blk
105 Blk
Blk
524 Yel
911 Wht
W1
W1
W1
W1
W1

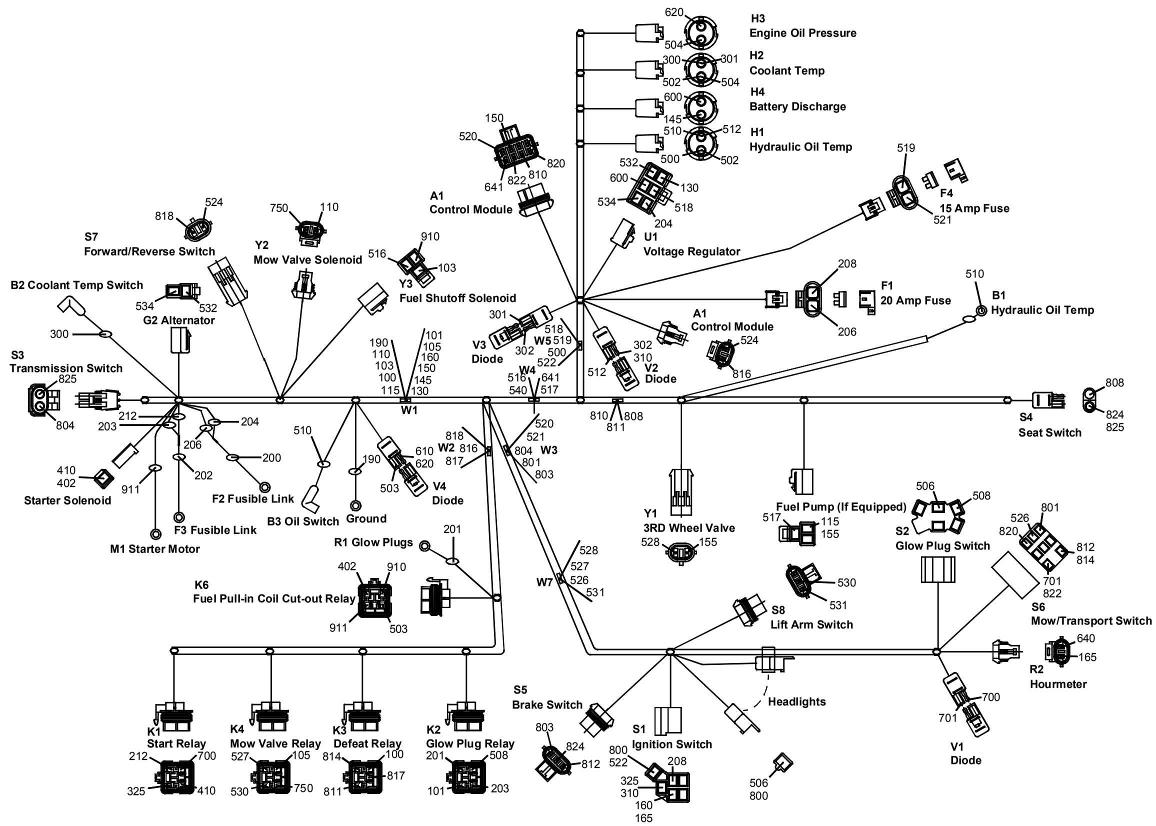


518 Yel
204 Red
518 Yel
V-Sense
600 Grn
U1
6 - Terminal
Rect - Reg
Yel/Blk
504 Yel
Hydro
rtemp
nt
H2 Engine
Overtemp
Light
H3
Oil
Light
H4
Discharge
Light
532 Brn
534 Brn
516 Yel
301 Org
300 Org/Wht
620 Tan
516 Yel
145 Blk
Engine
Connector
D
F
303 Brn
304 Brn
Y3
Fuel
Shut-off
Solenoid
V3
Diode
302 Org/Wht
610 Tan
310 Org
B2
B3
640 Org
G
G2
Alternator
(Isolated Output)
R2
Hour
Meter
1
115 Blk
503 Yel
910 Wht
V4
Diode
IN4004
402 Yel
85
30
86
87
87a
K6
AM106305
Pull-In
Coil Cut
Out Relay
Delay
er
T1531
165 Blk
130 Blk
103 Blk
105 Blk
503 Yel
W1
W1
W1
W1

WIRING HARNESS DIAGRAM (S.N. 060555—)

Circuit Number	Wire Size	Wire Color	Termination Point
100	0.8	Blk	Defeat Relay, W1
101	0.8	Blk	K2, W1
103	2.0	Blk	K8, W1
105	0.8	Blk	K6, W1
110	0.8	Blk	K5, W1
115	0.8	Blk	Not Used (fuel pump,W1)
130	3.0	Blk	U1, W1
145	0.8	Blk	H4, W1
150	0.8	Blk	A1, W1
155	0.8	Blk	K4, 115
160	0.8	Blk	S1, W1
165	0.8	Blk	R1, S1
190	5.0	Blk	Ground
200	1.0	Fus Lnk	F2
201	3.0	Wht/Blk	K2, R1
202	2.0	Fus Lnk	F3
203	3.0	Red/Wht	K2, F3
204	3.0	Red	U1, F2
206	2.0	Red/Wht	F1, F2
208	2.0	Red/Blk	F1, S1
212	1.0	Red	K1, F3
300	0.8	Org/Wht	H2, B2
301	0.8	Org	H2, V3
302	0.8	Org/Wht	V3, V2
310	0.8	Org	S1, V2
325	0.8	Org/Blk	K1, S1
402	0.8	Yel	K7, Starter
410	1.0	Yel/Blk	K1, Starter
500	0.8	Yel	H1, W5
502	0.8	Yel/Blk	H2, H1
503	0.8	Yel	K7, V4
504	0.8	Yel/Wht	H2, H3
506	0.8	Yel	S2, Headlight
508	0.8	Yel/Blk	K2, S2

Circuit Number	Wire Size	Wire Color	Termination Point
510	0.8	Yel	H1, B1
512	0.8	Yel/Wht	H1, V2
516	0.8	Yel	K8, W5
517	0.8	Yel/Blk	Not Used
518	0.8	Yel	U1, W5
519	1.0	Yel	F2, W5
520	0.8	Yel/Blk	A1, W3
521	1.0	Yel	F2, W3
522	0.8	Yel/Wht	S1, W5
524	0.8	Yel	S7, A1
526	0.8	Yel/Blk	S6, K6
527	0.8	Yel	K6, W7
528	0.8	Yel	K4, W7
530	0.8	Yel	S8, K6
531	0.8	Yel	S8, W7
532	3.0	Brn	U1, G2
534	3.0	Brn	U1, G2
600	0.8	Grn	U1, H4
610	0.8	Tan	B3, V4
620	0.8	Tan	H3, V4
640	0.8	Org	R2, W4
641	0.8	Org	A1, W4
700	0.8	Pur	K1, V1
701	0.8	Pur	S6, V1
750	0.8	Pur	K5, K6
800	0.8	Pnk/Blk	S1, Headlight
801	0.8	Pnk/Wht	S6, W3
803	0.8	Pnk	S5, W3
804	0.8	Pnk	S3, W3
808	0.8	Pnk/Blk	S4, W6
810	0.8	Pnk	A1, W6
811	0.8	Pnk/Blk	K3, W6
812	0.8	Pnk/Blk	S6, S5
814	0.8	Pnk/Wht	S6, K3
816	0.8	Blu	A1, W2
817	0.8	Pnk	K3, W2
818	0.8	Blu/Wht	S7, W2
820	0.8	Pnk/Blk	A1, S6
822	0.8	Pnk/Wht	S6, A1
824	0.8	Pnk/Wht	S4, S5
825	0.8	Pnk/Blk	S4, S3
910	2.0	Wht	K8, K7
911	2.0	Wht	K7, M1



WIRING HARNESS DIAGRAM (S.N. 060555—)

Circuit Number	Wire Size	Wire Color	Termination Point
100	0.8	Blk	Defeat Relay, W1
101	0.8	Blk	K2, W1
103	2.0	Blk	K8, W1
105	0.8	Blk	K6, W1
110	0.8	Blk	K5, W1
115	0.8	Blk	Not Used (fuel pump,W1)
130	3.0	Blk	U1, W1
145	0.8	Blk	H4, W1
150	0.8	Blk	A1, W1
155	0.8	Blk	K4, 115
160	0.8	Blk	S1, W1
165	0.8	Blk	R1, S1
190	5.0	Blk	Ground
200	1.0	Fus Lnk	F2
201	3.0	Wht/Blk	K2, R1
202	2.0	Fus Lnk	F3
203	3.0	Red/Wht	K2, F3
204	3.0	Red	U1, F2
206	2.0	Red/Wht	F1, F2
208	2.0	Red/Blk	F1, S1
212	1.0	Red	K1, F3
300	0.8	Org/Wht	H2, B2
301	0.8	Org	H2, V3
302	0.8	Org/Wht	V3, V2
310	0.8	Org	S1, V2
325	0.8	Org/Blk	K1, S1
402	0.8	Yel	K7, Starter
410	1.0	Yel/Blk	K1, Starter
500	0.8	Yel	H1, W5
502	0.8	Yel/Blk	H2, H1
503	0.8	Yel	K7, V4
504	0.8	Yel/Wht	H2, H3
506	0.8	Yel	S2, Headlight
508	0.8	Yel/Blk	K2, S2
510	0.8	Yel	H1, B1
512	0.8	Yel/Wht	H1, V2
516	0.8	Yel	K8, W5
517	0.8	Yel/Blk	Not Used
518	0.8	Yel	U1, W5
519	1.0	Yel	F2, W5
520	0.8	Yel/Blk	A1, W3
521	1.0	Yel	F2, W3
522	0.8	Yel/Wht	S1, W5
524	0.8	Yel	S7, A1
526	0.8	Yel/Blk	S6, K6
527	0.8	Yel	K6, W7
528	0.8	Yel	K4, W7
530	0.8	Yel	S8, K6
531	0.8	Yel	S8, W7
532	3.0	Brn	U1, G2
534	3.0	Brn	U1, G2
600	0.8	Grn	U1, H4
610	0.8	Tan	B3, V4
620	0.8	Tan	H3, V4
640	0.8	Org	R2, W4
641	0.8	Org	A1, W4
700	0.8	Pur	K1, V1
701	0.8	Pur	S6, V1
750	0.8	Pur	K5, K6
800	0.8	Pnk/Blk	S1, Headlight
801	0.8	Pnk/Wht	S6, W3
803	0.8	Pnk	S5, W3
804	0.8	Pnk	S3, W3
808	0.8	Pnk/Blk	S4, W6
810	0.8	Pnk	A1, W6
811	0.8	Pnk/Blk	K3, W6
812	0.8	Pnk/Blk	S6, S5
814	0.8	Pnk/Wht	S6, K3
816	0.8	Blu	A1, W2
817	0.8	Pnk	K3, W2
818	0.8	Blu/Wht	S7, W2
820	0.8	Pnk/Blk	A1, S6
822	0.8	Pnk/Wht	S6, A1
824	0.8	Pnk/Wht	S4, S5
825	0.8	Pnk/Blk	S4, S3
910	2.0	Wht	K8, K7
911	2.0	Wht	K7, M1

oint

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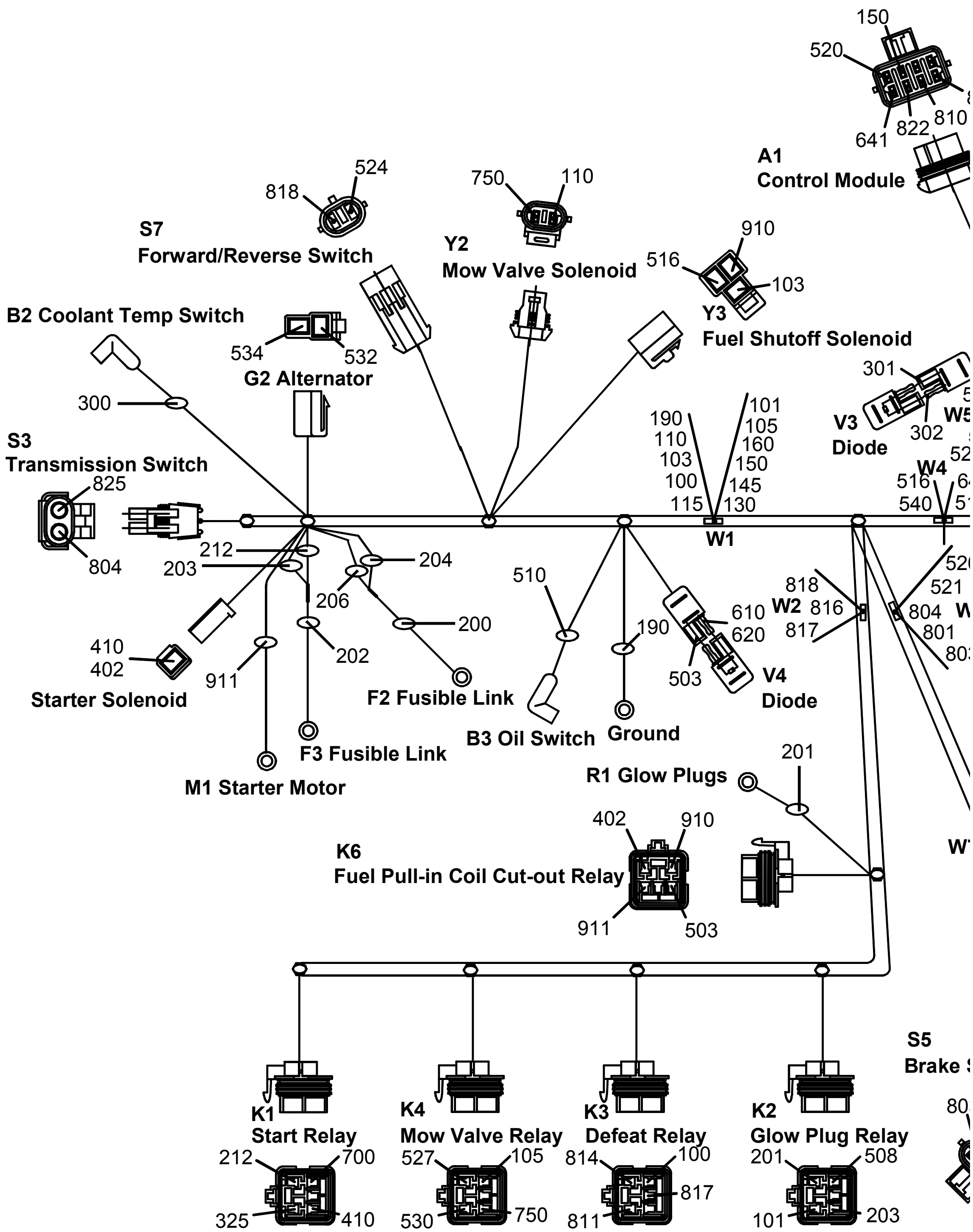
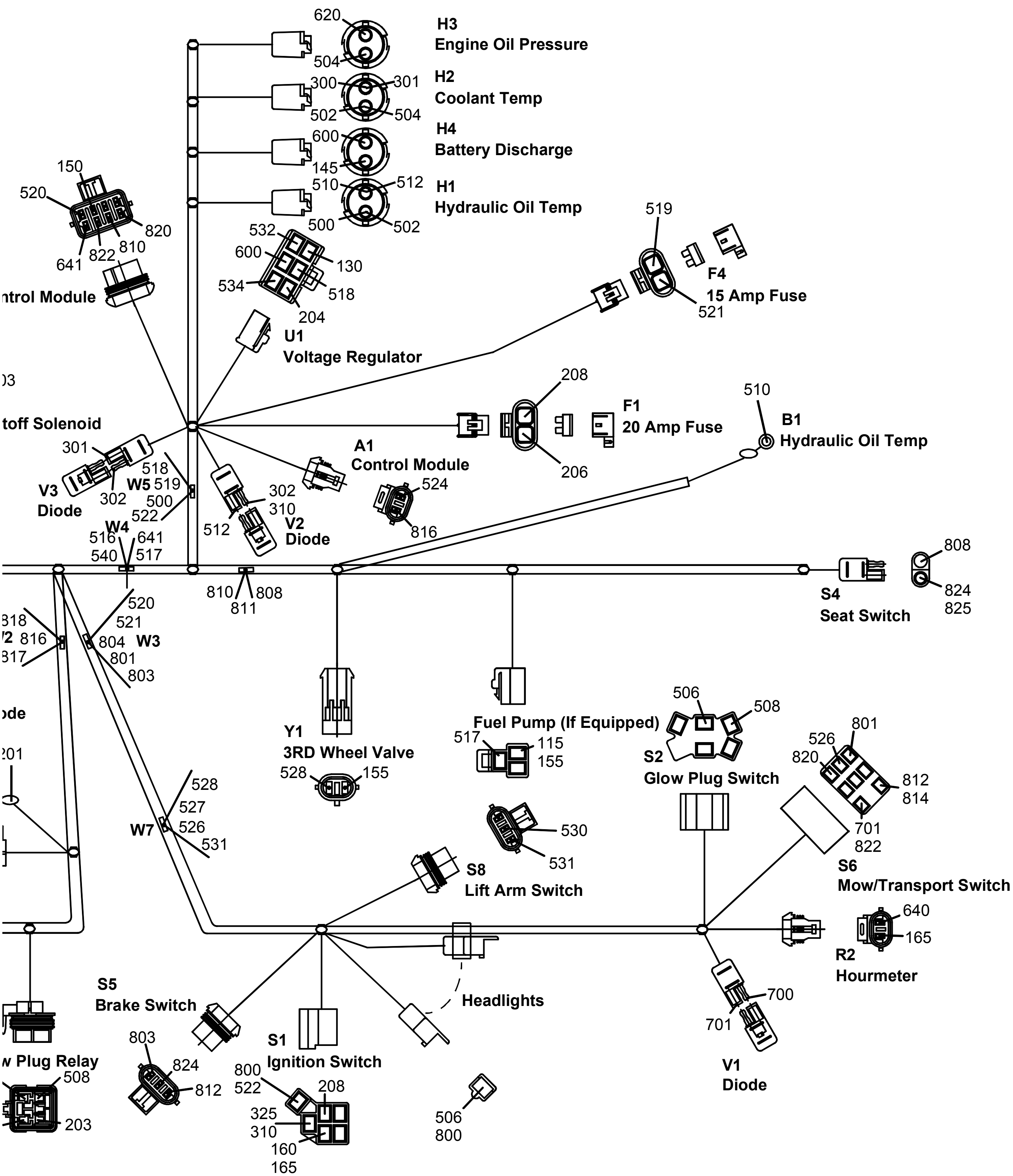

A1
Control Module
150
520
641
822
810
S7
Forward/Reverse Switch
818
524
Y2
Mow Valve Solenoid
750
110
516
910
103
Y3
Fuel Shutoff Solenoid
B2 Coolant Temp Switch
534
532
G2 Alternator
300
301
302
V3
Diode
S3
Transmission Switch
825
804
190
110
103
100
115
101
105
160
150
145
130
W1
W4
516
540
212
203
204
206
200
202
911
410
402
Starter Solenoid
F2 Fusible Link
F3 Fusible Link
M1 Starter Motor
510
B3 Oil Switch
190
Ground
610
620
503
V4
Diode
818
W2
816
817
521
804
801
R1 Glow Plugs
201
K6
Fuel Pull-in Coil Cut-out Relay
402
910
911
503
S5
K1
Start Relay
212
700
325
410
K4
Mow Valve Relay
527
105
530
750
K3
Defeat Relay
814
100
817
811
K2
Glow Plug Relay
201
508
101
203


620
504
H3
Engine Oil Pressure
300
301
502
504
H2
Coolant Temp
600
145
H4
Battery Discharge
510
512
500
502
H1
Hydraulic Oil Temp
150
520
820
641
822
810
ntrol Module
532
600
130
534
518
204
U1
Voltage Regulator
519
F4
15 Amp Fuse
521
208
F1
20 Amp Fuse
206
510
B1
Hydraulic Oil Temp
toff Solenoid
301
302
V3
Diode
518
W5
519
500
522
W4
516
641
540
517
302
310
512
V2
Diode
A1
Control Module
524
816
810
808
811
808
824
825
S4
Seat Switch
520
521
804
W3
801
803
818
816
817
Y1
3RD Wheel Valve
528
155
Fuel Pump (If Equipped)
517
115
155
506
508
S2
Glow Plug Switch
526
801
820
812
814
701
822
S6
Mow/Transport Switch
528
527
526
531
W7
530
531
S8
Lift Arm Switch
201
640
165
R2
Hourmeter
S5
Brake Switch
Headlights
700
701
V1
Diode
803
824
812
w Plug Relay
508
203
800
522
208
S1
Ignition Switch
325
310
160
165
506
800

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 leader line points to the exact point the test is to be made.

WIRE COLOR ABBREVIATION CHART

Blk	Black
Blu	Blue
Brn	Brown
Grn	Green
Gry	Gray
Org	Orange
Pnk	Pink
Pur	Purple
Red	Red
Tan	Tan
Wht	White
Yel	Yellow
Blk/Wht	Black/White
Blu/Wht	Blue/White
Brn/Wht	Brown/White
Brn/Yel	Brown/Yellow
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
Lt Blue	Light Blue
Lt Grn	Light Green
Org/Wht	Orange/White
Pnk/Blk	Pink/Black
Pur/Wht	Purple/White
Red/Blk	Red/Black
Red/Wht	Red/White
Wht/Blk	White/Black
Wht/Red	White/Red
Yel/Blk	Yellow/Black
Yel/Red	Yellow/Red
Yel/Wht	Yellow/White

THEORY OF OPERATION

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:

- Ignition switch **S1** in the START position.
- Travel pedal **S3** must be in NEUTRAL position.
- Mow switch **S6** must be in the OFF position.
- Parking brake **S5** ON.

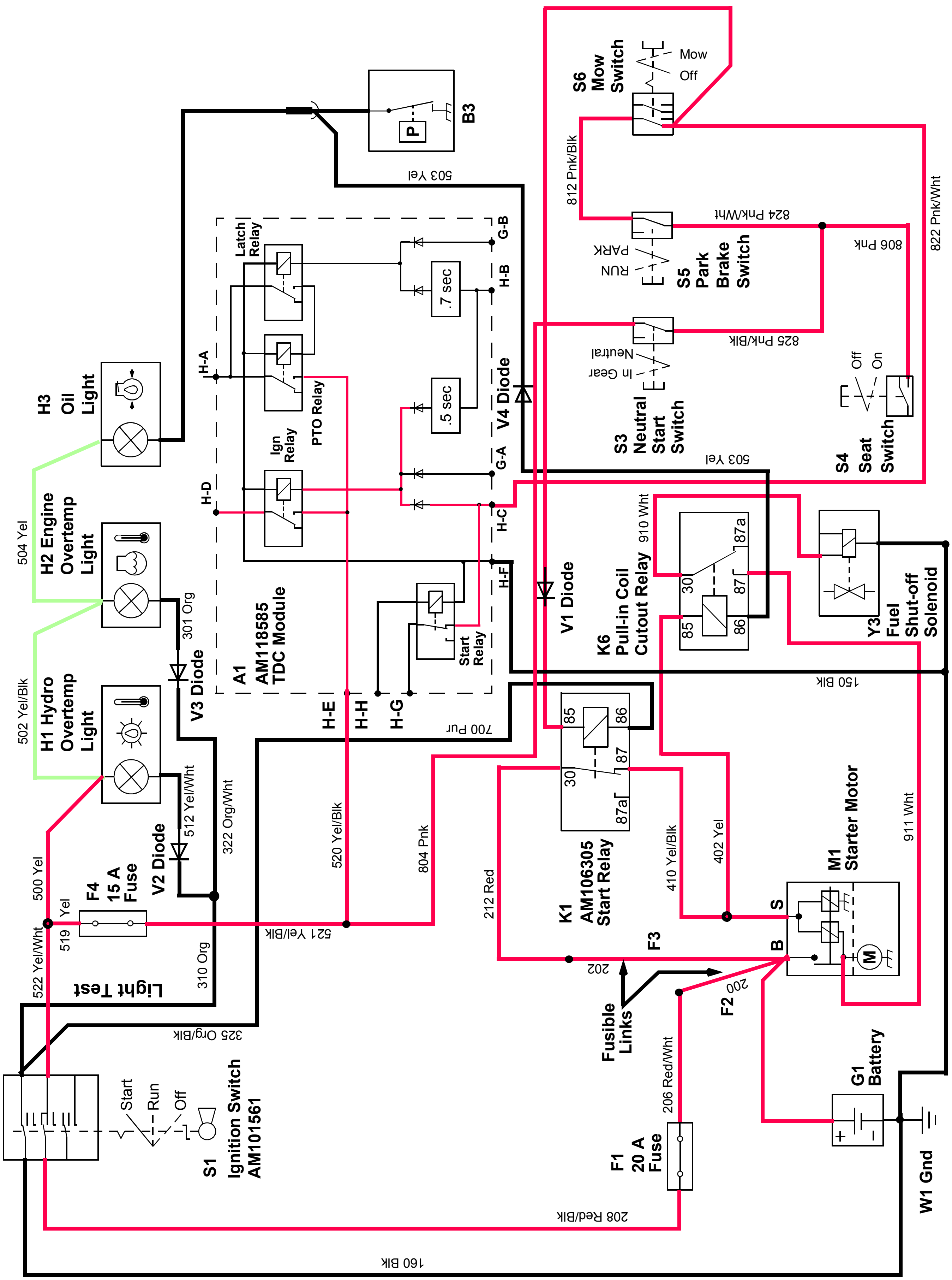
Theory of Operation:

The battery **G1** is connected to a tie point at the starter **M1**, the ignition switch **S1** is connected to the same tie point through a fusible link **F2** and a 20 amp fuse **F1**. When the Ignition switch is turned to the START position, the starter relay **K1** is energized through the neutral start switch **S3** (transmission in NEUTRAL), the park brake switch **S5** (ON), the mow switch (OFF) and the **V1** diode. The starter relay is grounded through the ignition switch in the START position.

The starter relay allows current to flow from the battery tie point on the starter, through a fusible link **F3**, the main contacts of the starter relay and to the starter solenoid. Once engaged, power flows from the battery through the main contacts of the starter solenoid through the field windings of the starter motor to crank the engine.

The fuel shutoff solenoid **Y3** pull-in circuit is energized through the main contacts of the pull-in coil cut out relay **K6**. The relay is energized when the starter solenoid receives power at the S terminal of the starter motor. A ground path for the relay is provided through the **V4** diode and the oil pressure switch.

*NOTE: In addition to the cranking circuit, a bulb check circuit for the hydro overtemperature **H1** and engine coolant overtemperature **H2** lights is completed when the Ignition switch is in the START position.*


S6 Mow Switch
Mow
Off
B3
P
503 Yel
812 Pnk/Blk
824 Pnk/Wht
PARK
RUN
S5 Park Brake Switch
808 Pnk
822 Pnk/Wht
Neutral
In Gear
825 Pnk/Blk
S3 Neutral Start Switch
Off
On
S4 Seat Switch
H3 Oil Light
Latch Relay
G-B
H-B
.7 sec
H-A
.5 sec
V4 Diode
Ign Relay
PTO Relay
G-A
H-D
H-C
H-F
504 Yel
H2 Engine Overtemp Light
301 Org
A1 AM118585 TDC Module
Start Relay
V1 Diode
910 Wht
K6 Pull-in Coil Cutout Relay
30
87a
87
85
86
Y3 Fuel Shut-off Solenoid
150 Blk
502 Yel/Blk
H1 Hydro Overtemp Light
V3 Diode
H-E
H-H
H-G
700 Pur
512 Yel/Wht
322 Org/Wht
520 Yel/Blk
804 Pnk
212 Red
K1 AM106305 Start Relay
410 Yel/Blk
402 Yel
M1 Starter Motor
911 Wht
500 Yel
F4 15 A Fuse
V2 Diode
519
Yel
522 Yel/Wht
521 Yel/Blk
S
B
F3
202
Light Test
310 Org
325 Org/Blk
Fusible Links
F2
200
206 Red/Wht
G1 Battery
Start
Run
Off
S1 Ignition Switch AM101561
F1 20 A Fuse
W1 Gnd
208 Red/Blk
160 Blk

IGNITION CIRCUIT OPERATION—OPERATOR ON SEAT

Function:

With an operator on the seat, allows the engine to run after the ignition switch is released to the RUN position (starter disengaged).

Operating Conditions:

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

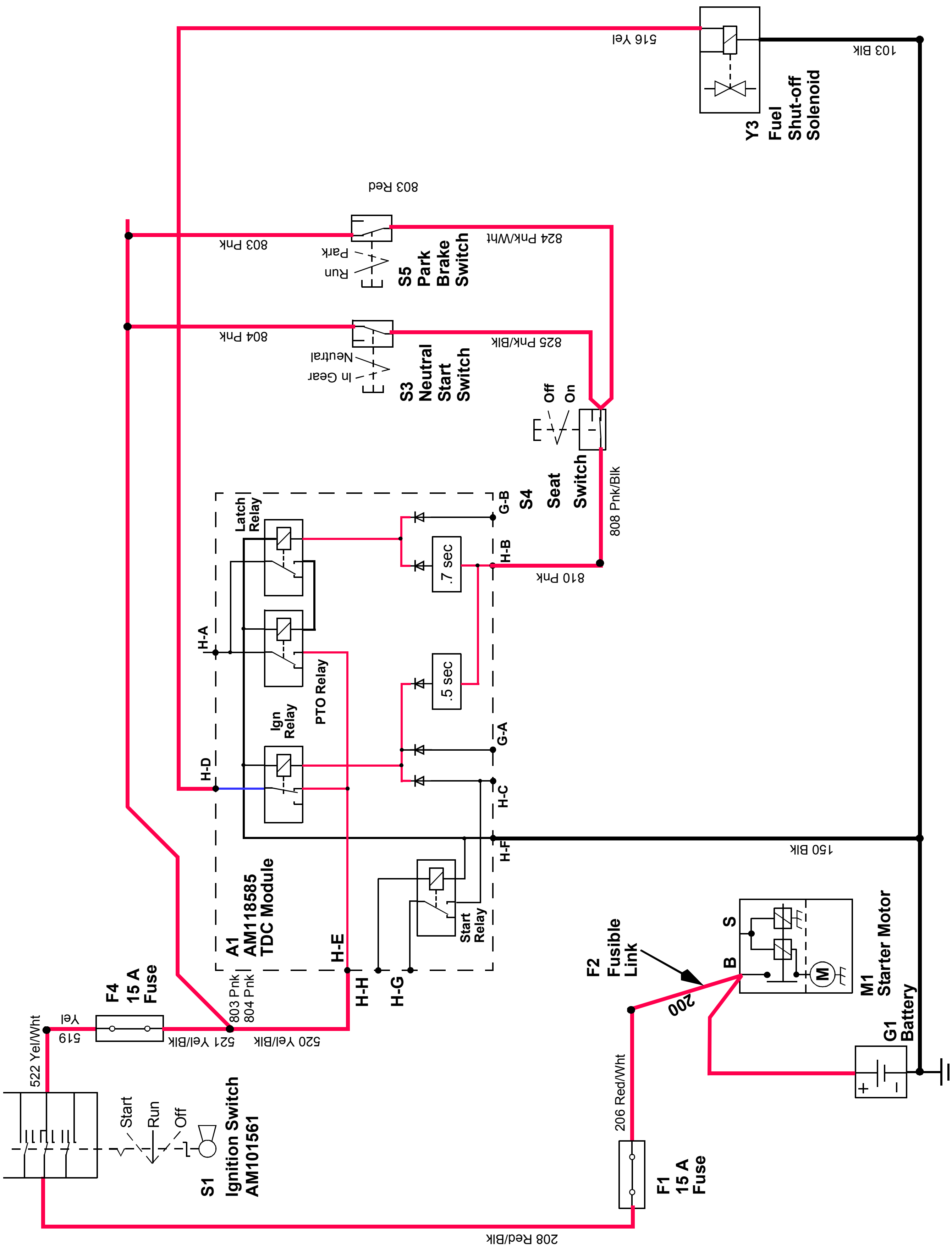
- Ignition switch **S1** in the RUN position.
- Operator on seat **S4** and parking brake OFF **S5** or operator on seat and travel pedal **S3** in NEUTRAL.

Theory of Operation:

With the Ignition switch **S1** in the RUN position and operator on the seat **S4**, voltage flows from the Ignition Switch through the neutral start switch **S3** (NEUTRAL), the seat switch (operator on seat) and into the TDC Module **A1**. Voltage then flows through a 0.5 sec. delay timer and energizes the Ignition Relay.

If the transmission is in gear, voltage flows from the Ignition Switch through the park brake switch **S5** (OFF), the seat switch (operator on seat) and into the TDC Module. Voltage then flows through a 0.5 sec. delay timer and energizes the Ignition Relay.

Either situation allows voltage coming from the Ignition switch to flow through the main contacts of the ignition relay and to the fuel shutoff solenoid **Y3**, providing fuel flow and allowing the engine to run.


516 Yel
103 Blk
Y3
Fuel
Shut-off
Solenoid
803 Red
803 Pnk
824 Pnk/Wht
Park
Run
S5
Park
Brake
Switch
804 Pnk
825 Pnk/Blk
Neutral
In Gear
S3
Neutral
Start
Switch
Off
On
S4
Seat
Switch
808 Pnk/Blk
810 Pnk
Latch
Relay
H-A
Ign
Relay
PTO Relay
.7 sec
.5 sec
G-B
H-B
G-A
H-C
H-D
H-F
150 Blk
A1
AM118585
TDC Module
Start
Relay
H-E
H-H
H-G
F2
Fusible
Link
S
B
M1
Starter Motor
200
G1
Battery
F4
15 A
Fuse
803 Pnk
804 Pnk
522 Yel/Wht
519
Yel
521 Yel/Blk
520 Yel/Blk
Start
Run
Off
S1
Ignition Switch
AM101561
206 Red/Wht
F1
15 A
Fuse
208 Red/Blk

IGNITION (RUN) CIRCUIT OPERATION—OPERATOR OFF SEAT

Function:

With an operator off the seat, allows the engine to run after the ignition switch is released to the RUN position (starter disengaged).

Operating Conditions:

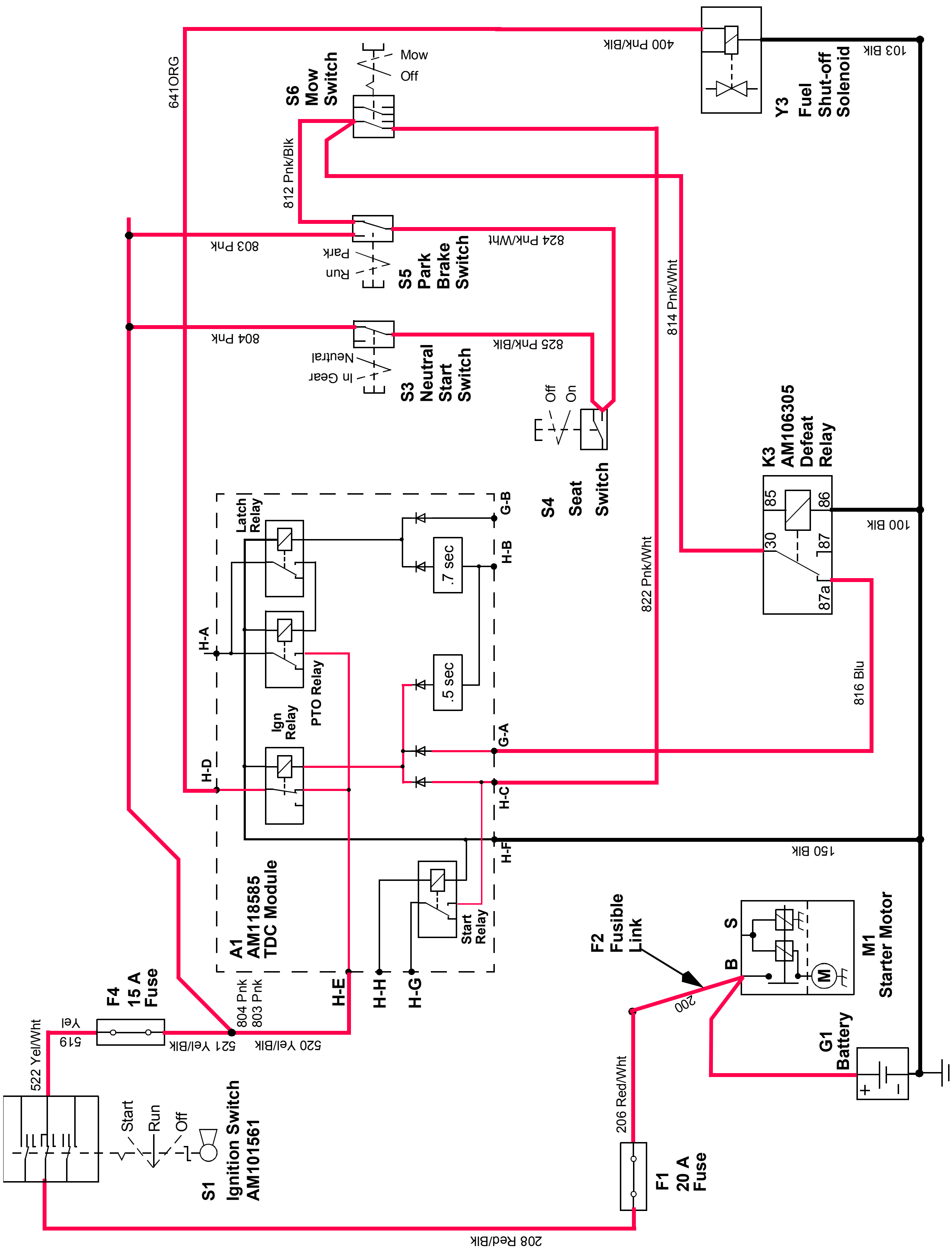
NOTE: These conditions are separate from the backlapping mode of operation.

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

- Ignition switch **S1** in the RUN position.
- Travel pedal **S3** must be in NEUTRAL position.
- Mow switch **S6** must be in the OFF position.
- Operator OFF seat **S4**.
- Parking brake ON **S5**.

Theory of Operation:

With the Ignition switch **S1** in the RUN position and operator OFF the seat **S4**, voltage flows from the Ignition switch through the neutral start switch **S3**, the park brake switch **S5** (ON) and mow switch **S6** (OFF). Voltage then flows into the TDC module **A1**, by-passing the 0.5 second time delay and activating the ignition relay.
This creates a path for the voltage coming from the Ignition switch to pass through the main contacts of the ignition relay and on to the fuel shutoff solenoid **Y3** providing fuel flow and allowing the engine to run.


S1
Ignition Switch
AM101561
Start
Run
Off
522 Yel/Wht
519
Yel
F4
15 A
Fuse
521 Yel/Blk
520 Yel/Blk
804 Pnk
803 Pnk
A1
AM118585
TDC Module
Latch Relay
Ign Relay
PTO Relay
Start Relay
.7 sec
.5 sec
H-A
H-B
H-C
H-D
H-E
H-F
H-G
H-H
G-A
G-B
641ORG
S6
Mow
Switch
Mow
Off
812 Pnk/Blk
803 Pnk
S5
Park
Brake
Switch
Park
Run
824 Pnk/Wht
804 Pnk
S3
Neutral
Start
Switch
Neutral
In Gear
825 Pnk/Blk
S4
Seat
Switch
Off
On
814 Pnk/Wht
822 Pnk/Wht
400 Pnk/Blk
Y3
Fuel
Shut-off
Solenoid
103 Blk
K3
AM106305
Defeat
Relay
85
86
30
87
87a
100 Blk
816 Blu
150 Blk
F2
Fusible
Link
200
B
S
M1
Starter Motor
G1
Battery
206 Red/Wht
F1
20 A
Fuse
208 Red/Blk

MOW & 3 WHEEL DRIVE CIRCUIT

Function:

To allow reels to turn and, at the same time, engage the Third Wheel Drive.

Operating Conditions:

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

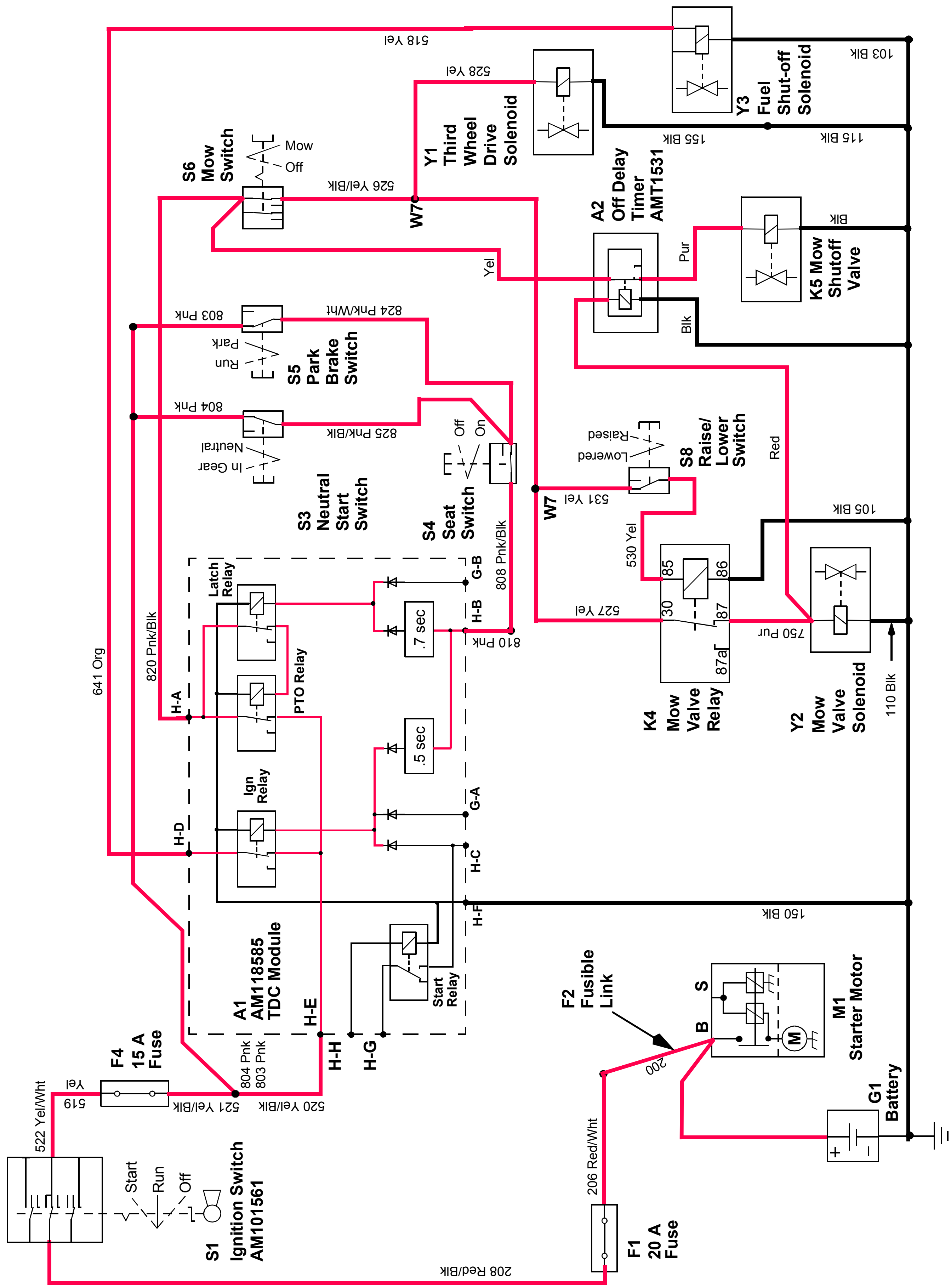
- Ignition switch **S1** in the RUN position.
- Park brake **S5** disengaged (OFF).
- Mow switch **S6** (OFF) initially, then (ON).
- Operator ON seat **S4**.
- Reels in LOWERED **S8** position.

Theory of Operation:

With the Ignition Switch **S1** in the RUN position, voltage flows from the Ignition switch, through the park brake switch **S5** (OFF) and to the seat switch **S4**. With the operator ON the seat, voltage flows into the TDC Module **A1** and through the time delays to energize the latch relay and keep the ignition relay energized. At this time voltage from the mow switch **S6** (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 ignition 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 **S8** (LOWERED), energizes the mow valve solenoid **Y2** and powers the relay inside the off delay timer **A2**. Voltage now passes through the main contacts of the relay inside the off delay timer and energizes the mow shutoff valve **K5** and the mow shutoff valve opens. When the mow switch is turned off a two second delay from the off delay timer prevents the mow shutoff valve from closing immediately allowing the reels to slow down before shutting off the flow of fluid to the reel motors. This prevents cavitation of the reel motors. Voltage from the mow switch also energizes the third wheel drive solenoid **Y1**.


S1 Ignition Switch AM101561
Start
Run
Off
522 Yel/Wht
519 Yel
F4 15 A Fuse
521 Yel/Blk
520 Yel/Blk
804 Pnk
803 Pnk
208 Red/Blk
F1 20 A Fuse
206 Red/Wht
200
F2 Fusible Link
G1 Battery
M1 Starter Motor
B
S
150 Blk
A1 AM118585 TDC Module
Start Relay
Ign Relay
PTO Relay
Latch Relay
.5 sec
.7 sec
H-A
H-B
H-C
H-D
H-E
H-F
H-G
H-H
G-A
G-B
641 Org
820 Pnk/Blk
810 Pnk
808 Pnk/Blk
S3 Neutral Start Switch
In Gear
Neutral
804 Pnk
825 Pnk/Blk
S4 Seat Switch
Off
On
S5 Park Brake Switch
Run
Park
803 Pnk
824 Pnk/Wht
S6 Mow Switch
Mow
Off
526 Yel/Blk
W7
518 Yel
528 Yel
Y1 Third Wheel Drive Solenoid
Y3 Fuel Shut-off Solenoid
103 Blk
155 Blk
115 Blk
A2 Off Delay Timer AMT1531
Yel
Pur
Blk
K5 Mow Shutoff Valve
S8 Raise/ Lower Switch
Raised
Lowered
531 Yel
530 Yel
527 Yel
Red
105 Blk
K4 Mow Valve Relay
85
86
30
87
87a
750 Pur
Y2 Mow Valve Solenoid
110 Blk

BACKLAPPING CIRCUIT

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:

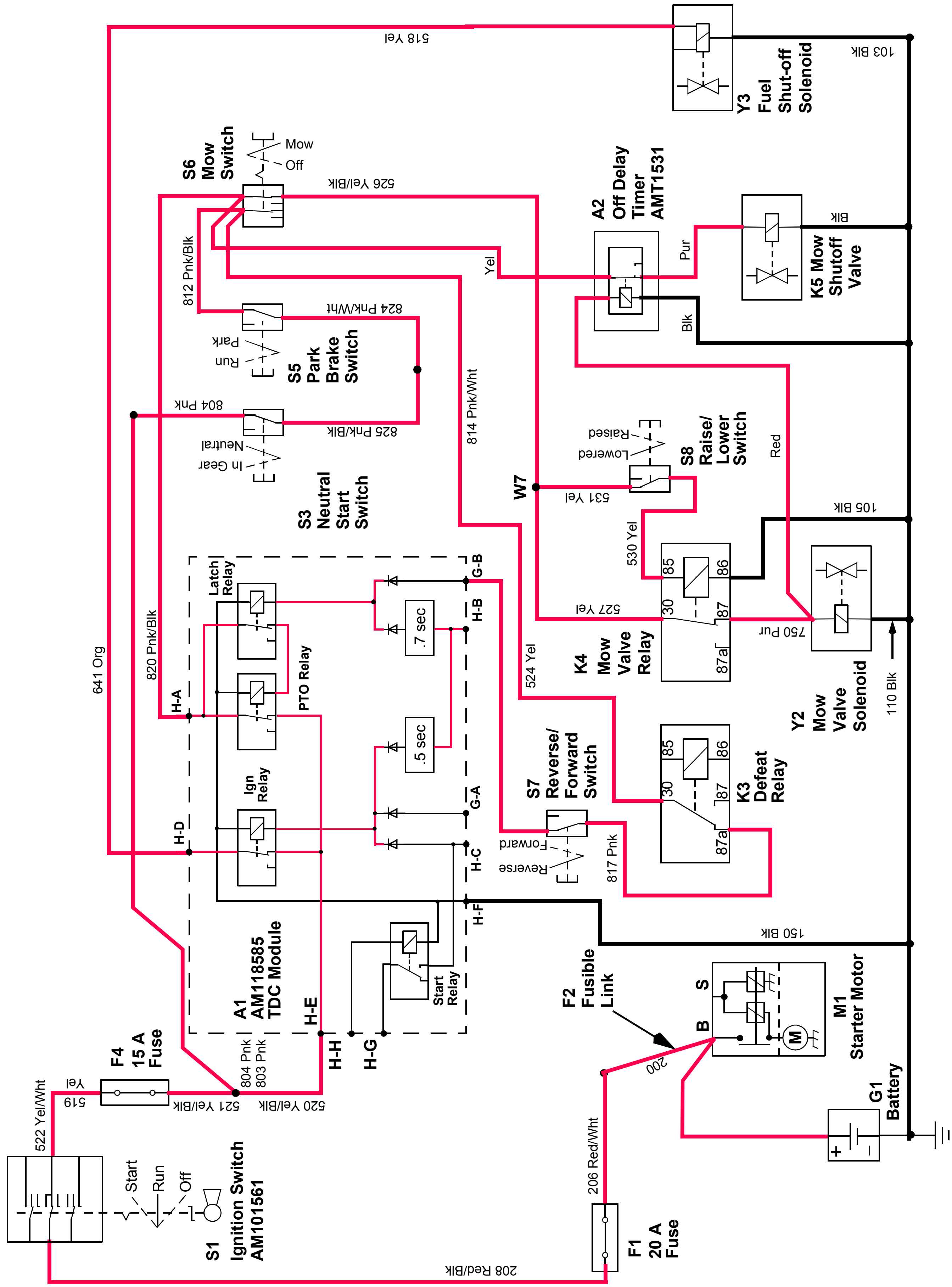
- Ignition switch **S1** in the RUN position.
- Travel pedal **S3** in NEUTRAL.
- Park brake **S5** engaged (ON).
- Mow switch **S6** (OFF) initially, then (ON).
- Operator OFF seat **S4**.
- Reels in LOWERED **S8** position.
- Forward/reverse switch **S7** in REVERSE position.

Theory Of Operation:

With the Ignition switch **S1** in the RUN position, voltage travels through the neutral start switch **S3** (NEUTRAL), the park brake switch **S5** (BRAKE ON) to the mow switch **S6** (NEUTRAL) and to the defeat relay **K3**. With the operator off the seat **S4** (not shown), the defeat relay is de-energized, allowing voltage from the brake switch to keep the ignition relay energized and provide voltage through the forward/reverse switch **S7** (REVERSE) to energize the latch relay. 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 Ignition 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 **S8** (LOWERED), energizes the mow valve solenoid **Y2** and powers the relay inside the off delay timer **A2**. Voltage now passes through the main contacts of the relay inside the off delay timer and energizes the mow shutoff valve **K5** and the mow shutoff valve opens.


S1 Ignition Switch AM101561
Start
Run
Off
522 Yel/Wht
519 Yel
F4 15 A Fuse
521 Yel/Blk
520 Yel/Blk
804 Pnk
803 Pnk
208 Red/Blk
F1 20 A Fuse
206 Red/Wht
200
F2 Fusible Link
M1 Starter Motor
B
S
G1 Battery
150 Blk
110 Blk
A1 AM118585 TDC Module
Start Relay
Ign Relay
PTO Relay
Latch Relay
.5 sec
.7 sec
H-A
H-B
H-C
H-D
H-E
H-F
H-G
H-H
G-A
G-B
641 Org
820 Pnk/Blk
812 Pnk/Blk
804 Pnk
S3 Neutral Start Switch
In Gear
Neutral
825 Pnk/Blk
824 Pnk/Wht
S5 Park Brake Switch
Run
Park
S6 Mow Switch
Mow
Off
526 Yel/Blk
518 Yel
814 Pnk/Wht
524 Yel
S7 Reverse/ Forward Switch
Reverse
Forward
817 Pnk
K3 Defeat Relay
K4 Mow Valve Relay
527 Yel
530 Yel
531 Yel
W7
S8 Raise/ Lower Switch
Lowered
Raised
Yel
Y2 Mow Valve Solenoid
750 Pur
105 Blk
Red
A2 Off Delay Timer AMT1531
Pur
Blk
K5 Mow Shutoff Valve
Y3 Fuel Shut-off Solenoid
103 Blk

TROUBLESHOOTING

Check or Solution / Problem or Symptom	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”
Transmission not in neutral or neutral start switch S3 is defective	●												
Park brake not set or park brake switch S5 is defective	●		●	●									
Mow switch S6 is on or mow switch is defective	●												
Start relay K1 defective	●					●							
Starter motor M1 defective	●	●				●					●		
Control module A1 ignition relay defective		●											
Loose or dirty electrical connections	●	●	●	●	●	●	●	●	●	●	●		
Fusible link F2 or F3 defective	●												
20 amp fuse F1 defective	●												
Micro switch on forward/reverse knob defective				●									
Mow switch or wiring defective			●							●			
Defeat relay defective			●										

TROUBLESHOOTING

Check or Solution / Problem or Symptom	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”
Seat switch S4 defective					●								
Park brake switch S5 defective	●				●								
Mow valve solenoid K5 defective									●				
Mow shutoff valve K5 defective or not energized									●				
Third wheel drive solenoid Y1 defective										●			
Battery weak or discharged	●	●									●		
Defective starter solenoid	●												
Defective ignition switch S1 (either power or ground circuit)	●												
Engine defective or seized	●										●		
Incorrect starter M1 alignment												●	
Faulty pinion return mechanism													●
Worn pinion or ring gear												●	

DIAGNOSTICS

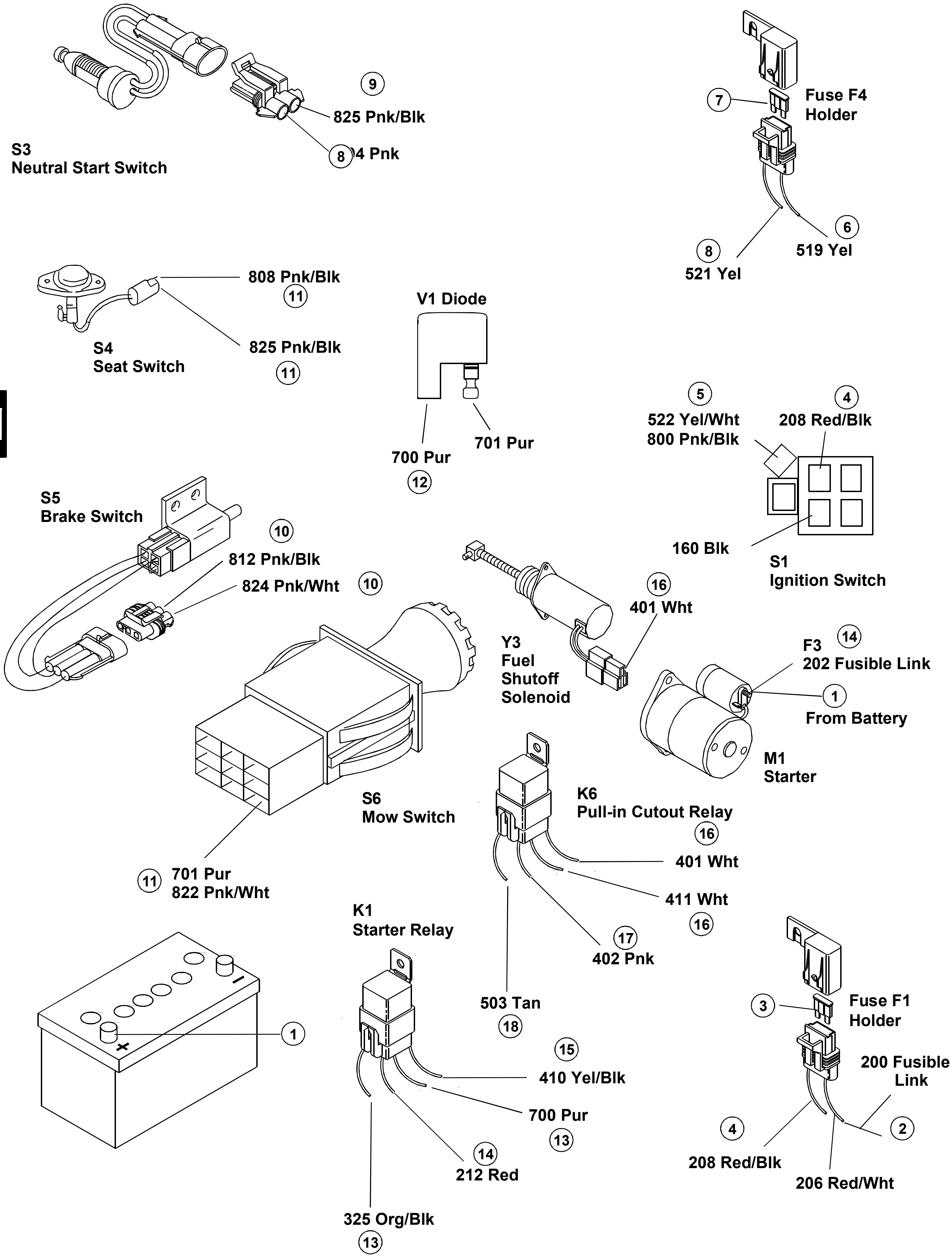
CRANKING CIRCUIT TEST

Test Conditions:

- Mow switch **S6** “OFF”
- Ignition switch **S1** “START”
- Park brake **S5** engaged
- Transmission in Neutral **S3**

Test/Check Point	Normal	If Not Normal
1. Starter positive terminal	11.8—13.2 volts	Check battery connections and test battery.
2. Fuse **F1**	11.8—13.2 volts	Test 200 fusible link, 206 Red/Wht and fuse connections.
3. Fuse **F1**	Continuity	Replace fuse.
4. Ignition switch	11.8—13.2 volts	Test 208 Red/Blk. If no voltage repair/replace wire harness.
5. Ignition switch	11.8—13.2 volts	Check ignition switch connections 522 Yel/Wht and 800 Pnk/Blk. If no voltage replace switch.
6. Fuse **F4**	11.8—13.2 volts	Test 519 Yel. If no voltage repair/replace wire harness.
7. Fuse	Continuity	Replace fuse.
8. Neutral start switch **S3**	11.8—13.2 volts	Test 804 Pnk at neutral switch. If no voltage check 521 Yel/Blk at **F4**. If voltage is ok, repair/replace wire harness.
9. Neutral start switch	11.8—13.2 volts	Ensure that neutral switch is in NEUTRAL position. Test 825 Pnk/Blk. If no voltage replace switch.
10. Park brake switch **S5**	11.8—13.2 volts	Ensure that park brake switch is in PARK position. Test 812 Pnk/Blk between mow switch and park brake switch. If no voltage Test 824 Pnk/Wht between the brake switch and the seat switch. If no voltage test 825 Pnk/Blk between the seat switch and the neutral switch. If voltage is ok at these points, replace the park brake switch.
11. Mow switch **S6**	11.8—13.2 volts	Ensure mow switch is OFF. Test 701 Pur. If no voltage replace mow switch.
12. Diode **V1**	11.8—13.2 volts	Test 700 Pur. If no voltage replace diode or repair harness
13. Start relay **K1**	11.8—13.2 volts and a clicking sound when ignition switch is placed to START	If no voltage, test 700 Pur. If voltage is present and no clicking sound is heard, test relay and 325 Org/Blk. Ignition switch contacts and 160 Blk are good if hydro and engine coolant overtemp lights illuminate when ignition switch is turned to start.
14. Start relay	11.8—13.2 volts	Test 202 fusible link and 212 Red.

Test/Check Point	Normal	If Not Normal
15. Starter solenoid	11.8—13.2 volts	Test 410 Yel/Blk. If voltage present and starter does not rotate, replace starter.
16. Fuel shutoff solenoid **Y3**	11.8—13.2 volts	Test 910 Wht, if voltage is present and solenoid does not click or open, replace fuel shutoff solenoid. If no voltage present test for voltage at pull-in cutout relay, 911 Wht.
17. Pull-in cutout relay **K6**	11.8—13.2 volts	Test 911 Wht, if voltage is present test 402 Yel, if no voltage is present, repair wiring harness. *NOTE: If starter solenoid is operational, the problem exists either at the starter solenoid connection or between the connector and the relay.*
18. Pull-in cutout relay	Ground	Test for ground at 503 Yel, if no continuity test the **V4** diode. *NOTE: If the V4 diode is good and the oil pressure light goes out when the engine is cranked, the problem exists between the starter motor connector and the relay.*
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.		

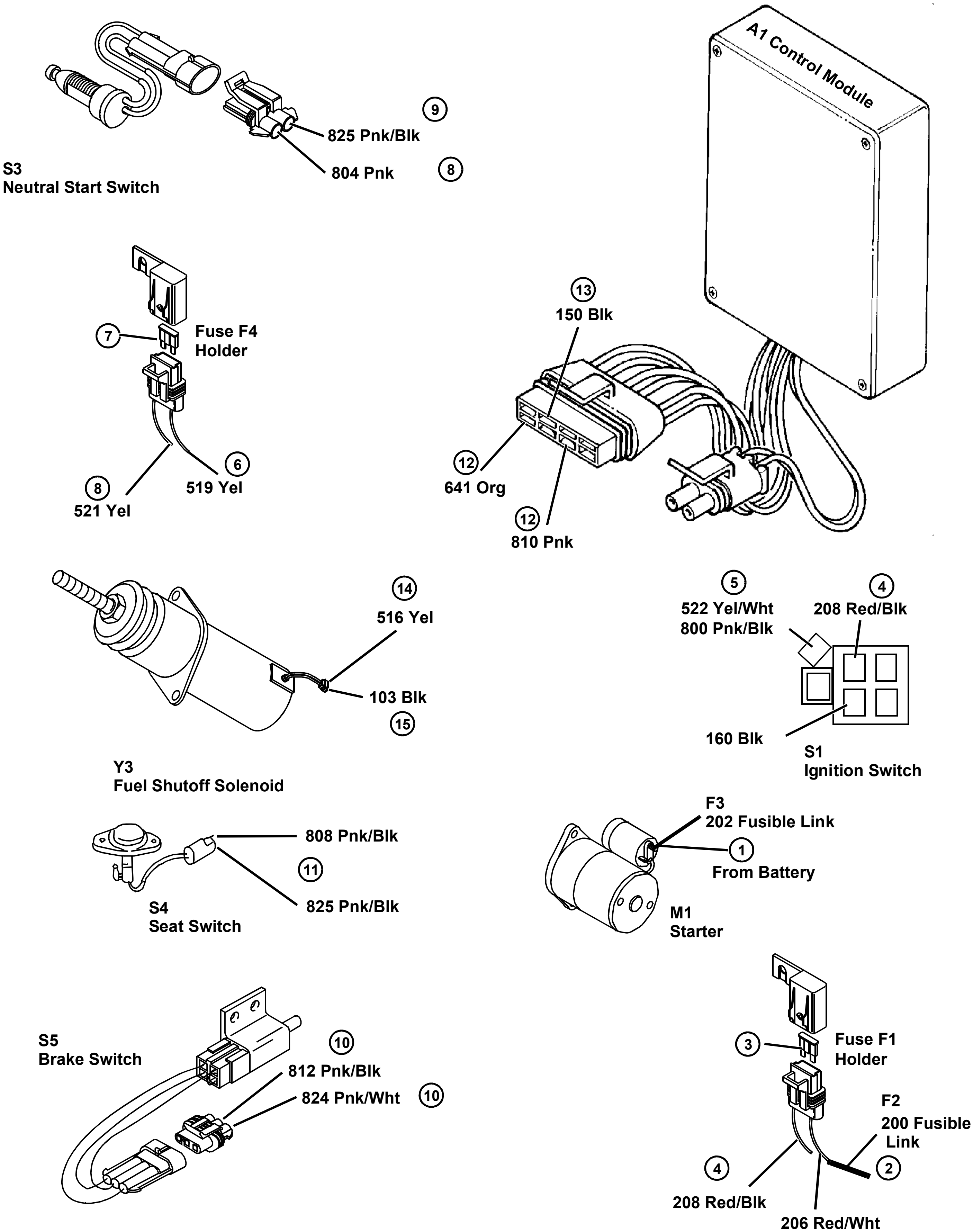

9
825 Pnk/Blk
8
4 Pnk
S3
Neutral Start Switch
7
Fuse F4
Holder
6
519 Yel
8
521 Yel
808 Pnk/Blk
11
825 Pnk/Blk
11
S4
Seat Switch
V1 Diode
700 Pur
12
701 Pur
5
522 Yel/Wht
800 Pnk/Blk
4
208 Red/Blk
160 Blk
S1
Ignition Switch
S5
Brake Switch
10
812 Pnk/Blk
824 Pnk/Wht
10
16
401 Wht
Y3
Fuel
Shutoff
Solenoid
14
F3
202 Fusible Link
1
From Battery
M1
Starter
S6
Mow Switch
K6
Pull-in Cutout Relay
16
401 Wht
411 Wht
16
11
701 Pur
822 Pnk/Wht
K1
Starter Relay
17
402 Pnk
503 Tan
18
1
3
Fuse F1
Holder
15
410 Yel/Blk
200 Fusible
Link
700 Pur
13
4
2
208 Red/Blk
206 Red/Wht
14
212 Red
325 Org/Blk
13

IGNITION TEST—OPERATOR ON SEAT

Test Conditions:

- Engine cranks
- Park brake **S5** disengaged
- Operator ON seat **S4**
- Battery **G1** fully charged
- Transmission in NEUTRAL **S3**
- Ignition switch **S1** in RUN position

Test/Check Point	Normal	If Not Normal
1. Fuse **F1**	11.8—13.2 volts	Test 200 fusible link, 206 Red/Wht, and fuse connections.
2. Fuse	Continuity	Replace fuse.
3. Ignition switch **S1**	11.8—13.2 volts	Test 208 Red/Blk. If no voltage repair/replace wire harness.
4. Ignition switch	11.8—13.2 volts	Check ignition switch connections 522 Yel/Wht and 800 Pnk/Blk. If no voltage replace switch.
5. Fuse **F4**	11.8—13.2 volts	Test 519 Yel. If no voltage repair/replace wire harness.
6. Fuse	Continuity	Replace fuse.
7. Neutral start switch **S3**	11.8—13.2 volts	Test 804 Pnk at neutral switch. If no voltage check 521 Yel at F4. If voltage is ok, repair/ replace wire harness.
8. Neutral start switch	11.8—13.2 volts	Ensure that neutral start switch is in NEUTRAL position. Test 825 Pnk/Blk. If no voltage replace switch.
9. Park brake switch **S5**	11.8—13.2 volts	Ensure that park brake switch is in RUN. Test 803 Pnk on park brake switch. If no voltage repair/replace wire harness. Temporarily place transmission in gear Test 824 Pnk/Wht. If no voltage replace park brake switch. Place transmission in neutral.
10. Seat switch **S4**	11.8—13.2 volts	Test 825 Pnk/Blk. If no voltage repair/replace wire harness. Test 808 PNK/BLK. If no voltage present with operator on seat replace seat switch.
11. Control module **A1**	11.8—13.2 volts	Test 810 Pnk at terminal H-B. If no Voltage repair/replace wire harness. If voltage present test for voltage on terminals H-D and 641 Org. If no voltage replace module with a known good module.
12. Control module	Ground	Test 150 Blk connections, if no ground repair/ replace wire harness. If ground is good replace module with a known good module and test for voltage on terminal H-D and 641 Org.
13. Fuel shutoff solenoid **Y3**	11.8—13.2 volts	Test 516 Yel. If no voltage repair/replace wire harness.
14. Fuel shutoff solenoid	Ground	Test 103 Blk. If ground is good and fuel shutoff solenoid does not work replace solenoid.



A1 Control Module
9
825 Pnk/Blk
804 Pnk
8
S3
Neutral Start Switch
7
Fuse F4
Holder
6
519 Yel
8
521 Yel
13
150 Blk
12
641 Org
12
810 Pnk
14
516 Yel
103 Blk
15
Y3
Fuel Shutoff Solenoid
5
522 Yel/Wht
800 Pnk/Blk
4
208 Red/Blk
160 Blk
S1
Ignition Switch
808 Pnk/Blk
11
825 Pnk/Blk
S4
Seat Switch
F3
202 Fusible Link
1
From Battery
M1
Starter
S5
Brake Switch
10
812 Pnk/Blk
824 Pnk/Wht
10
3
Fuse F1
Holder
F2
200 Fusible
Link
4
2
208 Red/Blk
206 Red/Wht

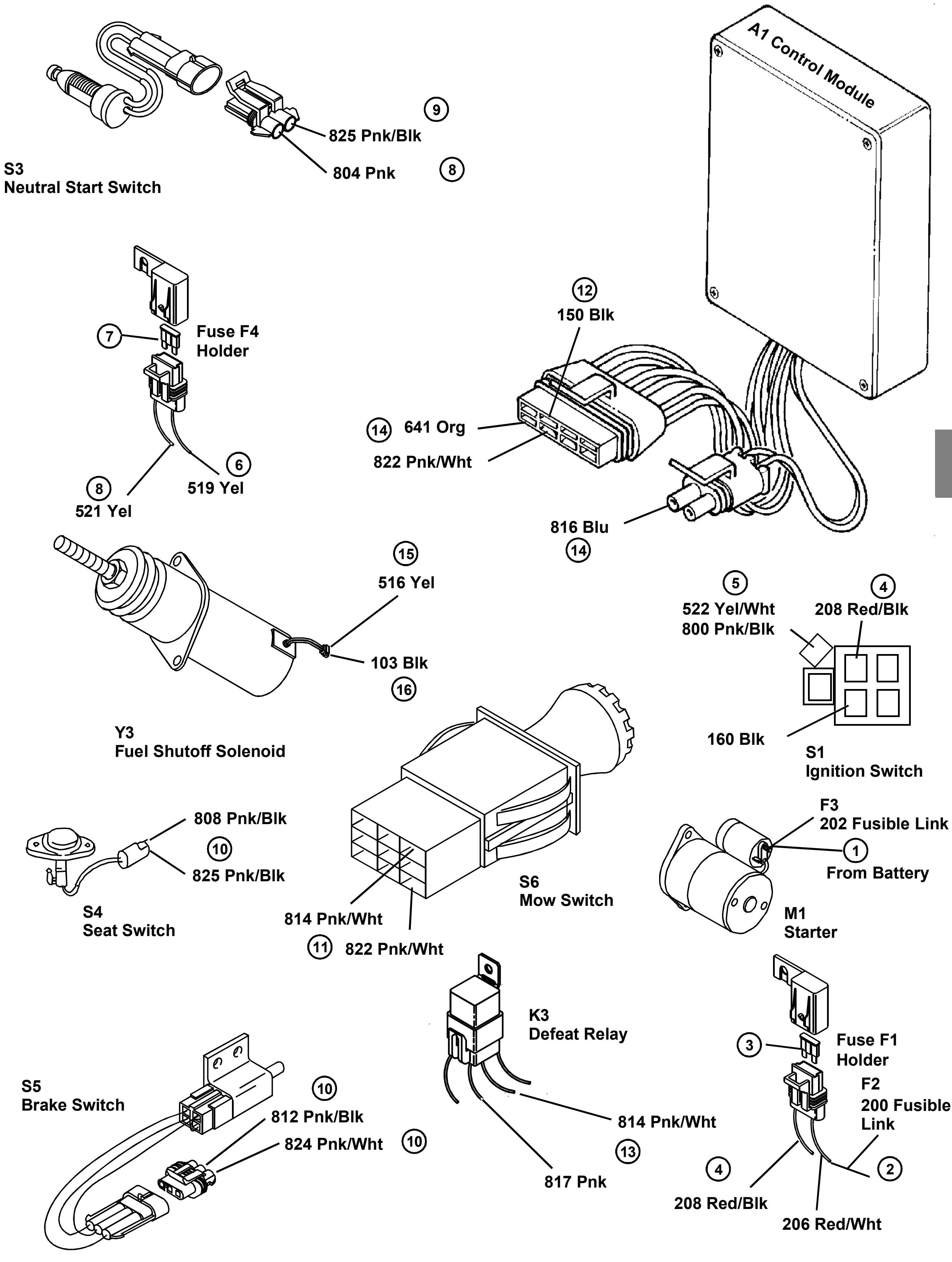
IGNITION TESTS—OPERATOR OFF SEAT

Test Conditions:

- Engine cranks
- Park brake **S5** engaged
- Operator off seat **S4**
- Battery fully charged
- Transmission in NEUTRAL **S3**
- Ignition switch **S1** in RUN position

Test/Check Point	Normal	If Not Normal
1. Fuse **F1**	11.8—13.2 volts	Test 200 fusible link **F2**, 206 Red/Wht, and fuse connections.
2. Fuse	Continuity	Replace fuse.
3. Ignition switch **S1**	11.8—13.2 volts	Test 208 Red/Blk. If no voltage repair/replace wire harness.
4. Ignition switch	11.8—13.2 volts	Check ignition switch connections 522 Yel/Wht and 800 Pnk/Blk. If no voltage replace switch.
5. Fuse **F4**	11.8—13.2 volts	Test 519 Yel. If no voltage repair/replace wire harness.
6. Fuse	Continuity	Replace fuse.
7. Neutral start switch **S3**	11.8—13.2 volts	Test 804 Pnk at neutral switch. If no voltage check 521 Yel/Blk at F4. If voltage is ok, repair/replace wire harness.
8. Neutral start switch	11.8—13.2 volts	Ensure that neutral switch is in NEUTRAL position. Test 825 Pnk/Blk. If no voltage replace switch.
9. Park brake switch **S5**	11.8—13.2 volts	Ensure that park brake switch is in PARK position. Test 812 Pnk/Blk between mow switch and park brake switch. If no voltage Test 824 Pnk/Wht between the brake switch and the seat switch. Test 825 Pnk/Blk between the seat switch and the neutral switch. If voltage is ok at these points, replace the park brake switch.
10. Mow switch **S6**	11.8—13.2 volts	Ensure mow switch is OFF. Test 814 Pnk/Wht. If no voltage repair/replace wire harness. Test 822 Pnk/ Wht. If no voltage replace mow switch
11. Control module **A1**	Ground	Test 150 Blk connections, if no ground repair/ replace wire harness. If ground is good replace module with a known good module and test for voltage on terminals H-D and 641 Org.
12. Defeat Relay **K3**	11.8—13.2 volts	Test 814 Pnk/Wht, if no voltage repair/replace wire harness. Test 816 Blu, If no voltage replace relay.
13. Control module	11.8—13.2 volts	Test 816 Blu Terminal G-A and 822 Pnk/Wht. If no Voltage repair/replace wire harness. If voltage present test for voltage on terminal H-D, 641 Org. If no voltage replace module with a known good module.

Test/Check Point	Normal	If Not Normal
14. Fuel shutoff solenoid **Y3**	11.8—13.2 volts	Test 516 Yel. If no voltage repair/replace wire harness.
15. Fuel shutoff solenoid	Ground	Test 103 Blk. If ground is good and fuel shutoff solenoid does not open replace solenoid.
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.		


A1 Control Module
9
825 Pnk/Blk
804 Pnk
8
S3
Neutral Start Switch
12
150 Blk
7
Fuse F4
Holder
14
641 Org
822 Pnk/Wht
6
519 Yel
8
521 Yel
816 Blu
14
15
516 Yel
5
522 Yel/Wht
800 Pnk/Blk
4
208 Red/Blk
103 Blk
16
160 Blk
S1
Ignition Switch
Y3
Fuel Shutoff Solenoid
F3
202 Fusible Link
808 Pnk/Blk
10
825 Pnk/Blk
1
From Battery
S6
Mow Switch
S4
Seat Switch
814 Pnk/Wht
M1
Starter
11
822 Pnk/Wht
K3
Defeat Relay
3
Fuse F1
Holder
F2
200 Fusible
Link
S5
Brake Switch
10
812 Pnk/Blk
824 Pnk/Wht
10
814 Pnk/Wht
13
4
2
817 Pnk
208 Red/Blk
206 Red/Wht

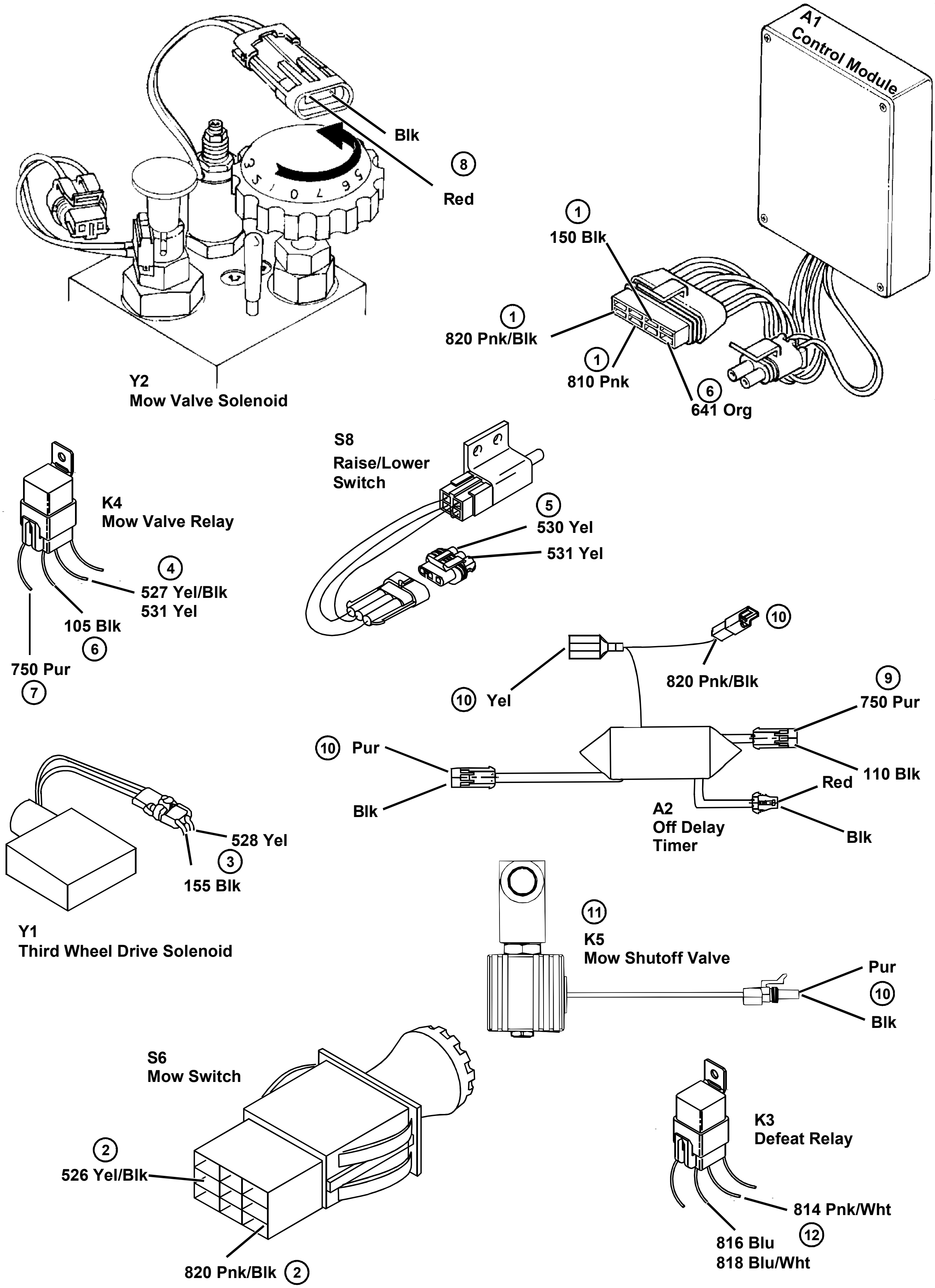
MOW CIRCUIT TEST

Test Conditions:

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

- Park brake **S5** on
- Ignition switch **S1** "RUN"
- Operator on seat **S4**
- Transmission in NEUTRAL **S3**
- Mow switch **S6** "ON"
- Cutting units lowered **S8**

Test/Check Point	Normal	If Not Normal
1. Control module **A1**	11.8—13.2 volts	Test 810 Pnk at terminal H-B. If no voltage, repair/replace wire harness. If voltage present, test 820 Pnk/Blk at terminal H-A. If no voltage, test 150 Blk connections, if no ground repair/ replace wire harness. If ground is good replace module with a known good module.
2. Mow switch **S6**	11.8—13.2 volts	Ensure mow switch is in the MOW position. Test 820 Pnk/Blk. If no voltage repair/replace wire harness. Test 526 Yel/Blk. If no voltage replace switch.
3. Third wheel drive solenoid **Y1**	11.8—13.2 volts	Test 528 Yel. If no voltage repair/replace wire harness.
4. Mow valve relay **K4**	11.8—13.2 volts	Test 527 Yel. If no voltage repair/replace wire harness.
5. Raise lower switch **S8**	11.8—13.2 volts	Make sure that switch is in the LOWERED position. Test 531 Yel. If no voltage repair/ replace wire harness. Test 530 Yel. If no voltage replace switch.
6. Mow valve relay	Ground	Test 105 Blk. If no ground, repair/replace wire harness.
7. Mow valve relay	11.8—13.2 volts	Test 750 Pur. If no voltage replace mow valve relay.
8. Mow valve solenoid **Y2**	11.8—13.2 volts	Test Red lead. If no voltage check connections/ repair wire harness. If voltage present check Blk lead. If ground is good and solenoid does not work, click when energized, replace solenoid
9. Off delay timer **A2**	11.8—13.2 volts	Test 750 Pur. If no voltage repair/replace wiring harness. If voltage is present check black leads for continuity to ground. Repair as necessary.
10. Off delay timer	11.8—13.2 volts	Test 820 Pnk/Blk and Yel leads. If no voltage repair/replace wiring harness. If voltage is present check Pur lead at mow shutoff valve. If no voltage check connections/remove off delay timer and test.
11. Mow shutoff valve **K5**	Ground	Check ground connections. If good test mow shutoff valve.

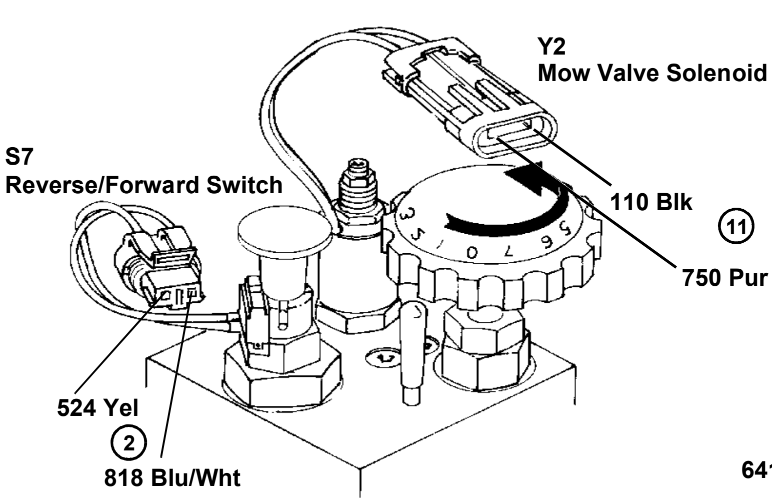

A1
Control Module
Blk
8
Red
1
150 Blk
1
820 Pnk/Blk
1
810 Pnk
6
641 Org
Y2
Mow Valve Solenoid
S8
Raise/Lower
Switch
5
530 Yel
531 Yel
K4
Mow Valve Relay
4
527 Yel/Blk
531 Yel
105 Blk
6
750 Pur
7
10
820 Pnk/Blk
10 Yel
9
750 Pur
10 Pur
110 Blk
Red
Blk
A2
Off Delay
Timer
Blk
528 Yel
3
155 Blk
Y1
Third Wheel Drive Solenoid
11
K5
Mow Shutoff Valve
Pur
10
Blk
S6
Mow Switch
2
526 Yel/Blk
820 Pnk/Blk 2
K3
Defeat Relay
814 Pnk/Wht
12
816 Blu
818 Blu/Wht

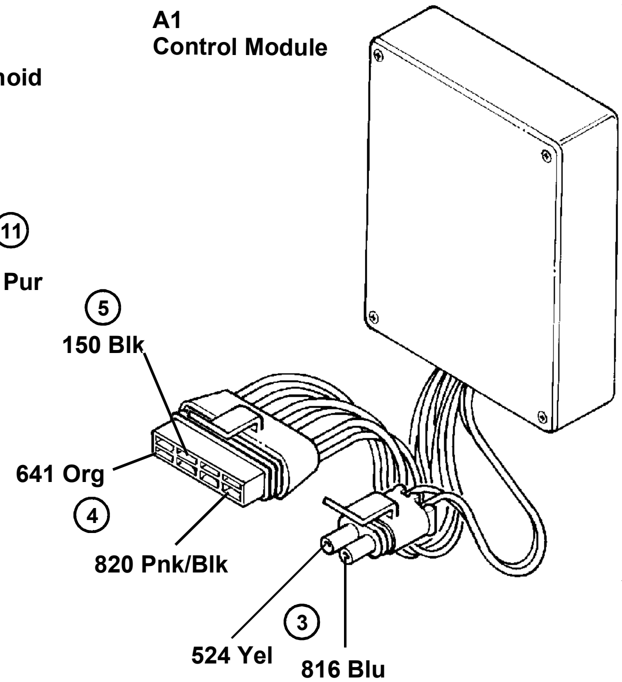
BACKLAPPING CIRCUIT TEST

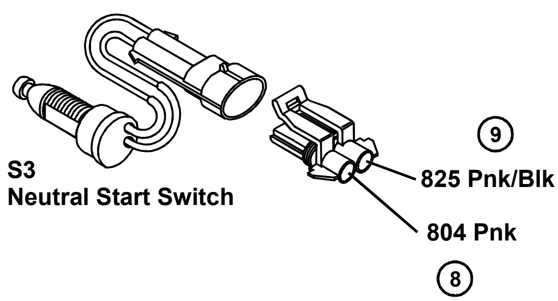
Test Conditions:

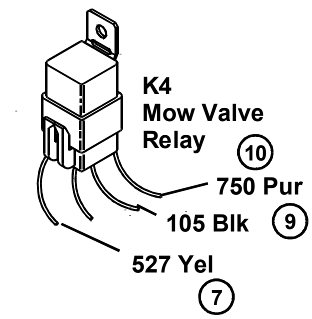
Ignition switch **A1** "RUN"
Transmission in NEUTRAL **S3**
Mow switch **S6** "ON"
Park brake **S5** "ON"
Operator off seat **S4**
Forward/Reverse switch **S7** "Pulled up for backlapping"

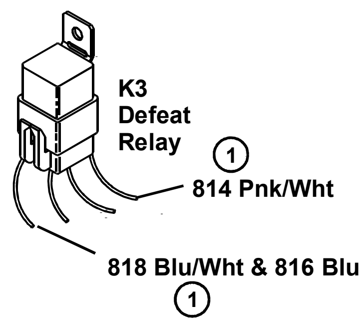
Test/Check Point	Normal	If Not Normal
1. Defeat relay **K3**	11.8—13.2 volts	Test 814 Pnk/Wht. If no voltage replace/repair wire harness. Test 818 Blu/Wht and 816 Blu. If no voltage, replace defeat relay.
2. Forward Reverse Switch **S7**	11.8—13.2 volts	Ensure switch in REVERSE position. Test 818 Blu/Wht. If no voltage replace/repair wire harness. Test 524 Yel. If no voltage replace switch.
3. Control module **A1**	11.8—13.2 volts	Test 524 Yel at terminal G-B and 816 Blu at terminal G-A. If no voltage replace/repair wire harness.
4. Control module	11.8—13.2 volts	Test 641 Org and 820 Pnk/Blk. If no voltage replace module with a known good module.
5. Control module	Ground	Test 150 Blk connections, if no ground repair/ replace wire harness. If ground is good replace module with a known good module and test for voltage on terminal H-D, 641 Org.
6. Mow switch **S6**	11.8—13.2 volts	Ensure mow switch is in MOW position. Test 820 Pnk/Blk. If no voltage replace/repair wire harness. Test 526 Yel/Blk. If no voltage replace switch.
7. Mow valve relay **K4**	11.8—13.2 volts	Test 527 Yel. If no voltage replace/repair wire harness.
8. Raise/lower switch **S8**	11.8—13.2 volts	Make sure that switch is in the LOWERED position. Test 531 Yel. If no voltage replace/repair wire harness. Test 530 Yel. If no voltage replace switch.
9. Mow valve relay **K4**	Ground	Test 105 Blk. If no ground, repair/replace wire harness.
10. Mow valve relay	11.8—13.2 volts	Test 750 Pur. If no voltage replace relay.
11. Mow valve solenoid **Y2**	11.8—13.2 volts	Test 750 Pur. If no voltage replace/repair wire harness. If voltage present check 110 Blk. If ground is good and solenoid does not work, click when energized, replace solenoid

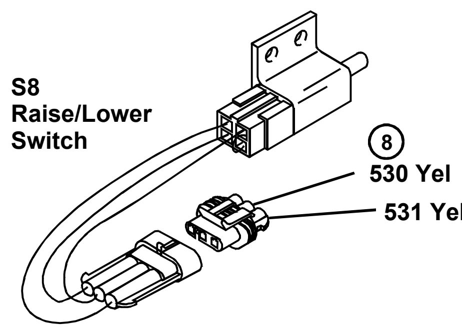

Y2
Mow Valve Solenoid
S7
Reverse/Forward Switch
110 Blk
11
750 Pur
524 Yel
2
818 Blu/Wht

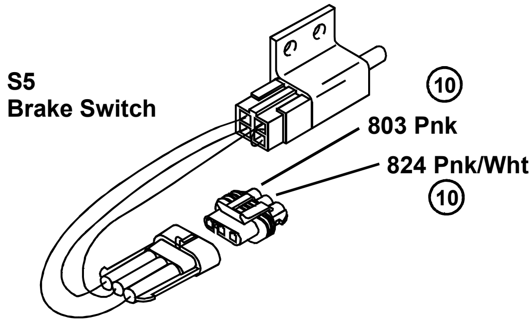

A1
Control Module
5
150 Blk
641 Org
4
820 Pnk/Blk
3
524 Yel
816 Blu

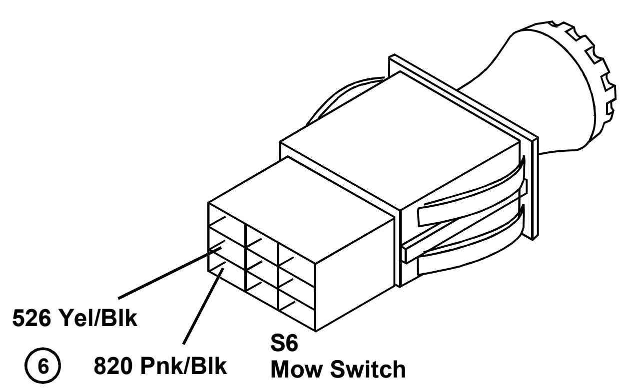

S3
Neutral Start Switch
9
825 Pnk/Blk
804 Pnk
8


K4
Mow Valve
Relay
10
750 Pur
105 Blk
9
527 Yel
7


K3
Defeat
Relay
1
814 Pnk/Wht
818 Blu/Wht & 816 Blu
1


S8
Raise/Lower
Switch
8
530 Yel
531 Yel


S5
Brake Switch
10
803 Pnk
824 Pnk/Wht
10


526 Yel/Blk
6
820 Pnk/Blk
S6
Mow Switch

TESTS & ADJUSTMENTS

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

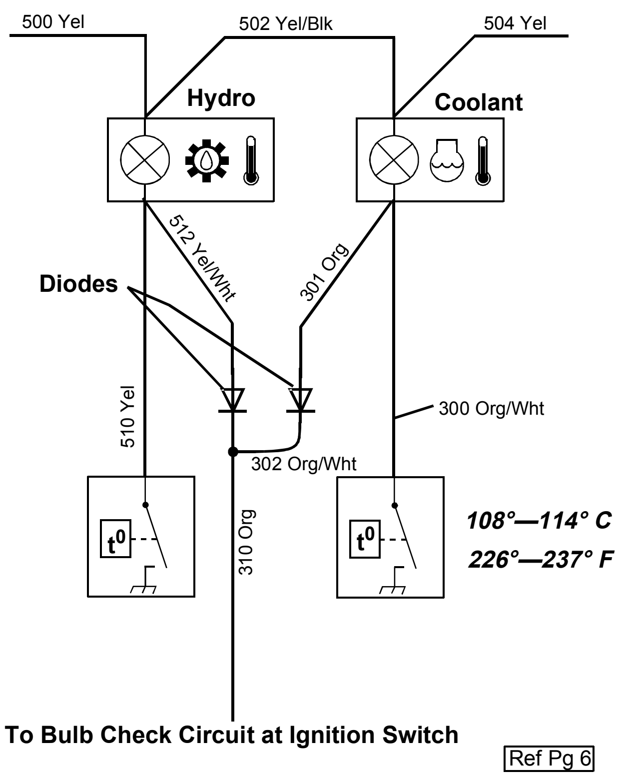
HYDRO/ENGINE OVERTEMP INDICATING LIGHTS

Tools Needed:

- JTO5791 Digital Multimeter

Procedure:

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 (500 Yel, 502 Yel/Blk, 504 Yel) 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 512 Yel/Wht wire (for the hydraulic temperature light) or 301 Org wire (for the coolant temperature light) to a splice point and look for a open in the wire before or at the splice point.
4. If neither indicator bulb illuminates, remove the diode, plugged into the wiring harness near the indicator bulb receptacle, and test. See “DIODE TEST” on page 35.
5. If diodes test good ground 512 Yel/Wht wire (for the Hydraulic circuit) or 301 Org 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

Tools Needed:

- JTO5791 Digital Multimeter

Reason:

- 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.
- 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.

Procedure:

1. 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.
2. If the indicator light fails to illuminate, inspect the wiring and engine connector for an open circuit, repair or replace as necessary.
3. 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.

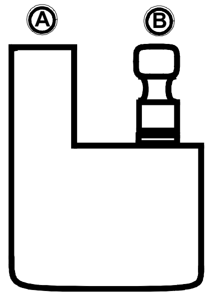
DIODE TEST

Tools Needed:

• JTO5791 Digital Multimeter

Procedure:

1. Remove the diode from the electrical harness.



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.

Results:

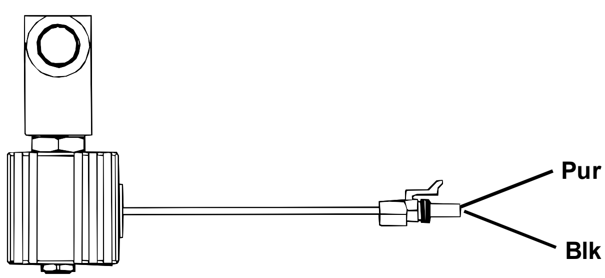
1. If continuity is noted in both steps, the diode is defective and must be replaced.
2. If continuity is noted in step 2 and not in step 3, the diode is good.

MOW SHUTOFF VALVE TEST

Tools Needed:

• 12 Volt Battery
• Test Leads (2)

Procedure:



1. Energize the shutoff valve by connecting the Pos (+) battery lead to the purple wire and the battery Neg (-) lead the black lead.

Results:

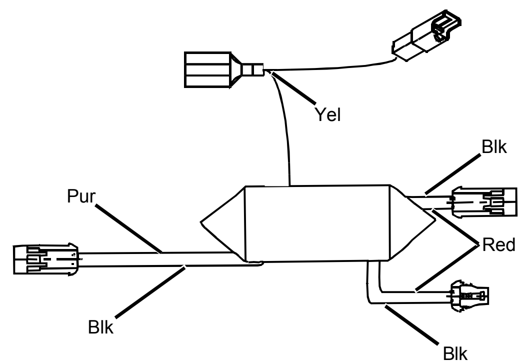
• If the shutoff valve fails to open or fails to shut when power is removed must be replaced.

OFF DELAY TIMER TEST

Tools Needed:

• JTO5791 Digital Multimeter
• 12 Volt Battery
• Test Leads (2)

Procedure:



1. Test for continuity between all black wires.
2. Test for continuity between both red wires.
3. Energize the module by connecting the Pos (+) battery lead to either red wire and the battery Neg (-) lead to either black lead. Check for continuity between the purple wire and the yellow wire.
4. With module energized as in step 3, remove power from the red lead while observing the continuity between the purple wire and the yellow wire. Approximately 2 seconds after removing power from the red wire continuity between the purple wire and the yellow wire should be lost.

Results:

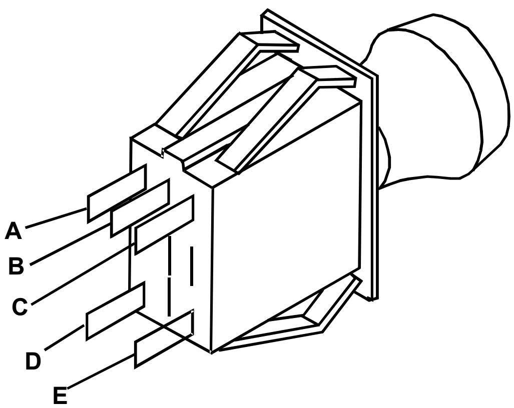
• If the module fails any of these tests, replace the module.

MOW SWITCH TEST

Tools Needed:

- JTO5791 Digital Multimeter

Procedure:



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.

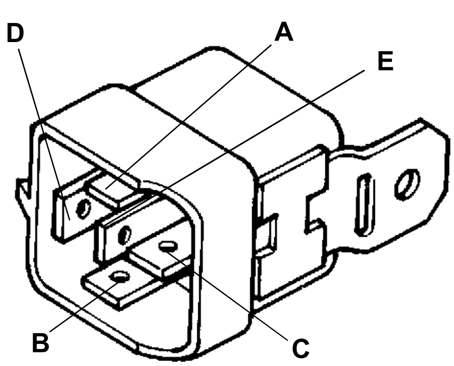
RELAY TESTS

NOTE: All five (5) relays are identical and are tested the same way.

Tools Needed:

- JTO5791 Digital Multimeter

Procedure:



M56509

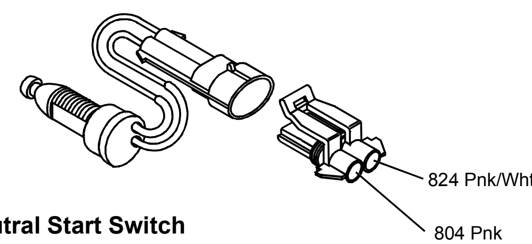
1. Remove relay to be tested from the vehicle.
2. Using a 12V battery and test leads, connect the battery POS (+) lead to terminal (A) and the battery NEG (-) lead to terminal (B).
3. With the relay energized, check for continuity between (C) and (D) terminals.
4. Replace the relay if it fails this test.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

NEUTRAL START SWITCH TEST

Tools Needed:

- JTO5791 Digital Multimeter

Procedure:



S3

Neutral Start Switch

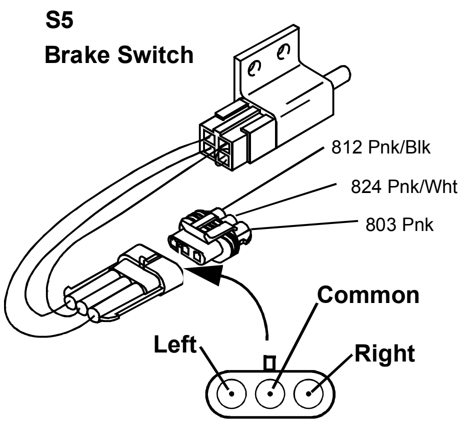
1. Remove the switch and inspect the plunger for flat spots and freedom of movement. Replace the switch if plunger end is rough, worn or if plunger does not move smoothly.
2. Connect an ohmmeter to the contacts of the switch.
3. There should be **NO** continuity with the plunger extended.
4. Depress plunger. Continuity should be indicated when the plunger reaches the midway point of full travel and should indicate continuity through the rest of the plunger travel. Replace the switch if it fails this test.
5. Perform Transmission Neutral Adjustment.

PARK BRAKE SWITCH TEST

Tools Needed:

- JTO5791 Digital Multimeter

Procedure:



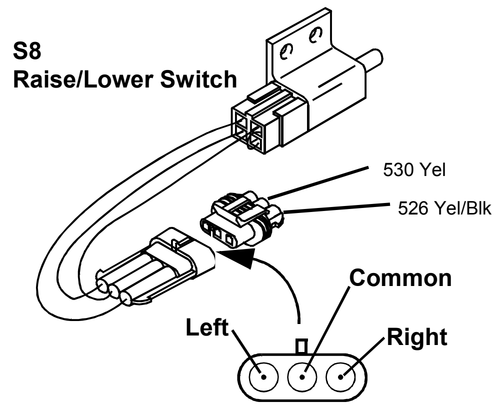
1. Remove the switch and inspect the plunger for flat spots and freedom of movement. Replace the switch if plunger end is rough, worn or if plunger does not move smoothly.
2. Using an ohmmeter, place one lead of the ohmmeter on the center terminal and touch the other lead to the **Right** outside terminal (looking at the end of the three terminal connector, see illustration). The ohmmeter **SHOULD NOT** have continuity until the switch is actuated. Continuity should be indicated until the lever is released. If not, replace switch.
3. Reverse the lead to the **Left** outside terminal (looking at the end of the three terminal connector, see illustration). The ohmmeter **SHOULD** have continuity with the switch in the extended position. Depress plunger, thus breaking the circuit. Continuity should not be indicated until the plunger is released. If it does, replace switch.

RAISE/LOWER SWITCH

Tools Needed:

- JTO5791 Digital Multimeter

Procedure:

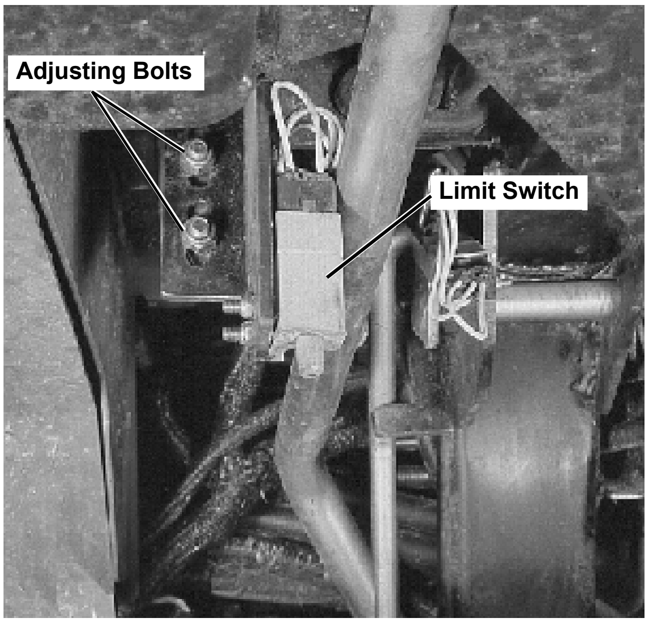


1. Remove the switch and inspect the plunger for flat spots and freedom of movement. Replace the switch if plunger end is rough, worn or if plunger does not move smoothly.
2. Using an ohmmeter, place one lead of the ohmmeter on the center terminal and touch the other lead to the **Right** outside terminal (looking at the end of the three terminal connector, see illustration). The ohmmeter **SHOULD NOT** have continuity until the switch is actuated. Continuity should be indicated until the lever is released. If not, replace switch.
3. Reverse the lead to the **Left** outside terminal (looking at the end of the three terminal connector, see illustration). The ohmmeter **SHOULD** have continuity with the switch in the extended position. Depress plunger, thus breaking the circuit. Continuity should not be indicated until the plunger is released. If it does, replace switch.

CUTTING UNIT RAISED SWITCH ADJUSTMENT

Procedure:

1. Park machine on level surface, reels raised, park brake on, engine off.
2. Block wheels to prevent inadvertent movement of the machine.
3. Loosen two bolts securing lift arm switch bracket to frame.



4. Slide lift arm switch bracket up or down as required to insure that switch is fully actuated when lift arm is in up position.

NOTE: There should be approximately 1/16" between lift arm switch bracket *lift arm when switch is properly adjusted.*

CONTROL MODULE TESTS

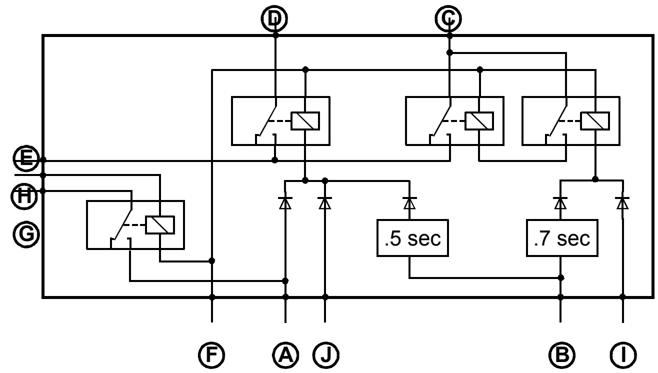
Tools Needed:

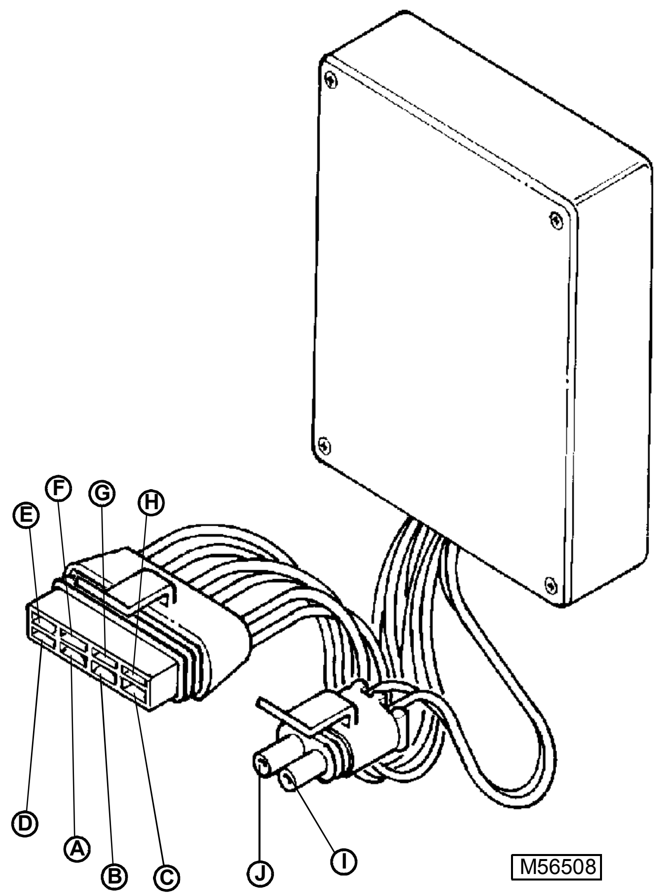
- Two, 12V Batteries
- JTO5791 Digital Multimeter
- 12V Test Light

Procedure:

COLOR CODES:

A—822 PNK/WHT	**F—150 BLK**
B—810 PNK	**G—700 PUR**
C—820 PNK/BLK	**H—522 YEL/WHT**
D—641 ORG	**I—524 YEL**





A—822 PNK/WHT	**F—150 BLK**
E—520 YEL/BLK	**J—816 BLU**

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 0.5 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 0.7 second release delay when voltage is removed from terminal (B).
5. If the Control Module fails any of these tests, replace it.

ENGINE ELECTRICAL

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	
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 run out	~	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.

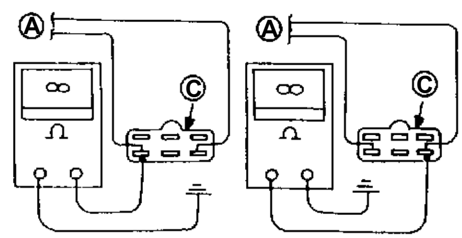
STATOR UNREGULATED OUTPUT TEST

Tools Needed:

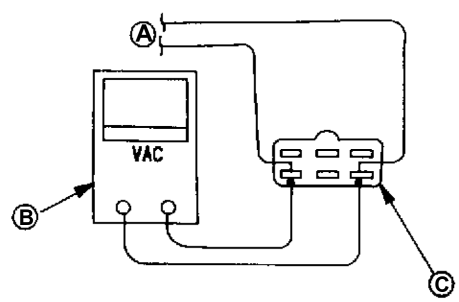
• JTO5791 Digital Multimeter

Procedure:

1. Disconnect the Engine wiring harness at the 6-point connector and connect an AC voltmeter to the stator pins.
2. Start and run engine at **fast idle (3400 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.



Stator Pin and Ground (Infinite Ohm)

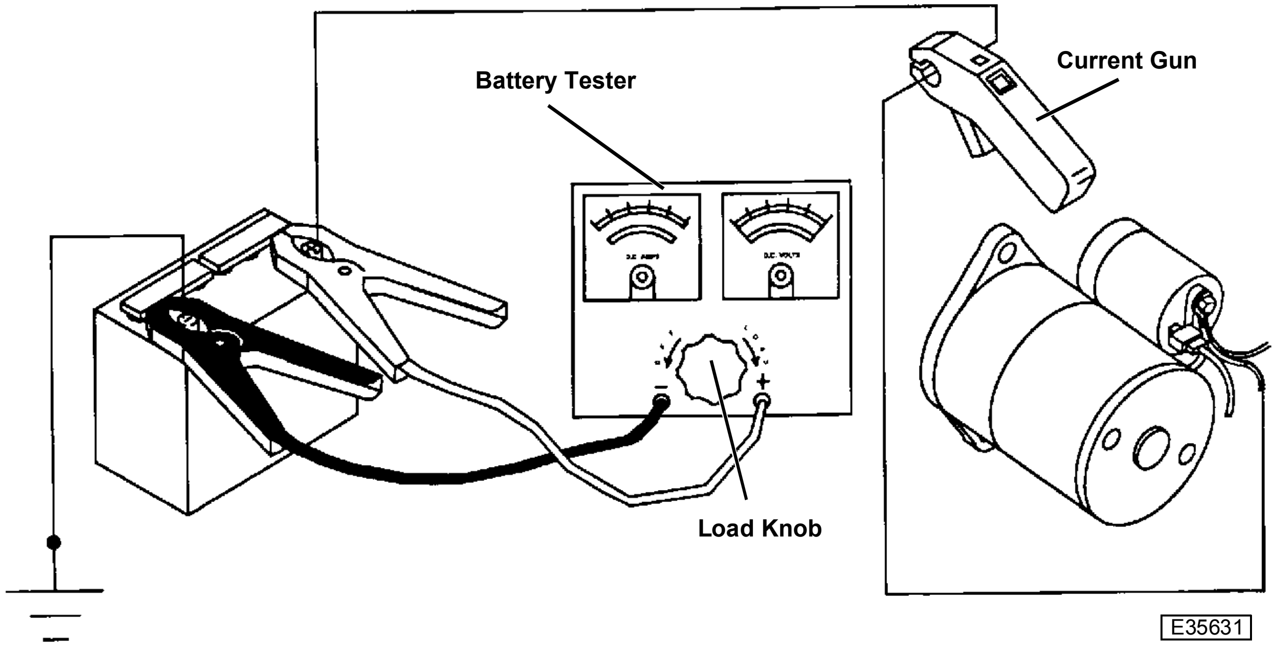


Unregulated Stator Output, 26 VAC/3000 RPM

M72871

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

REGULATED AMPERAGE AND VOLTAGE TESTS



Reason:

To determine the regulated voltage (charging) output of the regulator/rectifier.

Equipment:

- JTO5712 Current Gun
- JTO5685 Battery Tester

Procedure:

1. Park machine on level surface.
2. Move Mow/Transport lever to Transport position.
3. Lower cutting units to the ground.
4. Turn ignition switch OFF.
5. Engage parking brake.
6. Raise hood.
7. Disconnect pin connector from stator.

NOTE: Battery must be in a good state of charge.

8. Put JTO5712 Current Gun around positive (Red) battery cable going to starter so current-flow arrow cable points toward battery. Set current gun for DC current.

IMPORTANT: Turn load knob fully counterclockwise (out) into OFF position BEFORE making any test connections.

9. Connect battery tester to battery.

IMPORTANT: Perform this test quickly to prevent damage to battery tester. DO NOT apply full load to battery for more than 5—10 seconds.

10. Turn load knob clockwise (in) until voltage on voltage tester scale reads **11 volts for 5 seconds only** to partially drain battery.
11. Quickly turn load knob completely counterclockwise (out) to OFF position.
12. Start and run engine at **fast idle (3400 rpm).** Battery voltage should read **between 12.2—14.7 volts DC.**
13. Turn load knob clockwise (in) until voltage on voltage tester scale reads **11 volts** and look at current gun for a minimum reading of **13.5 amps.**
14. Quickly turn load knob completely counterclockwise (out) to OFF position.
15. After load test, voltmeter should return to a **maximum of 14.7 volts DC.**

Results:

- If current gun amp reading is BELOW specification, test for unregulated voltage output. If unregulated voltage output test meets specifications and you have verified voltage to ground to regulator/rectifier, replace regulator/rectifier
- If at any time voltage increase exceeds 14.7 volts DC, replace regulator/rectifier

STARTER NO-LOAD AMPERAGE DRAW TEST

Equipment:

- JT02153 Current Clamp
- JT05791 Multimeter
- Jumper Cables
- Jumper Wire

Procedure:

NOTE: Check that battery is fully charged and of proper size to ensure accuracy of test.

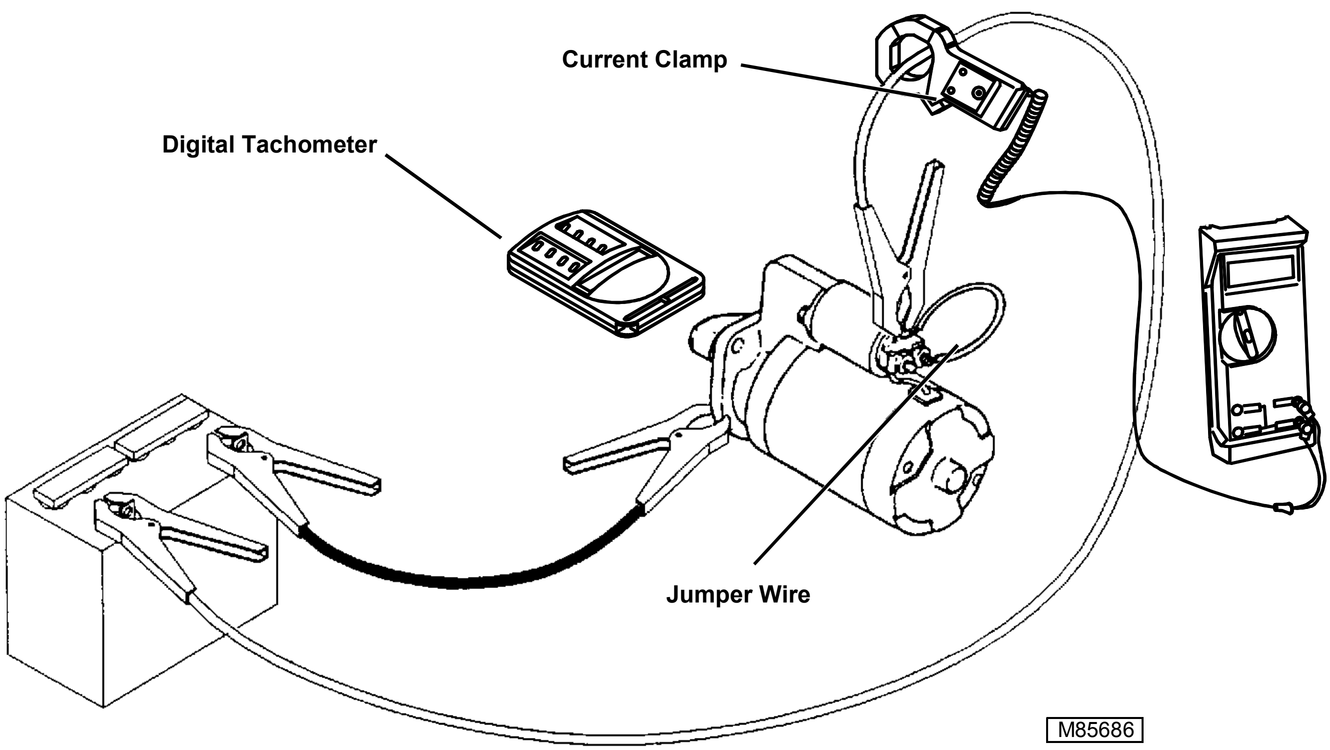
1. Remove starter assembly from mower and place starter in vice.
2. Connect jumper cables to a 12 volt battery.
3. Connect positive (+) cable to solenoid battery terminal on starter.
4. Connect negative (-) cable to starter body.
5. Attach current clamp around positive (+) cable.

IMPORTANT: Complete this test in 20 seconds or less to prevent starter damage.

6. Use jumper wire to briefly connect positive (+) starter terminal to solenoid battery terminal. Starter should engage and run.
7. Read and record amperage. 1mV = 1 amp

Results:

- If solenoid "clicks" or chatters and motor does not turn, replace solenoid
- If pinion gear engages and motor does not turn, repair or replace starter
- If starter engages and runs, but **amperage is more than 60 amps,** repair or replace starter



STARTER LOADED AMPERAGE DRAW TEST

Reason:

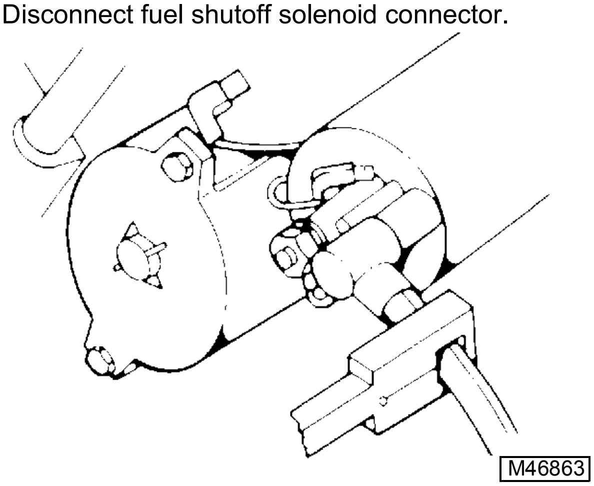
To determine the amperage required to crank the engine under load.

Equipment:

- JT02153 Current Clamp
- JT05791 Multimeter

Procedure:

1. Engage parking brake.
2. Test ground connections and battery.
3. Disconnect fuel shutoff solenoid connector.



4. Connect Red lead from current clamp to meter VW connection and Black lead to meter Common or ground connection.
5. Set current clamp slide switch to 200 Amp.
6. Set multimeter to 300mV range.
7. Crank engine and read voltage. 1mV = 1 amp

Results:

- If amperage is greater than 200 amps, test starter No-load amperage to determine if the starter is binding or damaged
- If the starter is good, check internal engine components for binding or damage

STARTER SOLENOID TEST

Reason:

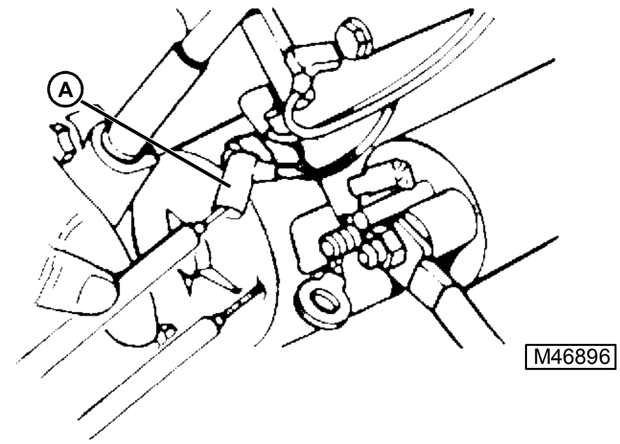
To determine if starter solenoid is defective.

Equipment:

- Voltmeter
- Ohmmeter

Procedure:

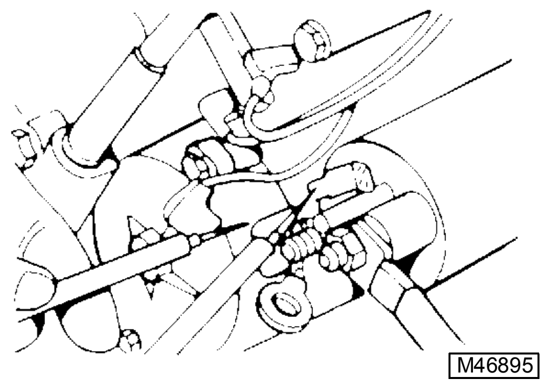
1. Engage parking brake.
2. Raise hood.
3. Disconnect fuel shutoff solenoid wire connector.



4. Disconnect 410 Yel/Blk wire from starter solenoid terminal (A).
5. With the ignition switch in the START position check for voltage at 410 Yel/Blk.

Results:

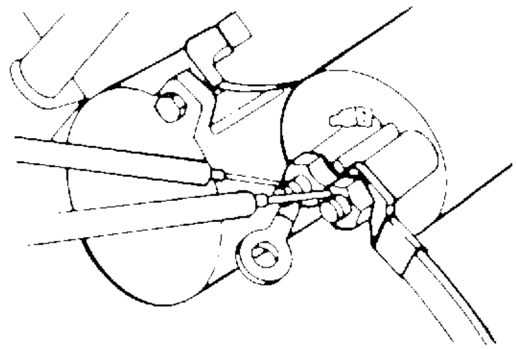
- If the meter reads battery voltage, the circuit is good.
- If not, inspect the wiring to and from the ignition switch for damage or breaks. Test ignition switch.



6. Measure the resistance between the solenoid starter terminal and ground with an ohmmeter. resistance should be zero or close to it.

Results:

- If circuit is open, replace solenoid.
- If resistance is zero or close to it, go to next step.


M46898

7. Disconnect the starter lead from the starter solenoid and keep it away from the solenoid.
8. Check resistance across the large terminals of the starter with the ignition switch in the START position. Resistance should be zero or close to it, a clicking sound should be heard and the pinion gear should engage the flywheel.

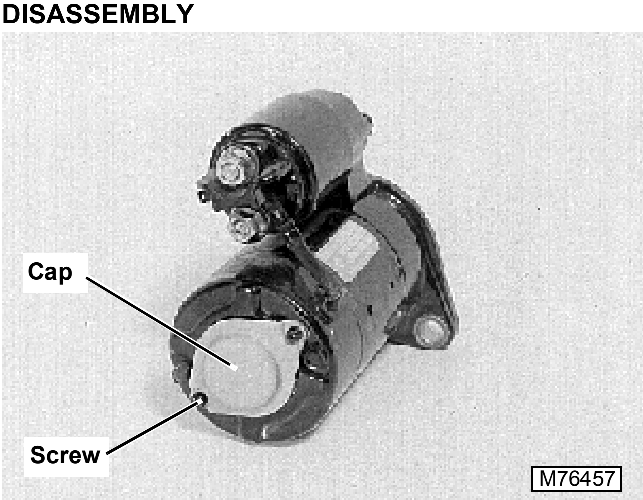
Results:

- If all tests are good, test the starter motor.
- If not, replace the solenoid.

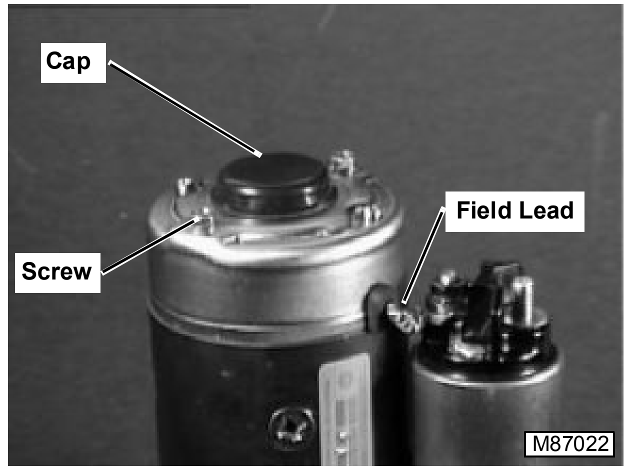
REPAIR

STARTER—HITACHI 0.8 kW

DISASSEMBLY

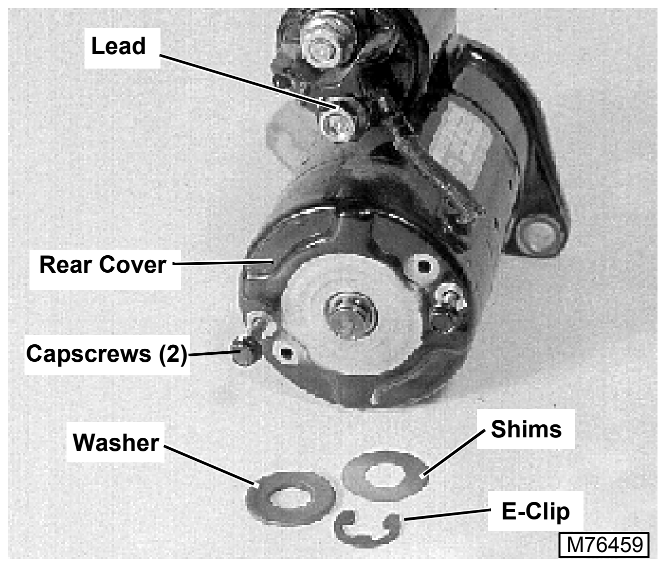


Older style starter

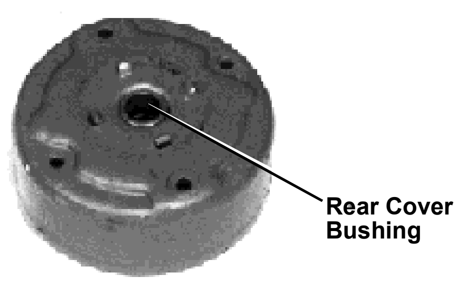


New style starter

1. Disconnect field lead.
2. Pry rubber end cap off using a screw driver and remove cap. (New style)
3. Remove two screws from end cap and remove cap.



4. Remove E-clip, washer and shims. (If included)
5. Remove two capscrews holding rear cover on field housing.

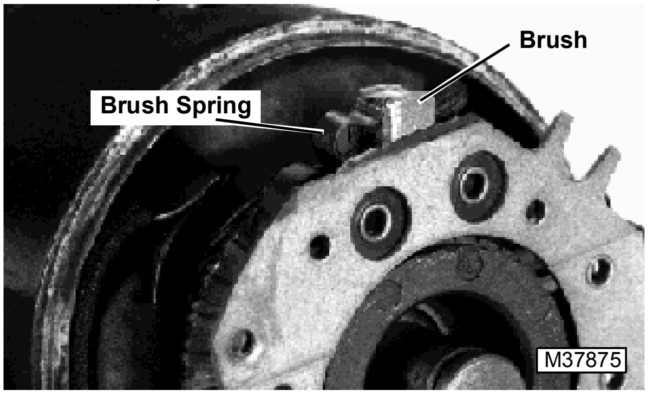


M37874

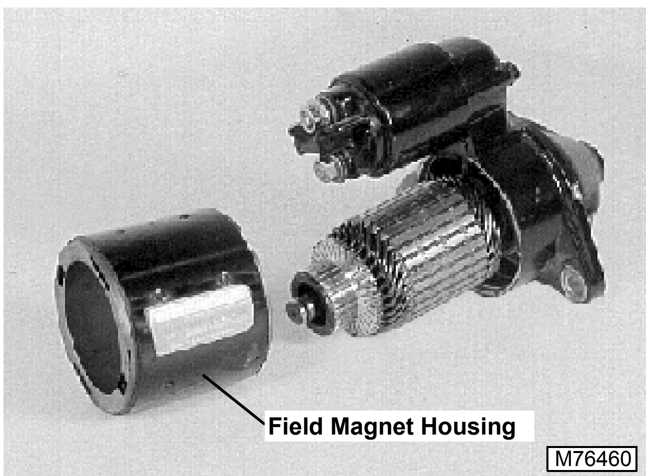
6. Inspect cover bushing for wear or damage. Measure inside diameter of bushing which should not exceed 12.53 mm (0.493 in.). Replace if necessary.

To replace bushing:

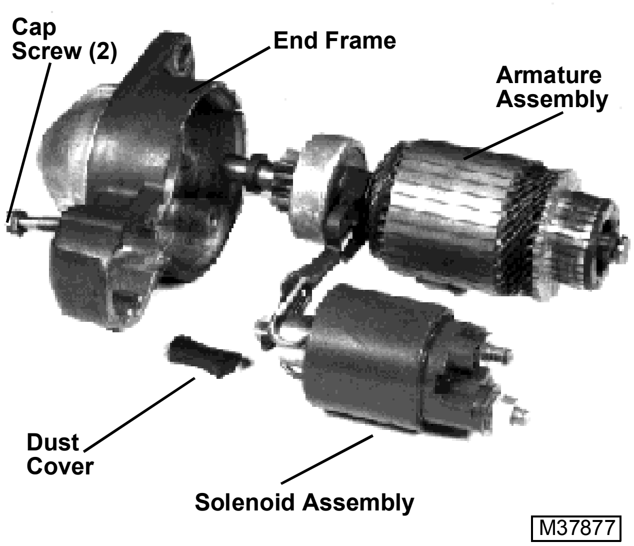
- Remove bushing using a blind-hole puller set. Install new bushing until it bottoms in cover bore using a driver set.
- Ream out bushing to **12.50—12.53 mm (0.492—0.493 in.)**.



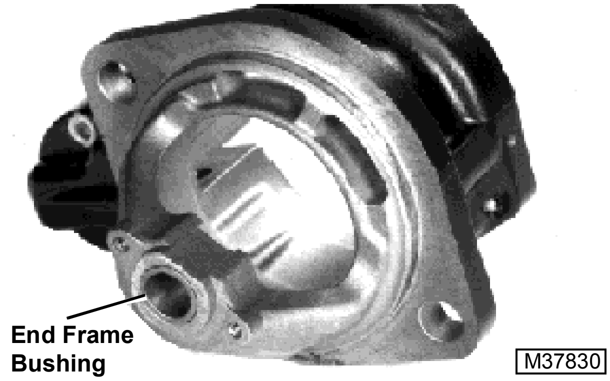
7. Pry brush springs away and pull brushes up enough to allow spring to hold brush in place.
8. Remove brush holder.



9. Remove field magnet housing from armature/ solenoid assembly.



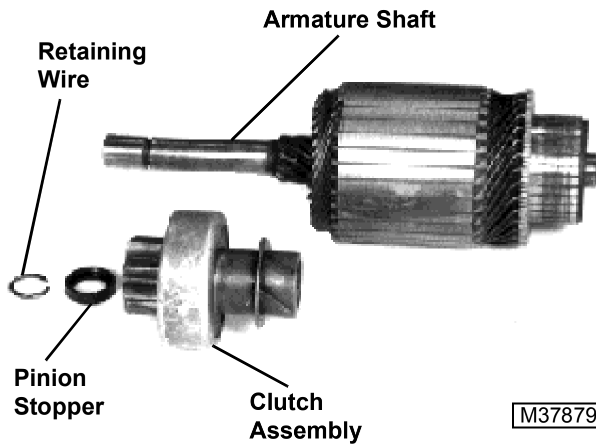
10. Remove two cap screws and pivot bolt, if equipped.
11. Remove dust cover.
12. Remove solenoid and armature assemblies from end frame.



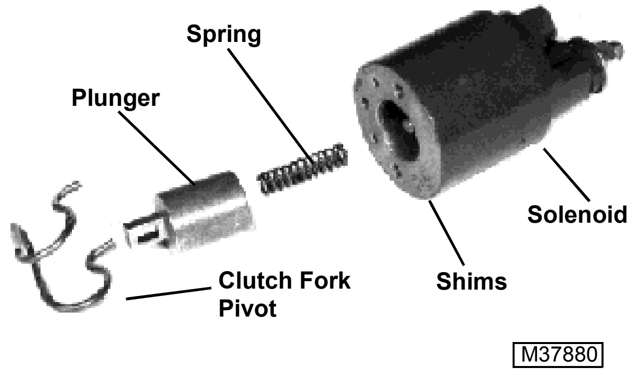
13. Inspect end frame bushing for wear or damage. Replace if necessary.

To replace bushing:

- Replace bushing using a driver set. Install bushing flush with face of housing.



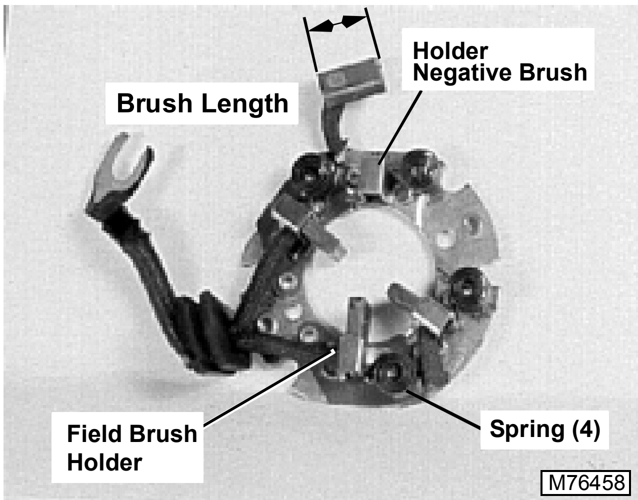
14. Slide pinion stopper away from retaining wire using a piece of pipe or deep socket. Remove retaining wire, pinion stopper, and clutch assembly from armature shaft.
15. Inspect clutch assembly for wear or damage. Gear should rotate in one direction only. Replace if necessary.



16. Remove clutch fork pivot, plunger, spring and shims from solenoid.
17. Inspect all parts for wear or damage. Replace as necessary.

18. Inspect and test brushes, holder, field coil and armature. (See *Test* procedures.)

INSPECTION



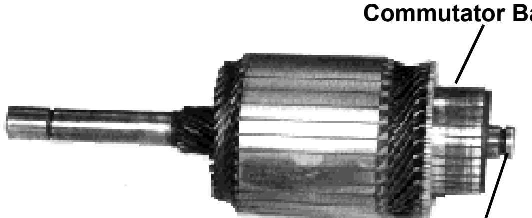
1. Measure brush lengths. Minimum brush length is **7.70 mm (0.303 in.)**. Replace brush if length is below minimum.

NOTE: *Test brush holder using an ohmmeter or test light.*

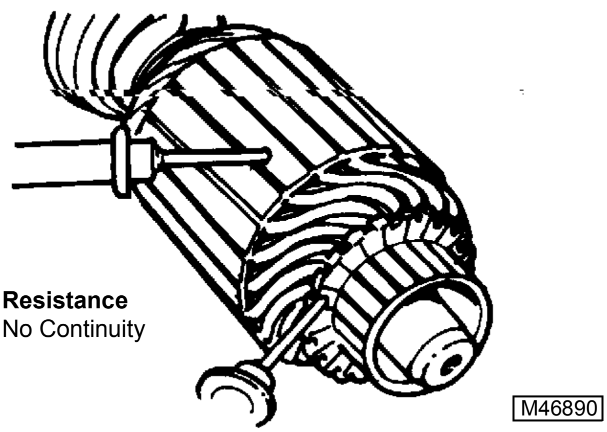
2. Test brush holder:
   Touch one probe of tester to negative brush holder and other probe to field brush holder. If there is continuity, replace the brush holder.
3. Inspect springs for wear or damage. Replace if necessary.

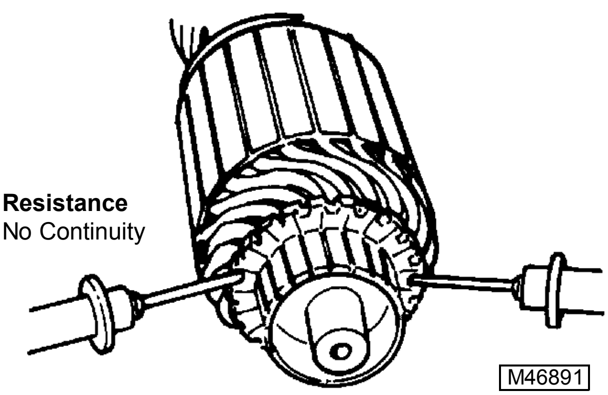
IMPORTANT: Do not clean armature with solvent. Solvent can damage insulation on windings. Use only mineral spirits and a brush.

4. Inspect armature. Look for signs of dragging against pole shoes.



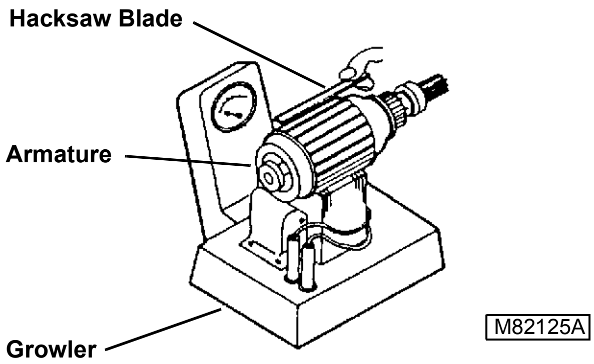
5. Inspect commutator. Look for roughness, burned bars, or any material which might cause short circuits between bars. If necessary, clean and touch up with 400 sandpaper. NEVER use emery cloth. Clean all dust from armature when finished. Test for grounded windings using an ohmmeter or test light.
6. Armature windings are connected in parallel, so each commutator bar must be checked.
7. If the test shows continuity, a winding is grounded and the armature must be replaced.
8. Test for open circuits in the windings. If the test shows no continuity, the armature has an open circuit and must be replaced





NOTE: *Test armature windings using an ohmmeter or test light.*

9. Test for grounded windings:
   Touch probes on one commutator bar and armature shaft. Armature windings are connected in series, so only one commutator bar needs to be checked.
   • If test shows continuity, a winding is grounded and the armature must be replaced.
10. Test for open circuited windings:
   Touch probes on two different commutator bars.
   • If test shows no continuity, there is an open circuit and the armature must be replaced.



11. Test for short circuited windings using a growler. Put armature in a growler and hold a hacksaw blade above each slot while slowly rotating armature.
   • If coil is shorted, the blade will vibrate on the slot.

NOTE: A short circuit most often occurs because of copper dust or filings between two commutator segments.

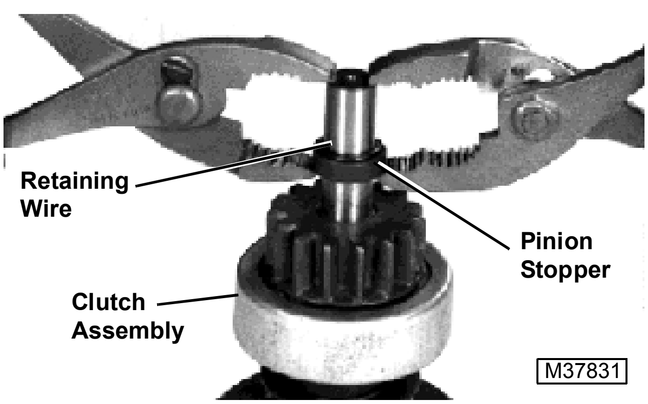
12. If test indicates short circuited windings, clean the commutator of dust and filings. Check the armature again. If the test still indicates a short circuit, replace the armature.

NOTE: Field uses permanent magnets which are not serviceable. Visually inspect for broken magnets or damage to housing.

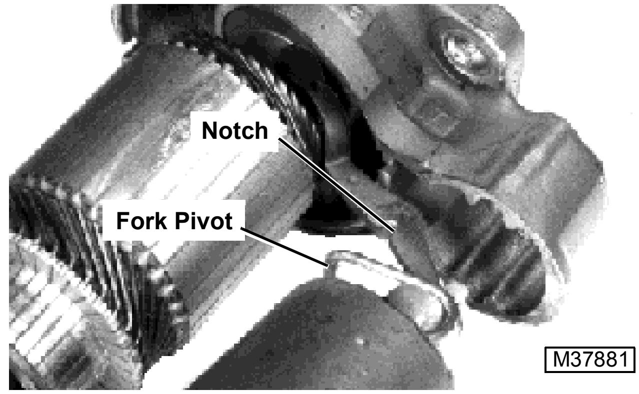
13. If rpm was slow and armature tests are normal, replace the field coil assembly.

ASSEMBLY

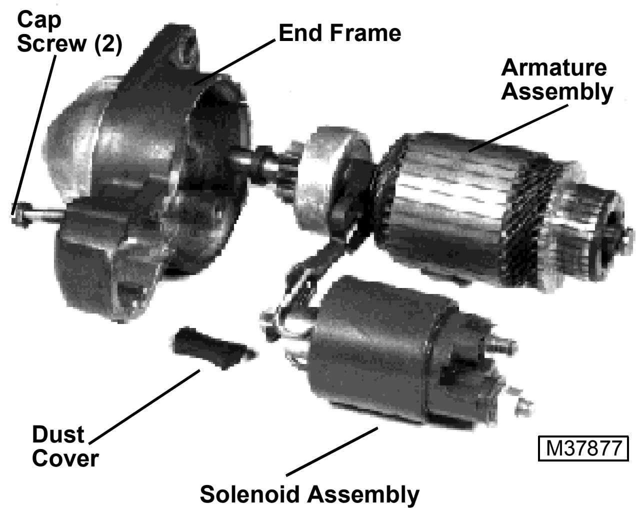
Assembly is done in the reverse order of disassembly.



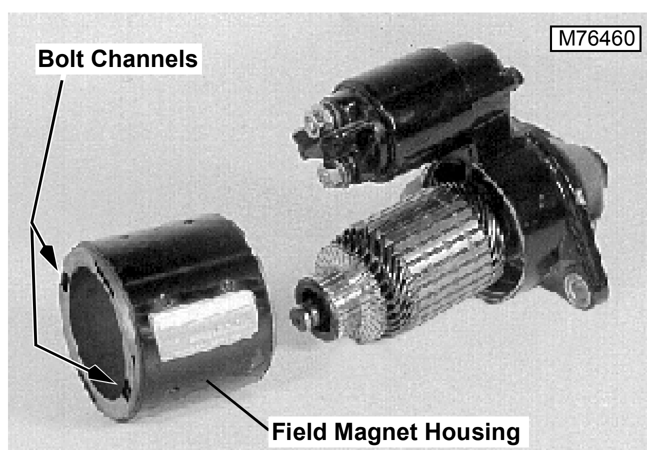
1. After installing clutch assembly, pinion stopper and retaining wire on armature shaft, use two pliers to press pinion stopper over retaining wire.



2. When installing solenoid and armature assemblies into end frame, make sure fork pivot seats in notch on clutch fork.

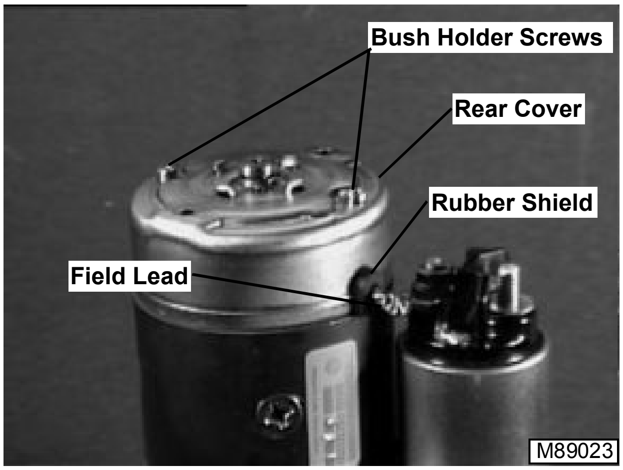


3. Be sure to install dust cover in recess between End Frame and solenoid assembly.

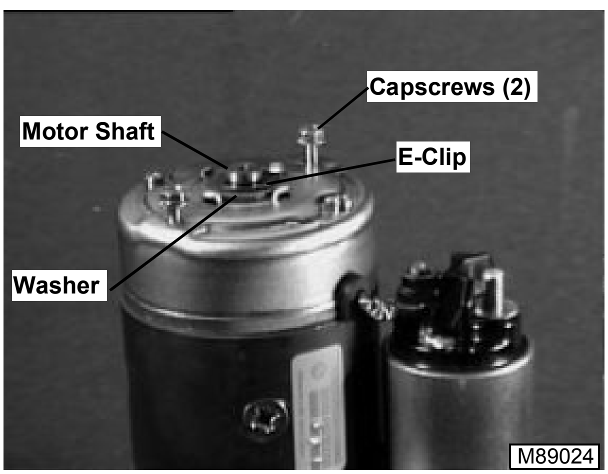


4. When installing field magnet housing be sure to align threaded bolt holes in end cap with channels in housing. (Older Style)

IMPORTANT: When installing rear cover, be sure wires do not touch cover. Press wires inward to clear rear cover.



1. Install field lead, washer and nut on solenoid.
2. Place rear cover over rubber shield and align cover with bush holder screw holes. Install screws in rear cover.(New style)

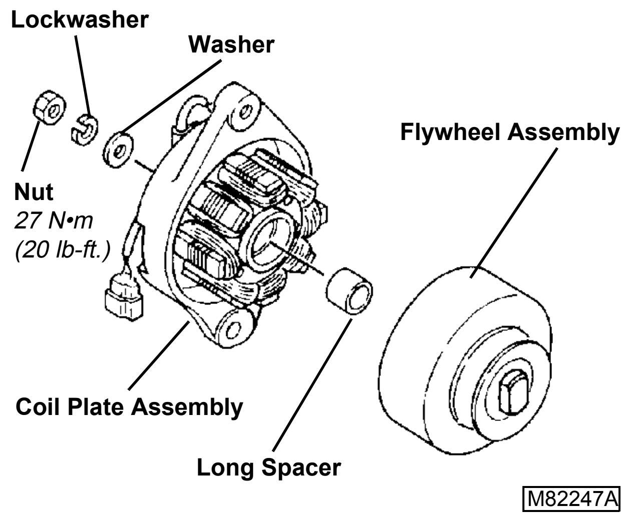


3. Install capscrews through end cap.
4. In order to install the washer and E-ring, it may be necessary to push up on the motor shaft to expose the E-ring groove. Install shims if included, washer and E-ring.
5. Install rubber end cap.

ALTERNATOR—KOKOSAN 20A

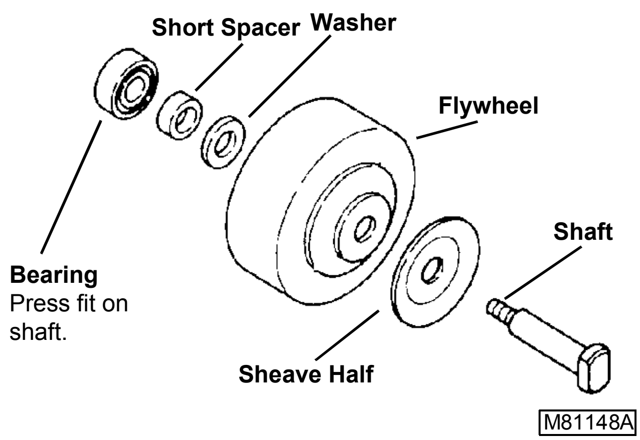
DISASSEMBLY/INSPECTION

1. Remove nut and washers.
2. Tap on end of shaft with a soft-faced hammer to separate flywheel assembly from coil plate assembly.
3. Remove long spacer.



NOTE: Bearing and flywheel are press fit on shaft.

4. Remove shaft from bearing, short spacer, washer, flywheel and sheave half, using a press.
5. Inspect all parts for wear or damage. Replace as necessary.

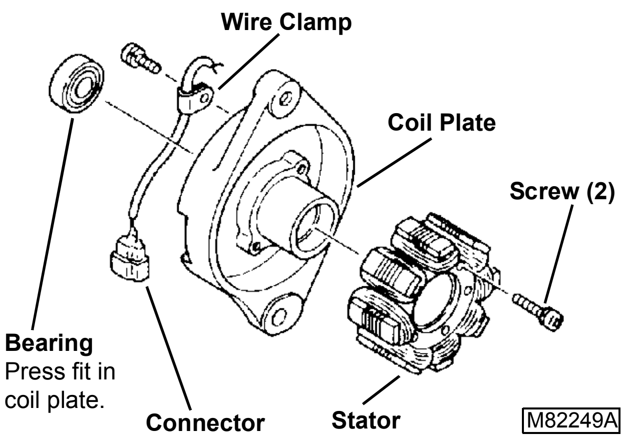


NOTE: Remove bearing only if replacement is necessary.

6. Inspect bearing in coil plate for wear or damage. Replace if necessary.

To replace bearing:
Remove bearing using a spark plug socket and a press. Install bearing into coil plate until it bottoms in bore using a 1 in. socket.

7. Remove wire clamp.
8. Remove connector from harness leads.
9. Remove two screws and stator.
10. Inspect all parts for wear or damage. Replace as necessary.

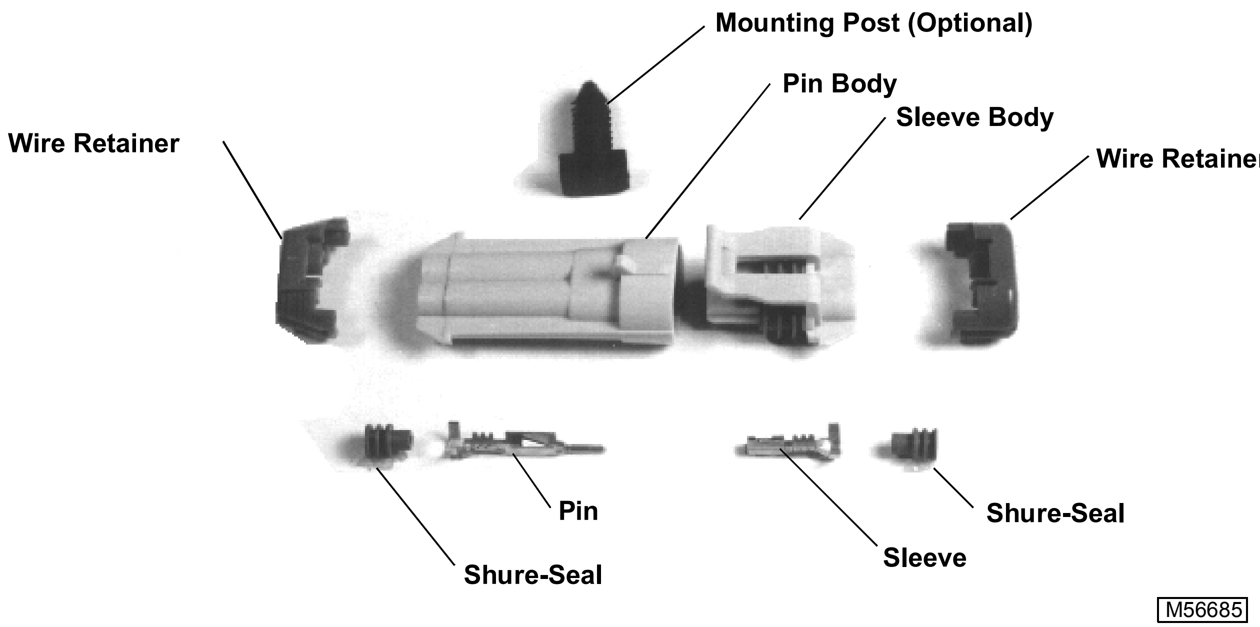


ALTERNATOR ASSEMBLY

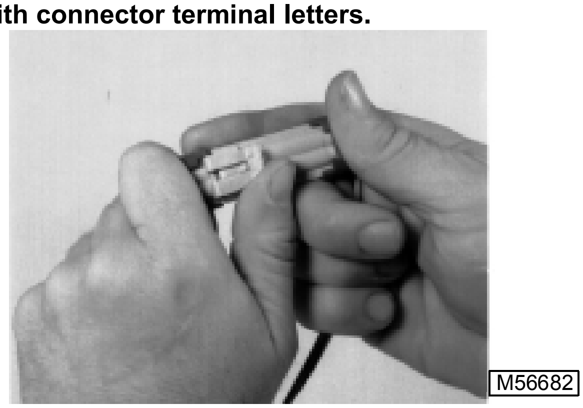
Assembly is done in the reverse order of disassembly.

- With sheave half on shaft, press shaft into flywheel until sheave half bottoms on flywheel face.
- With washer and short spacer installed, press new bearing onto shaft until it bottoms on spacer.

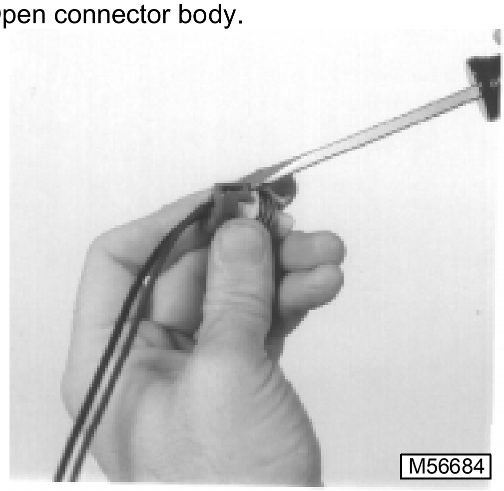
METRO-PACK™ CONNECTOR REMOVAL



IMPORTANT: Identify wire number/color locations with connector terminal letters.

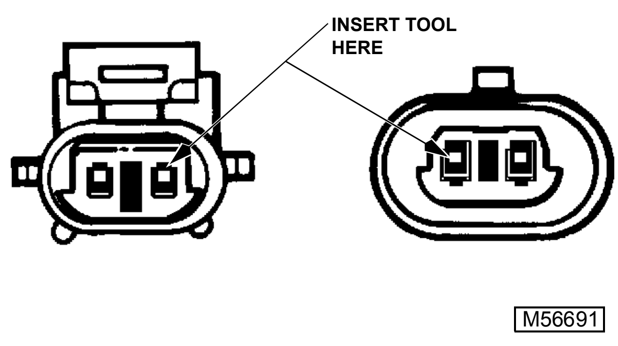


1. Open connector body.

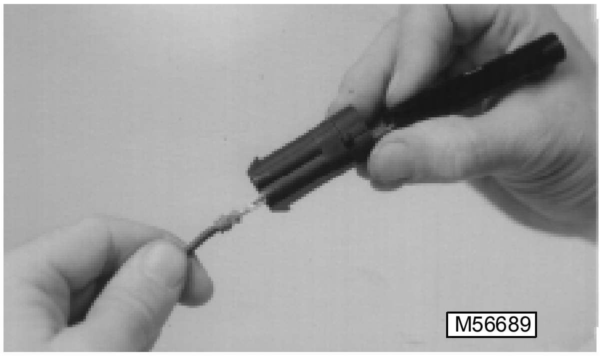


2. Remove retainer on wire end of connector with a screwdriver.

3. Use JDG777 Terminal Removal Tool to remove contact from connector body.



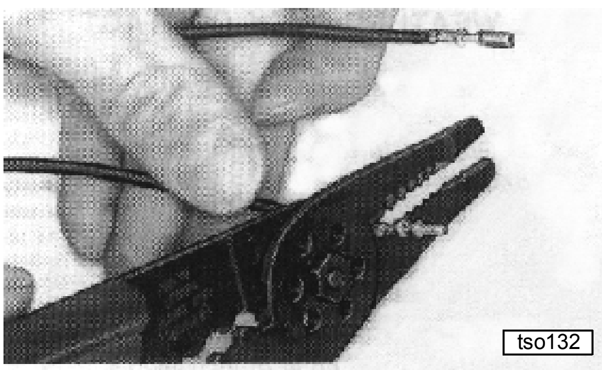
NOTE: *To remove sleeve connector from sleeve body (short connector half) insert tool in slot between terminal contact and connector body. To remove pin connector from pin body (long connector half) insert tool in center of contact.*


M56689

4. Hold the removal tool fully seated and pull wire from connector body

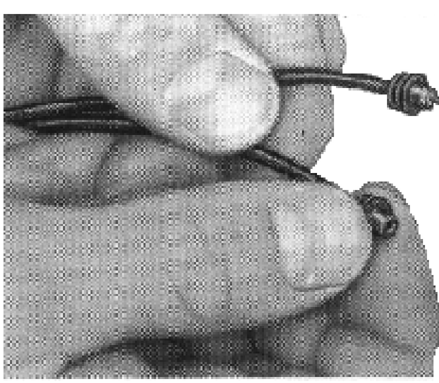
METRO PACK™ CONNECTOR REPLACEMENT

1. Remove wire from connector body as described above.


tso132

2. Use JDG145 Universal Electrical Pliers to remove wire as close as possible to old contact.

IMPORTANT: METRO PACK™ connectors are keyed A, B, C, etc. for proper contact mating. Be sure contacts and wire colors/numbers match and are in proper alignment.


tso136

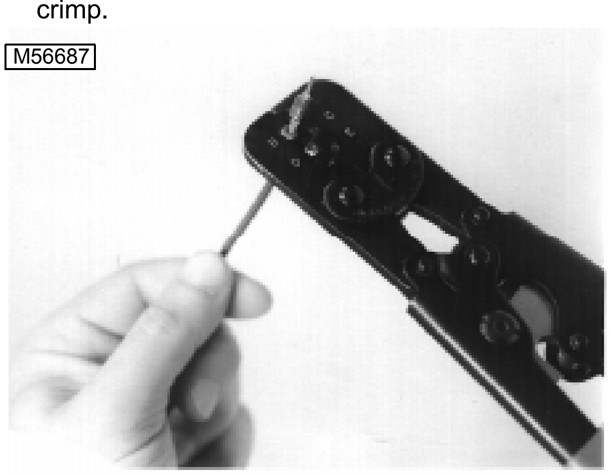
3. Install correct size cable seal on wire.

NOTE: Cable seals are available for three sizes of wire:
- *Large—1.0 mm (16 gauge) wire*
- *Medium—0.8 mm (18 gauge) wire*
- *Small—0.5 mm (20 gauge) wire*

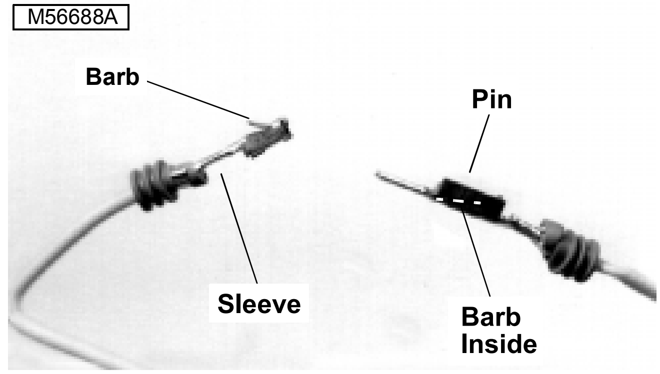
4. Strip insulation from wire to expose 6mm (1/4 in) and align cable seal with edge of insulation


M56686

5. Place proper size contact on wire and use JDG776 CRIMPER to crimp contact in place with a “W” type crimp.

M56687


6. Use JDG776 CRIMPER to secure cable seal to contact as shown.

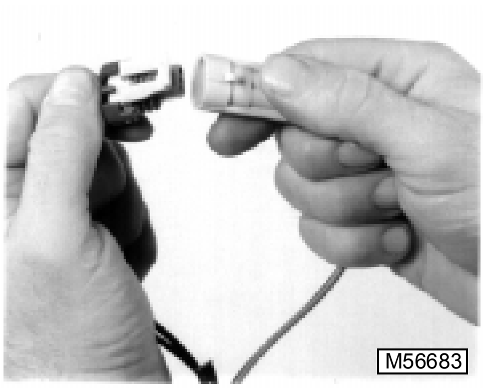
M56688A


IMPORTANT: Proper barb location and orientation for installation of “sleeve and “pin is shown.

NOTE: Connector bodies are “keyed for proper contact mating. be sure contacts are in proper alignment.

M56689

7. Push contact into new connector body until fully seated.
8. Pull on wire slightly to be certain terminal is locked in place.
9. Install wire retainer.



M56683

10. Transfer remaining wires to correct terminal in new connector.
11. Place retainer on wire end of connector and snap in place.
12. Close connector body.

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SPECIFICATIONS

Charge Pump

Make	Danfoss
Model / Series	YC
Type	Gear, Positive Displacement
Displacement	19482 cc/min
Flow @ 3400rpm	19.5 L/min (5.15 GPM)
Relief Valve Setting in Steering Valve	62 bar (900 psi)
Relief Valve Setting in Hydrostatic Pump	4.14—7.58 bar (60—110 psi)
Required Pressure at Hydro Input	6.89—7.58 bar (100—110 psi)

Filter

Type	Spin on
Clogged Filter By-passes Fluid-to-Tank at	3.45 bar (25 psi)
Filter By-pass Light Comes ON at	2.8 bar (40 psi)

Hydrostatic Transmission

Make	Eaton
Model	70145
Type	Rotating Piston, variable flow
Operating Pressure	207 bar (3000 psi)
Main Relief Valve Setting	none
Required Pressure at Hydro Input	6.89—7.58 bar (100—110 psi)

Wheel Motors

Make	Parker Ross TORQMOTOR
Model	1MB120208

REPAIR SPECIFICATIONS

Hydrostatic Transmission

Camplate Trunnion Seal Screws	5 N•m (38 lb-in.)
Valve Caps	135 N•m (100 lb-ft.)
Tow Valve	39 N•m (30 lb-ft.)
Housing-to-backplate Mounting Bolts	25 N•m (18 lb-ft.)
Coupler Socket Head Capscrew	61 N•m (45 lb-ft.)

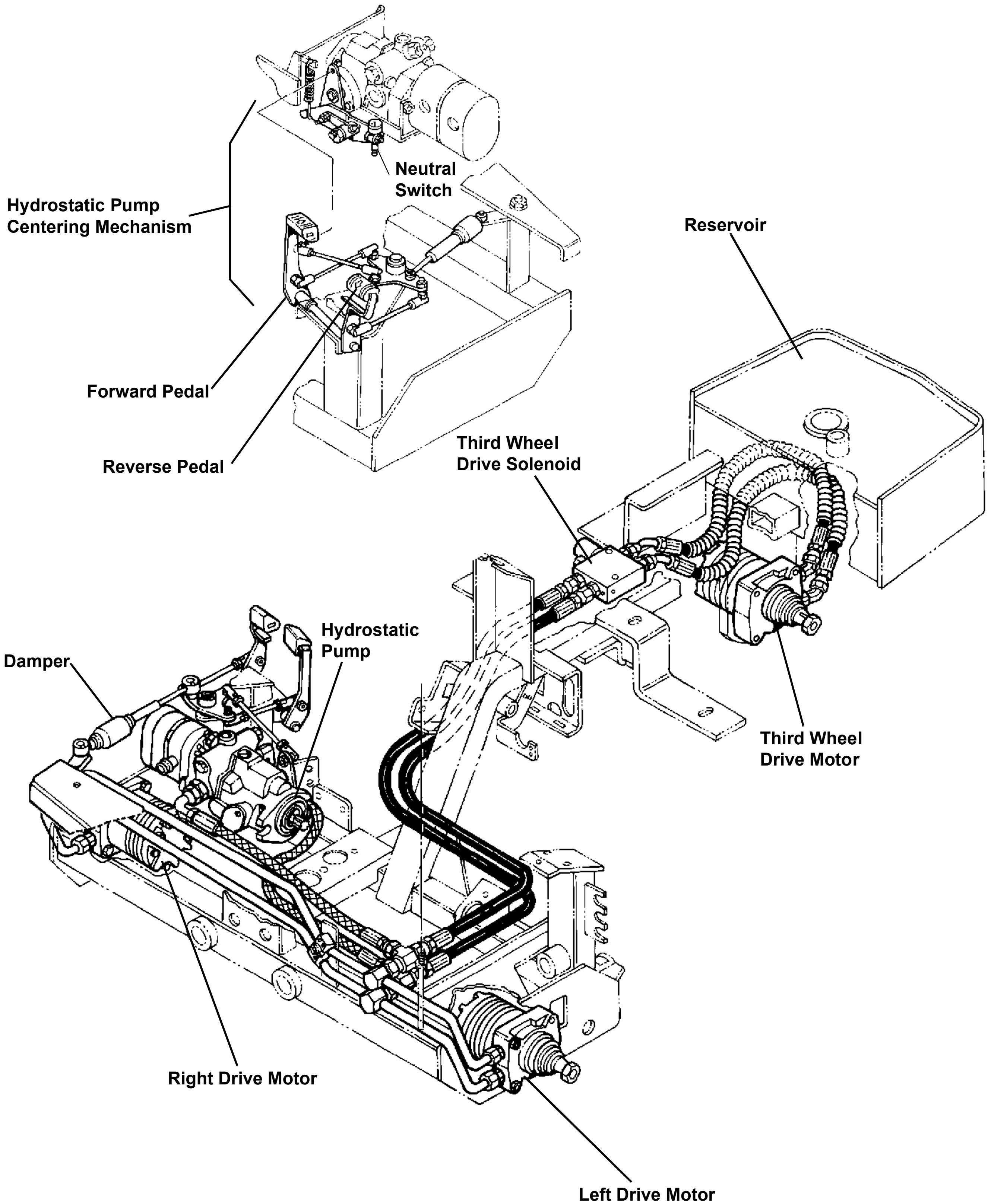
Wheel Motors

Valve Housing Bolts	50 N•m (38 lb-ft.)
Case Drain Plug	6 N•m (50 lb-in.)
Output Shaft Nut	725 N•m (140 lb-ft.)
Wheel Nuts	142 N•m (105 lb-ft.)

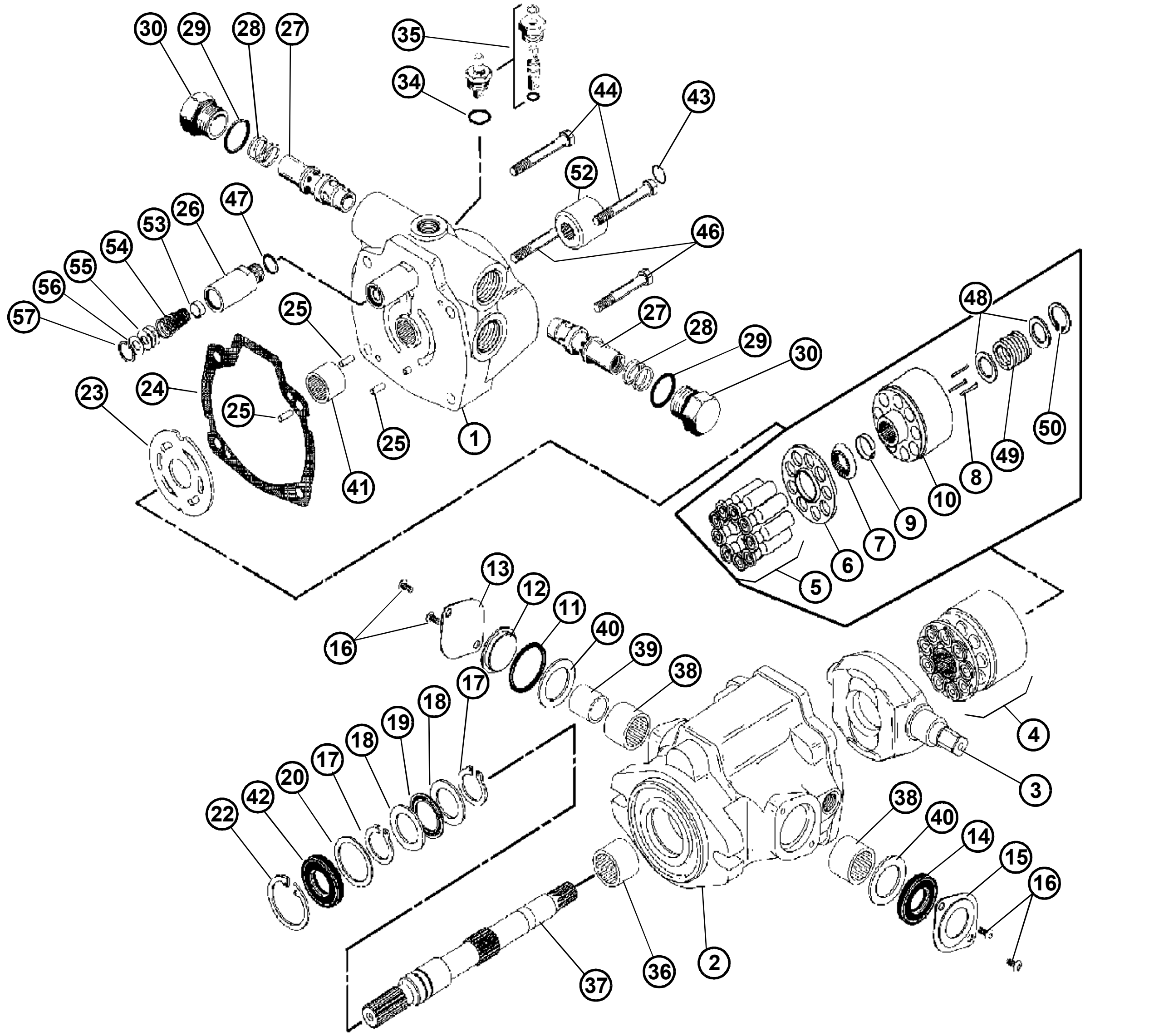
Miscellaneous

Spring Nut	2 N•m (20 lb-in.)

COMPONENT LOCATION



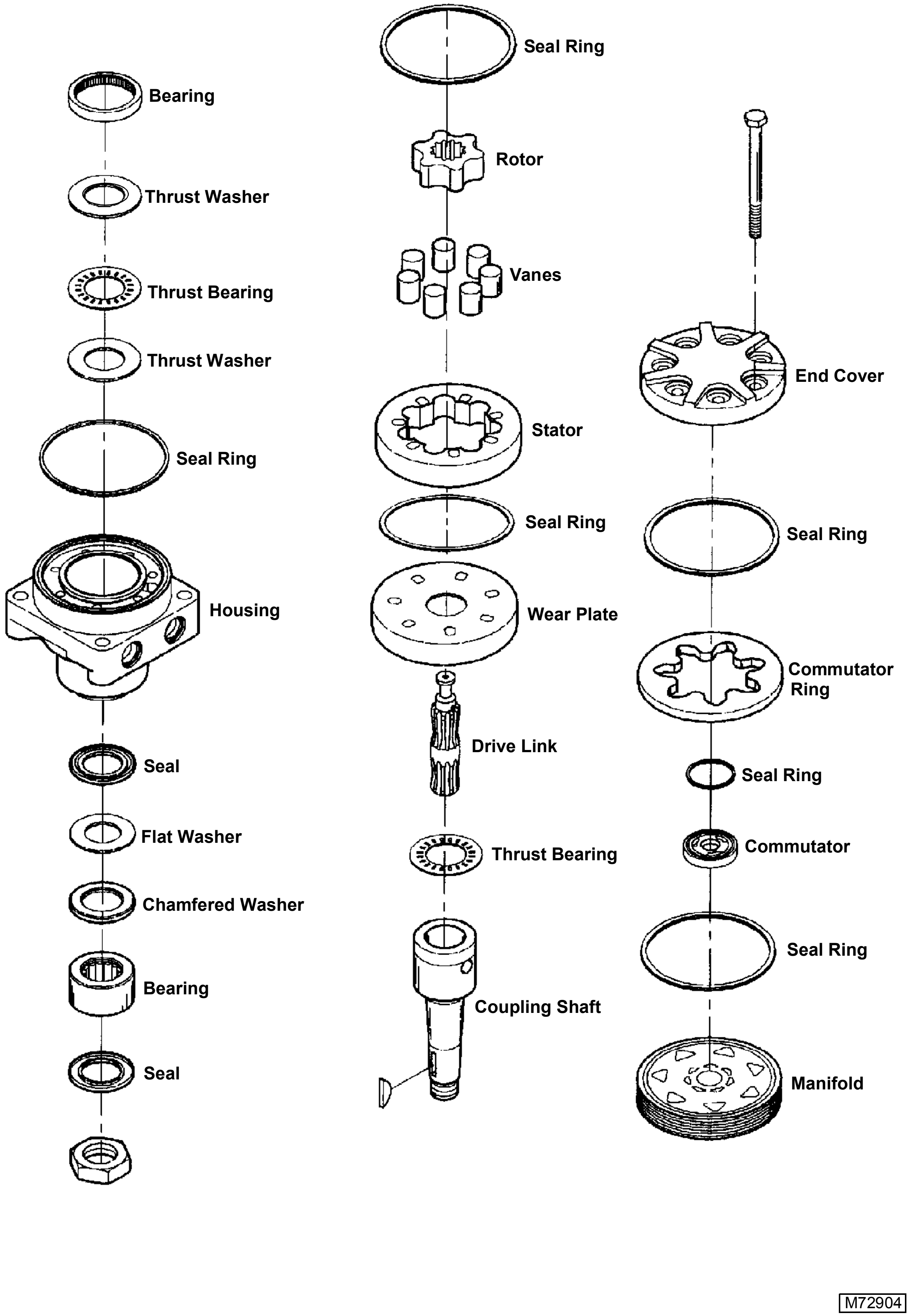
HYDROSTATIC PUMP



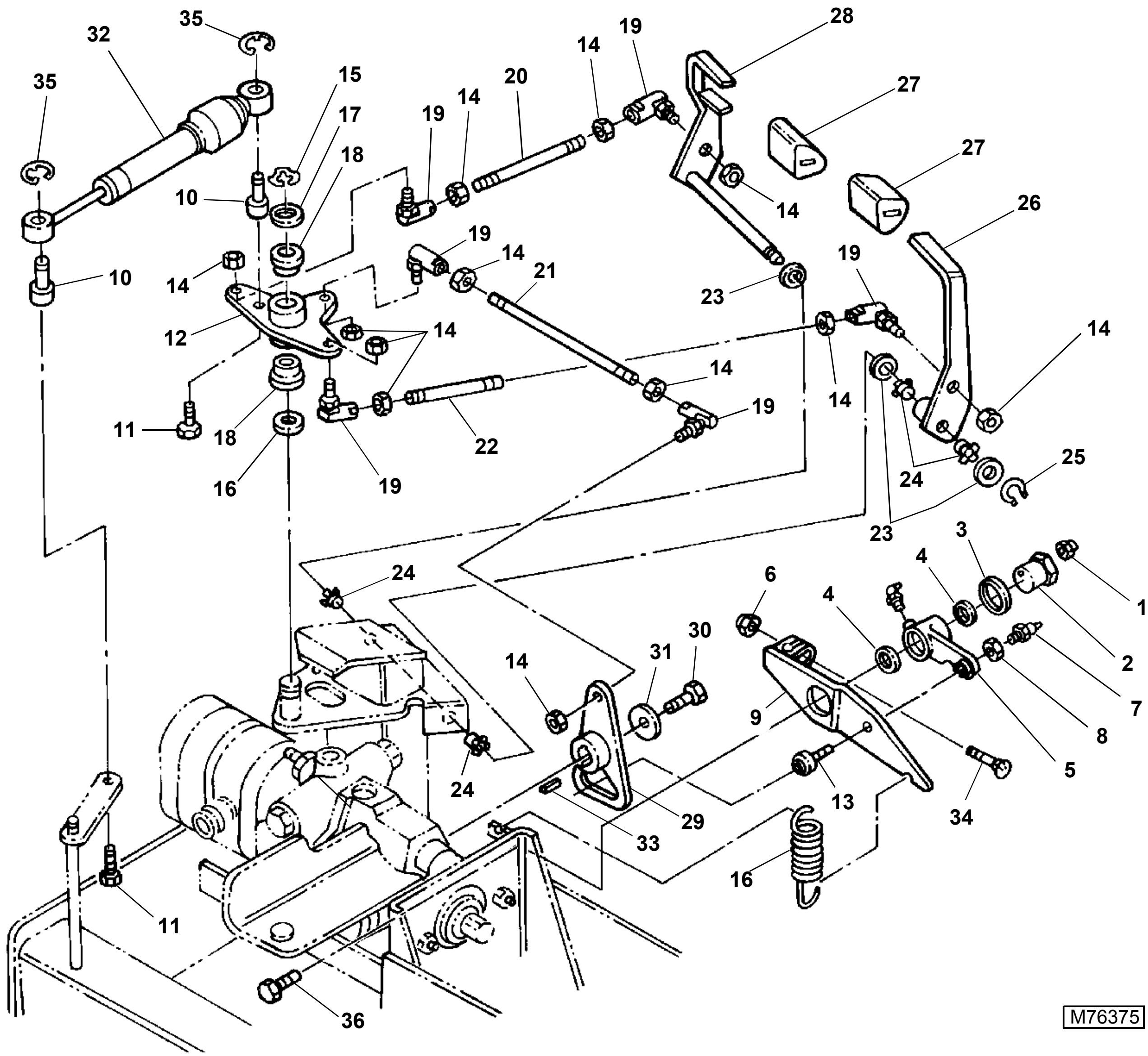
M56549

1. Backplate
2. Body
3. Camplate
4. Rotating Assembly
5. Piston Assembly
6. Spider
7. Spider Pivot
8. Pin
9. Pin Keeper
10. Piston Block
11. O-ring
12. O-ring Cover
13. Trunnion Cover
14. Trunnion Seal
15. Seal Cover
16. Cover Screws
17. Snap Ring
18. Bearing Race
19. Thrust Bearing
20. Washer
21. Spacer
22. Retaining Ring
23. Valve Plate
24. Gasket
25. Pin
26. Housing
27. Plug Seat
28. Spring
29. O-ring
30. Plug
31. Capscrews
32. O-ring
33. Capscrews
34. O-ring
35. Tow Valve
36. Bearing, Body
37. Shaft, Front Pump
38. Trunnion Bearing
39. Bearing Race
40. Washer
41. Bearing, Backplate
42. Seal, Main Shaft
43. O-ring
44. Capscrews
45. Backplate
46. Capscrews
47. O-Ring
48. Washer
49. Spring
50. C-Clip
51. Shaft, Rear Pump
52. Coupler
53. Poppet
54. Spring
55. Shims
56. Washer
57. Snap Ring

TORQMOTOR

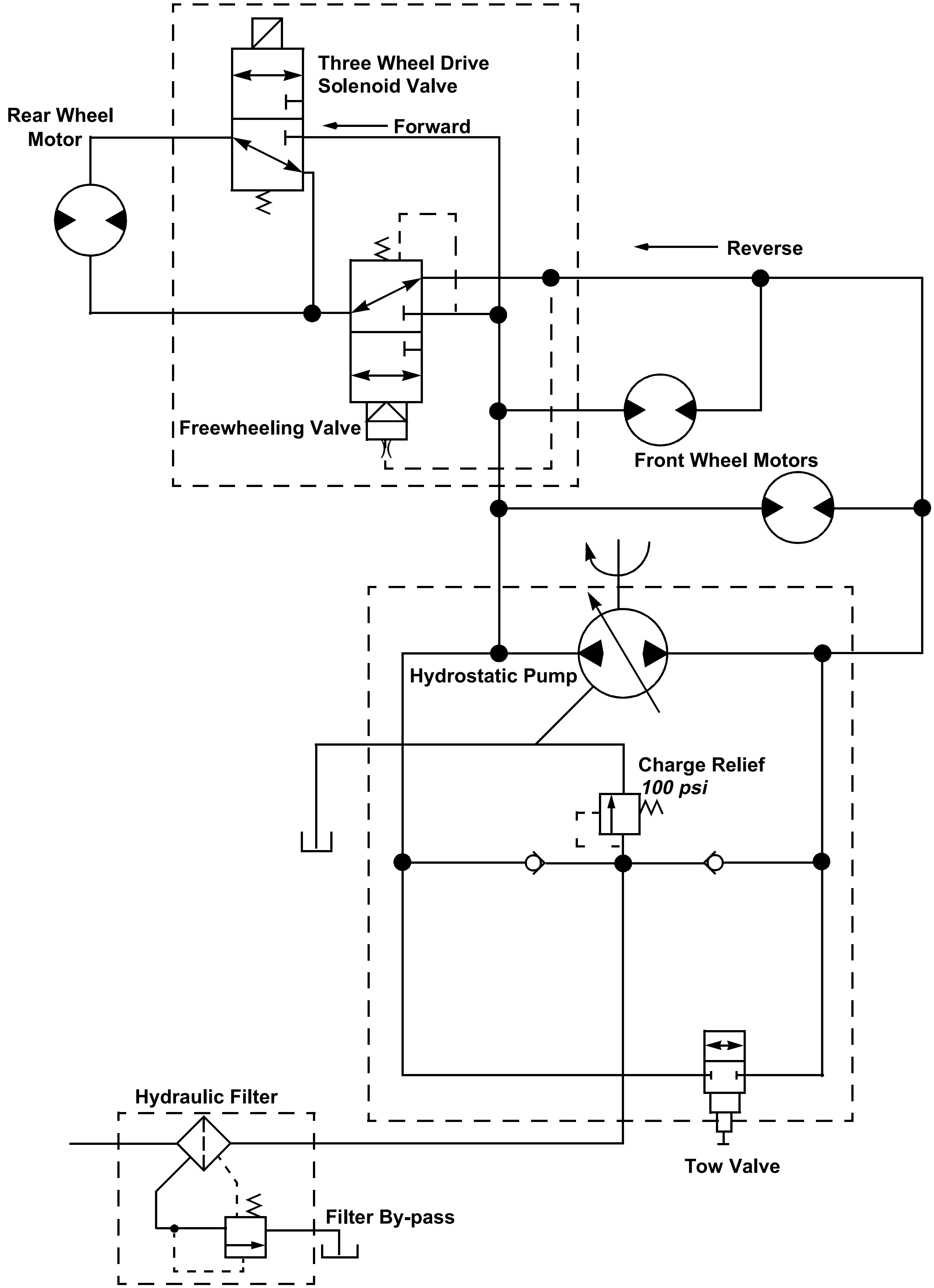

Seal Ring
Bearing
Rotor
Thrust Washer
Vanes
Thrust Bearing
Thrust Washer
End Cover
Stator
Seal Ring
Seal Ring
Seal Ring
Wear Plate
Housing
Commutator
Ring
Drive Link
Seal
Seal Ring
Flat Washer
Thrust Bearing
Commutator
Chamfered Washer
Seal Ring
Bearing
Coupling Shaft
Seal
Manifold
M72904

PUMP CONTROL MECHANISM



58. Nylock Nut
59. Eccentric
60. Washer
61. Fiber Washer
62. Arm
63. Nylock Nut
64. Zerk
65. Nut
66. Switch Arm
67. Stud
68. Capscrew
69. Control Plate
70. Cam Follower
71. Nut
72. Spring Clip
73. Washer
74. Washer
75. Bushing
76. Rod End
77. Rod, Reverse
78. Rod, Pump
79. Rod, Forward
80. Washer
81. Bushing
82. C-Clip
83. Forward Pedal
84. Rubber Tread
85. Reverse Pedal
86. Pintle Plate
87. Capscrew
88. Fender Washer
89. Damper
90. Key
91. Carriage Bolt
92. C-Clip
93. Capscrew

POWER TRAIN SCHEMATIC



TROUBLESHOOTING

Check or Solution / Problem or Symptom	Machine will not operate in either direction	Pump noisy	Sluggish response to acceleration or deceleration	Machine creeps in neutral	Machine will not achieve full ground speed
Oil supply low	●				●
Oil filter clogged	●	●			
Oil viscosity too high	●				
Control linkage broken or not adjusted properly	●				●
Low charge pressure, should be 60 - 110 psi	●		●		
Charge pump relief valve damaged	●				
Charge pump gears worn or scored	●				
Internal charge pump damage	●				
Drive shaft broken	●				
Relief valve stuck open, dirty or damaged	●		●		●
Air in system		●	●		●
Loose suction line		●			●
Internal pump or motor damage		●	●		●
Tow valve open or damaged	●		●		●
Transmission Neutral out of adjustment				●	

THEORY OF OPERATION

FUNCTION

The hydrostatic drive system provides a means of propelling the vehicle with infinitely variable speed control.

THEORY

The Hydrostatic system is a closed loop fluid power system that consists of a Eaton Piston Pump and two (two wheel drive) or three (three wheel drive) Geroler Motors. Speed and direction are controlled by two footpedals.

Hydrostatic Pump:

The pump is a Eaton Model 70144 axial piston, manually variable displacement pump. The pump is direct driven by a coupler attached to the engine crank balancer. The pump, or Hydrostatic Transmission, is mounted Transversely in the main frame under the radiator system.

Directional control, forward or reverse, is controlled by varying the direction of fluid flow through the hydrostatic pump by varying the direction of rotation of the swash plate in the pump. Control of the rotation is provided by two foot pedals. The left pedal controls forward motion, the right pedal controls reverse motion.

Speed is controlled by the angle of the swash plate. The greater the displacement of the swash plate from the vertical position, neutral, the greater the volume of fluid the pump will displace and the faster the vehicle will travel. Speed is governed by depressing the foot pedals.

The Hydrostatic Pump provides hydraulic fluid to the Motors though hydraulic lines and fittings. The hydraulic fluid in the power train circulates in a closed loop. Fluid leaves the pump and flows through the motor and is returned to the pump, not the reservoir. Fluid that leaves this closed loop circuit, such as case drain, is replenished by fluid from the Charge Pump located on the end of the double pump assembly. (See Hydraulic Section)

Wheel Motors:

The wheel motors are Parker Ross, positive displacement Geroler motors.

The Motors for the front wheels are mounted on the “T” frame. The motor for the rear wheel, with rear wheel drive option only, is mounted on the end of the third wheel steering yoke.

Each motor has a tapered keyed output shaft on which the wheel hubs are mounted. The two front wheel hubs incorporate a park brake disk.

Three Wheel Drive Solenoid Valve:

The Three Wheel Drive solenoid valve is a electrically operated, spring return shuttle valve. The solenoid is energized whenever the mow switch is engaged. When energized, fluid from the Forward side of the Hydrostatic Pump is directed to the rear wheel motor for added traction. When de-energized fluid in the rear motors and lines circulate in a closed loop allowing the rear wheels to freewheel.

Free Wheeling Valve (Three Wheel Drive Units Only):

The free wheeling valve is a differential pressure pilot operated, spring return shuttle valve.

During Three Wheel Drive operation and while descending inclines, it is possible to build higher pressures in the return lines of the rear wheel motor. This happens when the machine’s momentum develops more pressure in the reverse lines of the hydraulic system than the Hydrostatic pump develops in the forward lines. Effectively, the wheel motors try to drive the Hydrostatic pump. Higher pressure in the return lines can cause the rear wheels to stop turning or start them turning in the reverse direction. Either case will result in loss of steering control. The free wheeling valve is installed in the rear wheel drive circuit to counteract this effect.

The free wheeling valve compares the pressure in the forward and reverse lines of the wheel motors. If reverse pressure is higher than forward pressure, the valve shifts and sets up a bypass circuit in the rear wheel drive system. When a higher pressure is sensed in the forward side of the wheel motors, the free wheeling valve returns to normal position and allows full Three Wheel Drive again.

TROUBLESHOOTING HINTS:

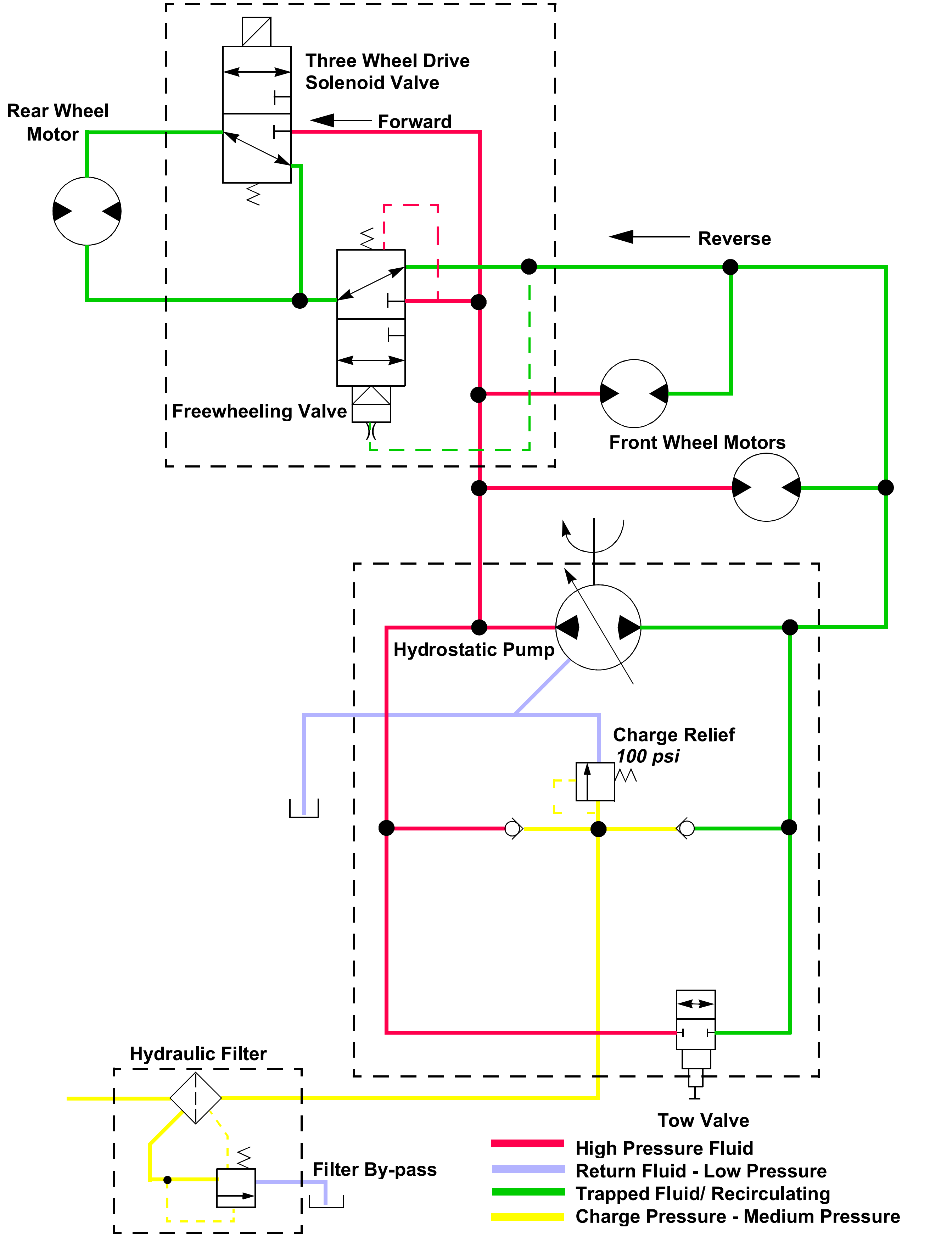
The most noticeable result of a worn pump or motor is reduced travel speed. This results from either the pump’s inability to provide the necessary flow at the required pressure, or the pump/motor bypassing fluid to case drain.

Component wear is normally caused by either fluid contamination or pump cavitation. Pump cavitation can be a result of fluid contamination, clogged filter, or insufficient fluid in the system.

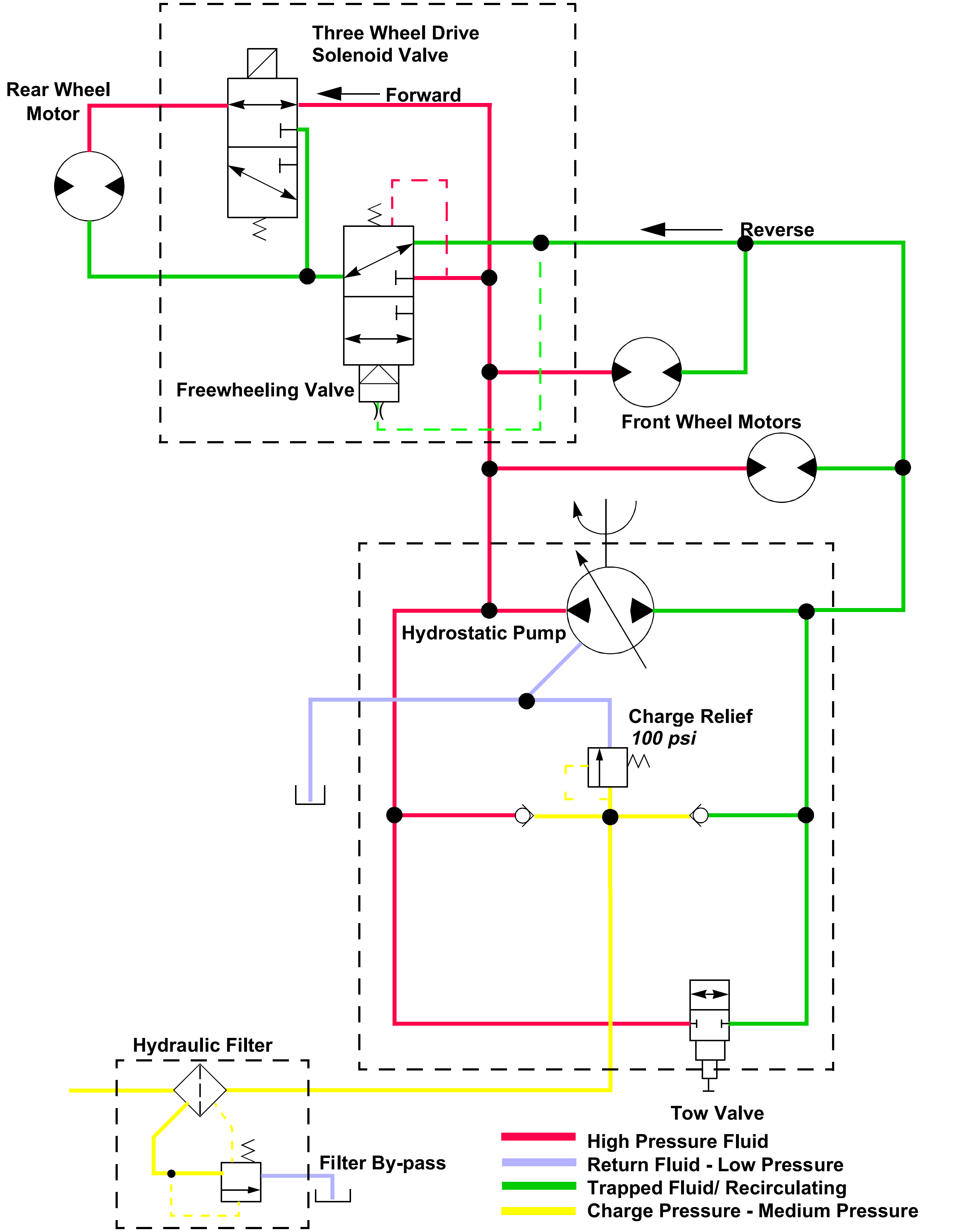
Before testing the hydrostatic pump, check the charge pump pressure. (See Hydraulic Section) Once you are satisfied that charge pressure is sufficient, test the hydrostatic pump efficiency, (Forward and Reverse), with a flow meter. If the hydrostatic pump is delivering the required flow at full output pressure, it is probably safe to assume that the problem is with a wheel motor.

THEORY OF OPERATION

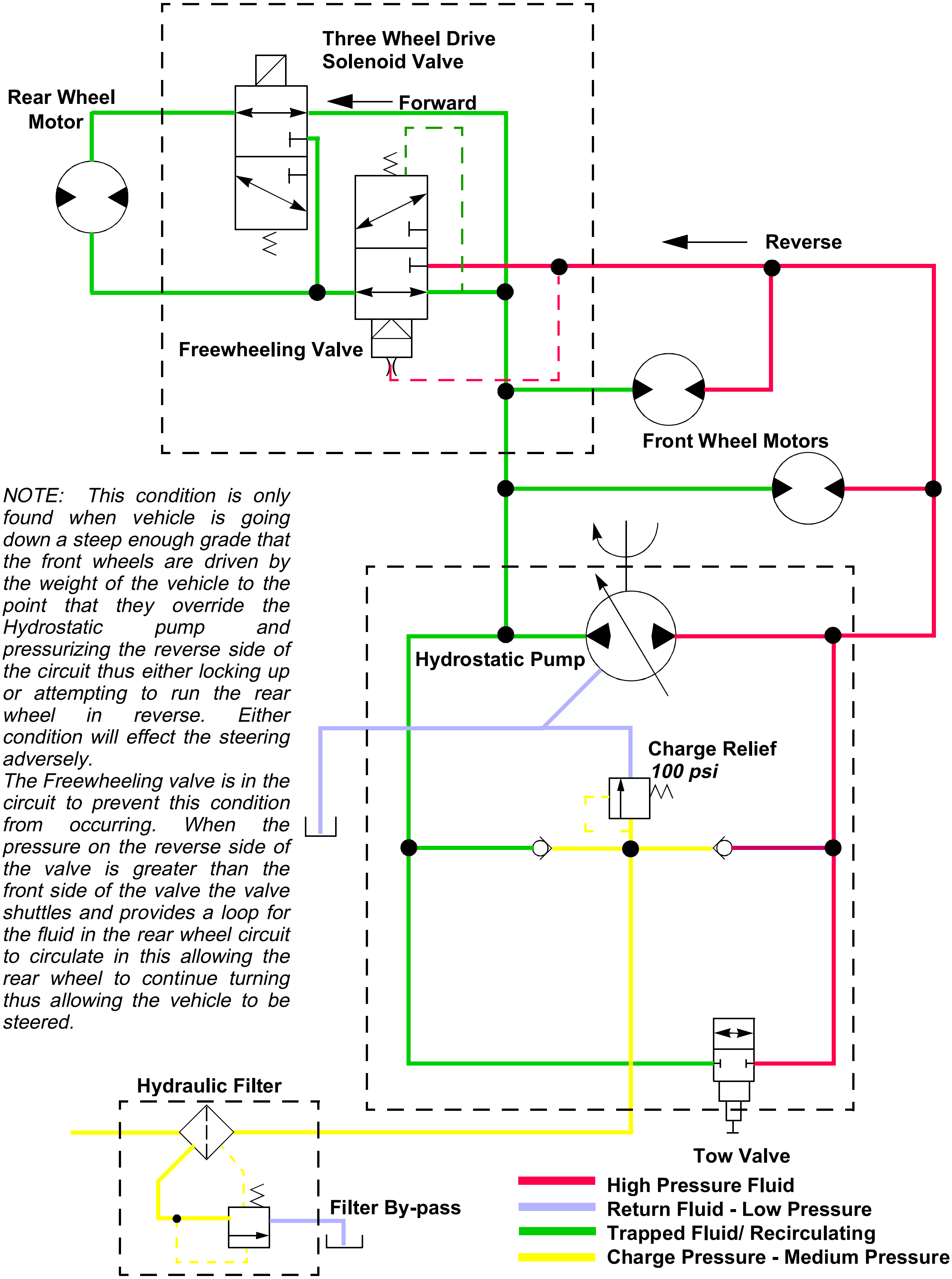
Forward Without Three Wheel Drive



Forward With Three Wheel Drive



Forward With Three Wheel Drive And Rear Wheels Freewheeling



NOTE: This condition is only found when vehicle is going down a steep enough grade that the front wheels are driven by the weight of the vehicle to the point that they override the Hydrostatic pump and pressurizing the reverse side of the circuit thus either locking up or attempting to run the rear wheel in reverse. Either condition will effect the steering adversely.
The Freewheeling valve is in the circuit to prevent this condition from occurring. When the pressure on the reverse side of the valve is greater than the front side of the valve the valve shuttles and provides a loop for the fluid in the rear wheel circuit to circulate in this allowing the rear wheel to continue turning thus allowing the vehicle to be steered.

MOWER WILL NOT MOVE - FORWARD OR REVERSE

Test Conditions:

- Transmission in neutral
- Park Lock switch off
- Brake disengaged
- Engine running
- Operator in seat
-

Test/Check Point	Normal	If Not Normal
1. Directional pedals	Pedals move freely down and back. machine should accelerate smoothly forward or backwards.	Check linkage for bent or broken components. Repair or replace as necessary.
2. Mow/Transport lever	Lever should move freely back and forth.	Check linkage for bent or broken components. Repair or replace as necessary.
3. Charge Pump	Charge pressure should be between 80 - 110 psi.	If pressure to low replace/rebuild charge pump. See Hydraulic section.
4. Hydraulic fluid level.	Check reservoir for proper fluid level	If low replenish fluid supply.

MOWER WILL NOT REACH FULL SPEED

Test Conditions:

- Transmission in forward
- Park Lock switch off
- Brake disengaged
- Engine running
- Operator in seat
-

Test/Check Point	Normal	If Not Normal
1. Directional pedals	Pedals move freely down and back. machine should accelerate smoothly forward or backwards.	Check linkage for bent or broken components. Repair or replace as necessary.
2. Charge Pump	Charge pressure should be between 80 - 110 psi.	If pressure to low replace/rebuild charge pump and/or replace relief valve. If pressure is high replace relief valve.
3. Check Pressure and Flow of Hydrostatic Pump.	Flow and pressure should be within specifications	Check and or replace relief valves. Replace/rebuild pump.
4. Remove Drive motors and bench check.		Replace Motor.

HYDROSTATIC SYSTEM OPERATING HOT

Test Conditions:

- Transmission in neutral
- Park Lock switch off
- Brake disengaged
- Engine running
- Operator in seat
-

Test/Check Point	Normal	If Not Normal
1. Check hydrostatic fluid	Proper level and viscosity for operating conditions. (See Owners Manual)	Fill and/or replace oil.
2. Oil Cooler	Cooling fins free of dirt and obstructions.	Clean and/or repair.
3. Charge Pump	Charge pressure should be between 80 - 110 psi.	If pressure to low replace/rebuild charge pump and/or replace relief valve. If pressure is high replace relief valve.

TESTS & ADJUSTMENTS

HYDROSTATIC TRANSMISSION FLOW TEST

Reason:

To verify that hydrostatic pump is operating at optimum efficiency

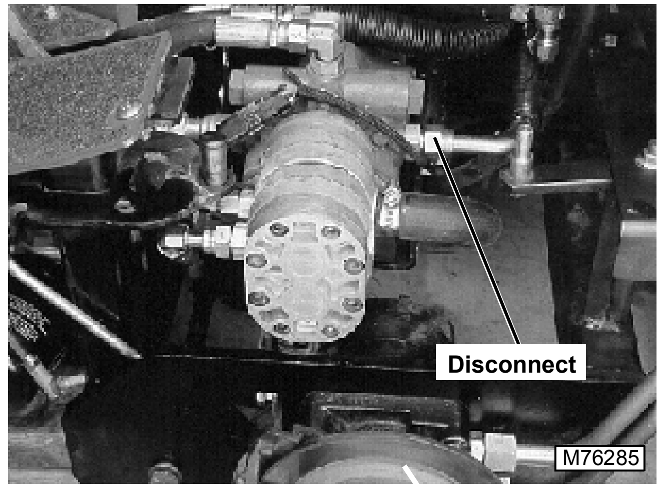
Tools:

- D01074AA In-Line Hydraulic Tester
- JTO3377 (2) 120” Hydraulic Test Hoses
- JTO3012 (2) Connector 3/4” F NPT x 1-1/16” F 37°
- JTO5689 Connector 1-1/16” M 37° x 1”-14 F ORFS
- JTO3492 Connector 3/4” F NPT x 1-7/16”-12 M ORFS
- JTO3493 Connector 1”-14 M ORFS x 1-7/16”-12 F ORFS
- JTO5719 Hand Held Digital Tachometer

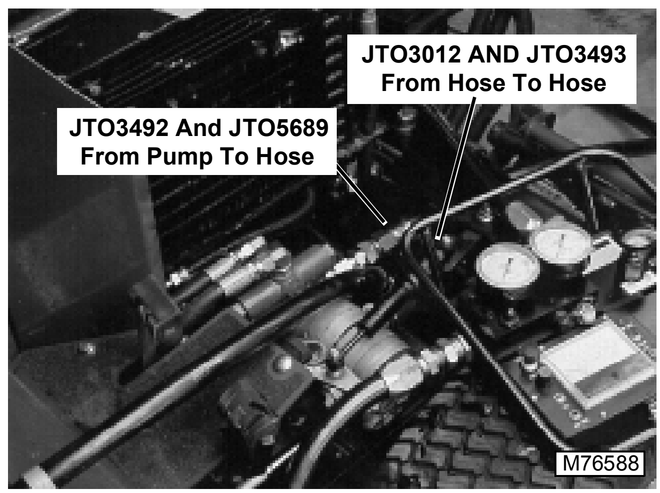
Procedure:

> **⚠ CAUTION**
>
> **Lower cutting units to the ground prior to removing any hydraulic lines or fittings.**
> **To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.**

1. Park machine on level surface, reels lowered, park brake on, engine off.
2. Chock wheels to prevent inadvertent movement of vehicle during test.
3. Place drip pan under double pump to catch oil that will leak out when lines are disconnected.
4. Disconnect Hydraulic hoses going into forward side of hydrostatic pump.



5. Connect JTO3377 hose to motor using JTO3492 and JTO5689 connectors. Connect another JTO3377 hose to hose disconnected from hydrostatic pump using JTO3012, and JTO3493 connectors.



6. Connect JTO3377 hose from pump into inlet port of DO1074AA Hydraulic Tester. Install second hose into outlet port.
7. Turn tester control knob out (counter-clockwise) completely.

NOTE: Make sure that pressure control valve is screwed out to a non restrictive setting. Be careful not to screw handle completely out of valve.

8. Start engine.
9. Using JTO5719 Hand Held Digital Tachometer set throttle at 3000 rpm.
10. Depress Forward pedal fully.
11. Record flow reading.

IMPORTANT: Accuracy in recording readings is very important!

12. Turn hydraulic tester load valve until pressure is 207 bar (3000 psi).
13. Record reading.
14. Return load valve to full flow position and turn engine off.

Specifications:

- Flow rate at 207 bar (3000 psi) must be at least 10.73 GPM (40.6 L/min), if not, replace Hydrostatic pump.
- Divide reading recorded at 207 bar (3000 psi) by free flow reading to determine pump efficiency.
- Pump efficiency must not be less than 80 percent.

Example:

Pump Free Flow 12.5 GPM
Pump Flow With 13,790 kPa (2000 psi) load. 12 GPM
Pump Efficiency:12 ÷12.5=0.96 or 96 percent.

Corrections:

- If pump flow or efficiency are below the minimum requirements rebuild and/or replace pump.
- Flow at 207 bar (3000 psi) must be at least 10.73 GPM (40.6 L/min), if not, replace or rebuild pump.

CHARGE PRESSURE CHECK

Reason:

To Insure that there is sufficient pressure to keep the Hydrostatic pump properly charged.

NOTE: For further charge pump tests and Diagnostics see Lift Sections.

Equipment:

- AMT846 Hose
- JTO3017 Hose 34,473 kPa (5,000 psi)
- RE48122 Female Quick Coupler
- RE43774 Male Quick Coupler 11/16-16 F ORFS
- 31H1031 T-Fitting, 11/16-16 F ORFS X 11/16-16 M ORFS X 11/16-16 M ORFS
- JTO5486 Connector 1/4” M NPT x 7/16” M 37°
- JTO5474 Gauge w/Quick Coupler,0- 2,000 kPa (0-300 psi).

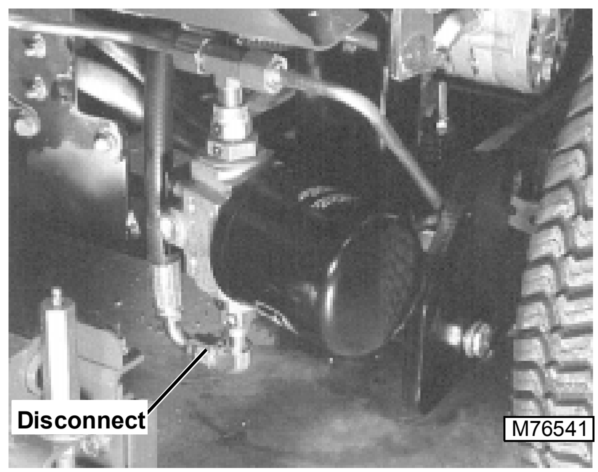
Procedure:

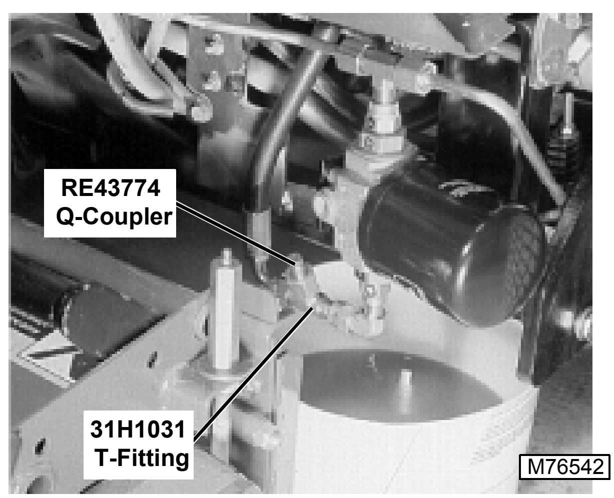
CAUTION

To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.

1. Park machine on level surface, reels lowered, park brake on, engine off.
2. Chock wheels to prevent inadvertent movement of vehicle during test.
3. Place drain pan under Oil Filter.
4. Disconnect hose fittings at lower oil filter port.

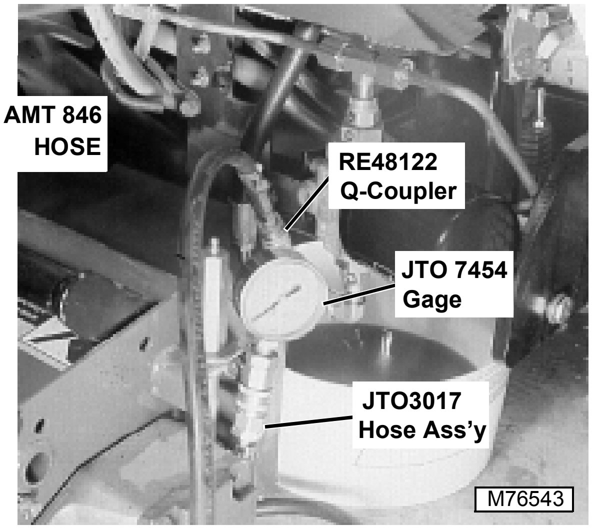
NOTE: Do Not remove Elbow fitting.





5. Connect hose AMT846 to hose JTO3017 with connector JTO5086 and attach RE48122 quick coupler on end of hose assembly.

6. Insert Gauge JTO5474 in one quick coupler and fasten other quick coupler to test port.



7. Start engine and set throttle to 2000 rpm (min).
8. Apply the parking brake.

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

9. Step on Reverse pedal to full travel position.
10. Note reading on gauge.

Specifications:

- Observe pressure gauge. Pressure should indicate 689 ± 130 kPa (100 ± 20 psi).

Corrections:

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

TRANSMISSION NEUTRAL ADJUSTMENT

Reason:

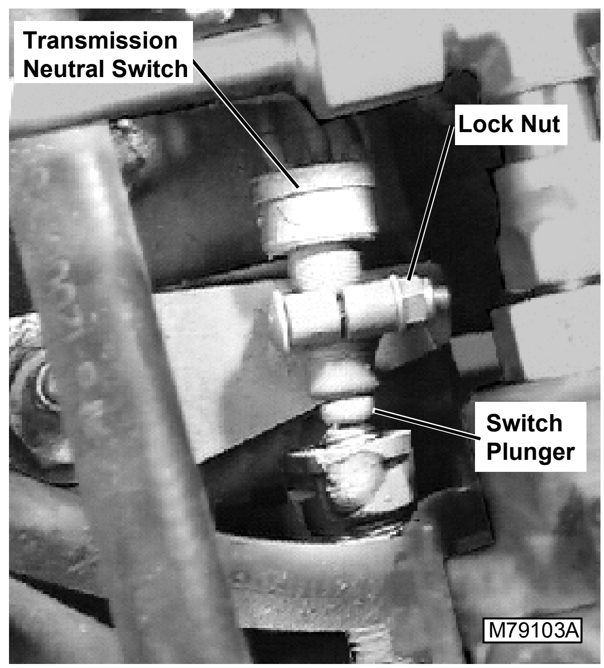
To insure that the transmission neutral mechanism is operating properly.

Procedure:

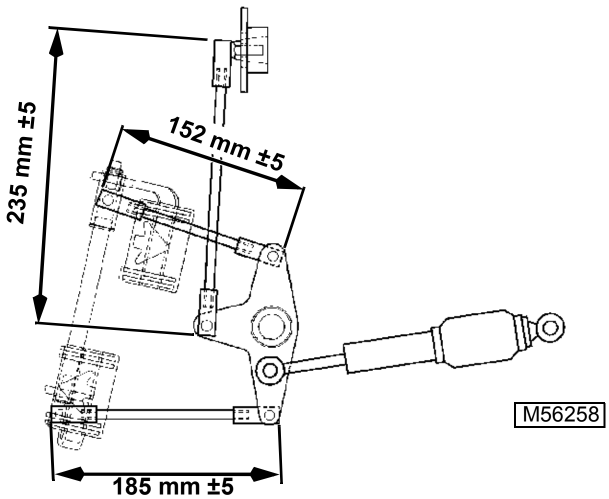
1. Park vehicle on a level surface.

> ⚠ **CAUTION**
>
> **Raise the machine safely and support it with suitable jack stands. Ensure all wheels are off the ground (three-wheel drive units)**
>
> **Drive wheels are free to spin during this adjustment, stay clear and keep other people clear of drive wheels during adjustment.**
>
> **Never work on machine while supported only on mechanical or hydraulic jack**

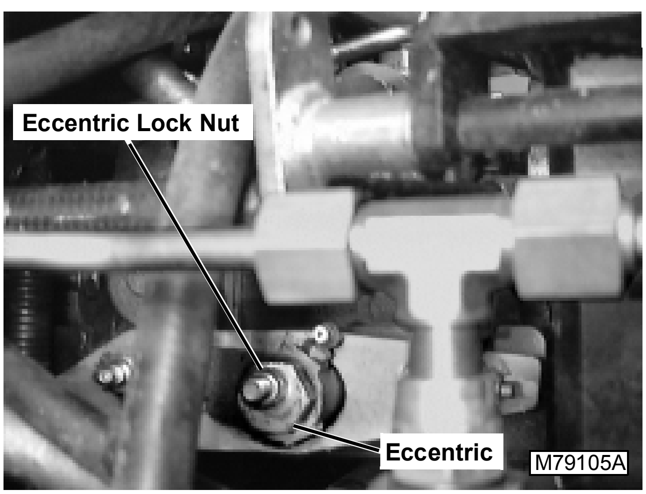
2. Lift and support machine with jack stands.
3. Operate lift control and allow cutting units to settle on ground.
4. Before making any adjustment, perform a thorough visual inspection of linkages and return springs for damage, repair or replace as necessary.



5. Locate transmission neutral switch and insure that switch plunger is not "bottoming out". Switch should be set in holder at the midpoint of the threaded shaft of the switch. Loosen lock nut and adjust switch accordingly.



6. Check Transmission link to insure that it is 235 mm ±5 (9.252 in. ±0.2) overall length, from end of rod end to end of rod end. If not, adjust.
7. Set forward pedal link at 152 mm ±5 (5.984 in. ±0.2).
8. Set reverse pedal link at 185 mm ±5 (7.283 in. ±0.2).
9. Start engine and run at low idle.
10. With an operator in the operator's seat, release the parking brake.



11. Loosen eccentric lock nut.
12. Rotate eccentric forward or backward until drive wheels stop turning, tighten eccentric lock nut while holding eccentric in position.
13. Have the operator depress the drive pedals in both directions and release.
14. Drive wheels should stop turning when pedals are released, if not, repeat adjustment.
15. Adjust reverse pedal Link until reverse pedal lines up with forward pedal.

IMPORTANT: Neutral start switch adjustment must be performed after this procedure has been completed.

TRANSMISSION NEUTRAL ADJUSTMENT

Reason:

To insure that the neutral switch is properly set.

Procedure:

IMPORTANT: Transmission neutral adjustment (previous section) should be performed before this adjustment is made.

NOTE: Before performing this procedure check switch for proper operation.

1. Park vehicle on a level surface.

⚠ CAUTION

Raise the machine safely and support it with suitable jack stands. Ensure all wheels are off the ground (three-wheel drive units)

Drive wheels are free to spin during this adjustment, stay clear and keep other people clear of drive wheels during adjustment.

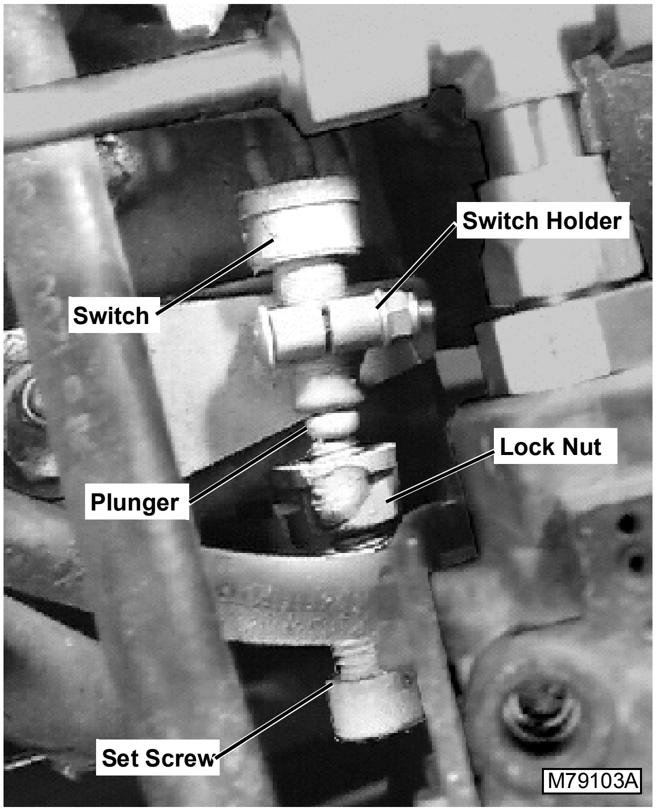
Never work on machine while supported only on mechanical or hydraulic jack

2. Lift and support machine with jack stands.
3. Operate lift control and allow cutting units to settle on ground.
4. Start engine and run at slow idle.
5. Move hydrostatic control forward pedal.
6. Move hydrostatic control reverse pedal.

Result:

- **Engine should stop within first inch of pedal travel.**

Corrections:



1. Inspect switch to insure that it is securely in switch holder.
2. With engine turned off turn set screw out until switch clicks.
3. Turn set screw in until switch clicks.

NOTE: If switch plunger does not move when set screw is backed of, or if switch does not click in either direction, replace switch.

4. Tighten lock nut.
5. Repeat test procedure to insure that engine kills in the first inch of pedal travel.
6. When switch is properly set remove vehicle from jack stands.

TORQMOTOR EFFICIENCY TEST

Reason:

To determine if the Torqmotor is operating at peak efficiency.

Equipment:

JTO5984 Flo Tester

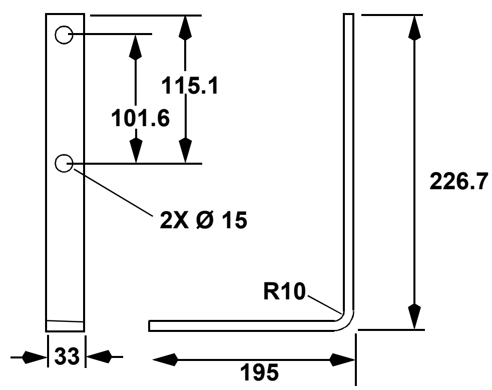
Fabricated wheel stop (See dimensions)

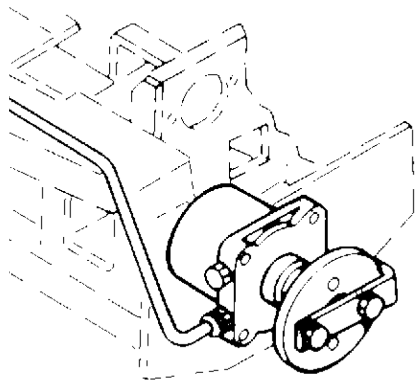
Photo Tachometer

Connections:

1. 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.
2. Install a cap on the wheel not being tested.
3. Ensure the Mow switch is OFF when testing a front wheel motor - ON when testing the rear wheel motor

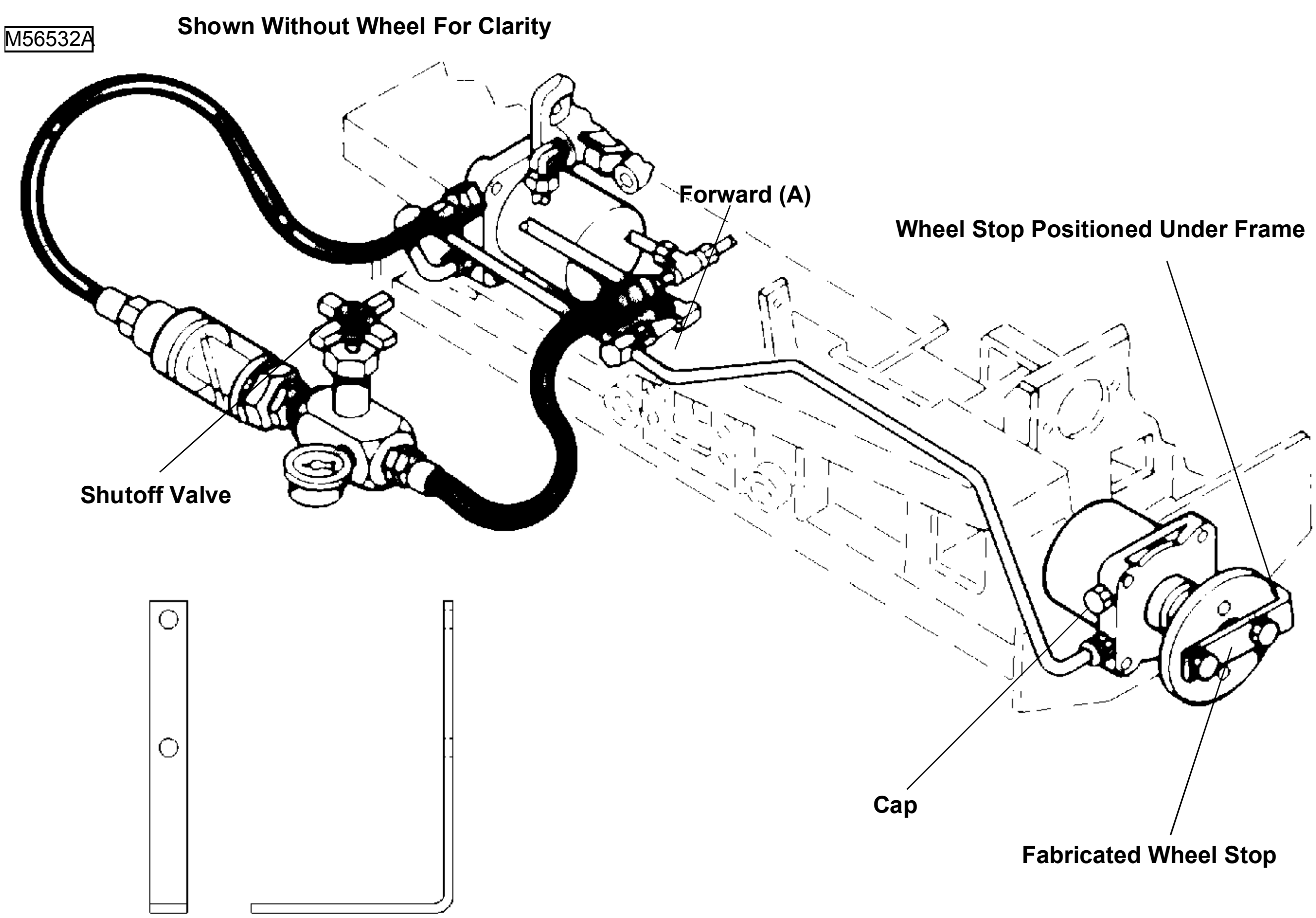
NOTE: Install the wheel stop on the front wheel not being tested as shown.





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.



REPAIR

HYDROSTATIC PUMP REMOVAL

1. Park vehicle on a level surface and block wheels to prevent inadvertent movement of the machine.
2. Move Mow/Transport lever to TRANSPORT position.
3. Lower cutting units to the ground.
4. Turn key switch OFF.
5. Engage park brake.
6. Disconnect battery negative (-) cable.

CAUTION

- **Raise machine safely and support it with suitable jack stands.**
- **Never work on machine while supported only on mechanical or hydraulic jack**

7. Lift and support machine with jack stands.

CAUTION

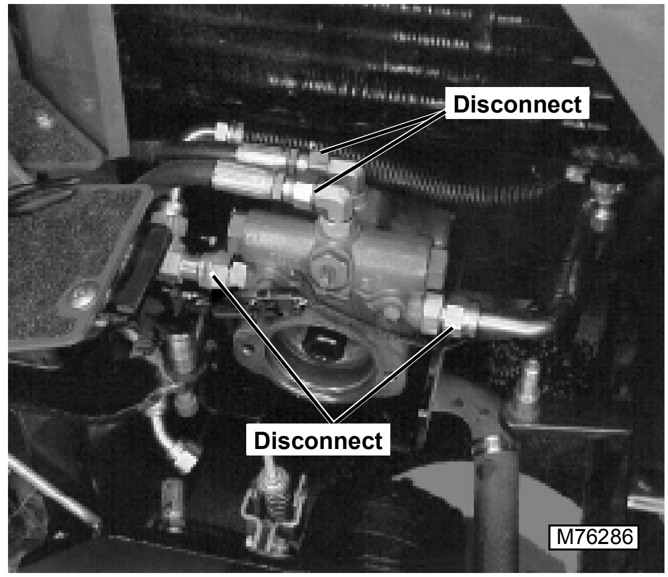
Lower cutting units to the ground prior to removing any hydraulic lines or fittings

8. Remove hood.
9. Remove Plenum.
10. Remove right hand wheel.

CAUTION

To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.

11. Place a 10 gallon container below the Hydraulic sump and drain oil.
12. Remove double pump assembly.
13. Clean port areas of the Hydrostatic pump with a suitable solvent.
14. Place drip pan under double pump to catch oil that will leak out when lines are disconnected.

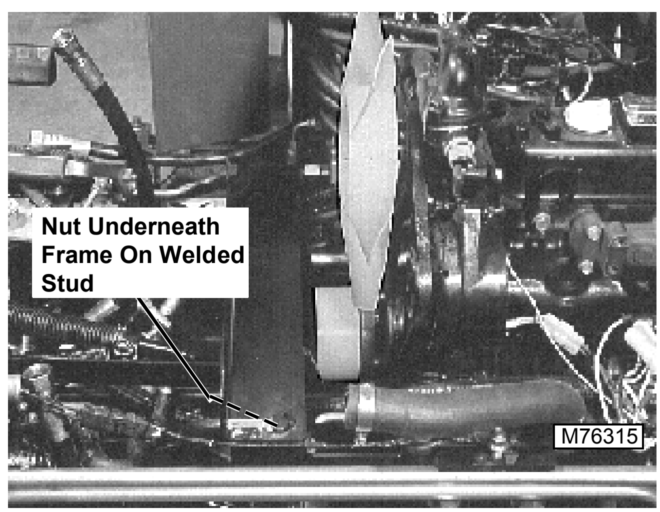


15. Mark for reinstallation and disconnect all hydraulic lines connected to the Hydrostatic pump.

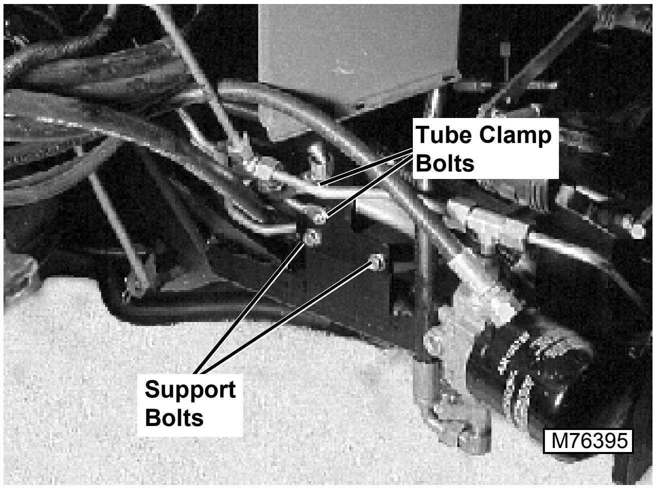
CAUTION

Explosive release of fluids from pressurized cooling system can cause serious burns. Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap.

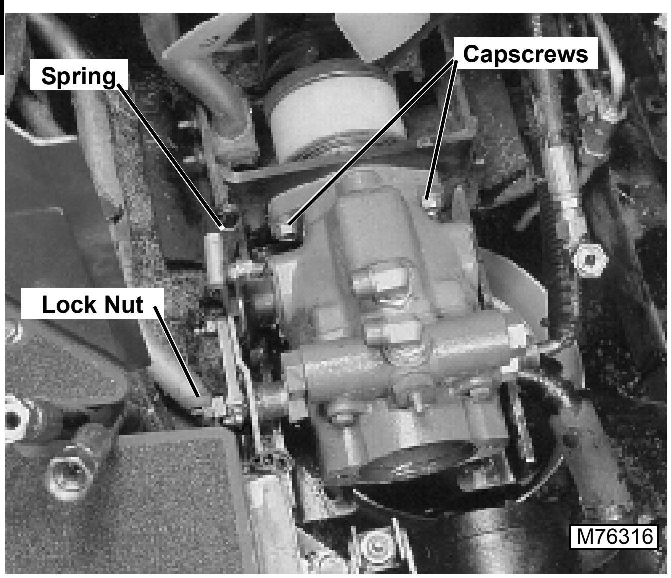
16. Remove Radiator.



17. Remove nut from welded stud on underside of radiator support crossmember.



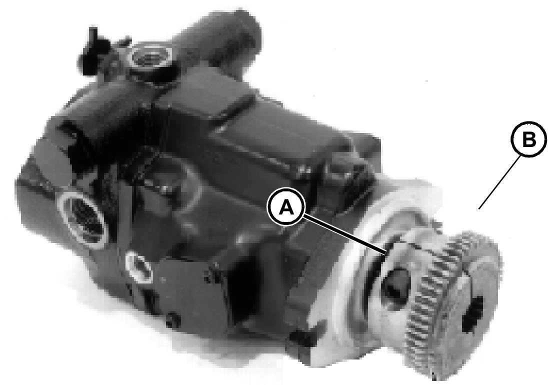
18. Remove two flange head bolts securing tube clamp to frame.
19. Remove two flange head bolts retaining lower end of radiator support to frame.
20. Remove radiator support crossmember.



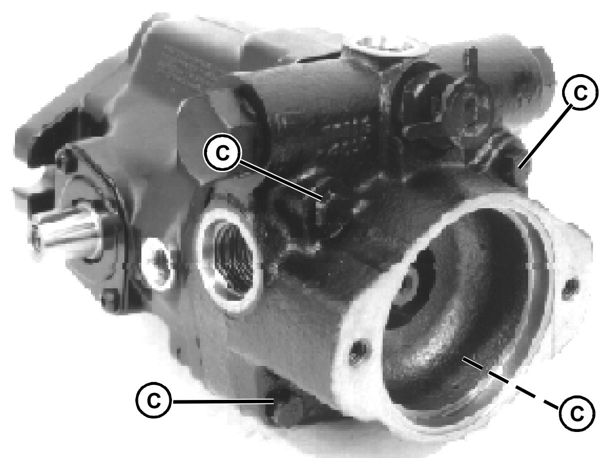
21. Unhook spring from frame hook.
22. Remove neutral mechanism eccentric and spring arm assembly by removing Lock Nut.
23. Remove two flange head Capscrews and nuts securing the Hydraulic pump unit to the Engine subframe.
24. Remove Hydro Pump.

HYDROSTATIC PUMP DISASSEMBLY

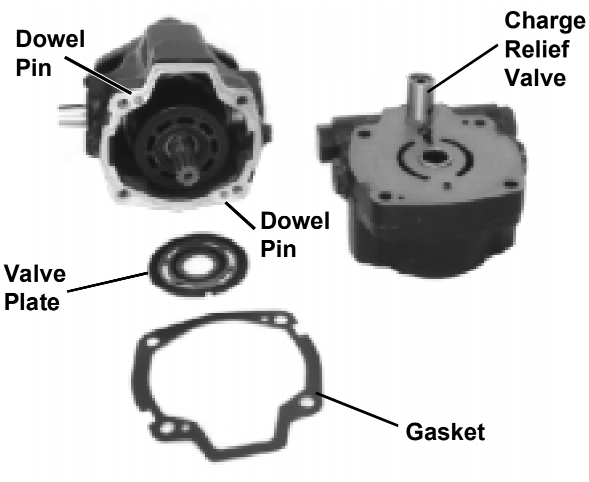
IMPORTANT: Plug all ports and thoroughly clean the outside of the pump. Remove plugs and drain oil.



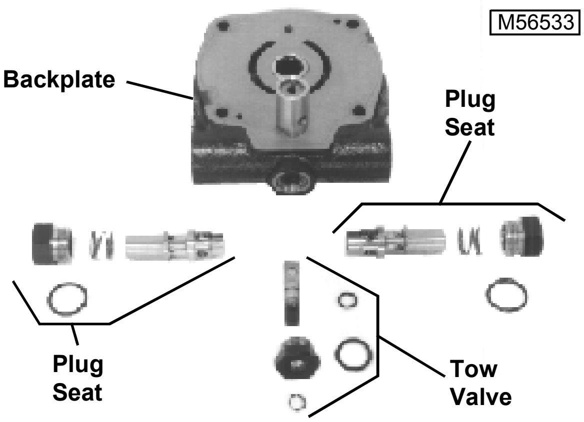
1. Loosen socket head cap screw (A) and remove driven coupler (B).



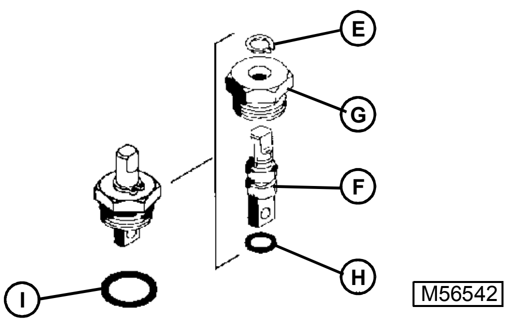
2. Remove four cap screws (C) from the backplate.
3. Use screwdriver slots in housing to pry up on the backplate or tap with a plastic mallet to loosen, then pull the backplate straight up to remove.



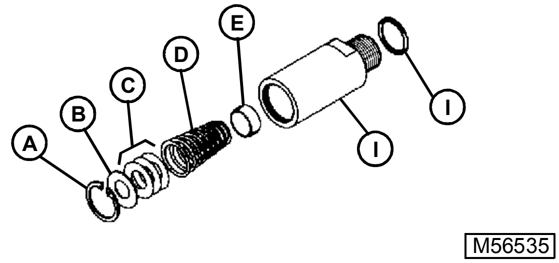
4. Remove gasket and valve plate.
5. Inspect dowel pins for wear or damage. Replace if necessary.
6. Remove charge relief valve.



7. Remove plug, spring and plug seats from backplate.
8. Remove Tow Valve from backplate.



9. Disassemble tow valve by removing the retaining ring (E) and pulling the spreader (F) from the spreader plug (G) taking care not to damage O-rings (H) and (I).

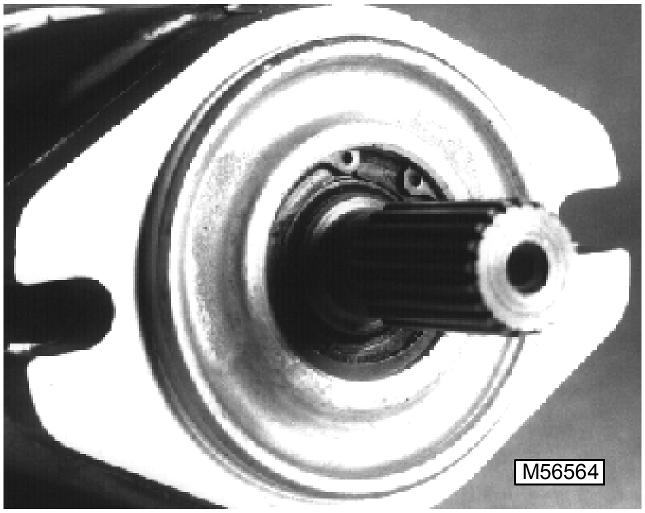


10. Disassemble charge relief valve by removing retaining ring (A), washer (B), shim(s) (C), conical spring (D) and plunger (E). Make note of the number of shims removed for reassembly. Inspect parts for wear or damage. Replace if necessary.

IMPORTANT: Try to keep the pistons and piston block together as an assembly when removing the rotating assembly.

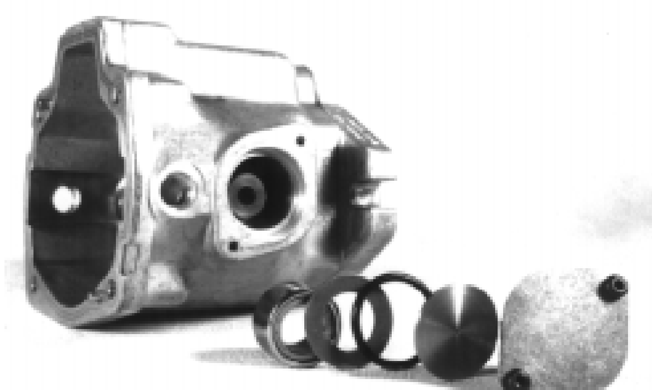
11. Hold your hand over the rotating assembly and turn the housing upside down. Remove the rotating assembly and any pistons that did not come out with the assembly.

12. Remove retaining ring and press the shaft, with seal and washer, from the housing.


M56564

NOTE: Bearing is press fit in housing. Remove bearing only if replacement is necessary.

13. Inspect bearing for wear or damage. If necessary remove bearing using a blind-hole puller.
14. Remove trunnion covers, O-rings and bearing races as shown.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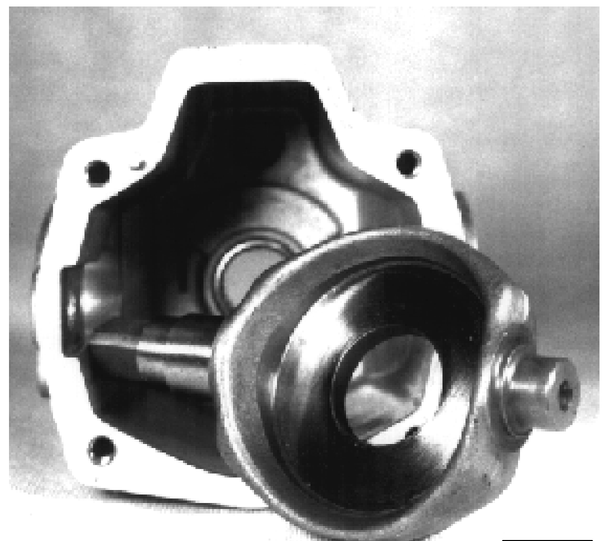
M56565

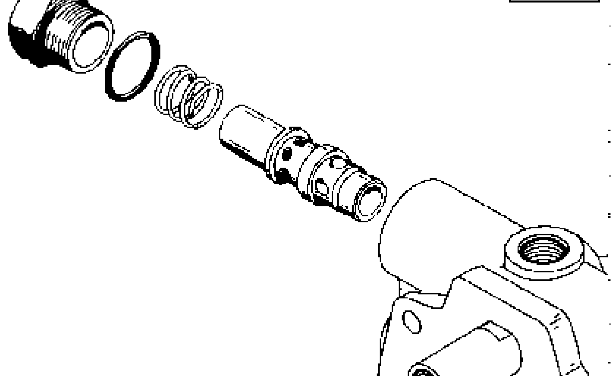
15. Remove cam plate.


M56561

16. Remove cam plate.

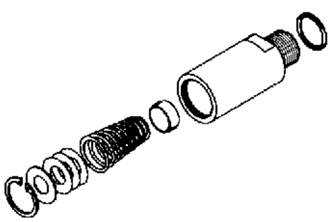
HYDROSTATIC PUMP INSPECTION

IMPORTANT: Keep work area clean and use lint-free cloth and mineral spirits to clean parts for inspection



M56533

17. Inspect the plug seats and springs for condition and wear, replace if necessary.



M56535

18. Inspect the charge pump relief valve spring, cup and seat for wear, replace the entire relief valve if worn.

M56557

19. Inspect the needle bearings in the housing assembly, making sure the bearings remain in the bearing cage. Inspect the complete shaft and thrust washers for wear, replace if necessary.
20. Inspect the polished surfaces of the camplate for scoring, galling or fretting, replace if necessary.

M56555

M56558

21. Inspect the piston block surface and the camplate for scoring or wear, replace if necessary.

M56554

22. Examine the outside diameter of the pistons for finish condition. They should not show wear or deep scratches. Inspect the shoes for a snug fit on the ball end of the pistons and a flat smooth surface that comes in contact with the camplate. DO NOT LAP PISTON SHOES.

NOTE: Disassembling the piston block assembly is not required unless the pins are damaged.

CAUTION

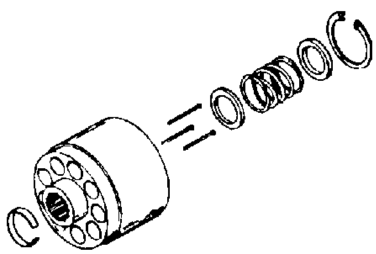
The spring inside the piston block is compressed and should not be removed without compressing the spring first, use the following procedure to remove the spring safely.

The following parts will be needed to disassemble the piston block.

2 ea. . . . . 5/16” I.D. X 15/16” O.D. Flat washers

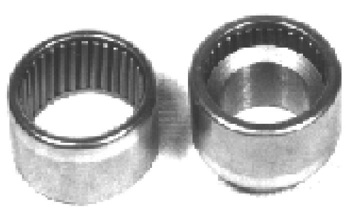
1 ea. . . . . 5/16” x 2—7/8” N.C. cap screw

1 ea. . . . . 5/16” N.C. nut



M56625

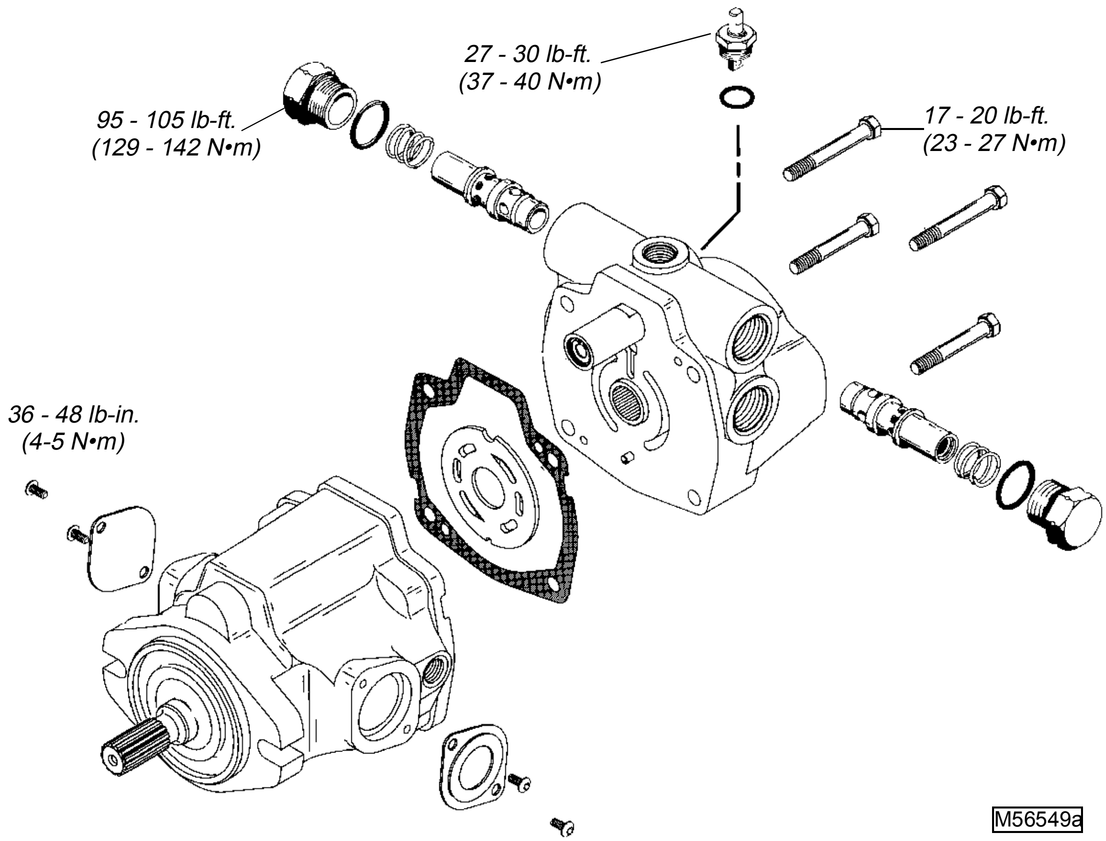
23. Place one of the flat washers over the 5/16 x 2—7/8” cap screw and place this through the center of the piston block.
24. Place the other washer over the cap screw and let it rest on the three pins.
25. Screw the nut on and compress the spring inside the piston block.
26. Using retaining ring pliers, remove the internal retaining ring.
27. Remove the nut, washer and cap screw.



M56556

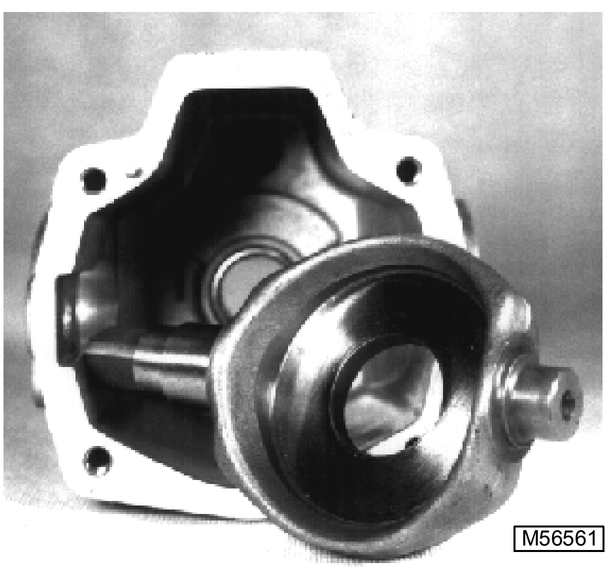
28. Inspect the needle bearings and sleeve of the camplate trunnion bearings for wear or galling, keeping the needle bearings in the cage.

HYDROSTATIC PUMP ASSEMBLY



M56549a

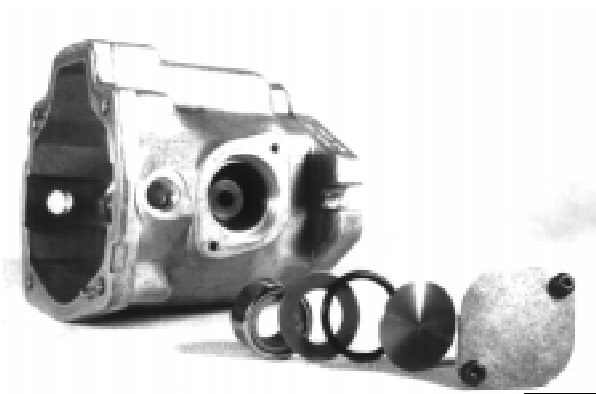
IMPORTANT: Ensure work area is clean, ensure all parts are clean and free of lint. Use plenty of clean hydraulic fluid when assembling the pump.


M56561

1. Place camplate in housing, long end first.

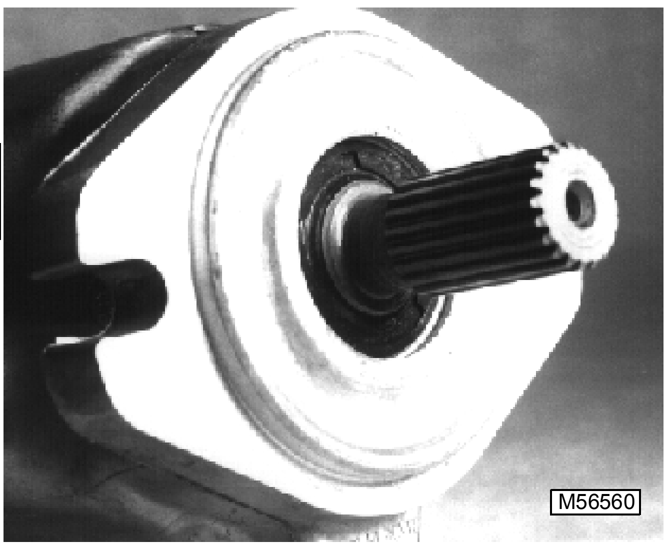

M56565

2. Assemble parts in order shown, use plenty of hydraulic fluid to lubricate bearings and to aide in seal installation.



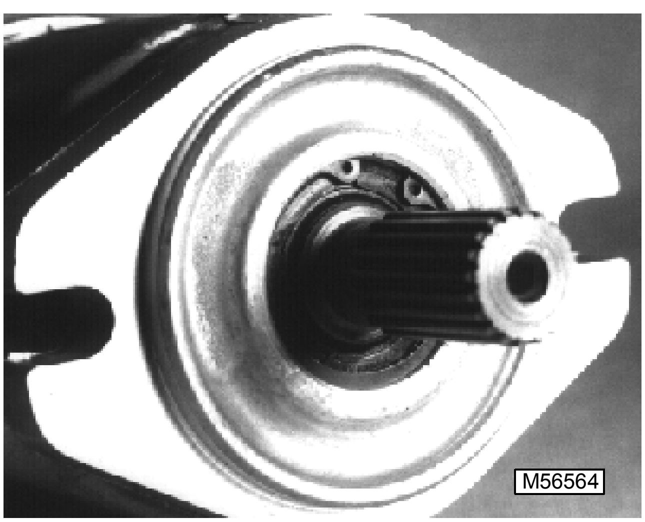
M56562

3. Assemble parts in order shown, use plenty of hydraulic fluid to lubricate bearings and O-ring. Ensure camplate has full travel and moves freely.



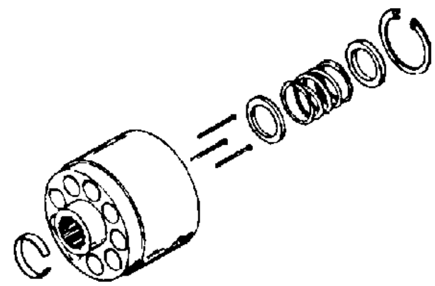
M56560

4. Install shaft and shaft seal, use hydraulic fluid liberally to avoid damaging the seal during installation. Ensure seal is positioned below the retaining ring groove.



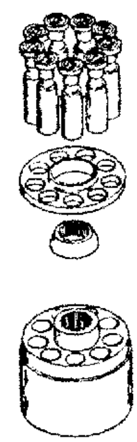
M56564

5. Install retaining ring with sharp edge of ring facing the outside of the case. The sharp edge can be felt with your finger.



M56625

6. If the piston block assembly was disassembled, complete the following.
7. Compress the pin keeper and install in the spline of the piston block.
8. Install the three pins with the head end to the inside of the block and install in the special grooves of the piston block spline.
9. Install the washer, spring and second washer in the piston block.
10. Compress the spring with the cap screw and washer tool used to compress the spring during disassembly.
11. Install the retaining ring. Ensure the sharp edge of the retaining ring faces away from the spring.

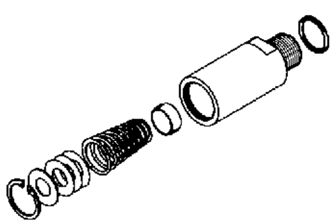


M56559

12. Assemble the rotating assembly as shown.

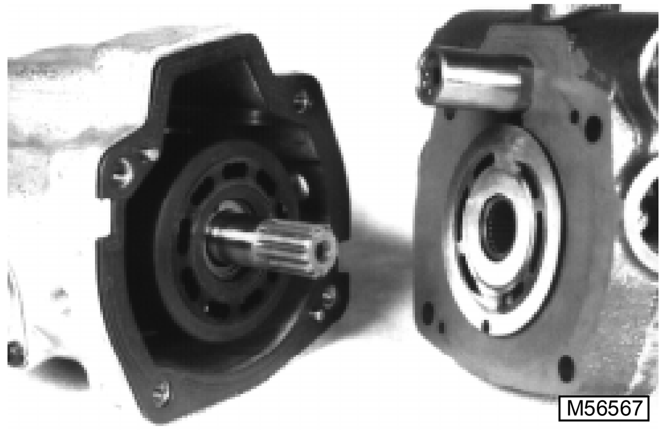
M56566

13. Hold the housing upside down and install the rotating assembly, make sure the rotating assembly is seated against the camplate.



M56535

14. Assemble charge relief valve as shown, use the same number and thickness of shims as removed.

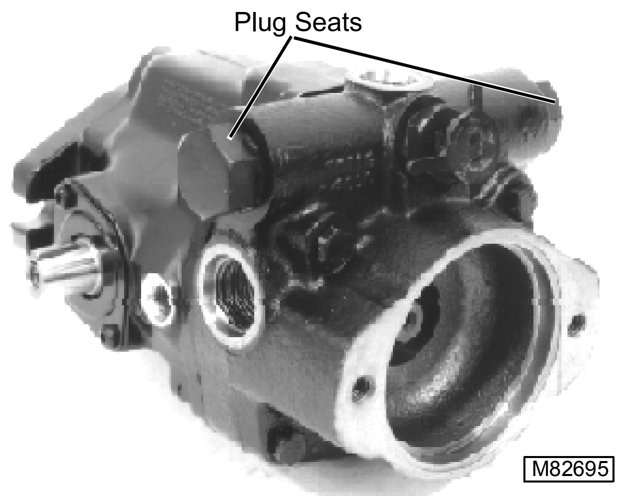


M56567

15. Install charge relief valve, gasket and valve plate. Torque to **38 N•m (29 lb-ft.)**.

IMPORTANT: Do Not use the bolts to force the parts to mate when assembling backplate to housing. 10 - 15 lb-ft. of force should be all that is necessary for assembly.

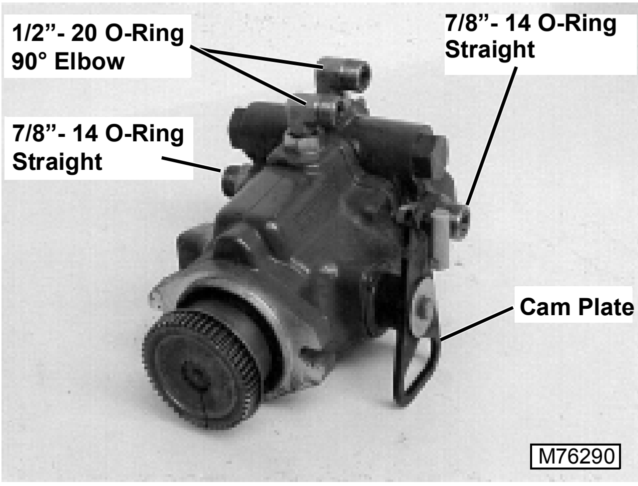
16. Assemble the backplate and housing, secure with four bolts, torque to **25 N•m (19 lb-ft.)**.
17. Install tow valve, torque to **33 N•m(28 lb-ft.)**.



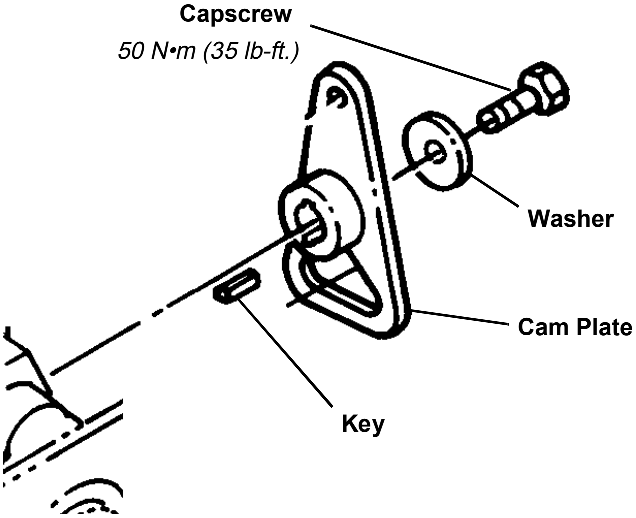
M82695

18. Install plug seats, torque to **135 N•m (100 lb-ft.)**.

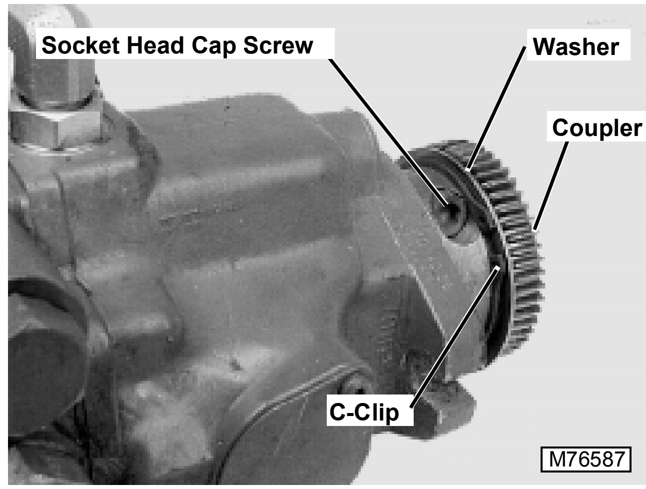
HYDROSTATIC PUMP INSTALLATION



1. Install fittings in Hydrostatic Pump if previously removed.

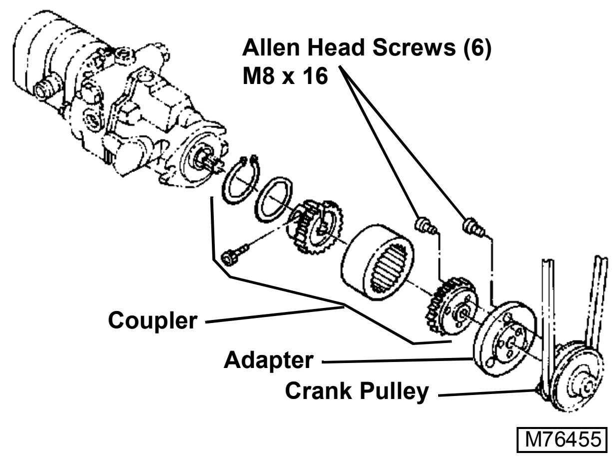


2. Install Cam plate on end of pintle shaft. Torque Capscrew to **50 N•m (35 lb-ft).**
3. Inspect Nylon coupler for wear or damage to internal teeth. Replace if damaged.

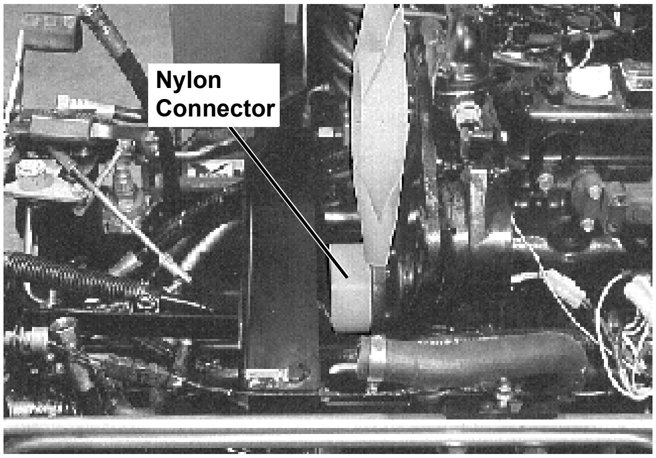


NOTE: Do not tighten socket head capscrew at this time.

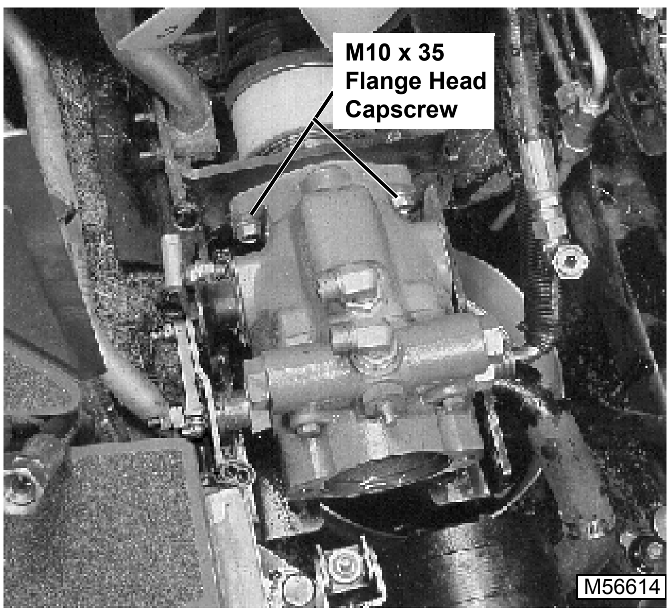
4. Install Coupler on to end of Hydro input shaft insuring that washer is in place by large C-clip.



NOTE: The hydraulic coupler transfers power from the engine to the Hydrostatic pump assembly (See Engine Section).

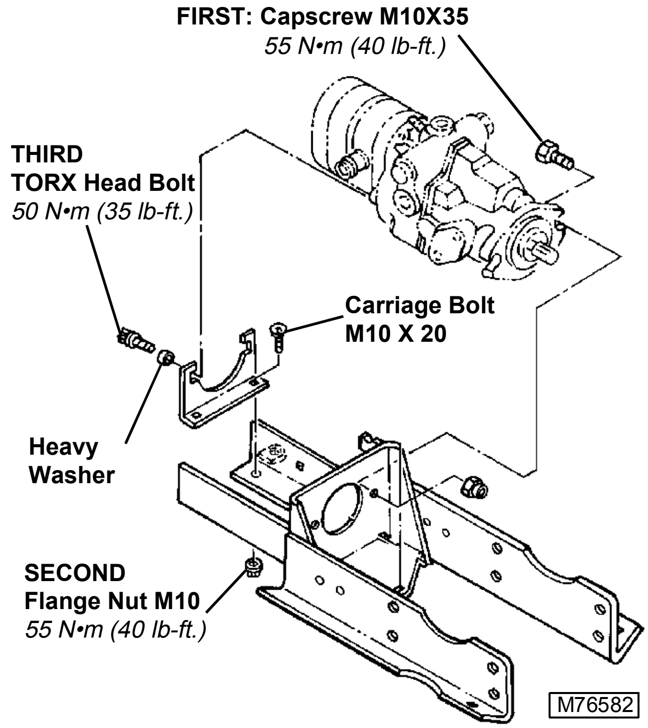


5. Place Nylon connector on coupler on engine. Insure that Socket Head Capscrew on pump half of connector is loose and connector is free to move on pump shaft.



IMPORTANT: DO NOT torque any pump mounting hardware until all components - hydrostatic pump, double pump, and support bracket - are in place. Torque fasteners only in order specified in the following instructions.

6. Slide the hydro pump into position to connect the drive shaft coupler. Secure Hydro pump to vehicle frame with two (2) M10 x 35 flange head cap screws and flange lock nuts. Finger tighten only at this time.
7. Install double pump and support.



8. After all components are in place torque fasteners to the following specifications in the following order:

First:

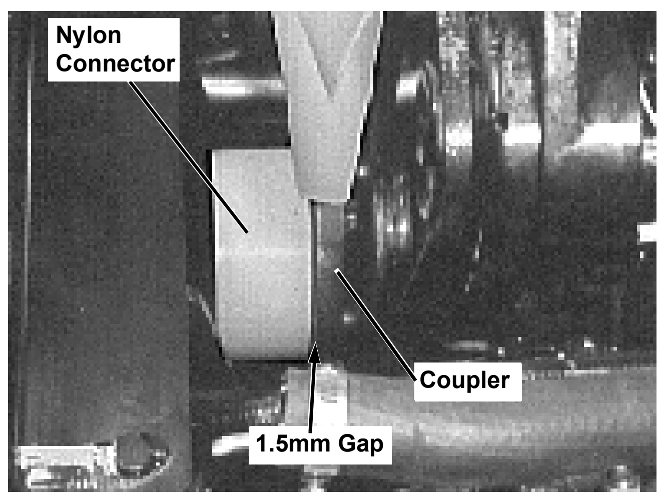
Hydrostatic pump to subframe . . . 55 N•m (40 lb-ft).

Second:

Support bracket to frame . . . . 55 N•m (40 lb-ft)

Third:

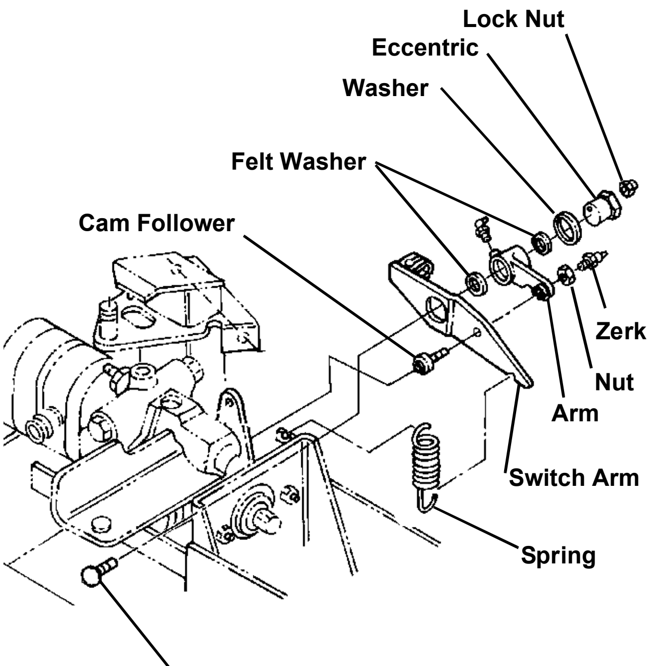
Double pump mounting bolts . . . . 50 N•m (35 lb-ft).



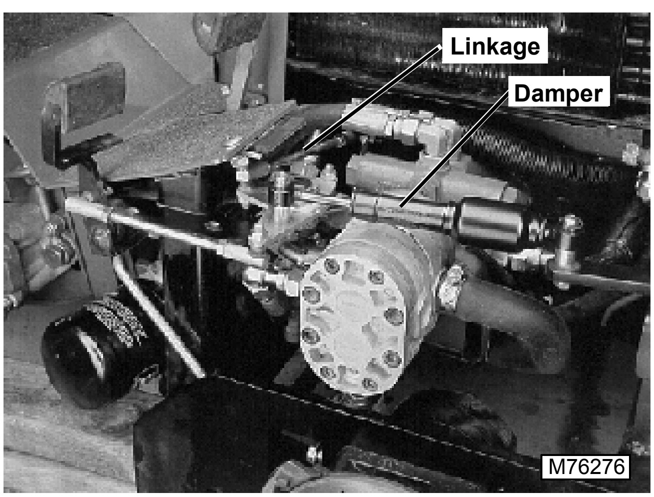
9. Adjust nylon connector by shifting pump coupler section until there is **1.5 mm (0.062 in.)** gap between coupler and nylon connector.

NOTE: Nylon connector must be free to move on coupler. If Nylon connector binds and can not be shifted by hand realign pumps and/or engine.

10. Tighten socket head capscrew on pump half of connector to **61 N•m (45 lb-ft.)**.



11. Assemble eccentric mechanism and install with carriage bolt to subframe.
12. Connect linkage at the hydrostatic transmission.
13. Install cam lever linkage.



14. Install linkage, damper and connect all hydraulic lines to the double pump assembly.
15. Install radiator. Fill with coolant.
16. Install drain plug in Hydraulic reservoir and fill to specification with hydraulic fluid.

CAUTION

Because Transmission mechanism has been disturbed vehicle may move when engine is started if wheels are on ground. Neutral adjustment must be performed before unit is lowered to ground.

17. Connect battery.

IMPORTANT: Always run START-UP PROCEDURE on page 37 after working on hydraulic components.

18. Perform Transmission Neutral Adjustment. (See "TRANSMISSION NEUTRAL ADJUSTMENT" on page 19 this section)
19. Replace wheel.
20. Replace hood.
21. Remove blocking and lower vehicle to ground.

REPAIR - TORQMOTOR™

TORQMOTOR™ REMOVAL

1. Park vehicle on a level surface.
2. Operate lift control and allow cutting units to settle on ground.
3. Disconnect battery.

Place a 10 gallon container below the Hydraulic sump and drain oil.

CAUTION

- **Raise machine safely and support it with suitable jack stands.**
- **Never work on machine while supported only on mechanical or hydraulic jack**

4. Lift and support machine with jack stands.
5. Remove wheel.

CAUTION

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

6. Disconnect and remove brake calliper.
7. Remove Brake Disk

CAUTION

To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.

8. Disconnect Hydraulic lines to Motor.
9. Remove four capscrews securing motor to frame.
10. Remove Motor.

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 (0.005 in) of clearance, replace Torqmotor™
6. Inspect the wear plate 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 (0.020 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™.

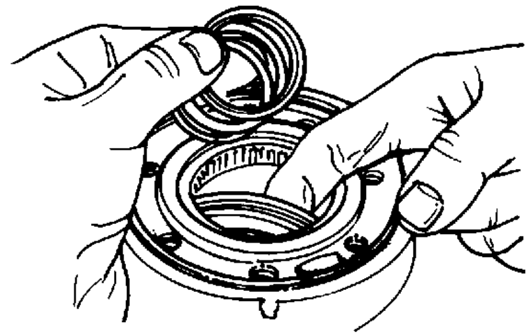
TORQMOTOR™ ASSEMBLY

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

NOTE: Apply masking tape to the threaded portion of the shaft to prevent damage to seal.

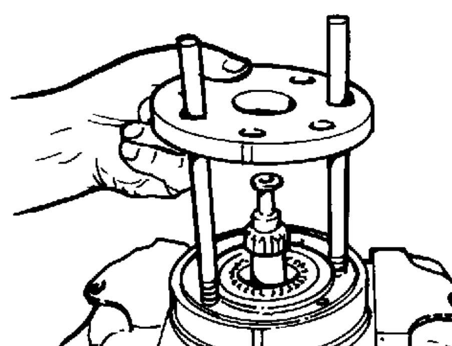


M72906

3. 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 0.500 in longer than the bolts used on the Torqmotor™.

6. Install drive link (long splined end down and previously marked when disassembled) to engage the coupling shaft splines.

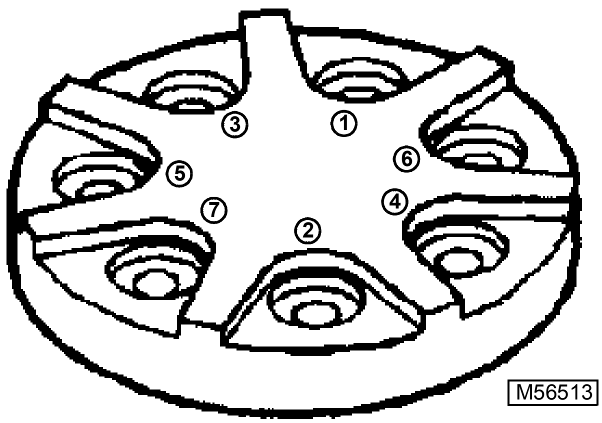


M72905

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.)**.

TORQMOTOR™ 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™.

IMPORTANT: Always run START-UP PROCEDURE on page 37 after working on hydraulic components.

START-UP PROCEDURE

IMPORTANT: Follow this procedure to properly purge the Hydrostatic pump before returning the machine to service.

1. Ensure hydraulic reservoir is full.
2. Shut off fuel to the engine and crank engine for 15 seconds.
3. Return fuel supply to the engine. With transmission in neutral, start engine and run at low idle.
4. Operate steering and lift system through several cycles. Slowly operate the machine in forward and reverse to purge the air from the system.
5. Check and replenish the reservoir.
6. Check all connections for leaks and tighten if necessary.

Short hour filter changes are recommended for the first two changes after returning the machine back to service. Change the first filter after 3—5 hours of operation and the second after 50 hours.

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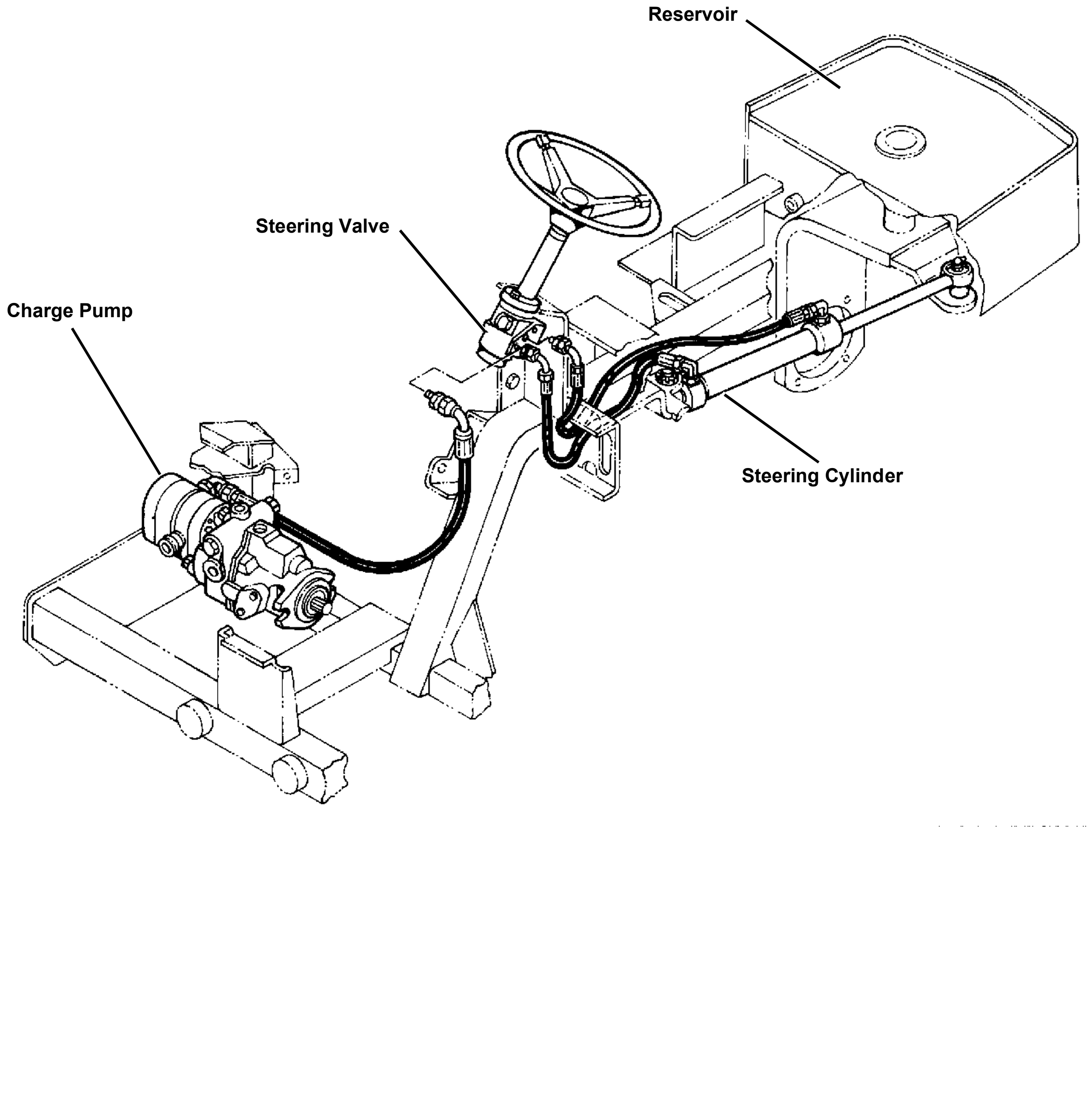
NOTES

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 (4.25 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

COMPONENT LOCATION



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		●	●				●	

THEORY OF OPERATION

Function:

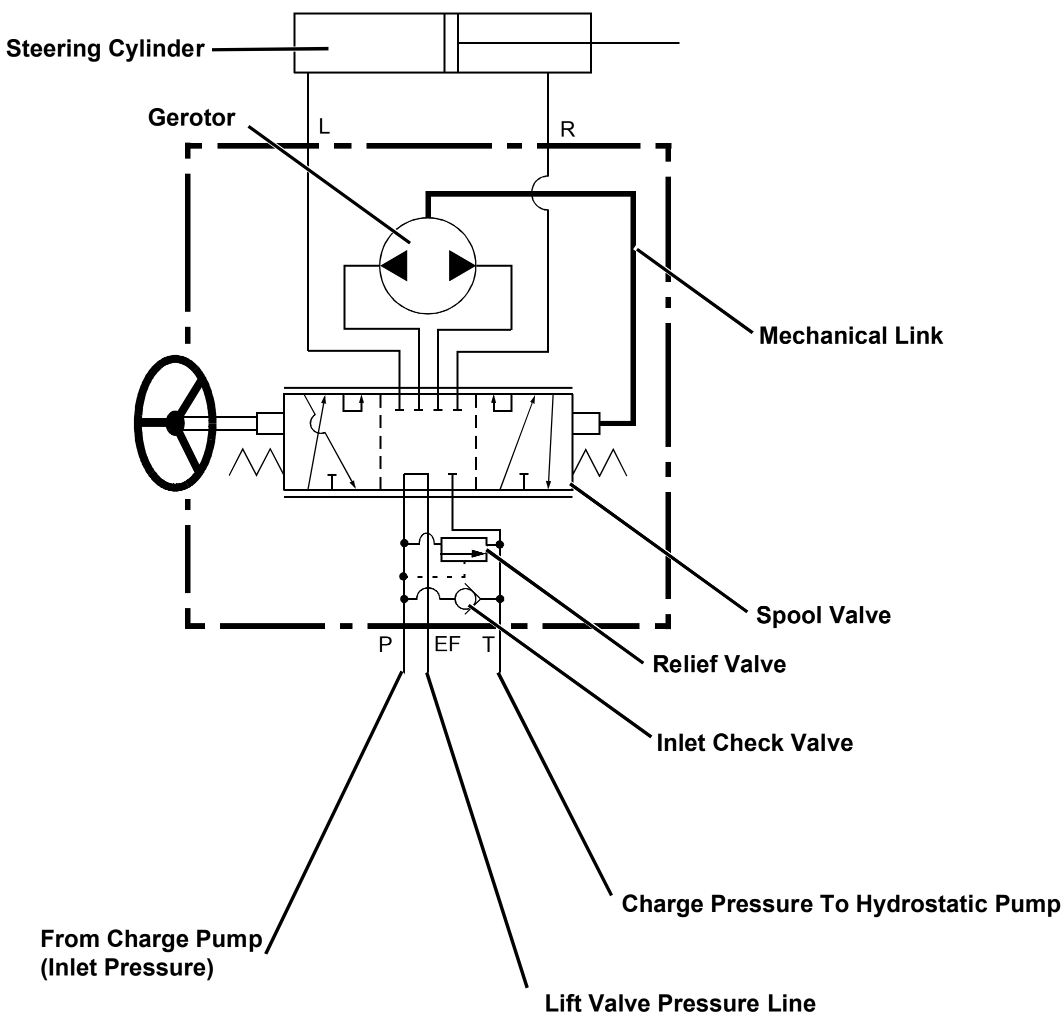
Controls oil flow to and from the steering cylinder for hydraulic or manual steering.

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 7Bar (100 psi) on the low pressure side of the circuit to supercharge the variable displacement pump (Hydrostatic pump).
- Maintains a pressure of 4.25 Bar (50-900 psi) at 1.7 -5.7 LPM (0.4-1.5 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.



TESTS AND ADJUSTMENTS

SYSTEM LEAKAGE TEST

Reason:

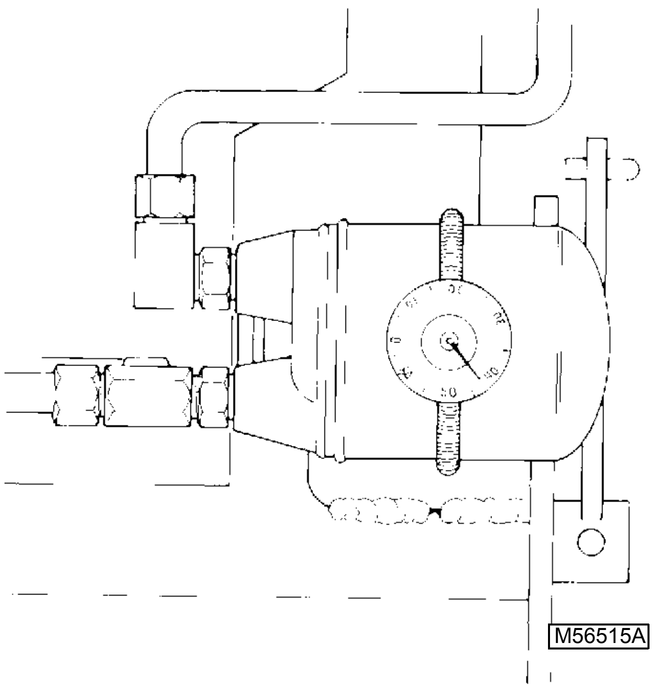
To determine if steering system has excessive internal leakage.

Equipment:

- Torque Wrench

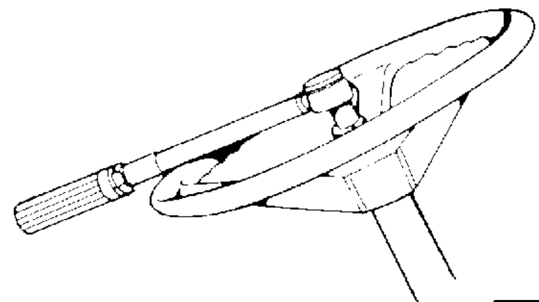
Procedure:

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



M56515A

1. Place thermometer on oil filter and fun system until oil temperature reaches 43° C (110F°).
2. Start engine and set throttle to slow idle.



M46864A

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 3 with the steering wheel at a maximum left turn position.

Results:

- If rpm/min exceeds 6, perform the steering valve leakage test.

STEERING VALVE LEAKAGE TEST

Reason:

To determine if leakage is in steering valve or in steering cylinder.

Equipment:

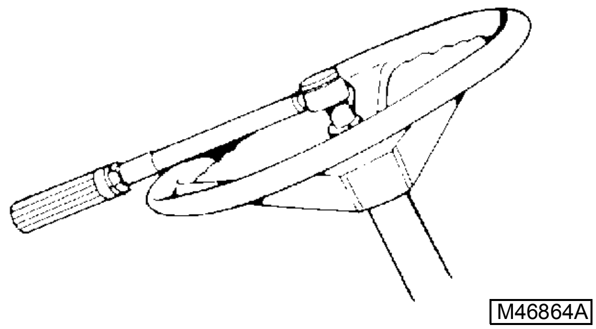
- Torque Wrench
- Plugs to cap the lines at the steering cylinder.

Procedure

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 3 with the steering wheel at a maximum left turn position.

Results:

- If rpm/min. exceeds 6, repair the steering valve.
- If rpm/min. is less than 6, replace the steering cylinder.

STEERING SYSTEM RELIEF VALVE PRESSURE TEST

Reason:

To determine if the charge pump is producing enough pressure to operate lift system

Tools:

- JTO7047 Gauge w/Quick Coupler, 0- 40,000 kPa (0-6000 psi).
- RE48122 Female Quick Coupler
- AMT846 Hose
- RE43774 Male Quick Coupler X 11/16-16 F ORFS
- AMT1043 T-Fitting, 9/16-16 F ORFS X 9/16-16 M ORFS X 9/16-16 M ORFS

Procedure:

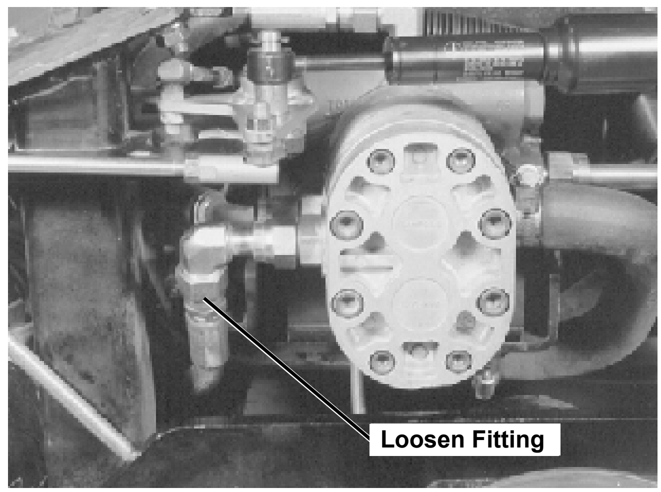
Test is performed by reading system pressure between rear section of double pump (charge pump) and steering valve.

1. Park machine on level surface, lock park brake, lower cutting units to ground, engine off.
2. Assemble AMT846 Hose, re48122 Female Quick Coupler and JTO7047 Gauge. Connect to test fitting

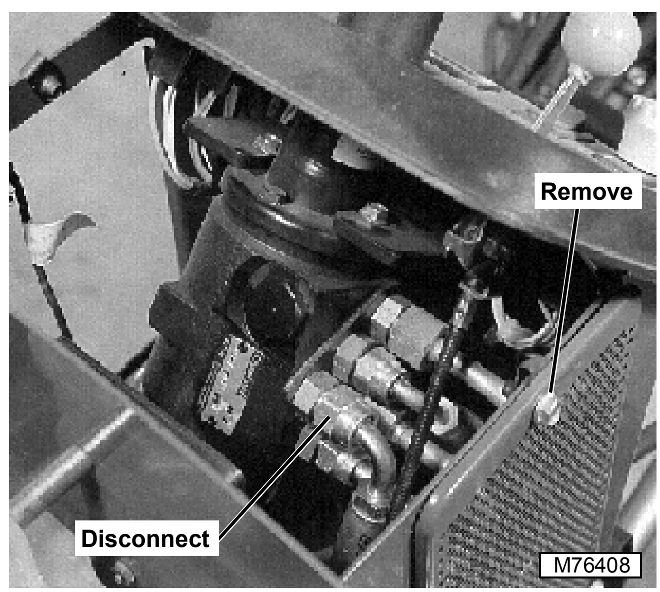
CAUTION

To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.

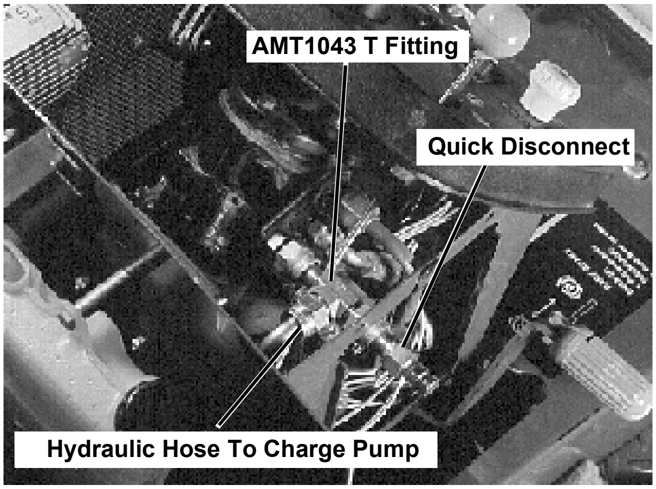
3. Loosen hose fitting, at charge pump outlet, to allow hose to rotate.



4. Remove screw securing screen to side of steering housing. Remove screen.
5. Disconnect hose fitting on forward port as shown.



6. Install AMT1043 T-Fitting and RE43774 Disconnect Fitting.
7. Connect charge pump hose to AMT1043 T-Fitting.



8. Install JTO3345 0-20,000 kPa (0-3000 psi) test pressure gauge to the test fitting.
9. Assemble AMT846 Hose, RE48122 Female Quick Coupler and JTO7047 Gauge. Connect to test fitting

> **⚠ CAUTION**
>
> **DO NOT USE A TEST PRESSURE GAUGE RATED LOWER THAN RECOMMEND. DO NOT MOVE STEERING WHEEL OR LIFT LEVERS WHILE TEST IS IN PROGRESS**

10. Apply and lock parking brake.
11. Set raise/lower lever to lower position.

IMPORTANT: DO NOT turn steering wheel or operate lift system while performing this test. Doing so will result in readings above the pressure setting because of system backpressure.

12. Start engine and run at full throttle.
13. Note reading on gauge.

Specifications:

- Observe pressure gauge. Pressure should indicate 2930.27 kPa (900 psi).

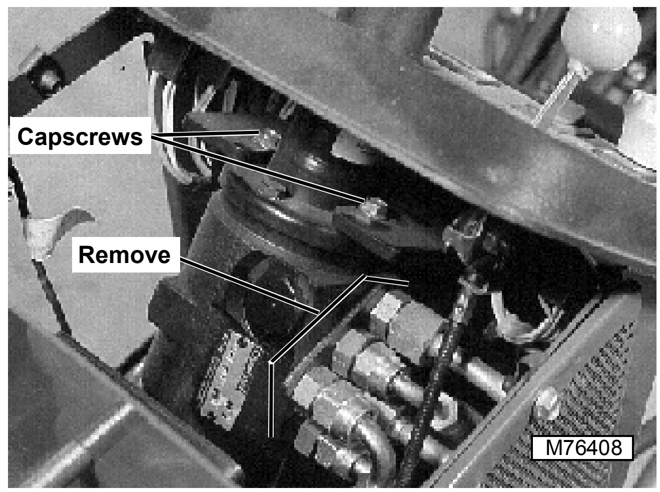
Corrections:

- If charge pump does not meet specifications, rebuild or replace charge pump

REPAIR - STEERING CONTROL UNIT (SCU)

REMOVAL

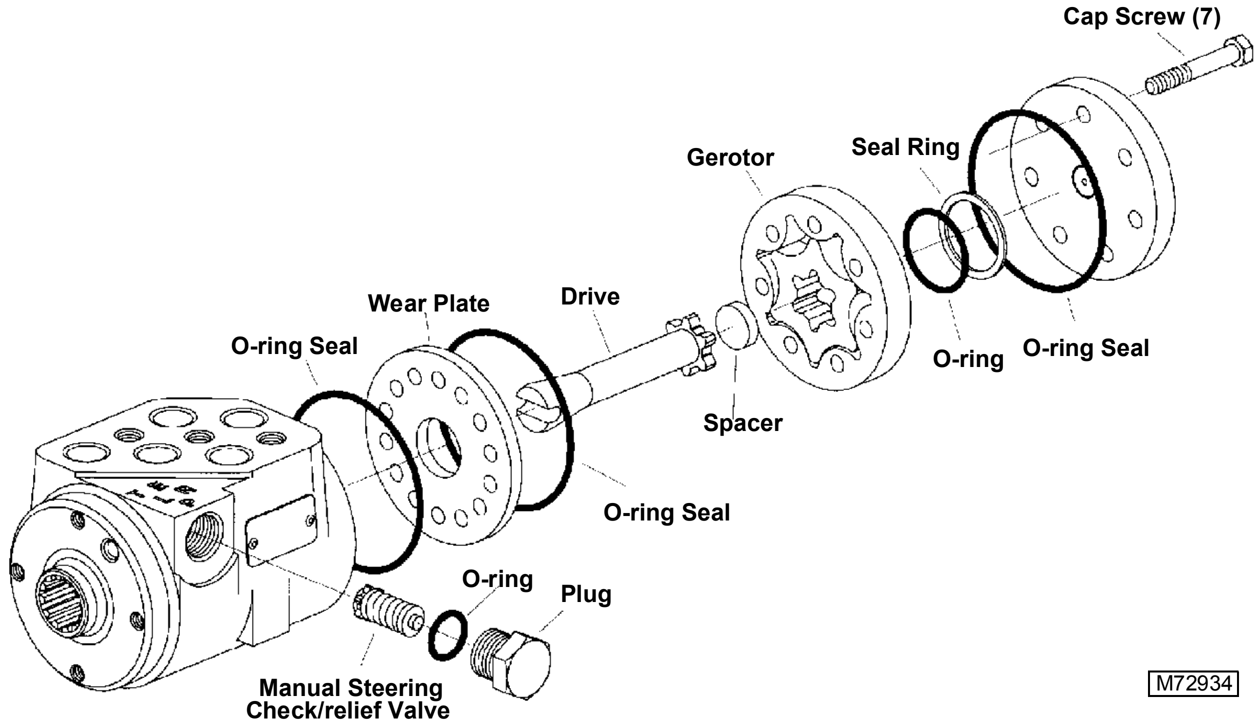
1. Park vehicle on a level surface.
2. Move Mow/Transport lever to TRANSPORT position.
3. Lower cutting units to the ground.
4. Turn key switch OFF.
5. Engage park brake.
6. Disconnect battery negative (-) cable.
7. Chock front wheels to prevent inadvertent movement of vehicle.
8. Raise hood and secure in the upright position.



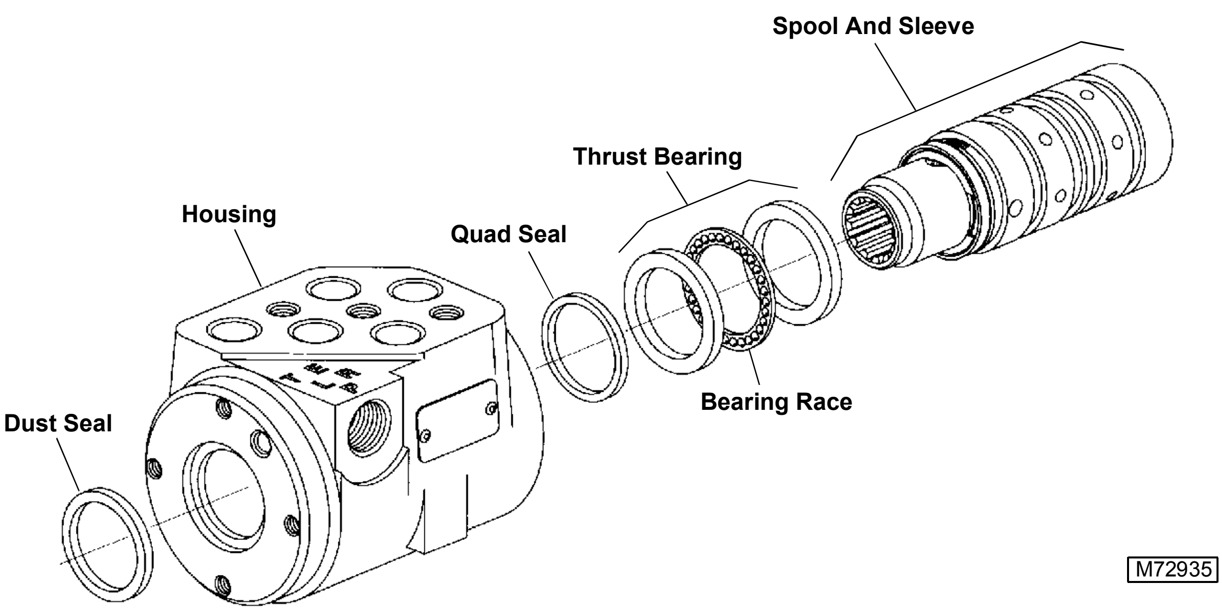
9. Remove Hydraulic connections from side of SCU.
10. Remove steering wheel
11. Remove two capscrews securing SCU to vehicle frame.
12. Remove SCU.

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.

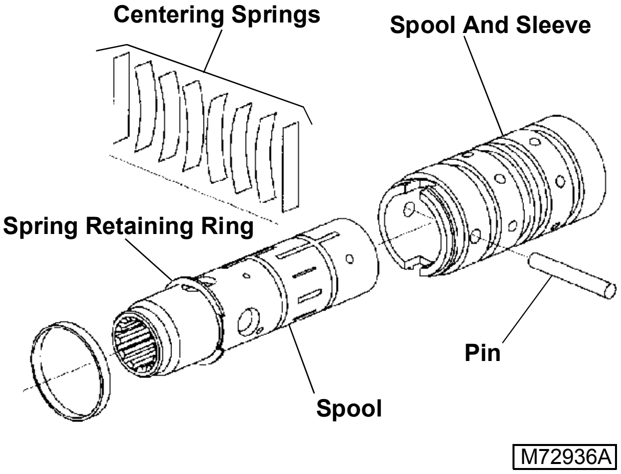


1. Remove the 7 cap screws and disassemble the SCU as shown.
2. Slide the spool and sleeve from the housing. Remove the thrust bearing and bearing races.
3. Remove the quad seal.



IMPORTANT: Do Not damage the dust seal seat.

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



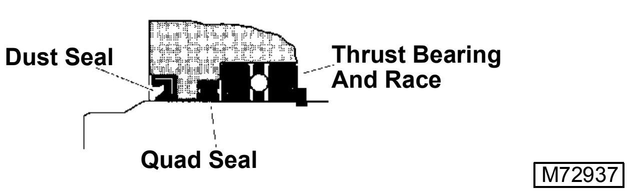
5. Carefully slide the spool out of the sleeve. The springs and retaining ring will stay with the spool when it is removed.
6. Remove the retaining ring and springs.

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

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.

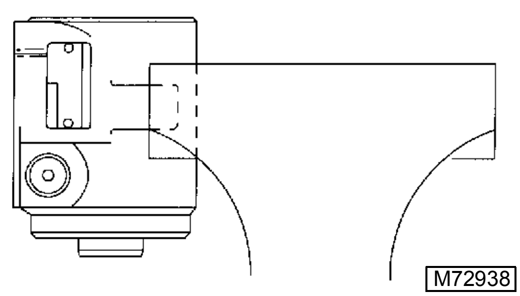
NOTE: Always use new seals when reassembling the hydraulic steering control unit. During reassembly, lubricate the new seals with a petroleum jelly. Also lubricate the machined surfaces and bearings with clean hydraulic fluid.



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.

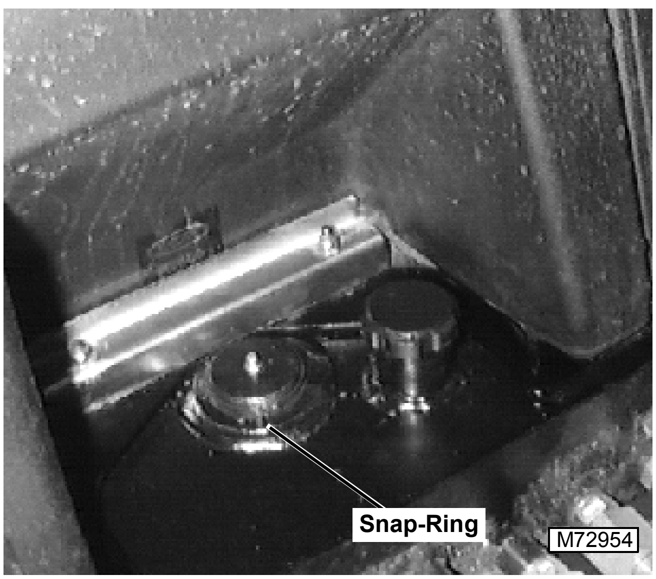
NOTE: The holes in the wear plate are symmetrical.

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 **17 N•m (150 lb-in.)**.

REPAIR - STEERING CLEVIS

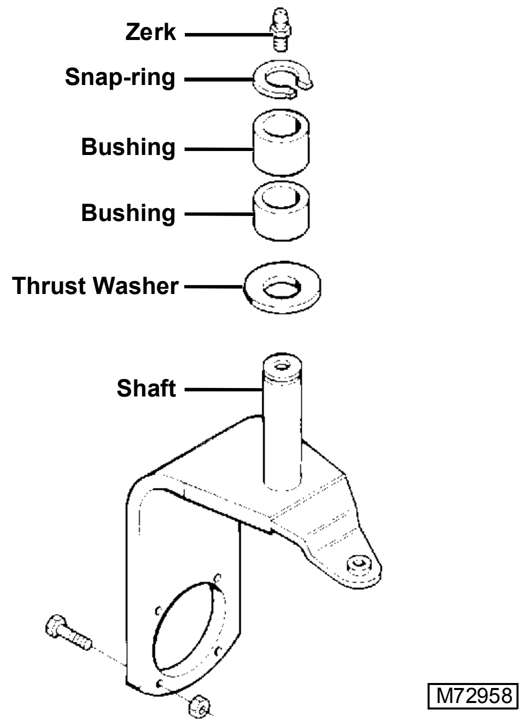
REMOVAL

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, if equipped.



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.

INSTALLATION



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.

TORQMOTOR™ REPAIR

The drive motor on the rear wheel is identical to the front wheel drive motors. See REPAIR - TORQMOTOR™ on page 34 Section 6 HYDROSTATIC POWER TRAIN.

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SPECIFICATIONS

GENERAL

Type . . . . Mechanical
Rotor Dia. (Nominal) . . . . 203.84 mm (8.025 in.)
Rotor Thickness (New). . . . . 4.77 mm (0.188 in.)
Rotor Minimum Thickness . . . . 3.6 mm (0.140 in.)
Rotor Run Out . . . . 0.63 mm (0.025 in.)
Pad Thickness, Usable . . . . 3.43 mm (0.135 in.)

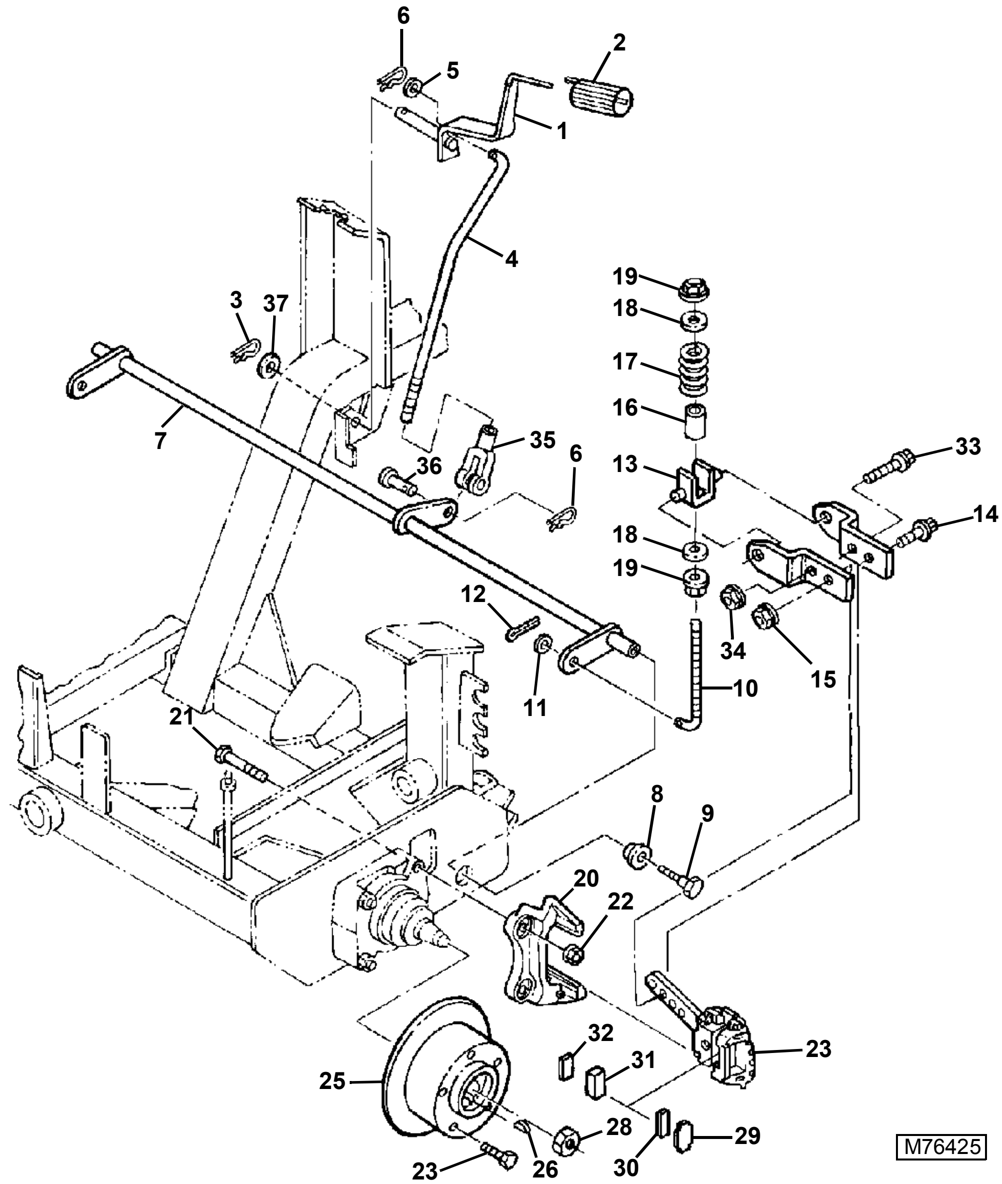
SERVICE PARTS KITS

Brake Pads. . . . . AMT 442

TORQUE SPECIFICATIONS

Wheel Motor Bolt Torque . . . . 725 N•m (540 lb-ft.)

COMPONENT LOCATION



1. Lever
2. Grip
3. Hairpin Clip
4. Rod
5. Washer
6. Hairpin Clip
7. Shaft
8. Bushing
9. Shoulder Bolt
10. Rod
11. Washer
12. Cotter Pin
13. Clevis
14. Bolt
15. Nut
16. Spacer
17. Spring
18. Washer
19. Locknut
20. Bracket
21. Bolt
22. Nut
23. Caliper LH
24. Caliper RH
25. Hub
26. Key
27. Lug Bolt
28. Nut
29. Backing Plate
30. Brake Pad, Thin
31. Brake Pad, Thick
32. Backing Plate
33. Bolt
34. Nut
35. Clevis
36. Pin
37. Washer

TROUBLESHOOTING

Check or Solution / Problem or Symptom	Engine will not run	Park brake does not hold	Excessive brake wear	Brakes grab	Brakes do not release	Brake pedal does not return	Brakes noisy
Interlock switches mis-adjusted or not functioning	●						
Pads or rotors worn		●	●	●			●
Calipers broken or worn		●	●	●	●	●	●
Spring length mis-adjusted		●		●	●	●	
Linkage, bent, worn or binding		●	●	●	●		
Spring broken or stretched						●	

THEORY OF OPERATION

Function

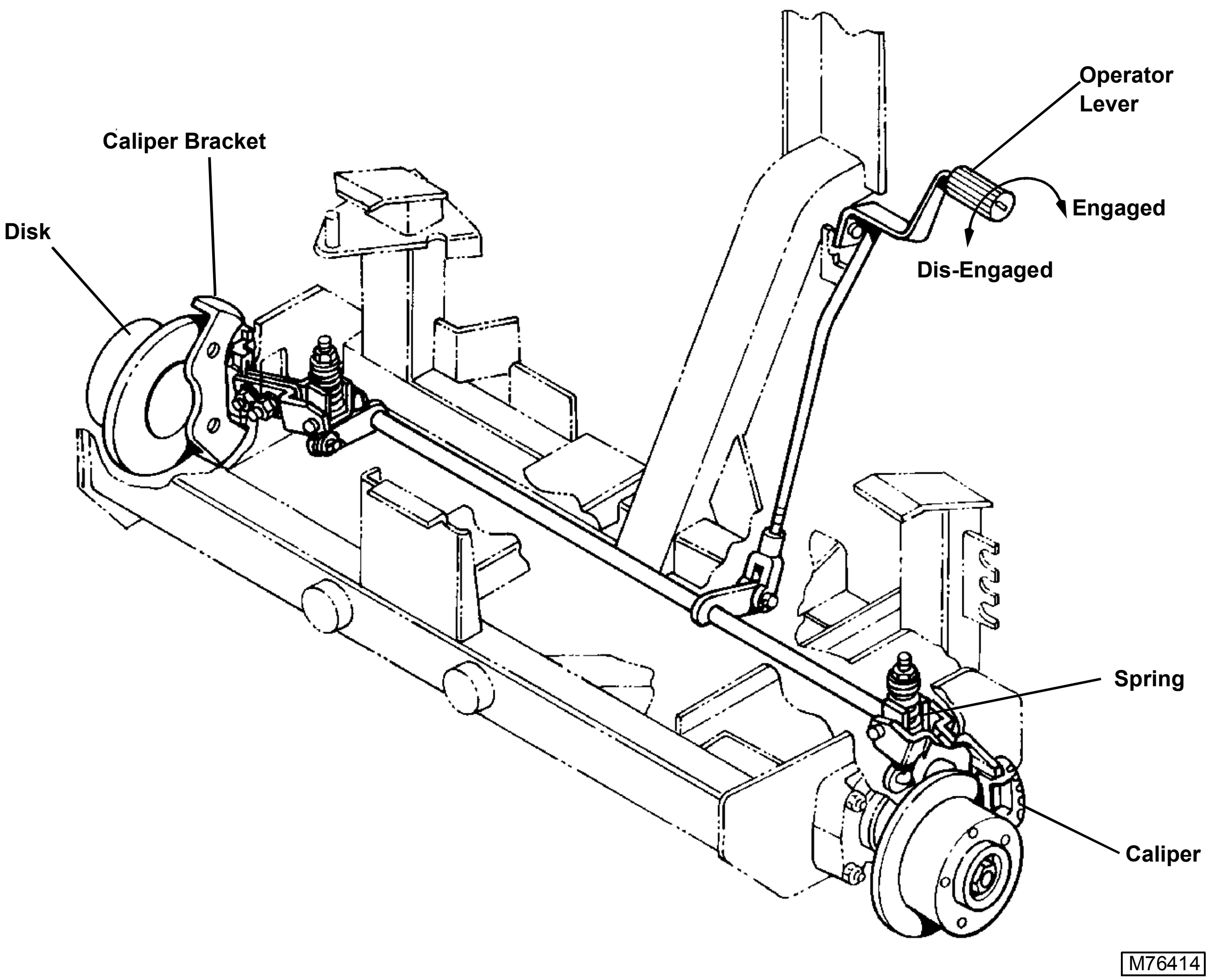
The parking brake is used to prevent movement when the mower is not in use. The brake is not intended for use in controlling speed or stopping the mower while it is in motion. Primary braking is accomplished by the back pressure in the Hydrostatic Transmission.

Brake interlock switch will stop the engine if operator attempts to move the unit with the brake engaged or leaves the seat without engaging the brake.

Theory

When the brake lever is pulled towards the operator the link rod rotates the pivot rod which in turn actuates the caliper link which causes the brake caliper to force the brake pads against the brake disc. This prevents the unit from moving. Operating the brake lever also operates the brake interlock switch which will stop the engine under certain circumstances.

The brake is automatically locked on by moving the park brake lever fully to the operator in its slot. It is unlocked by pushing the lever to the top of the slot. When the park brake lever is engaged the brakes will remain engaged until the lever is disengaged.



DIAGNOSTICS

Test Conditions:

- Engine off.
- Hydrostatic ground drive pedals in neutral.
- Mow/Transport lever in Transport position.
- Operator on seat.

Test/Check Point	Normal	If Not Normal
1. Disengage park brake and attempt to start engine.	Starter should not engage.	Check interlock switches, adjust or replace if necessary (see Electrical section).
2. Engage park brake and attempt to start engine.	Starter engages and engine runs.	Check interlock switches, adjust or replace if necessary (see Electrical section).

Test Conditions:

- Engine running
- Operator in seat

Test/Check Point	Normal	If Not Normal
1. Lock park brake and attempt to drive forward and backward.	Engine stops when drive control pedals are depressed.	Check interlock switches, adjust or replace if necessary (see Electrical section).
2. Release park brake.	If operator leaves seat, the engine will stop.	Check interlock switches, adjust or replace if necessary (see Electrical section).

TESTS AND ADJUSTMENTS

BRAKE ADJUSTMENT

Reason:

To ensure brake linkage is adjusted properly.

Procedure:

1. Park machine on level surface and turn engine off.
2. Block rear wheel.

CAUTION

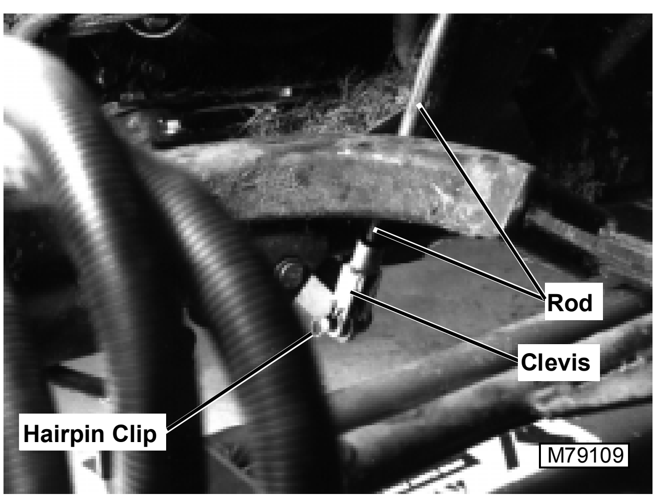
Raise machine safely and support it with suitable jack stands.

Never work on machine while supported only on mechanical or hydraulic jack

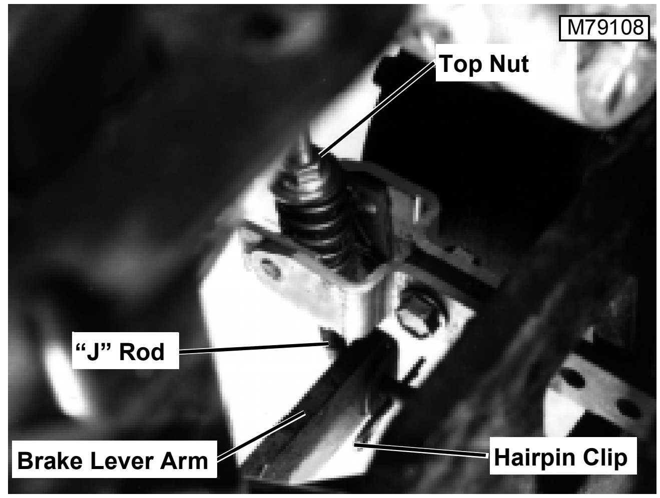
3. Use jack stands to support the front wheels off the ground.
4. Inspect all rods and linkage for wear or other damage. Replace if required.
5. Check brake pads for excessive wear. Replace both pads if either is less than 3 mm (0.125 in.) thick.

NOTE: There are two pads in each caliper. The inboard one (closest to actuator) is approximately 1/2 in. thick new. The outboard pad is approximately 3/8 in. thick new.

6. Disengage Park Brake.



7. Adjust clevis by removing Hairpin Clip from pin, remove pin from clevis and screwing clevis up or down on rod until the threads on the rod are flush with the inside of the clevis.
8. Reassemble clevis, pin, and hairpin clip.



IMPORTANT: Do not loosen top nut until spring is loose. If top nut is backed off to far spacer on inside of spring may jump out of hole in spring bracket and bind up brake when top nut is tightened.

9. Loosen top nut approximately 1/4 inch.
10. Remove hairpin clip from end of “J” rod.
11. While holding caliper arm, with spring assembly, up as far as possible adjust “J” rod until end of rod aligns with hole in brake lever arm.
12. Reassemble “J” rod, washer, and hairpin clip.
13. Tighten top nut until it contacts spacer. Torque to **10 N•m (7 lb-ft)**.
14. Engage park brake and insure that spring is compressing and that spacer is protruding through bottom of spring bracket.

IMPORTANT: Insure that spring bracket is sliding on spacer when brake is engaged.

15. Repeat steps 6 through 14 on other wheel.
16. Remove jack stands.

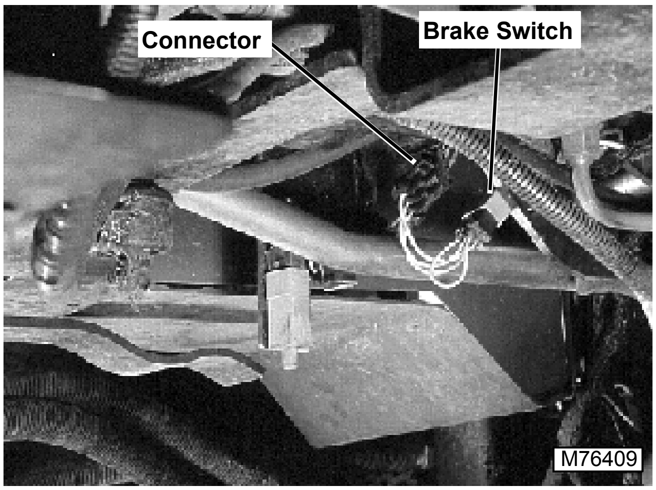
BRAKE SWITCH TEST

Reason:

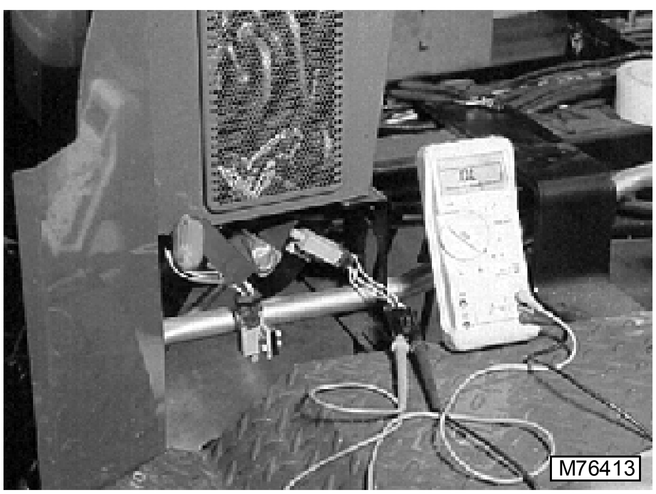
To insure that parking brake switch is operating properly.

Procedure:

1. Release parking brake lever. Make sure brake is completely off.



2. Locate connector to brake switch. Disconnect.



NOTE: Above photo shown with sheet metal removed for clarity.

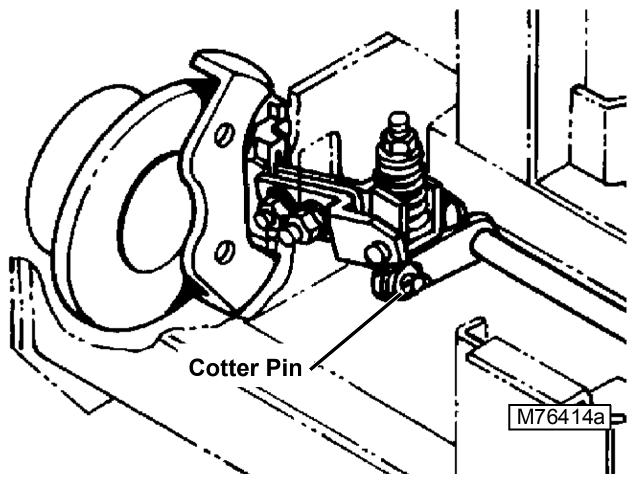
3. Use test meter to test continuity from center lead to either side. One contact will be on, the other off.
4. Rotate brake lever until brake switch is completely depressed.
5. Use test meter to test continuity from center lead to either side. The opposite contacts should be on/off from step #3. If not replace switch.

REPAIR

BRAKE PAD REPLACEMENT

IMPORTANT: Complete pad replacement on one side of vehicle at a time. Right and left units are different internally. *Do Not* reverse units.

1. Park vehicle on a level surface.
2. Jack and block front of machine to provide clearance between the floor and bottom of tires.
3. Move Mow/Transport lever to TRANSPORT position.
4. Lower cutting units to the ground.
5. Turn key switch OFF.
6. Disengage park brake.
7. Disconnect battery negative (-) cable.
8. Raise hood and block in upright position.
9. Remove wheel and tire.



10. Remove cotter pin from spring linkage arms.
11. Remove two capscrews securing caliper bracket to frame.

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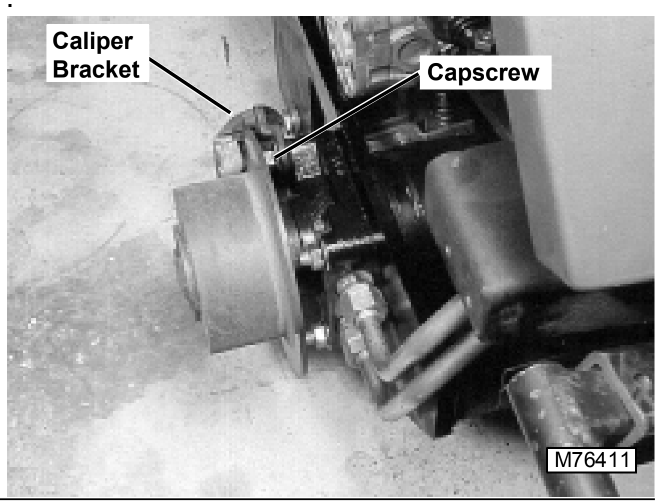
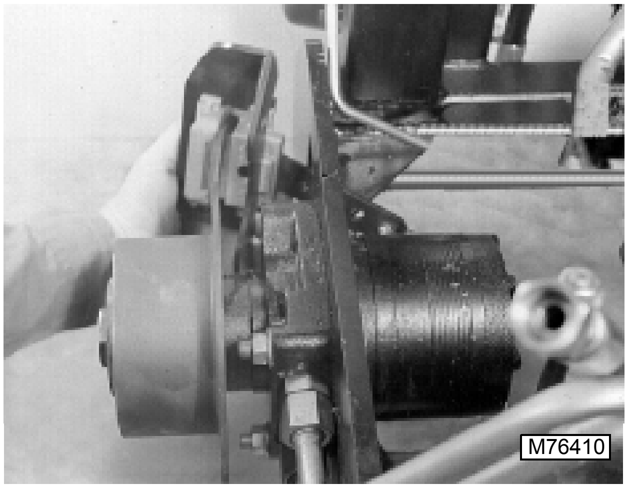
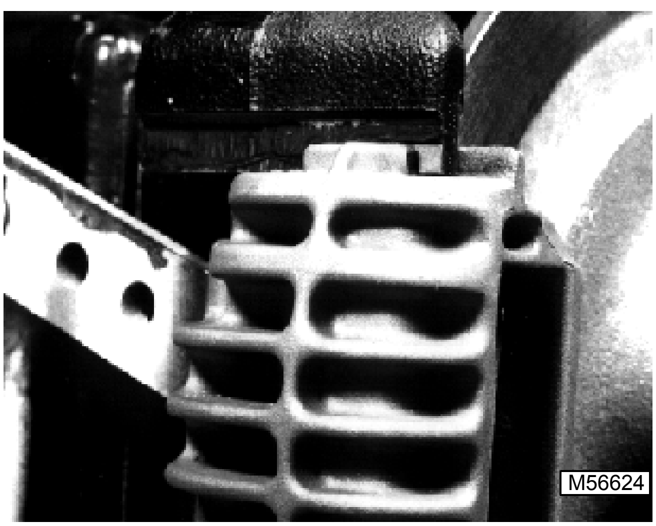


12. Rotate spring linkage assembly and remove complete brake assembly from frame.



NOTE: There are two pads in each caliper. The inboard one (closest to actuator) is approximately 1/2 in. thick new. The outboard pad is approximately 3/8 in. thick new.

13. Replace pads.
14. Inspect caliper housing for damage or wear. Make sure that caliper slides easily on bracket.
15. Install calipers in reverse order of removal.



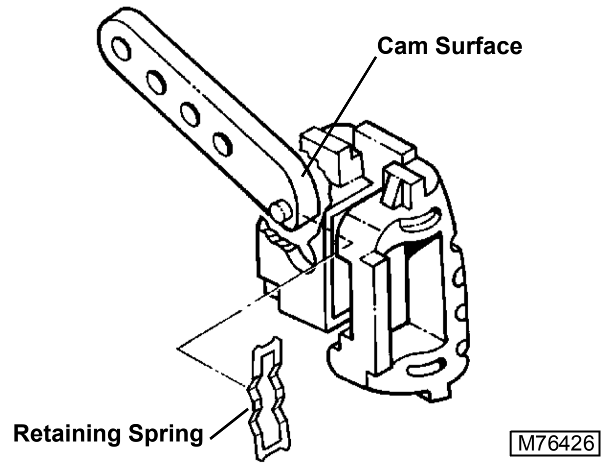
IMPORTANT: Ensure caliper assemblies are positioned on sliders as shown.

IMPORTANT: Complete pad replacement on one side of vehicle at a time. Right and left units are different internally. *Do Not* reverse units.

16. Install linkage arms and secure with cotter pins.
17. Install wheel and tire assembly.
18. Adjust brakes. (See "BRAKE ADJUSTMENT" on page 8 this section.)

CALIPER REPLACEMENT

1. Remove brake caliper. (See "BRAKE PAD REPLACEMENT" on page 9 this section.)



2. Assemble new caliper as shown. (Left hand caliper shown.)

NOTE: Pay special attention to orientation of actuator arm cam surface. Pins should be in top slot in caliper body.

3. Install brakes. (See "BRAKE PAD REPLACEMENT" on page 9 this section.)

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SPECIFICATIONS

Charge Pump

Make	Danfoss
Model / Series	YC
Type	Gear, Positive Displacement
Displacement	5.73 cc/rev (0.35 cu-in/rev)
Flow @ 3400rpm	19.5 L/min (5.15 GPM)
Relief Valve Setting in Steering Valve	62 bar (900 psi)
Relief Valve Setting in Hydrostatic Pump	6 bar (90 psi)

Reel Pump

Make	Danfoss
Model / Series	YC
Type	Gear, Positive Displacement
Displacement	8.19cc/rev (0.50 cu-in/rev)
Flow @ 3400rpm	27.86 L/min (7.36 GPM)
Case Drain Flow	Not to exceed 6.3 L/sec (1 gpm)

Reel Motor

Make	Danfoss
Type	Gear, with case drain flow

Front Inboard and Rear Lift Cylinders

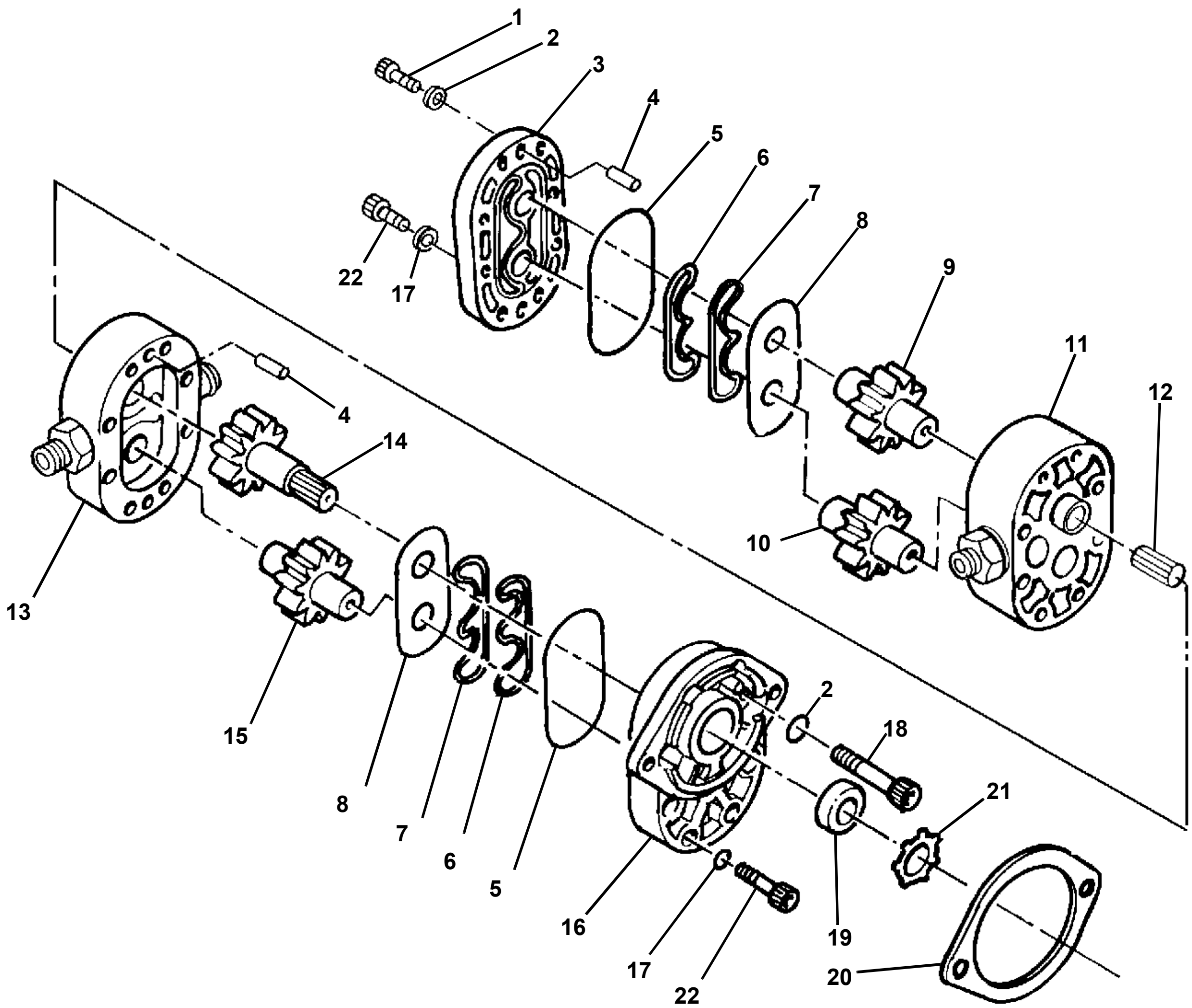
Stroke	101.6 mm (4 in.)
Compressed Length	203.2 mm (8 in.)

Hydraulic Filter

Type	Spin on
Clogged filter by-passes fluid to tank at	3.4 bar (25 psi)

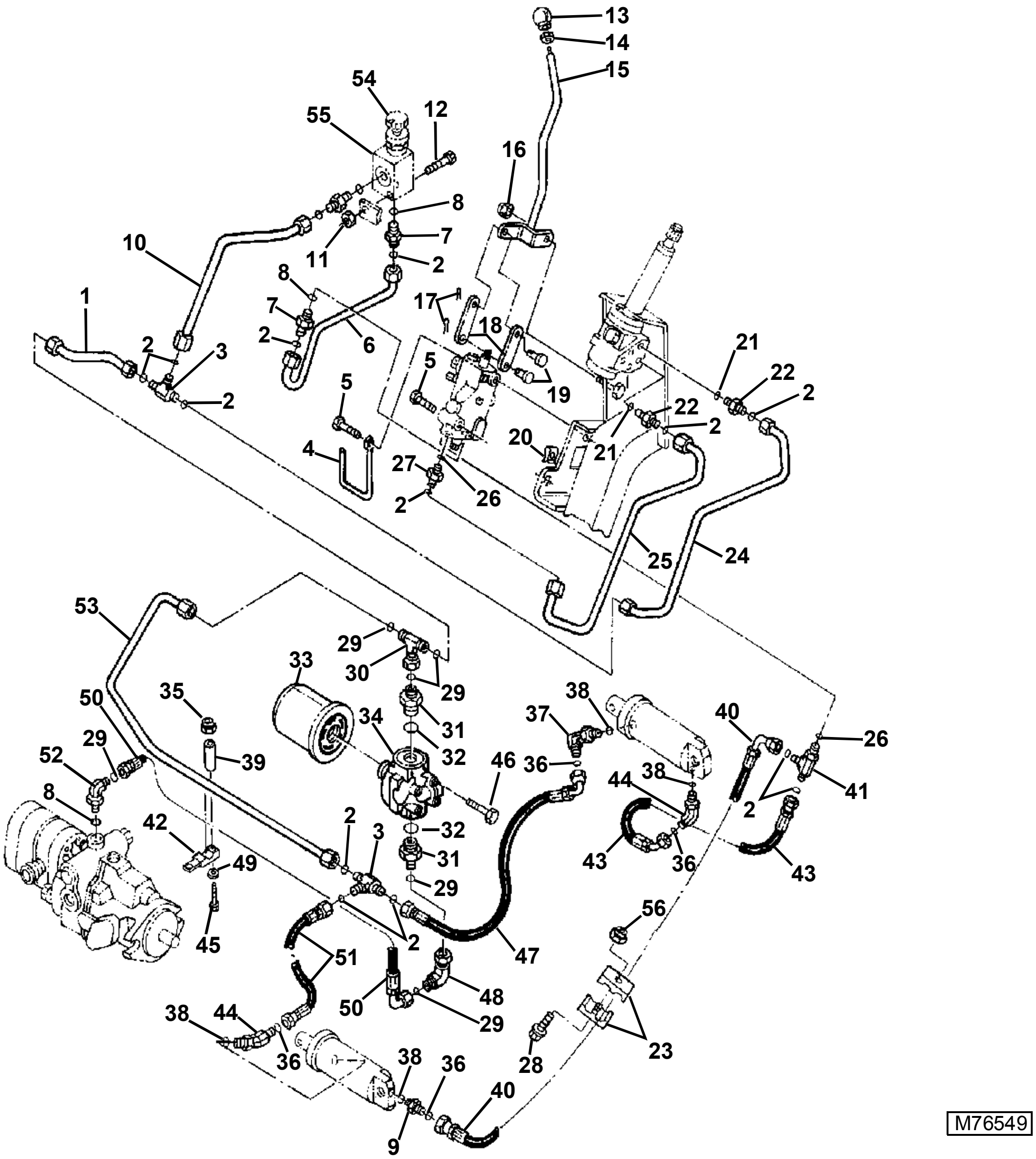
COMPONENT LOCATION

PUMPS



1. Socket Head Cap Screw 5/16" X 1-1/4"
2. Washer, Plain, 5/16"
3. End Cap
4. Dowel
5. O-Ring, Formed
6. Gasket, Formed
7. Gasket, Formed
8. Wear Plate
9. Drive Gear
10. Driven Gear
11. Body
12. Shaft. Splined Coupler
13. Body
14. Gear, Input
15. Gear Driven
16. Cap, Front
17. Washer, Plain 3/8"
18. Socket Head Cap Screw 5/16" X 2-3/4"
19. Bearing
20. Gasket
21. Keeper
22. Socket Head Cap Screw 3/8" X 1-1/2"

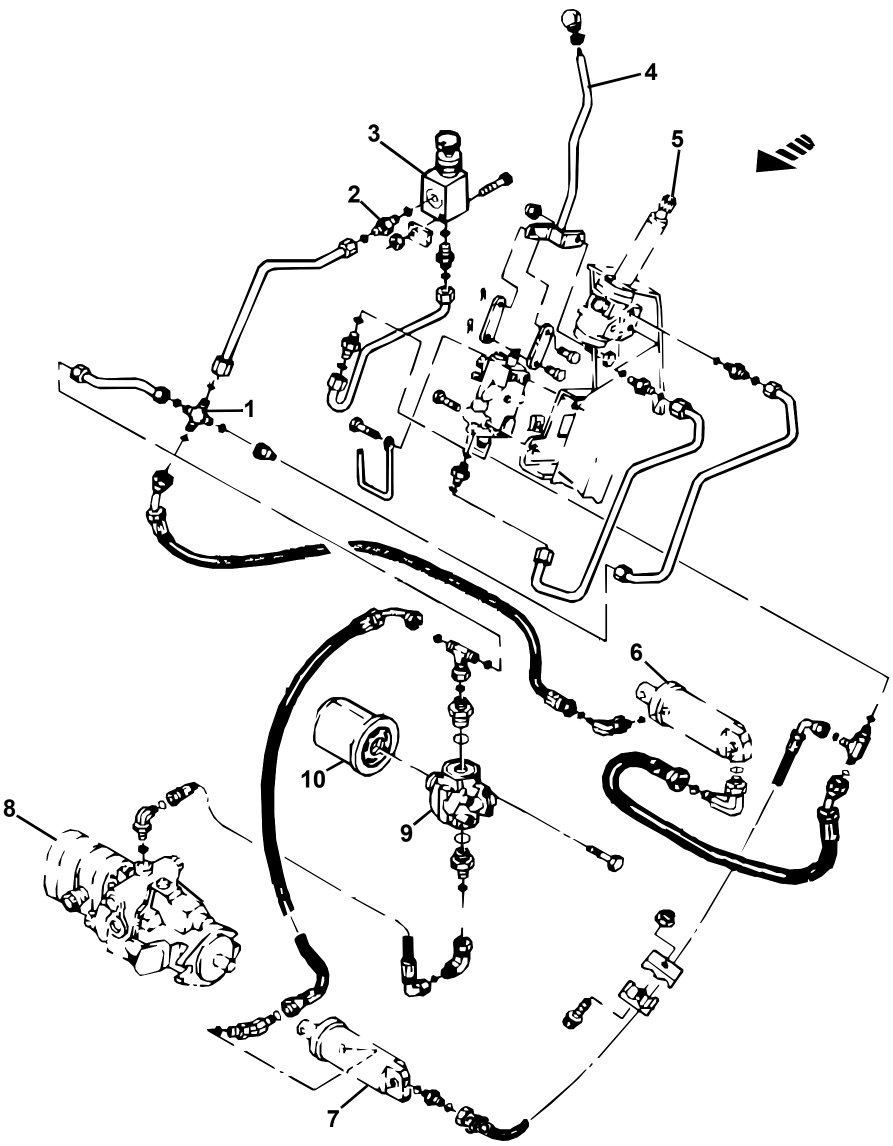
LIFT SYSTEM HYDRAULICS (S.N. —060844)



1. Tube
2. O-Ring
3. T-Fitting
4. Bracket, Hose
5. Capscrew
6. Tube
7. Fitting
8. O-Ring
9. Fitting
10. Tube
11. Nut
12. Capscrew
13. Knob
14. Lock Nut
15. Lever
16. Lock Nut
17. Hairpin Clips
18. Link
19. Pin
20. Sheet Metal Nut
21. O-Ring
22. Fitting
23. Hose Clamp
24. Tube
25. Tube
26. O-Ring
27. Fitting
28. Capscrew
29. O-Ring
30. T-Fitting
31. Fitting
32. O-Ring
33. Filter
34. Adapter
35. Nut
36. O-Ring
37. Elbow
38. O-Ring
39. Spacer
40. Hose, Front Lift, Up
41. T-Fitting
42. Tube Clamp
43. Hose, Rear Lift, Up
44. 45 Fitting
45. Capscrew
46. Capscrew
47. Hose, Rear Lift, Down
48. Elbow
49. Washer
50. Hose, Charge
51. Hose, Front Lift, down
52. Elbow
53. Tube
54. Down Pressure Valve
55. Body, Down Pressure
56. Capscrew

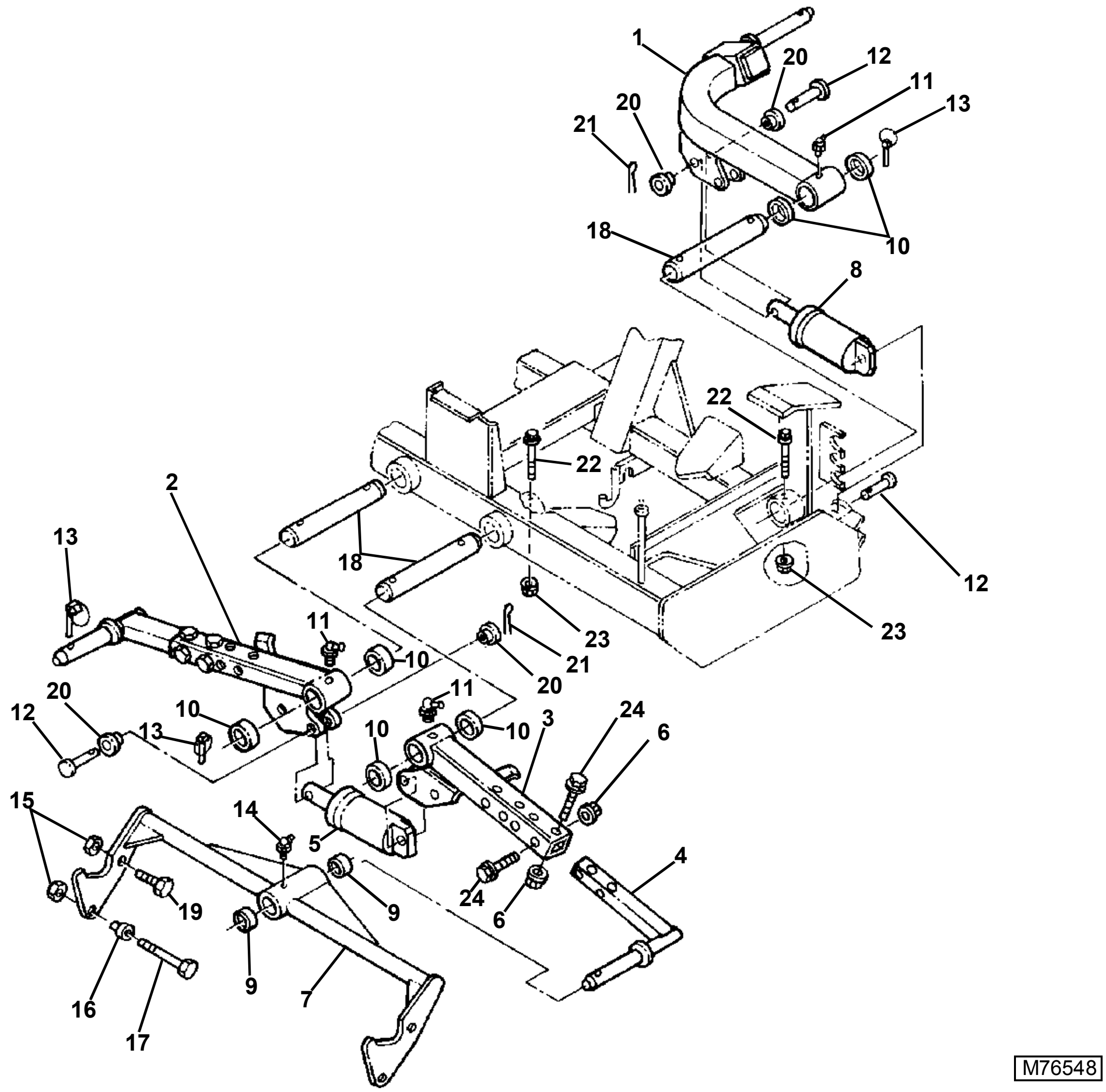
LIFT SYSTEM HYDRAULICS (S.N. 060845—)

(And those units modified with Ground Following Kit AMT1899)



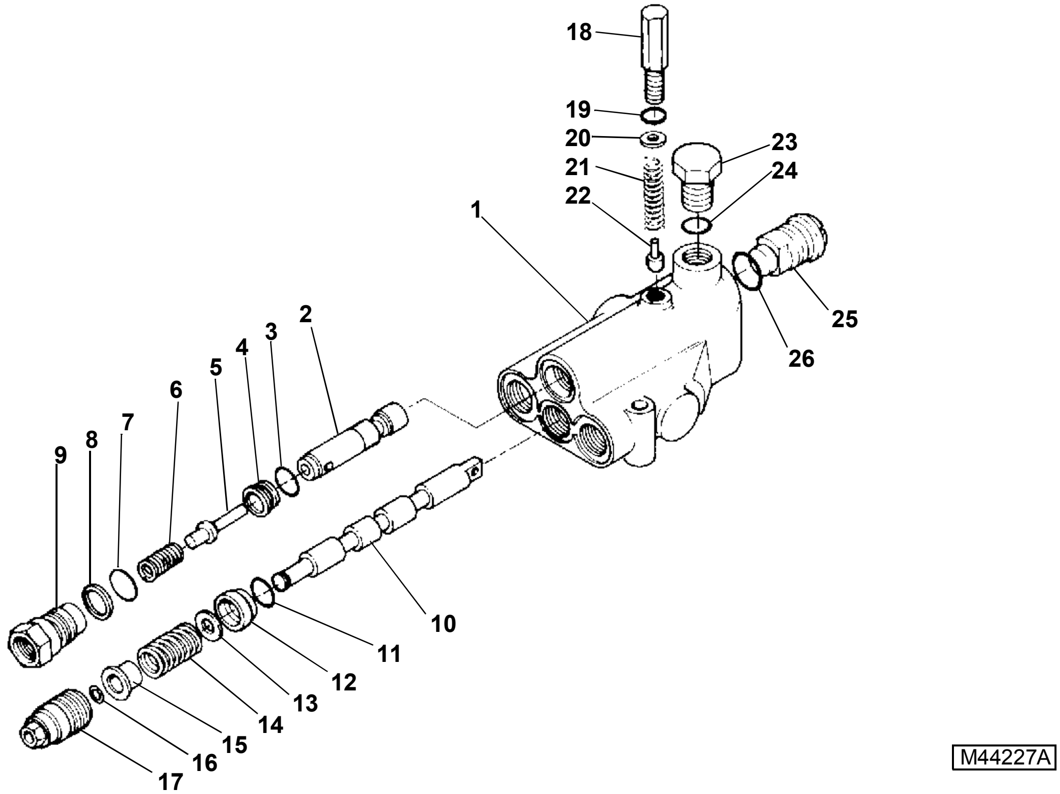
1. Cross fitting	6. Rear lift cylinder
2. Flow restrictor	7. Front lift cylinder
3. Down pressure valve	8. Pump assembly
4. Lift lever	9. Filter mount
5. Steering valve	10. Hydraulic oil filter

LIFT ARMS & CYLINDERS



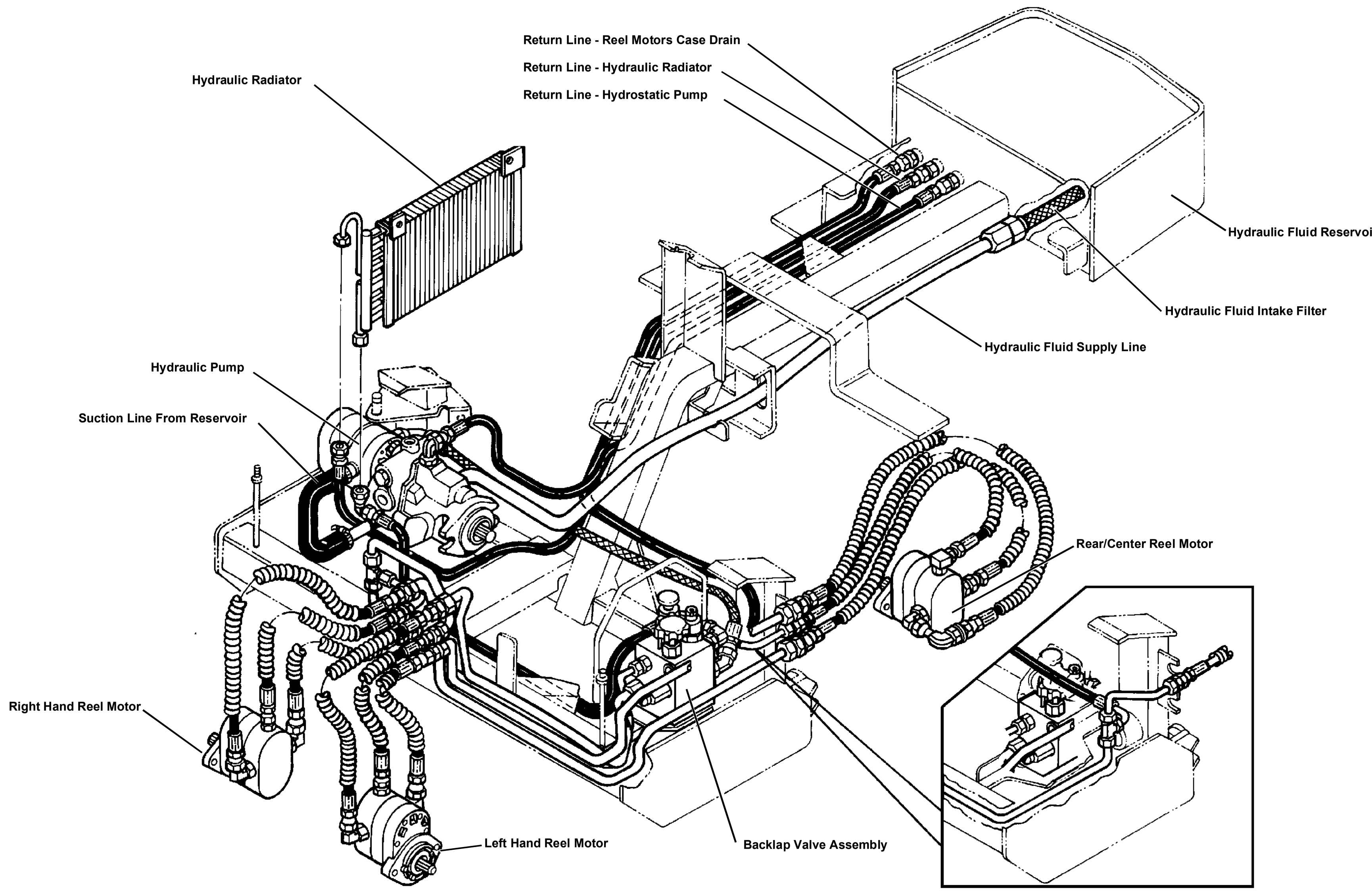
1. Rear Lift Arm
2. Right Lift Arm
3. Left Lift Arm
4. Lift Arm Extension
5. Cylinder, Front Lift
6. Nut, Flanged
7. Yoke
8. Cylinder, Rear Lift
9. Bushing, Yoke
10. Bushing, Lift Arm
11. Zerk
12. Pin
13. Lynch Pin
14. Zerk
15. Nut
16. Bushing
17. Capscrew
18. Pin
19. Capscrew
20. Bushing, Flanged
21. Cotter Pin
22. Capscrew
23. Nut
24. Capscrew

LIFT VALVE COMPONENT LOCATION

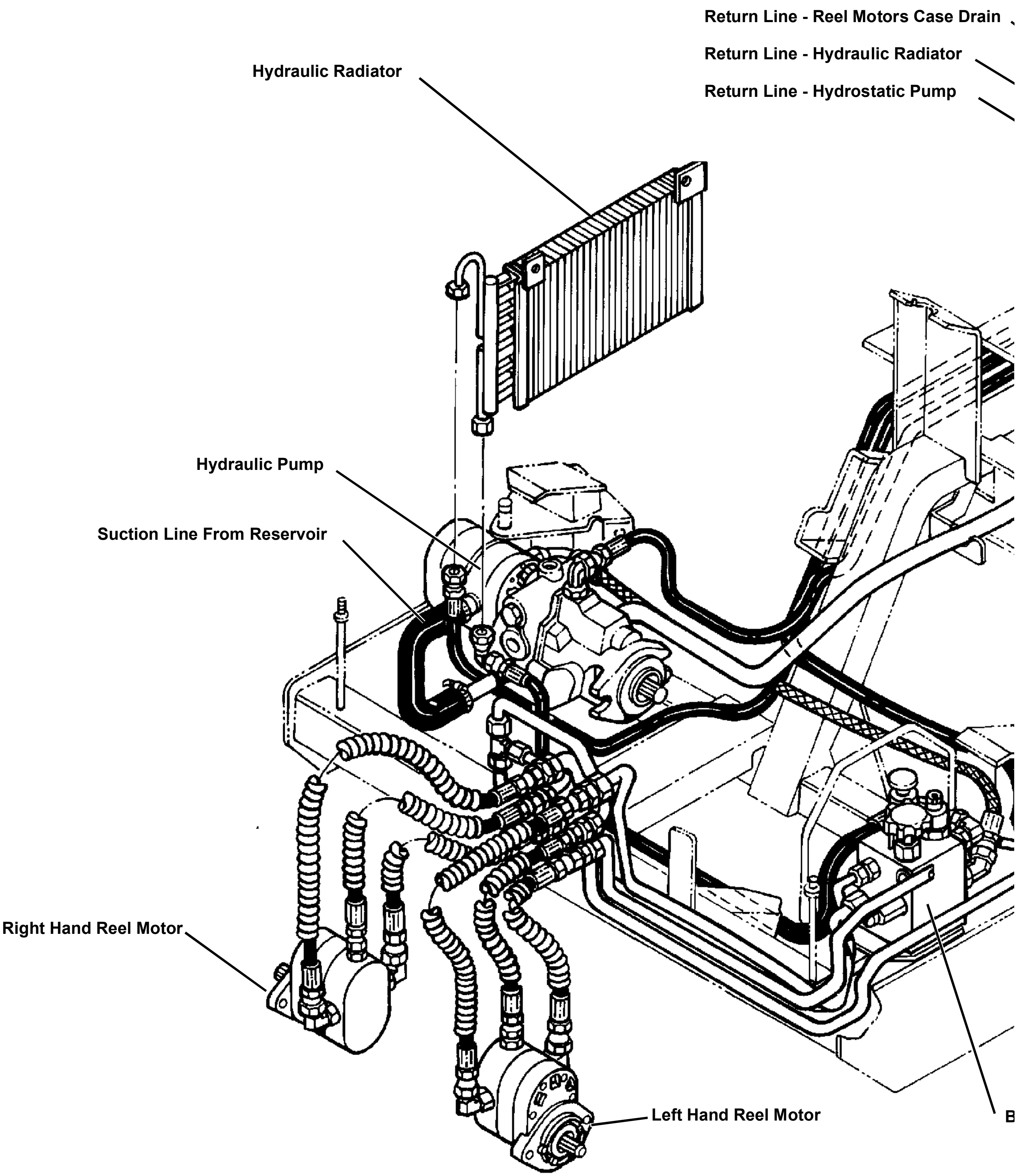


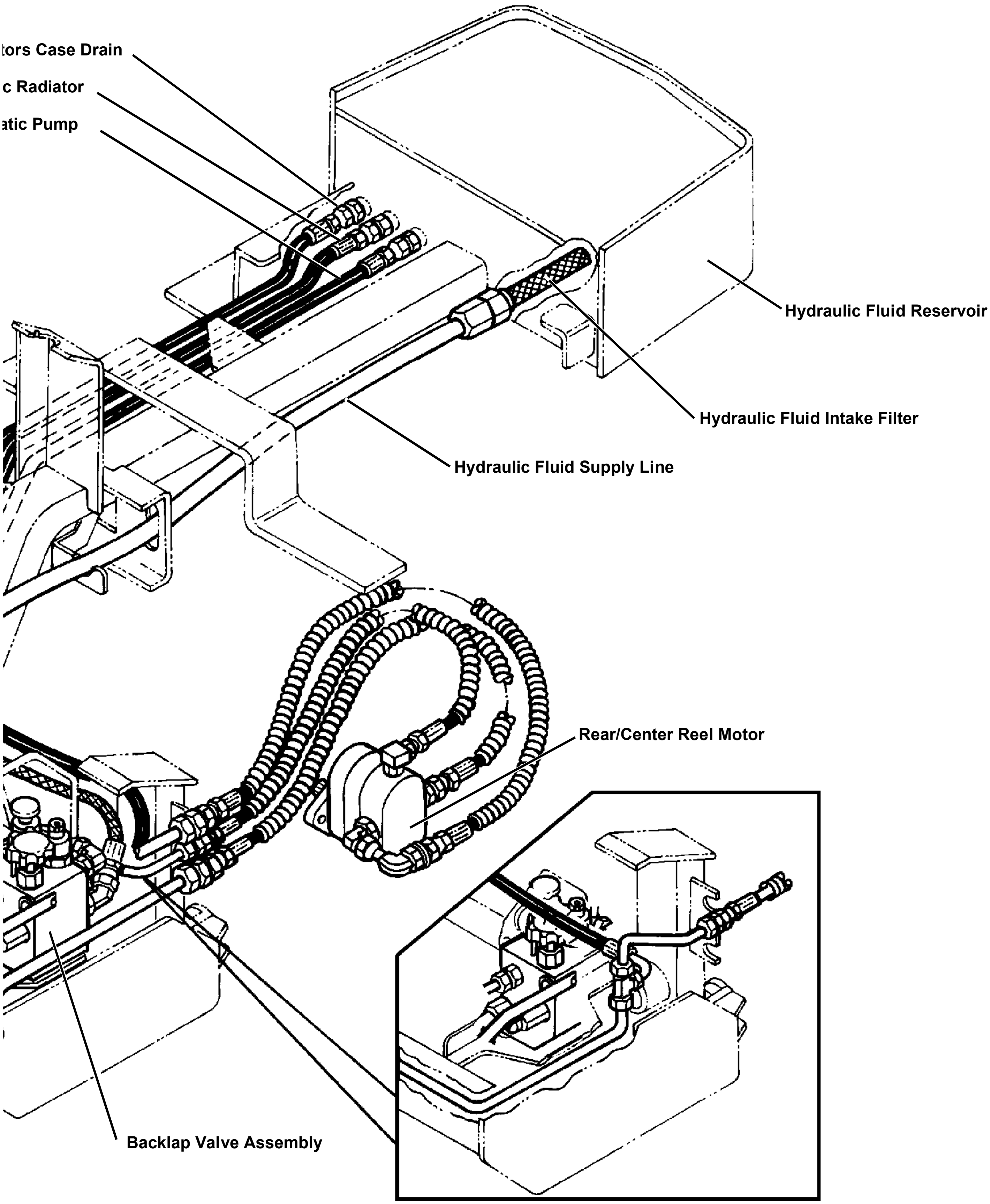
1. Valve Body
2. Detent Spool
3. O-Ring
4. Orifice
5. Actuator
6. Spring
7. O-Ring
8. Back up Washer
9. Fitting
10. Control Spool
11. O-Ring
12. Cup
13. Washer
14. Spring
15. Keeper
16. Circlip
17. Cap
18. Spring housing
19. O-ring
20. Gasket
21. Spring
22. Detent Plunger
23. Plug
24. O-Ring
25. Screw Cap
26. O-Ring

COMPONENT LOCATION

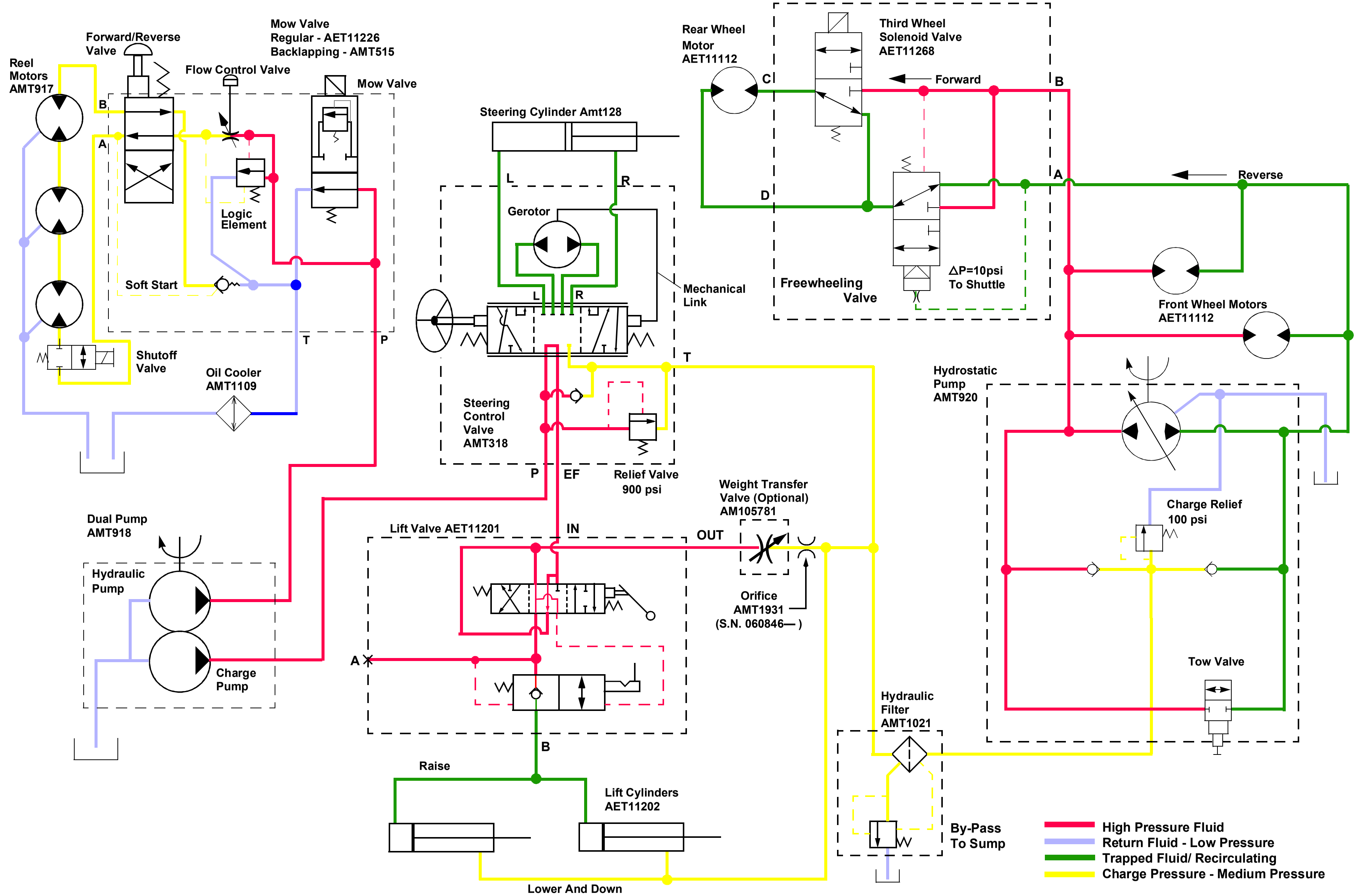


COMPONENT LOCATION




tors Case Drain
c Radiator
atic Pump
Hydraulic Fluid Reservoir
Hydraulic Fluid Intake Filter
Hydraulic Fluid Supply Line
Rear/Center Reel Motor
Backlap Valve Assembly

HYDRAULIC SCHEMATIC



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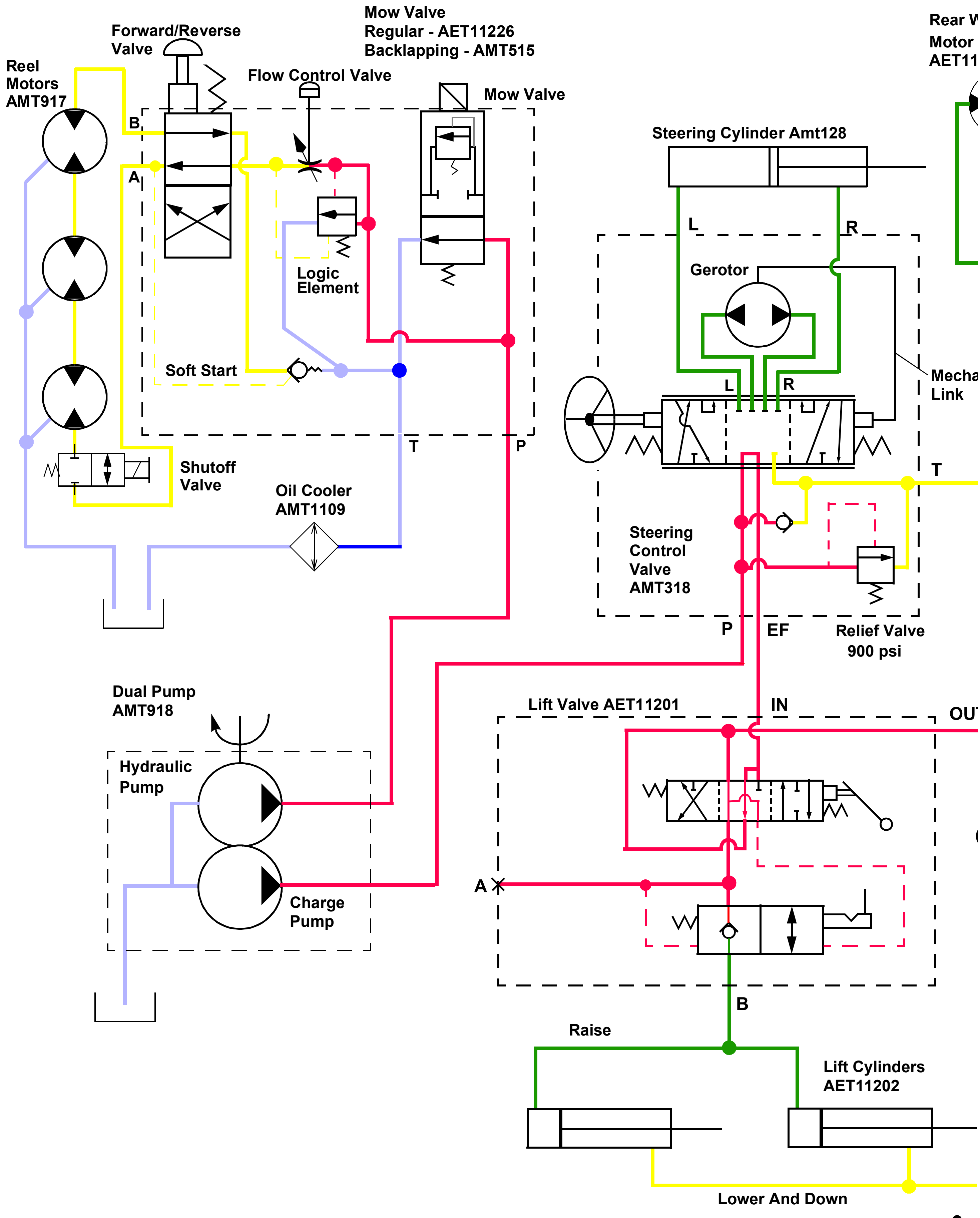
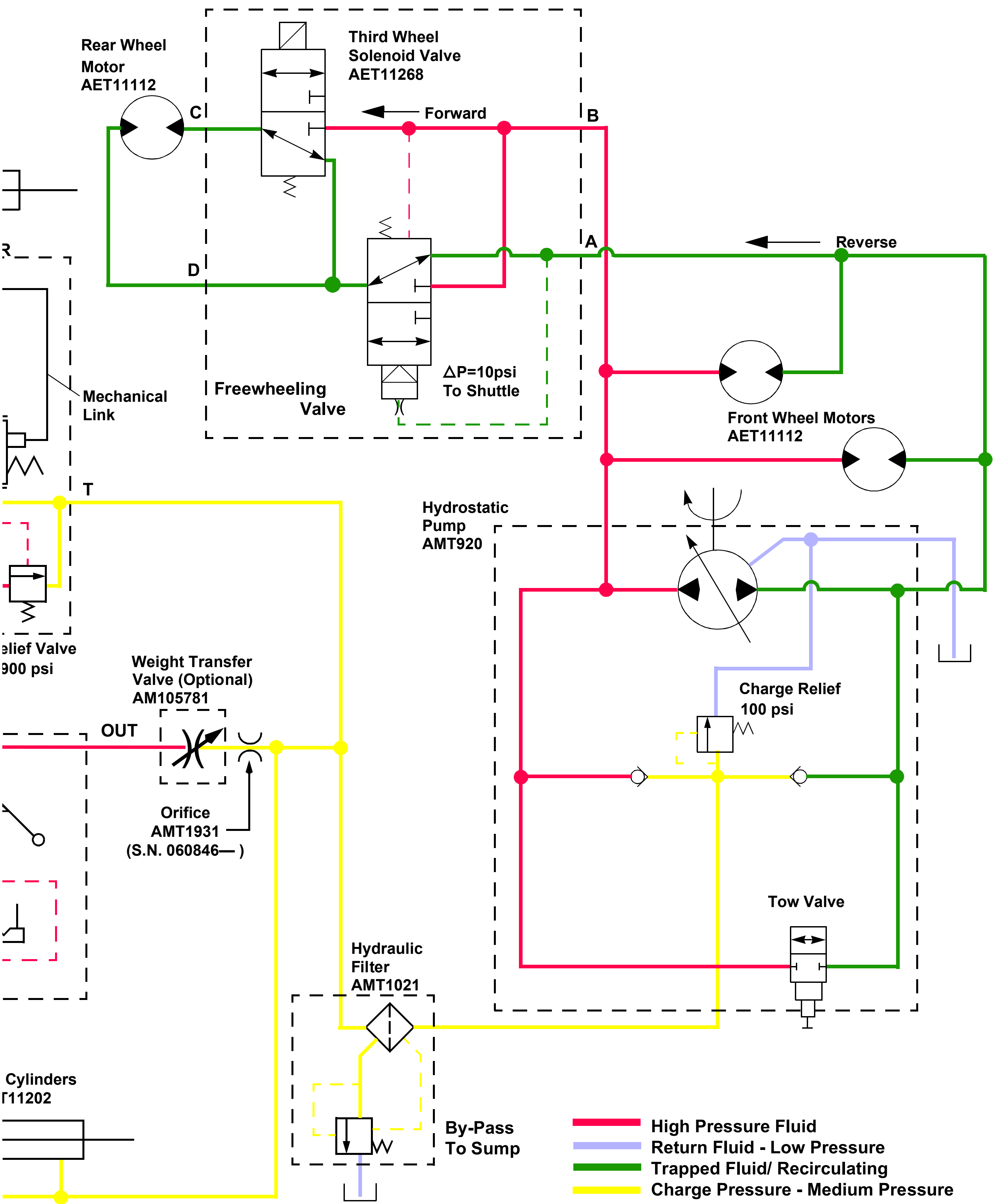
HYDRAULIC SCHEMATIC




Rear Wheel
Motor
AET11112
Third Wheel
Solenoid Valve
AET11268
Forward
C
B
A
D
Reverse
Mechanical
Link
Freewheeling
Valve
ΔP=10psi
To Shuttle
Front Wheel Motors
AET11112
T
Hydrostatic
Pump
AMT920
elief Valve
900 psi
Weight Transfer
Valve (Optional)
AM105781
OUT
Charge Relief
100 psi
Orifice
AMT1931
(S.N. 060846—)
Tow Valve
Hydraulic
Filter
AMT1021
Cylinders
T11202
By-Pass
To Sump
High Pressure Fluid
Return Fluid - Low Pressure
Trapped Fluid/ Recirculating
Charge Pressure - Medium Pressure

TROUBLESHOOTING

REEL DRIVE

Problem or Symptom / Check or Solution	One reel turning slow	All reels turning slow	Second and third reels turning slow	One cutting unit not turning	No reel speed	No backlap	Reel decel excessive	Pump noisy	Pump cavitation	Oil foaming	Tires slip while trying to climb hills
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					●	●					
Install orifice AMT1931 if unit is equipped with a weight transfer valve											●

LIFT SYSTEM

Problem or Symptom / Check or Solution	Front and rear lift arms will not lower	Front and rear lift arms will not raise	Front and rear lift arms will not stay in raised position	Rear lift arms will not raise	Rear lift arms will not lower	Rear lift arms raise too high	Tires slip while trying to climb hills
Internal and/or external steering valve leakage		●					
Air in lift system		●		●			
Hydraulic fitting(s) loose		●	●	●			
Defective charge pump		●		●			
Engine rpm too low		●		●			
Defective steering valve		●		●			
Defective lift valve	●	●	●				
Delay orifice plugged on rear lift cylinder				●	●		
Lost motion linkage on rear lift cylinder binding or broken				●	●		
Rear lift arm stop not down						●	
Down pressure valve (optional) not operating correctly	●	●	●				
Install orifice kit AMT1931							●

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 one pump or valve has problems it will usually result in poor cutting from all front or all rear 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 in the system. Before taking the 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 of 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. All the cutting units are driven in series by the same hydraulic system, problems that appear to affect only one reel may be caused by the reel prior to the one showing the symptom.

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.

THEORY OF OPERATION

REEL DRIVE SYSTEM

System Function:

Rotates the cutting reels for forward mowing and if equipped, reverses for backlapping operations.

Reel Pump:

The reel pump is a Danfoss Series YC, positive displacement gear pump rated at 7 GPM. The pump is located between the hydrostatic transmission and the steering and lift system pump.

Mow Valve:

The Mow valve is a solenoid actuated, pressure limiting shuttle valve. It is used to control the flow to the reel motors. The mow valve is energized through the time delay control (TDC) module during mowing operations. It limits pressure in the reel drive circuit to 3000 psi. The mow valve is contained within the backlapping valve assembly.

NOTE: European models may not have a backlapping valve assembly installed. If not, the mow valve is located in a valve block.

Flow Control Valve:

The flow control valve, located in the backlapping valve assembly, is a manually operated flow restrictor. It is used to control reel speed when backlapping or in normal mode. It is adjusted by rotating the knob clockwise to restrict and counterclockwise to increase flow.

Backlapping Valve:

The backlapping valve, located in the backlapping valve assembly, is a manually operated, two position, push-pull valve that changes fluid flow direction. The knob, when pushed in, directs the fluid flow to the motors for forward cutting. When pulled out, the cutting units will reverse direction for backlapping, and a switch is actuated to allow the mow valve solenoid to be energized with the operator off the seat and the mow/transport switch in the mow position.

Shutoff Valve:

The shutoff valve, installed in-line prior to the first reel motor, is a solenoid operated shutoff valve used to stop the flow of hydraulic fluid to the cutting units and prevent "reel creep". An off delay timer provides a one second delay before closing the shutoff valve. This delay allows the reels to slow down before shutting off hydraulic fluid flow to prevent the reel motors from cavitating.

Theory: (Units With A Backlapping Valve)

When the mow solenoid is energized, the pressure limiting part of the mow valve shifts to limit pressure in the mow circuit to a maximum of 3000 psi at a maximum flow rate of 7GPM.

Pressure and flow are now routed to the flow control valve and logic element. The flow control valve determines the rpm of the reels. Pressure in the reel circuit will vary according to the amount of resistance that the cutting units are generating.

The logic element, a pilot operated dump valve, compares pressure at the inlet and outlet ports of the flow control valve. As the flow is restricted, pressure builds on the input side of the flow control valve to a value higher than that on the output side. This forces the logic element to open and dump excess flow to the tank. As flow returns to the reservoir, pressure to the input side of the flow control valve drops and the logic element closes. The logic element will continue this cycle as needed to equalize pressure on both sides of the flow control valve.

After leaving the flow control valve, fluid enters the forward/reverse valve where it is directed to the forward or reverse side of the reel motors. The forward/reverse valve is equipped with a detent to hold the valve in the forward position.

A soft start feature is used in the mow valve to prevent damage to the cutting units from full pressure start-ups. After leaving the backlapping valve, flow is directed to the forward or reverse side of the reel motors. The reel motors are connected in series beginning with the left front, the center, and the right front cutting unit motor.

Theory: (Units Without A Backlapping Valve)

When the mow solenoid is energized, the pressure regulating part of the mow valve shifts to regulate pressure in the mow circuit to a maximum of 3000 psi and a maximum flow rate of 7 GPM.

A soft start feature is used in the reel circuit to prevent damage to the cutting units from full pressure start-ups. After leaving the mow valve, flow is directed to the forward side of the reel motors. The front reel motors are connected in series starting with the left front, center, and right front motor.

LIFT SYSTEM

Function:

Provides a means to raise or lower the cutting units for three operating modes;

- Transport
- Mowing
- Service or Backlapping

Charge Pump:

The charge pump is a Danfoss model YC direct drive, positive displacement gear pump capable of displacing 4.25 GPM at 1500 psi and it is the forward pump of the double pump assembly. The charge pump operates in a “Open Center Series” type hydraulic system consisting of the Steering, Lift, and Hydrostatic drive systems. Each system has a controlling valve with an open center that allows fluid flow, in series, to operate each system in the order mentioned above. Also, in this type of circuit, the first controlling valve (steering) takes priority over the next valve downstream in the circuit.

Raise/Lower Spool Valve:

The lift valve is a manually positioned (raise/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.

Weight Transfer Valve:

The weight transfer valve is used by dialing the weight transfer knob clockwise, the weight of the cutting unit is transferred to the wheels thus increasing traction. If dialed far enough the cutting units will lift off the ground. The valve is manually operated and controlled by the operator. Hydraulic pressure is routed through the neutral position of the lift valve, and to the valve.

Lift System Theory:

The lift system receives pressure from the charge pump through the steering valve. The steering valve will take first priority and limited pressure will be available to the lift system during steering operations.

The raise/lower is a manually operated spring centered valve that controls the up/down movement of the cutting units. Moving the lever in the raise position will raise the cutting units to the full up position for transport or servicing operations.

Moving the lever in the down position the cutting units will be lowered completely to the ground for cutting or backlapping operations.

The cutting units may be lifted slightly for turning by momentarily activating the lift valve until the units clear the ground. The units will be held at this height until they are lowered again.

TESTS & ADJUSTMENTS

REEL PUMP PRESSURE RELIEF TEST

Reason:

To ensure that reel pressure relief valve is operating properly

Tools:

- JTO5486 Connector 1/4” M NPT x 7/16” M 37°
- AMT846 Hose
- JTO3017 Hose 34,473 kPa (5,000 psi)
- RE48122 Female Quick Coupler
- JTO3362 Gauge 70,000 kPa (10,000 psi).

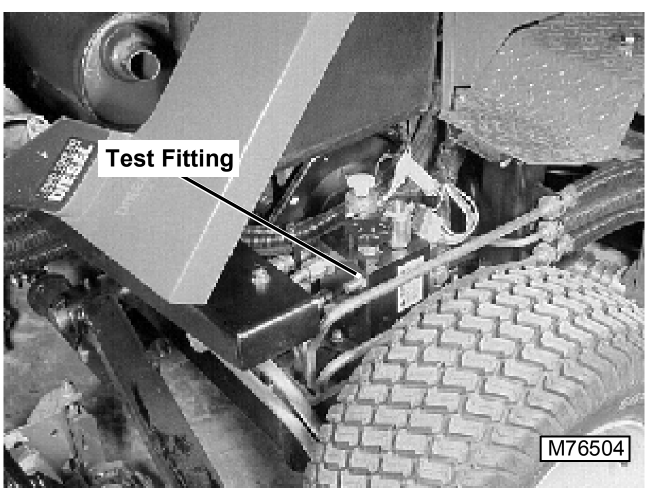
Procedure:

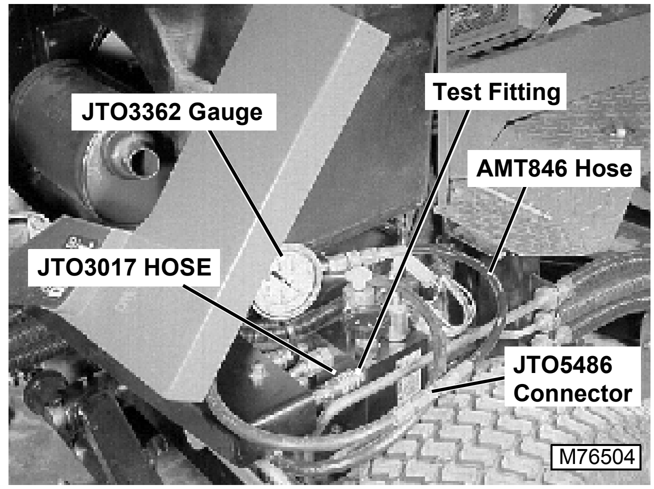
CAUTION

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 test fitting provided in mow/backlapping valve.
2. Locate Test fitting in the mow/backlapping valve.





3. Connect hose AMT846 to hose JTO3017 with connector JTO5086 and attach RE48122 quick coupler on end of hose assembly.
4. Insert Gauge JTO5474 in one quick coupler and fasten other quick coupler to test port.
5. Apply parking brake.
6. Check and top off Hydraulic reservoir.
7. With cutting units lowered to ground, block all three reels with small wooden blocks
8. 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.

9. Set mow/transport knob to mow.
10. Note reading on gauge.

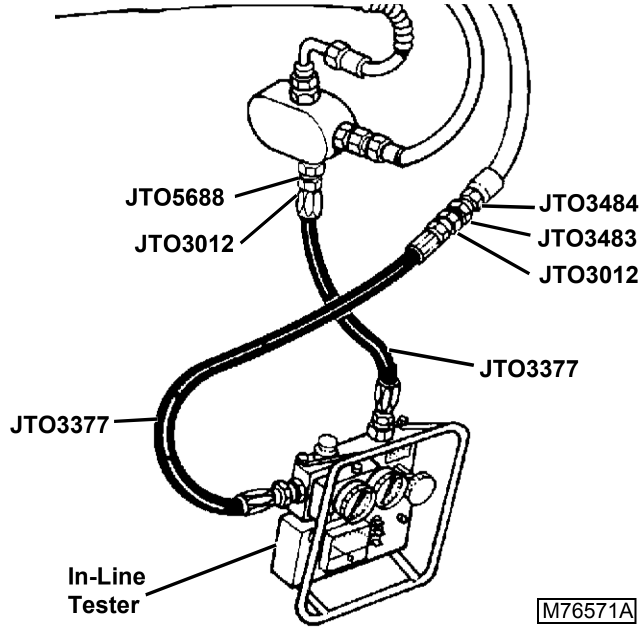
Specifications:

- Observe pressure gauge. Pressure should indicate 2068 ± 1034 kPa (3000 ± 150 psi).

Corrections:

- If relief valve does not meet specifications replace relief valve or try to adjust by turning Allen head screw on top of solenoid, tighten to increase, loosen to decrease.

REEL PUMP FLOW TEST



Reason:

To determine if reel pump is worn by testing hydraulic flow at reel motors

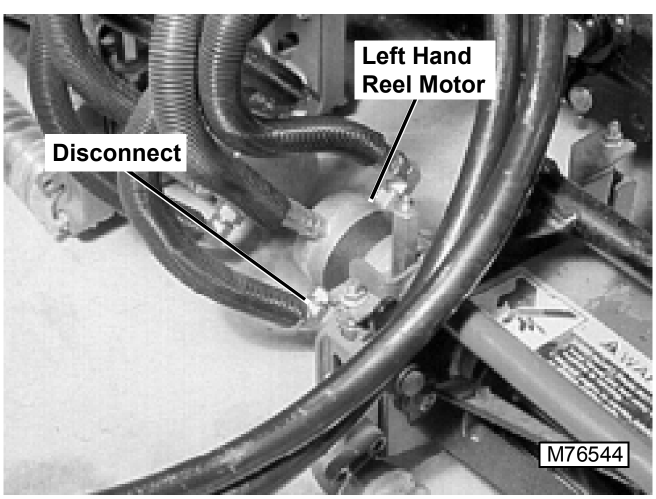
Tools:

- D01074AA In-Line Hydraulic Tester
- JTO3377 (2) 120” Hydraulic Test Hoses
- JTO3012 (2) Connector 3/4” F NPT x 1-1/16” F 37°
- JTO5688 Connector 1-1/16” M 37° x 13/16” F ORFS
- JTO3483 Connector 1-1/16” M 37° x 1-3/16” M ORFS
- JTO3484 Connector 1-3/16” F ORFS x 13/16” M ORFS
- JTO5688 Connector 13/16” F ORFS x 1-1/16” M37°

Procedure:

1. Park machine on level surface, reels lowered, park brake on, engine off.
2. Block wheels to prevent inadvertent movement of the machine.
3. Check and top off Hydraulic reservoir.

> **CAUTION**
>
> **To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.**
> **Lower cutting units to the ground prior to removing any hydraulic lines or fittings.**



4. Place drain pan under left front reel motor. Clean hydraulic hose fittings and disconnect hose fitting at elbow.
5. Connect JTO3377 hose to motor using JTO3012 and JTO5688 connectors. Connect another JTO3377 hose to hose from backlap valve using JTO3012, JTO3483 and JTO3484 Connectors.
6. Connect JTO3377 hose from backlap valve into inlet port of DO1074AA Hydraulic Tester. Install hose from reel motor into outlet port.
7. Turn tester control knob out (counter-clockwise) completely.
8. Set front backlapping valve to forward (mow) position.
9. Start machine and run at full throttle.
10. Slowly turn tester control knob in (clockwise) and note flow and maximum pressure.
11. Turn out control knob and stop engine

Results:

- The reel pump should put out 22.7 L/m (6 gpm) at 20,683 kPa (3000 psi). If not, replace or rebuild pump.

IMPORTANT: After completing test check and top off Hydraulic reservoir.

REEL MOTORS CASE DRAIN TEST

NOTE: All three reel motors are the same and use the same procedure for testing.

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:

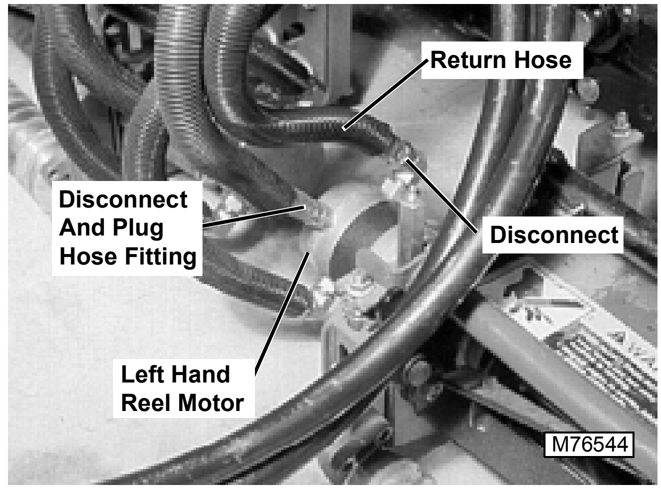
- D01074AA In-Line Hydraulic Tester
- JTO3377 (2) 120” Hydraulic Test Hoses
- JTO3012 (2) Connector 3/4” F NPT x 1-1/16” F 37°
- JTO5688 Connector 1-1/16” M 37° x 13/16” F ORFS
- JTO3483 Connector 1-1/16” M 37° x 1-3/16” M ORFS
- JTO3484 Connector 1-3/16” F ORFS x 13/16” M ORFS
- JTO5688 Connector 13/16” F ORFS x 1-1/16” M37°
- JTO3392 Plug, 13/16 M ORFS

Procedure:

1. Park machine on level surface, reels lowered, park brake on, engine off.
2. Block wheels to prevent inadvertent movement of the machine.
3. Check and top off Hydraulic reservoir.

CAUTION

To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.
Lower cutting units to the ground prior to removing any hydraulic lines or fittings.



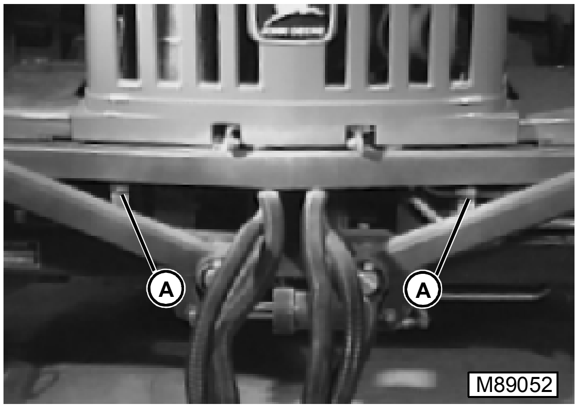
4. Place drain pan under reel motor to be tested. Clean hydraulic hose fittings and remove top/rear hose from elbow on motor.
5. Connect JTO3377 hose to motor using JTO3012 and JTO5688 connectors. Connect another JTO3377 hose to hose from backlap valve using JTO3012, JTO3483 and JTO3484 Connectors.
6. Connect JTO3377 hose connected to return line into inlet port of DO1074AA Hydraulic Tester. Install hose from reel motor into outlet port.
7. Remove case drain hose from motor. Plug hose with JTO3392 plug.
8. Place a 1/2” I.D. hose on center port fitting of both rear reel motors and place other end into a clean container.
9. Turn tester control knob out (counterclockwise) completely.
10. Set rear backlapping valve to forward (mow) position. (Knob pushed in.)
11. Have a helper technician start machine, run at full throttle and engage reels.
12. Turn tester control knob in (clockwise) until pressure reaches **2500 PSI**. Hold for **15 Seconds**.
13. Turn out control knob and stop engine.
14. Measure amount of oil in each container.
15. Multiply volume of oil in each container by 4 to arrive at amount of case drain in one minute.

Results:

- Reel motor case drain should not exceed 3.78 L/m (1 gpm). Rebuild or replace motors.

IMPORTANT: After completing test check and top off Hydraulic reservoir.

FRONT LIFT ARM ADJUSTMENT



1. Push down on one of the lift arms.
2. Measure the distance between the lift arm stop and the adjustment bolt head (A).
3. Turn the adjustment bolts equally in or out to obtain 6 mm (0.236 in.) total clearance between the adjustment bolt and the lift arm stop.

REPAIR

LIFT SYSTEM

AMT1931 ORIFICE INSTALLATION

1. Remove oil line (A).

2. Remove straight adaptor fitting (B) from weight transfer valve and replace with orifice fitting AMT1931.
3. Replace oil line (A) making sure all O-rings are in place.

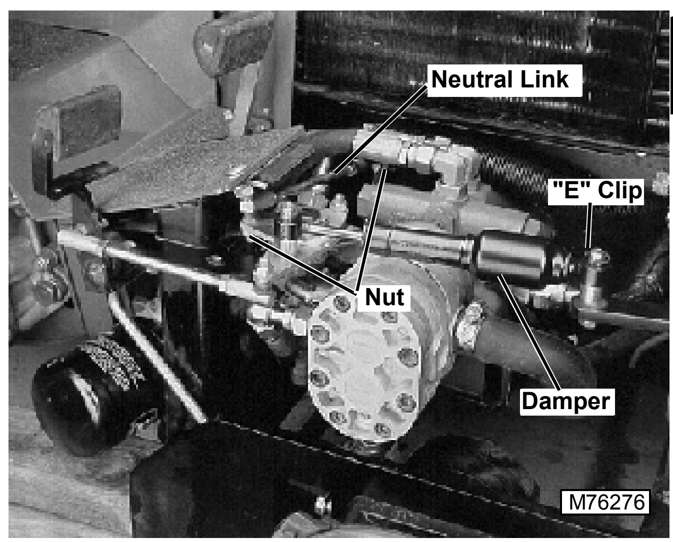
DOUBLE PUMP REMOVAL

1. Park vehicle on a level surface reels lowered, park brake locked, engine off.
2. Block wheels to prevent inadvertent movement of the machine.
3. Disconnect battery.
4. Place a 10 gallon container below the Hydraulic sump and drain oil.
5. Drain coolant from Radiator/Engine. Drain cock is located under frame on lower left side of radiator.

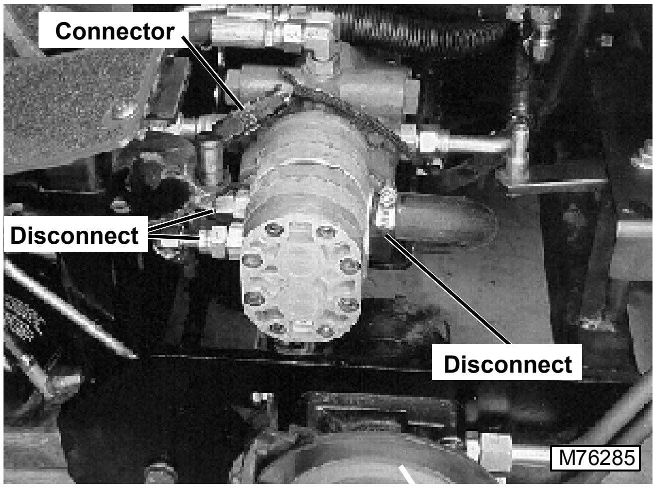
CAUTION

To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.
Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

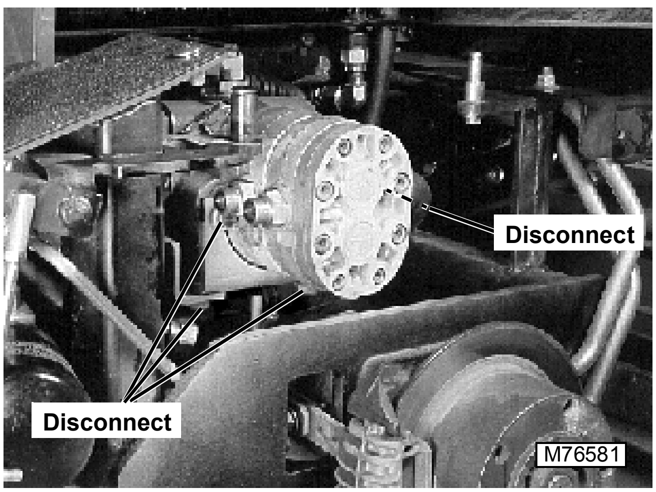
6. Remove Neutral Linkage by disconnecting the Link from the cam plate and the Pintle Lever.
7. Remove "E"-Clips from Damper mounting studs and remove Damper.



8. Clean port areas of the double pump assembly and Hydrostatic pump with a suitable solvent.
9. Separate electrical connector for the neutral switch.



10. Place drip pan under double pump to catch oil that will leak out when lines are disconnected.
11. Mark for reinstallation and disconnect all hydraulic lines connected to the double pump assembly.



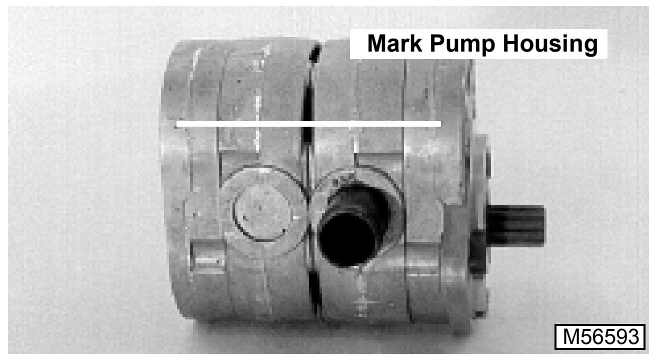
12. Remove TORX head bolts securing the double pump to hydrostatic pump.
13. Remove bolts securing pump support bracket to subframe.
14. Pull double pump assembly from hydrostatic pump by sliding forward to disengage spline shaft.

DOUBLE PUMP DISASSEMBLY

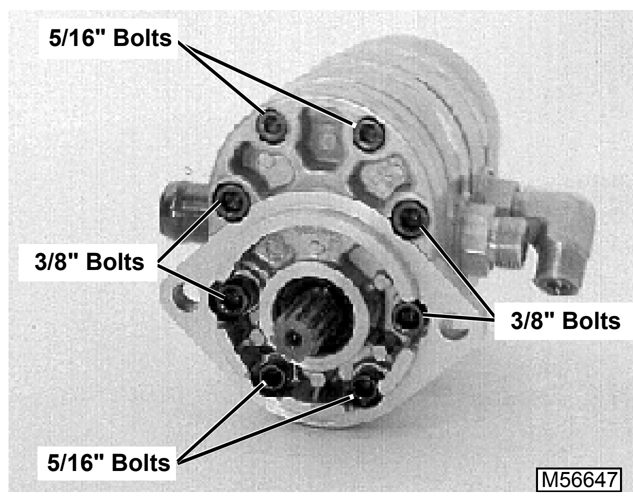
SEPARATING DOUBLE PUMPS

CAUTION

Pump components are aluminum. Use extreme care in cleaning all machine surfaces of old gasket materials. Use of steel pry bars etc. can severely damage the machined surfaces of the pumps.

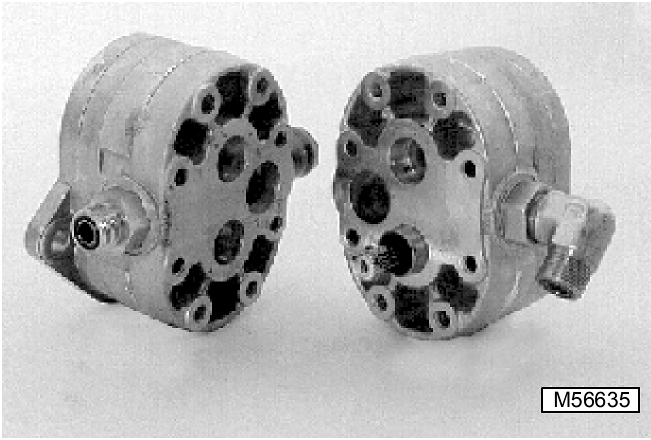


1. Mark pump housing with solvent resistant marker or paint to guide reassembly



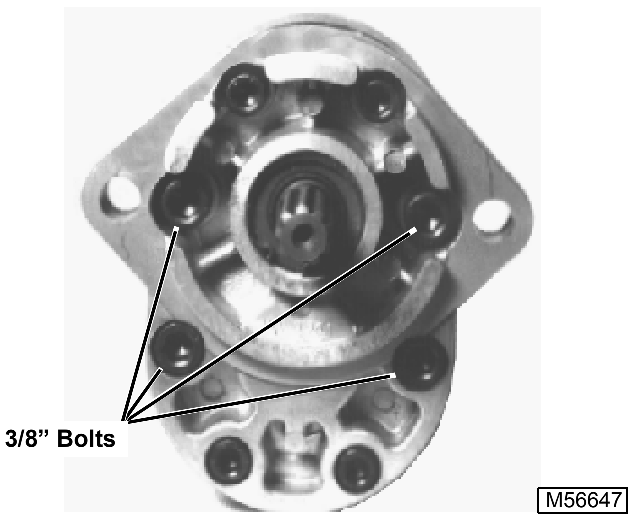
2. Remove four 5/16” Allen head bolts that hold center section of double pump together.

NOTE: Make sure to keep washers with bolts.



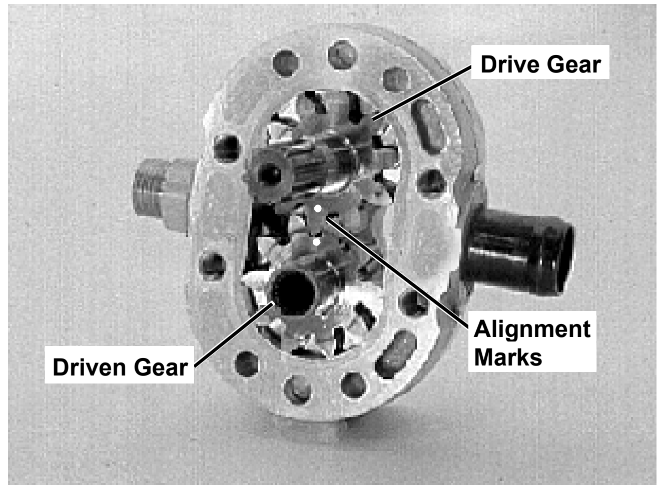
3. Separate center section of pump into halves.

DISASSEMBLY - REEL PUMP (FIRST PUMP)

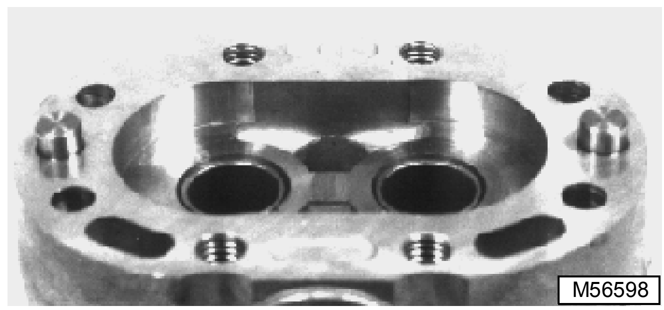


1. Remove four 3/8” Allen head bolts holding end plate to pump body.
2. Carefully separate pump halves.

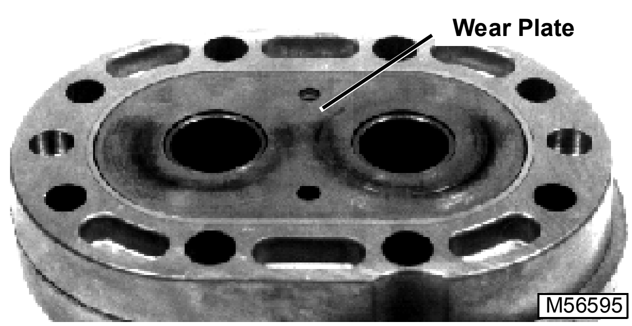
NOTE: It may be necessary to tap lightly on the end of the drive shaft with a soft paced hammer to assist in separating the pump halves.



3. Mark mating teeth of gear pump for assembly.
4. Remove pump shaft and gears

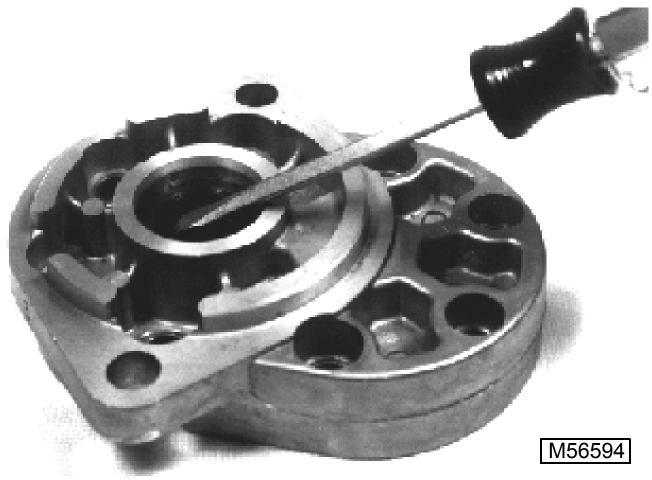


5. Inspect housing and shaft bearings for scratches, scoring or fretting. Replace individual pump section if worn.



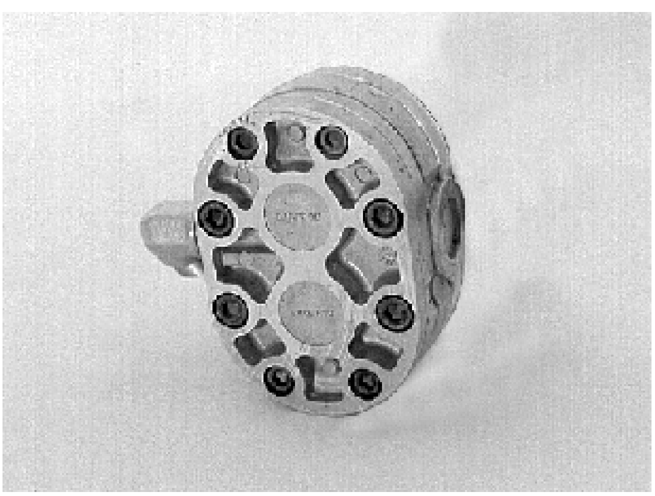
6. Remove the wear plate.

7. Remove formed seals.

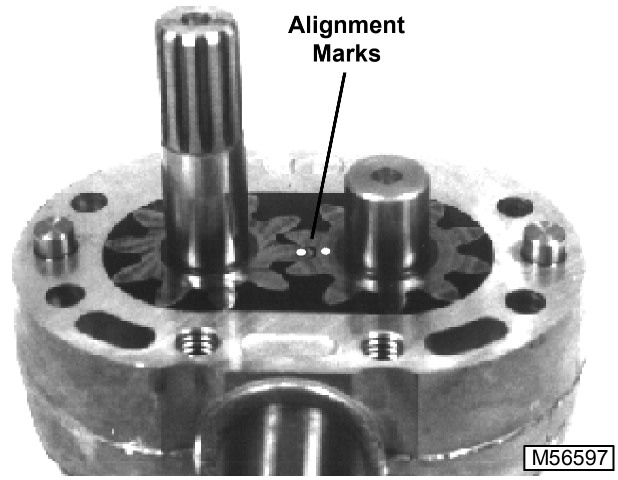


8. Remove the shaft seals.

DISASSEMBLY - CHARGE PUMP (SECOND PUMP)



1. Remove Allen head bolts holding end plate to pump body.
2. Carefully separate end plate of center pump from other pump housing
3. Clean old gasket from pump housings



4. Separate end plate from pump body.
5. Mark the mating teeth of the gears for assembly.
6. Remove gears. Inspect housing and shaft bearings for scratches, scoring or fretting. Replace individual pump section if worn.

DOUBLE PUMP ASSEMBLY

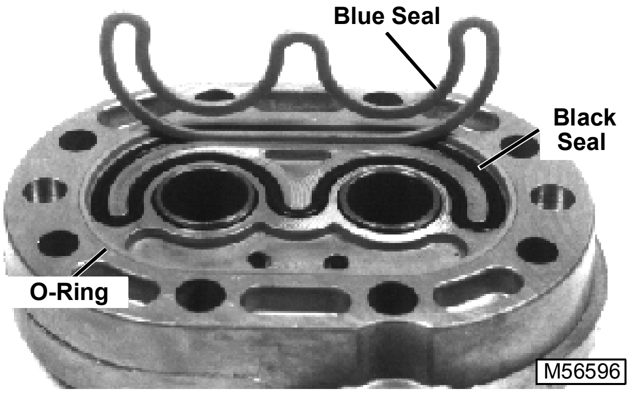
NOTE: Always use new wear plates, gaskets, and seals when rebuilding hydraulic components.

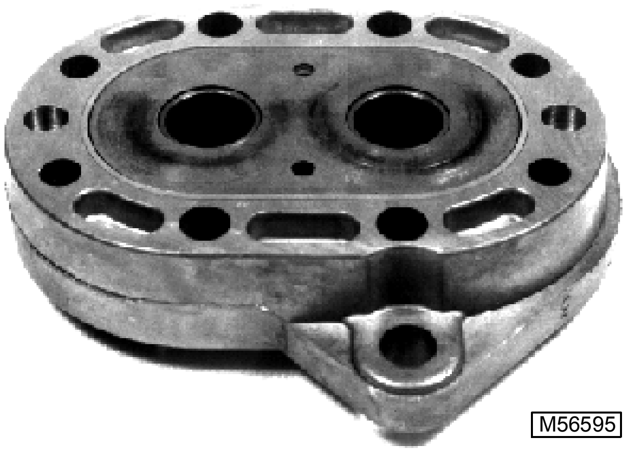
NOTE: Assembly procedure for both pumps is the same.

1. Clean all components of old gasket material and debris with suitable solvent and blow dry.

> **CAUTION**
>
> **Pump components are aluminum. Use of steel scrapers etc. can severely damage the machined surfaces of the pumps. Use extreme care in cleaning all machine surfaces of old gasket materials.**
> **Extreme caution must be used when using a vise to avoid distorting any parts.**

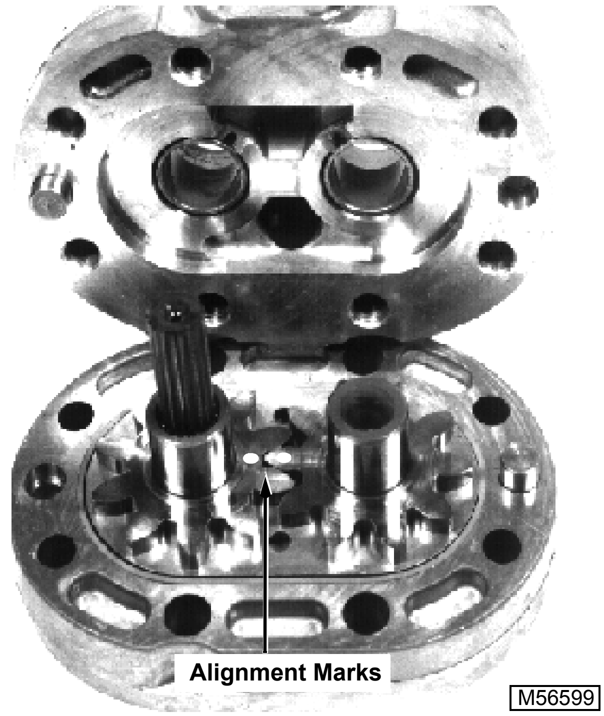
2. Install seals and O-rings on flat end plate of pumps.





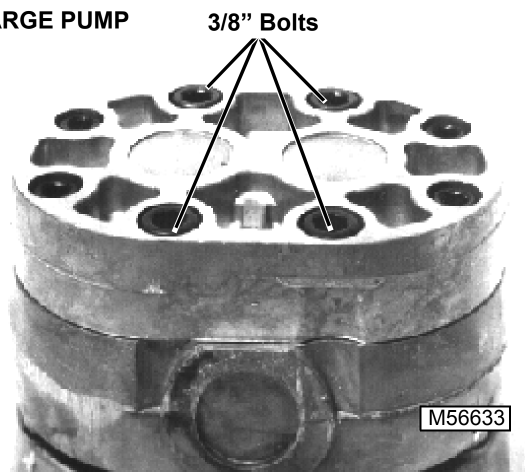
3. Lubricate wear plate and install with bronze side facing gears

4. Install new shaft seals on flanged pump housing using suitable seal driver. Lubricate inner seal lip with grease.



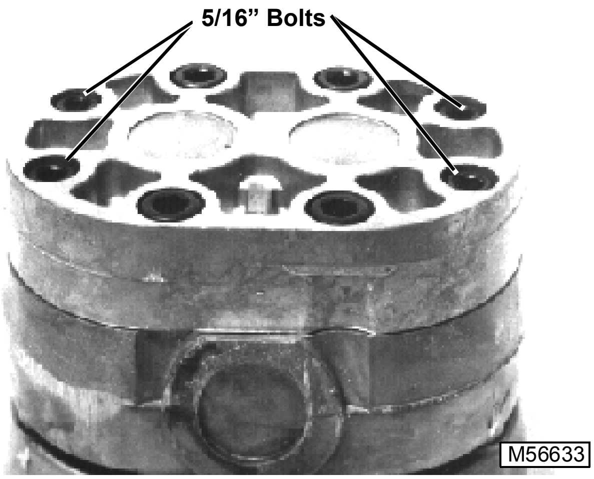
5. Lubricate wear plate and install with bronze side facing gears.
6. Install gears with alignment marks lined up.
7. Install dowel pins if removed.

CHARGE PUMP

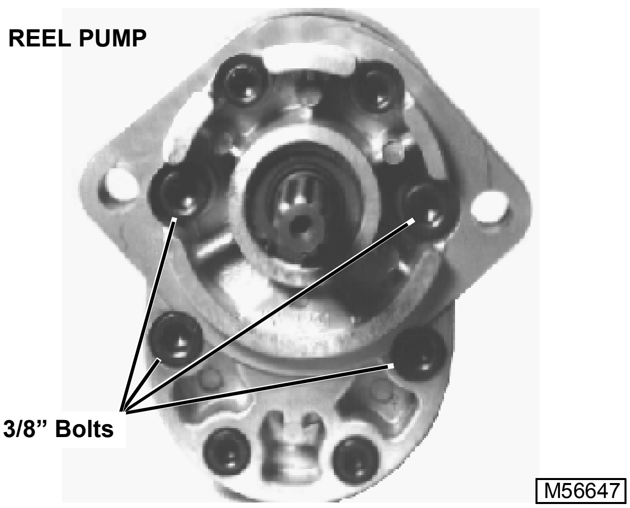


8. Install reel pump end plate.

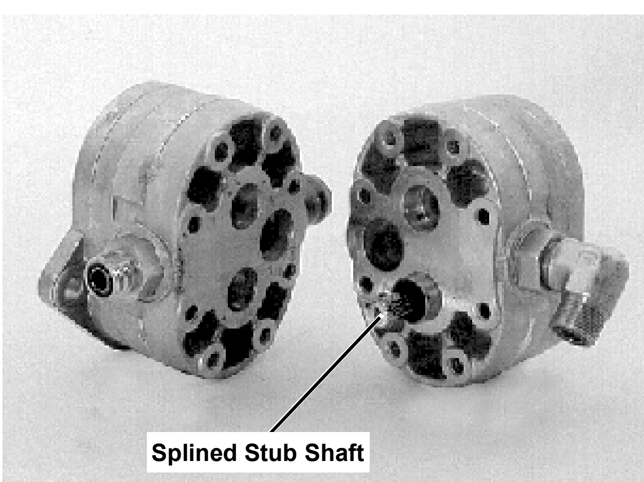
Loosely install four 3/8”” Allen bolts. Rotate drive shaft to be sure pump is not binding. Torque bolts evenly to **40.7—43 N•m (360—380 in-lbs.)**



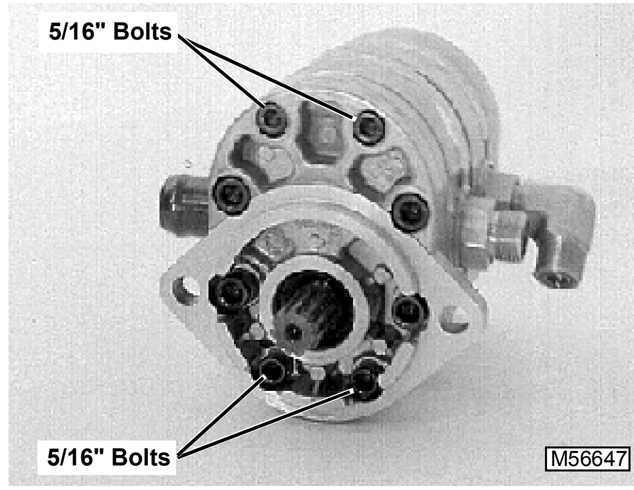
9. Install four 5/16” x 3” Allen head bolts to hold end pump to center pump housing.
   Torque to **21.5—23.7 N•m (190—210 in-lbs)**.



10. Install reel pump end plate.
11. Loosely install four 3/8" Allen bolts. Rotate drive shaft to be sure pump is not binding. Torque bolts evenly to **40.7—43 N•m (360—380 in-lbs.)**

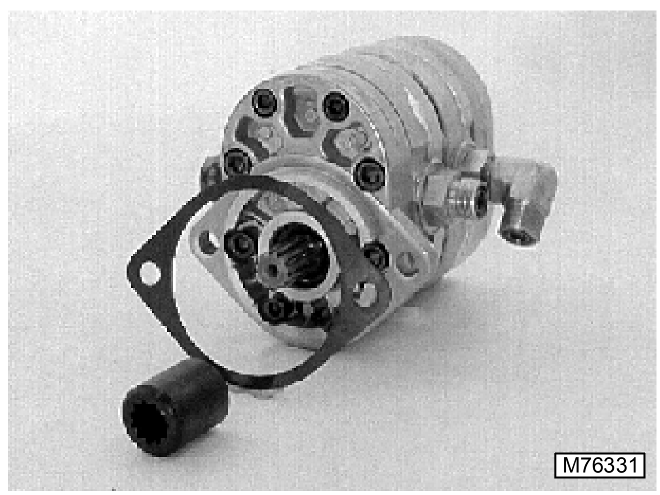


12. Install splined stub shaft in charge pump drive gear shaft.
13. Install gasket on end pump
14. Place charge pump body on reel pump assembly, aligning bolt and shaft holes.

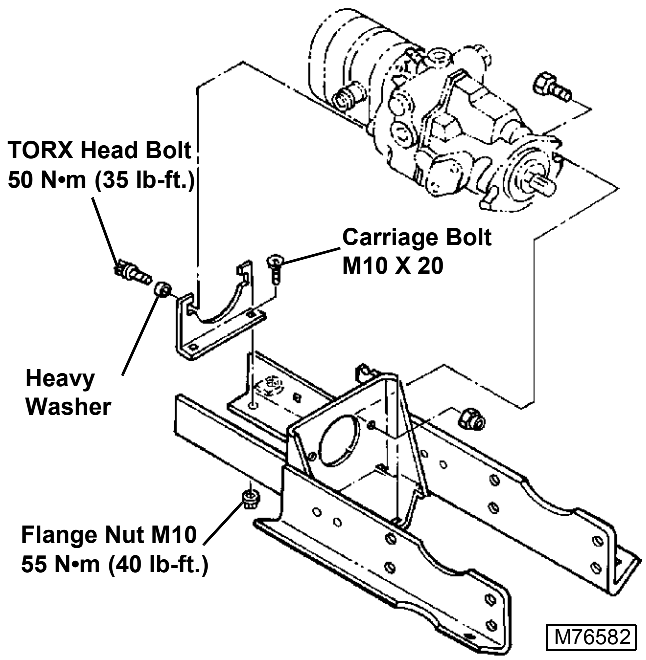


15. Loosely install four 5/16” x 4” Allen head bolts
16. Rotate drive shaft to check for binding.
17. Evenly torque bolts to **21.5—23.7 N•m (190—210 in-lbs)**

DOUBLE PUMP INSTALLATION

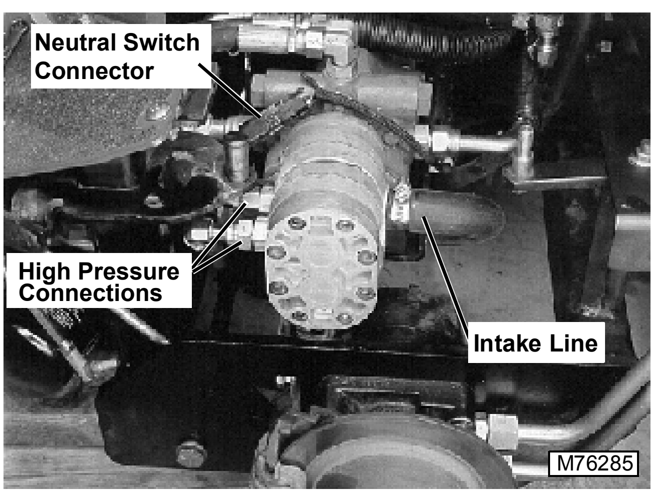


1. Install coupler onto drive shaft.
2. Place gasket on pump flange.

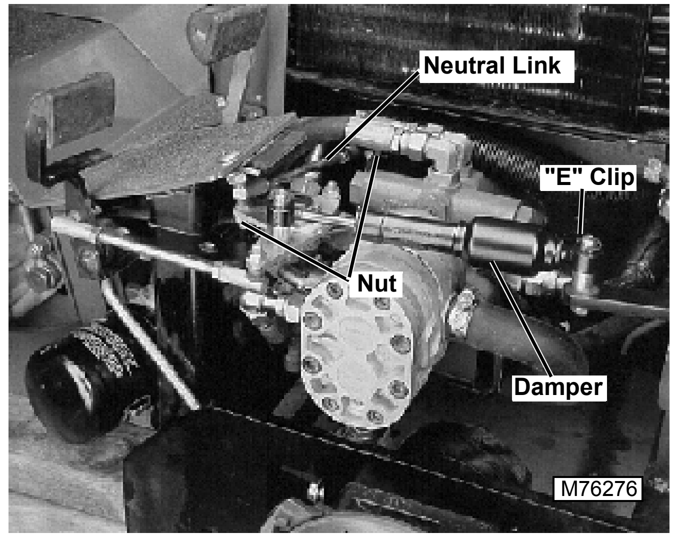


3. Set double pump in place, lining up coupler splines and mounting holes on hydrostatic pump.
4. Locate pump support bracket and attach to frame with two (2) Carriage bolts and nuts. Tighten finger tight at this time.
5. Place heavy washer on TORX head bolts and install bolts through pump support bracket slots, double pump mounting flange, and into hydrostatic pump. Tighten finger tight only at this time.
6. Torque all mounting bolts at this time to the following specifications:

Torx Head Bolts . . . . 50 N•m (35 lb-ft.)
Carriage Bolt Nut . . . . 55 N•m (40 lb-ft.)



7. Install two high pressure hoses to left side of double pump.
8. Install pump intake line from reservoir to right side of double pump
9. Connect neutral switch.



10. Install Neutral Link, place damper on mounting studs and secure with "E" clips.

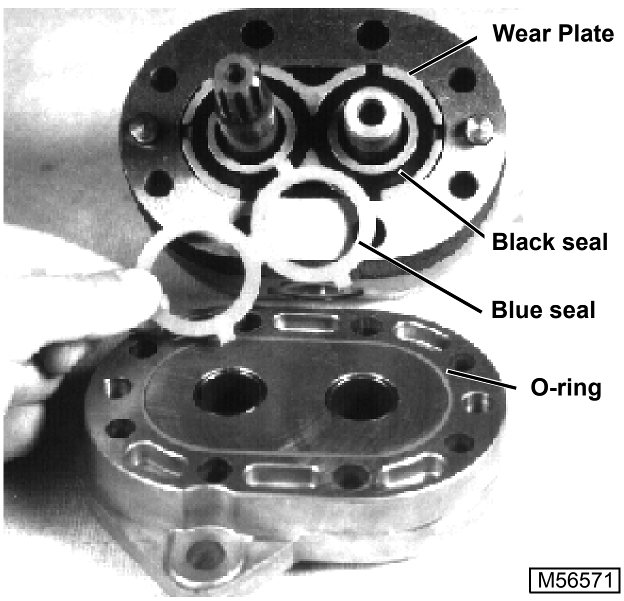
HEAVY DUTY (YC SERIES) REEL MOTOR REPAIR

DISASSEMBLY

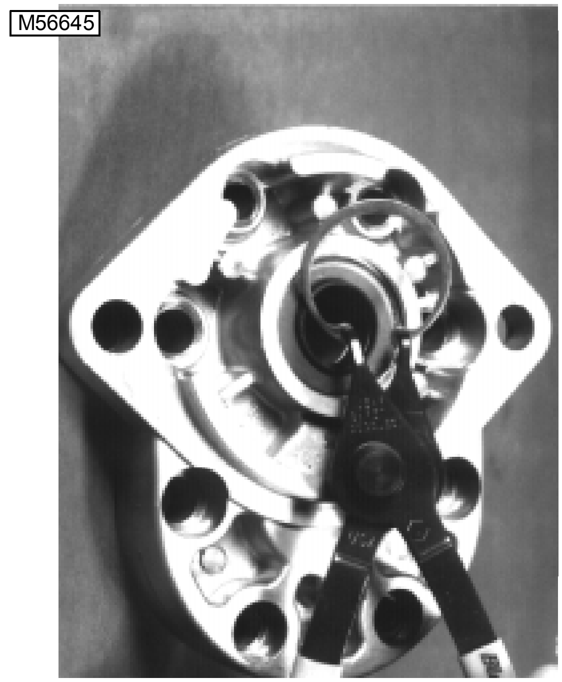
⚠ CAUTION

Never pry components apart. Light tapping with a plastic hammer on drive shaft will separate components without burring.

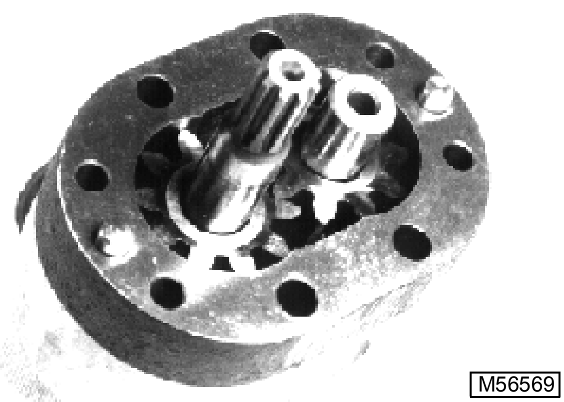
IMPORTANT: Be careful not to drop any parts or disengage gear mesh when separating assemblies.



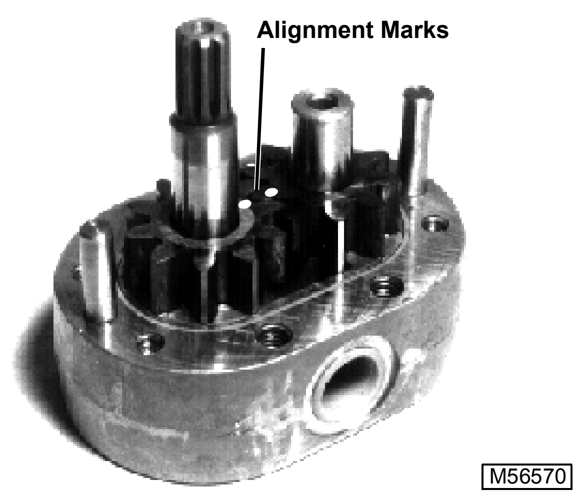
1. Remove eight allen head bolts and separate the cover from the gear housing.
2. Remove seals and wear plate.



3. Remove internal snap ring from shaft seal
4. Remove shaft seal using a two jaw puller

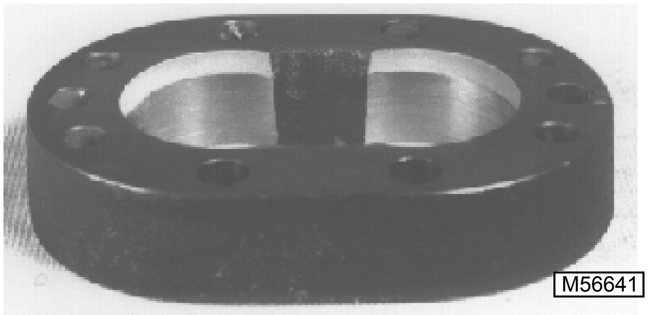


5. Remove center bore section. Do not disturb gears



6. Mark mating teeth of pump gears for assembly

7. Remove gears. Inspect for scoring, burrs, fretting or uneven wear patterns, replace pump assembly if gears are worn.



M56641

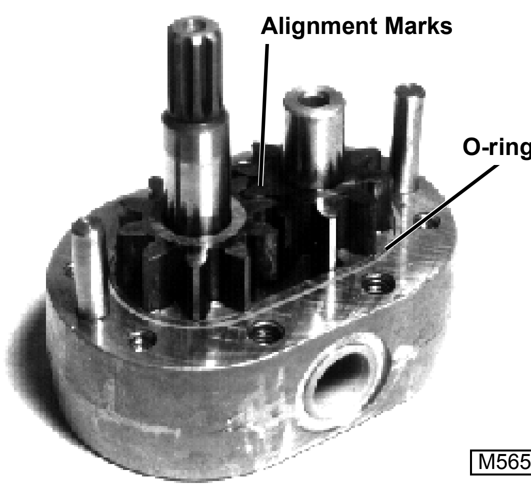
8. Inspect bore area for scoring, burrs, fretting or uneven wear patterns, replace pump assembly if worn.

ASSEMBLY

1. Clean all parts with suitable solvent. Blow dry.

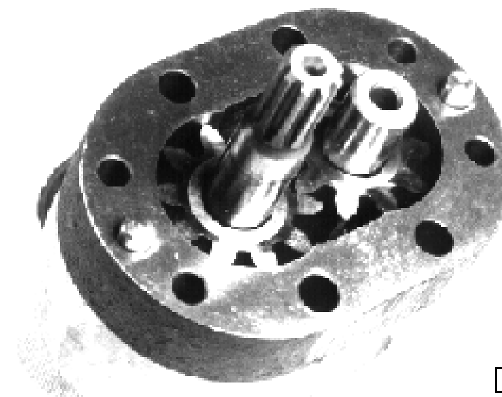
Service Parts

- Seal Kit AMT419



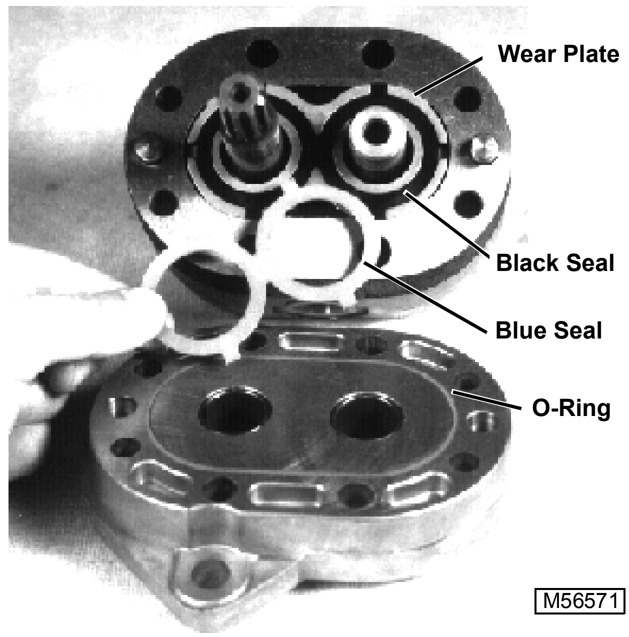
M56570

2. Install gears. Be sure gear teeth are matched to alignment marks
3. Install dowel pins if removed.
4. Install O-ring seal.



M56569

5. Install center bore section.

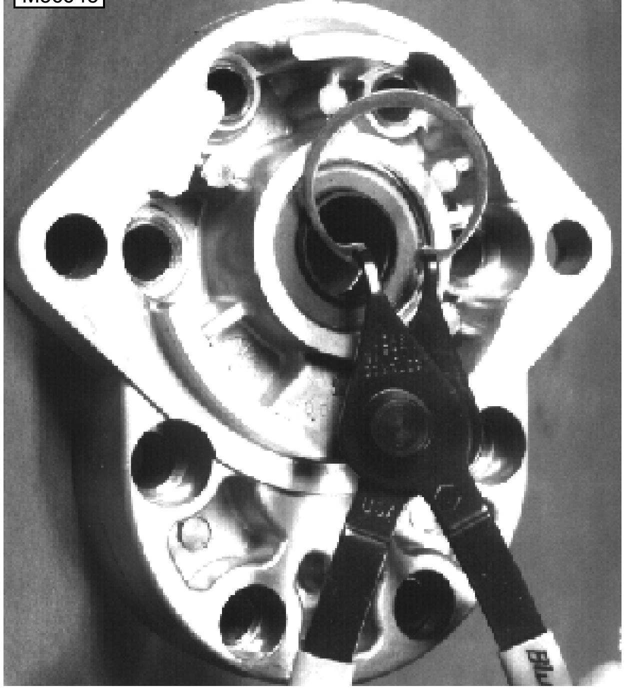


M56571

6. Install wear plate and seals.

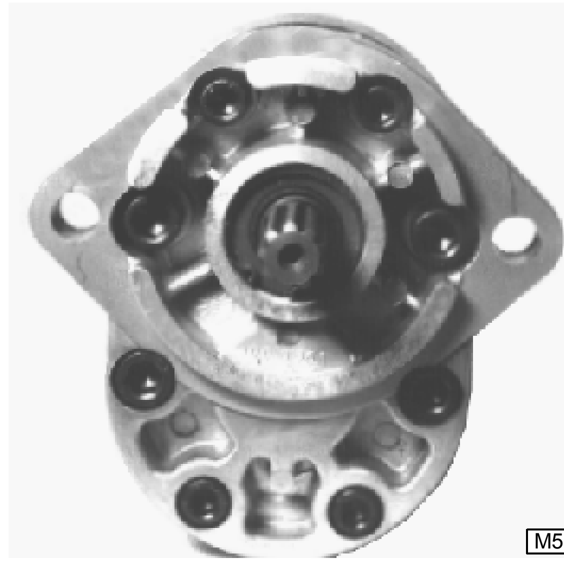
7. Press in shaft seal (metal side facing out) using a suitable seal driver

M56640



M56645

8. Install snap ring, ensure sharp edge of ring faces out.

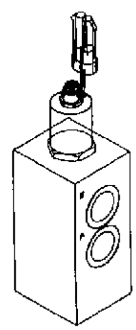


M56647

9. Install eight 5/16” Allen head bolts and torque evenly to **21.5—23.7 N•m** (**190—210 in-lbs)**

MOW VALVE

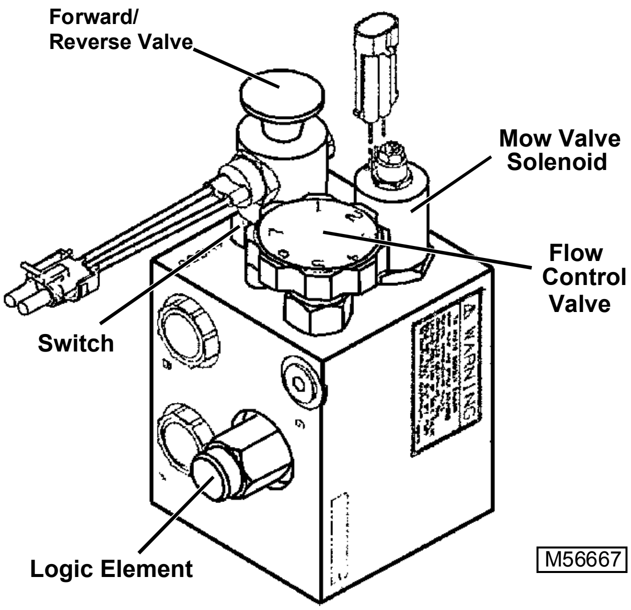
Standard Mow Valve



M89021

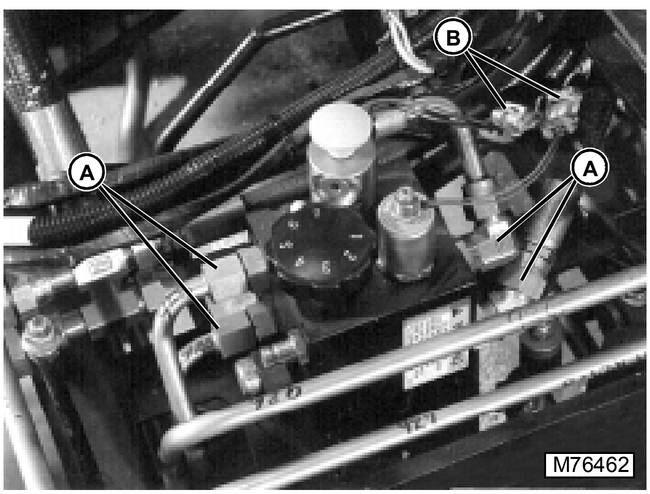
NOTE: See Mow Valve Solenoid Plunger to replace O-rings.

Mow Valve with Backlapping Capability



MOW VALVE REMOVAL

1. Place drain pan under mow valve



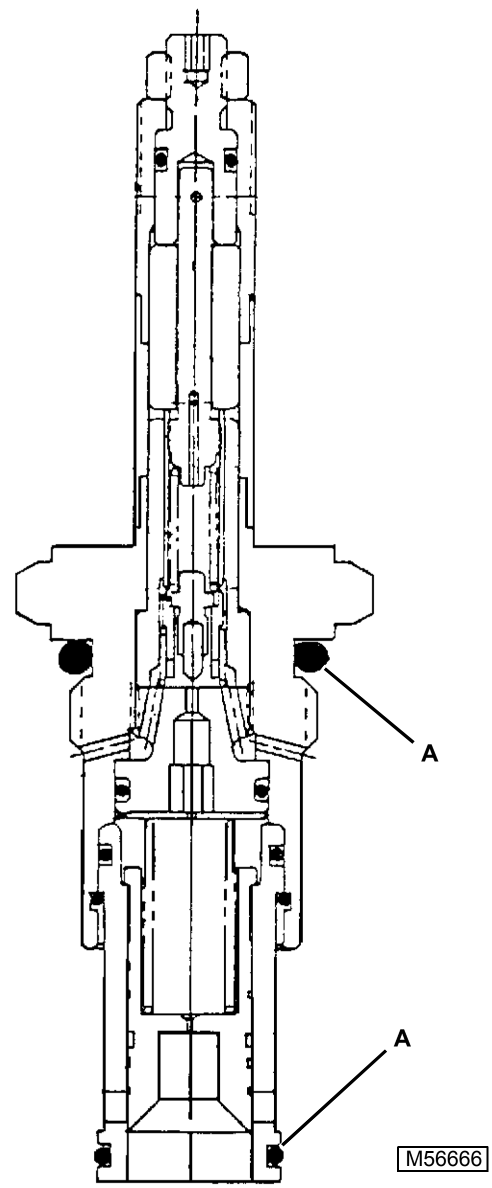
2. Label and remove four hydraulic lines (A) to valve body.
3. Remove two electrical connectors (B) to harness
4. Remove two mounting bolts holding valve body to frame

MOW VALVE 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 for individual components:

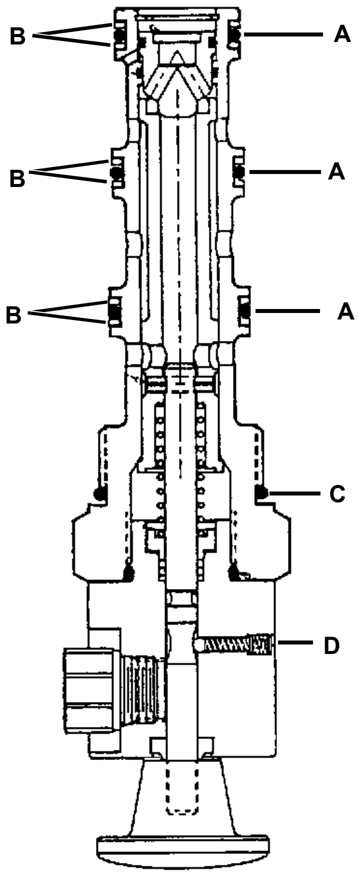
NOTE: *If the standard mow valve is being repaired, follow procedures for Mow Valve Solenoid Plunger for O-ring replacement. Tighten plunger to 95 N•m (70 lb-ft.) and solenoid coil to 31N•m (22 lb-ft.).*

MOW VALVE SOLENOID PLUNGER



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

FORWARD/REVERSE VALVE



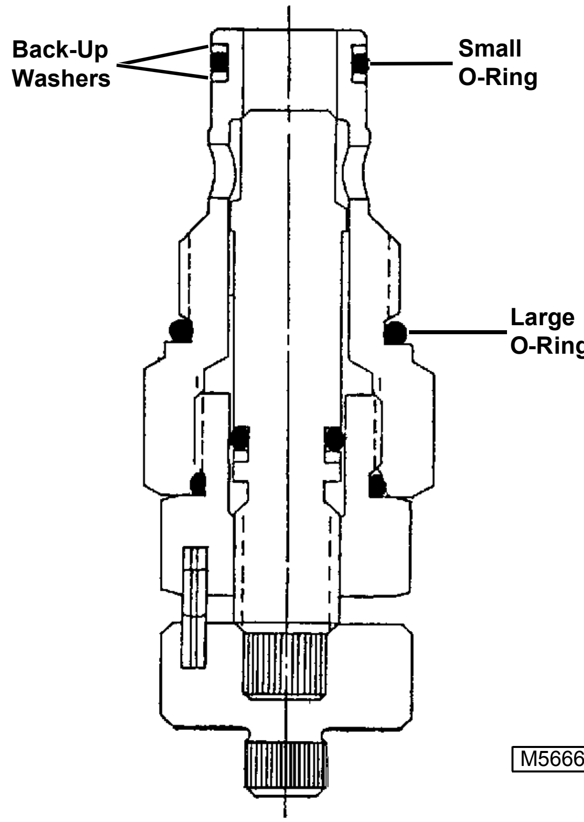
M56665

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.

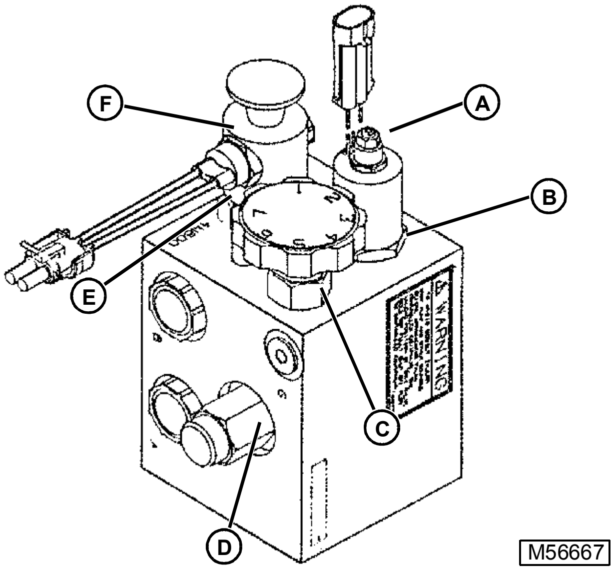
FLOW CONTROL VALVE



M56664

6. Ensure small O-ring is installed between back-up washers. Install large O-ring. Lubricate O-rings and back-up washers before installing flow control valve.

MOW VALVE ASSEMBLY



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

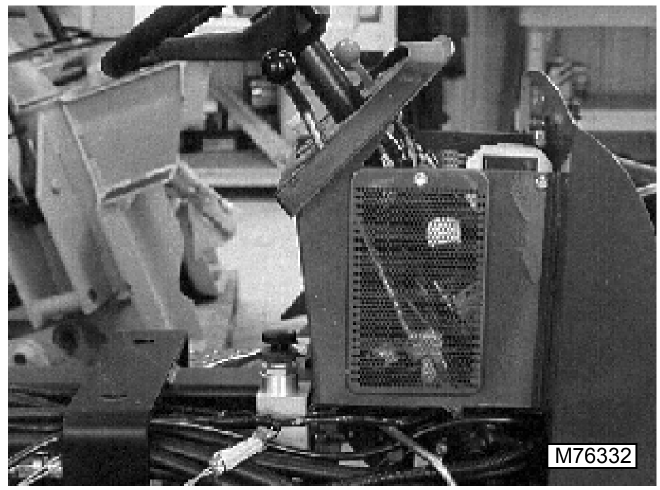
Item	Description	Torque N•m (ft-lbs)
A	Solenoid Coil	31 (22)
B	Solenoid Plunger	95 (70)
C	Flow Control Valve	65 (47)
D	Pressure Relief Valve	65 (47)
E	Forward/Reverse Valve	237 (175)
F	Switch	17 (12)
	SAE Plugs	
	#2	58 (42)
	#4	12 (9)
	#6	28 (17)

LIFT VALVE REMOVAL

CAUTION

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

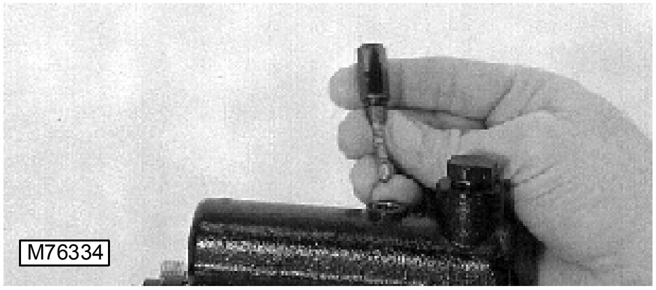
1. Remove four carriage bolts securing tunnel panel to frame. Remove tunnel panel with seat.



2. Remove inspection grill on right side of steering housing to gain access to lift valve.
3. Disconnect hydraulic lines at lift valve.
4. Remove link connecting the lift valve to the lift handle. Remove two bolts securing lift valve to instrument cluster frame. Remove valve.

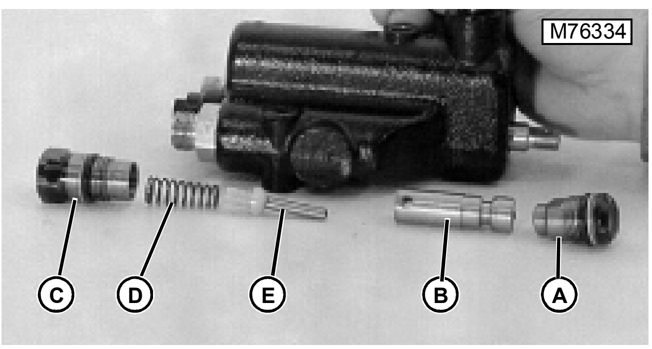
LIFT VALVE DISASSEMBLY

NOTE: Plug all ports and wash valve assembly with a suitable solvent before disassembly.

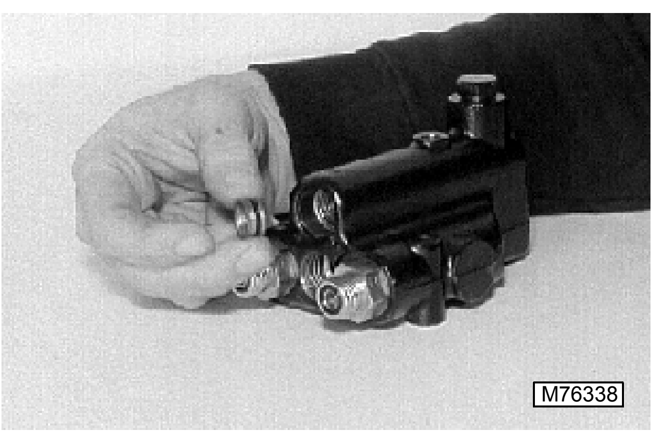


1. Remove detent plunger and spring.

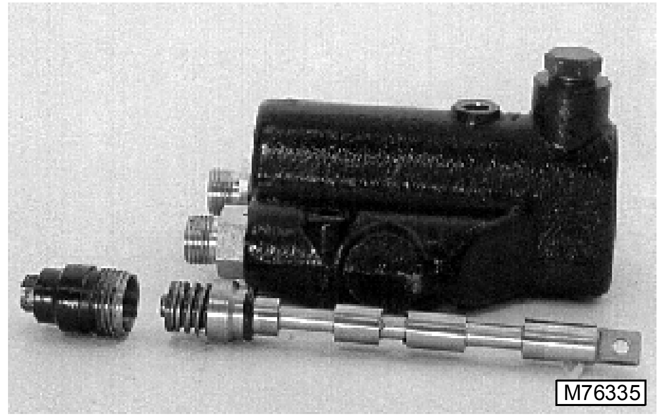
IMPORTANT: Detent Plunger must be removed prior to removal of the spools. Failure to do so will damage detent plunger and/or spool.



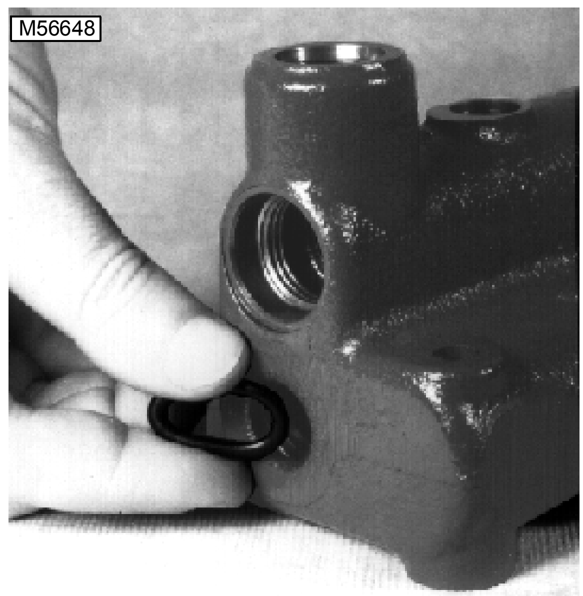
2. Remove plug (A) and spool (B) from one end of valve and cap (C), spring (D), and plunger (E) from other end.



3. Remove orifice from top center bore. Push out from back side with brass rod.



4. Remove cap, spool assembly from lower center port.



5. Remove O-ring from lower spool port.

LIFT VALVE INSPECTION

- Clean all parts with a suitable solvent, clean bores with a brush hone and solvent.
- Inspect bores in valve housing for scoring.
- Inspect spools for scoring, fretting and straitness.
- Check all springs for breakage.
- Replace all seals and O-rings.
- If any parts are worn, the valve assembly must be replaced.

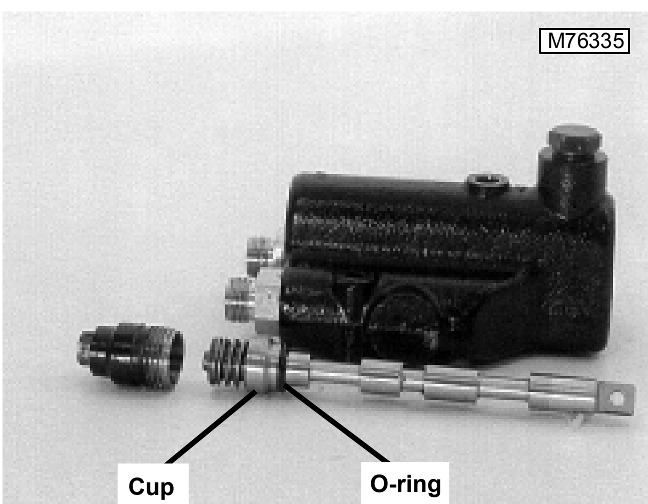
LIFT VALVE ASSEMBLY

SERVICE PARTS

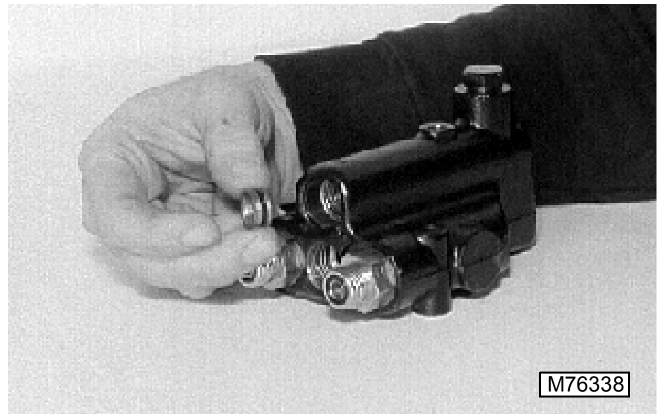
- Seal Kit
- Solenoid Assembly

IMPORTANT: Use plenty of fresh hydraulic oil to lubricate parts during assembly.

1. Lubricate and install O-ring into cavity of housing.

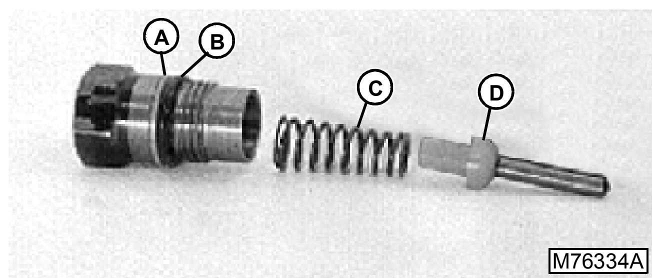


2. Lubricate O-ring and cup. Slide cup and O-ring onto spool and install spool into housing.

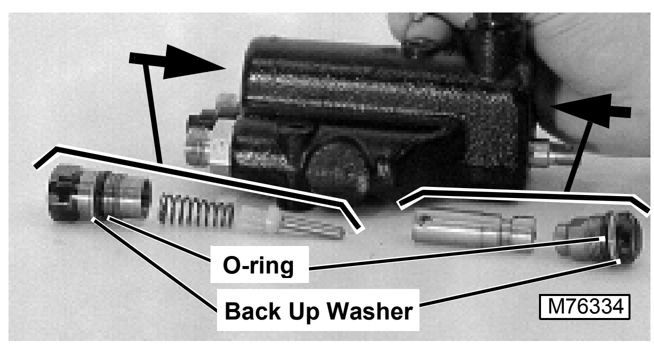


3. Install new O-ring on orifice plate and push plate into top center bore with tapered pocket facing out.

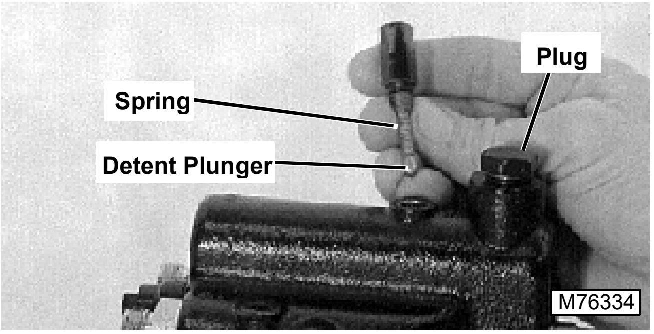
NOTE: Spring is tapered. Install larger end in body of fitting.



4. Lubricate and install back up washer(A) and O-ring (B). Assemble spring (C) and return plunger (D) as shown.



5. Replace O-rings and back up washers on both caps.
6. Install end fitting and plunger assembly. Torque fitting to **44 N•m (33 Lb-ft)**
7. Install detent plunger and screw cap. Torque screw cap to **44 N•m (33 Lb-ft)**



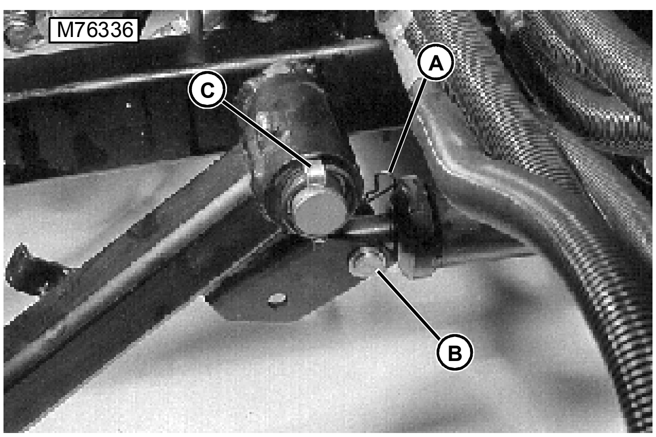
8. Install detent plunger (E), spring (F) and body (G). Torque to **4 N•m (40 Lb-in)**.
9. Replace O-ring on Plug and Torque to **14 N•m (10 Lb-ft)**

LIFT VALVE INSTALLATION

1. Secure valve to brake with two capscrews. Torque to **4 N•m (40 Lb-in)**.
2. Install hydraulic connections.
3. install control link.

LIFT ARM REMOVAL

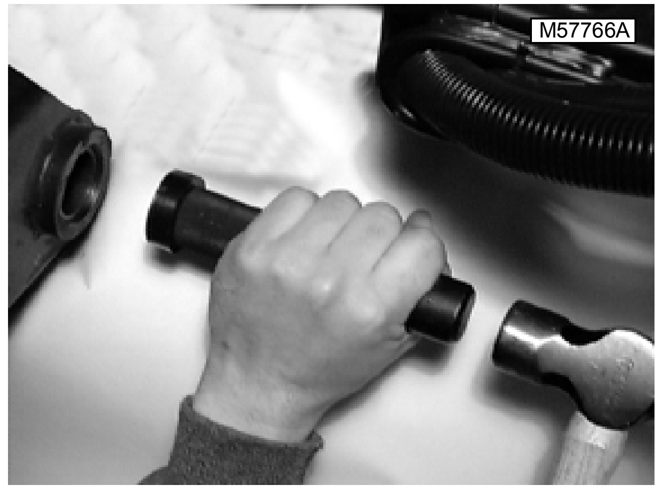
1. Remove cutting units from lift arm being serviced
2. Remove hydraulic hoses from hose support (if applicable) on top of lift arm by unwinding from support spiral



3. Remove hairpin clip (A) from hydraulic cylinder attachment pin (B) and remove pin from lift arm yoke. Secure cylinder to frame with wire to keep work area clear
4. Remove retaining lynch pin (C) lift arm pivot
5. Remove lift arm shaft from frame pivot pin

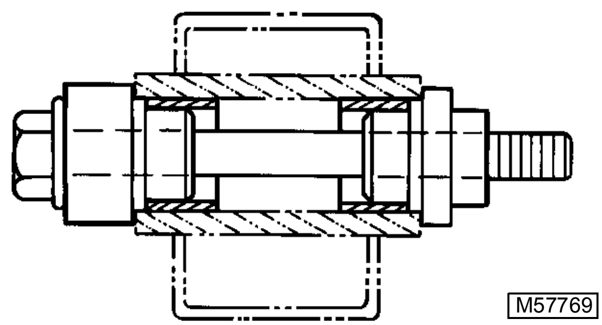
LIFT ARM BUSHING REMOVAL

1. Remove lift arm (see Lift Arm Removal)



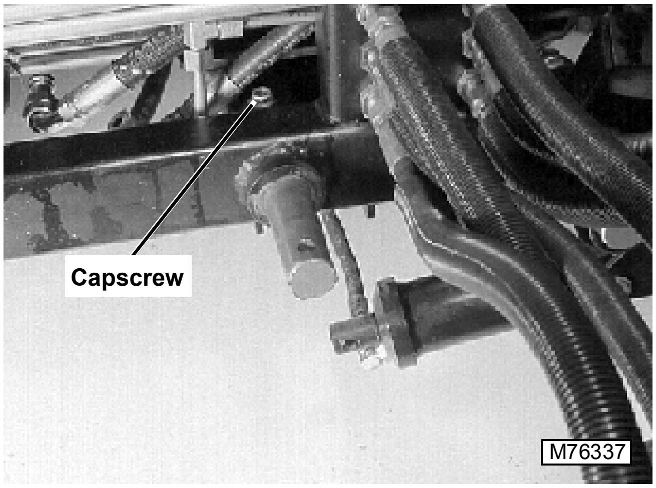
2. Using 1-5/8” bearing driver, drive front and rear bushing out of lift arm tube

LIFT ARM BUSHING INSTALLATION



1. Place bushing on threaded end of JDG892 installation tool and place on back of lift arm frame tube. Place front bushing on front half of tool and thread bolt from front to rear of tool.
2. Tighten bolt on tool to pull bushings into frame tube until bearing face is flush with face of tube.

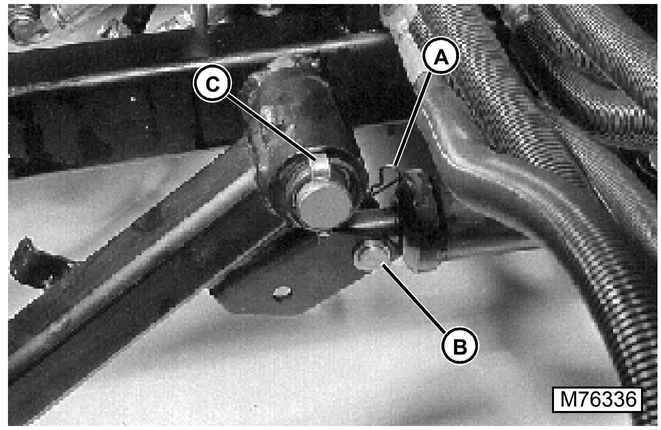
LIFT ARM PIN REPLACEMENT



1. Remove capscrew retaining pin in vehicle frame.
2. Inspect pin for scoring or excessive wear. Replace if necessary.
3. Replace pin and secure with capscrew.

LIFT ARM INSTALLATION

1. Clean old grease from lift arm and frame tube
2. Inspect bushings for wear. Replace if necessary.



3. Place lift arm pivot on lift arm pivot shaft.
4. Install lynch pin (C) on end of lift arm pivot shaft.
5. Lift cylinder end into place and secure with attachment pin (B) and hairpin clip (A).

IMPORTANT: Cylinder pin (B) should always be installed from the reel side of the bracket (as shown).

LIFT CYLINDER REMOVAL

1. Park machine on level surface, reels lowered, park brake on, engine off.
2. Block wheels to prevent inadvertent movement of the machine.

CAUTION

To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.
Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

1. Remove hydraulic hoses.
2. Remove cotter keys and washers at end of hydraulic cylinder mounting pins.
3. Remove mounting pins and cylinders.

NOTE: Lift cylinders are not rebuildable. If a cylinder is defective replace entire unit.

4. Replace cylinder.
5. Check and top off Hydraulic reservoir.

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SPECIFICATIONS

Make	John Deere
Size	66 cm (26 in.)
Backlapping	On machine variable speed (Standard)
Clip Ratio	
5 Blade	0.201/mph
8 Blade	0.126/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 — 1-5/8 in.) (1-1/2 — 3-1/2 in.)
Number of Blades	(5 or 8)
Cutting Unit Drive	Hydraulic

Options:

Rear Solid Roller Scraper	Optional

REPAIR SPECIFICATIONS

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	47 N•m (35 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

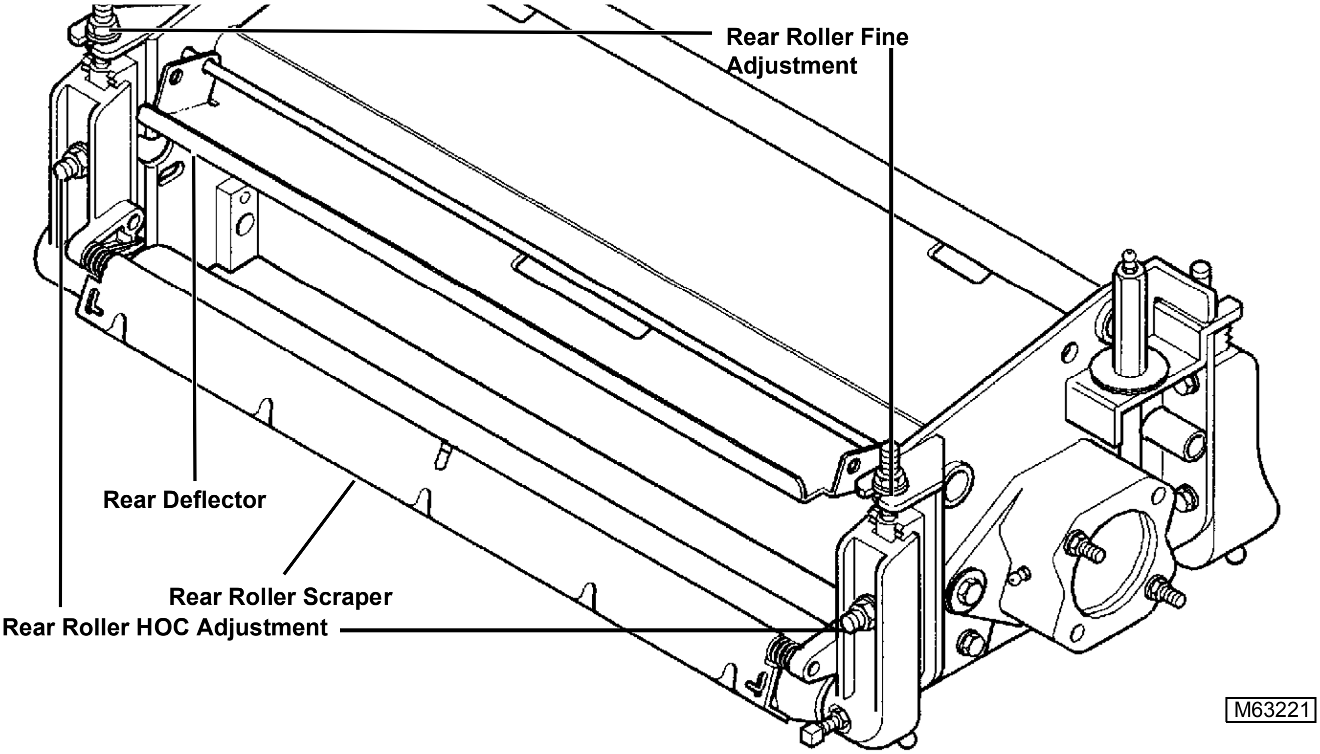
Roller Mounting

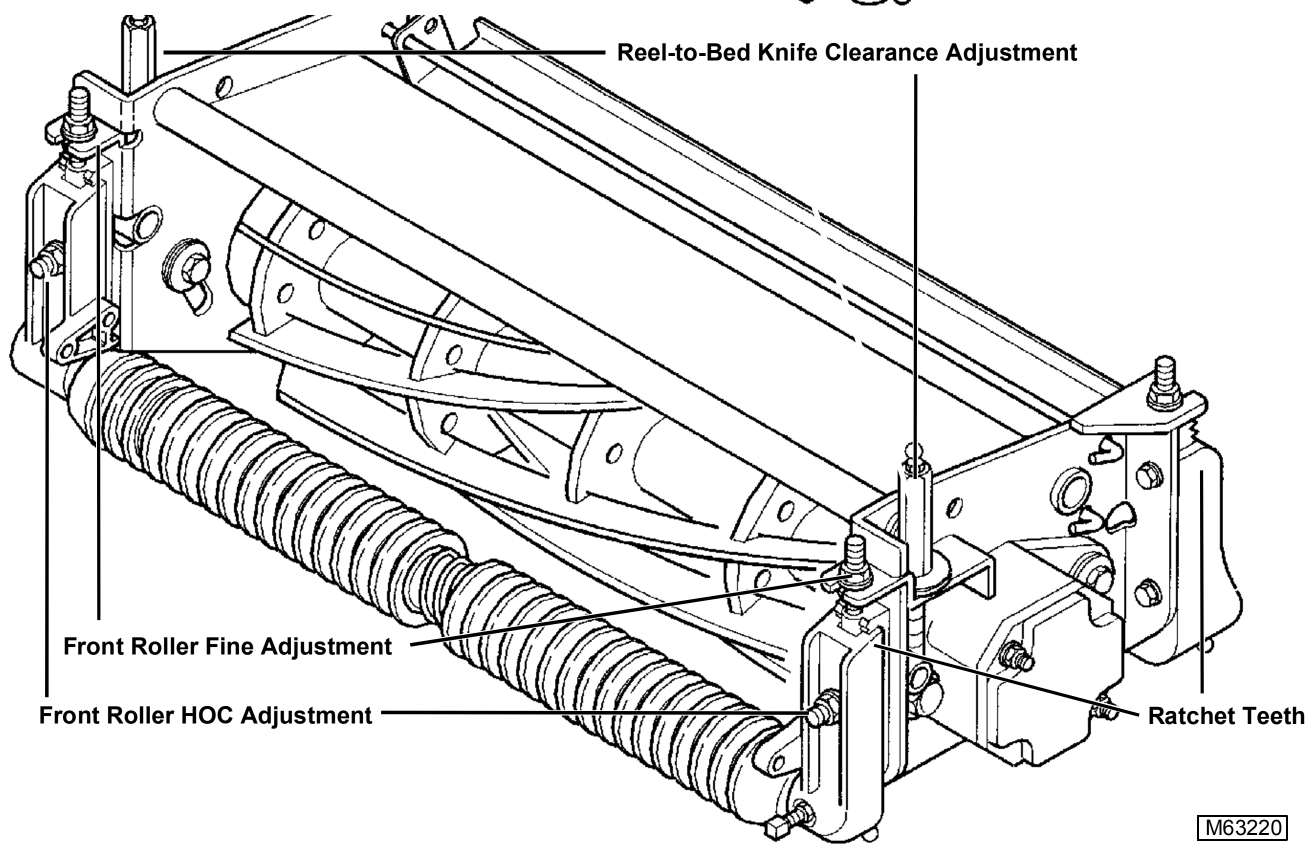
Bolts	47 N•m (35 lb-ft.)
Shaft end-play	0.152 mm (0.006 in.)

Reel/Bed Knife Clearance

Range	0.001-0.003 in.

COMPONENT LOCATION





TROUBLESHOOTING

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

THEORY OF OPERATION

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 0.002 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 rollover, 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).

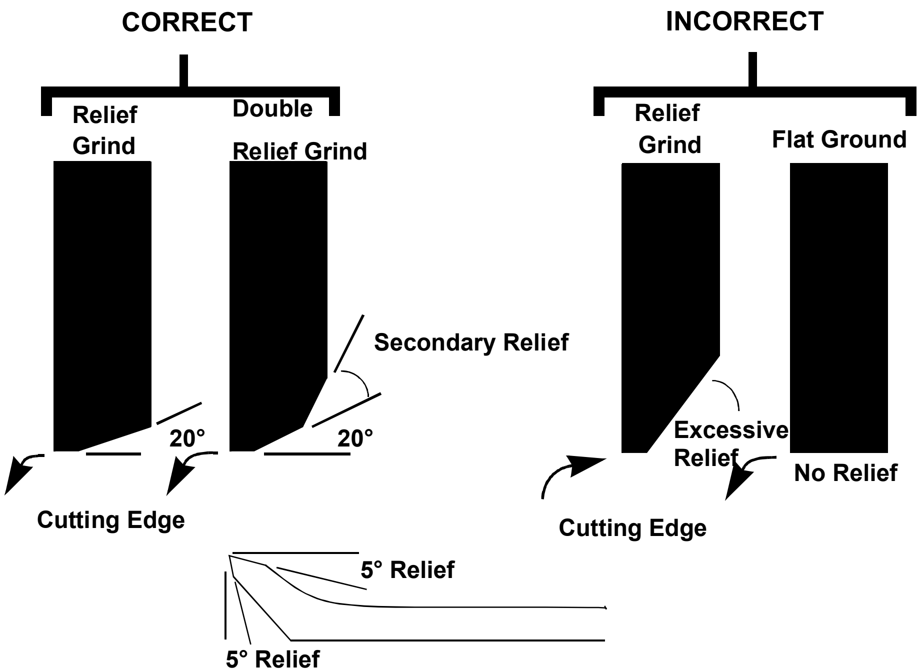
Cutting action begins as the bed knife positions the grass to be cut at the cutting edge. The reel then pulls the grass towards the bed knife where it is sheared by the cutting edges as they pass one another.

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 0.001" to 0.002" 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 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:

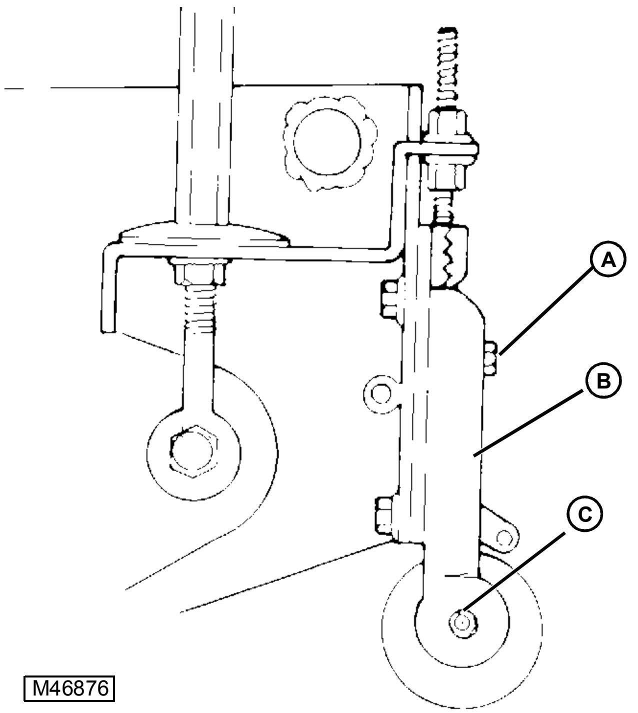
- 2653 Professional Utility Mower at a tested reel speed of 1000 - 1050 RPM
- 8 blade reel on a E.S.P. cutting unit
- CH = CR (0.58)

Find: MPH (Vehicle Speed)

NOTE: *To calculate MPH, multiply 0.68148 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.*

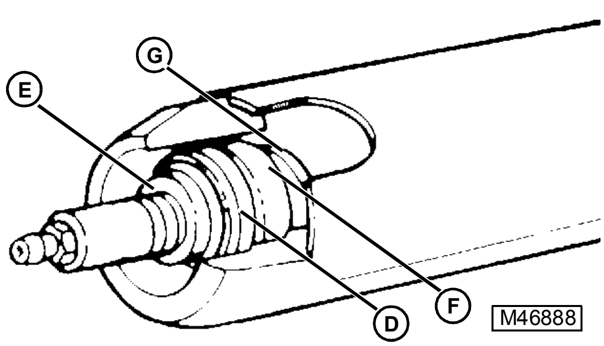
26 in E.S.P. CUTTING UNIT REPAIR

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).

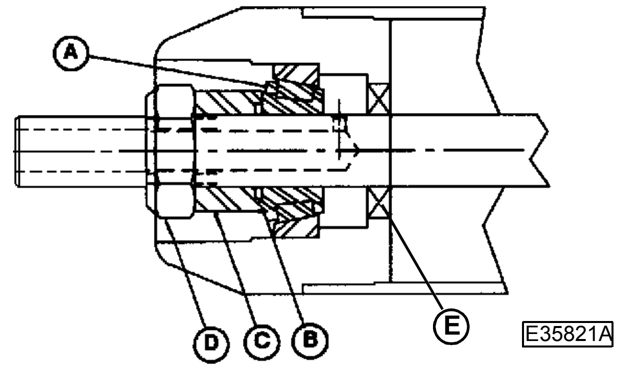
ROLLER DISASSEMBLY AND INSPECTION



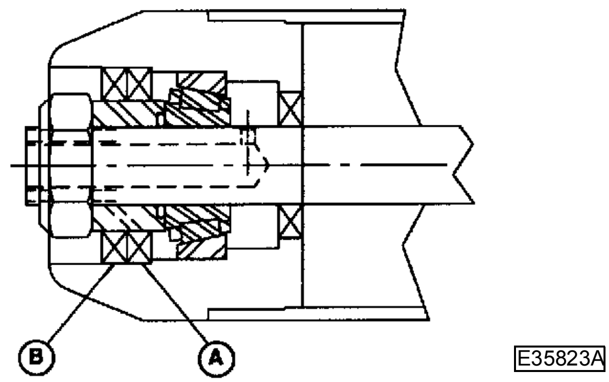
1. Remove lock nuts from each end of the roller.
2. Press roller shaft out of roller. (See Roller Bearing Puller Instructions.)
3. Remove seals (D) (G, smooth roller only) spacer (E) and bearings (F), clean bearings and end caps with a suitable solvent.
4. Inspect bearings and bearing cups for pitting,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

ROLLER ASSEMBLY

1. Install bearing cup. Install shaft into roller.



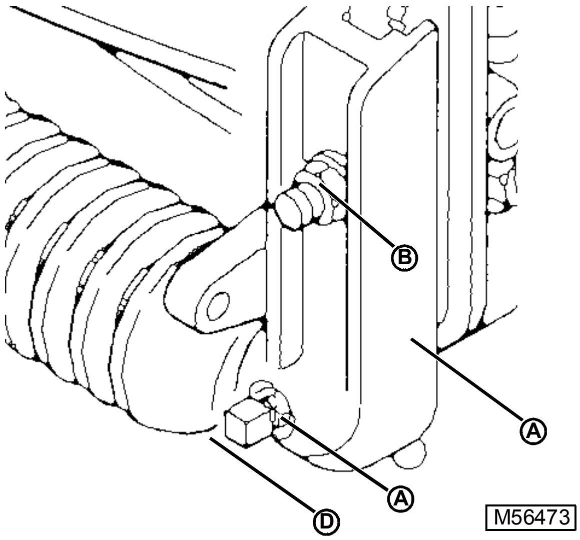
2. Apply grease to seal lip and install seal (E) over shaft with lip of seal facing out.
3. Pack bearing (A) with grease and slide over shaft into bearing cup.
4. Lubricate O-ring (B) and install next to bearing.
5. Slide spacer (C) over shaft with O-ring groove facing bearing.



6. Apply grease to lips of seals (A, B) and install (seal lip facing bearing). Repeat steps 2 through 6 on opposite end. Pack area between A & B with grease. This is to prevent H_2O from accumulating in this area.
7. Install self-locking nuts (D) and tighten until snug, then back off slightly and retighten to a rolling torque of **0.35 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.

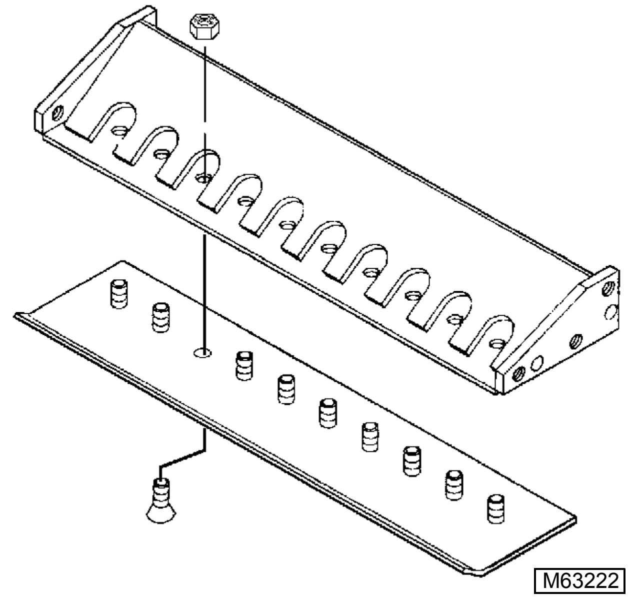
BED KNIFE/SUPPORT REMOVAL

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 0.25 mm (0.010 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.

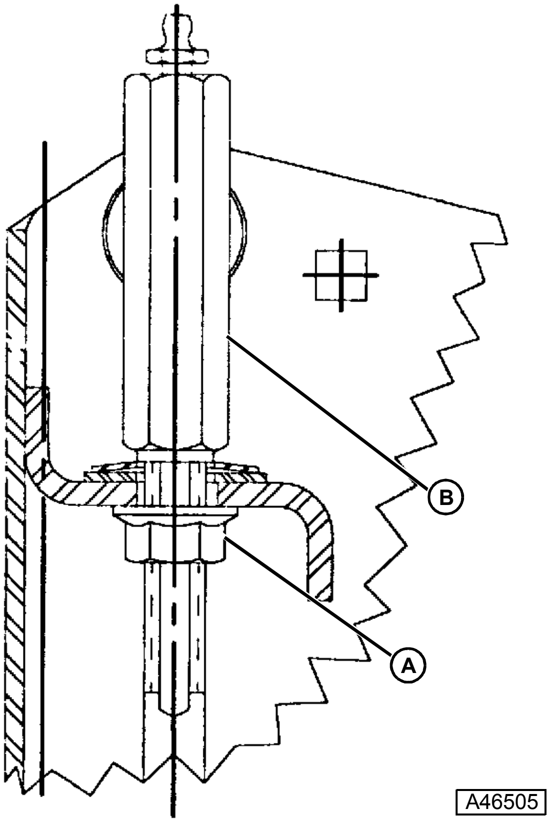
BED KNIFE/SUPPORT INSTALLATION



7. Position the bed knife on the support. Secure 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 with a 5° top and front relief angle across the top surface), after securing it to the support and before installing in cutter frame.

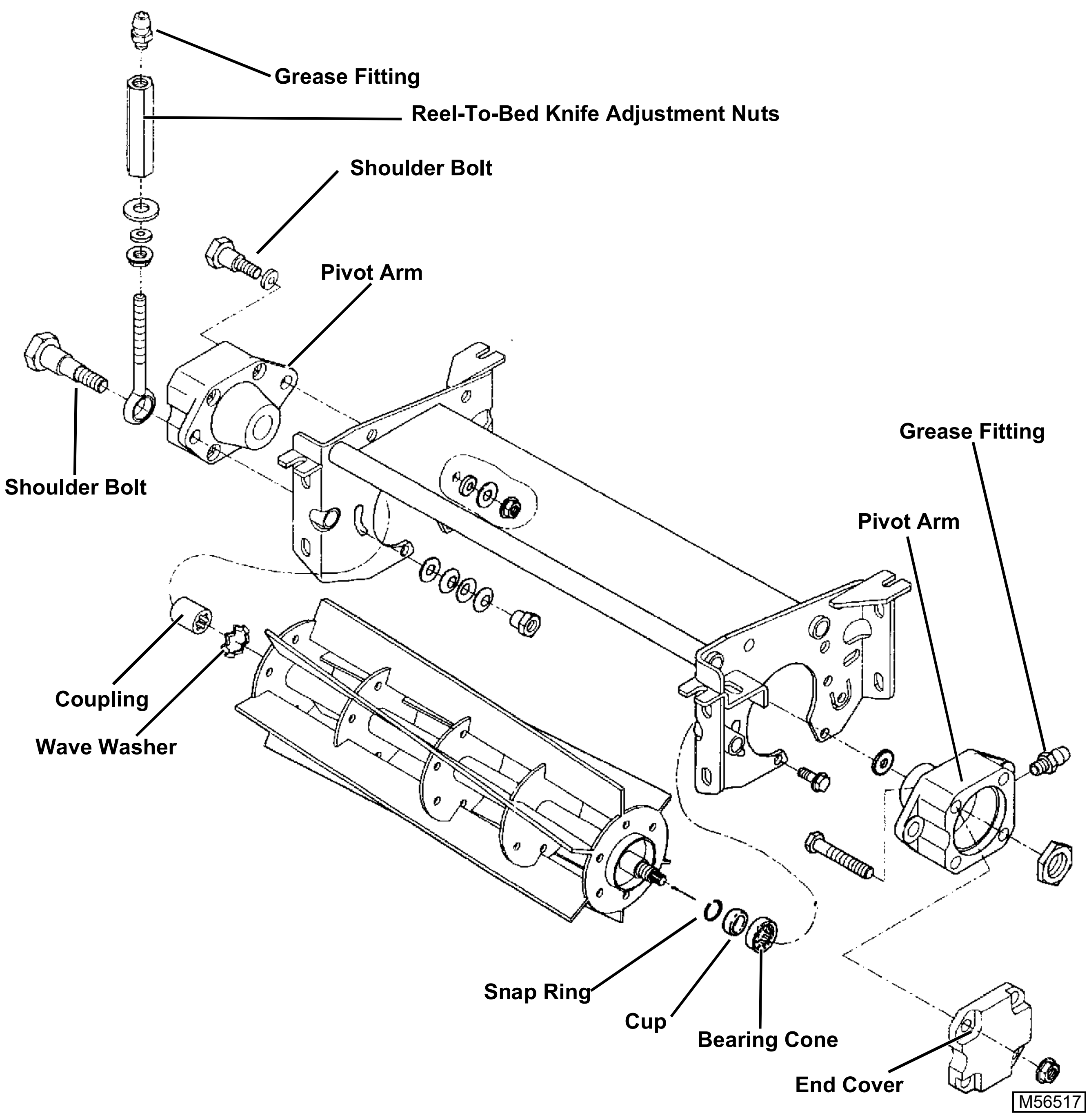


12. Raise reel, by turning nut (A) counterclockwise, and reel adjusting nut (B) clockwise, until the knife can be installed.
13. Position the bed knife support in the frame and snug the cap screws (6) on both ends of the support.
14. Tap both ends of the bed knife support with a brass hammer to remove 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.

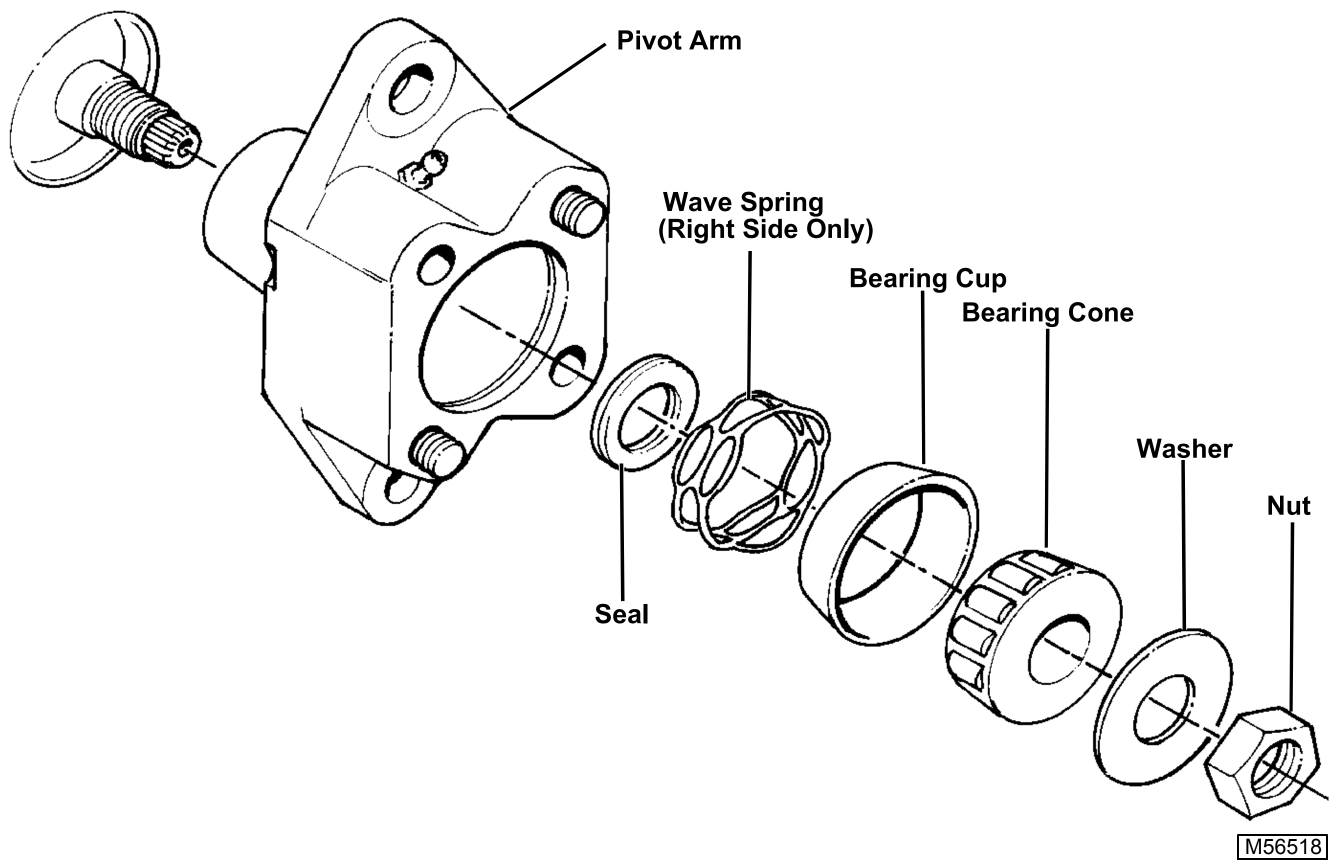
3. Inspect bearings and bearing cups for wear, scoring and bluing from overheating. Replace if necessary.
4. Inspect wave spring for distortion or wear, replace if worn.

PIVOT ARM ASSEMBLY

1. Install seals (flush with pivot arm housing).
2. Install wave spring (right side only) on end of reel where the “V” between reel and knife is pointed at spring.
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. Fill housing with grease to prevent a pocket for moisture to accumulate.
7. See Reel-To-Bed Knife Adjustment.



TESTS AND ADJUSTMENTS

BACKLAPPING AND REEL-TO-BED KNIFE ADJUSTMENT

Essential Tools:

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

Fabricated Tools:

- 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.

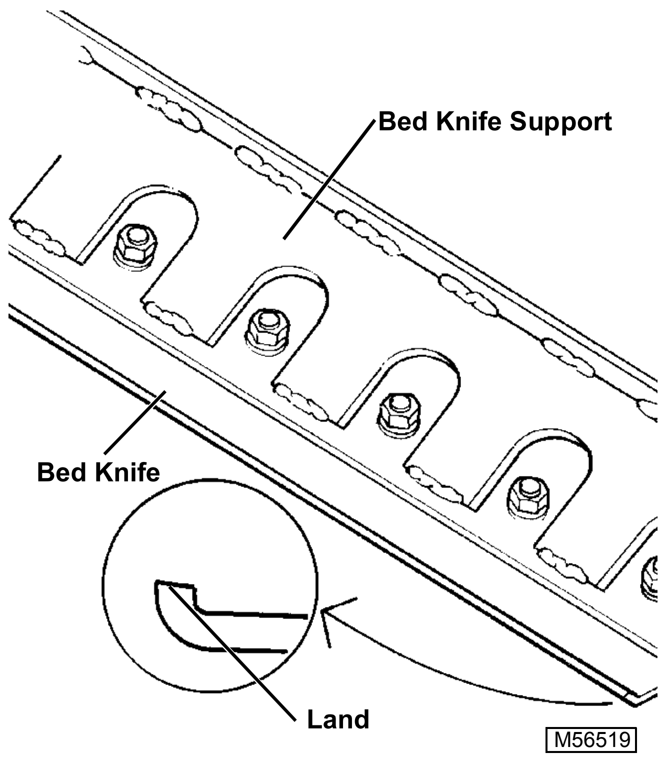
It is best to think of backlapping and reel-to-bed knife adjustments as one procedure. Although backlapping removes only a small amount of metal, the clearance between the reel and bed knife will be increased and must be readjusted.

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

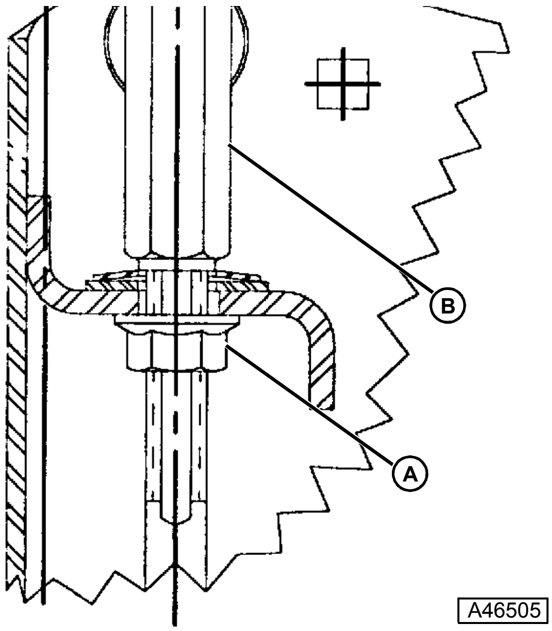
Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.
Never allow more than one person at a time to work on any one cutting unit. Never allow work to be accomplished on more than one cutting unit at the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



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.

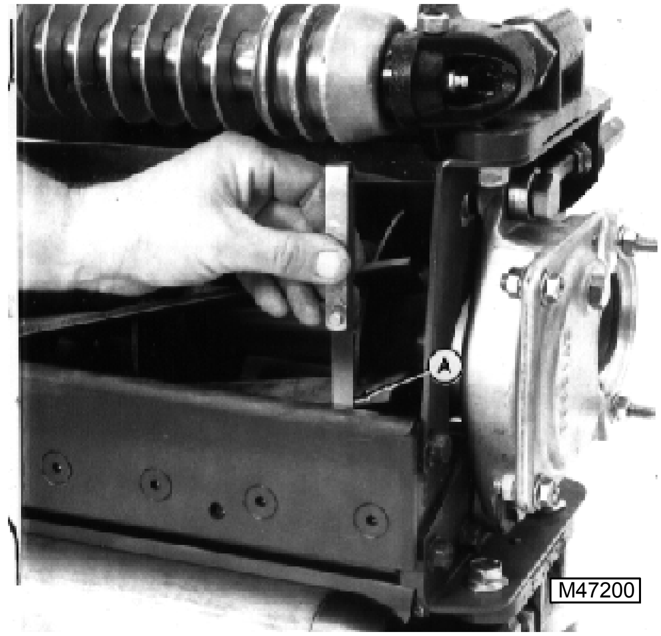
5. Inspect the bed knife for uneven wear (indicated by uneven land width across the length of the bed knife). Ensure the cutting edge land does not exceed 3/4 of the cutting edge. Replace the bed knife if the cutting edge extends below 1.45 mm from the mounting surface.

REEL-TO-BED KNIFE ADJUSTMENT



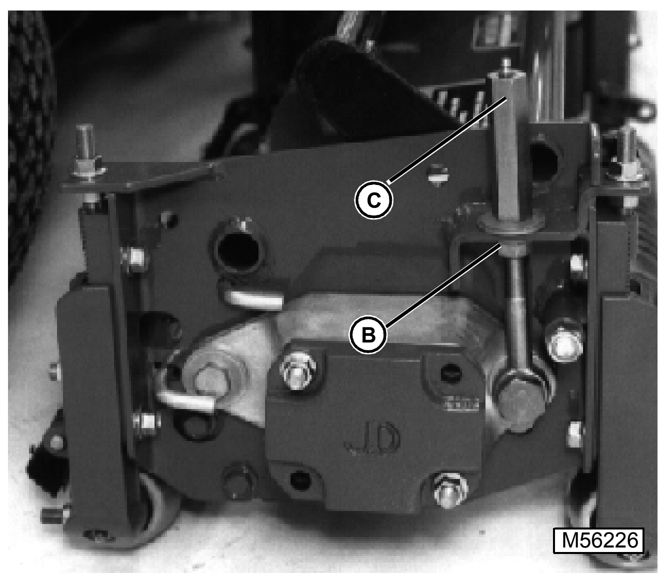
> **⚠ CAUTION**
>
> **Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.**

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 adjusters.

2. Adjust ends of reel to set drag with a 0.002" 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 0.05 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 0.010 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 0.002" clearance (max.).

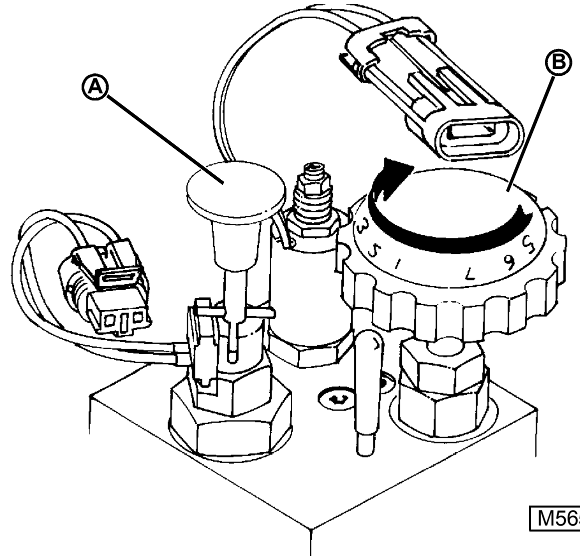
BACKLAPPING

(WITH STANDARD BACKLAPPING VALVE)

⚠ CAUTION

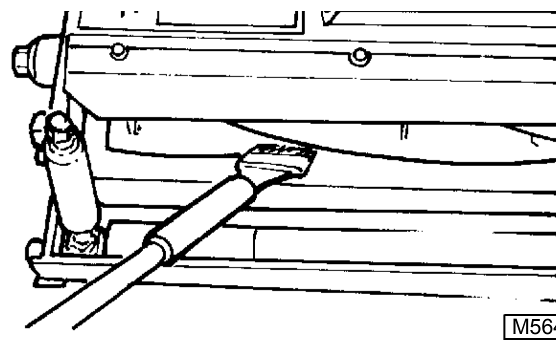
Avoid injury from rotating blades. keep hands and feet away from blades while machine is running.
Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.
Never allow more than one person at a time to work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

1. Prior to starting, be sure limit is set with a 0.002”-.003” clearance.
2. Set the parking brake and start the engine. Lower the cutting units to the ground.



M56504

3. Lift the hood to expose the backlapping valve. Pull up the Forward/Reverse knob (A).
4. Engage the PTO. (The reels should now be rotating in the reverse direction)
5. 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.



M56482

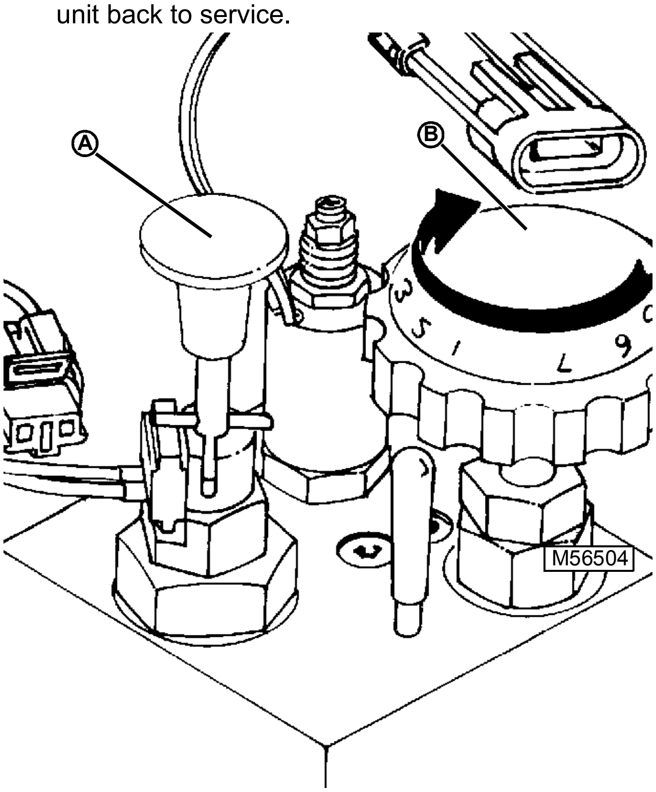
6. Apply 60-80 grit compound for units with extended service time and 120 grit compound for new, newly ground reels or when applied on a weekly basis to the rotating reel evenly from one side to the other and back again with a long handled brush (see Fabricated Tools).
7. Allow the reel to spin until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

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



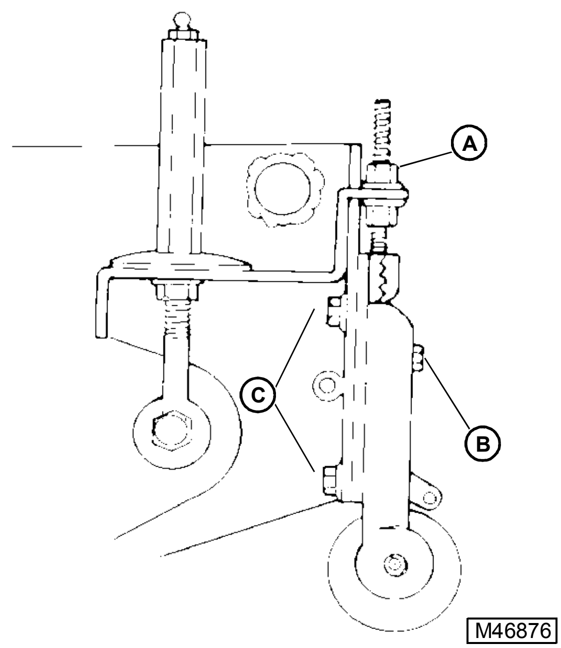
9. Disengage PTO switch and shut off the engine. Turn the flow control knob (B) fully counterclockwise.
10. Push Forward/Reverse knob (A) down.

HEIGHT - OF - CUT (HOC) ADJUSTMENT

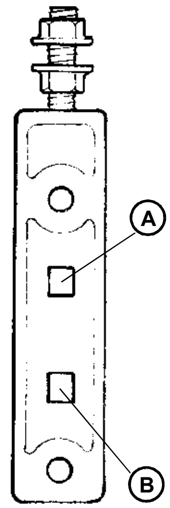
CAUTION

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.*

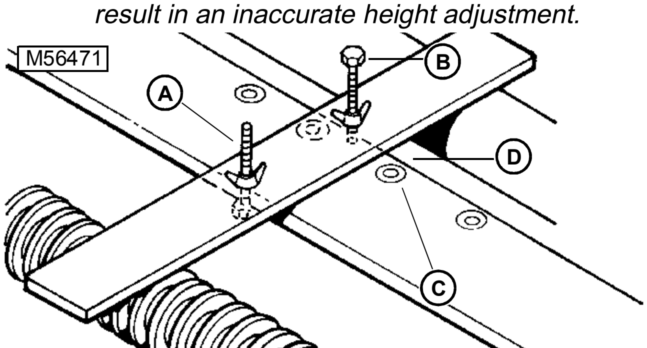


1. If HOC range needs to be changed, loosen nut (A). Remove nut and washer (B) and two bolts (C) (per side) and position the carriage bolt for the cutting height range.



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.

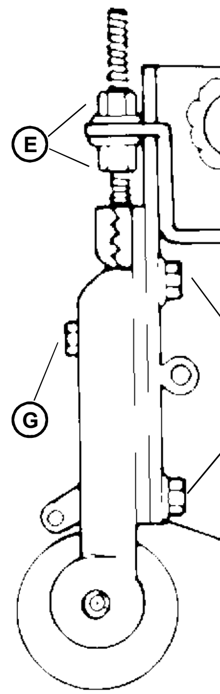
A—FORWARD BOLT	**C—BED KNIFE MOUNTING BOLT**
B—REAR BOLT	**D—BED KNIFE SUPPORT**

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.

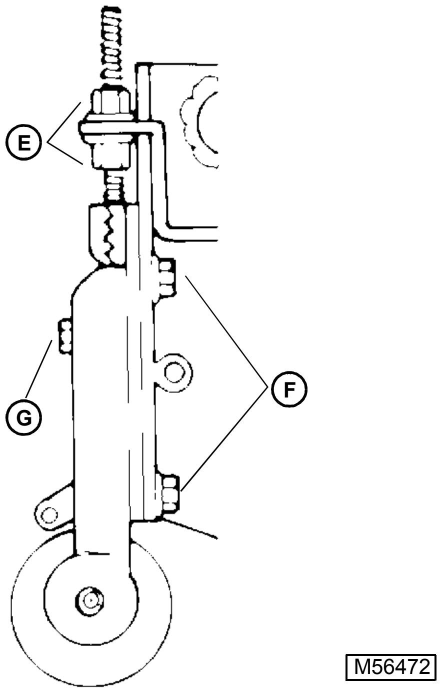
Rear Roller



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.

NOTE: To assist in making quick change HOC adjustments, the front and rear adjusters should be placed in the same notch.

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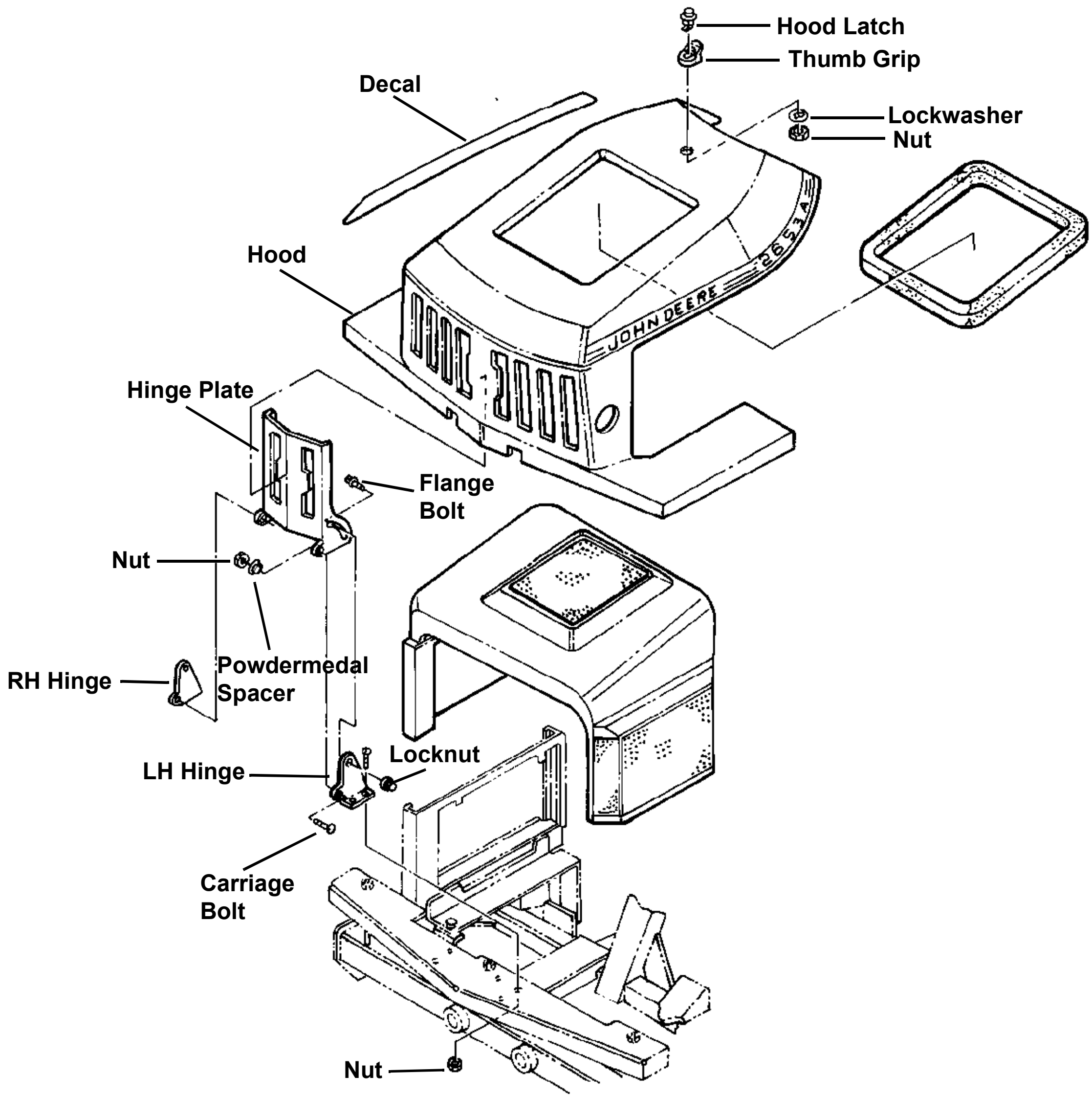

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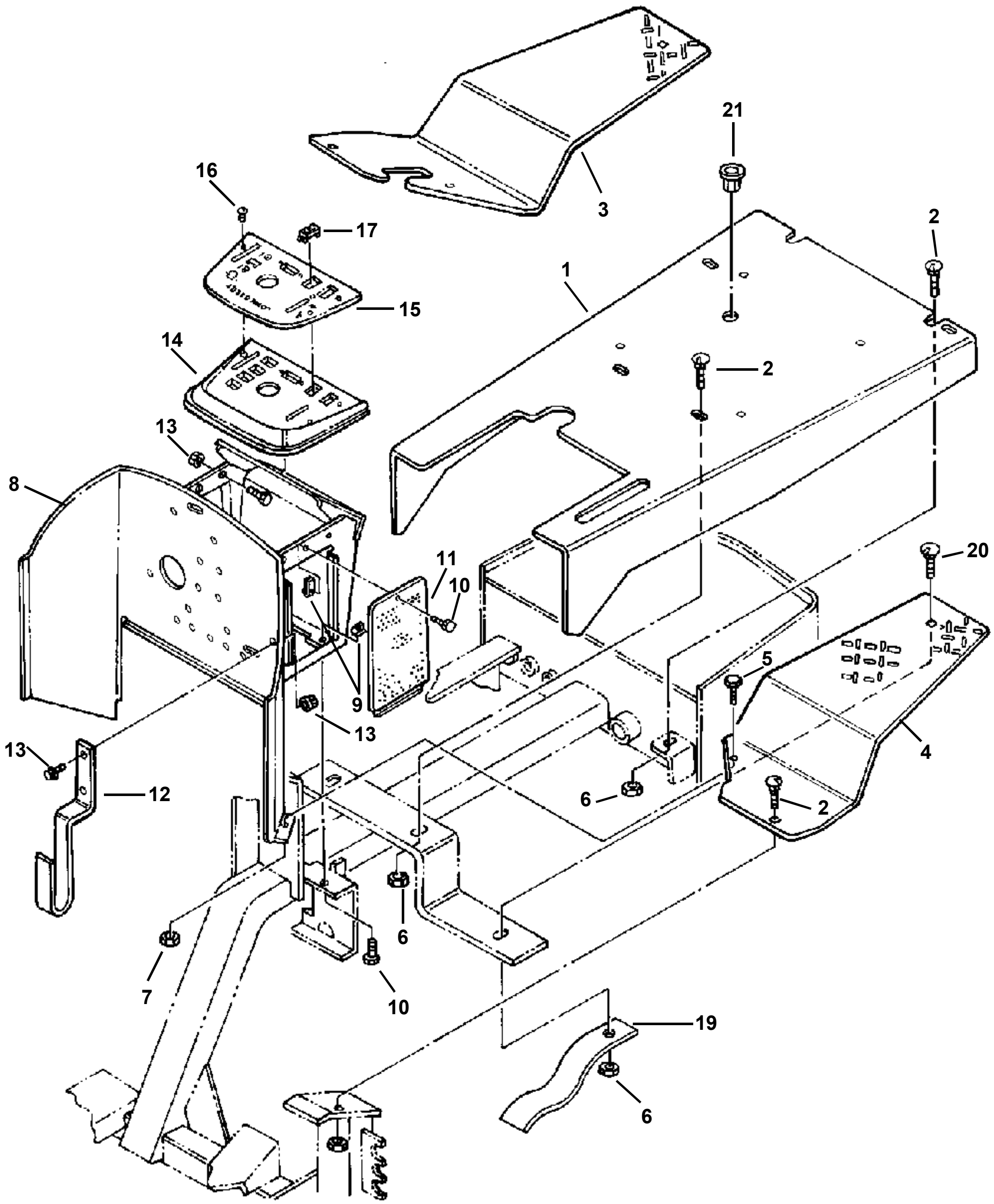

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